IMPACT OF THE CURRENT POSTHARVEST STORAGE PRACTICES ON THE QUALITY OF GHANA MANGO FOR EXPORT

A Research Project Submitted to Larenstein University of Applied Sciences in Partial Fulfillment of the Requirements for the Degree of Masters in Agricultural Production Chain Management, specialization Post Harvest Technology and Logistics

By

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LIST OF ABBREVIATIONS

ADRA	Adventist Development and Relief Agency
AfDB	African Development Bank
CEPS	Customs Excise and Preventive Services
DAES	Directorate Agricultural Extension Services
DAMFA	Dangme West Mango Farmers Association
EMQAP	Export Marketing and Quality Awareness Project
EPA	Environmental Protection Agency
EU	European Union
FAGE	Federation of Associations of Ghanaian Exporters (FAGE)
GDP	Gross Domestic Product
GEPC	Ghana Export Promotion Council
GLOBALGAP	Global Good Agricultural Practice
GPHA	Ghana Ports and Harbours Authority
GSB	Ghana Standard Board
GTZ	German Technical Cooperation
HAG	Horticultural Association of Ghana
HEII	Horticultural Export Industry Initiative
IMO	Institute for Marketecology
MCA	Millennium Challenge Account
MOFA	Ministry of Food and Agriculture
MOTI	Ministry of Trade and Industry
NGOs	Non Governmental Organisations
NLC	National Labour Commission
PAMPEAG	Papaya and Mango Producers Exporters Association Ghana
SPEG	Sea - Freight Pineapple Exporters of Ghana
USAID	United States Agency for International Development
YKMFA	Yilo Krobo Mango Farmers Association

ABSTRACT

Mango is an emerging tropical export fruit produced in over 90 countries worldwide. Export markets for mangoes have expanded in temperate regions because of social changes, increase in international cargo space and promotion of export fruit production in developing countries. Ghana has been producing and exporting insignificant volumes of mangoes in the last 15 years. Ghana's main export destination of mangoes is the EU market.

Agriculture in Ghana continues to be the main driving force behind its economy and in the past agriculture had been centred around production driven rather than market demand driven. Over the past few years the government has encouraged the development of non traditional agricultural sector in order to diversify the country's export. Emphasis is placed on horticultural production in recognition of Ghana's natural and competitive advantages in the area. Gradually the horticultural sector has become impressive with horticultural exports increasing its level over the last seven years with exports of pineapples, bananas and vegetables taking the forefront followed by mangoes and others.

The mango sector holds lot of promise for Ghana's economy if the best practices are applied at every level of the supply chain.

The research therefore seek to access the impact of post harvest storage practices on the quality of mangoes for the export market, to identify for the improvements and recommend appropriate storage practices at the producer and exporter levels.

A survey and a case study were conducted on chain actors and stakeholders in the mango export chain to review the current post harvest storage practices of producers, post harvest losses and awareness level of producers and exporters on the effect of storage on quality. Data from the field study was analysed using statistical programmes to determine the differences on storage practices of mango and quality between the different producers.

Based on the findings there were differences in the way producers handle and store their mangoes. Small scale producers did no or little storage of mangoes. Small scale producers who stored their mangoes stored them in the open air exposed to direct sunlight. On the converse, commercial scale producers stored their mangoes ranging from a period of one (1) to two (2) days. Commercial scale producers' practices of storing mangoes ranged from under sheds, enclosed rooms without cooling and cooling rooms.

The study concluded that there were differences in the level of quality of mangoes produced by different producers considering intrinsic and extrinsic attributes of quality. Furthermore it was concluded that there were differences on the awareness level of producers on the effect of storage on quality.

The study made recommendations to specific organisations in the government, as well as specific companies for the exporters and producers.

Keywords: Post harvest storage, mango quality, export value chain

CHAPTER 1 INTRODUCTION

1.1 Background of Study

Mango (*Mangifera indica L.)* is a very delicious tropical fruit which has an excellent flavour, attractive fragrance and nutritional value. It is a large, fleshy drupe, containing edible mesocarp of varying thickness. It is resinous and highly variable with respect to shape and size. It's colour at maturity is genotype – dependent. Peel colour is an important component of fruit quality and, therefore, plays an important role in consumer acceptability (Medlicott *et al.* 1986).

Mango as an emerging tropical export fruit is produced in over 90 countries worldwide with a production of over 28.51 million metric tonnes in 2005. Asia accounts for approximately 77% of global mango production, and the Americas and Africa account for approximately 13% and 9%, respectively (FAOSTAT, 2007). Currently, only about 3% of the world production of mango is traded globally representing a noticeable increase over the quantities traded 20 years ago (Evans, 2008). Export markets for mangoes have expanded in temperate regions because of social changes, increased international air cargo – space for some sectors and promotion of export fruit production in developing countries (Proctor and Cropley, 1994).

In 2005, world exports of mangoes reached 912,853 metric tonnes, totalling US $543.10 million (FAOSTAT, 2007). The major exporters of mango include Mexico, India, Brazil, Pakistan and others.

Although Ghana has been producing and exporting mangoes over the past 15 years, the country's exports are very insignificant in the international market, as the country is not listed in the first 40 exporters of mangoes in spite of the fact that the country has a comparative advantage over the other exporters of mango. Table 1 below gives details of production and export of mangoes from Ghana.

Table 1 Production and export of mangoes in Ghana from 1944 - 2007 in tonnes

Years	Production	Export
1994	4000*	9
1995		26
1996		79
1997		81
1998		158
1999		144
2000		244
2001		169

2002	4000*	126
2003		193
2004		227^
2005	6600	772
2006	6996	369^
2007	6800*	711

(Source FAOSTAT, 2009) *=FAO estimate, ^=Estimated data using trading partners database

The EU specifically, United Kingdom, Germany, Switzerland, France, Italy and Netherlands are the main export destinations of mangoes from Ghana. In 2004, the EU imported 170,000 metric tonnes valued at more than US$ 200 million. Out of this, Ghana registered only 227 metric tonnes representing less than 1% of the total volume of imports of the product. (GIPC, 2005)

Agriculture in Ghana continues to be the main driving force behind its economy. Past interventions in the sector had mainly focused on production aspect of agricultural commodities without adequate consideration of market demand (GTZ Ghana, 2006). In recent years, the government has encouraged the use of the value chain approach for the development of the non-traditional agricultural sector in order to diversify the country's export base.

Emphasis is placed on horticultural production in recognition of Ghana's natural and competitive advantages in the area. The major crops that are mainly produced in the horticultural sector include the following; pineapple, mango, papaya, banana, citrus, chilli pepper, tomatoes, plantain and other fruits and vegetables (GIPC, 2008).

Gradually, Ghana's horticultural sector has become impressive. Horticultural exports are more than 250 percent of the level they were seven (7) years ago, when measured in dollar terms. Ghana's pineapple sector gets the credit for much of this success, exceeding US$ 55 million in export revenue in 2006, Ghana's banana exports in 2007 reached 20 times their 2000 volume, vegetable shipments to Europe are up 75 percent over the decade, and shipments of other fruits such as melons, mangoes and papayas are becoming significant.

Ghana's location, climatic and soil conditions place it in a better position to be one of the top exporters of horticultural products to Europe especially at a time when Europeans are turning to imports to satisfy consumers' growing demand and broadening tastes for fresh fruits and vegetables as well as for new, high quality, ready to eat foods. Ghana is one of the few countries in the world with two mango seasons in the southern part of the country.

The mango sector therefore holds a lot of promise for revenue generation for Ghana's economy and source of livelihoods for the rural populace since the mango industry has all the natural conditions that can position it as a top exporter if the appropriate infrastructure and best practices are applied at every level of the supply chain.

1.2 Business Environment of the Mango Sector

Ghana since 1982 has enjoyed a long period of political stability that enabled it to create in 1992 a liberal democratic constitutional order based on multi-party democracy (Jonah, 2005). At the end of 2008 it has been able to conduct five peaceful and successful elections with change in government from one party to the other. The country's broad and sound political stability puts Ghana ahead of other sub – Saharan African countries that produces mango in the sub region.

Agriculture in Ghana is guided by a policy document which was developed to guide development and interventions in the agriculture sector. MOFA mandated by the government is responsible for development and growth of agriculture in Ghana. (MOFA, 2007)

Under its crop development policy, MOFA seeks to enhance an integrated promotion of food, horticultural and industrial crop, enhance the competitiveness and profitability of crops through access to improved technological packages for increased productivity and lastly ensure sustainable management of environment in crop production systems. The strategies of the crop development policy are;

- To support production of certified seeds/planting materials and increased farmer usage through intensification of awareness campaigns,

- To intensify dissemination of updated crop production technological packages, facilitate the development of high-yielding, disease and pest-resistant varieties and increase supply of certified planting material, and

- To ensure that operators of urban agriculture are reached with the needed information, technology and inputs. (MOFA, 2007)

In supporting the growth and development of Ghana's horticulture export industry the government supported by the World Bank implemented the Horticultural Export Industry Initiative (HEII) Project. The project made investments in key areas in the pineapple sector that set basis for accelerated development of the horticulture industry (Faalong, 2006).

Land tenure is highly insecure in Ghana. The constitution gives the authority to local chiefs to manage and allocate land, and divides land into public tenure and customary land holdings. Public land is held in trust by the President and is managed by the central lands commission, whereas the title to customary land is held in trust by local chiefs. Land is generally allocated and held in perpetuity and can be transferred by inheritance, but there are restrictions on its sale or transfer.

Consequently, accessing land is difficult for agricultural, industrial, commercial and residential development purposes due to conflicting claims of ownership, and outmoded land disposal procedures. However, it is possible to assemble relatively large tracts of land in Ghana, in particular if the government is favourable to the investment. It is possible to lease land from government or from the chiefs for long periods of time. For example, the tropical fruit exporter, Golden Exotics, has a long-term lease for some 2,000 acres used for pineapple and banana crop production.

Smaller investments are possible as well, if the investor is willing to engage in the lengthy process of locating the land, determining its availability, and negotiating with the respective chief of the region. (World Bank Group, 2006)

The operative law regulating general investment in the country is the GIPC Act 1994 (Act 478), which makes provision for the automatic award of investment incentives and benefits without prior approval. Incentives under the law include:

Customs Import Duty Exemptions for agricultural and industrial plant, machinery and equipment imported for investment purposes as contained in chapters 82, 84, 85, and 92 of the Customs Harmonized Commodity and Tariff Code. However, with the exception of goods imported specifically for the Educational, Health and Agricultural sectors, all import duty-exempted goods attract the relevant processing and/or other related fees or levies ranging between 0.5% and 1.0%

Income Tax Incentives for Income from Non-Traditional Exports such as horticultural produce since 2007 is 8%. Whiles the tax rate applicable to income derived by a financial institution from a loan granted to a farming enterprise for use by that enterprise in the production of its income is also 20%.

There are exemptions (tax holiday) on all agriculture and agro-industry from start of operations.

Location incentives (tax rebates) on agro-processing enterprises which use local agricultural raw materials as their main inputs, after the initial 5-year tax holiday period are to enjoy corporate tax rates fixed according to their location as follows:

Accra-Tema – 20%

Other Regional Capitals – 10%

Outside Regional Capitals – 0%

All over Northern, Upper East, Upper West Regions – 0%

To facilitate the settlement of industrial disputes, manage labour and employment issues, the NLC an independent organisation is mandated by the government to enforce the Ghana Labour Act (NLC, 2005) which takes into account condition of employees and employers.

The EPA a governmental organisation is mandated by the government to oversee all environmental issues in the country and enforce the Environmental Protection Law enshrined in the Ghana Environmental Protection Agency Act (Act 490). (EPA, 2006)

Agriculture continues to contribute the largest share to the GDP, even though the share of the sector in national output declined from 44% in 1990 to 37% in 2005. Agricultural growth increased from about 4% in 2000 to 6% in 2005 but much of the recent growth has been stimulated by the cocoa industry.

Current inflation rate is 20.3%, the highest since December 2004. The upward surge is attributed to 2008 high world oil prices, high food prices and a declining cedi currency. Interbank interest rate is 22.28% at May 2009. (BOG, 2009)

Analyst anticipates oil and gas production of initial output estimate of 120,000 barrels of oils per day and 120 million cubic feet of gas in 2010 which is expected to bring much revenue to the country.

The agriculture sector employs 60% of workforce with most people living below the minimum wage of GHC 2.25/day. Ghana’s unemployment rate declined from 75.9% to 71.6% according

to the World Bank, which says the drop is because of rapid population growth over the last couple of years

The mango industry consists of both small and medium to commercial scale producers. Ownership of companies in the industry is diverse with about 51% locally owned firms, 21% joint ventures and 28% completely foreign owned.

Smallholders are indigenous rural inhabitants who operate their farmland in their own villages with low level of formal education. There is high rural - urban migration of youth to cities for white colour jobs. Small scale farmers are mostly old folks. The way of life in rural communities is subsistence farming. Labour used in small scale farms are family labour, hired labour and labour exchange groups. Medium and commercial scale farmers have high level of formal education. The medium scale farmer operates farm as part time business

The involvement of the private sector in the industry has continually increased the volume of mango exports progressively from 126 metric tonnes in 2002 to 711 metric tonnes in 2007.

Consumers in EU who are the main destination market for Ghana mangoes are increasingly becoming aware for need for health and safety consciousness, and environmental sustainability in the food industry.

The industry lacks the institutional support for research and development in mango for newer cultivars and varieties and thus greatly relies on foreign cultivars and varieties.

1.3 Problem Statement

The Ghanaian mango export chain continues to register low export volumes and low quality of mangoes.

1.4 Research Objectives

The research objectives are to assess the impact of the current postharvest storage practices on the quality of Ghana fresh mangoes, in particular for the export market, to identify for the improvements and to recommend appropriate storage practices at the producer and exporter levels.

1.5 Research Questions

1.5.1 What are the current postharvest storage practices?

i. How is the fresh mango chain organized in Ga Dangme West and Yilo Krobo Districts in Ghana?
ii. What factors do small and commercial producers consider in harvesting their mangoes?
iii. What is the length of the storing period of mangoes between small and commercial producers?
iv. How do small and commercial producers transport their mangoes?
v. What are the current ways of storing mangoes between the small and commercial producers?

1.5.2 What are the effects of the current storage practices on quality of mangoes for export?

i. What are the volumes produced and volumes exported in Dangme West and Yilo Krobo Districts?
ii. What are the post harvest losses and current level of mango quality for export between small and commercial producers?
iii. What are the quality standards for the export market?
iv. What are the factors affecting quality of mangoes for export?

1.5.3 What are the appropriate storage practices for the Ghanaian mango producer and exporter?

i. What is the level of awareness of producers and exporters on the effect of storage on quality?
ii. What are the improvements needed on storage practices for Ghanaian mango producer and exporter?

1.6 Research Methods

The research methodology is presented in Chapter 3.

1.7 Outline of the Study

This study is organized into six (6) main chapters. Chapter 1 deals with the background of the study and business environment of the mango sector. It further describes the problem statement, the research objectives and three main research questions followed by its sub questions which forms basis of the study.

Chapter 2 gives a review of studied secondary data for the research where findings and views of related studies to the research topic has been carried out. This chapter reviews post harvest storage of mango and its impact on quality for the mango export chain.

Chapter 3 deals with the research methodology elaborating on the research area, sampling size, tools used for collection of data and the data analysis. The results of the empirical findings of the research and its subsequent discussion are covered in Chapters 4 and 5 respectively.

In Chapter 6 conclusion and recommendations from the study are drawn in comparison with existing literature.

1.8 Limitations of Research Study

Though mango is produced in both the southern and northern sectors of the country, the research could not cover both sectors of the country; hence it may be possible that the data and subsequent information generated may not be a proportionate representation of the whole population. This is because the research time frame and resources does not make it possible for an in-depth analysis of the entire mango industry across the country.

Another limitation of this study was the unwillingness of some producers and exporters to share information because they were of the view that researchers always collected information from them yet they failed to provide solutions to their problems.

CHAPTER 2 OVERVIEW OF LITERATURE ON MANGO STORAGE AND QUALITY

During post harvest storage of mango several factors such as temperature, relative humidity, maturity level, ethylene inducement, etc have adverse effects on quality characteristics of mangoes. This chapter deals with the review of literature on post harvest storage of mango and quality.

2.1 Post harvest Storage Conditions of Mango

Most of the postharvest technologies for mangoes have been developed for controlling diseases and insects and for protection against injury during packaging and transport. Mangoes have poor storage qualities and technologies for longer term storage, such as controlled or modified atmospheres which have not been applied successfully to mango storage (Litz, 1997). This is because mangoes are not stored at the right maturity level thereby inducing ripening processes. Storage methods for mangoes have been characterised by variable results and the occurrence of physiological disorders (Chaplin, 1989). The practices relating to the storage of mangoes should therefore be given maximum attention to increase the shelf life and maintain quality.

According to Rathore (2007) the quality of mangoes are highly influenced by postharvest handling techniques due to its high perishable nature and its susceptibility to postharvest disease, extremes of temperature and physical injury. Mangoes thus have short shelf life and reaches respiration peak of ripening process between three (3) to four (4) days after harvest at ambient temperature. This seriously limits mangoes commercialisation in distant markets hence mangoes have to be consumed soon after harvest or given the proper storage conditions.

On the effect of maturity on transportation and storage of mango, Mitra and Baldwin 1997 states that generally, fruits designated to local markets or shipments by air (a three-day marketing frame) are harvested after the colour break or medium-ripe and fruits intended for longer transportation distances or storage (8–10 days) are in general harvested firm and green, but physiologically mature. However, improper handling and inadequate transport and storage conditions result in poor quality of the fruits, and limit mango marketability.

The above assertion appears to reflect the study of Malik et al. (Eds) 2005 who reviewed that 25 - 30% of mango produce is lost due to improper post harvest operations; as a result there is considerable gap between the gross production and net availability. They further suggested that if proper care is taken from harvesting to final marketing, considerable losses can be minimized and better quality fruit can reach to consumers, ensuring higher returns to the producers.

Some optimal conditions for the handling of some fresh fruits are listed in table 2.

Table 2 Optimal conditions for fresh produce

Fruit Name	Storage temp. (°C)	Relative humidity (%)	Highest freezing temp.(° C)	Ethylene sensitivity	Approximate storage life	Observations & beneficial CA conditions
Mango	13	85 – 90	- 1.4	Medium	2 – 3 weeks	3-5% O_2 + 5 – 10% CO_2
Pineapple	7 - 13	85 – 90	-1.1	Low	2 – 4 weeks	2 – 5%O_2+ 5 – 10CO_2%
Papaya	7 – 13	85 – 90	-0.9	Medium	1 – 3 weeks	2-5%O_2 + 5 – 8%CO_2

Source: Kader 2002.

2.2 Effect of Temperature on Storage Conditions of Mango

Lee and Kader (2000) states that, temperature management after harvest is the most important factor to maintain vitamin C of fruits and vegetables. They further state that vitamin C losses are accelerated at higher temperatures and with longer storage durations. They report that the loss of vitamin C after harvest can be reduced by storing fruits and vegetables in reduced oxygen and or up to 10% carbon dioxide atmospheres, with higher levels of carbon dioxide accelerating vitamin C loss.

Jobling (2000) also reports that temperature management is essential for maintaining produce quality. He explained that the ideal temperature of fresh produce after harvest often depends on the geographic origin of the product. He states that tropical plants have evolved in warmer climates and therefore cannot tolerate low temperatures during storage.

In comparison with the study of Lee and Kader (2000) and Jobling (2000) it is clear that both researchers regard temperature management as a key factor in maintaining fruit vitamins and produce quality.

Again, according to Jobling (2000) temperature has big effect on the rate of metabolism of produce. He explains that when temperature of products rises, so too does the rate of metabolism. One of the main processes of metabolism is respiration which is the process of breaking down stored carbohydrate to produce energy. When temperature rises in products which do not have a lot of stored reserves, such as leafy vegetables and flowers, carbohydrate can become limited and more simply they run out of food and as a result the shelf life and quality is rapidly reduced by warm temperatures. He presents that lowering temperature as quickly as possible after harvest will slow the rate of metabolism and therefore extend the product's shelf life.

Jobling (2000) further explains that high temperatures usually result from exposure to either direct sunlight, hot air in the field or heat treatments used for the eradication of pests. Some examples include not removing the field heat from harvested products, leaving harvested product in the direct sunlight or a breakdown of refrigeration and lack of air circulation. The temperature is also increased by the heat generated by the product itself. As the product

respires it produces heat and if the products are packed in a way that prevents air circulation then the heat can build up considerably. At extreme temperatures problems may arise. For example some enzymes which keep the plant functioning slows down at temperatures above 30° C and cease operating at 40°C. This results in high temperature injury. The consequences are a general loss of pigment or colour and effected areas develop a watery appearance and appear translucent. Kader (1992) and Mitra and Baldwin 1997 both also describes the consequences of chilling injury as surface pitting, discolouration, internal breakdown and decays.

