

**ANALYSIS OF POST HARVEST LOSSES IN THE MANGO MARKETING
CHANNEL IN SOUTHERN GHANA**

BY

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**THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF
MASTER OF PHILOSOPHY DEGREE IN AGRIBUSINESS**

DEPARTMENT OF AGRICULTURAL ECONOMICS & AGRIBUSINESS

SCHOOL OF AGRICULTURE

COLLEGE OF BASIC AND APPLIED SCIENCES

UNIVERSITY OF GHANA, LEGON

JULY, 2016

DECLARATION

I, Charles Narteh Boateng, the author of this thesis titled “**ANALYSIS OF POST HARVEST LOSSES IN THE MANGO MARKETING CHANNEL IN SOUTHERN GHANA**”, hereby declare that, this work except for past and present literature which have been duly cited was done entirely by me at the Department of Agricultural Economics and Agribusiness, University of Ghana, Legon, from August 2015 to June 2016. See attached in Appendix seven (7) the report of plagiarism check. This work has never been presented either in whole or in part for any other degree of this university or elsewhere.

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DEDICATION

This work is dedicated to Mrs. Vida Narteh-Boateng (my lovely wife) and the entire family for their unflinching support, love and encouragement.



ACKNOWLEDGEMENTS

Glory and adoration be to the Almighty God for His abundant love, grace and mercies throughout my academic life and particularly in the preparation of this thesis.

I would also like to take this opportunity to express my deepest appreciation and gratitude to Mr. D. P. K. Amegashie and Prof Daniel Bruce Sarpong for their fatherly tutelage, suggestions and corrections throughout the execution of this study. I also sincerely thank all lecturers of the department.

I also wish to thank my family for their support throughout my education. Again, I thank my fellow students, who through diverse ways, helped me to complete this work.

Finally, I am indeed grateful to all respondents who provided the needed data for this work especially the executives of Volta Mango Farmers Association (VOMAGA), Yilo Krobo Mango Farmers Association (YMFA) and Dangme West Mango Farmers Association (DAMFA) and everyone who might have offered any form of assistance in the accomplishment of this study, accept my thanks with utmost sincerity.

May God richly bless you.

ABSTRACT

National data on post-harvest loss of mango fruits is estimated to be between 20% to 60%. This constitutes a huge financial loss to all actors. The major obstacles in dealing with this challenge are little knowledge of the nature of the marketing channels, absence of exact estimates, stages along the marketing channel where the losses occur as well as the socio-economic factors that lead to the losses. The study assessed the nature of the marketing channel, estimated losses at each stage of the channel, and identified causes and determinants of losses at various stages of the marketing channel. The study was conducted in three (3) major mango producing regions in southern Ghana (i.e. Greater Accra, Eastern and Volta regions), four (4) Municipalities and Districts in eight (8) communities. Multistage sampling method was used to select 180 respondents. Data was collected through interview with a semi-structured questionnaire. The data was analysed using both descriptive and inferential methods. Kendall's Coefficient of Concordance (W) was used to measure the level of agreement between rankers of the causes of post-harvest losses. SPSS was used for the descriptive statistics and the Tobit regression was used to identify determinants of post-harvest losses. The study revealed that the most preferred channel was farmer to processor to consumer. The first four most prevailing causes of loss of fruits along the marketing channel were pest, disease, mechanical damage and uneven ripening. Retailer level had the highest losses of 23.6% while processors recorded the least of 5.3%. Age of respondents, packaging, transportation, length of storage and training significantly influence post-harvest losses. The study recommended more use of farmer to processor channel, adoption of modern handling practices, training of actors and establishment of storage and processing facilities in the area.

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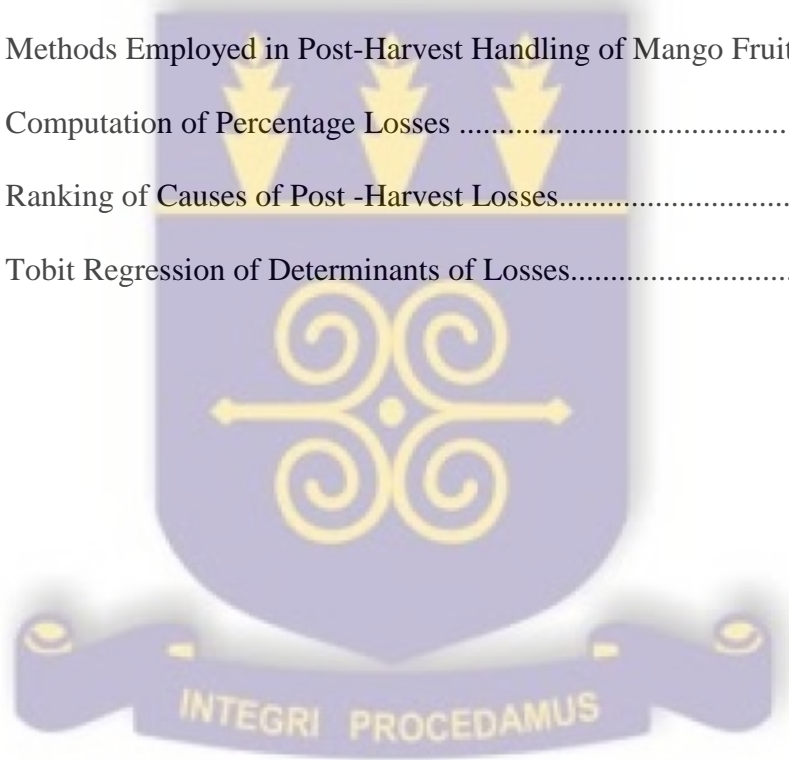
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LIST OF ABBREVIATIONS

ADAIF	Export Development, Agricultural and Investment Fund
ADRA	Adventist Development and Relief Agency
DAMFA	Dangme West Mango Farmers Association.
ECOWAS	Economic Community of West African States
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FASDEP	Food and Agriculture Sector Development Policy
GFSI	Global Food Security Index
KIA	Kotoka International Airport
METASIP	Medium Term Agriculture Sector Investment Plan
MOFA	Ministry of Food and Agriculture
PHL	Post-Harvest Loss
USAID	United States Agency for International Development
THN	Trade Hub Network
TIPCEE	Trade and Investment Programme for Competitive Export Economy
USAID	United State Agency for International Development
VOMAGA	Volta Mango Growers Association
YKMFA	Yilo Krobo Mango Farmers Association

CHAPTER ONE

INTRODUCTION

1.1 Background

Mango, (*Mangifera indica* L.) is a fruit of high economic importance that constitutes approximately half of all tropical fruits grown globally. Globally, India is the highest producer of mango contributing 42.06% to total world production (Yadav, 2013).

Ghana has two seasons of harvesting mangoes in the south zone of the country. This gives Ghana a comparative advantage in mango production over her neighbours (Baidoo-Wiiliams, 2015; Melle and Buschmann. 2013). Mango has therefore been identified as one of the potential commodities for diversification as non-traditional export crop in Ghana (FASDEP II 2009-2015; METASIP 2011-2015).

Commercial production of improved varieties of mango has continuously been accepted by farmers in Ghana from the late 1990s, mainly as a result of food security programs supported by the United States Agency for International Development (USAID), attempts by the Ministry of Food and Agriculture (MOFA), other governmental and nongovernmental interventions. Consequently, mango production for export has become a new business in the horticultural industry (Zakari, 2012). As at 2012, Ghana had planted about 31,661 acres of mango trees (Baidoo-Wiiliams, 2015). Though the export of the fresh fruits from the country to the global markets is comparatively low in terms of volumes supplied from the West African region, fresh-cut mango from the country has

performed fairly well in the last decade (Zakari, 2012). This value addition has so far directly and indirectly impacted on the economy of the country specifically in area of revenue generation and job creation (Zakari, 2012). Many people are employed in the sector. The harvesting and the retailing of mango help in the alleviation of poverty among many women in production areas (FAO 2011a; Melle and Buschmann, 2013).

Commercial mango production, according to Melle and Buschmann (2013), is mainly found in the following three distinctive agro-ecological demarcations: The Southern zone (in areas close to the capital, Accra), the Brong Ahafo region and the Northern Zone.

Southern Ghana enjoys a bimodal rain pattern. Consequently, there exist two harvest seasons, with the main starting from middle of May to July, and the minor one in December to January. Due to the relatively higher humidity, production of mango in the southern zone suffers from greater pest and disease challenges than in the Northern zone (FAO, 2009a). These and other managerial weaknesses results in huge losses that are affecting profitability. Post-harvest losses have been estimated to be between 20-50% in developing countries (Kader, 2005; Morris and Kamarulzaman, 2014). Later studies in Ghana gave an overall national mango fruit loss of between 20%-60% (Zakari, 2012; Baidoo-Wiiliams, 2015; Melle and Buschmann, 2013).

Though the post-harvest loss situation affects all crops (due to infrastructural deficit), food losses along the marketing channels of perishables commodities including mango

are most common and severe such that losses of between 30% and 80% among perishable fruits are possible in the sub-region (Obayelu, 2014).

Food losses present an urgent challenge to national food systems. The least to mention among these challenges is the waste of scarce resources, including the land, water, energy and power used to produce food (GFSI 2014; FAO 2011a). Post-harvest loss (PHL) reduction activities have a major positive economic impact and should increasingly become a major focus in development strategies (FAO, 2011a). Carefully selected interventions leading to reductions in PHL are likely to be much more cost-effective than investments towards increased production. According to FAO (2011a), increasing production implies using scarce and costly resources through intensive farming practices and expansion of cultivated areas. It further stated that marginal environmental cost of qualitative and quantitative saving through improved post-harvest techniques is generally much lower than trying to reach the same value through additional production. PHL reduction aims at maintaining or optimizing the value of already existing (produced) products through improved and cost-effective conservation and value-addition strategies. Furthermore, post-harvest activities generate on- and off-farm employment opportunities in rural areas, reduce rural exodus, enhance rural income, contribute to value-addition and increased competitiveness. Post-harvest activities generally belong to a more formal sector and should directly (through tax on revenues) and indirectly (through VAT), participate in increasing public revenues. In addition, postharvest activities, including transformation and marketing, are to a large extent assumed by women, thereby contributing to increased female empowerment (FAO, 2011a).

Thus reducing post-harvest losses of finished produce is more prudent than producing more to make up for these losses (Kader, 2005; FAO, 2011a). Undoubtedly, efforts to solely increase production without addressing particularly postharvest losses could become fruitless. Post-harvest handling of fruits has a decisive effect on the extent of the final quality, losses and the market value of horticultural crops. Apart from leading to high food insecurity and huge economic losses, post-harvest losses during handling, transport, storage and distribution increases transport and marketing costs (FAO, 2011a).

The West African mango sector records large post-harvest losses in all countries during the harvesting seasons. Post-harvest losses of mango in West Africa are more than one-third of production (and in some countries even 50 percent), due to pests, fruit flies, and poor handling and transport of mangoes. Turning this around could generate wealth within the countries or through exports. Out of the economically usable quantity, the regional market for local consumption is estimated to be around 40 percent with the remaining 60 percent going for fresh fruit exports and to the growing processing industry (THN, 2014).

Though there have been some studies as cited earlier on the production of mango in Ghana, not much has been done in mapping and estimating losses along the supply chain. There is therefore the need for information on the specific causes of postharvest and their impact at various stages of the marketing channel chain in the study area.

1.2 Problem Statement

Commercial mango production both for the domestic and export market has been around in Ghana just in the late 1990s (FAO, 2009). The industry, being relatively young, is facing huge challenges with post-harvest losses. The processing industry is not well developed and unable to absorb much of the produce. Effective and efficient storage facilities are also scarce resulting in high post-harvest losses. Available data indicates that the post-harvest situation in the study area is not different. Both small and large scale commercial mango producers in the Dangme –West District (now the Shai-Osudoku District) had up to 50% and 35% fruit rejection due to decay and mechanical damages respectively (Aboagye, 2009). Furthermore, Melle and Buschmann (2013) registered fruit loss of up to 40% of total production in the same district. Zakari (2012) reported an annual post-harvest loss of between 20-25% of total mango produced by Farm Management Services Limited, a mango farmer organization in the Yilo Krobo Municipality. According to the study, only about 15% of the total mango produced by the organization met export grade or standard.

To minimize these losses, we must first of all understand the biological and environmental factors that are responsible for these losses which help us to apply the right PHL techniques and procedures that will minimize and sustain recommended standards of the produce (Kader, 2005).

Meanwhile, the key challenges confronting marketing of mango in the area are; there is not much knowledge on the nature of the mango marketing channel in the study area.

Thus the absence of sufficient knowledge of the nature of the mango marketing channel in the study area makes it difficult to know the policy framework and post-harvest technologies that are appropriate for addressing the post-harvest loss problems in the area. Secondly, there is no study to empirically quantify losses over the entire marketing channel. All earlier studies focussed on individual stages of the supply chain, especially at the farmer stage, making the loss situation bias and incomplete for any policy direction. This presents us with the difficulty in addressing holistically the losses along the marketing channel. Thirdly, it is also not clear from Zakari (2012), Agyepong (2013), Baidoo-Williams (2015), and others the causes of loss at the various levels of the marketing channel. Finally, there is lack of information on the determinants of the losses along the channel. This has the potential of making interventions ineffective since these factors constitute the primary causes of post-harvest losses. The above gap makes the following questions relevant:

- i. What is the nature of the mango fruit marketing channel in the study area?
- ii. What percentage of mangoes produced in the area is lost at each stage of the marketing channel?
- iii. What are the major causes of post-harvest losses being experienced in the area?
- iv. Which factors determine losses along the mango marketing channel?

1.3 Objectives of the Study

The research primarily intends to analyse the post-harvest loss situation of the mango marketing channel in southern Ghana. Specifically, the study seeks to:

1. Describe the nature of the mango marketing channel in southern Ghana.
2. Estimate the losses at each stage of the marketing channel in the area.
3. Identify the causes of post-harvest losses along the marketing channel.
4. Identify the factors that determine losses in the mango marketing channel.

1.4 Relevance of the Study

The mango sector holds great prospects for the national economy and households' livelihood (Aboagye, 2009). Currently 31,661.00 acres of mango are planted with an expected yield of 148,000 tons (6,000kg/acre) of mangoes annually at an estimated farm gate value of GhC 153.92m. An acre of mango farm gives permanent job to 1 to 2 persons. The 31,661.00 acres could hence be reducing unemployment to a projected 47,400 persons (Baidoo-Williams, 2015). The economic benefits of the mango sub-sector to the growth of the economy cannot therefore be overstated. It is in the direction of this that many governmental and Non-governmental organizations like the Export Development, Agricultural and Investment Fund (ADAIF), the Trade and Investment Project for a Competitive Export Economy (TIPCEE), Ghana Export Promotion Authority, consultants and sponsors such as United States Agency for International Development (USAID) Adventist Development and Relief Agency International (ADRA) and many more have so far made huge investment in the sector. However huge volume of the fruit is lost along the marketing channel to post harvest loss due to weaknesses in the fruit marketing channels.

According to the Ghana national mango study (Zakari 2012), the average national post-harvest losses are between 20% and 50%. A study by Baidoo-Williams (2015) reported a national overall fruits loss of 20-60%. The value of this loss for FBOs and unorganized individuals is quantified to be between \$22.20 and \$66.60m yearly. The situation is even worse for plantations, out growers affiliated to nucleus plantations and exporters with higher pricing as they record annual revenue loss of between Gh¢ 30.78 million and Gh¢ 92.35 million at the farm gate. Post-harvest loss robs the farmer of optimal revenue. Minimising post-harvest losses will therefore translate into higher revenues and principally better standard of living of all actors (MOFA, 2014). Tackling post-harvest loss is therefore crucial. However, reducing post-harvest loss requires an efficient marketing channel based on informed policy framework. This also warrants comprehensive econometric assessment of the marketing channel, estimate losses at various stages, identify the causes of loss at each stage and the determinant of the loss.

A serious setback to the quest to minimize post-harvest losses according to Affonon *et al.* (2015) is the absence of proper understanding of the exact levels of losses, which hampers the process of evaluating achievements against any loss mitigation process. The study further stated that imprecise measurements of post-harvest loss, in addition to poor knowledge of the stages in marketing channel where the losses take place coupled with social and economic factors which are responsible for the losses could result in policy blunders and imprecise mitigation approaches. MOFA has identified limited knowledge of post-harvest loss to be one of the main factors responsible for the huge post-harvest deteriorations (MOFA, 2013).

The study will provide relevant information to bridge the knowledge gap and provide policy makers as well as investors with an in-depth understanding of the key contributors to the apparent loss along the mango marketing channel. The information will specifically provide the following benefits:

- Serve as a guide to government and relevant stakeholders towards designing research based policy framework and strategy for reduction in post-harvest losses.
- Reduction in PHL will lead to improved incomes and general wellbeing of all actors as reduced post-harvest loss means an increase in economically usable quantity of fruits.
- Marketing of larger quantities of economically usable fruits will boost GDP.
- Lower losses leading to high profit will sustain the mango industry and create more employment.

1.5 Organization of the Study

This thesis is structured into five chapters. Chapter one is the introductory part which introduces the subject matter of the present study. Chapter two is the review of important literature on the study. The third chapter presents the research methodology employed for the study. The methodology covers areas such as scope of study, description of data and definitions, and specification of models etc. Chapter four contains the results and discussions of the study. The study is concluded in chapter five, which presents the summary of major findings, the policy implications of results and policy recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter is organized under five main themes. The first (2.2) reviews the mango sub-sector in Ghana. The second (2.3) is the review of the challenges of the Ghanaian mango industry. The third section (2.4) reviews post-harvest losses in mango. The review of the channels of mango marketing is captured in Section 2.5. The fifth section reviews the methods of measuring post-harvest losses in mango.

2.2 Overview of Ghanaian mango sub-sector

There are three major mango growing areas, comprising: the southern zone (around the capital Accra), the middle zone (mainly the Brong Ahafo region) and the Northern zone which is dominated and lead by the Integrated Tamale Fruit Company's organic mango production project (Melle and Buschmann 2013). The southern zone is the major production area with two (2) main seasons; major from middle of April to middle of August and the minor from middle of December to middle of March (Adongo, 2006).

According to the National Plant Protection Organization (NPPO) in a report by the Food and Veterinary Office (FVO) of the European Commission (2015), mango production in Ghana was 7,200ha in 2012 and 7,400ha in 2013 whilst 12,813ha (31,661ac) was reported by Baidoo Williams (2015) for 2012.

To boost Ghana's comparative advantage in mango production and obtain real competitive advantage will demand that we seriously do more to produce mangoes of high standards in required quantities (Baidoo-William, 2015).

Mango production in Ghana is characterized by several small holder farmers whose contribution to total production and export are relatively smaller (Baidoo Williams; 2015, Melle, and Buschmann 2013; Boateng and Tettey-Wayo 2011). It is estimated that 76% of the total area under cultivation belongs to the members of farmer-based organizations (FBOs) and scattered individual. The remaining 24% is owned by nucleus farmers and their respective out growers. The out growers who work under the centralized plantations are able to sell their fruits with ease to the mother plantation farms that in turn export and or process the fruits (Baidoo-William, 2015).

2.3 Challenges of the Ghanaian mango industry

As an infant industry, the main challenge to growing the industry is low capacity in terms of human resource and investment in needed infrastructure. Prominent among these challenges are:

- (i) marketing,
- (ii) lack of appropriate storage facilities,
- (iii) rising cost of inputs,
- (iv) land tenure,
- (v) high incidence of pests and diseases (mango stone weevil, fruit fly and anthracnose),
- (vi) limited skills in the handling of mango for export, and
- (vii) inadequate nursery for quality planting material because of absence of a legal framework (Yeboah and Kunze, 2004; FAO 2010b; Boateng and Tettey-Wayo, 2011; Zakari, 2012).

The most disturbing challenges that lead to huge losses among the above mentioned challenges are pests and diseases. The important pests of mango include; mango seed weevil, mealy bug, fruit fly, mango thrips, tip wilters, and mango scale insect whilst the major post-harvest diseases of mango include; anthracnose, powdery mildew, bacteria black spot, anthracnose is the most important field and post-harvest disease of mango in Ghana (USAID/TIPCEE, 2007).

There are also agronomic challenges such as dropping of flowers and young fruits, adapting exotic varieties to the local environment etc. Producing for the export market comes with the challenge of high standards that need to be certified by the importer. After harvest, mango must be handled in a cold chain to preserve quality. However, Cold chain infrastructure, including pack houses and cold vans, is not yet developed. Poor road infrastructure in producing areas further hampers the quality of transportation of fresh mangoes. (FAO, 2010b)

2.3.1 Review of post-harvest losses in mango

Post-harvest loss refers to any loss in quantity (like losses in physical weight) and quality (loss in edibility, nutritional quality, caloric value, and consumer acceptability) that take place within the period of harvest until it gets to the user (Ajilore, 2013).

The minimum requirements concerning quality of mangoes by codex standard states that mangoes must be: whole, sound, clean (fairly devoid of any observable foreign material), fairly devoid of destruction caused by pests, devoid of any sign of strange liquid except condensations that occur immediately after being removed from a

refrigerator, free of any strange odour and/or taste, hard, fresh in appearance, free from chilly injury, free of black necrotic traits, free from noticeable abrasions, completely matured and show appreciable ripeness (Yadav, 2013). Brecht et al., (2014) also listed a number of attributes which are considered defects that lead to fruit losses. These defects include: abrasions, rot, excess carbon dioxide damage, peel discoloration (resulting from heat or chilling damage), immaturity, pulp discoloration (resulting from heat or chilling damage), over ripening, sap burn, weight /water loss, sunken discoloration (owing to chilling injury), sunken shoulder areas (resulting from heat burn of the mesocarp), non-uniformity in ripening (resulting from heat or chilling damage), jelly seed (disintegration of the fresh from the seed). This therefore implies that fruits that either fail to meet these standards and or affected by the defects stand the risk of suffering economic loss or being entirely discarded. The higher the number of violation of these standards during sorting and grading, the higher the losses in quantitative or qualitative terms. It is clear therefore that these conditions lead to huge losses which deprives producer and other actors of their optimum returns.

The Trade Hub Network reported that the West African mango sector records large post-harvest losses in all countries during the harvesting seasons to the tune of more than one-third of production (and in some countries even 50 percent), due to pests, fruit flies, and poor handling and transport of mangoes (THN, 2014).

Post-harvest loss situation in Ghana is similarly very high. The Food and Agricultural Organization (FAO, 2011a), reported 60.5% and 36.0% post-harvest loss in mango for

the major and minor seasons respectively for the country. According to Badoo-William (2015), mango suffers huge losses of between 20% and 60% in the country. He estimated that the 31,661ac (12,813ha) of the planted area as at 2012 is estimated to yield about 148,000 tons of fruits per annum, at a farm gate revenue of GHS 153.92m. Meanwhile, the 20-60% fruits loss is valued between GHS 30.78m and GHS 92.35m at farm gate. The FOB price for this volume of lost fruits is between \$22.20 and \$66.60m yearly (at 6,000kg/ac yield and average price of GHS 1.04).

Available data indicates that the post-harvest situation in the study area is not different. Both small and large scale commercial mango producers in the Shai-Osudoku District (then Dangme –West District) had up to 50% and 35% respectively of their produce rejected by buyers due to decay and mechanical damages Aboagye (2009). Meanwhile Melle and Buschmann (2013) registered fruit loss of up to 40% of total production in the same district. According to Aboagye (2009) all members of the cluster small scale producers interviewed in the Yilo Krobo municipality and the Shai-Osudoku District received rejections from their buyers due to quality problems while 35% of commercial farmers received rejections from buyers also due to quality problems. The study recorded a negative relationship between the size of farm and the PHL in both the Yilo Krobo municipality and the Shai-Osudoku District. The Ghana national mango study reported an annual post-harvest loss of between 20-25% of total mango produced by Farm Management Services Limited, a mango farmer organization in the Yilo Krobo Municipality. The organization's export grade mangoes, according to the study, were estimated to be just about 15% of total output (Zakari, 2012).

2.3.2 Nature and causes of post-harvest losses

Fresh fruits by nature have high perishability rate. In the course of transferring the fruits from point of production to the final consumer, appreciable losses are experienced which stem from a gradual reduction in quality to complete deterioration. Post-harvest losses could happen at all stages in the distribution channel, beginning from plucking, grading, packaging, transporting from farm to storage and assembly point, and during transfer to the final consumer (Yadav, 2013).

Losses are experienced at each level along the marketing channel and contribute to total PHL. These losses at each stage is influenced by different factors. The major factors that are usually persistently associated to higher volumes of losses include careless handling, use of substandard packages, high temperatures and delayed marketing (Kitinoja and Kader 2015, Yadav, 2013). However, the particular causes comprise of physical injuries during handling and transportation, physiological decay, water loss, damages from heat impact, disease and pest attack, Microbial attack, Physio-biochemical causes etc. (Brecht et al., 2014; Yadav, 2013). Yadav further stated that this causes are influenced by handling practices at various stages of handling as elaborated in Table 2.1

Table 2.1: Main Causes of Post-Harvest Losses at different Stages of Handling

Stage	Causes
Harvesting	<ul style="list-style-type: none">i) Plucking at wrong maturity period.ii) Improper harvestingiii) Contaminated harvesting equipmentiv) Harvesting under high temperaturesv) Exposure to unwarranted high temperature
Transportation	<ul style="list-style-type: none">i) Over stackingii) Bad roadsiii) Unfitted transport containers.iv) Absence of proper access road.v) Poor ventilation leading to high temperatures in transport vehicles.vi) Non-use of refrigerated trucks.
Grading / Packing	<ul style="list-style-type: none">i) Absence of standardization.ii) Improper handling.iii) Unsuitable packaging material.iv) Over stuffing.
Assembling	<ul style="list-style-type: none">(i) Inadequate prepared assembly point.
Loading/ offloading	<ul style="list-style-type: none">i) Wrong handling.ii) Overloading.iii) Improper stacking.iv) Poor cushioning of carrier
Storage	<ul style="list-style-type: none">i) Absence of provisions for ventilation in used packages and carriers.ii) Storing under higher than required temperatureiii) Poor handling.iv) Over stacking.
Ripening	<ul style="list-style-type: none">i) Uneven ripening.ii) Inefficient equipment and methods of ripening.iii) Rough handling.

(Yadav, 2013)

2.4.0 Post-Harvest Handling Practices that Influence Quality of Mango

2.4.1 Harvesting

Harvesting is a key factor that influences and controls post-harvest management. Harvesting of fruit earlier or later than required harvesting date and any harvesting technique that cause mechanical injuries such as abrasions on the skin will have negative impact on the quality of the fruit. The cut or injured fruits are easily infected with fungi such as *Aspergillus sp Botryodiplodia*, and *Diplodia natalensis* that cause decays (Sivakumar *et al.*, 2011).

Green matured fruits are harvested by hand or by plucking with a harvester. Fruits that are within reach are usually harvested with clippers. A long pole with an attached picking bag which can take about four fruits is also used for harvesting of the fruits. Harvesting fruits with stick must be discouraged, as this may lead to damage due to falling, resulting in rapid decay, poor quality and attract low price. Whitish spots and air pockets develop when fruits are harvested before full maturity. This affects the taste and flavor. On the other hand, over-mature fruits ripe rapidly and lose their shelf life. Such fruits create a lot of problems in the course of handling. Fruits for foreign markets must be harvested at full maturity stage. When fruits are harvested at fully matured, they usually tend to have fast rate of ripening and turn yellow in 3 to 5 days at room temperature, while fruits harvested before full maturity will not ripen well, have poor taste and loose water easily. (Yadav, 2013). The recommended time to pluck mangoes is late in the morning, since before late morning, the fruit's oil glands are filled and therefore results in rapid contamination of the skin, if they are accidentally pressed. An

injured skin predisposes the fruit to microbial attack and subsequent rapid decay. Harvesting in moistly conditions must as well be discouraged, as wet fruits are highly predisposed to growth of microorganism. Secondly clinging of soil particles to the fruit again predisposes the fruits to soil-borne decay causing organisms. (Yadav, 2013).

Majority of the handlers (32 people) representing 45.70% of the respondents harvested the fruits by handpicking, 20.00% harvested by knives and clippers; 30.00% by using scateurs and 4.30% used picking poles (Agyepong, 2013)

2.4.2 Packaging

Packaging of fruits is also necessary for effective handling and distribution, attractiveness and prolonged life by decreasing physical injuries and shriveling. Effective packaging shields the product from being pilferage, dirt, physiological and pathological deterioration during repeated handling (Yadav, 2013). Packaging for mangoes basically performs a protective function for the fruit from damages caused by abrasions, compaction, shakes, and shocks. Another crucial role of packaging is to give a brand and serve as advertisement to the product and the person or the organization who is marketing the mangos (Brecht et al., 2014). Inner lining of the packaging container must be new, hygienic, and durable so as to prevent any injuries, externally or internally, to the produce (Agyepong, 2013; Yadav, 2013). Thus packaging processes that fall short of the above packaging standards will make fruits susceptible to losses.

Most of the farmers in the Yilo Krobo municipality and the Shai-Osudoku District used plastic and wooden crates representing 30.21% and 50.00% respectively. While 3.13% used paper boxes/cartons, 12.50% and 4.16% used baskets and polythene sacks respectively to package the mango fruits (Agyepong, 2013).

2.4.3 Transportation

Transportation plays a key role in distributing the fresh fruit to required destinations or to the user and on time. The mode and type of transportation has an influence on the quality of the produce while in transit. Efficient marketing/distribution of agricultural produce is considered to be dependent on effective transportation. Meanwhile transportation of fruits is predominantly by land, air and water (Yadav, 2013). It is also important to note that the shelf life of fruits is cut short when exposed to direct impact of the scorching sun as it leads to rapid water loss. Vehicles used for transportation of mangoes should therefore be covered to protect the fruits on top from direct exposure to sunlight while in transit (Brecht et al., 2014).

Mango producers in the Yilo Krobo municipality and Shai-Osudoku District used different means of transportation to convey their fruits from the farm to points of sale. According to Aboagye (2009), 50% of all members of the cluster small holder producers use open carts or trucks for transportation of their mangoes. Meanwhile large commercial farmers use numerous means including the open carts and trucks. About 50% of them use open carts or trucks while three - quarters of the other 50% used refrigerated vans and one – fourth of the rest use non-refrigerated container trucks. The report further pointed

that the type of means of transportation employed by the large scale farmers has a relationship with the scale of production of the commercial farmer in terms of the size of mango farm. Farmers who have larger mango fields use refrigerated vehicles while owners of medium size fields of mango use container trucks that had no refrigeration systems and lastly farmers with real small scale farmers using open carts or trucks similar to the small holder commercial producers.

More than sixty-eight percent (68.74%) of the respondents in the same area used trucks to convey the fruits, 14.57%, 8.32%, 5.21% and 3.16% respectively used open vans (pickups), tractor, mini-buses, 3.16% and taxis to convey fruits. None of them used refrigerated trucks (Agyepong, 2013).