Jobling (2000) concludes that at extremes of temperatures, products get damaged. He explains that some suffer chilling injury whiles others suffer damage at very high temperatures and all products are damaged if they freeze. He further presents that short exposures or few hours of exposures to extreme hot or cold temperatures can cause a marked decrease in shelf life and loss of quality. Hence he suggests that correct and careful temperature management throughout harvest and marketing chain is essential if the quality of the product is to be assured. Jobling (2000) reports, that mango should be stored at temperature above 10º C.

However, according to Mitra and Baldwin 1997 cited in Nune et al. 2007 besides the quality of fruit at harvest, the use of an optimum temperature during handling and storage of fresh mango is a major factor and determines the quality of a fresh fruit. Mango fruit is very sensitive to cold temperatures and prolonged storage periods at temperatures below 10º C may delay ripening and lead to chilling injury damage. Depending on the cultivar, maturity stage and season of harvest, some mango fruits can be stored between 7º and 8º C for 25 days while others require temperatures above 13º C. Green fruit should be stored between 10º and 15º C, while ripe fruit can tolerate much lower temperatures. Therefore, in order to reduce the risk of chilling injury, Mitra and Baldwin 1997 cited in Nune et al. 2007 recommends storage temperatures for mangoes between 12º and 13º C. This assertion somehow falls in line with Jobling (2000) who recommends that mango should be stored at temperature of above 10°C.

Nune et al. 2007 states that although some studies refer to the quality changes in mango fruit during storage, no information are found regarding precise quality curves for mangoes stored at different temperatures or regarding which quality factor(s) are the most important to determine the limits of marketability.

Nune et al. 2007 further carried out a study to (1) obtain quality curves for mango stored at different temperatures; (2) to identify for each temperature which quality factor(s) limits mango marketability; and (3) to compare the quality curves and shelf life of mango based on quality evaluations with those predicted by respiration rates reported in literature.

As part of their study two mango varieties (cv. Tommy Atkins and palmer) were harvested medium – ripe and held for 7 to 20 days at five different temperatures and evaluated for quality attributes.

The fruits were removed from the field with minimal delay after harvest and transported to the laboratory within 6 hours. Chilling injury and increased fruit softness were the limiting quality factors for mango stored at 2º and 5º C. Softening of fruit, changes in colour and development of decay were the limiting quality factors for mango stored at 12º, 15º and 20º C. Predication of mango shelf life calculated from the data reported in the literature is not precise unless the characteristics of the fruit and environmental factors involved are well known. The curves obtained from quality evaluations for each temperature showed that a single quality attribute cannot be used to express loss of quality of mango over the normal physiological range of temperatures.

The study also resulted that the weight loss of mangoes increased during storage, regardless of storage temperature, and the rate of the weight loss was comparable for two mango cultivars. The study suggests that a weight loss between 7 and 9% may be the maximum acceptable loss before tommy atkins and palmer mangoes become unacceptable for sale.

The study revealed that the colour of the fruits changed regardless of the storage temperature. However, the changes were faster in mangoes stored at temperatures higher than 5º C. Besides, the colour of “Tommy Atkins” mango changed much faster than that of “Palmer.” Overall, after 4 days at 20º C, the skin of the “Tommy Atkins” mango was almost full yellow-reddish, while it took approximately 6 days at the same temperature for the skin of the “Palmer” mango to reach the same colour stage.

Firmness of the fruit was the first quality factor to change, particularly in fruits stored at temperatures higher than 5º C. Harvesting the fruits at the medium-ripe stage might have contributed to the accelerated ripening and softening during storage. Although “Tommy Atkins” and “Palmer” mango cultivars were rated very firm on touch at the time of harvest, the softness of the fruit increased during storage, despite the storage temperature or cultivar.

In the mango stored at non-chilling temperatures, increased softness was the quality factor that determined the maximum shelf life of the fruit.

Although softness was the first quality factor to reach the limiting quality rate, colour changes and decay should not be disregarded as they also contributed to the loss of quality in the fruit stored at non-chilling temperatures.

Morton (1987) reports, that in India some cultivars, especially Bangalora, Alphonso, and Neelum have much better keeping quality than others. He reported that Alphonso kept well for 4 weeks at 11.11° C and 6 to 7 weeks at 7.22° C. He further reported that storage at lower temperatures is detrimental inasmuch as mangos are very susceptible to chilling injury. Any temperature below 13° C is damaging to Kent. In Florida, this is regarded as the optimum for 2 to 3 weeks storage. The best ripening temperatures are 21.11°- 23.89° C.

2.3 Effect of other factors on Storage Conditions of Mango

According to Morton (1987), Irwin, Tommy Atkins and Kent mangos, held for three (3) weeks at storage temperature of 13° C and relative humidity 98% to 100% and atmospheric pressure of 76 or 152 mmHg, ripened thereafter with less decay at 21° C under normal atmospheric pressure, as compared with fruits stored at the same temperature with normal atmospheric pressure in Florida.

Influence of storage period on post harvest characteristics of different varieties of mango were investigated by Zambrano et al. (2000) and reported that the following mango varieties Kent, Palmer, Keitt, Springfels and Anderson have good performance under intermediate temperatures of storage. Uniform fruits and free of visual defects stored at 13° C and 85% – 95% relative humidity for 18 days showed significant difference among varieties in pulp and peel colour parameters (lightness, hue and chroma). Soluble solids content, ascorbic acid and starch content changed significantly ($P<0.05$) during storage and they were significantly different among varieties. Total and reducing sugars content did not change significantly after 15 days of storage.

Ortega-Zaleta and Elhadi (2000) reported that 'Manila' mangos (*Mangifera indica L.)* were exposed to controlled atmospheres (CA) (0 kPa O_2 – 50 kPa CO_2) at 40, 42, 43, 44, 45, 46, 47, 48, and 49°C for 160 minutes, cooled in water at ambient temperature, and then stored at 10°C and 80% RH for up to 20 days. Relative to non - treated controls, fruit heated at 40, 42, 43°C did not show any external or internal injury, while those subjected to 44°C developed slight injury after 10 days and severe injury after 20 days. Fruit subjected to > 45°C had severe injury after storage for 10 days and the injury increased very significantly after storage for 20 days. Fruit exposed to 49°C and stored for 20 days had 100% injury. Weight loss was similar in control and in heat-treated fruit. Fruit firmness losses decreased as the temperature increased to 46°C and then increased. Chroma of exocarp and mesocarp decreased, while hue angle value of mesocarp increased as temperature increased. Based on the extent of fruit injury, CA is tolerated by 'Manila' mangos at <44°C, but not at 44°C.

Bower et al. (2003) observed that although it is desirable to minimize ethylene in the storage atmosphere, benefits are likely to be minor compared with the potential gains from good temperature management. The effect of ethylene on the quality of 'Bartlett pears' stored at either – 1 or 28°C was examined. Fruit from three different harvest dates were stored for 3 months in 0, 1, 5 or 10 ml ethylene. Quality attributes, including skin colour, firmness, scald and internal browning, were assessed when the fruit were removed from storage and after 4 days ripening at 28°C. All levels of ethylene increased the incidence of physiological disorders. However, the effect of ethylene was minor compared with the influence of temperature. Fruit at -1°C remained firm and green, subsequently ripening normally at 28°C, irrespective of exposure to ethylene. In contrast, all of the pears kept at 28°C softened and yellowed during storage, and developed symptoms of superficial scald and internal browning. The severity of these disorders increased when fruit were ripened at 28°C.

Fonseca, MJ. de. O., et al. (2001) reported that haden mangoes were dipped in benomyl (1 g/litre) or benzalkonium chloridebenzalkonium chloride (2 g/litre), with or without clean wax (an emulsion containing 18.5 to 20.5% of carnauba wax and acrylic resins mixture) and stored at 13±1 °C and 80 – 90% RH for 21 days. Partial ripening occurred during storage. Waxing increased the general appearance of the fruits, mainly by maintaining them more turgid. Both fungicides controlled anthracnose [*Glomeralla cingulata*] development during storage.

2.4 Mango Quality Attributes and Grade Standards for Export

2.4.1 Mango Quality Attributes

According to Zind 1989 cited in Nune et al. 2007 appearance, colour, texture and aroma are probably the most important criteria used by a consumer to evaluate the immediate quality of a fruit and thus, persuade him or her to buy it.

Zuniga – Arias et al. 2007 also suggests that the different attributes included in the concept of quality depend on the relevant actor who is acquiring the product. Major actors participating in the valuation of food quality for the export market are producers, processors, exporters, importers, wholesalers, retailers and consumers, while external agents like voluntary agencies and the government may influence these perceptions wholesalers and retailers emphasize visual attributes such as size, form, colour and shelf life, taking into consideration consumer preferences.

Government officials are involved in regulations concerning health and safety aspects. Producers and processors commonly give preference to profit attributes, like higher yields, suitability for mechanical harvesting and industrial preparation, and resistance against plagues and diseases.

However, consumers are interested in many more aspects related to food quality such as taste, freshness, appearance, nutritional value and food safety. This criterion of consumers described by Zuniga – Arias et al. 2007 supports what Zind 1989 cited in Nune et al. 2007 described about consumers.

According to Kader (1999, p.203-204) quality, that is, the degree of excellence or superiority of fresh fruits and their products is a combination of attributes, properties, or characteristics that give each commodity value in terms of human food. He further state that the relative importance of each quality component depends upon the commodity and its intended use (example, fresh or processed) and varies among producers, handlers and consumers. This confirms what Zuniga – Arias et al. 2007 stated earlier.

Romano et al. (2006) stated that quality has different meanings for different stakeholders (producers, distributors, consumers, etc) but consumer acceptance seems to be the most important factor to consider. This supports Kader 1999, p. 203 - 204 argument on the definition of fruit quality.

Kader (1999) stated that to producers a given commodity must have high yield and good appearance, it must be easy to harvest, and must withstand long distance shipping to markets. He further explains that appearance quality, firmness, and shelf – life are important from the point of view of wholesale and retail marketers whiles consumers judge quality of fresh fruits on the basis of appearance (including freshness) and firmness at the time of initial purchase.

Consumers are also concerned about the nutritional quality of fresh fruits, which are not only colourful and flavourful components of our diet, but also a good source of energy, vitamins, minerals, dietary fibres and many bioactive compounds that enhance human health. (Kader 1999). This is in agreement with the statement by Medlicott et al. 1986 cited in Nune et al. 2007 on consumer acceptability of mangoes.

Kader (2008) stated that although consumers may buy fruits on the basis of their appearance and firmness, subsequent purchases depend on their satisfaction with how these fruits taste. He further stated that Mango flavour quality is influenced by the cultivar, maturity stage at harvest, post harvest handling procedures and environmental conditions (avoiding mechanical damage and chilling injury), ripeness stage at the time of eating the mango.

Kader (2008) asserts that mango quality indices include uniformity of shape and size, freedom from decay and defects, skin colour that is characteristics of the cultivar, flesh colour, flesh firmness (juiciness, fibre content), and flavour (sweetness, acidity, aroma intensity). There are large differences in flavour quality and fibre content of mango cultivars, which can be grouped on the basis of fibre content into none to slight (less than 1%), moderate (1-2%), and high (more than 2%).

Kader (2002) reports that the quality performance of mango fruit is based upon the external and internal quality attribute. The external attributes include the weight of the mango fruit, the presence of black spots, latex and damages. The internal quality attributes include the presence of mango fly, flesh maturity (based on flesh colour), internal damages, pH and Brix % of fruit juice.

Zuniga – Arias et al. 2007 reported that the choices of attributes are based on the following; weight is an important fruit quality attribute for the whole chain. Actors, such as producers are paid on the basis of the kilograms of mango fruit delivered to the next actor in the chain. The presence of black spots is a negative quality attribute. This can be the result of a disease such as a fungus, or the damages due to latex. As a result the presence of latex, a sticky juice which exudes when the stem of the mango fruit is cut, can damage the skin of the fruit.

This damage is irreversible and will appear as black streaks on the fruit skin. The presence of external damages is a negative fruit quality attribute. Damage could be for example due to harvest, tight fruit packing, transport or general rough fruit handling.

The chosen internal fruit attributes are important because for example the presence of mango fruit fly is a negative quality attribute (Prinsley & Tucker 1987). The fly itself burrows into seed of the fruit and the fly and its larvae eat and damage the seed and the fruit flesh, which results in an un-eatable fruit for the consumer. Export markets such as the United Stated have strict laws regarding the presence of pest and disease in and on fruit (Prinsley & Tucker 1987). The result of this is, is that fruits are given a heat treatment in the sorting and packing plant to kill the fruit fly, when being exported to the United States.

Romano et al. (2006) stress that management practices and decisions in the orchard can affect fruit quality at the point of sale.

Zuniga – Arias et al. 2007 reported that quality variability is lower in the export side of the chain and the variability in quality increases the closer you get to the costumer. This might be because the closer to the costumer bigger the niches and outlets and consumer wishes the product must meet, then the retailers must have any type of mango to cope with that wide range of options. Producers delivering to the export market face the international regulations, forcing them to have a certain type of produce to meet the strict requirement for the export market. This is in line with the statement of Shewfelt (2006) in which consumer do not behave uniformly, being influenced by their cultural, historic, religious, demographic, economical and social background.

2.4.2 Factors Affecting Fruit Quality

Kader (2008), reports that there are several factors which affect fruit quality. He mentions maturity at harvest as an important factor in determining eating quality of ripe mangoes. According to Mitcham and McDonald (1992), 6 stages of maturity and ripeness of ‘Keitt’ and ‘Tommy Atkins’ mangos are as follows: (1) Immature-green (underdeveloped shoulders); (2) Mature-green (well-rounded shoulders); (3) Firm (yields slightly under pressure); (4) Fairly-firm (yields significantly under pressure); (5) Soft-ripe (soft fruit); and (6) Over-ripe (extremely soft, mushy).

However, Mitra and Baldwin (1997) reports that many maturity indices have been tested however, due to differences among cultivars, production conditions and locations, there is no consensus on maturity indices.

Kader (1999) asserts that the eating quality of mangoes when ripe depends upon maturity at harvest, avoiding physical damage and chilling injury during postharvest handling, and minimizing anthracnose incidence.

Another factor affecting quality of fruits which Kader (2008) reports on is genotype (cultivar or variety). He also mentions it as a very important factor for determining mango quality.

He further reports on cultural practices such as water and nutrients (especially nitrogen and calcium) supply, integrated pest management procedures, and crop load on the tree influence mango maturity rate, quality at harvest, and postharvest-life potential (related to incidence and severity of physiological disorder and decay).

Kader (2008) reports on another factor affecting quality of fruits as postharvest handling practices such as preparation of fruits for market (washing, heat treatment, waxing, fungicide treatment, packaging, cooling); management of temperature and relative humidity (to avoid chilling injury and minimize water loss). According to Kader 1999, the optimal temperature for mature-green mangoes ranges from 12º to 14ºC and 8º to 12ºC for partially-ripe and ripe mangoes with an optimal relative humidity range of 85 to 95% for all mangoes.

Kader (2008) reports that delaying ripening by modified or controlled atmospheres and/or treatment with 1-methylcyclopropene (1-MCP; Smartfresh) cannot substitute for keeping mangos at the optimal range of temperature and relative humidity , but can be useful supplemental treatments under conditions when a longer postharvest-life is needed for successful marketing.

In general, the shorter the time between harvest and consumption of fruits, the better the eating quality because postharvest-life based on flavour quality is generally about 70% of postharvest-life based on appearance quality of fruits. This is because of losses in sugars and organic acids used in respiration, losses of the fruit's capacity to produce its characteristic aroma due to depletion of precursors, and/or development of off-flavours (Kader, 2008).

2.4.3 Quality attributes in International Grade Standards

- Maturity Indices

  In the US Standards for Grades of Mangos (USDA, 2007), mature means that the mango has reached the stage of development that will ensure the proper completion of the ripening process.

  The definition of mature in the European Standards, both the UN Economic Commission of Europe Standard FFV-45 (UNECE,1991) and the CODEX Standard for Mangoes (CODEX,2005) is as follows: mangoes must be sufficiently developed and display satisfactory ripeness; mangoes must be carefully picked at the stage of physiological development so as to enable them to ensure a continuation of the ripening process until they reach the appropriate degree of ripeness corresponding to the varietal characteristics, to withstand transport and handling, and to arrive in a satisfactory condition at the place of destination. In relation to the evolution of maturing, the colour may vary according to variety.

  Mature in the 1993 Mango Standards of Queensland, Australia (where 'Kensington Pride' is the main cultivar produced) is defined as the fruit has reached such a state of development as to ensure a proper completion of the ripening process and attained a dry matter content of not less than 14% and the fruit is not wilted (shrivelled).

  Mango exporters whose countries do not have grade standards use grade standards of importing countries.

- Fruit Size

  Size is not included in the 2007 US Standards for Grades of Mangos in contrast to standards of other countries. Sizing is compulsory for all mangoes marketed in Europe. The minimum weight of mangoes must not be less than 200 g. Mangoes are sized according to their weight into 3 categories as follows in table 2:

Table 3 Category of mangoes according to size and weight

Size Code	Weight Range (g)	Maximum variability within package (g)
A	200 – 350	75
B	351 – 550	100
C	551 – 800	125

Source: Kader 2008

Size tolerances for all classes are 10% by number or weight of mangoes conforming to half of the permissible difference of the related size group above or below the range specified on the package, with a minimum of 180 g in size A and a maximum of 925 g in size C. For cultivars where there is a weak relationship between weight and diameter, weight-graded fruit must also be packed to uniform diameter consistent with the presentation requirement of the class.

- Peduncle size

  While the US Standards for Grades of Mangos allow up to one inch (2.54 cm), the European Standards limit peduncle length to 1 cm. It would be useful to conduct a study of the extent of fruit punctures caused by 1-cm versus 2.54-cm long peduncles and on the basis of the results of this study, modify the allowable peduncle length in the US Standards if necessary to reduce potential fruit damage during postharvest handling of mangos.

- Defects

  Some of the defects listed in the US Standards for Grades of Mangos can be caused by several conditions. For example, external (surface) discoloration can result from sunburn, sapburn, heat damage, scuffing and abrasions, or chilling injury. Internal discoloration can result from impact bruising, heat damage, chilling injury, or elevated carbon-dioxide injury.

- Contaminants and Hygiene

  The CODEX Standard for Mangoes includes the following two food safety issues that are not covered in the US Standards: (1) Mangoes shall comply with maximum levels of heavy metals and pesticide residues established by the Codex Alimentarius Commission; and (2) Mangoes shall be prepared and handled in accordance with the appropriate sections of the Recommended International Code of Hygienic Practice for

Fresh Fruits and Vegetables and other relevant Codex texts such as Codes of Hygienic Practices and Codes of Practice. Also, the produce shall comply with any microbiological criteria established in accordance with the Principles for the Establishment and Application of Microbiological Criteria for Foods.

2.5 Quality, Safety, GhanaGAP and Traceability in Ghana

Sefa - Dedeh (2006) reports that with increasing expectations for safe produce by consumers, the Ghanaian horticultural industry has developed programs to build local capacity in production and quality management to assure the delivery of safe produce. Challenging areas have been maximum residue levels compliance and residue testing. The Ghana Standards Board has been supported with equipment and training of personnel to measure residue levels in produce.

He further states that GlobalGAP certification of farms has been on going in the Ghanaian industry. Over 60% of major exporters are currently GlobalGAP certified and many more are in the process of being certified. In order to increase the number of producers with GlobalGAP certification there is a strategic plan to assist smallholder farmers. Group certification is being pursued with training of about 20 groups to pre – certification level.

According to Sefa – Dedeh (2006), the horticultural industry has considered strategies for quality assurance and food safety as components in the normal operations of the actors. The concept of GhanaGAP is evolving towards a national quality management system. The approach taken is a gradual mainstreaming of best practices in Ghanaian horticulture and benchmarking with other protocols. It is expected to guide issues on quality safety and traceability. GhanaGAP is another public-private partnership to improve safety and quality of horticultural produce from Ghana.

Sefa – Dedeh (2006) goes on further to report that a significant development in the Ghanaian horticulture industry is the acceptance of traceability as the norm which allows produce from Ghana to be traced from the farm to the importer. A farmer Geographic Information System (GIS) put in place allows the industry to have accurate information on crop estimates and allow planned shipping volumes, times and modes of transport for efficiency. With this system the Ghanaian industry will have better information to allow production planning and promote market access.