2.4.4 Storage

Mangoes are highly perishable and gets to its threshold of ripening between three (3) to four (4) days after harvesting at normal room temperature. This greatly affects marketing of mangoes in distant markets because they have to be used immediately after harvest or must be properly stored (Aboagye, 2009). Therefore, storage plays a crucial role in increasing shelf life of the fruits, ensuring steady supply to the market and to enable its distribution to distant markets without deterioration. Storage also makes products available even in the off seasons as mangoes are produced seasonally (Yadav, 2013).

Preventing high temperatures and immediately decreasing temperatures to acceptable limits for transportation keeps down the rate of physiological and biochemical change

that take place in mangos after plucking, reduces water loss, and curtails the development of microorganisms that cause decays (e.g. those responsible for anthracnose and stem-end rot) (Yadav, 2013). Low temperatures also decrease the possibility of proliferation of human pathogens in cases of fruit contamination (Brecht et al., 2014). According to Kitinoja and Cantwell (2010), temperatures during harvest, handling, transport and marketing must be as recommended for the produce for quality maintenance. Storage at 10 to 13 °C (50 to 55 °F) with 85 to 90% RH, give a shelf life of 14 to 28 days for fully matured fruit and dependent on the variety. Ripe fruits can be stored at 7 to 8 °C (44.6 to 46.4 °F). Matured unripen fruits can be stored at ambient temperature from 4 to 10 days, depending upon variety. The shelf life of fruits are improved when they are chemically treated and given precooling to 10-12 °C before storing them at the right temperature (Yadav, 2013).

According to Aboagye (2009) only one respondent representing 1.04% in the Yilo Krobo municipality and the Shai-Osudoku District stored fruit under cold conditions. With the remaining handlers, 70.83% stored under farm sheds and 28.13% stored under open-air sheds to extend the shelf life of fruits.

2.4.5 Post-harvest treatment of mango fruits

Various treatments are given to mango fruits after harvest to extend its shelf life and or to maintain certain economic attributes. It follows that fruits which are marketed without any form of treatment are highly vulnerable and have short shelf life. These treatments

include: temperature reduction, de-greening, vapor-heat treatment, the hot water treatment, and irradiation.

De-greening is the process in which the green chlorophyll in the skin of the mango is disintegrated and yellow/orange xanthophyll and carotenoid pigments are formed. The de-greening procedure entails introducing green-skinned mango fruits of uniform grade to low levels of ethylene (mostly from 1 p.p.m to 10 p.p.m) at 20°C to 25°C (68°F to 78°F) and 90% Relative Humidity (Yadav, 2013).

Vapor-heat treatment (VHT) is recommended quarantine measures for export of mangoes. VHT enhances ripening of fruits in storage, leading to better marketability of fruits due to uniform skin appearance. It also lowers the speed of fruit softening and changing of the mesocarp colour. In vapor-heat treatment, hot air, saturated with water vapor is used to increase temperature of produce to an acceptable limits and kept up to a particular period. Latent heat given out by condensation of vapor on fruits increases pulp temperature immediately and evenly and thus curtails possible damages (Yadav, 2013).

The hot water treatment decreases the amount of active microorganisms on the skin of mangoes, as it has been established that the process importantly brings down the incidence of anthracnose decays (Brecht *et al.*, 2014).

Irradiation involves introducing product to ionizing energy for a specified period of time with the intention of destroying or sterilizing bacteria, microorganisms, and any targeted

pests. Energy waves emitted during the irradiation action practically destroy molecular structure of the pests' DNA, thereby destroying or getting them sterilized (Yadav, 2013).

2.5.1 Mango marketing channels

Mangoes production is done in distant villages but consumption takes place in smaller and big cities apart from the local area where the production takes place. Different organization and middlemen are involved in the movement of mangoes from the point of production to the point of consumption resulting in the formation of marketing channel(s) of distribution. Thus, a channel of distribution of a product, according to Yadav (2013), is the path taken by the ownership of goods as they move from the producer to the consumer or industrial user.

Postharvest loss for fruits has direct relationship with the particular marketing channel in question, which includes factors like the period it takes to dispose off the produce (delayed marketing) and also the distance to market (destruction in transit). A huge number of middlemen in the channel leads to further losses due to repeated handling of fruits between the farmer and the consumer (Kitinoja and Kader, 2015). Channels greatly influence cost of marketing such as transportation cost, commission charges, etc. and market margins that go to the middle men like traders, commission agents, wholesalers and retailers. Ultimately, this determines the price at which the produce is sold and what finally goes to the producer. A channel is regarded as better or optimal if it makes the produce accessible to the buyer at the lowest price and also leads to the maximum share to the producer. This is also evident in low cost of marketing. Selected channel must

therefore be shorter (having lesser intermediaries), distributes the produce appropriately without compromising the quality and quantity. This reduces marketing cost and increases producer's share (Yadav, 2013).

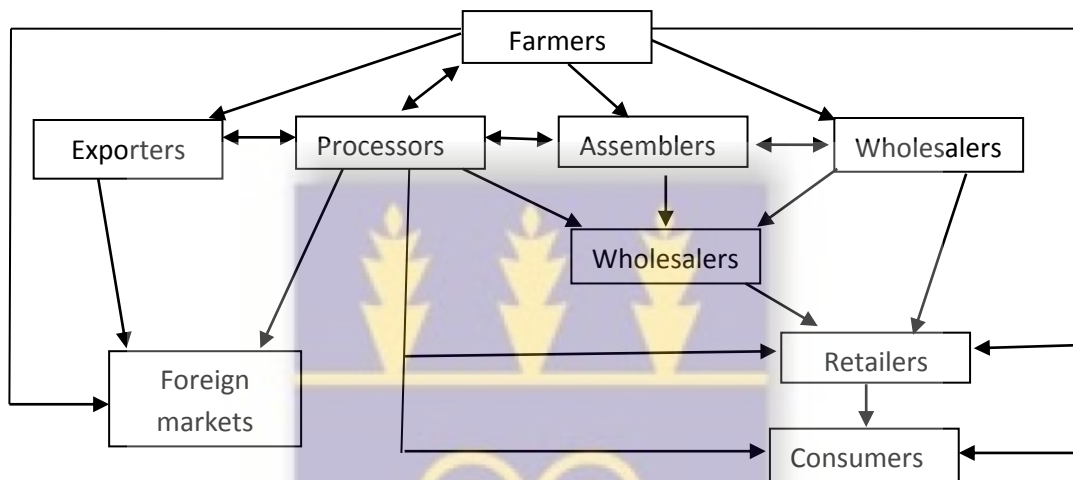
Yadav (2013) identified the following channels in the marketing of mangoes;

1. Grower – Pre-harvest contractor – Commission Agent – Retailer – Consumer,
2. Grower – Wholesaler – Commission Agent – Retailer – Consumer,
3. Grower – Commission Agent— Processing Industry - Retailer – Consumer,
4. Grower – Retailer – Consumer and
5. Grower– Exporter

As illustrated above, producers may sell their fruits directly to pre-harvest contractors, wholesalers, commission agents, retailer or exporters. Pre-harvest contractors and wholesalers sell their fruits to commission agents who in turn sell to the retailer. Commission agents also buy directly from the farmer and sell to processors. The processed fruits are sold to the retailer who finally sell to the consumer. Retailers and exporters also buy directly from producers. Yeboah and Kunze (2004), also identified five main levels of channels for marketing fruits in Ghana. These levels include: the farm-gate level, the wholesale level, the retail level, the processor level and the export level. As illustrated in Figure 2.1, there are export producers who sell fruits directly on the international markets. Other farmers sell to exporters who in turn sell to the international markets. Farmers also sell directly to the assemblers, wholesalers, and to processors. Processors buy from assemblers and wholesalers. The processed fruits are largely sold to wholesalers, retailer and to consumer with the minority going to the

international market. Wholesalers and assemblers sell their fruits to other wholesalers, retailers and even consumers. The retailers sell directly to consumers. Meanwhile some consumers buy fruits directly from the farm-gate.

Figure 2.1 Channels of Marketing Fruits in Ghana.



Source: Yeboah and Kunze (2004)

According to Muthini (2015), over 50% of mango farmers in Kenya used farmer to broker channel, 30% used farmer to export channel and 12% sold direct to the market. The rest, mainly low quality fruits, are sold to insignificant groups such as rural retailers.

2.5.2 Factors affecting marketing channels

There exist numerous channels of distribution depending on the kind of commodity. According to Muthini (2015), the factors responsible for this variation in marketing channels include:

1. Perishability of the produce
2. Bulkiness and weight.
3. Nature of storage facilities.

4. Strength of the marketing agencies.
5. Distance from the producer to the consumer.
6. Characteristics of market i.e. local or distant market

The farmer is therefore faced with the challenge of choosing the appropriate channel that gives him the maximum share of profit. The farmers hence consider several factors in choosing of supply channels. The factors that influence the choice of marketing channel include: how far or near is the assembling point, household income, scale of production, absence of information asymmetry, frequency of access to extension services, access to training, membership to mango marketing association and experience in mango farming (Muthini, 2015). According to the report, farmers who are farther from assembling centers/markets are likely to use the export channel. The reason may be what Martey et al. (2012) found among Nigeria's yam farmers that farmers who are far from assembling points were most likely involved in marketing cooperatives, which exporters prefer to deal with than to deal with individual farmers. Farmers with higher household income had higher probability of choosing export and direct market over brokers. Wealthy farmers are more likely to afford farm inputs which would enable them attain required quality for export market. alternatively, they are able to afford transport to sell their produce in distant markets where prices are high.

In terms of the scale of production, farmers who produce on large scale and those who are in associations who for that matter are able to bulk were more likely to sell to export market rather than to brokers. Farmer groups are attracted to exporters because it is easier and cheaper for exporters to enforce quality and grade requirements of the export market through

reaching farmers in groups than individually. On the contrary, Martey et al. (2012) noted that farmers who produce more prefer selling at their immediate market especially if the product in question is highly perishable, as is the case with mangoes. Muthini (2015) noted further that access to market information had significant positive association with farmers selling to immediate market channels relative to broker whereas frequency of access to extension services and access to training were found to be significantly associated with higher probability of selling to the export channel. This he said was attributed to the fact that farmers who had gone through training were likely to be able to attain quality requirements of the export market.

Muthini (2015) found significantly associated between experience in mango farming and likelihood of farmers selling to the export channel rather than to brokers. He again reported that the probability of the farmer to choose export market over the broker increases by 2 percent for every additional year of experience of the farmer. This was due to the fact that farmers who had been growing mangoes for a long period gained expertise overtime and were able to meet the quality requirements of exporters.

2.6 Measurement of post-harvest losses

According to Morris and Kamarulzaman (2014), estimating of PHLs is by (tracking) or indirect estimates via survey interviews of producers and marketers who experienced the losses. Each approach has its advantages as well as disadvantages. While the direct measurement by tracking approach may focus only on discarded/quantitative losses, the estimate by survey approach may not give true representative values because of the possibility of underestimating or overestimating actual losses. The estimate by survey

approach allows larger population samples whereas this is hardly possible for direct measurement by tracking which is more tedious. Another approach of quantifying food losses, according to the report, is by mass flow of food flowing through the supply chain. The paper further stated that post-harvest loss consists of quantitative and qualitative loss.

Quality and quantity loss

FAO (2014) defined quantitative loss as the reduction in mass weight (kg) of the produce and qualitative loss as reduction of nutritional value, monetary value, food safety and/or consumer acceptability. Quantitative loss of food refers to a decrease in the original quantity as a result of attack by pests at harvest or storage, physical loss during handling, or decrease in quantity because of variation in temperature, moisture level, or chemical composition. Qualitative loss of food leads to changes that decrease its economic or nutrient content, usually warranting outright rejection (i.e., resulting in quantitative loss) (Auklah *et al.*, 2013).

Another aspect of postharvest loss is economic losses which apply when products of higher quality are restricted to lower markets (Morris and Kamarulzaman, 2014). The basis for measuring loss can be monetary loss (Qualitative loss) or unit loss. Unit loss is associated with loss estimation expressed by the percentage of units or a percentage weight loss (quantitative loss). Often loss is registered when the unit is regarded unwholesome for use by humans as food, and is consequently rejected. Monetary loss is market prices dependent, and unit loss can be estimated as reduction in quantity of the commodity or as percentages of weight loss (Kitinoja and Kader, 2015). One demerit of monetary loss estimation is the characterization of the accrued costs of the produce.

Losses recorded in monetary terms should appreciate at each and every level in the postharvest handling process, up until the produce is finally used. It is logic to hypothesise that the economic value of a commodity, as represented by price per kg, would possibly be a true estimation of costs as averaged over a period of years. Prices at any one time and point, however, will vary with supply and demand, various governmental interventions, and other variables that influence the market. Monetary losses are one of the main factors that could prompt actors to consult and invest into postharvest technologies that can ensure reduction of losses.

Some challenges associated with unit loss estimation include the following:

- (1) The stage of deterioration where a commodity is declared unusable is dependent on the standard of living and the preferences of the indigenes.
- (2) Decrease in quality, condition, or appearance might trigger serious monetary losses but would usually not be counted so long as the produce was consumed.
- (3) Selling of a produce on a lower market may cause reduction in expected revenue but that economic loss will not be reckoned by this method of estimation for the fact that the produce is finally consumed.
- (4) Shrinkages highly affect consumer acceptability of perishable produce. Though this will affect acceptability, it can only be estimated if dehydration was so severe to render the produce unusable for humans (Kitinoja and Kader, 2015).

CHAPTER THREE

METHODOLOGY

3.1 Introduction

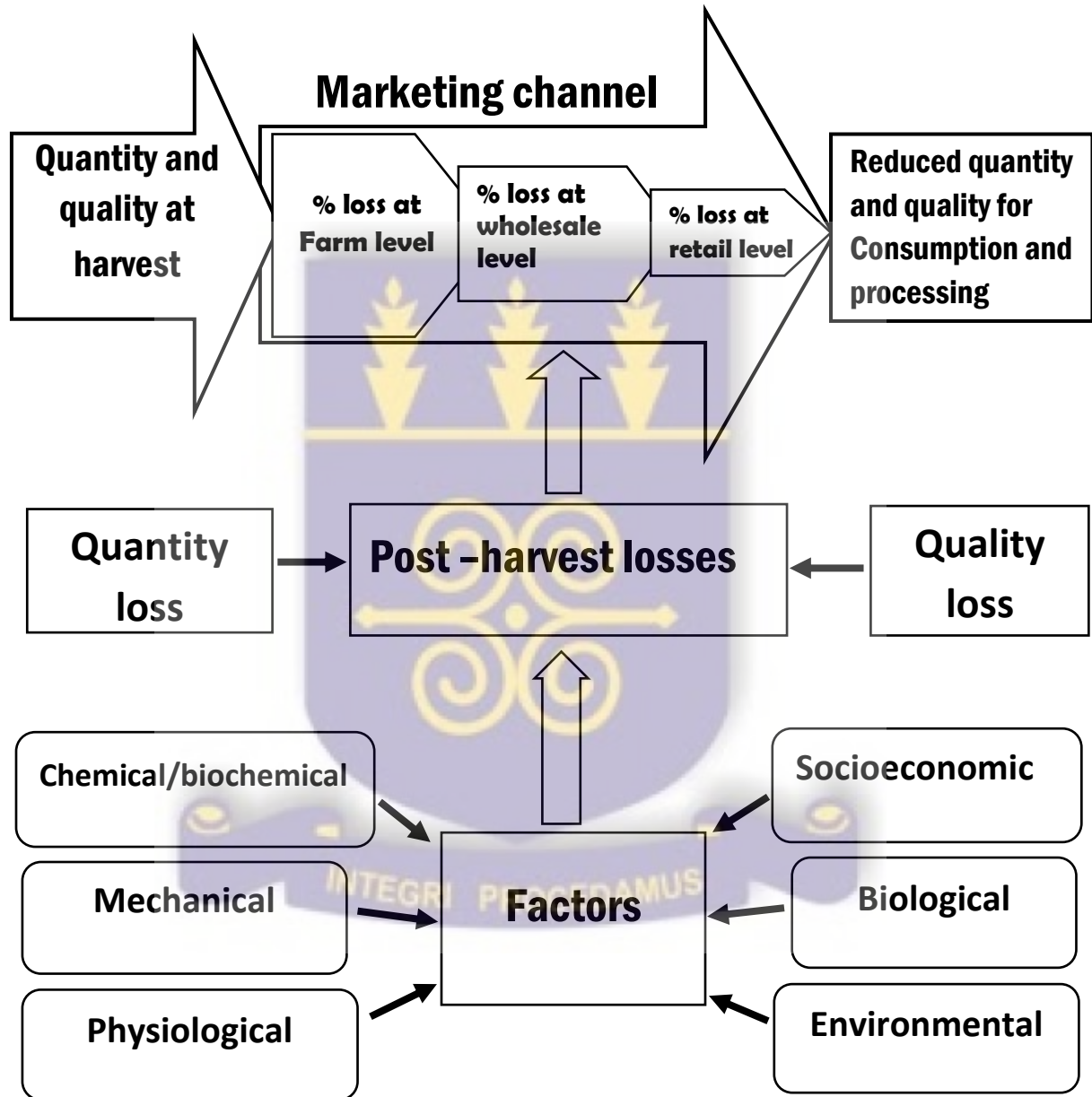
This chapter is divided into eight sections. Section 3.2 explains the conceptual framework of the study. Section 3.3 describes the study area. Section 3.4 shows the theoretical framework while 3.5 describes the method of analysis. Section 3.6 presents the type of data and sources and section 3.7 explains sample size and sampling technique.

3.2 Conceptual Framework

Figure 3.1 is the conceptual framework for estimation of postharvest losses. The framework stipulates that various factors are independently responsible for post-harvest losses that are either qualitative or quantitative. The conceptual framework also assumes that quality and quantity of fruits are at maximum at harvest but decrease due to post harvest losses caused by these factors as the fruit travel through the marketing channel. The framework conceptualized that at each level within the length of the marketing channel, there is further reduction in quantity and quality of the fruit as depicted in Figure 3.1 by the size of each box representing the farm level, the wholesale level and the retail level by certain percentages. Morris and Kamarulzaman (2014) assessed that while it may be obvious that losses occur at each stage of the marketing channels, the exact percentage losses can only be known through an econometric assessment of the loss situation at each stage of the marketing channel. Furthermore, to minimize losses, according to Kader (2005), it is also important to have clear knowledge of the biological, environmental and socioeconomic factors that influence postharvest losses as this enables us to use an

effective postharvest approach and techniques that will retard deterioration and sustain quality and safety of the commodity.

Figure 3.1: Conceptual Framework



Source: Author's construction.

3.3.1 The Study areas

Commercial mango production in Southern Ghana is mainly found in the Greater Accra, Eastern and Volta Regions. Losses are also prevalent due to humidity and scattered small holder farmers (FAO, 2009a). Therefore, the Yilo Krobo and the Nsawam Adoagyire municipalities (in the Eastern Region), the North Tongu district (in the Volta region) and the Shai-Osudoku District (in the Greater Accra Region) were purposively selected for the study due to the organized nature and volume of production in these areas. Processors were chosen from the Nsawam Adoagyire Municipal where almost all the major mango processing industries like Blue Skies, Bomarts, HPW -fresh and dry, Sunripe, etc. were cited.

3.3.2 The Yilo Krobo Municipal

The Municipality shares common boundaries with Lower and Upper Manya Krobo Districts to the North and East respectively. To the South, the Municipality shares boundary with Shai-Osudoku and Akwapim North Districts. In addition, the Municipality shares boundaries with New Juaben and East Akim in the south-west. The Municipality also shares its western boundary with Fanteakwa District. It lies approximately between latitude 60.00°N and 00.30°N and between longitude 00.30°W and 10 .00°W. The Municipality covers an estimated area of about 805 square kilometers, constituting 4.2 percent of the total area of the Eastern Region. The Municipal Capital, Somanya is approximately 45 km from Koforidua and 50 km from Accra, the nation's capital.

The Yilo Krobo Municipality is within the dry equatorial climatic zone which registers significant amount of precipitation. This is predominantly by a bi-modal rainy season, which gets to its peak during the two peak periods of May - June and September - October. The annual rainfall is between 750 mm in the southeast and 1600 mm on the slopes of the Akwapim ranges in the northwest. Temperature ranges between a minimum of 24.90 C and a maximum of 29.90 C. A relative humidity of 60-93 percent is a characteristic of the Municipality.

As high as 57.3 percent of households in the district are engage in agriculture. Most farmers in the Municipality are into the cultivation of mangoes on a very large scale which is exported and also used locally in their raw state (Ghana Statistical Service, 2014).

3.3.3 The North Tongu District

North Tongu District is one of the newly created District Assemblies in 2012 with its capital at Battor. The climate of the District is tropical, highly affected by the South-West Monsoons from the South-Atlantic and the dry Harmattan winds from the Sahara. The rain pattern is bimodal. The major one starts from middle of April to early July and the minor from September to November. The mean annual rainfall varies from 900mm to 1100mm with more than 50 percent of taking place in the major season. Temperature and relative humidity vary slightly throughout the year. The average temperature is 27°C while the daily minimum and maximum temperature is 22° C to 33° C respectively.

Average relative humidity is about 80 percent, making the weather fairly appropriate for agricultural activities.

Agriculture is the leading sector in the District's economy. 64.9 percent are engaged in agriculture. The major crops cultivated are maize, cassava, groundnuts, cowpea, sugar cane, vegetables, oil palm, rice and mangoes (Ghana Statistical Service, 2014).

3.3.4 The Shai-Osudoku District

The Shai-Osudoku District is situated in the South-Eastern part of Ghana in the Greater Accra Region. In all, the district occupies a total land area of about 968.361 square km. The district has Dodowa as its capital. Based on LI 2137, Dangme West District was split into two in June 2012 to have Ningo Prampram District and Shai-Osudoku District. It shares boundaries with the North Tongu District to the North-East, Yilo and Lower Manya Districts to the North-West, Akwapim North District to the West, Kpone Kantamanso District to the South-West, Ningo Prampram District to the South and the Ada West District to the East. The Volta River washes the North-Eastern portions of the district. The absolute maximum temperature is 40°C. Average annual rainfall increases from 762.5 milliliters on the coast to 1220 milliliters in the North and North-east close to the Akwapim Range.

Agriculture (crop/ livestock farming, and fisheries) is the major activity in the district, employing 58.6 percent of the people. The Shai-Osudoku District is noted for the production of fruits such as mangoes, pineapple, and banana (Ghana Statistical Service, 2014)

3.3.5 The Nsawam-Adoagyiri Municipal

The Nsawam Adoagyiri Municipality is approximately 23km from Accra the national capital. The Municipality is located in the south eastern part of the Eastern Region between latitude 5'.45 N and 5'.58 N and longitude 0.07'W and 0.27' W. The Municipality has a total population of 86,000. It is bordered to the south by the Ga and Tema Municipalities of the Greater Accra Region, to the north by Akuapem North Municipality, to the west by Suhum Municipality and Upper West Akim District. The Nsawam Adoagyiri Municipal covers an area of about 175 square kilometers, out of the total area of the Eastern Region.

Weather conditions in the Municipality are generally cool due to its location in the wet semi-equatorial climate, coupled with the double maxima rainfall, which records an average annual rainfall of between 125cm and 200cm. The highest temperatures averaging 30 C are recorded between March and April. With the lowest average temperature of 26 C recorded in August. About 31.4 percent of the total number of households is engaged in agriculture (Ghana Statistical Service, 2014).

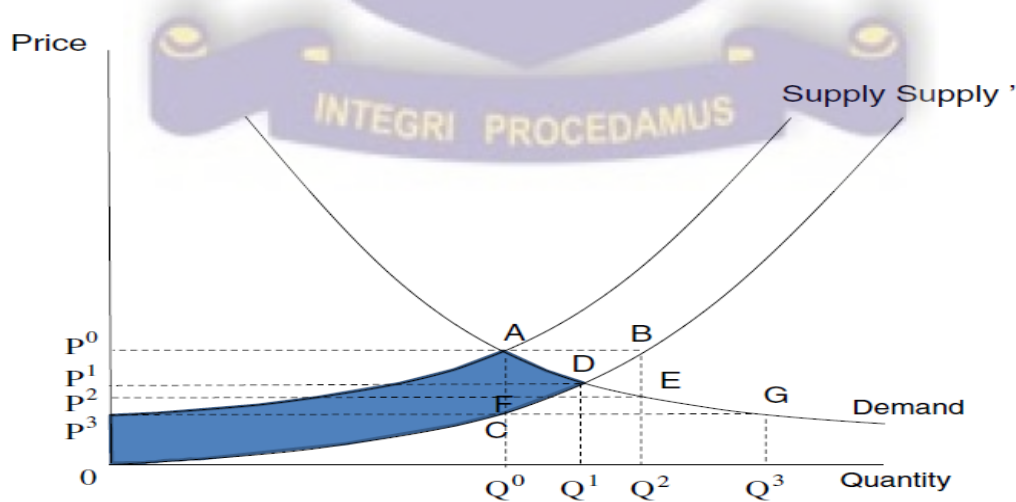
3.4 Theoretical framework

The study is based on Rutten (2013) which postulates that reduction in losses results in welfare gains for both producers and consumers. He theorized that if losses exist in the production and distribution of a produce, the socially optimal supply curve for the supply of the particular produce which would not experience these losses, falls beneath the original supply curve, as shown by Supply' in Figure 3.2. Granted the initial price, P^0 ,

higher quantities can practically be produced and supplied to the market (Q^2 at point B), or the initial quantity, Q^0 , can really be produced at fairly lower cost (P^3 at point C) in the absence of losses. Any effort to avert the losses would lead to lower price, P^1 , and a higher equilibrium quantity, Q^1 , in the market, as given by point D. At this new equilibrium, consumers can purchase more of the commodity at a lower price, leading to a welfare gain to consumers as measured by the change in the consumer's surplus of P^0ADP^1 . Similarly, producers can supply higher quantities, but at a lower price, leading to a change in the producer surplus of $P^1D^0 - P^0AP^3$, which is also positive. The overall welfare gain equals the sum of the change in the producer and the consumer surplus, which is equal to the area P^3AD^0 .

The ultimate impacts as depicted by Figure 3.2 are lower equilibrium price, higher quantity of food produced and consumed, and welfare gains for both producers and consumers.

Figure 3.2: Impact of reducing food losses in the supply chain



Source: Rutten (2013)

3.5 Methods of Analysis

The data was analysed using both arithmetic calculation and econometric methods. Statistical packages and programmes such as SPSS and Eviews were used for the analysis of the data.

3.5.1 Describing the nature of the mango marketing channel

The study conducted a survey through the use of semi-structured questionnaires to solicit information from respondents on available channels of marketing mango, their preferred channels of marketing, volumes of mango supplied to the preferred channels and the factors that influence the selection of channels. SPSS version 21 was used to analyse the responses by descriptive statistics. The results were presented using descriptive and inferential statistics such as averages, percentages and frequencies. A flow chart diagram was used to depict the nature of the marketing channel in the study area for better understanding of the distribution channel towards development of appropriate post-harvest management interventions.

3.5.2 Estimating the losses at each stage of the marketing channel

Losses in developing countries according to Gustavsson et al. (2011) happens usually within the field-to-market levels, with the smallest percentage of losses happening at the consumer level. The project therefore focused on the marketing channel which covers harvesting through to sales and to the consumer. Considering the complexity of qualitative estimation and the deficiencies with the sole use of quantitative or unit measurement of post-harvest loss as outlined by Morris and Kamarulzaman (2014) and

Kitinoja and Kader (2015), the study adopted the use of both qualitative and quantitative methods of measurement to achieve higher accuracy and to give a complete picture of the loss situation.

According to Affognon (2015), for different kinds of fruits and vegetables, crop volumes ranging from 4.8–81% at farm levels, 5.4–90% at wholesale level, and 7–79% at retail level undergo damage, spoilage or decay, and such produce becomes only sellable at reduced prices culminating in economic value losses estimated at 16–40% of the actual prices. He further pointed out that the quality deterioration leads to substantial monetary value losses as consumers will first endorse critical tolerance limits for low-quality produce, beyond which they pay discounted prices leading to significant revenue losses for producers and traders. Qualitative loss estimation was therefore based on buyer acceptability. Whenever mangoes are sold at discount prices due to reduction in quality, the difference relative to actual prevailing market price at which it would have been sold, was captured as monetary loss as employed by Affognon (2015). The monetary values were later converted into kilogram equivalence based on the per kilogram prevailing market price.

The study used a base unit of 100kg in estimation of the losses following the method employed by Global Strategy (2015) in estimating percentage losses during the shelling of grains.

Losses at each stage of the marketing channel were arithmetically quantified as follows:

$$\% \text{ Post Harvest Loss (PHL)} = \frac{\text{Total PHL (Kg)}}{\text{Total Production/purchase (Kg)}} \times 100 \dots \dots \text{Eqn. (1)}$$

Where;

$$\text{Total PHL (Kg)} = \sum \text{Quantitative losses} + \sum \text{qualitative losses}$$

(N.B: qualitative losses will be converted into Kg for common unit during estimation)

Descriptive and inferential statistics such as averages, percentages and frequency were used to present the results.

3.5.3 Identifying and ranking the causes of post-harvest losses

A list of causes of loss at the post-harvest stage confirmed by literature and those identified by respondents in pretesting were presented to respondents to rank according to level of severity.

The Kendall's coefficient of concordance (W) was used to measure the degree of agreement among the respondents in rankings of the causes. When there are more than two judges, this statistic is used to measure the extent to which all judges agree. It measures the degree of agreement on a zero to one scale. The coefficient of concordance (W) has positive value ranging between zero (0) and one (1). It is one (1) in the situation where the ranks assigned by respondents are the same and zero (0) when there is a maximum disagreement among the respondents. The coefficient concordance (W) is given as,

$$W = \frac{12 \left[\sum T^2 - (\sum T^2) / n \right] / n}{nm^2(n^2 - 1)} \dots\dots\dots \text{Eqn. (2)}$$

Where;

T= the sum of ranks of each factor being ranked,

m = Number of sets of ranking by the farmers and

n = the number of specific causes being ranked.

The hypothesis and the significance of the rankings are further tested using the chi-square (χ^2) test as follows:

The null (H_o) and the alternative (H_a) hypothesis are stated as follows;

H_o : There is no agreement among the rankings of the respondents.

H_a : There is agreement among the rankings of the respondents.

The coefficient of concordance (W) is tested for significance in terms of the chi-square (χ^2) distribution: It is given as,

$$\chi^2 = \lambda(n^2 - 1)W / (k + 1) \dots\dots\dots \text{Eqn. (3)}$$

With $n-1$ degrees of freedom, the parameter k is the number of causes presented at one time. $k = n - 1$

λ = depicts the number of times that a given comparison occurs.

Decision rule: If the chi-square (χ^2) calculated from the simulation is greater than the relevant critical χ^2 from Fisher's chi-square (χ^2) statistics distribution, the null hypothesis is rejected.