This coupled with a bar code pallet tracking and tracing promoted by SPEG with donor support are to ensure that all farmers satisfy market requirements. As a starting point, fields of smallholder pineapple and mango farms have been mapped using GIS technology. It is expected that the industry will have real time pallet tracking and tracing from field to reception by the importer. Through these activities Ghana's produce can be part of the global integrated produce distribution network.

2.6 Value Chain Development Concept

Roduner (2007) defines value chain as an analytical as well as an operational model that takes up the fact that a product is rarely consumed at the place of its production. It is transformed, combined with other products, transported, packaged, displayed etc, before reaching the final consumer. In this process raw materials, intermediate products and final products are owned by various actors who are linked by trade and services, and each add value to the product.

Posthumus (2008) describes value chain as the full range of activities necessary to bring a product from its conception to its end use including its disposal.

Value chain actors are those who directly deal with the products, i.e. produce, process, trade and own them. Value chain supporters are those who never directly deal with the product, but whose services add value to the product and value chain influencers are those who provide the regulatory framework, policies, infrastructures, etc. at the local, national and international level (Roduner, 2007).

Chain developments require value chain upgrading strategy which concerns what chain actors must do to become more competitive and to generate greater value added in future. It also requires value chain promotion strategy which concerns the role of external facilitators such as government and donor agencies running economic development programme in chains. External facilitators do not engage in upgrading directly. Rather they facilitate upgrading and provide assistance without becoming actors themselves (ValueLinks Manual GTZ, 2007).

KIT et al (2006) describes intervention strategies for chain actors to empower their position in value chain development. The strategies are for actors to operate as vertical integrators and chain managers. That is, for vertical integrators producers take on several activities in the chain such as procuring inputs, processing, trading, transportation, etc and for chain managers producers take on high degree of control over management such as controlling terms of payment, definition of grades and standards, targeting consumers, etc.

Posthumus (2008) reports that developing value chains is often about improving access to (new) markets and ensuring a more efficient product flow whiles ensuring that all actors in the chain benefit equally in relative terms.

Confronted by short project timeframes and limited funding, development organizations often make the mistake of trying to intervene too much – for example, by taking over management of the chain, rather than enabling the farmers' organization (or other players) to do it themselves. When the project finishes and the development organization withdraws, the value chain is left without a key link, so it collapses.

Intermediary organizations should aim instead to support farmer organizations to strengthen their capacity to manage chains or chain activities. The principles of sustainable businesses, social responsibility, equity, gender responsiveness and inclusion and exclusion should be embraced before engaging smallholders in a value-chain development process. (KIT et al 2006)

Posthumus (2008) introduces typical value chain development interventions designed by governments, donors or NGO's as five VCD models. He reports that the five models are

a. Facilitating value chain development,

b. Supply chain development with small holder inclusion,

c. Contract farming to include non – entrepreneurial farmers,

d. Leading farming organisations and,

e. Do it yourself.

He describes the facilitating value chain development as true VCD intervention where in most cases analysis conclude that there is sufficient potential in the selected value chain, yet the

coordination between various chain actors is insufficient. He further explains that often the lack of coordination is due to lack of information sharing between actors, high level of mistrust and orientation on quick gains on prices. Posthumus (2008) outlines that the way forward under these circumstances is for an organisation to facilitate only, facilitate plus or facilitate to the max.

Posthumus (2008) further describes the supply chain development with small holder inclusion as an intervention needed in a value chain where lead company often the most mature value chain actor nearest to the market (large global retailers or smaller local exporters) face constraints in the upstream of the chain due to irregular supplies and products not meeting market requirements by small scale producers.

2.7 Mango Supply Chain in Ghana

According to Adongo (2006) the mango industry in Ghana is divided in two (2) production zones namely the southern and northern with the southern being the major production area with about 457 farmers and a total of 5,600 acres under cultivation. He further states that there are two (2) mango seasons in the southern sector; major from mid April to mid August and the minor from mid December to mid March.

Adongo (2006) estimates the average yields of production as 5 tonnes per hectares and states that the major varieties cultivated are kent and keitt. However varieties such as Palmer, Julie, Tommy Atkins, Haden and Zill are also in existence.

Adongo (2006) further describes the features of the chain as production, processing, wholesaling, exporting and retailing. He describes small scale farmers who are in production of mangoes as with average farm size of not more than five (5) hectares. He further states there are more numerous small scale farmers but fewer representatives in total production terms and share of exports. He further describes them as using less capital intensive production practices and application of less technology regarding irrigation systems, crop management and post harvest management. He further states that the small scale farmer depends on peers and largely on commercial farmers and project teams for technical assistance.

He states that commercial scale farmers who are in production of mangoes have average farm size more than 5 hectares. He further state that these category of farmers have more capital intensive production systems and technologies and they employ own staff for technical assistance.

According to SLE (2006), the Regional West African market for mangoes is developing rapidly with surrounding countries such as Burkina Faso, Mali and Ivory Coast producing mango successfully and with high productivity on small-scale farms. Exports of mangoes from these countries range at about 11,000 tonnes per annum.

According to SLE (2006) in comparison with the surrounding countries Ghana's mango industry is still in an infant stage with low productivity and low exports.

According to SLE (2006) the participating actors in the supply chain of mangoes in Ghana are input suppliers, mango producers who comprise of small as well as medium and commercial producers with the latter mostly exporters, processors, distributers and exporters.

According to SLE (2006) an assessment on the distribution of profits along the value chain suggests that producers gain about one quarter of the profit, input suppliers a third, whereas traders realize more than a third. SLE (2006) suggests traders transactions with producers are not based on exploitative relationships, even though traders get a higher share of profit due to their stronger bargaining position. SLE (2006) further suggests that there is widespread mistrust between mango value chain operators.

CHAPTER 3 RESEARCH METHODOLOGY

This chapter deals with the processes involved in carrying out the research study. It further describes the study areas in detail.

3.1 Overview of research design

The research employed desk study in gathering relevant literature and secondary data. During the field study the research employed a survey and a case study in gathering data and information from actors and stakeholders in the mango export chain in Ghana. It also used the case study to gather official statistical materials.

3.2 Data Collection

The data material for this report was collected in Accra the capital of Ghana during a period of ten (10) working days from 13th – 24th July 2009. Editing of questionnaires, data entry and analysis as well as search for literature was carried out during a period of twenty (20) working days in both Ghana and the Netherlands. Data collection was based on a survey on individual mango producers and exporters and members of the mango producers associations, using a set of questionnaires. Data collection was also based on interviews with representative from the District Agricultural Office, Export Marketing and Quality Awareness Project and the Papaya and Mango Producers Exporters Association of Ghana using interviewee structured interviews. Structured and semi structured interviews were employed in the data collection. The research therefore had a quantitative and qualitative approach based on empirical and literature review. Two (2) categories of mango producers and exporters were selected based on their scale of production within two (2) districts to assess the impact of post harvest storage practices on quality by the different types of mango producers and exporters and also to identify for the improvements and to recommend appropriate storage practices at the producer and exporter levels.

3.3 Study Area

The Yilo Krobo and Dangme West districts were selected for the purpose of the research out of the other mango producing districts based on the fact that the bulk of mango producers and exporters operate within the two (2) districts (MOFA, 2007).

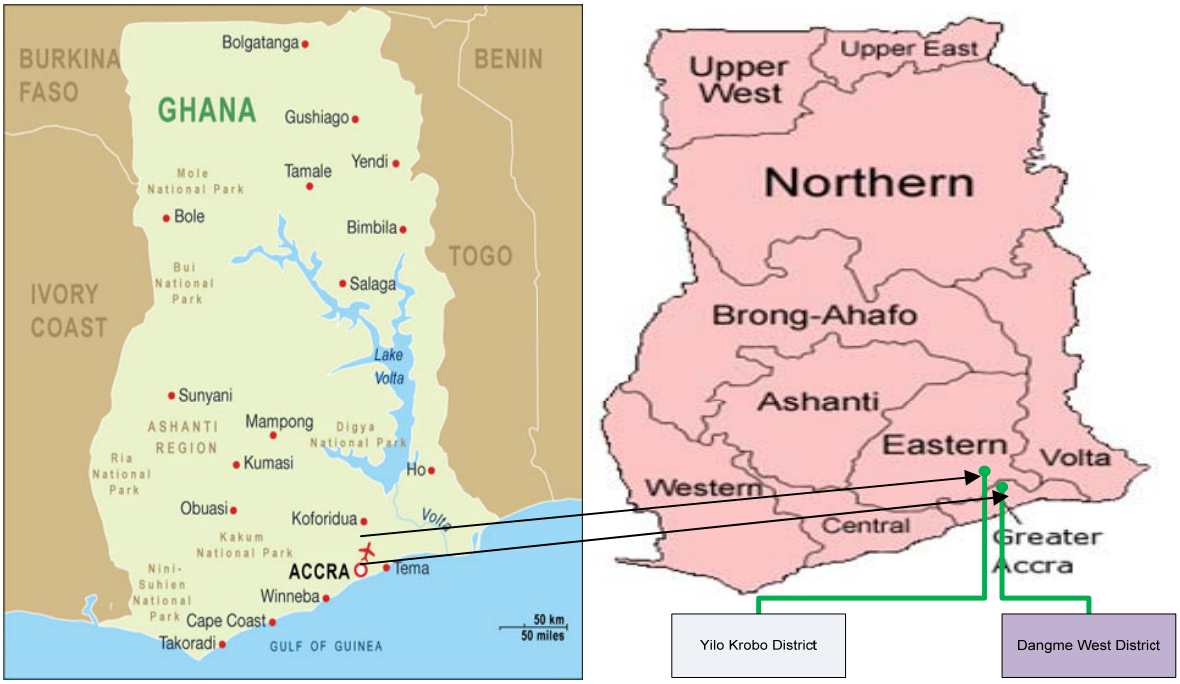

Figure 1 Map of Ghana showing Yilo Krobo and Dangme Districts inset (Source: Internet)

3.3.1 Yilo Krobo District

The Yilo Krobo District is one of the seventeen districts in the Eastern Region. It lies approximately between latitude 60.00'N and 00.30'N and between longitude 00.30' and 10.00'W. It covers an estimated area of 805sq.km, constituting 4.2 percent of the total area of the Eastern Region with Somanya as its capital. (Figure 1)

The district is bounded in the north and east by Lower Manya Krobo District, in the South by Akwapim North and Dangme District and on the West by New Juaben Municipal, East Akim Municipal and Fanteakwa District.

Crop farming is the principal agricultural activity in the district. The main crops grown in the district are maize, cassava, yam, cocoyam and plantain. A wide range of vegetables like tomatoes, garden eggs, pepper and okro are also grown. All these crops are cultivated largely on small-scale basis with labour intensive tools such as the hoe and cutlass.

The district has however seen the emergence of a few medium scale farms within the last few years. Plantation crops such as large scale mango cultivation are gaining much ground as a result of the good soil and climatic conditions and interventions of MOFA and some NGOs (e.g. ADRA).

Much of the foodstuffs grown by farmers are lost as a result of poor post harvest technologies, notably poor handling, poor storage, poor pest management, poor harvesting methods, inadequate market/pricing and processing.

Most of the farmers sell their produce to middlemen who, in turn, send them to other marketing centers within and outside the district for sale. However, these middlemen dictate the prices of the agricultural produce. In most cases the prices are unfavourable to the farmers. Even though

farmers complained about this situation, they have no alternative since most of the items they produce are perishables.

3.3.2 Dangme West District

The Dangme West District is situated in the South-eastern part of Ghana, lying between latitude 5° 45' south and 6° 05' North and Longitude 0° 05' East and 0° 20' West. The District has a total land area of 1,442 square kilometres, making it the largest in the Greater Accra Region. The land size represents 41.5% of the regional land area. (Figure 1)

The district was carved out of the former Dangme District in 1988 as a result of a national re-demarcation exercise carried out in relation to decentralization reforms in the country. The district shares boundaries with the Yilo Krobo District on the North - West, North -Tongu District on the North - East, Akwapim - North District on the West, Tema District on the South - West and Dangme - East District on the East.

The Dangme West District is one of the six (6) Districts in the Greater Accra Region. It forms about 41.5% of the landmass of the Region and therefore the largest. The total land area is 1,442 sq km (144,201 ha), which consists of total cultivable land of 129,600 hectares and has a coastline stretch of about 37kms.

The District has 22km of the Lower Volta River running through and along the Northern to Eastern boundaries. About 45,600ha of the land is currently under cultivation with about 2,200 hectares under irrigation.

The vegetation is mainly coastal savannah with a small transitional zone along the foothills of the Akwapim Range. The soil type is mainly of the heavy Akuse series with sandy and sandy-loams in certain areas. The rainfall pattern is bimodal and the main agricultural activities undertaken are livestock and crop production, fish production, fishing and fish processing and other agro - processing activities.

Crops produced include maize, cassava, rice, tomatoes, garden eggs, okra, pepper, watermelon, sugarcane, banana, pineapple, pawpaw and exotic vegetables (for export). Tree crops grown are mainly mangoes with a few small- scale cashew plantations in the Ningo area.

Livestock production comprise of cattle, sheep and goats with a large local poultry population, some medium scale holdings (ASAS, Sapporo Farms, Ratio Farms etc.) and few commercial holdings (e.g. Gateway (AAH) McBaron for Ostiches, Farmer George for broiler production etc.)

Fish production in inland waters is undertaken by Tropo Farms, a privately owned business enterprise and Aqua Agric, a development NGO with a few dams and dugouts being stocked with fish by the communities. Marine fishing and traditional fish processing are the main activities undertaken along the 37km stretch of coastline.

The District is also home to a prolific beekeeping activity that produces arguably the best honey in the country. The District, in spite of its proximity to the national capital is basically rural with a poor state of socio-economic and infrastructure development.

By virtue of its strategic location, that is the nearness to the urban cities Accra and Tema which have the airport and sea port respectively and the Volta Lake Transport System that links the South to the North, the District has the potential to be converted into a preferred agribusiness destination.

3.4 Survey

Data from the field study was collected through a survey employing set of questionnaires. The survey research strategy was used to gain an overall clear picture of the current postharvest storage practices of mango producers in the southern sector of Ghana. The survey was carried out on producers of mangoes in the Yilo Krobo and Dangme West Districts which are the leading mango producing areas in Ghana. Forty (40) producers were selected through a selective sampling from the total number of mango producers operating in the district. The sampling was carried out by the use of members' register of the mango producers and exporters association.

Two (2) clusters of producers were established based on district of production. One cluster was made up of twenty (20) producers in Yilo Krobo and the other cluster was made up of twenty (20) producers from Dangme West. Out of these clusters, ten (10) small scale producers with mango farm size less than five (5) hectares and ten (10) commercial scale producers with mango farm size more than five (5) hectares were also grouped into scale of production.

The clusters were formed to assess the impact of postharvest storage on quality by the different types of mango producers and also identify the storage needs and requirements of the different types of producers.

The questionnaires focussed on how the mango chain was organised in the two (2) districts, how producers harvest their mangoes, the period of storage, means of transportation and the current ways of storing mangoes between producers. The data generated answered sub questions 1.5.1 (i – v).

The questionnaire also gathered data on the volumes produced and exported, post harvest losses, the current level of quality of export mangoes, quality standards for export mangoes, and factors affecting quality. The data generated also answered sub questions 1.5.2 (i – iv).

3.5 Case Study

A case study was conducted with three (3) interviews. One (1) interviewee structured interview was conducted at the District Agricultural Office of MOFA with a district officer. The second interview was conducted at the Export Marketing and Quality Awareness Project (EMQAP) with a project officer. The third interview was conducted with a representative of Papaya and Mango Producers Exporters Association of Ghana (PAMPEAG). Interviews tackled issues related to the mango export chain, constraints faced by the export chain, level of awareness of producers and exporters on the effect of storage on quality of mangoes and improvements needed for the export chain. The data generated relates to sub questions 1.5.3 (i – ii). A voice recorder was used to record the interviews of the informants and later transcribed.

3.6 Data Analysis

Data generated from the field were subjected to analysis employing cross tabulations, cluster bar charts and chi - square test under the SPSS statistical package to establish the relationships between small scale producers and commercial producers on postharvest storage practices and to determine the difference between the impact of storage practices on quality of small scale mango producers and commercial producers. Qualitative data from the case study

was categorised and analysed from the perspective of chain actor and influencer or supporter. Results gathered were interpreted and compared with relevant literature.

The value chain analysis was used to map out the actors and players within the chain and also used to demonstrate the added value of the mango export chain. The margin shares of actors were compared among different actors to get a clear idea on the distribution of added values.

The PEST tool was used to analyse the business environment of the mango chain for potential investors who are interested in participating in the mango export chain. The OT tool adapted from SWOT analysis tool was also used to analyse the business environment of the mango export chain.

CHAPTER 4 RESULTS

This chapter deals with the results and findings of the survey and case study carried out in the study area. The findings are organized in section wise in order to answer the research sub questions based on the survey.

4.1 Survey Findings

4.1.1 Background Data

The sampling of respondents was carried out through selective sampling by the use of members' register of the mango producers and exporters association. Out of the target of 40 respondents for the survey, 40 mango producers responded to the closed questionnaires. Some of the producers doubled played roles as both producers and exporters. The respondents were made up of farm managers and farm owners. 80% of the respondents were able to communicate using the English language fluently. 20% of the respondents communicated using the local language "twi" so the contents of the questionnaires had to be translated to the local language. All respondents did not have problem responding to the questionnaires.

4.1.2 The Mango Chain in Yilo Krobo and Ga West Districts

From the results of the survey conducted, the fresh mango chains organized in both districts have the ability to supply mangoes to several actors within the mango chain. Data analysed from the survey revealed that in Yilo Krobo district, seven (7) respondents representing 17.5% of producers supply mangoes to the open market only whiles seven (7) respondents representing 17.5% of producers supply mangoes to traders and exporters. Two (2) respondents, representing 5% supply mangoes to both open market and exporters whiles the other two (2) respondents, representing 5% also supply mangoes to processors and open market. One (1) respondent, representing 2.5% supply to processors, traders and exporters and lastly one (1) respondent representing 2.5% supply to traders only.

In Dangme West district, the data analysed established that seven (7) respondents representing 17.5% of producers supply mangoes to open market only whiles four (4) respondents representing 10% supply to traders and exporters. Three (3) respondents, representing 7.5% supply mangoes to processors, traders and exporters whiles another three (3) respondents representing 7.5% supply to open market and exporters. In addition three (3) respondents representing 7.5% supply to the processors and open market and lastly none of the respondents supply to traders only. This is presented in table 3 and figure 2

From figure 2 it is established that in both districts, the mango chain is centred around the supply of mangoes to the open market and traders - exporters.

Table 4 Supply of mango between districts

		District		Total
		Yilo Krobo	Dangme West	District
To whom do you supply your mangoes?	trader only	1	0	1
	open market only	7	7	14
	processor, trader, exporter	1	3	4
	open market, exporter	2	3	5
	processor, open market	2	3	5
	trader, exporter	7	4	11
Total		20	20	40

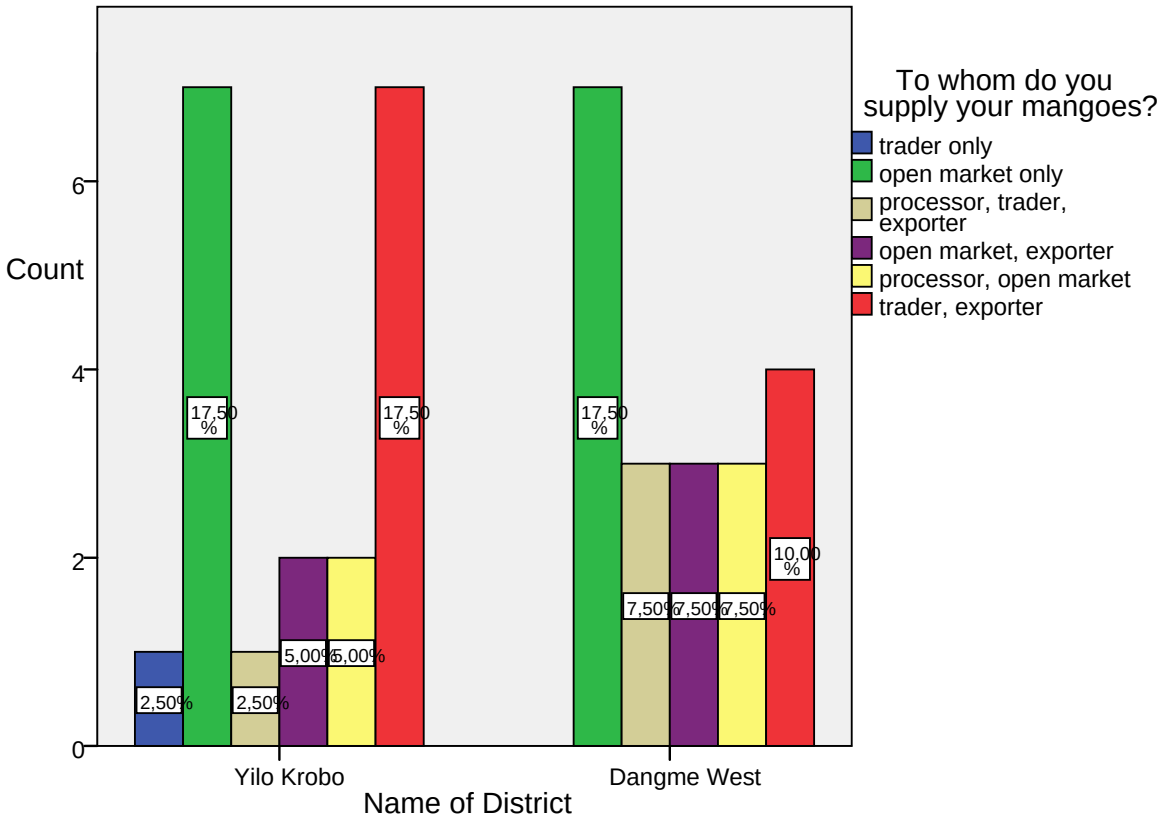

Figure 2 Supply of mango between districts

From the supply analysis, it is revealed that the mango chain in both districts are organised as shown in the chain maps in figures 3 and 4 respectively.