The result was represented through descriptive and inferential statistics such as averages, percentages and frequencies etc.

3.5.4 Identifying the factors that determine losses in the mango marketing channel.

The Tobit regression model in E views (version 8) was used to examine the extent of influence and significance of key variables on loss along the mango marketing channel. An explicit specification of a single model for all levels i.e. farm, wholesale, retail and processing levels is as follows;

$$Y = A_0 + A_1AGE + A_2 GEND + A_3 EDUBSIC + A_4 EDUTER + A_5EXP + A_6 HVMET + A_7STORG + A_8LSTORG + A_9TRANS + A_{10}PACKG + A_{11}TRAINING + A_{12}FARMER + A_{13}WSALER + A_{14}RETAIL + A_{10}PROC + E_i \quad \dots\dots Eqn. (4)$$

Where;

'Y' = the dependent variable (proportion of fruit losses (%))

'A' = parameter estimates, and

'Ei' = stochastic error term.

A_0 is the constant term (intercept) and $A_1 \dots\dots A_N$, are the coefficients of estimates in the model. The explanatory variables are defined as in Table 3.1

(NB: One variable (farmer) was dropped in the overall estimation to avoid dummy variable trap). The a priori expectations of each equation in the model are also provided in Table 3.1 to indicate the expected relationship between the explanatory variables and the dependent variable (i.e. proportion of mango being lost). This relationship was either negative or positive.

NB: Same specification is used for individual levels by taking out variables that are not applicable to the particular level.

Table 3.1: Description, Measurement and a Priori Expectation of Variables

VARIABLE	VARIABLE DESCRIPTION	MEASUREMENT	EXPECTATION	
1	GENDER	Gender	Dummy ('1' For female, '0' male)	-
2	AGE	Age Of Respondent	Years	+
3	EDUBSIC	Basic Education	Dummy ('1' Yes, '0' Otherwise)	-
4	EDUTER	Tertiary education	Dummy ('1' Yes, '0' Otherwise)	-
5	EXPE	Experience	Years	-
6	HVMET	Harvesting method	Dummy ('1' Approved '0' Otherwise)	-
7	STORG	Storage method	Dummy ('1' Approved '0' otherwise)	-
8	LSTORG	Length Of Storage	Days	+
9	TRANS	Method Transportation	Dummy ('1' Approved '0' otherwise)	-
10	PACKAGN	Packaging Method	Dummy ('1' Approved '0' Otherwise)	-
11	TRAING	Post-Harvest Management Training	Dummy ('1' For Yes, '0' Otherwise)	-
12	FARMER	Farmer respondent	Dummy ('1' For Yes, '0' Otherwise)	+/-
13	WSALER	Wholesaler respondent	Dummy ('1' For Yes, '0' Otherwise)	+/-
14	RETAIL	Retailer respondent	Dummy ('1' For Yes, '0' Otherwise)	+/-
15	PROC	Processor respondent	Dummy ('1' For Yes, '0' Otherwise)	+/-

The methods will be ticked as approved/otherwise based on standards as reviewed in Section 2.4

Gender (female), education, experience, approved harvesting technique, approved storage method, approved transportation, approved packaging, and training in post-harvest management were expected to have negative relationship with the proportion of post-harvest losses at all levels. Education improves one's ability to retrieve, process and

make meaning from an information and appropriately apply. The higher the education of a person, the more the person is disposed to employing more efficient post-harvest management technologies in one's business activities. Gender as an explanatory variable in the model is expected to show negative relationship with proportion of post-harvest losses. It is the expectation that females would record lower food crop losses than males at all the levels. This is based on the fact that females show more dexterity and are proficient at handling activities along the marketing channel. Harvesting with modern and approved technique was expected to result in lower proportion of post-harvest loss. Other variables, age and length of storage are expected to move in the same direction with proportion of post-harvest losses. The longer the fruit is kept in the store, the more the deterioration and losses through weather condition, pest, diseases, softening etc. The above expectations were met by (Ahmed *et al.* 2015). The expectation for variables; farmer respondent, wholesaler respondent, retailer respondent and processor respondent, is negative or positive depending on the intensity of loss pertaining to the particular level.

3.6 Types of Data and Sources

The study made use of both primary and secondary data. Secondary data was sourced from government sources and internet sources. Primary data was obtained by use of semi-structured questionnaires were administered through personal interviews to the randomly sampled respondents in the study area to obtain the primary data.

3.7 Sample size and sampling technique

Regions, Districts, communities (as in Table 3.2) and farmer associations were purposively sampled.

Table 3.2: Mapping of Respondents

Region		District/Municipality	Communities
i. Eastern	i.	Yilo Krobo Municipality	i. Somanya ii. Okwenya
	ii.	Nsawam-Adoagyire Municipality	iii. Nsawam iv. Adeiso
ii. Greater Accra	iii.	Shai-Osudoku District	v. Dodowa vi. Agomeda
iii. Volta	iv	North Tongu District	vii. Juapong viii. Fodzoku

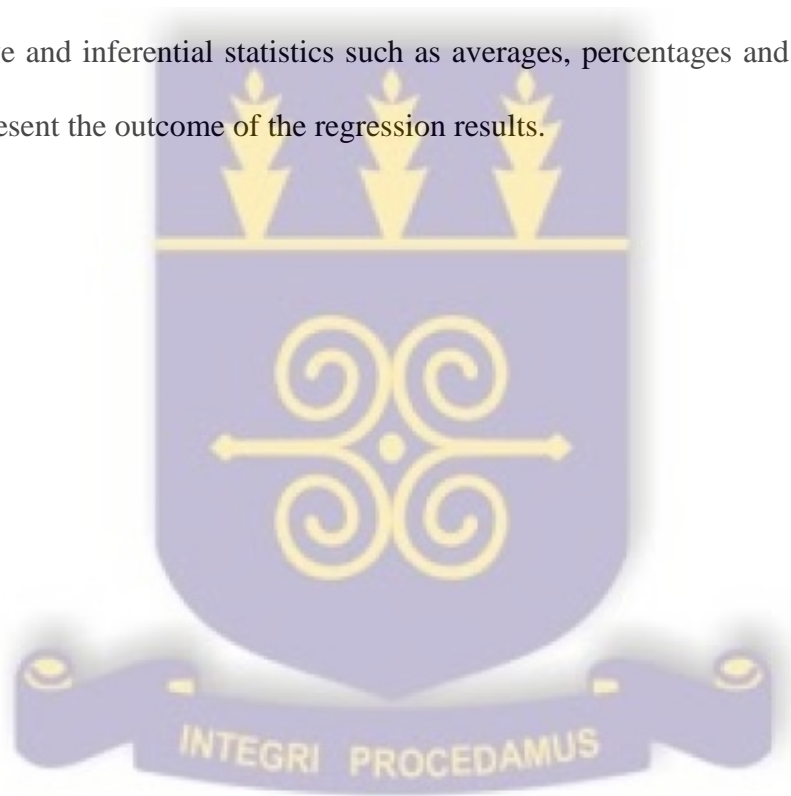
The whole marketing channel was divided into farmer level, wholesaler level, retailer level, and processor level. Simple random sampling and snowballing were used to select number of individual respondents according to the population of actors at a particular level and area in accordance with the method adopted by Ahmed *et al.* (2015). Farmers, wholesalers and retailers were not chosen from the Nsawam-Adoagyire municipality due to the relatively low production of mangoes in the area as revealed by the reconnaissance survey. However, all available processors were located in the municipality. Personal interview and observation methods were employed to interact with respondents. The study targeted a sample size of one hundred and eighty respondents. The break down is presented in Table 3.3.

Table 3.3: Sample Distribution

District /Municipality	Number of Farmers	Number of Wholesalers	Number of Retailers	Number of Processors	Total
Yilo Krobo	27	20	20	0	67
Shai-Osudoku	25	20	20	0	65
North Tongu	25	10	10	0	45
Nsawam Adoagyire	0	0	0	3	3
Total sample					180

Presentation of Results

Descriptive and inferential statistics such as averages, percentages and frequencies were used to present the outcome of the regression results.



CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of the study. Section 4.2 describes the demographic and socioeconomic background of the respondents. Section 4.3 presents the results of facilities and methods employed in handling fruits by respondents. Section 4.4 outlined the nature of the mango marketing channel. Section 4.5 reports on the estimation of losses at various levels of the marketing channel while 4.6 presents the causes of losses, and finally section 4.7 presents the results of a regression to determine factors that contribution to post-harvest losses.

4.2 Demographic and socioeconomic profile of respondents

Gender

Majority of the respondents were females. Actually, 60 respondent (who were all farmers) representing 34% of the total sample were males and 117 respondents representing 66% were females. All wholesalers and retailers were females. This confirms the assertion by FAO (2011a) that post-harvest activities to a large extent are assumed by women thereby contributing to female economic empowerment.

Educational Background of respondents

Figures in Table 4.1 revealed that 11.7% of the respondents had no formal education and 60% of the respondents (mainly wholesalers and retailers) are basic education graduates. Secondary and tertiary graduates (mainly farmers) were 15.5% and 12.8% respectively.

Thus mango marketing is a source of livelihood for these J.H.S graduates who were probably drop outs.

Age of respondents

Table 4.1 contains the age distribution of respondents. Detailed analysis showed a general mean age of 45. Farmers had mean age of 56 while a mean age of 38 was for both wholesalers and retailers. The maximum ages were 60 for retailers and wholesalers and 90 for farmers. Though there were some few old women among wholesaler and retailers, the result indicates the involvement of a lot of young females at these levels. This implies that mango marketing is a means of livelihood and economic empowerment for the young women in the study area.

Table 4.1: Demographic and socioeconomic profile of respondents

Variable	Frequency	Percentage
Age		
≤ 35	44	24.4
36-60	112	62.2
61+	24	13.3
Total	180	100.0
Educational background		
None	21	11.7
Basic	108	60.0
Secondary	28	15.5
Tertiary	23	12.8
Total	180	100.0
Gender		
Female		
Farmer	17	9.6
Wholesaler	50	28.2
Retailer	50	28.2
Male		
Farmers	60	34.0
Wholesalers	0	0.0
Retailers	0	0.0
Total	117	100.0

Gender is less than 180 because the three processing companies were treated gender neutral

4.3 Handling facilities and methods employed by channel actors

Facilities and methods used can contribute to loss if they are not standard. It was found that most respondents used unapproved facilities and methods that have negative influence on losses. These facilities and methods are classified under: packaging, storage, and transportation.

Packaging materials

Sixty-three (63) of the respondents representing 35% used wooden crates while fifty (50) respondents representing 27.8% used plastic crates. Thirty (30) respondents representing 16.7% and twenty-seven (27) respondents representing 15% who are mainly retailers use baskets and aluminium/plastic bowls respectively. Only ten (10) respondents representing 5.6% use paper cartons. The dominant use of wooden crates supports Agyepong (2013) that reported 50% and 20% for wooden and plastic crates respectively among farmers only. Fruits that were meant for the local markets were put in large cane baskets, those for distant markets were put in wooden and plastic crates and those for export were put in paper boxes (cartons). The use of wooden crates and baskets as packages were found to have rough surfaces, too big and heavy and resulted in significant fruit injury due to scratches and weight compression of upper fruits. Packages were also found to be unclean and could enhance microbial attack and this could partly be responsible for the huge losses at the wholesaler and retailer levels as reported by Yahia (1999). Packaging can either enhance or impede good temperature management (Brecht et al., 2014). Thus the use of aluminium and plastic bowls which were not perforated could raise the temperature and cause rapid deterioration.

Storage of Mango Fruits

Storage of produce under the appropriate conditions extend the shelf life and the usable period of the produce that could have otherwise been lost. Proper storage is therefore a major means of reducing post-harvest loss (Brecht et al. 2014; Yadav, 2013).

As in Table 4.2, the analysis shows one hundred (100) respondents representing 55.6% stored in open air or open room, sixty-nine (69) representing 38.3% who are mainly farmers used farm sheds, and eight (8) representing 4.4% used a public pack house situated in Somanya to keep the fruits. Only 3 respondent representing 17% who were processors used cold storage facilities.

Further analysis indicates that 98% of the respondents used unapproved storage methods. They store fruits in open air or under natural cold air by spreading the fruits in shades and airy places. The other 2% who are all processors (i.e. Blues Skies, Bomarts and HPW) use cold storage facility to store fruits in wait of processing. This is a confirmation of Aboagye (2009) and Agyepong (2013) on storage in the Yilo Krobo municipality (in the Eastern Region) and the Shai-Osudoku District (in the Greater Accra). This certainly contributed to the highest losses recorded at the retailer level since in the absence of cold storage facilities they keep mangoes for the longest period of up 9 days to finish selling a consignment. Also only 2% of the respondents treated their fruits before storing. During major seasons, farmers and traders face the risk of losing fruits whenever there is delay in getting buyers. They are therefore forced to sell at unsatisfactory prices to avoid decay because of the lack of proper storage facilities. These practices are common among respondents in the study area. According to the report, respondents rely on natural cold air as main means of reducing temperatures during storage.

Transportation of Fruits

The study showed that transportation had negative relationship with post-harvest loss and was highly significance. Meanwhile, the final quality of mango to the consumer is affected by the type of transport used to convey the produce. A careful analysis of the data as in Table 4.2 revealed handlers mostly used trucks and mini buses which were not equipped with any refrigeration systems. The containers in which the fruits are packed during transportation are not recommended. Handlers, especially retailers, sometimes poured mangoes into taxi boots, pick-up cabins and tractor trailers to their destinations without any package or covering. The fresh fruits are therefore exposed during transport to high temperature and bruising of fruits which could cause injury and softening of the tissue for rapid microbial deterioration. The results also agree with the FAO (2003) that stated that transportation was a main challenge confronted by fruit growers in the developing world where vehicles are used to transport huge raw fruits to markets. Refrigerated trucks and vans were found expensive and unavailable for farmers to use.

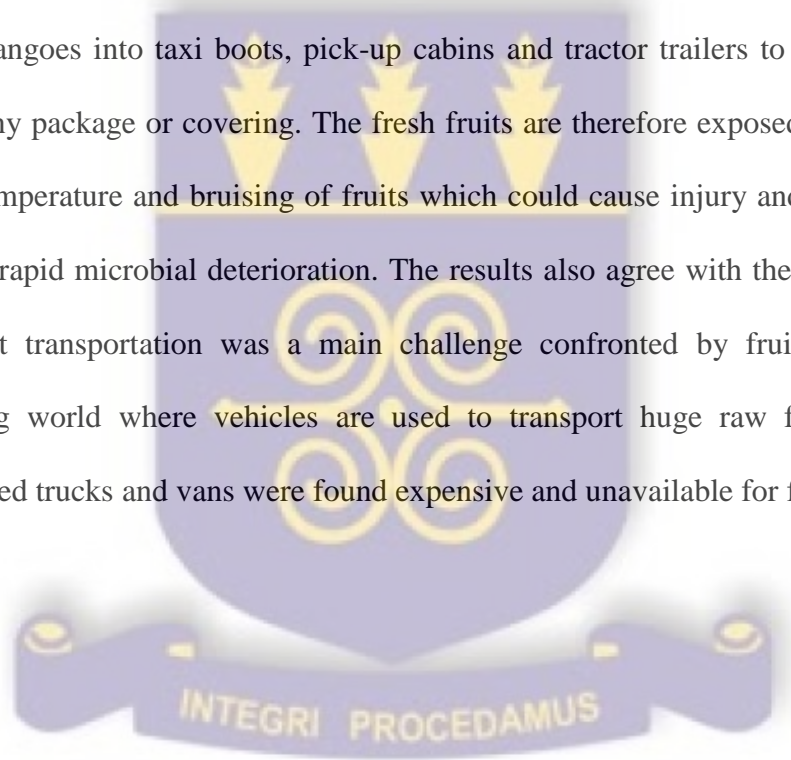


Table 4.2: Facilities used in post-harvest handling of mango fruits

Item	Frequency	Percentage
Packaging Containers		
Wooden Crates	63	35.0
Plastic Crates	50	27.7
Cartons	10	5.6
Baskets	30	16.7
Aluminium/Plastic Bowls	27	15.0
Total	180	100.0
Place Of Storage		
Farm Shed	69	38.3
Pack House	8	4.4
Open Air/Room	100	55.6
Cold Storage (Refrigeration)	3	1.7
Total	180	100.0
Transportation		
Trucks	90	50.0
Open Vans	37	20.6
Mini Buses	20	11.1
Tractor	18	10.0
Taxis	15	8.3
Total	180	100.0

Source: Field Survey, 2015

As in Table 4.3, further analysis was carried out on methods involved in performing certain tasks aside the equipment employed. This was done by juxtaposing the process of performing these tasks to standards by Medina and García (2002), Yadav (2013), and Bretch *et al*, (2014). The analysis revealed that the techniques employed by some 67% of respondents in harvesting fruits were not standard. Again, 60.6% of the respondents employed transportation methods that are not standard and 81.7% of the respondents used storage methods that were not standard. Finally, 58.3% of the respondents practiced sub-standard packaging. One hundred and seventy (170) respondents representing 94.4% did

not apply any treatment to fruits while 138 respondents representing 76.7% had no training in post-harvest handling of fruits.

The use of substandard practice accounted for mechanical damages that resulted in quality losses and eventual deterioration and discarding of fruits. Furthermore, the huge number of untrained actors could contribute to ignorance of standard practice and poor handling of fruits.

Table 4.3: Methods employed in post-harvest handling of mango fruits

Method	Frequency	Percentage
Harvesting method		
Standard	25	32.5
Not standard	52	67.5
Total	*77	100
Transport method		
Standard	71	39.4
Not standard	109	60.6
Total	180	100
Packaging method		
Standard	75	41.7
Not standard	105	58.3
Total	180	100
Storage method		
Standard	33	18.3
Not standard	147	81.7
Total	180	100
Treatment of fruits		
Treated	10	5.6
No treatment	170	94.4
Total	180	100
Training in Post-harvest handling		
Trained	42	23.3
No training	138	76.7
Total	180	100

NB: Total with asterisk (i.e.*77) is not up to 180 because harvesting pertains to only farmers.

Source: Field Survey, 2015

4.4.1 Mango marketing

Mango fruit marketing in southern Ghana involves the following core activities: assembling, sorting, grading, packaging, loading, transportation, offloading, and storage. These activities are carried out by four major players along the marketing channel namely the farmer, the wholesaler, the retailer and the processor.

4.4.2 The Nature of the Mango Marketing Channel

Data analysed as in Figure 4.1 revealed that farmers significantly sell their mangoes domestically to processors, wholesalers and retailers. Only six (6) of the farmers do direct export of some of their mangoes. Significant portion of farmers supplied to more than one buyer. Seventeen (17) farmers representing 22.4%, and ten (10) farmers representing 13.2%, respectively supplied mangoes to wholesalers only and processors only. Only two (2) respondents representing 2.6% of producers supplied to retailers only. Significantly, twenty-five (25) respondents representing 32.9% of producers supplied mangoes to wholesaler and processors. Furthermore, five (5) representing 6.6% supplied to processors and direct export, five (5) representing 6.6% to supplied wholesalers, processors and exporters, another five (5) representing 6.6% supplied to wholesalers, retailers and processors, two (2) representing 2.6% supplied to wholesalers, retailers and consumers and one (1) representing 1.3% supplied to wholesalers and did direct export. Farmer inability to take advantage of the export market due to their failure to meet export standards deprive them of the relatively higher revenue from foreign exchange. The decision to sell to any of these channels depends on factors such as price offered, quality, quantity of fruits and accessibility to a market.

Further analysis of the marketing system revealed that the supply of mangoes to these various clients and its subsequent movement through to the consumer has developed into identifiable marketing channels. As in Figure 4.1 five main marketing channels of marketing mangoes with four main domestic actors namely the farmer, the wholesaler, the retailers, and the processor were identified. This confirms Yeboah and Kunze (2004) about channels of marketing fruits in Ghana.

Analysis of the data indicates that processors absorb 53% of mangoes produce in the area. This is followed by wholesalers who absorb 30%. The rest are direct exports and the retail market who take 10% and 7% respectively. Wholesalers in turn distribute 90% and 10% of their share to retailers and consumers respectively.

Farmers are suffering huge economic losses due to their inability to take advantage of the better prices of the export market as they sell about 90% of their fruits domestically.

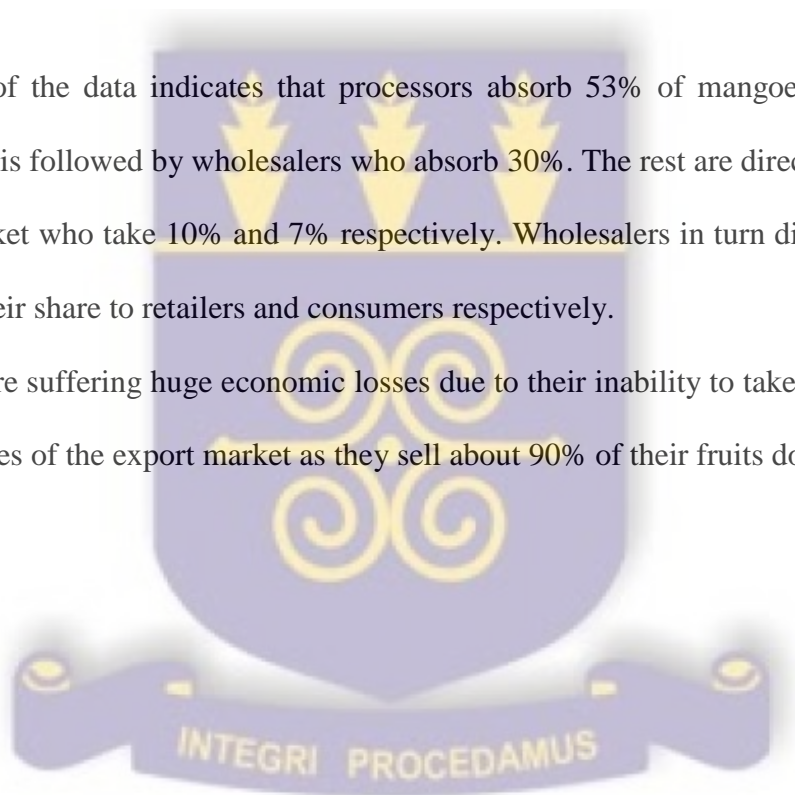
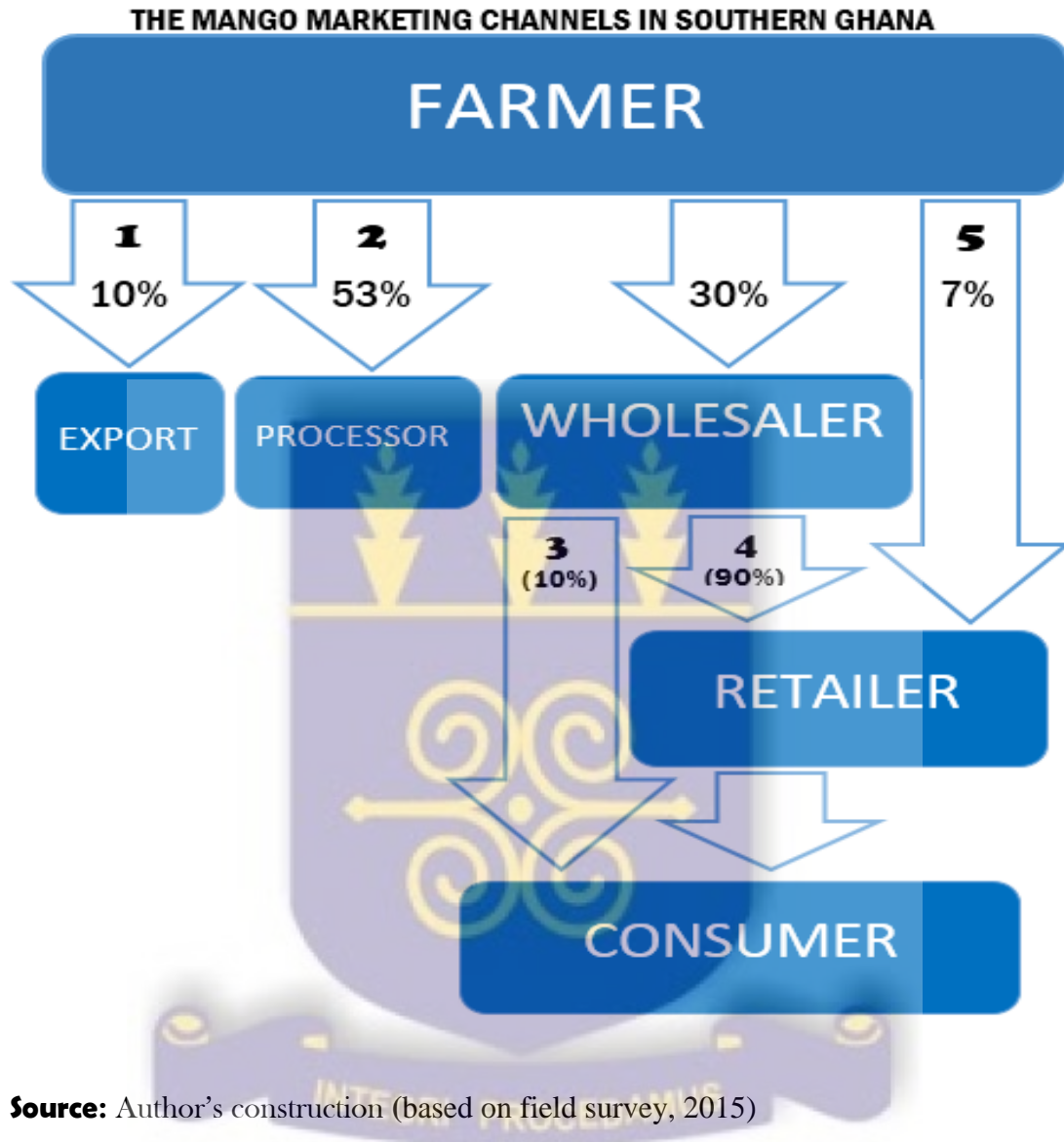


Figure 4.1 Channels of Marketing Mangoes



Roles of key actors in the marketing channel

Farmers

As shown in Figure 4.1, the farmer can sell through any of these channels depending on factors such as price offered, quantity and quality. Farmers with smaller quantities and

low quality fruit were willing to sell to retailers while those with huge and high quality fruits preferred selling to processing companies or exporters.

Farmers, being at the starting point of the marketing channel, perform several important functions in setting the marketing process in motion. The key marketing functions performed by farmers include: assembling, sorting, cleaning, grading, packaging, financing, distribution and transportation.

Some farmers assemble their fruits in the farm either under trees or farm sheds while others assemble theirs in their homes. Assembling was important as it facilitates sorting, cleaning, grading and packaging. Farmers sort out damaged, diseased, deformed and fruits that are carrying defects that made them unsellable. Sorting and cleaning were carried out either during gathering of fruits or after assembling. Cleaning was performed on fruits that were dirty or stained. Cleaning was usually carried on few fruits where dirt and stains were conspicuous and could possibly cause rejection from buyers. The use of water for cleaning was occasional relative to the use of rags or dusters.

Farmers grade mangoes taking into consideration factors such as size, ripeness, colour, maturity, variety, wholesomeness etc. The grading helped the farmers to price the fruits and to choose the appropriate marketing channel(s) for marketing each grade of fruits depending on the quality. Grading of mangoes meant for export was more thorough in order to meet the high standards of the export market.

Farmers on most occasions do packaging of their fruits except on occasions where buyers take fruits at the farm gate with their own packages. Most farmers package fruits in plastic crates as they wait for buyers or during transportation of fruits. Though farmers make arrangements such that buyers usually come for fruits immediately after harvest, there were occasions where the farmers stored the fruits for a while when buyers delayed. Few farmers in the Yilo Krobo Municipality however, used the only public pack house at Akorley in Somanya to store their fruit for relatively longer periods. Farmers also do transportation of fruits from farm to assembling points and when it became necessary to transport the fruits to processing companies by themselves. Transportation of fruits to processors was mostly done by farmer associations while transportation from farm to assembling points was done individually.

Farmers also financed all the above functions as they bear transportation cost, packaging cost, cost of storage etc.

Wholesalers

Wholesalers play important role in moving mangoes in huge volumes from producers to non-producing area across the country. The wholesaler retailer channel was found to be the second in terms of volume of market share. This gives an indication of the importance of the wholesaler in mango marketing in southern Ghana. The result indicates that 43 respondents representing 86% of wholesalers sell solely to retailer and seven (7) respondents representing 14% sell their fruits to retailers and consumers. Wholesalers

only buy from farmers and sell mainly to retailers outside the production areas in major cities like Accra, Tema, Koforidua, Takoradi etc. covering average distance of 98 km.

Wholesalers become more important especially during periods when the processing companies are unable to accept fruits due to lack of space, high incidence of infestation/infection by pest and diseases etc. Therefore, wholesalers can have access to all grades of mangoes based on the prevailing demand trends.

Retailers

Retailers also play an important role of making mangoes available to consumers at their door steps in smaller quantities. Almost all retailers in the study area buy mangoes directly from farmers by virtue of their nearness to the famers. The other compelling reasons are that buying from the farmers was relatively cheaper as transaction cost and profit of the wholesaler made buying from the wholesaler unprofitable alternative to these retailers. It was also to get high quality mangoes as there is reduction in quality as the channel becomes longer. Unlike the wholesalers, the retailers cover relatively shorter distance from the farms to the point of sale. The average distance from the farms to point of sale was 10km. As in Figure 4.1, the retailer is the final intermediary of the marketing channel in the sale of fresh mangoes. They sell all their produce to consumers. The domestic sale of the mangoes at the market place is insignificant. However, retailer prefer displaying fruits on mounted tables along the main roads linking major cities and towns such as Akosombo –Tema road at Okwenya, Somanya to Accra at Trom in Somanya, Agomeda and Dodowa. Most fruits are covered and left on these tables overnight at the road sides.

Processors

In terms of volume of movement of fruits along the various channels, farmer to processor channel emerged as the first by absorbing 53% of total production. Farmers therefore, rely heavily on processors to stay in business. Processors happened to be the most preferred buyers of the farmers produce due to their ability to buy in large quantities and reliability in payments. Again, the processors would accept fruits of lower standards as compared to that of the export market. For example, processors would accept mangoes with skin and structural deformities which did not affect the quality of the pulp. All four mango processing companies were cited in the Nsawam Adoagyire municipal and about 150 to 200km from the other three mango production districts.

Length of the marketing channel was also found to have a relation with loss in that the longer the channel, the higher the loss. This is because the number of handlers increases along the channel and this leads to repetition of handling. The result is further mechanical damages and rapid ripening and softening due to the delay. Secondly, marketing margins builds up at each level thereby making the fruit expensive for quick clearance. The delay in selling due to high price led to further economic losses.