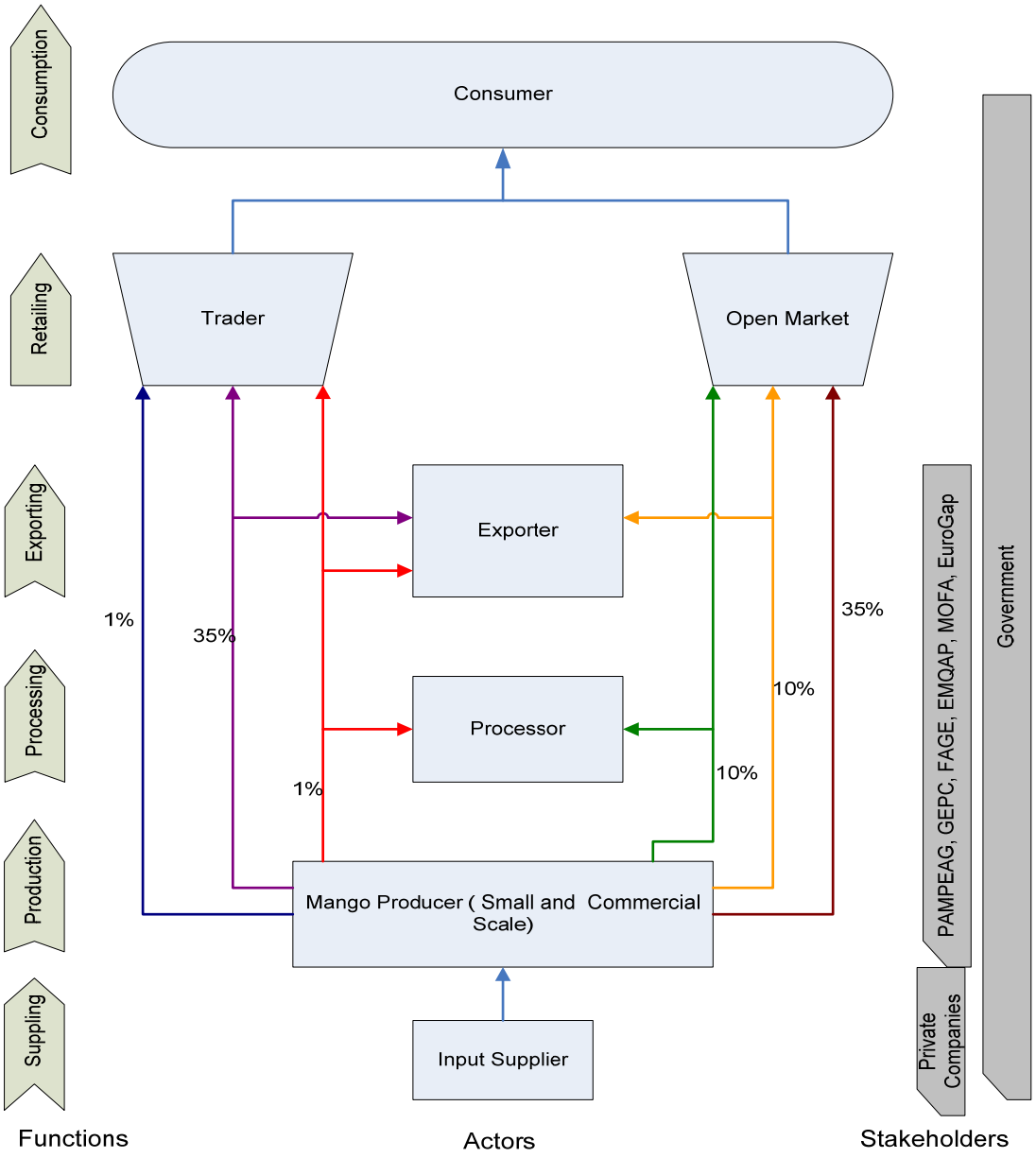

Figure 3 Chain map of mango supply in Yilo Krobo District

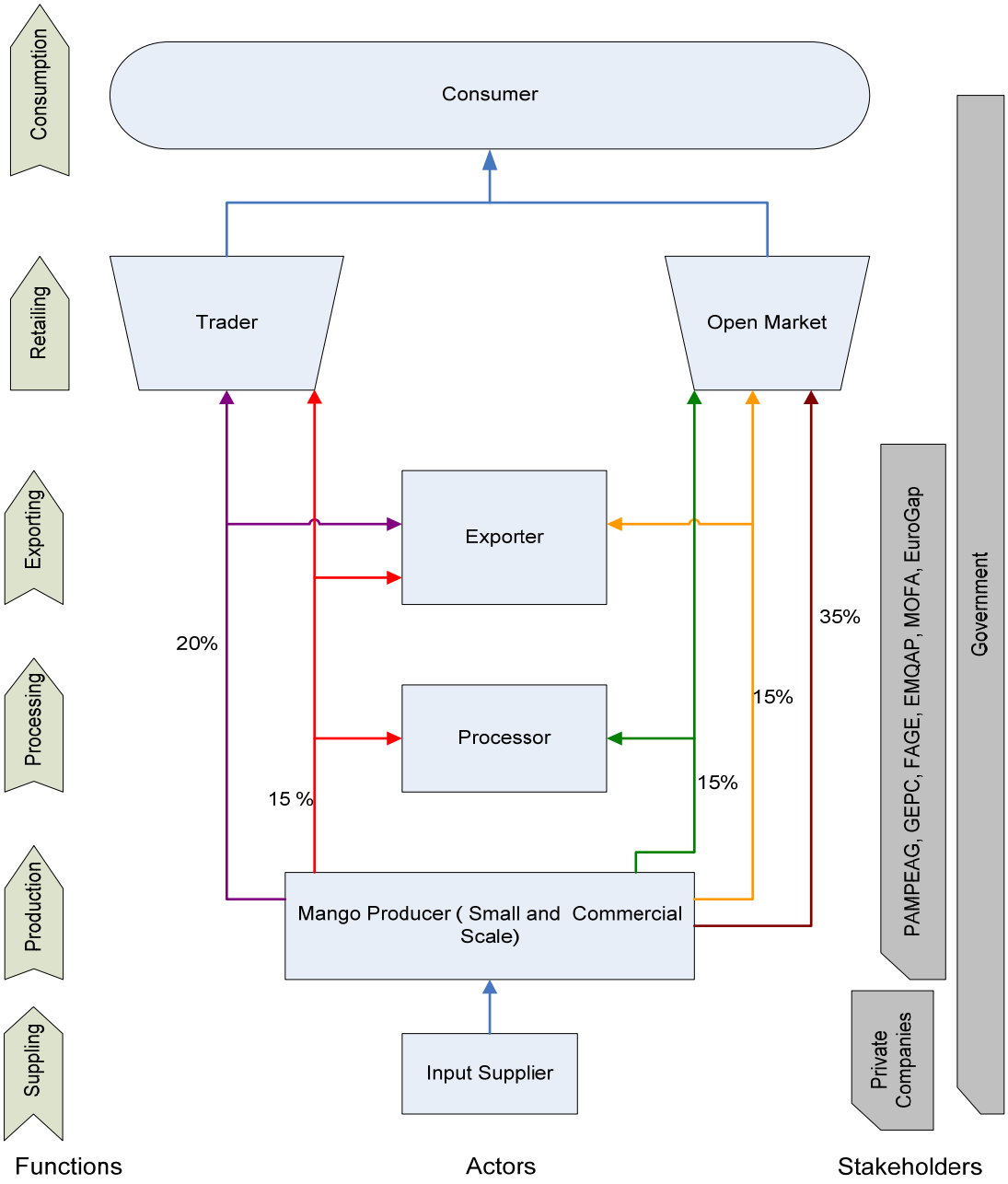

Figure 4 Chain map of mango in Dangme West District

Further analysis of the data from the survey on supply of mangoes from the perspective of scale of production shows that 30% of respondents under the category of small scale producers supply mangoes to the open market only as compared to the supply to traders - exporters market. This indicates that a greater number of small scale producers are involved in the domestic market specifically the open market.

On the other hand 22.5% of respondents under the category of commercial mango producers supply their mangoes to the traders - exporters as compared to the open market. It is interesting to note that the commercial producers are however involved in almost all the chains in the mango sector. This is presented in figure 5.

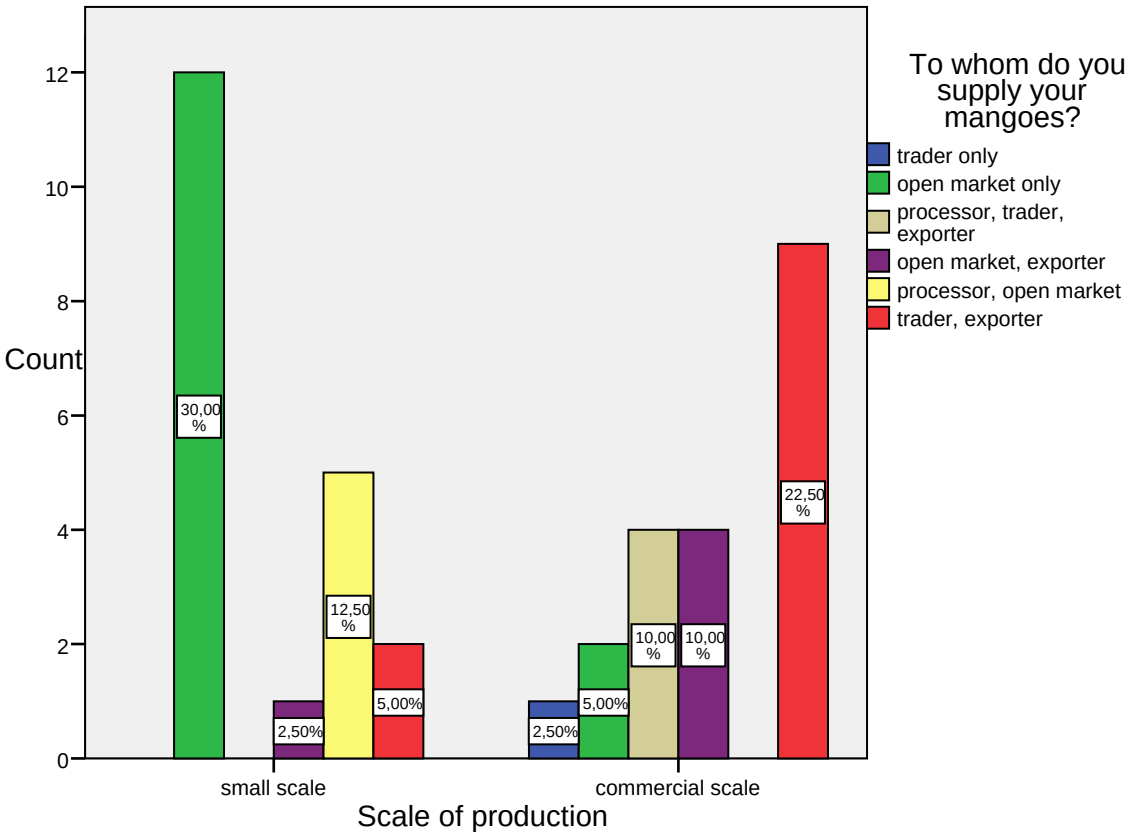

Figure 5 Supply of mango between clusters of producers

4.1.3 Harvesting Factors and Storage Period of Mango Producers

Analysis of the data from the survey indicates that 15 small scale mango producers respondents representing 37.5% harvest their mangoes at fully ripen stage whiles five (5) respondents representing 12.5% of that category of producers harvest at mature green. On the other hand, only two (2) respondents under the commercial scale mango producers representing 2.5% harvest their mangoes at fully ripen whiles 18 of them representing 47.5% harvest at mature green. This is indicated in figure 6

A chi – square statistic test carried out to determine the significance difference between the harvesting factors used by small and commercial scale producers before harvesting their mango proved that there was a significance difference between the two clusters of producers at 5% significance level. (Chi square 0.000, df = 1, $p < 0.05$) Details of test is presented in Appendix 4

The above findings proved that since small scale producers are largely involved in the open market chain, they do not have to consider the fruit travelling over longer distances to consumers hence harvesting the fruits at fully ripen stage whiles commercial producers who are involved in the export market have to consider the distance the fruit has to travel to its final destination hence the need to harvest at mature green to increase the transportation and shelf life of the mango to maintain its quality after harvest.

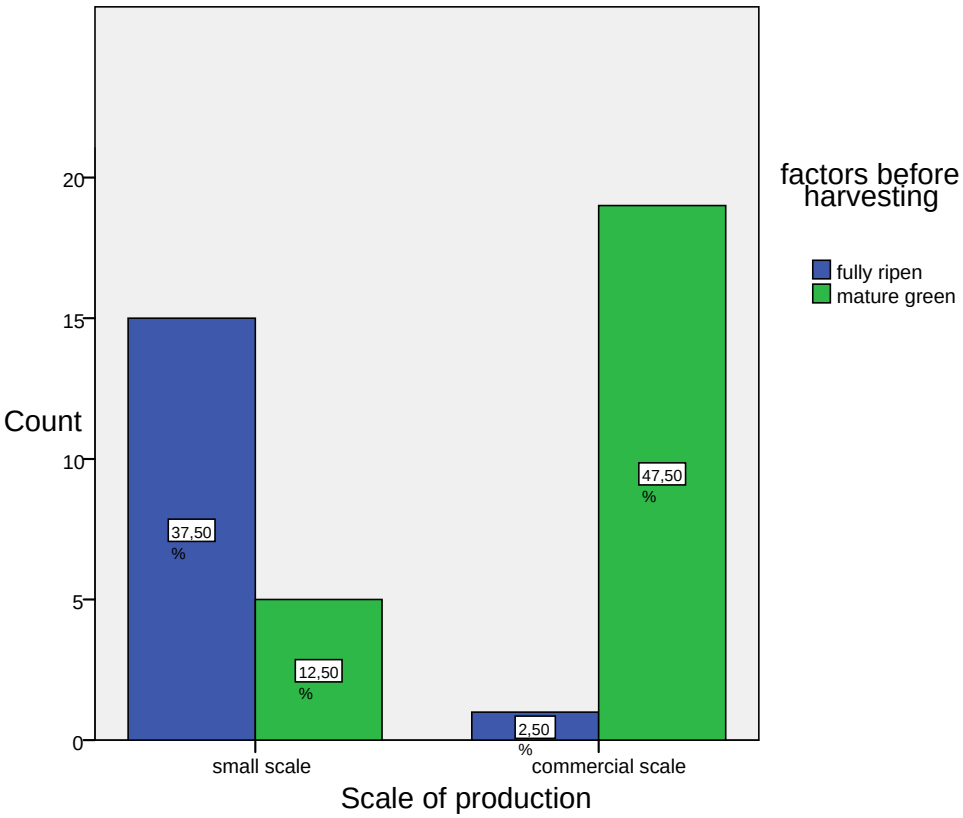

Figure 6 Harvesting factors between clusters of producers

The analysis of the data also reveals that 22.5% of small scale mango producers do not store their mangoes at all whiles 27.5% of them store their mangoes for a period of one (1) day. Conversely, 32.5% of commercial producers store their mangoes for a period of one (1) day whiles 17.5% store for longer period of two (2) days. Summary for both categories establish that mango producers harvest their mangoes when their markets are ready. It is interesting to note that commercial producers who are involved in export market and use the harvesting factor mature green store their mangoes for longer periods whiles small scale producers who are mostly involved in domestic market and use the harvesting factor fully ripen do little or no storage. The storage period between the small and commercial scale producers is presented in figure 7.

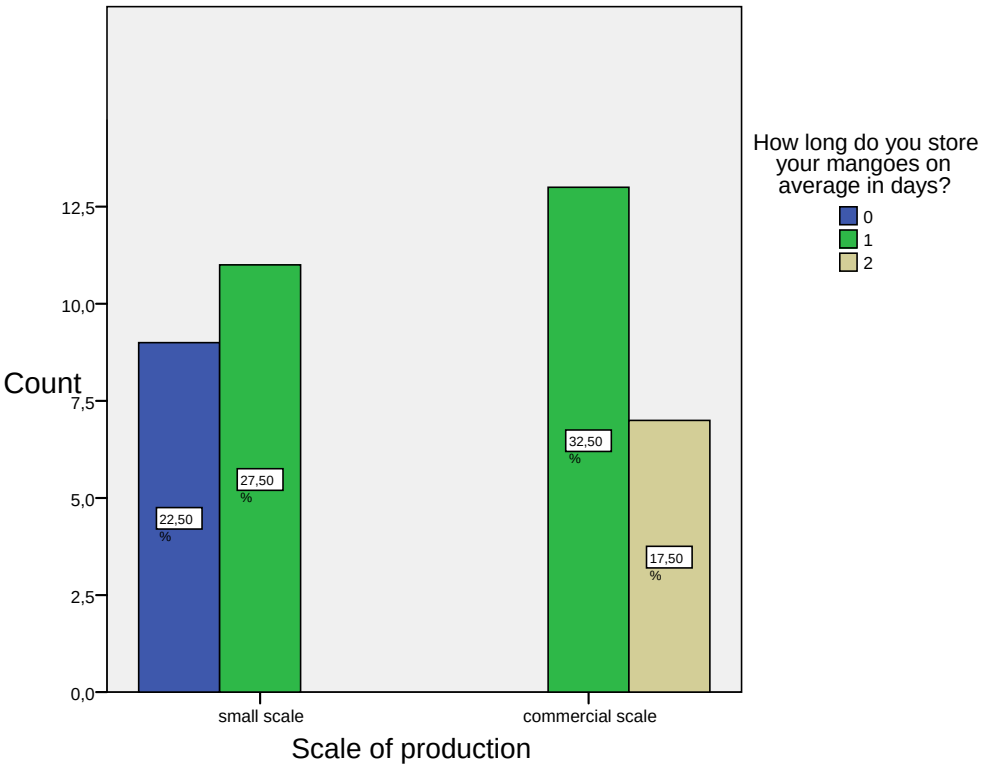

Figure 7 Storage period between clusters of producers

4.1.4 Transportation Practices of Mango Producers

The analysis on the transportation means of moving mango from the farm between the clusters of producers revealed that 50% of the small scale producers that is, all the respondents under small scale cluster transport their mango from the farm by means of open carts or trucks. Conversely, under the cluster of commercial producers, 25% transport using open carts/trucks whiles 15% transport using cooling vans and the rest of 10% under same cluster transport using container trucks without cooling. This analysis is presented in figure 8. An analysis to determine the difference among commercial scale producers using the different transportation means revealed interestingly that 15% of commercial producers who transport their mango in cooling

vans are producers with large tracts of mango land whiles producers who transport in container trucks without cooling have much lesser tracts of land compared to the group of 15% (Appendix 5).

Figure 9 show pictures of container truck without cooling and cooling truck being used to haul fruits by commercial producers.