4.4.3 Price determination along different channels

Buyers use several strategies to settle on prices with the farmers. The four approaches identified were individual negotiation, group negotiation, buyer decides and farmer decides. Individual negotiation refers to a situation where there is a negotiation of prices

between the individual farmer and buyer, where the farmer may belong or not belong to a group. Group negotiation occurs between a buyer and a farmer group. Group executives or mandated negotiation team meet particularly processors or exporters to fix prices on behalf of the group. This is being practiced by YKMFA and DAMFA in the Yilo Krobo municipality (in the Eastern Region) and the Shai-Osudoku District (in the Greater Accra Region) respectively.

The buyer decides approach does not require any negotiation. In this case is the price was decided by the buyer alone. This usually happens between processors and unorganized or poorly organized farmers. Farmers in VOMAGA complained about this being practiced against them by some processing companies.

The farmer decides approach similarly does not require any negotiation. In this is a case, the farmer decides on the price to sell his fruits. Retailers and wholesaler are mainly the victims of this practice.

Wholesalers and retailers mainly bought from individual farmers who may or may not belong to any farmers' associations. As such, there are price differences among farmers to the extent that even neighboring farmers are given different prices from the same customers. Farmers with few mango trees, poor quality and low quantity have low bargaining power and would take any price offered by the buyer in order to get better price before mangoes start ripening and rotting in the farms and also to prevent delayed marketing.

4.5 Losses at various stages of the marketing channel

The analysis of data collected as presented in the Table 4.4 revealed percentage losses of 16.3, 9.4, 23.6 and 5.3 at the farmer, wholesaler, retailer and processor levels respectively. The analysis also revealed that quantitative losses were higher. Farmers had the highest of 90%, and wholesalers the least at 51%. Retailers had 66% and processors had 100% quantitative losses. The mean quantitative loss was 76%.

Table 4.4: Computation of percentage losses

Level	Total product (Kg)	Mean quantitative loss (Kg)	Mean qualitative loss (Kg)	Total Mean loss (Kg)	Mean percentage loss
Farmer	4,505,965	663228 (90%)	71244 (10%)	734,472	16.3
Wholesaler	566,771	27171 (51%)	26106 (49%)	53,277	9.4
Retailer	355,927	55439 (66%)	28560 (44%)	83,999	23.6
Processor	14,046,237	744451 100%	0 -	744,451	5.3

Source: 2015 field survey (based on the 2015 major and minor seasons)

Quantitative and qualitative losses result mainly from attributes that make the fruit wholly unusable or difficult to be accepted by buyers. Exporters usually follow strict Global GAP grading standards while local processors and consumers were a bit flexible with the standards. For instance, processors may accept disorders that affected the peel but did not affect the mesocarp. Consumers were seen buying lightly bruised and over ripped (soft) fruits but at reduced prices. The study revealed that most of the sellers sorted the mangoes by removing fruits that had physical injuries such as cuts and bruises, diseased, evidence of decay and misshapen fruits. Grading of the fruits was done by

variety, uniform size, shape and skin colour by farmers and fruit sellers to facilitate destination and pricing.

The result of the study indicates that losses differ at different levels along the mango marketing channel. The significant difference was due to handling processes pertaining to the level, length of the channel, physiobiological and socioeconomic factors as confirmed by Aboagye (2013). According to the chief agronomist of Blue Skies Ghana Limited, some diseases and reactions of pest infestations may manifest after some days. Due to lack of proper storage facilities, the longer the fruit stays without being consumed, the higher the manifestation of these infections and rate of the losses. Those at the bottom of the channel (i.e. retailers) are therefore heavily affected by softening and subsequent decays.

The mean loss at the farmer level was 16%. Farmers register only fewer losses than retailers because most of them sell immediately after harvest at the farm gate. Those who have their produce received by the processors also take advantage of the relatively better transportation of fruits thereby reducing transit losses. However, harvesting methods, disease and pest among other things resulted in relatively higher losses during sorting and grading at the farmer level. It was also discovered that farmers in the Yilo Krobo Municipal and Shai-Osudoku District Mango Farmers' Associations had mean losses of only 8 % and 10% respectively. This is possibly so because most of them are Global GAP certificated farmers who are constantly being trained in good agronomic and phytosanitary practices through a USAID sponsored programme. Meanwhile, the average

post-harvest loss at the farmer level in the north Tongu District was as high as 21 percent. Interestingly, farmers in the north Tongu district own the smallest farm sizes. Losses may therefore have a lot to do with other managerial practices rather than farm size.

The mean loss at the retailer level was the highest at 23%. Losses at retailer level are obvious because the study revealed that they keep fruits for the longest period before selling. Meanwhile the data collected indicates that their storage facilities, packaging and mode of transportation are the poorest. Again since they cannot predict exactly the daily sales they take the risk of buying fruit according to their experience and bears losses through unsold quantity. The few retailers who buy from wholesalers are likely to register higher losses due to the length of the channel. Length of the marketing channel has a positive relationship with loss in that the longer the channel, the higher the loss. For instance, if a farmer sells direct to a processor, the total loss is estimated to be the sum of the farmer's loss and that of the processor which was about 22% (i.e. 16.3 plus 5.3%). This implies that, a farmer to retailer and to consumer channel would result to about 40% loss (i.e. 16.3 plus 23.6%) whereas the longest channel of farmer to wholesaler, to retailer to consumer would, all factors held constant, experience about 49.3 post-harvest loss (i.e. 13.4 plus 9.4 plus 23.6%). The empirical results in conclusion reveals that post-harvest loss along the domestic mango marketing channel in southern Ghana was about between 22% and 49%.

The study reveals a little improvement in earlier estimations such as the Trade Hub and African Partners Network (2014) which reported 33% to 50% mango losses in West

Africa, Zakari (2012) which reported 20% to 50% and Badoo-William (2015) which reported that mango suffers huge losses of 20% to 60% in the country.

4.6 Causes of losses emanating from post-harvest handling

Eight (8) causes of mango loss as in Table 4.5 were presented to the respondents for ranking. Respondents ranked the causes on a scale of 1-8 by assigning 1 to the severest and 8 to the least. The result, as in Table 4.5 indicates that losses vary with levels in terms of severity. The overall analysis, however, shows that the first four most prevailing causes of loss of fruits along the marketing channel were pest, disease, mechanical damage and softening/decay. The rest of the causes were jelly seed, sun burn, sap burn and uneven ripening. The Kendall's W^a shows that there is about 87 percent agreement among the rankers within the marketing channel (i.e. farmers, retailers, wholesalers, and processors), 97% among farmers, 94% among wholesalers, and 87% among retailers and processors. Since the chi-square computed is greater than the read in each case, the null hypothesis is rejected and the study concludes that there is an agreement among the rankers at all levels. The results can also be validated by using asymptotic significant value (0.000) which was less than one percent. In terms of the first three most severe causes, the overall channel and farmer level rankings showed pest, disease and mechanical damage as the first, second and third causes of post-harvest loss respectively. Wholesaler, retailers and processors also ranked disease and pest as the first and the secondly respectively. Mechanical damage was ranked the third at the farmer, wholesaler and the overall levels. Softening/decay and uneven ripening were the third for retailers and processors levels respectively.

Table 4.5: Ranking of Causes of Post -Harvest Losses

Causes	Farmers	Wholesalers	Retailers	Processors	Overall
Pest	1st	2nd	2 nd	2 nd	1 st
Disease	2nd	1st	1 st	1 st	2 nd
Mechanical Damage	3rd	3rd	4 th	5 th	3 rd
Softening/Decay	7th	4th	3 rd	6 th	4 th
Jelly Seed	6th	6th	6 th	4 th	5 th
Sun Burn	4th	5th	5 th	7 th	6 th
Sap Burn	5th	7th	8 th	8 th	7 th
Uneven Ripening	8th	8th	7 th	3 rd	8th
Statistics					
N	77	50	50	3	180
Kendal's W ^a	0.965	0.942	0.886	0.873	.866
Chi Sq	Cal.=513.26 Crit. =14.07	Cal.=329.77 Crit.=14.07	Cal=310.00 Crit.=14.07	Cal =18.33 Crit.=14.07	Cal=1091.77 Crit. =14.07
df	7	7	7	7	7
Asymp. Sig.	0.000	0.000	0.000	0.011	0.000

Source: Field Survey, 2015

Detailed description of the above causes of losses

Diseases

From the study, the main diseases that posed problems to the industry in order of severity were anthracnose, black spot, and bottom end rot. Farmers were able to sort out fruit that manifested signs of disease. Unfortunately, wholesalers, retailers and processors suffer great losses from those infected fruit that develop symptoms later. Some of the diseases also resulted from lack of sanitation during handling. Respondents did not practice cleaning of fruits before transportation or storage except at the processing level. The packaging materials, vehicles for transportation and place of storage were also either not properly cleaned or never cleaned and never fumigated to destroy pathogens. Fruits were therefore prone to contamination and microbial attack.

Pest

The major pest of economic importance at all levels was the fruit fly. This was followed by the stone weevil mainly at the processor level and finally the mealy bug. The fruit flies suck on farm and cause infections that later cause deterioration along the marketing channels. Yahia (1999) reported that the fruit flies are established in ninety-five countries and it is considered as a very destructive insect pest of mango. USAID\ TIPCEE (2007) also stated that several fruit flies render fruits useless for human consumption. The mango stone weevils were identified when the fruits were cut.

Mechanical damage

The technique used in harvesting was a mixture of approved and unapproved techniques. For instance, the use of hands and secateurs which is an approved means of plugging was mixed with the use of sticks to plug those fruit that the farmer could not reach due to the height of the trees. This sticks which had no porches to collect the fruits resulted in the falling of the fruit which caused mechanical damage. The fruits as well got contaminated and dirty in the process. Fall during harvesting cause a lot of damage in the form of injuries, cracks, and internal breakdown which led to rapid deterioration of fruits and easy microbial attack. Handling and transportation also led to bruises and reduction in firmness of fruits which resulted in rapid softening and decay. Mechanical damages led to huge qualitative and quantitative losses due to the rather poor handling methods and facilities. This confirms Kitinoja and Kader, (2015) who asserted that quality losses due to physical damages were constantly very high in Sub-Saharan Africa, irrespective of the country or crop.

Jelly seed

Jelly seed is a disorder which causes loss of fruit to processors when the fruits were cut. It is a physiological disorder caused by disintegration of the flesh around the seed into a jelly-like mass. The chief agronomist of blue skies noted that these disorders could be reduced by increasing fruit calcium content via proper pre-harvest calcium applications.

Sun burn

Some of the fruits suffer browning of portions due to the scorching sun. This leads to loss in value of fruits. Severe burns can render the fruit entirely unusable.

Sap burn/contamination

Sap-burn is a brown to black discoloration of mango skin which results from latex exudates from the cut stem at harvest. Unapproved techniques of harvesting handling caused the exudate to spurt on the skin of the fruit. Contamination of the fruit on the skin with the sap made the mango unattractive thus loses its market value.

Uneven ripening

Processors and retailers reported prevalence of this situation which they concluded was caused by harvesting of immature fruit.

4.7 Determinants of post-harvest loss

The study hypothesized that handling activities and socio-economic factors contribute to Post harvest losses. The hypothesis was therefore determined by regressing key variables.

The whole channel regression, as shown in as in Table 4.7, indicates that all the variables met the a priori expectations and are significant except education, experience and gender.

Table 4.6: Tobit regression of determinants of losses

Variable	Overall	Farmers Level	Wholesalers Level	Retailers Level
	Coefficients	Coefficients	Coefficients	Coefficients
Age of Respondent	0.0024** (0.0009)	0.0023** (0.0010)	-0.0011 (0.0009)	-0.0011 (0.0012)
Experience	-0.0026 (0.0021)	-0.0021 (0.0034)	-0.0034** (0.0013)	-0.0059** (0.0022)
Basic Education	-0.0074 (0.0188)	-0.0017 (0.0269)	-0.0242 (0.0174)	-0.0189 (0.0201)
Packaging Method	-0.0909*** (0.0260)	-0.0209*** (0.0711)	-0.0212 (0.0133)	-0.0277 (0.0312)
Transportation Method	-0.0588** (0.0207)	-0.0444* (0.0265)	-0.0070 (0.0154)	-0.0150 (0.0278)
Storage method	-0.0705* (0.0270)	-0.0085 (0.0421)	-0.0154 (0.0205)	●
Length of Storage	0.0114* (0.0066)	0.0485** (0.0195)	0.0111** (0.0041)	0.0359*** (0.0063)
Training	-0.0840** (0.0266)	-0.0848*** (0.0241)	-0.0745** (0.0140)	-0.0660** (0.0279)
Gender	-0.0027 (0.0321)	0.0028 (0.0275)	●	●
Harvesting method	-0.0289 (0.0276)	-0.0820* (0.0425)	-	-
Retailer (Dummy)	-0.1415*** (0.0415)	-	-	-
Wholesaler (Dummy)	-0.1011* (0.0580)	-	-	-
Processor (Dummy)	-0.0275 (0.0811)	-	-	-
Constant	0.2572*** (0.0621)	0.2849* (0.1130)	0.3167*** (0.0533)	0.2745** (0.0929)

*** = Significant at 1%, ** = Significant at 5%, * = Significant at 10%, — = N/A to the level, ● = dropped due to correlation. The Standard Errors are shown in brackets.

Experience however, showed significance at 5% at the wholesale level. Gender was to measure the influence of female participation in mango marketing. Gender was therefore expected to have negative relationship with loss in that female involvement in the

marketing of mango will reduce post-harvest loss. Female participation in mango marketing showed an inverse relationship with PHL in the overall channel analysis. Though gender is not significant and had positive relationship with PHL at the farmer level, the results clearly suggest from the overall results that involvement of females in the marketing of mango has the potential to reduce losses compared to participation of males. Packaging, transportation and storage methods were all significant and had inverse relationship with loss by the whole channel analysis. Training showed a negative relationship with post-harvest loss while length of storage showed a positive relationship with post-harvest loss. Training and length of storage were significant across the entire channel. This implies that though education and experience could contribute to reduction in losses, training was more important in helping to reduce losses across the entire marketing channel even among inexperience and the illiterates. Thus frequent training of all actors involved the marketing of mangoes is a sure means of reducing post-harvest losses. Again, across channel significance of length of storage suggests that no matter the effectiveness of the marketing system and equipment employed in post-harvest handling of mangoes, the longer the fruits stay in the hands of the handler, the higher the post-harvest loss. This calls for an efficient market system that ensures rapid movement of fruits to the final point of consumption or processing.

Age has a positive relationship with post-harvest losses for the entire channel analysis and at the farmer level at 5% significance. This relationship together with the high mean age of 56 for farmers will require farmers to have a succession plan for their farm business when getting old.

Meanwhile, though not significant, age showed negative relationship with loss at the wholesaler and retailer levels. The comparatively lower mean age among retailers and wholesalers could account for the negative relationship registered for those levels. This is because most of the respondents in these levels are within active labour age such that as they grow from the twenties to the forties, they are rather becoming more intelligent, experienced and physically strong which helps them to be rather more efficient.



CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, main conclusions and policy recommendations of the study. Section 5.2 presents a summary of the study while the conclusions from the study are presented in section 5.3. Finally, section 5.4 presents the recommendations from the study.

5.2 Summary

National data on post-harvest loss of mango fruits is estimated to be between 20% to 60%. These losses in monetary terms constitute a huge financial loss that worsens the economic wellbeing of all players along the marketing channel. Meanwhile, there is obvious absence of proper understanding of the causes, actual levels and determinants of the losses. This makes it difficult to effectively formulate and estimate success of policies against post-harvest losses. The study hence assessed the nature of the marketing channel, estimated losses at each stage of the channel, identified causes of loss at the post-harvest handling stage and identify handling practices and socio-economic factors that determine losses. The study was conducted in three major mango producing regions in southern Ghana, eight (8) communities from two (2) Districts and two (2) Municipalities. The sample size was 180. Multistage sampling method was used. Data was collected through interview with a semi-structured questionnaire. The data was analysed using both descriptive and inferential methods. Kendall's Coefficient of Concordance (W) was employed to determine the degree of agreement among rankers of the causes of post-

harvest losses. SPSS was used for the descriptive statistics and the Tobit regression in e-views was used to determine the contribution to loss by socio-economic factors and handling practices. Farmers had mean age of 56 while a mean of 38 was for both wholesalers and retailers. Females dominate the mango marketing channel by 66%. The study revealed five (5) distinct channels of marketing mangoes fruits in southern Ghana. The shortest channel which also happens to be the largest absorber of fruits is the farmer to processor while the longest channel moves from the farmer through the wholesaler and retailer to the final consumer as shown below;

1. Farmer → export
2. Farmer → processor
3. Farmer → retailer → consumer
4. Farmer → wholesaler → consumer
5. Farmer → wholesaler → retailer → consumer

Length of the marketing channel has a relation with the extent of loss. The longer the channel, the higher the loss. This is due to repeated handling. Channels 2, 3 and 5 were the major channels for mango marketing.

The result indicates that the four most prevailing causes of loss of fruits along the marketing channel were pest, disease, mechanical damage and softening/decay. The rest of the causes were jelly seed, sun burn, sap burn and uneven ripening. Post-harvest loss varies along the marketing channels with 23.6% being the highest and 5.3% being the lowest at the retailer and processor levels respectively. Key socio-economic factors

significantly contributed to post-harvest losses. Literacy, experience, training, packaging, storage and transportation had negative relations with post-harvest loss. Meanwhile age and length of storage had positive relations with post-harvest mango losses. These huge post-harvest losses were due to poor handling techniques due to lack of proper education on post-harvest handling, use of unapproved handling equipment and materials, lack of infrastructure and delayed marketing. The results indicate that majority of the respondents used methods and facilities that are not standard. 98% of the respondents used unapproved storage methods. About 67% respondents used unapproved packaging materials and over 50% used unapproved methods of transportation. These deviations contributed to the substantial losses along the marketing channel.

The study recommended mass mango disease and pest control programme, training of actors and establishment of storage and processing facilities in the study areas.

5.3 Conclusions

The shortest and the most preferred channel is the farmer to processor channel.

Post-harvest loss varies along the marketing channels with the highest and the lowest being at the retailer and processor levels respectively.

The first four major causes of losses, in order of importance, were pest, disease, mechanical damages, and softening/decay.

Age, training, storage, length of storage, packaging and transportation significantly determine post-harvest losses in the study area.

5.4 Recommendations

The use of the farmer processor channel should be encouraged to reduce the huge losses associated with the use of longer channels.

Government through the Trade Ministry should facilitate the establishment of mango processing plants in major mango producing centers.

The Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture should periodically embark on mass mango disease and pests control program to principally control anthracnose and fruit flies which emerged as the first two leading causes of losses.

Major stakeholders (MoFA, USAID, ADRA etc.) should organise frequent education and training on recommended post-harvest handling practices for all actors involved in the marketing of mangoes.

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APPENDIXES

Appendix 1: Questionnaire

DEPARTMENT OF AGRICULTURAL ECONOMICS AND AGRIBUSINESS

COLLEGE OF BASIC AND APPLIED SCIENCES

UNIVERSITY OF GHANA-LEGON

This questionnaire is to solicit your response on the topic below for academic purpose.

Please kindly provide accurate responses as much as possible to the questionnaires. Your responses will be treated with the highest level of confidentiality.

TOPIC: “Analysis of Post-Harvest Losses in the Mango Marketing Channel in Southern Ghana”

1. Name of respondent.....
2. Community.....
3. Sex: [1] female, [0] otherwise
4. Age of respondent (years).....
5. Educational Background (years).....
6. Experience (years).....
7. Farmer respondent: [1] farmer, [0] otherwise
8. Wholesaler respondent: [1] wholesaler, [0] otherwise
9. Retailer respondent: [1] retailer, [0] otherwise
10. Processor respondent: [1] processor, [0] otherwise
11. What tool(s) do you use in harvesting?
12. What is the total mango harvested/purchased in the major season?kg
13. What quantity (kg) of that is rejected/thrown away?

14. What proportion of that (Kg) was sold at a reduced price due to decline in quality?.....
15. How much was that proportion sold due to decline in quality? GHC.....
16. What is the total mango harvested/purchased so far the minor season (kg)?.....
17. What quantity (kg) of that is rejected/thrown away?
18. What proportion of that (Kg) was sold at a reduced price due to decline in quality?.....
19. How much was that proportion sold due to decline in quality? GHC.....
20. What is the total PHL for both seasons? (a =quantitative..... Kg, b =qualitative.GHC.....)
21. From whom do you buy the mangoes? (1) farmers (2) Wholesalers (3) Farmers association (6) Retailers (7) Others (specify).....
22. To whom do you sell the mangoes? (1) Wholesalers (2) Retailers (3) Processing companies (4) Consumers (5) Farmers association (6) Direct export (7) Others (specify).....
23. What proportion was sold to (1) Wholesalers (2) Retailers (3) Processing companies (4) Consumers (5) Farmers association (6) Direct export (7) Others
24. What are the reasons why you sold those quantities to those buyers?
25. How do you determine the price?
26. What is the distance from your farm/location to the place?..... km
27. What vehicle is used in conveying the mangoes? (1) open trucks, (2) open buses, (3) pick-ups, (4) taxis, (5) tractor (6) Others (specify).....
28. How is the produce packaged? (1) Paper cartons (2) Plastic crates (3) Baskets

(4) Wooden crates (5) Polythene/nylon sacks (6) Others (specify).....

29. How long do you keep your mango?days

30. How do you store the fruits?

31. Where do you store the fruits? (1) refrigerated (2) pack house (3) under trees (4) farm sheds (5) open-air (6) Others (specify).....

32. Did you apply any post-harvest treatment? [1] Yes, [0] No

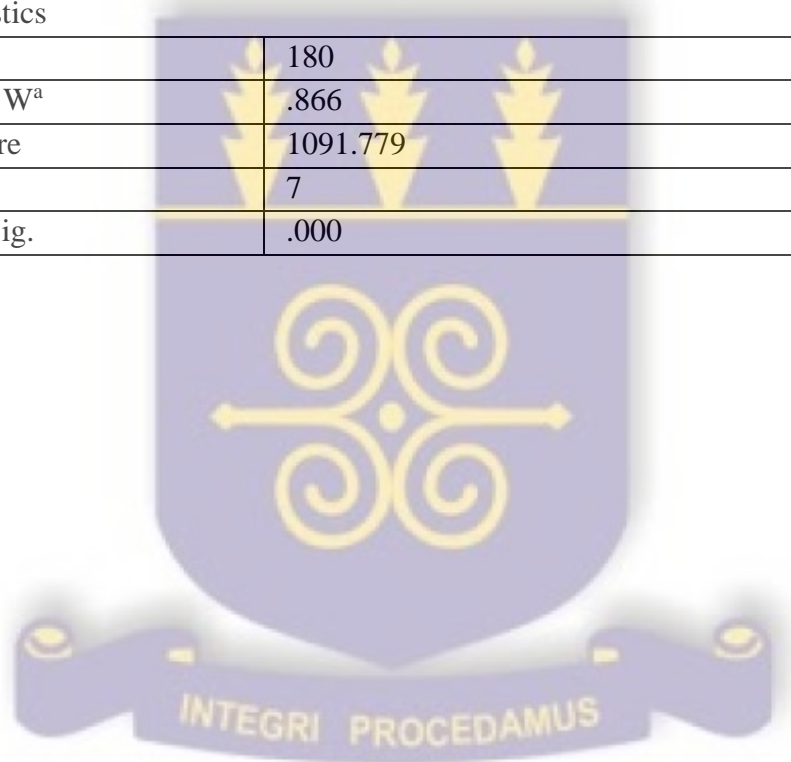
33. Do you have any post-harvest management training? [1] Yes, [0] No

34. Tick the following causes of loss applicable to you and rank them according to severity:

	CAUSES	TICK	RANK
1	Disease		
2	Pest		
3	Mechanical damage		
4	Sap burn		
5	Heat damage		
6	Jelly seeds		
7	Softening/decay		
8	Sun burn		
OTHERS			
9			
10			
11			
12			

Appendix 2: Whole channel ranking of causes of post -harvest losses

Causes	Mean Rank	Rank
Pest	1.28	1 ST
Disease	2.18	2 ND
Mechanical Damage	2.99	3 RD
Softening/Decay	4.43	4 TH
Jelly Seed	4.65	5 TH
Sun Burn	5.66	6 TH
Sap Burn/Contamination	7.15	7 TH
Uneven Ripening	7.65	8 TH
Test Statistics		
N	180	
Kendall's W ^a	.866	
Chi-Square	1091.779	
df	7	
Asymp. Sig.	.000	



Appendix 3: Whole Channel Regression Results

Dependent Variable: PPHL

Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)

Date: 04/13/16 Time: 20:00

Sample: 1 180

Included observations: 180

Left censoring (value) series: 0

Right censoring (value) series: 1

Convergence achieved after 4 iterations

Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.257194	0.062115	4.140586	0.0000
WSALER	-0.141419	0.041466	-3.410442	0.0006
RETAIL	-0.101100	0.057994	-1.743289	0.0813
PROCES	0.027487	0.081142	0.338749	0.7348
AGE	0.002417	0.000943	2.562808	0.0104
EXPE	-0.002631	0.002108	-1.248090	0.2120
EDUBSIC	-0.007417	0.018777	0.395027	0.6928
HVMET	-0.028863	0.027594	-1.045978	0.2956
PACKAGN	-0.090854	0.026028	-3.490593	0.0005
TRANS	-0.058832	0.020260	-2.903802	0.0037
STORG	-0.070497	0.026993	-2.611618	0.0090
LSTORE	0.011445	0.006588	1.737346	0.0823
TRAING	-0.084026	0.026591	-3.159955	0.0016
GENDER	-0.002781	0.031216	-0.089101	0.9290

Error Distribution

SCALE:C(16)	0.106430	0.005609	18.97367	0.0000
-------------	----------	----------	----------	--------

Mean dependent var	0.189361	S.D. dependent var	0.145261
S.E. of regression	0.110764	Akaike info criterion	-1.464876
Sum squared resid	2.012076	Schwarz criterion	-1.181058
Log likelihood	147.8389	Hannan-Quinn criter.	-1.349800
Avg. log likelihood	0.821327		

Left censored obs	0	Right censored obs	0
Uncensored obs	180	Total obs	180

Appendix 4: Farmer Level Regression Results

Dependent Variable: PPHL

Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)

Date: 05/13/16 Time: 21:54

Sample: 1 76

Included observations: 76

Left censoring (value) series: 0

Right censoring (value) series: 1

Convergence achieved after 4 iterations

Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.284900	0.113005	2.521133	0.0117
AGE	0.002359	0.001030	2.290395	0.0220
EXPE	-0.002101	0.003428	-0.612886	0.5400
EDUBSIC	-0.001683	0.026890	-0.062595	0.9501
HVMET_1	-0.081967	0.042520	-1.927709	0.0539
PACKAGN	-0.208916	0.071069	-2.939627	0.0033
TRANS	-0.044401	0.026542	-1.672850	0.0944
STORG	-0.008497	0.042133	-0.201670	0.8402
LSTORE	0.048466	0.019515	2.483499	0.0130
TRAING	-0.084830	0.024096	-3.520501	0.0004
GENDER	0.002799	0.027525	0.101694	0.9190

Error Distribution

SCALE:C(13)	0.092257	0.007483	12.32895	0.0000
Mean dependent var	0.175050	S.D. dependent var	0.148119	
S.E. of regression	0.100018	Akaike info criterion	-1.586370	
Sum squared resid	0.630229	Schwarz criterion	-1.187692	
Log likelihood	73.28206	Hannan-Quinn criter.	-1.427039	
Avg. log likelihood	0.964238			
Left censored obs	0	Right censored obs	0	
Uncensored obs	76	Total obs	76	

Appendix 5: Wholesaler Level Regression Results

Dependent Variable: PPHL

Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)

Date: 05/14/16 Time: 06:58

Sample: 1 50

Included observations: 50

Left censoring (value) series: 0

Right censoring (value) series: 1

Convergence achieved after 4 iterations

Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.316686	0.053255	5.946572	0.0000
AGE	-0.000998	0.000868	-1.149877	0.2502
EXPE	-0.003435	0.001331	-2.580096	0.0099
EDUBSIC	-0.024215	0.017418	-1.390196	0.1645
PACKAGN	-0.021152	0.013290	-1.591625	0.1115
TRANS	-0.007009	0.015358	-0.456372	0.6481
STORG	-0.015432	0.020529	-0.751743	0.4522
LSTORE	0.011090	0.004102	2.703484	0.0069
TRAING	-0.074474	0.024012	-3.101578	0.0019
GENDER	-0.121803	0.028742	-4.237872	0.0000

Error Distribution

SCALE:C(12)	0.041268	0.004127	10.00046	0.0000
Mean dependent var	0.123202	S.D. dependent var	0.068334	
S.E. of regression	0.047022	Akaike info criterion	-3.057456	
Sum squared resid	0.084019	Schwarz criterion	-2.598570	
Log likelihood	88.43639	Hannan-Quinn criter.	-2.882710	
Avg. log likelihood	1.768728			

Left censored obs	0	Right censored obs	0
Uncensored obs	50	Total obs	50

Appendix 6: Retailer Level Regression Results

Dependent Variable: PPHL

Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)

Date: 05/14/16 Time: 08:57

Sample: 1 50

Included observations: 50

Left censoring (value) series: 0

Right censoring (value) series: 1

Convergence achieved after 4 iterations

Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.274540	0.092945	2.953784	0.0031
AGE	-0.001136	0.001208	-0.939826	0.3473
EXPE	-0.005897	0.002236	-2.637823	0.0083
EDUBSIC	-0.018853	0.020117	-0.937177	0.3487
PACKAGN	-0.027724	0.031222	-0.887984	0.3745
TRANS	-0.014996	0.027822	-0.539015	0.5899
LSTORE	0.035907	0.006343	5.661129	0.0000
TRAING	-0.065998	0.027888	-2.366562	0.0180
GENDER	-0.029949	0.040077	-0.747297	0.4549

Error Distribution

SCALE:C(11)	0.059727	0.005972	10.00073	0.0000
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Mean dependent var	0.288234	S.D. dependent var	0.150126
S.E. of regression	0.067431	Akaike info criterion	-2.358078
Sum squared resid	0.177332	Schwarz criterion	-1.937433
Log likelihood	69.95195	Hannan-Quinn criter.	-2.197894
Avg. log likelihood	1.399039		

Left censored obs	0	Right censored obs	0
Uncensored obs	50	Total obs	50

Appendix 7: Plagiarism Report

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CHAPTER ONE

INTRODUCTION

1.1 Background

Mango, (*Mangifera indica L.*) is a fruit of high economic importance that constitutes approximately half of all tropical fruits grown globally. Globally, India is the highest producer of mango contributing 42.06% to total world production (Yadav, 2013).

Ghana has two seasons of harvesting mangoes in the south zone of the country. This gives Ghana a comparative advantage in mango production over her neighbours (Baidoo-Williams, 2015, Melle, and Buschmann, 2013). Mango has therefore been identified as one of the potential

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