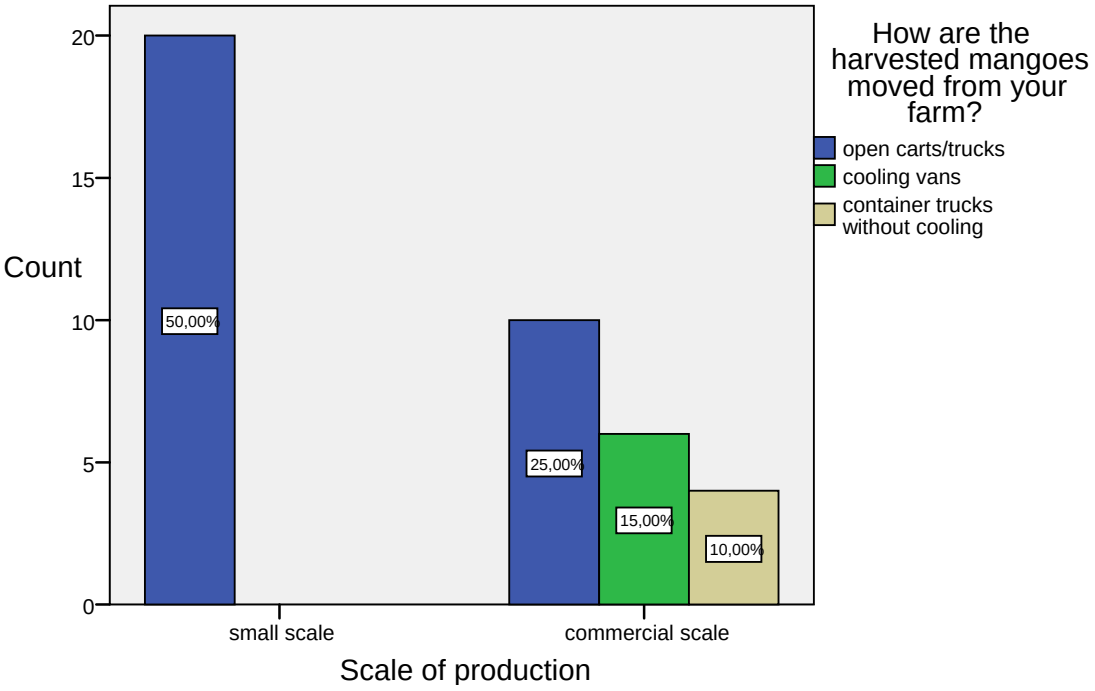

Figure 8 Transportation ways between clusters of producers

Figure 9 Container truck without cooling and cooling truck in use for transportation

4.1.5 Current storage ways of Mango Producers

Data analysed from the survey to determine the difference of storage ways between producers showed that 22.5% of small scale producers do not store their mangoes whiles 25% of them store in the open air exposed to direct sunlight, and 2.5% store under sheds. Conversely, 17.5% of commercial producers' store their mangoes under sheds whiles 15% store their mangoes in cooling rooms. 10% of the same cluster store their mangoes in enclosed room without cooling whiles smaller number of them representing 7.5% store their mango in the open air exposed to direct sunlight. This is presented in figure 10.

It is interesting to note that the commercial producers who store their mangoes in the open air exposed to direct sunlight are producers with less than seven (7) hectares of mango land whiles the small scale producer who store his mango under shed has mango land of five (5) hectares. This implies that there is a relation between the number of tracts of mango farm and the storage ways employed by producers. This is presented in figure 11.

Figure 12 shows picture of a cooling storage room owned by a commercial scale producer and post harvest handling of mangoes in the open air exposed to sunlight by small scale producers.

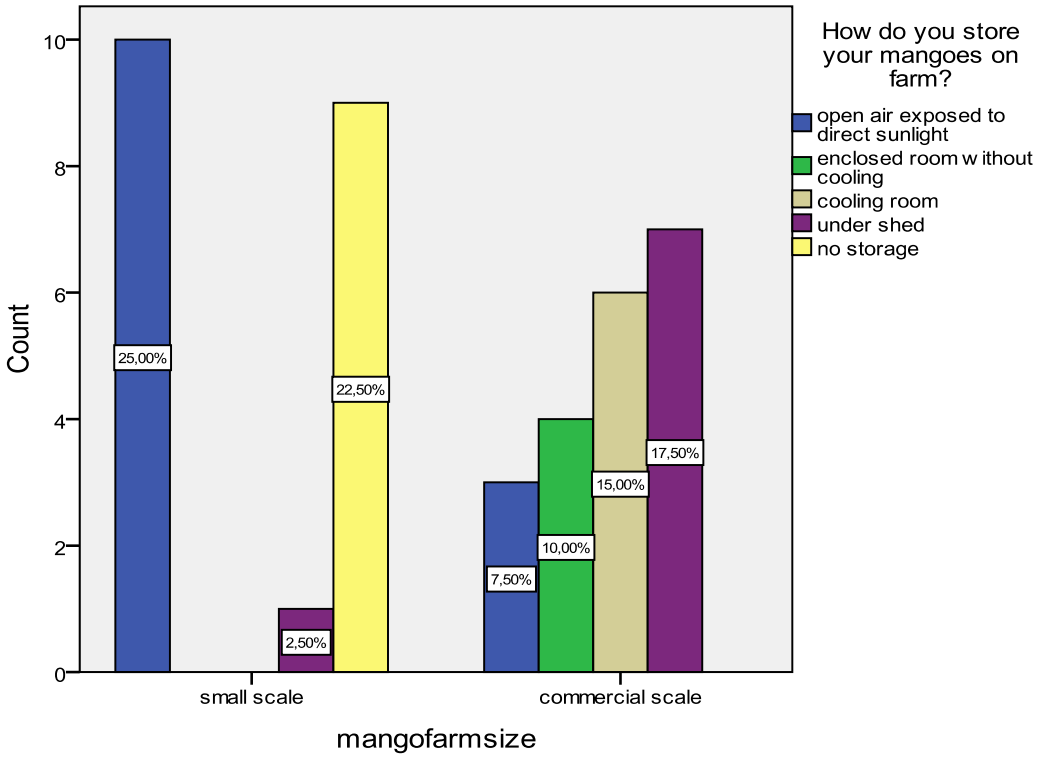

Figure 10 Storage ways between clusters of producers

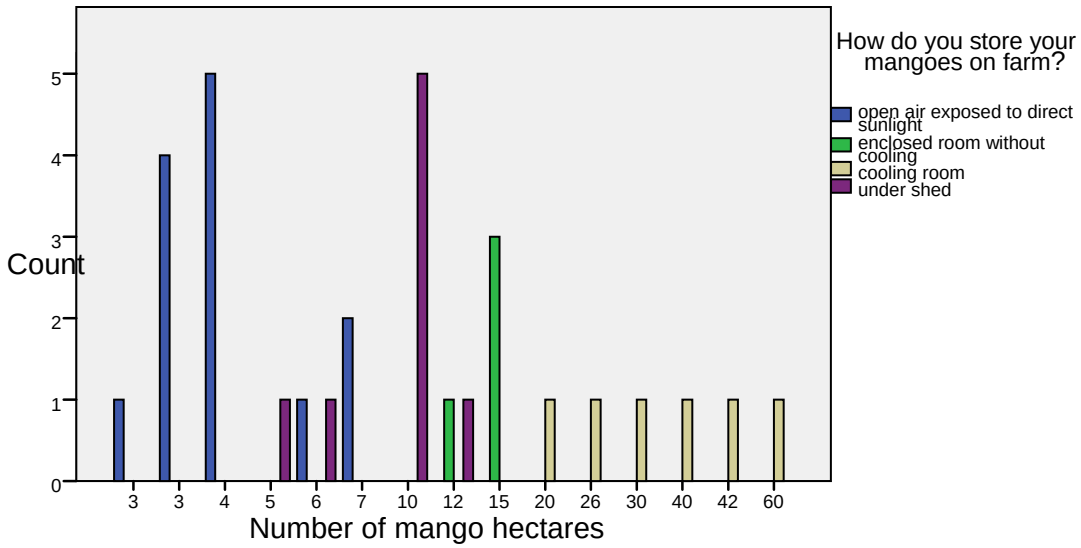

Figure 11 Storage ways in relation to number of hectares of land

Figure 12 Cooling storage facility and on farm handling of mango

4.1.6 Production and Export volumes of Mango

From the study it is revealed that the total volume of mango produced during the major and minor seasons in the two districts amounts to 4,194 tonnes with Yilo Krobo accounting for 2,184 tonnes and Dangme West accounting for 2,010 tonnes. Out of the total produced 1,132 tonnes are exported with Yilo Krobo accounting for 638 tonnes and Dangme West accounting for 494

tonnes. It is worth noting that majority of exporters operate within the Yilo Krobo district. (Refer to appendix 6).

4.1.7 Post Harvest Losses and Quality Level

Results from the data analysis shows that 20 respondents under the cluster of small scale mango producers representing 50% of the survey size experience post harvest losses. On the other hand 13 respondents under the cluster commercial scale mango producers representing 35% experience post harvest losses whiles 7 respondents under the same cluster representing 15% do not experience post harvest losses.

Further analysis showed that 10 respondents representing 29.4% of small scale producers receive post harvest losses of <5%, 8 respondents representing 23.5% receives post harvest losses of 6 – 10% and 2 respondents representing 5.8% receives post harvest losses of 11 – 15%. On the converse, 14 respondents representing 41.2% under commercial scale receives post harvest losses of < 5%. These findings are presented in figures 13 and 14 respectively.

It is worth noting that producers within the Dangme West cluster experience more post harvest losses as compared to the other cluster that is, Yilo Krobo.

The results from the data analysis further indicate that all 20 respondents under the cluster small scale producers receive rejects from their buyers based on quality issues. Conversely 35% of commercial producers receive rejects from buyers also based on quality issues whiles 15% do not receive rejects. It is worth noting that the 15% of commercial produces who do not receive rejects are producers who use cooling facilities for storage of their mangoes. Additionally these are commercial producers who cultivate mango on large tracts of land. (Figure 15)

A chi – square statistic test carried out to determine the significance difference in the reasons for rejects from buyers between the small and commercial scale producers proved that there is a significance difference between the two clusters of producers at 5% significance level. (chi square 0.000, df = 1, $p < 0.05$) Detail of test is presented in appendix 7.

Further analysis showed that 41.18% of small scale producers receive rejects due to signs of decay and rot on fruits whiles 17.65% of small scale producers receive rejects due to signs of mechanical damage. On the other hand 38.24% of commercial scale producers receive rejects due to signs of mechanical damage whiles as low as 2.94% receive rejects due to signs of decay and rot. (Figure 16)

It is interesting to note that small scale producers receive majority of rejects and the reasons for rejects are due to signs of decay and rot. This is attributed to the fact that small scale producers harvest their mangoes when the fruits are fully ripen hence become more vulnerable to decay and rot as compared to fruits harvested at mature green.

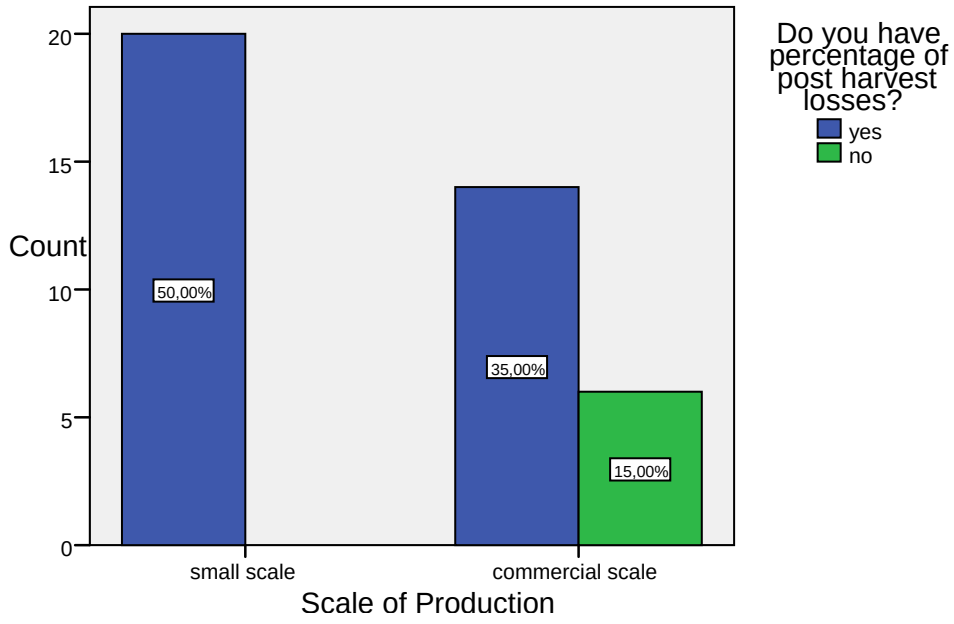

Figure 13 Post harvest losses between clusters of producers

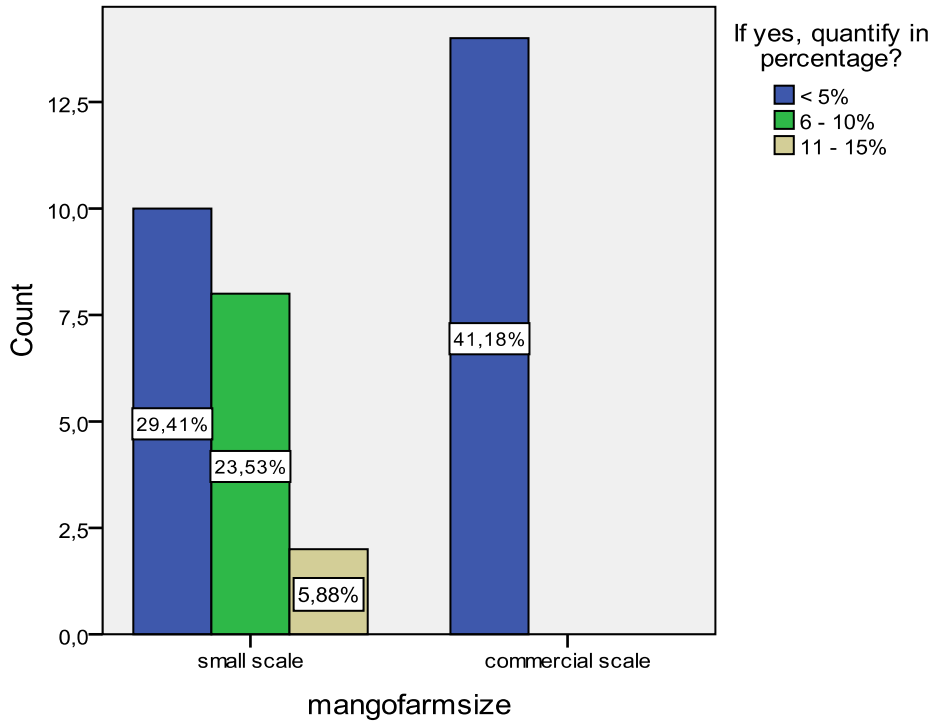

Figure 14 Post harvest losses between clusters of districts

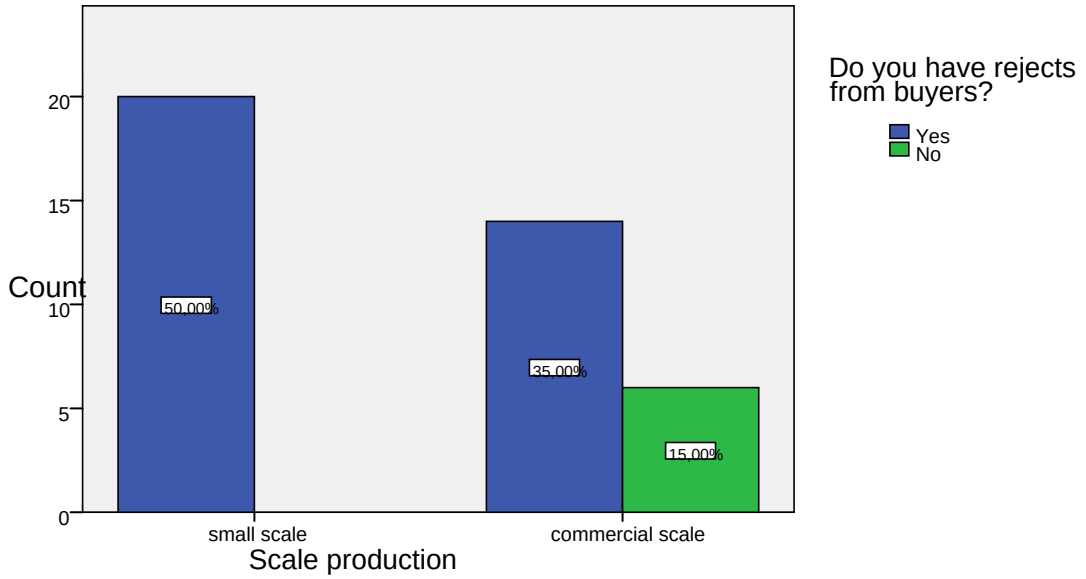

Figure 15 Rejects rate between clusters of producers

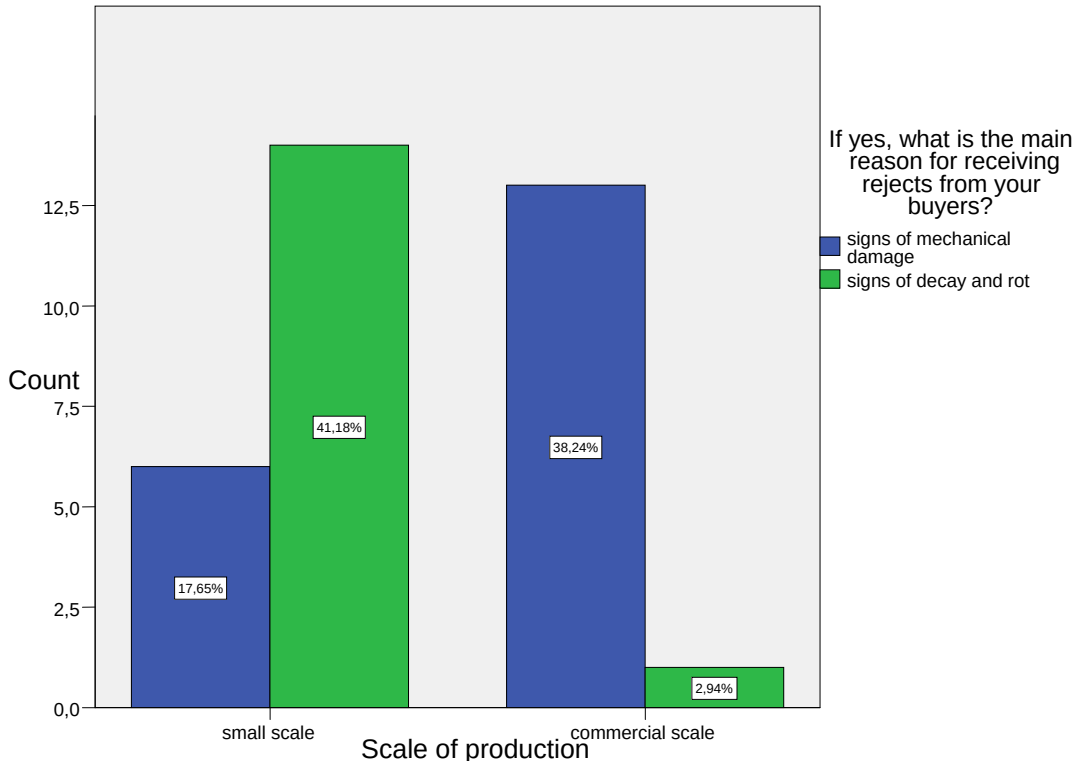

Figure 16 Reasons for rejects between clusters of producers

4.1.8 Awareness level of producers on effect of storage on quality

A chi – square statistic test carried out to determine the significance difference between the awareness level of small and commercial scale producers on effect of storage on quality proved that there is a significance difference between the two clusters of producers at 5% significance level. (chi square 0.000, df = 1, $p < 0.05$) Detail of test is presented in appendix 8.

Further analysis shows that 14 respondents under the cluster small scale producers representing 35% do not employ any quality measures or have any knowledge on quality measures during post harvest storage of mangoes. However, six (6) of the respondents representing 15% of the same cluster employ some quality measures or have some knowledge on quality measures during post harvest storage of mangoes. Conversely, 18 respondents representing 45% under the cluster commercial scale producers employ some quality measures during the post harvest storage of mangoes whiles two (2) respondents representing 5% do not employ any quality measures during storage. This is represented in figure 17.

This confirms that small scale producers do little or no storage on their farms hence do not see the need for ensuring quality measures during storage to maintain product quality. On the other hand, commercial scale producers who are more in the export chain have much knowledge on quality during storage thus invest in ways of storage such as cooling rooms, rooms without cooling and sheds.

It is worth noting that the six (6) respondents representing 15% under the cluster small scale producers operate on mango lands of hectares between four (4) and five (5) whiles the two (2) respondents representing 5% under the cluster commercial producers have mango lands six (6) hectares or less.

Further analysis showed that greater number of producers within the cluster commercial producers, employ quality checks such as temperature and degree of dryness (relative humidity) on their storage facilities before embarking on storage. Others also employ checks such as temperature only. (Appendix 9)

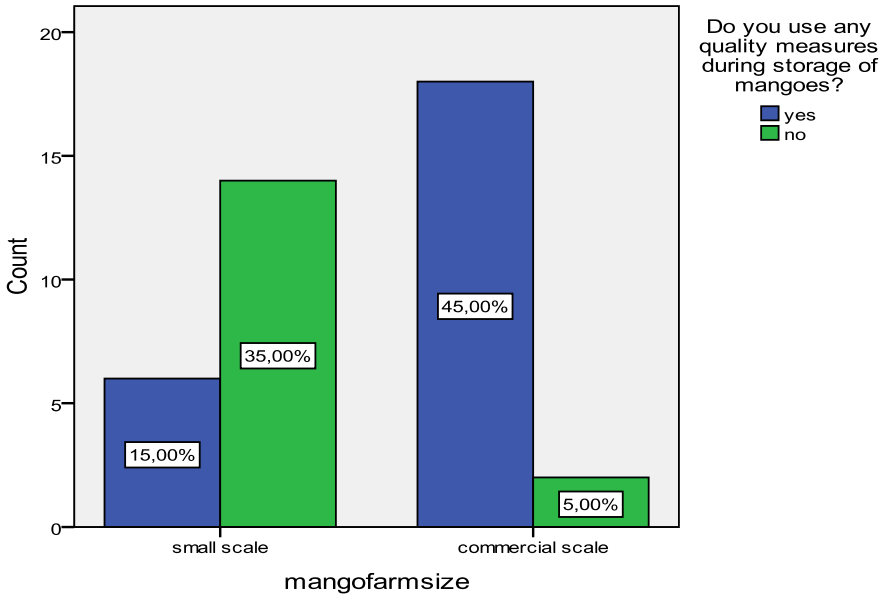

Figure 17 Storage awareness level on effect of quality between clusters of producers

4.2 Outcome of Interviews

Interviews conducted with representatives from exporters and government in the case study on the mango export chain specifically the constraints faced by the chain in terms of post harvest storage and quality as well as improvement plans are presented below:

4.2.1 Constraints faced by Mango Export Chain

From the case study it was realised that the constraints in the mango export chain were viewed by the different informants in the same way. The representative of the exporters mentioned that the issue of lack of adequate cold chain facilities including storage facilities within the immediate surroundings of mango producing areas has resulted in high post harvest losses and the inability of harvested mangoes to maintain thier quality. This assertion was confirmed by the representative of the government. The representative of the government noted that the lack of the required personnel capacity in the area of post harvest handling management of mango for export in MOFA renders district agric extension agents helpless in giving the requisite trainings and technical support to producers and exporters. This statement again was also in agreement with the assertion from the representative from the exporters association that their members and mango producers lack the technical support in terms of extension from the government side.

The bureaucratic export documentation procedure at the ports of export was also established from the interview as a constraint in the mango chain. Exporters had to fulfil all documentation before exports were made hence increasing the storage life of the mangoes that have to stay at the port without the adequate storage facility resulting in the loss of quality of mangoes. This constraint was noted by the different informants as one of the major setbacks within the export chain. The representative from the exporters association cited an example whereby due to the long delay at the port, an exporter's quality of mangoes dropped as a result of high temperature injury.

High freight cost and irregular movement of vessels from Ghana ports coupled with poor cold chain and storage facilities at the ports causes mangoes to loss quality. The irregular movement of vessels further delays the export of mango thus exporters are not able to deliver their consignment at the agreed times with importers. This deteriorates the relationship between exporters and importers. This constraint again was shared by the different informants.

The lack of good planting material in the country causes producers and exporters to access planting materials from neighbouring countries such as Togo, Burkina Faso and Ivory Coast resulting in high cost of production. This constraint made by the representative of the exporters was not listed by the other informants.

The representative of the exporters asserted that commercial producers and exporters largely depend on small scale producers to meet their export volumes however the poor production management practices such as pruning among small scale producers' results in low quality fruits which are rejected by importers.

The lack of mistrust among producers and exporters poses a great danger in the mango export supply chain. Producers turn to sell their mangoes to alternative markets such as domestic when world market prices fall for better prices. This is however not the case for organic and fair trade mangoes because producers are paid premium prices at all times. There is little legal support for signing of contract agreements in the area of supply chain hence producers and exporters turn to violate contracts agreements often. These factors have led to the mistrust

between producers and exporters. These constraints asserted from the representative of exporters were corroborated by the other informants. However the representative from the district agric office suggested that the issue of mistrust was as a result of exporters cheating and delaying payments to producers which causes producers to turn to shift away from the export chain and move on to the domestic or local chains.

Other constraints such as poor access road network from mango producing centers to ports of exports, high cost of certification and complex standard requirements for individual small scale producers, issues with pest and diseases such as fruit flies and anthracnose, and low production volumes by mango producers were all shared by all informants.

The representative of exporters stressed that the lack of transportation companies providing services in the area of adequate cold chain and modern temperature controlled and storage facilities puts much pressure on the small and medium scale exporters who often do not have the capacity to invest in the transportation part of the supply chain. Hence they turn to the use of open trucks and carts to transport their mangoes from producing areas to ports resulting in the reduction of mango quality. This constraint was not reported by the other informants.

4.2.2 Quality Standards and Level of Quality in Mango Export Chain

According to the informant from the government side, the horticulture industry through support from government is adopting and implementing international quality and food safety standards such as GlobalGAP (EurepGAP) and HACCP standards adopted by US and European governments to ensure food safety from production to export of horticultural products including mangoes. He further mentioned that the horticultural industry has adopted norms and standards for an array of products including mango which serve as the basis for training farmers, exporters and pack house operators. Illustrated norm posters have been produced and circulated to producers to depict major quality aspects such as maturity, colour, shape, fruit condition and packaging. Posters have been produced for pineapple, papaya, mango, griffonia, voacanga and cashews.

Comparing views from the different informants on the level of quality of export mango from Ghana the informants shared the same views that mango for the export chain where of much better quality than mangoes going into the domestic market which were of low standards. The representative of the exporters added that the mangoes produced by the commercial scale producers were of more quality than small scale producers since commercial scale producers invested more in production system and post harvest management.

4.2.3 Way-forward and future improvement plans in the Mango Export Chain

According to the informants from the government, MOFA is building and strengthening the private and public institutions surrounding the horticultural industry of which the mango chain is covered. As an outgrowth of MOFA's HEII programme, the five years EMQAP under the ADB continues to train extension officers in post harvest handling and management of mangoes including storage and as at end of May 2009 over 200 AEAs have benefited from these trainings.

EMQAP in collaboration with the private sector continues to establish demonstration centers and farmer model farms on commercial farms for producers and exporters to learn new and updated techniques of farm practice including post harvest management. This assertion by the

informant from the government was corroborated by the informant from the exporters who added that the pro - activeness of PAMPEAG and other stakeholder association made members of association participate in demonstrations and trainings to upgrade their knowledge on post harvest management of mango.

EMQAP in collaboration with a well established mango commercial scale producer – exporter BOMART farms has demonstrated the use of pack house and storage facilities to farmers and AEAs within the mango growing areas. The Ministry is thus building extension capacity in post harvest management using the existing facilities of the private sector who are leading the development of the horticultural industry.

To further improve the mango export chain the informant from the government mentioned that EMQAP is constructing two (2) pack house and storage facilities at concentrated horticultural producing areas. The pack house and storage facilities will be used for both pineapples and mangoes. The project has refurbished a four (4) million US dollars first class fruit handling terminal with cooling facilities at the Tema Sea Port (shed 9) to support the post harvest cold chain system in the country. The terminal covers a floor space of 4,400m², provides exporters the capacity to hold more than 375,000 pallets annually and is equipped to store eight (8) different kinds of products at the same at different temperatures to maintain fruit freshness.

This assertion from the informant from the government was also mentioned by the informant from the exporters adding that members have started using the services of the facility to store their mangoes at the ports whiles waiting for vessels to load their consignments.

The informant from the government suggested that EMQAP has also procured two (2) temperature control vans which are being used for demonstration exercises and promotion of cold chain facilities among horticultural producers.

He added that MIDA under the MCA as part of its objective of developing the entire horticultural supply chain in an integrated fashion to improve the economy of the country, is constructing first class roads from horticulture producing centers to the ports to facilitate the smooth transportation of produce from farms to ports. MIDA is also constructing pack houses and storage facilities at horticulture growing centers. This he said will benefit the mango export chain since mango is part of the horticultural products.

He further mentioned that as part of government efforts to further improve the export chain, the government through MIDA is augmenting the credit services available for on farm and value chain investments. The government through its extension directorate is promoting and creating awareness on mango processing as a value addition for the export market.

The informant from the exporters also mentioned that the PAMPEAG was working closely with the government and other international organizations such as USAID under TIPCEE, ADRA and GTZ under MOAP to further develop and improve the mango export chain in terms of post harvest handling management including storage. This statement supported what the informant from the government also said about the government role in strengthening the collaboration with stakeholders to further develop the mango export chain.

The informant from the exporters mentioned that several commercial producers and exporters are now making huge investment in infrastructure such as cold chain trucks and storage facilities to improve the supply chain by providing hiring services to small scale producers and exporters who do not have access to these facilities.

CHAPTER 5 DISCUSSION

This chapter deals with the analysis of the findings in combination with literature review and responses from the informants from EMQAP, PAMPEAG and MOFA to answer the main and sub questions asked in the research.

5.1 The Mango Chain in Yilo Krobo and Ga West Districts

The research reveals that there are various actors and stakeholders who play various direct and indirect roles and functions in the mango chain in both districts. This assertion is supported by the concept of value chain by Roduner (2007) who states that "value chain actors are those who directly deal with the products, i.e. produce, process, trade and own them whiles value chain supporters are those who never directly deal with the product, but whose services add value to the product and value chain influencers are those who provide the regulatory framework, policies, infrastructures, etc. at the local, national and international level".

The main actors who directly own the mango, that is, the small and commercial producers, processors, traders, exporters and open market are identical in both districts. The roles of supporters in the chain such as transporters and freight forwarders who never directly deal with the mango but whose services add value to the mango are also identical in both districts. An interesting phenomenon in the two (2) district showed that commercial producers doubled played chain actor roles as exporters and stakeholder roles as transporters respectively. This phenomenon agrees with what KIT et al (2006) describes about vertical integration that chain actors can get empowered by taking on downstream activities in the chain.

The above phenomenon also corresponds with SLE (2006) who states "that participating actors in the supply chain of mangoes in Ghana are input suppliers, mango producers who comprise of small as well as medium and commercial producers with the latter mostly exporters, processors, distributors and exporters".

There are general influencers in the names of PAMPEAG, FAGE, HAG, MOFA, EMQAP and GOG that play various functions in supporting the chain in both districts.

From the findings of the field study it is noted that the study areas have similar characteristics in terms of the way the mango chain is organised. In Yilo Krobo district mango producers' supply to several actors in the chain such as traders, open market, processors and exporters. This is somehow similar to what happens in Dangme West. However the slight difference between the two districts on the way the chain is organised is that, in Yilo Krobo some producers tend to supply to traders only without supplying to any other actor in the chain whiles in Dangme West some producers do not supply to traders only. The reason behind this difference may be that there are more traders operating in Yilo Krobo than in Dangme West. This reason came out from the survey conducted however there is no available literature found backing this assertion.

From the perspective of the export chain it is gathered from the studies that there are more traders and exporters operating in the Yilo Krobo district as compared to Dangme West even though the difference is not so significant. However, from the perspective of scale of production of mango producers the mango supply chain presents a different picture as compared to the pattern of the districts. The small scale producers with mango farm size of less than five (5) hectares are more involved in domestic chain that is, the open market as compared to the export chain. This is proven by the fact that 30% of the respondents under the cluster of small

scale producers supply mangoes to the open market chain. However this is to say for the least that small scale producers are not involved in the export chains. On the contrary commercial scale producers with mango farm size of more than five (5) hectares are more inclined to the export chain and other chains. This argument is supported by Adongo (2006) who states that "small scale mango producers operate on less than five (5) hectares of farm size and are more numerous but less representative in total production terms and share of exports whiles commercial scale producers operate on more than five (5) hectares of land and use more intensive production systems as well as being involved in the export market".

5.2 Harvesting Factors and Storage Period of Mango Producers

From the findings of the study it is established that the clusters of mango producers under scale of production do not consider the same factors before harvesting of their mango. This was proved by the chi square test that there is significant difference between the small and commercial scale producers on the factors they consider before harvesting their mangoes ($p < 0.05$). As much as 47.5% of the respondents under the cluster commercial producers consider the factor of mature green before harvesting their mangoes, whiles 37.5% of the cluster small scale producers consider the factor of fully ripen before harvesting their mangoes. The research study proves that there is a link among the variables; harvesting factors, pattern of the supply chain and scale of production. Small scale producers who are attached to the domestic open market consider more of fully ripen factor than mature green. Conversely, the commercial scale producers who are also linked to the export market harvest at mature green.

It is clear that the commercial scale producer in selecting mature green as a harvesting factor for the export chain considers the fact that the fruit has to be transported overseas for longer periods. On the other hand, transporting to domestic market requires shorter periods, hence the need to increase the transportation and shelf life of the fruits to enable it maintain its quality and property considering that mangoes are highly perishables. This assertion is supported by Mitra and Baldwin 1997 cited in Nune et al. 2007 that "generally fruits designated to local markets or transportation by air (a three-day marketing frame) are harvested after the colour break or medium-ripe and fruits intended for longer transportation distances or storage (8–10 days) are in general harvested firm and green, but physiologically mature". This point is also further buttress by Kader (1999) who states that "fruits must withstand long distance shipping to export markets".

Further findings of the study also revealed that there are differences in the periods that producers store their mangoes. About half of the small scale producers do not store their mangoes at all whiles the other half store their mangoes for one (1) day. However quite a number of commercial scale producers, that is, 32.5% of the cluster size store their mangoes for one (1) day whiles the other 17.5% store their mangoes for period of two (2) days. It is clear from this picture that due to the lack of access to storage facilities by the small scale producers they do not store their mangoes. It was interesting noting from respondents who do not store their mangoes that they get the market and transportation ready before embarking on harvesting their mangoes. This point is substantiated by Adongo (2006) that small scale mango producers use less technology regarding post harvest handling. This finding about the lack of access to post harvest storage facilities is in agreement with the constraints mentioned by the different informants under the case study.

5.3 Transportation Practices of Mango Producers

The research establishes that there are differences in the way mango producers move or transport their mangoes from the farm. 50% of the small scale producers that is, all respondents under the cluster small scale producers move or transport their mangoes by means of open carts or trucks whiles commercial scale producers use several means including open carts or trucks. About half of the commercial scale producers use open carts or trucks whiles three - fourth of the remaining half use cooling vans and one – quarter of the balance use container trucks without cooling. An interesting point is that the kind of transportation means used by the commercial scale producer corresponds to the size of the commercial producer in terms of mango plantation. Producers with large tracts of mango fields use cooling vans whiles producers with medium tracts of mango land use container trucks without cooling and lastly producers with few tracts of mango land use open carts or trucks just like the small scale producer. This draws up a clear picture that all levels of small scale producers employ less efficient means of transportation of mangoes from their farm whiles the commercial producer employ less efficient through to more advanced means of transportation based on the level of commercial producer. This picture again is supported by Adongo (2006) that small scale producers apply less technology in regards to production systems and post harvest management.

With this mass system or means of transportation by all clusters of small scale producers and some commercial producers in the study areas, mangoes are subjected to high degrees of temperature which has negative effect on quality of mangoes. Furthermore it is established that small scale producers harvest their mangoes at fully ripen. This however implies that fully ripen mangoes at higher temperatures have the tendency for fruits to decay and rot at faster rate. This is attributed to literature by Kader (1999) that states that partially-ripe and ripe mangoes should be kept at temperatures between 8º to 12ºC. The transportation practices of all small scale and some commercial producers in the study areas are therefore in contrary to what literature mentions.

5.4 Current storage ways of Mango Producers

The research revealed that there are differences in the way mango producers store their mangoes. Twenty – two percent (22.5%) of small scale producers do not store their mangoes whiles as much as 25% who store their mangoes for one (1) day store them in the open air exposed to direct sunlight with as little as 2.5% storing under sheds. It is interesting noting that the percentages of small scale producers who store their mangoes under sheds are producers with farm size of five (5) hectares. On the other hand, 17.5% of the cluster commercial scale producers store their mangoes under sheds whiles quite a substantial percentage of 15% store their mangoes in cooling rooms. The rest, that is, 10% and 7.5% store their mangoes in enclosed rooms without cooling and in the open air exposed to direct sunlight respectively. It is also interesting noting that the commercial producer with farm size of less than seven (7) hectares store their mangoes in the open air exposed to direct sunlight. A very interesting phenomenon developed here is that there is a relation among the variables; type of storage facilities used by producers, the storage period or length and the number of hectares of mango plantation the producer owns. Commercial producers with large tracts of mango land are able to invest in cooling storage facilities and invariably are able to store their mangoes in cooling facilities for longer periods compared to the other producers (figure 11).

From the above it is clear that most small scale mango producers store their mangoes in the open air exposed to direct sunlight. With an average temperature range of 28º - 30º C in the

producing areas, it is right to infer that the mangoes are subjected to severe high temperatures which affect the physiological characteristics of the mango fruits leading to poor quality.

From literature, Jobling (2000) explains that high temperatures usually result from exposure to either direct sunlight, hot air in the field or heat treatments used for the eradication of pests. Some examples include not removing the field heat from harvested products or leaving harvested product in the direct sunlight and lack of air circulation. The temperature is also increased by the heat generated by the product itself. As the product respires it produces heat and if the products are packed in a way that prevents air circulation then the heat can build up considerably. Jobling (2000) further explains that at extreme temperatures problems may arise. For example some enzymes which keep the plant functioning slows down at temperatures above 30° C and cease operating at 40°C. This results in high temperature injury. The consequences are a general loss of pigment or colour and effected areas develop a watery appearance and appear translucent.

Lee et al (2000) also states that, “temperature management after harvest is the most important factor to maintain vitamin C of fruits and vegetables”. They further state that “losses are accelerated at higher temperatures and with longer storage duration, hence the loss of vitamin C after harvest can be reduced by storing fruits and vegetables in reduced oxygen and or up to 10% carbon dioxide atmospheres”. On the effect of low temperature, Jobling (2000) suggest that “temperature management is essential to maintain produce quality”. He explains that “the ideal temperature of fresh produce after harvest often depends on the geographic origin of the product. He states that tropical plants have evolved in warmer climates and therefore cannot tolerate low temperatures during storage”.

Jobling (2000) further establish that “temperature has big effect on the rate of metabolism of produce. He explain that when temperature of products rises, so too does the rate of metabolism. One of the main processes of metabolism is respiration which is the process of breaking down stored carbohydrate to produce energy. When temperature rises in products which do not have a lot of stored reserves, such as leafy vegetables and flowers, carbohydrate can become limiting and more simply they run out of food and as a result the shelf life and quality is rapidly reduced by warm temperatures. Lowering temperature as quickly as possible after harvest will slow the rate of metabolism and therefore extend the product’s shelf life. Jobling (2000) states that, at extremes of temperatures products get damaged. He explains that some suffer chilling injury whiles others suffer damage at very high temperatures. He concludes that short exposures or few hours of exposures to extreme hot or cold temperatures can cause a marked decrease in shelf life and loss of quality. He further states that correct and careful temperature management throughout harvest and marketing chain is essential if the quality of the product is to be assured”.

Analysing the current storage practices of small scale producers in the study areas with the above literature, it is proven that the storage practices have negative impacts on the chemical composition and appearance of their mangoes. These therefore suggest that the practices of the small scale producers are in contrary to what is published by researchers.

Figure 18 shows pictures of how small scale producers handle mangoes after harvest.

Figure 18 Small scale producers handling mango in open air exposed to direct sunlight

5.5 Production and Export volumes of Mango

From the findings of the study it is seen that there are differences in the production and exports volumes of mango within the two (2) study areas. A difference of 174 tonnes in the production volumes and 144 tonnes in export volumes suggest that more mangoes are produced and exported from Yilo Krobo. This allude to the reasons that even though the same sample size of producers were selected that is, 20 respondents selected from both districts it is clear that producers in Yilo Krobo have large tracts of land compared to producers from Dangme West District. (Figure19).

Again from the study it is noted that 30% of the total production of 4,194 tonnes from the two (2) districts are exported. According to Adongo 2006, the total number of land under mango cultivation in the southern sector of Ghana is 5,600 acres which translates to 2,267 hectares. From the data analysis it is realised that the average yield per hectare of the 40 respondents is 11 tonnes per hectare. Assuming that the total land under cultivation in the southern sector produces an average yield of 11 tonnes per hectare, the total production will therefore be equal to 24,939 tonnes. Again assuming the case of the study area where 30% of the total production is shipped for the export market the volume exported will be equal to about 7,480 tonnes.

Hence the producers in the southern sector have the capacity to produce about 24,939 tonnes per year and export about 14,964 tonnes with an export rate of about 60% of production.

However, in comparison with the current estimate of production and export volumes of 6,800 tonnes and 711 tonnes respectively in 2007 (table 1), to the data analysis from the study it is realised that producers and exporters are producing and exporting below their capacities. According to SLE 2006, neighbouring West African countries like Burkina Faso, Mali and Ivory Coast export about 11,000 tonnes per annum whiles Ghana currently exports less than 1,000 tonnes, further comparison shows that if the industry in Ghanaian put to use its full capacity of production and exports of estimation 24,939 tonnes and 14,964 tonnes Ghana will have the competitive edge over its neighbouring countries.

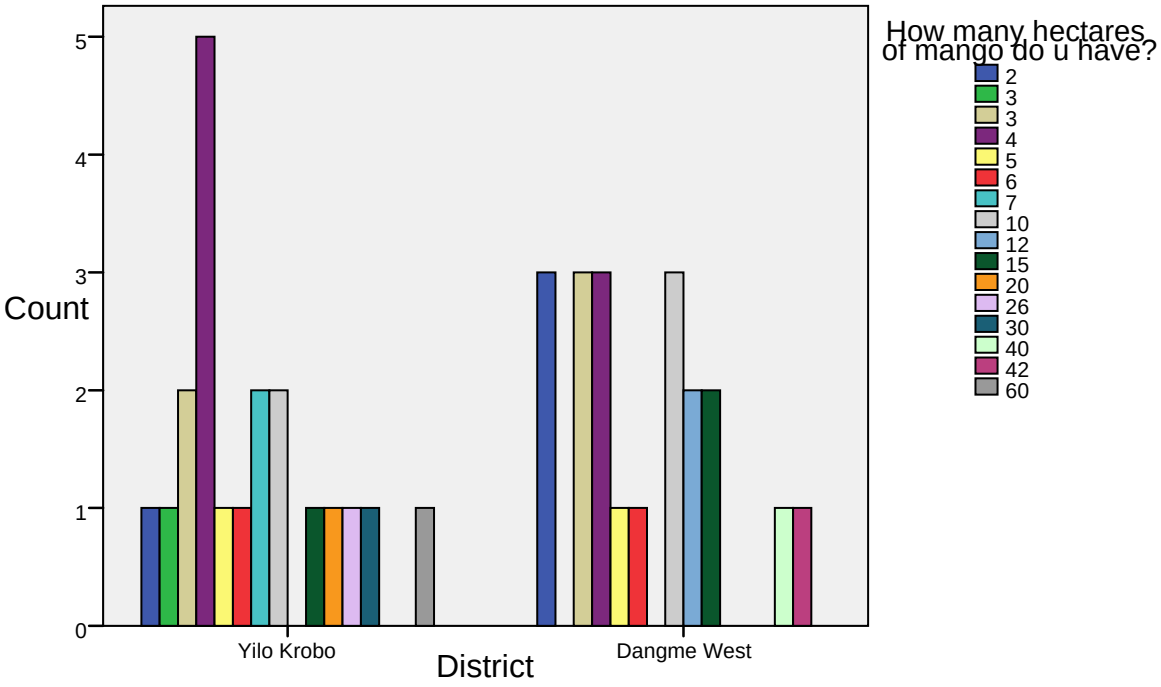

Figure 19 Comparison of farm size between clusters of districts

5.6 Post Harvest Losses and Quality Level

According to Malik et al. (Eds) 2005, 25 - 30% of fruit produce are lost due to improper post harvest operations including storage hence as a result there is considerable gap between the gross production and net availability. They further suggested that if proper care is taken from harvesting to final marketing, considerable losses can be minimized and better quality fruit can reach to consumers, ensuring higher returns to the producers.

The research reveals that there are differences in the post harvest losses due to storage between the clusters of producers. In the same way there are differences in the quality level of mangoes between the clusters of producers. It is seen that all 20 respondents representing 50% under the cluster small scale producer experience post harvest losses whiles 32.5% of commercial scale producers experience same. However 17.5% of the commercial producer do not experience post harvest losses. It has been realised that 29.41% of small scale producers experience post harvest losses of < 5%, 23.53% experience 6 -10% and 5.88% experience 11 - 15%. Comparing with commercial scale producer it is seen that with the exception of commercial producers who do not experience post harvest losses at all, the rest fall under or experience post harvest losses of only < 5% whiles small scale producers have varying degree of post harvest losses of < 5% through to 15%. It is therefore evident that small producers experience more and intense post harvest losses (figure 20). The losses experienced by small

scale producers are as result of their harvesting factors and storage practices. It is now established that small scale producers harvest at fully ripen, transport and also store their mangoes in the open air exposed to sunlight. As reviewed by Malik et al (Eds) 2005, that 25 – 30% of fruit produce are lost due to improper post harvest operations it is now clear why small scale producers are exposed to high range of post harvest losses in comparison with commercial scale producers.

From the research, the post harvest losses experienced by the two districts shows a similar pattern of losses with majority of respondents in the two (2) districts experiencing losses. However there are some differences which appear in number of respondents. In Yilo Krobo, 40% of respondents experience losses whiles 10% do not, whiles in Dangme West, as high as 45% of respondents experience losses whiles only 5% do not. From this relationship between the two (2) districts it is clear that Dangme West experience more post harvest losses as compared with Yilo Krobo. It is therefore conclusive enough to say that producers in Dangme West do little storage. Hence the number of respondents experiencing post harvest losses relates to the storage practices of producers.

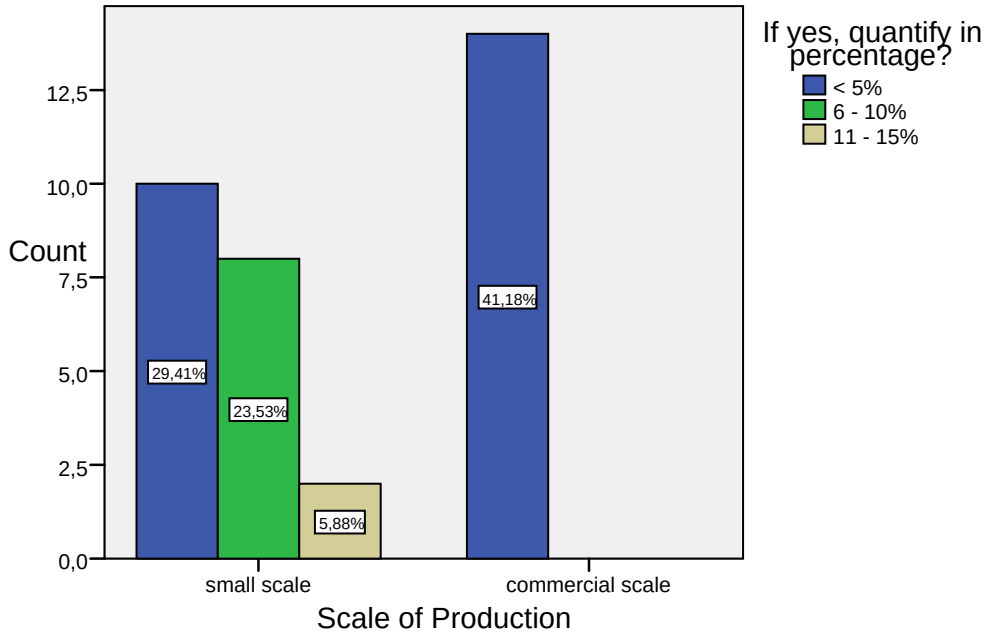

Figure 20 Percentage of post harvest losses between clusters of producers

The research establishes that there are differences between the current quality levels of mango produced by the different clusters of producers. The quality level is based on the number of rejects of mangoes received by producers from buyers. It seen from the results that all respondents under cluster small scale producers received rejects from buyers indicating low quality level of produce. On the other hand, 35% of commercial producers received rejects while 15% did not receive rejects. According to Zind 1989 cited in Nune et al. 2007 appearance,

colour, texture and aroma are probably the most important criteria used by a consumer to evaluate the immediate quality of a fruit and thus, persuade him or her to buy it.

From the research study it was established that producers in both districts were involved in several chains such as export, domestic and processing. Even though majority of small scale producers supplied to the domestic market there were some who also supplied to the export market. This implies that there are different customers who have different uses for mangoes supplied by producers. It is therefore possible that customers will have different expectations about mangoes supplied by producers. This is supported by Shewfelt (2006) who states that "consumers do not behave uniformly, being influenced by their cultural, historic, religious, demographic, economical and social background."

This argument is supported by Zuniga – Arias et al. 2007 who suggests that "the different attributes included in the concept of quality depend on the relevant actor who is acquiring the product." Whiles wholesalers and retailers emphasize on visual attributes such as size, form, colour and shelf-life, taking into consideration consumer preferences, producers rather emphasize on or give preference to profit attributes, like yields, input requirements, suitability for mechanical harvesting and industrial preparation, and resistance against pests and diseases. This assertion is also supported by Kader (1999) who also states that "to producers a given commodity must have high yield and good appearance, it must be easy to harvest, and must withstand long distance shipping to markets. He further explains that appearance quality, firmness, and shelf – life are important from the point of view of wholesale and retail marketers whiles consumers judge quality of fresh fruits on the basis of appearance (including freshness) and firmness at the time of initial purchase"

Again, Romano et al. (2006) also supports the argument about what the definition of quality is to the different target markets in the mango chain by stating that "quality has different meanings for different stakeholders (producers, distributors, consumers, etc) but consumer acceptance seems to be the most important factor to consider".

The rejection of mangoes by buyers in the study areas are therefore attributed to several reasons. To be able to thoroughly analyse the situation of rejects by buyers it is therefore important to understand and know buyers expectations. From the results of the study it was observed under the cluster small scale producers that most reasons for rejects were due to signs of rot and decay. However, according to Kader (2008) mango quality indices include uniformity of shape and size, freedom from decay and defects, skin colour that is characteristics of the cultivar, flesh colour, flesh firmness (juiciness, fibre content), and flavour (sweetness, acidity, aroma intensity). This analysis therefore confirms that mangoes from the cluster small scale producers are of low quality. It further justifies the reason why buyers reject mangoes from small scale producers.

Several factors such as harvesting and maturity, cultivar or variety, cultural practices including production systems and post harvest handling practices are noted to affect the quality of mango. This is supported by Kader (2008) who reports that "postharvest handling practices such as preparation of fruits for market (washing, heat treatment, waxing, fungicide treatment, packaging, cooling); management of temperature and relative humidity (to avoid chilling injury and minimize water loss) have adverse effect on the quality of mango".

From the above assertion it is established that the current post harvest handling practices of mango producers such as storing in the open air direct under sunlight and transporting in open carts or trucks contributes greatly to the low level of quality of mangoes in the research districts.

The above findings correspond with the information gathered from the interview on the quality level of mangoes. Informants from the interview mentioned that the quality level of mango produced from small scale producers are of low quality compared with commercial scale producers.

5.7 Awareness level of producers on effect of storage on quality

From the research it was gathered that there are differences in awareness level of producers on effect of storage on quality. 35% of small scale producers do not use any quality measures during storage. This may be for the fact that small scale producers do not store their mangoes hence they do not need to use any quality measures. However about 15% of this category of producers who store their mangoes use some quality measures. On the other hand, commercial scale producers carry out storage of mangoes and also use quality measures during storage.

Mango product management for export market outlets is tightly related to international practices and standards, like Hazard Analysis and Critical Control Points (HACCP), ISO and EurepGap certifications. On the other hand, management practices for mangoes deliveries to the national market are far less standardized. Hence for producers and exporters to be able to fully participate in export chains there are several requirements that need to be fulfilled including ensuring quality standards. It is therefore critical for producers and exporters to have the maximum knowledge and awareness on product quality and the factors that affect product quality from farm operations to the final destination of the product. Comparing the export market and domestic market, it is noted that export markets are concern with the intrinsic and extrinsic attributes of quality in terms of appearance, taste and nutritional value unlike domestic markets where consumers do not consider much of quality attributes. This is supported by (Prinsley & Tucker 1987) who states “that Export markets such as the United Stated have strict laws regarding the presence of pest and disease in and on fruits”.

Zuniga – Arias et al. 2007 also states that quality variability is lower in the export side of the chain and the variability in quality increases the closer you get to the costumer. This might be because the closer to the costumer bigger the niches and outlets and consumer wishes the product must meet, then the retailers must have any type of mango to cope with that wide range of options. Producers delivering to the export market face the international regulations, forcing them to have a certain type of produce to meet the strict requirement for the export market.

Commercial producers who are more often in the export chain therefore employ quality measures to enable them meet the high standard export markets compared to the small scale producer who do not have to care much about quality. This therefore answers the difference in the level of knowledge between producers on quality with regard to post harvest handling of mango.

5.8 Constraints faced by Mango Export Chain

From the research it is established that the lack of appropriate storage facilities is linked to the storage practices of producers. Majority of producers carry out their post harvest handling in the open air exposed to direct sunlight. This is as a result of lack of cold chain facilities within producing centres. On the other hand, big commercial producers who have access to cold chain facilities carry out their post harvest handling operations under favourable conditions that

maintains fruit quality. It is in this regard that such producers encounter less post harvest losses as compared to small scale producers who encounter high post harvest losses.

The lack of developed infrastructure such as adequate access road network from mango producing centres to ports greatly affects the effectiveness of the chain. Due to the poor access road mango heading for the ports stay longer in transit on the roads without the appropriate cooling transportation trucks. As a result product quality is affected in the long run. In the current mango export situation it is seen that the whole chain of the mango from farm to ports of exports indicates lapses in the cold chain management of the mango which is highly perishable. The inadequate storage facilities or pack house on the producers fields, lack of appropriate transportation and cold storage facilities at the ports therefore presents a situation where it is very difficult for mangoes to maintain their quality as several factors like temperature and relative humidity have adverse consequences on the quality of mangoes. Considering the average temperature in the producing areas of range 28 – 30° C it is likely for mangoes to suffer injury due to high temperatures. This is supported by Kader 1999, who states that "the optimal temperature for mature-green mangoes ranges from 12º to 14ºC and 8º to 12ºC for partially-ripe and ripe mangoes with an optimal relative humidity range of 85 to 95% for all mangoes".

High cost of certification and complex standard requirements for individual small scale producers presents such a big issue to the export chain since most commercial producers and exporter largely depend on small scale producers to top up their export volumes. It will therefore be more beneficial to commercial producers to organise certifications for these individual farmers.

5.9 Way-forward and Future Improvement Plans in the Mango Export Chain

From the research it is noticed that there is a strong private – public partnership and collaboration in the industry working for further developments. This is seen by the case where the ministry carries out demonstration and training sessions for small scale producers using the pack house and storage facilities of commercial scale producers who are more entrepreneurial and so they invest and apply higher technology in their operations.

From the concept of value chain development facilitators such as government, NGOs are to act as facilitators only or facilitating plus or facilitating to the max according to Posthumus 2008. It is therefore seen in the improvement plans of the government under EMQAP, MOFA and MIDA that these organisations are playing various roles such as facilitating to the max through the strengthening and linkages of the chain actors and supporters by providing financial, infrastructure and technology and technical assistance to chain actors. Strengthening, improving the linkages between actors and creating the enabling environment in the industry by the government through its agencies will therefore lead to the better performance of the export chain. These activities coupled with the chain actors performing at their optimum levels will thus increase the low export volumes of mangoes from Ghana.

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

The beginning of this final chapter deals with analysis of the value chain and the opportunities and threats of the mango export sub sector. It further deals with an overview of findings made and the extent to which the aims of this research have been achieved. The latter part of this chapter presents practical strategies to address the research questions.

6.1 Value Chain Analysis of the Export Chain

A value chain analysis of the mango export chain revealed that the following actors; input supplier, small scale and commercial scale producers, exporters, supermarkets and consumers play various roles and functions ranging from input supplying, producing, exporting, retailing and consuming. The analysis also realised that there are different gross income, added value, gross margins and value share among the different actors in the chain. This is in agreement with what Roduner (2007) defines about value chain that a product before reaching the final consumer is transformed, combined with other products, transported, packaged, displayed etc, and in the process raw materials, intermediate products and final products are owned by various actors who are linked by trade and services, and each add value to the product.

From the value chain analysis it is realised that the actor who receives the highest value share is the producer followed by the exporter since they add more value to the product. However the producer receives the least gross income because of his high cost of production (fixed and variable cost).

Additionally, from the analysis it is revealed that money exchange flows from upstream of the chain to downstream whiles there are two (2) – way information flow. In terms of traceability of quality issues, there is a movement of tracing from upstream to downstream and movement of tracking from downstream to upstream. A clearer picture of this analysis is presented in figure 21, 22 and 23 and table 4.

The various stakeholders and influencers providing support and policies in the export chain are listed below with their functions:

- PAMPEAG

Its functions are to assist members of the association produce export quality papaya and mango and increase production volumes. Act as lobby force for the sub sector. Train its members on international market trend, developments, quality requirements and standards for export

- YKMFA and DAMFA

These are different associations belonging to producers in the different producing areas. They share the same functions such as to assist their members produce and market fresh mangoes and to provide training to members on good and improved production practices

- FAGE

Its function are to assist in developing export quality standards, provide business services to firms dealing in non traditional commodities and provide market and trade information

- GEPC

Its function is similar to FAGE but they are government export trade institution unlike FAGE that is a private institution.

- GHPA

It acts as freight forwarders in the export chain and controls exports at the ports.

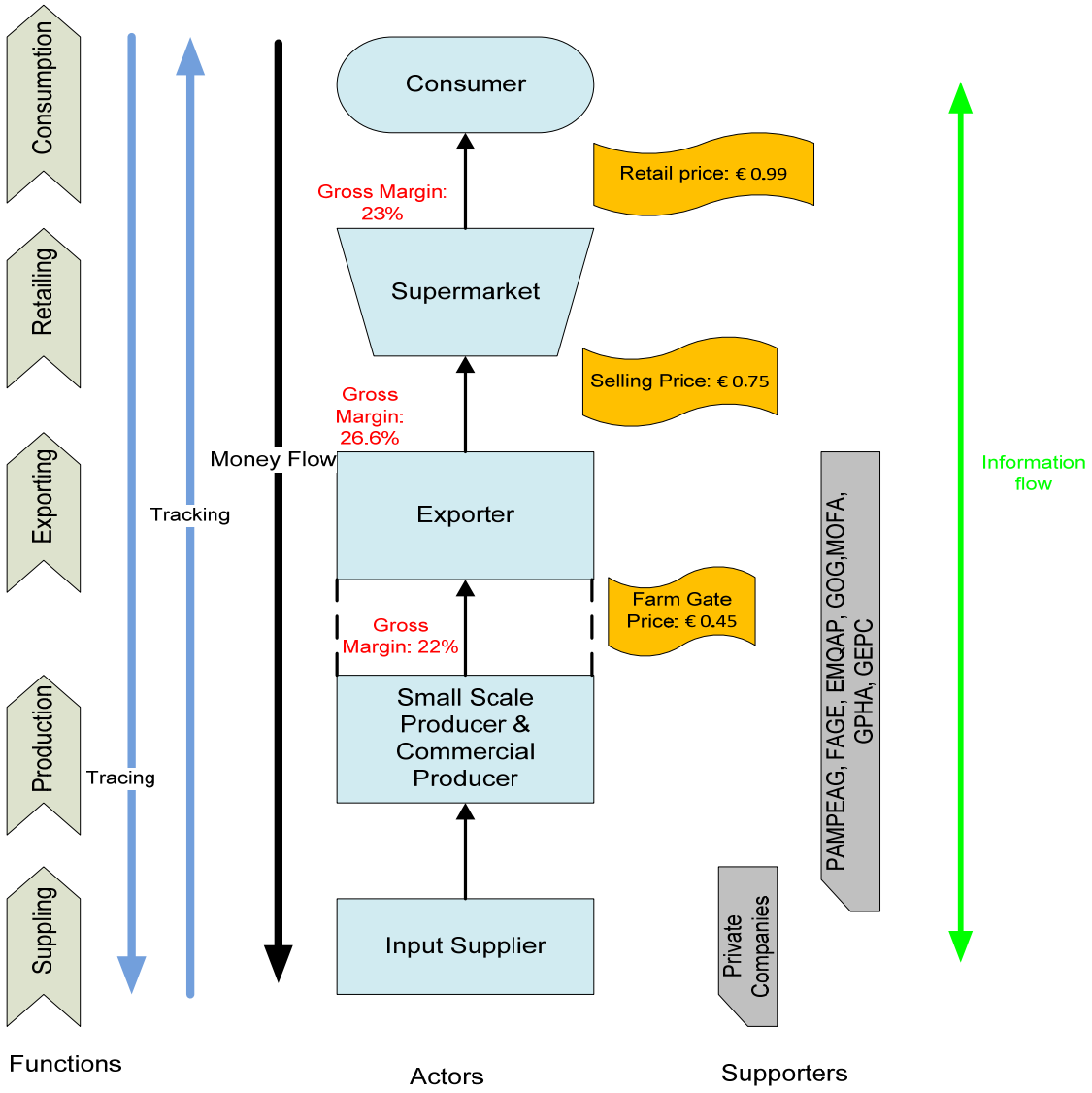

Figure 21 Chain map of mango export chain

6.1.1 Economic Analysis of Mango Export Chain

An analysis of the economic situation of the chain looks at the cost price taking into account all fixed and variable cost, farm gate price of mango per kg, gross margins and added value at each stage of actors. Prices fluctuate according to season and market however a farm gate price of 1.4 Euros per box of 4 kg is used for the analysis assuming good season and good market. An exporter selling price of 3.0 Euros per box of 4 kg is also used assuming good season and good market. Prices are derived from average price of producer and exporter. Data are as of July 2009. Below gives overview of the economic analysis.

Table 5 Economic analysis of mango export chain

Chain Actor	Cost Price (€)/kg	Selling Price (€)/kg	Gross Income (€)/kg	Added value (€)/kg	Gross margin (%)	Value share (%)
producer	0.35	0.45	0.10	0.45	22.22	45.45
exporter	0.55	0.75	0.20	0.30	26.67	30.30
supermarket	0.76	0.99	0.23	0.24	23.23	24.24
Total				0.99		100

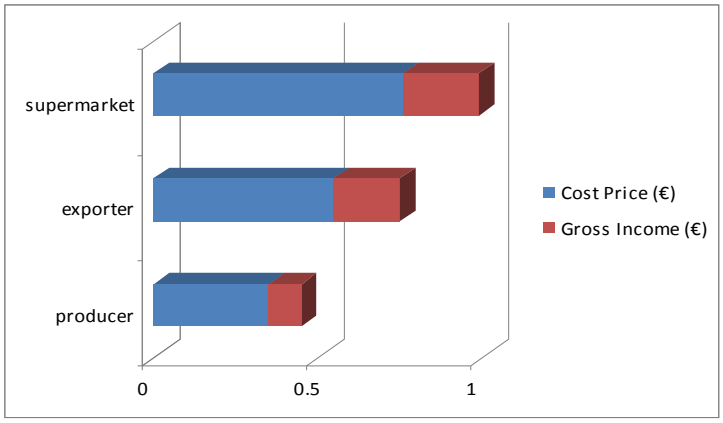

Figure 22 Cost price and selling price of different actors in mango export chain

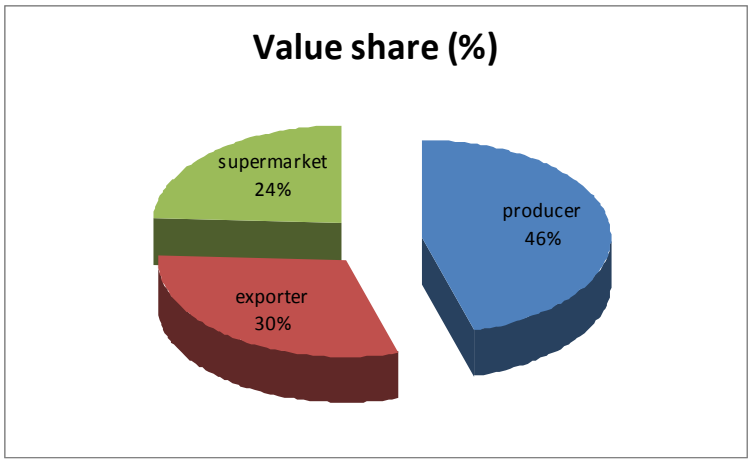

Figure 23 Value shares of different actors in mango export chain

6.2 Opportunity and Threats Analysis

An analysis of external favourable and unfavourable factors surrounding the mango export chain are identified and presented in table 5 below.

Table 6 Opportunity and threats of the mango export industry

Opportunities	Threats
In terms of future developments and sustainability the strong private – public sector collaboration and partnership gives the industry an opportunity to grow.	The complex and cumbersome quality and safety systems requirements for certification (GLOBALGAP, Fairtrade, IMO, etc) by small scale producers present threat to the industry.
The involvement of international donor such as MCA, AfDB and USAID and other international NGOs such as ADRA and GTZ gives the industry an added opportunity for the industry to grow.	The withdrawal of preferential access to international markets through bi – lateral agreements such as African Growth and Opportunity Act (AGOA) of the US and African Caribbean Pacific countries (ACP) of the EU poses a threat to the industry.
The high and growing European consumer demand for high quality and safe exotic fresh fruits (organic and fair-trade products) gives the sector an opportunity to explore bigger markets. In addition African immigrants living in Europe also presents an opportunity for the industry to explore wider market.	Current recession in European economy presents itself as threat to the industry since consumers who see mango as luxury product may opt for cheaper fruits.

Ghana's climatic and stable political conditions coupled with the strategic location to European markets are extremely well suited for investment in the industry.	Low production volumes coupled with mistrust between producers and exporters also presents a threat to the industry.
The refurbishment of 4,400 m² floor space fruit handling terminal with cooling facilities at the sea port at Tema gives the industry an opportunity to increase its export volumes and maintain quality.	Poor access roads from mango producing centers to air and sea ports coupled with lack of access to transportation service companies with adequate cold chain infrastructure also presents a threat to the industry.
Available air and sea freight capacity gives the industry opportunity to explore international markets.	The state of under developed cold chain infrastructure in the industry presents a threat to the industry.
There are other alternatives alongside the fresh mangoes for export such as processing into mango juice, cut mangoes, etc which presents an equal opportunity for the export chain.	Competition from neighbouring regional countries and international exporters presents a threat to the export chain of the Ghanaian mango industry.

6.3 Conclusions

The research examined the impact of the current post harvest storage practices on the quality of Ghana mango for export and after a thorough study of the mango export chain number of conclusions is drawn.

The study revealed that the fresh mango chain in both Yilo Krobo and Dangme West districts are organised in a similar way with different actors and players playing different roles in the chain such as producing, trading, processing, exporting and retailing at open market. Small scale producers are more linked to the domestic market that is, retailing at open market even though to some extent they are also involved in the export market whiles commercial scale producers are more linked to the export market and other markets.

Small scale producers consider the harvesting factor fully ripen whiles commercial scale producers consider the harvesting factor mature green. A link between harvesting factors to the type of supply chain revealed that small scale producers linked to the open market considers the harvesting factor fully ripen whiles commercial scale producers considers the factor mature green.

The study revealed that about half of small scale producers do not store their mangoes whiles the other half store their mangoes for a period of one (1) day. More than half of commercial scale producers store their mangoes for a period of one (1) day whiles the rest store for a period of two (2) days.

Small scale producers employ means of open carts or trucks to transport their mangoes whiles commercial scale producers employ several means of transportation ranging from open cart or trucks, container trucks without cooling and cooling vans.

The study further revealed that small scale producers who store their mangoes store them in the open air exposed to direct sunlight whiles a fraction of them store under sheds. Commercial scale producers use different storage ways of storing mangoes including storing in open air exposed to direct sunlight, storing under sheds, storing in enclosed room without cooling and storing in cooling rooms. About 17.5% of commercial scale producers store their fruits under sheds, whiles a substantial percentage of 15% store in cooling rooms, and 10% and 7.5% store in enclosed room without cooling and open air exposed to direct sunlight respectively. A very interesting phenomenon developed from the study was that the type of storage facilities used by producers and the storage period or length relates to the number of hectares of mango plantation the producer owns.

Yilo Krobo district produced 2,184 tonnes and exported 638 tonnes whiles Dangme West district produced 2,010 tonnes and exported 494 tonnes.

Small scale producers experience post harvest losses ranging from 0 – 15%. About two – thirds of commercial scale producers experience post harvest losses ranging from 0 – 5% and the rest do not experience post harvest losses. The study also revealed that the quality of mangoes from small scale producers is of low quality based on rejects received from buyers. Mangoes from two – thirds of commercial producers are also classified low quality based on rejects received from buyers whiles the rest are classified high quality based on no rejects from buyers.

The quality standards used for the export market are based on international quality standards such as EurepGAP and HACCP.

The quality factor signs of decay and rot affect mangoes produced by small scale producers and the quality factor signs of mechanical damage affect mangoes produced by commercial scale producers.

Small scale producers have little or low level of awareness on measures for storing mangoes whiles commercial scale producers have medium to high level of awareness on measures for storage.

New knowledge learnt from the research shows that the low export mango volumes is not only as a result of the effect of post harvest storage on quality of mangoes but also other several factors such as poor production management, inadequate control of pests and diseases (fruit flies and anthracnose), access to good planting materials, high freight cost among others cripples the mango export chain.

6.4 Recommendations

For the mango export chain to be well developed and compete favourably on the international market in terms of quality of volumes exported in a more sustainable way the following recommendations on the appropriate storage practices are made to the different stakeholders and actors in the mango export chains as follows:

- To Stakeholders

With the current bureaucratic structure and slow pace of export documentation processes at the countries ports which causes delays and further increase storage time of mangoes at the ports resulting in the exertion of too much pressure on the inadequate storage facilities at the ports, it is highly recommended that management of Customs Excise and

Preventive Services (CEPS) and Ghana Ports and Harbours Authority (GPHA) streamline the bureaucratic structures and hasten the documentation processes at the countries ports to reduce delays of exporters and cut down on storage time at the ports to maintain fruits quality.

To cut down on mango post harvest losses and maintain product quality at all times, the Export Marketing and Quality Awareness Project (EMQAP) under the Ministry of Food and Agriculture is recommended to support the mango industry with the installation of adequate pack houses and cooling storage facilities at producer communities.

To increase the level of awareness of producers and exporters especially, small scale producers on the effect of good storage practices on quality of export mangoes the Directorate of Agricultural Extension Services is recommended to train extension agents in mango producing districts with up to date knowledge and skills on post harvest management of mangoes.

- To Exporters

To ensure that producers supply regular and high quality mangoes for export it is recommended that big exporters like Bomarts Farms and Blue Skies invest in cold storage facilities at producers' fields.

- To Producers

To ensure that small scale producers supply high quality mangoes to exporters it is recommended to small scale producers under the Yilo Krobo Mango Farmers Association (YKMFA) and Dangme West Mango Farmers Association (DAMFA) that at places where there are no proper cold storage facilities, producers should handle and store their mangoes for shorter periods in enclosed rooms with adequate ventilation and at lower temperatures not exceeding 13°C or under sheds where there are not too much sunlight.

Since some commercial scale producers have existing storage infrastructure and are capable of investing in cold storage facilities and applying high technology compared to the small scale producer it is recommended that commercial scale producers like Prudent Exports Farms, Georgefields Farms and Volta River Estate Limited contract small scale producers who are non – entrepreneurs producers to produce for them whiles they the commercial scale producers carry out the post harvest handling and storage.

Further research study in the area of optimum transportation and storage conditions for the different varieties and cultivars of mango exported in Ghanaian is recommended.

REFERENCES

Adongo, A., 2006. *The supply chain for the mango industry in Ghana*. Accra: FAGE.

BOG, 2009. Bank of Ghana: Statistics. [Online]. Available at http://www.bog.gov.gh/index1.php?linkid=173 [accessed 16/05/09]

Bower, J. H., Biasi, W. V., Mitcham, E. J., 2003. Effect of ethylene in the storage environment on quality of 'Bartlett pears. *Postharvest Biology and Technology*. 28: 371 – 379.

Chaplin, G. R., 1989. *Advances in postharvest physiology of mango*. Acta Horticulturae 231, 639 – 648.

Ortega – Zaleta, D. & Elhadi, M. Y., 2000. Tolerance and quality of mango fruit exposed to controlled atmospheres at high temperatures. *Postharvest Biology and Technology,*[Online] 20 (2000), 195–201.Available at: http://www.elhadiyahia.net/pdf/Ortega%20and%20Yahia,%20Mango%20ICA,%20PBT,%202000.pdf [accessed 10 August 2009]

EPA, 2006. Environmental Protection Agency Law. [Online]. Available at http://www.epa.gov.gh/ [accessed 22/05/09]

Evans, E. A., 2008. *Recent trends in world and U.S. mango production, trade and consumption.* (Publication FE718) [Internet]. Gainesville, Florida: (Published 2008). Available at: http://edis.ifas.ufl.edu/pdffiles/FE/FE71800.pdf [accessed 25 June 2009]

Faalong, J. Y., Agboka, M., Amamoo- Otchere, E. and Akuetteh, B. 2006. Capacity Building in Digital Mapping and GIS for Boosting the Agricultural Sector: Development of GIS-driven Horticulture Produce Information System for Managing the Export Sector. Accra [Online]. Available at http://www.fig.net/pub/accra/papers/ts11/ts11_04_faalong_etal.pdf [accessed 19/05/09]

FAOSTAT, 2007. *FAO Statistics, Food and Agriculture Organization of the United Nations*. [Online]. Available at: http://faostat.fao.org/site/339/default.aspx. [accessed 25 June 2009]

Fonseca, M.J. de. O., Salomao, L. C. C., Cecon, P. R. and Puschmann, R., 2001. Use of fungicide and wax in storage and post harvest quality of "Haden" mango (*Mangifera indica L.*) in cold storage. *Revista – Brasileira – de – Armazenamento*. 26 (2): 28 -35. (CAB Abs. 2002/08-2003/07).

GIPC, 2008. *Profile of Ghana's horticulture industry*. Ghana Investment Promotion Council: Accra.

GTZ Ghana, 2006. *Sustainable development*. Accra: GTZ [Online] Available at: http://www.gtz.de/de/dokumente/en-gtz-in-ghana-sustainable-development.pdf [accessed 25 June 2009]

Harvey, E.C. (1987) .Maturity Indices for Quality Control and Harvest Maturity. IN: Mangoes a Review. The Commonwealth Secretariat, London, p 39-53.

Jobling, J., 2000. *Temperature management is essential for maintaining produce quality*. Sydney Postharvest laboratory Information Sheet. Melbourne Australia. [Online] Available at http://www.postharvest.com.au. [accessed 14 August 2009]

Jonah, K., 2005. Inter-Party Dialogue in Ghana. The institute of economic affairs. Accra

Kader, A. A., 1999. Fruit maturity, ripening, and quality relationships. *International Symposium on Effect of Pre and Post Harvest Factors on Storage of Fruit*, [Online]. 485 (ISHS), p. 203-204. Available at: http://postharvest.ucdavis.edu/datastorefiles/234-167.pdf [accessed 30 June 2009]

Kader, A. A., 2002. Quality and Safety Factors: Definition and Evaluation for Fresh Horticultural Crops. In: Postharvest Technology of Horticultural Crops, University of California, p. 279-285.

Kader, A. A., 2008. *Mango quality attributes and grade standards: A review of available information and identification of future research needs.* [Online]. Available at: http://www.mango.org/en/industry/researchprogram/quality-standard-research-and-analysis.aspx [accessed 2 September 2009]

KIT, Faida MaLi and IIRR. 2006. *Chain empowerment: Supporting African farmers to develop markets.* Royal Tropical Institute, Amsterdam; Faida Market Link, Arusha; and International Institute of Rural Reconstruction, Nairobi.

KIT & IIRR, 2008. *Trading up: building cooperation between farmers and traders in Africa*. Amsterdam: Royal Tropical Institute; Nairobi: International Institute of Rural Reconstruction.

Litz, R. E., 1997. *The mango: botany, production and uses*. Cambridge: University of Cambridge Press.

Lee, S. K., & Kader, A. A., 2000. Preharvest and postharvest factors influencing vitamin C content of horticultural crops. *Postharvest Biol. Technol*. 20: 201 – 220.

Malik, W., Farooq, U., Sharif, M., 2005. Citrus marketing in Punjab: Constraints and potential for improvement. The Pakistan Development Review. [Online]. 44: 4 part 2 (Winter 2005): 673 – 694. Available at: http://www.pide.org.pk/pdf/PDR/2005/Volume4/673-694.pdf [accessed 15 August 2009]

Medlicott, A., Bhogol, M., Reynolds, S., 1986. Changes in peel pigmentation during ripening of mango fruit (Magnifera indica, var. Tommy Atkin). *Annals Appl Biol.*, *109*, 651-656.

Mitcham E., & McDonald, R., 1992. Cell wall modification during ripening of 'Keitt' and 'Tommy Atkins' mango fruit. *Journal of the American Society for Horticultural Science.* 117 (1992), pp. 919–924.

Mitra, S. K., & Baldwin, E. A., 1997. Mango. In: S. Mitra (ed.). Postharvest physiology and storage of tropical and subtropical fruits. CAB International, Wallingford, UK, pp. 85-122

MOFA, 2007. *Food and agriculture sector development policy (FASDEP II)*. Accra: Ministry of Food and Agriculture.

Morton, J. 1987. Mango. p. 221–239. In: Fruits of warm climates. Julia F. Morton, Miami, FL. Available at: http://www.hort.purdue.edu/newcrop/Morton/Mango_arS.html [accessed 1 July 2009]

NLC, 2005. National Labour Commission: Labour Act [Online]. Available at http://www.nlcghana.org/ [accessed 15/05/09]

Nunes, M. C. N. et al., 2007. Quality curves for mango fruit (cv. Tommy Atkins and Palmer) stored at chilling and non chilling temperatures. *Journal of Food Quality*, 30 (2007), 104 – 120.

Posthumus, H., 2008. Five VCD models. Hans Posthumus Consultancy.

Prinsley, R.T., Tucker, G., 1987. Chapter 1: Introduction. IN: Mangoes a Review. The Commonwealth Secretariat, London, p1-3.

Proctor, F. J., & Cropley, J. P., 1994. Trends and changes in the European market for tropical fruits and their impact on technology requirements. In: Champ, B. R., Highley, E. & Johnson, G. I. (eds) *Postharvest handling of tropical fruits, ACIAR Proceedings 50*. Canberra, pp. 65 – 72.

Rathore, H., A., K., 2007. *Effect of surface coating and packaging on the keeping quality of mango (Mangifera indica L.).* Ph. D. University of Arid Agriculture

Roduner, D., 2007. Donor Interventions in Value Chain Development. 1st Edition. Switzerland: VCRD CoP.

Romano, G.S., Cittadini, E.D., Pugh, B., and Schouten, R., 2006. Sweet cherry in the horticultural production chain. *Stewart Postharvest Review*, 6 (2): 1-7.

Sefa - Dedeh, S., 2006. Ghana's fresh produce hits the market with increased volume, diversified and premium quality products. Ghana National Horticultural Taskforce: Accra. [Online]. Available at: http://www.gepcghana.com/assets/file/Sefa_Dedeh_Article.pdf [Accessed on 31 August 2009]

Shewfelt, R.L., 2006. Defining and meeting consumer requirements. *Acta Horticulturae*, 712, 31-38.

SLE, 2006. *Poverty orientation of value chains for domestic and export markets in Ghana.* [Internet]. Available at: http://www.berlinerseminar.de/bs/files/_SLE_Downloads/auslandsprojekte/2006/Ghana_2006_Final_Report_(Ebook).pdf [accessed 30 August 2009]

World Bank Group/MIGA, 2006. Snapshot Africa – Ghana. [Online] available at http://www.fdi.net/documents/WorldBank/databases/snapshot_africa/docs/snapshot_africa_ghana.pdf [accessed 22/05/09]

Zambrano, J., Materano, W., & Briceno, S., 2000. Influence of storage period on postharvest characteristics of five varieties of mango (*Mangifera indica* L.). *Revista-de-la-Faculated-de-Agronomia, Universidad-del Zulia*, [Online]. 17(2): 164 – 172. (CAB Abs. 2000/08-2002/07). Available at: http://www.revfacagronluz.org.ve/PDF/marzo_abril2000/ra2005%20abstract.pdf [accessed 30 June 2009]

ZIND, T. 1989. Fresh trends '90: A profile of fresh produce consumers. *Packer Focus* 96, 37–41. In Nunes, M. C. N. et al., 2007. Quality curves for mango fruit (cv. Tommy Atkins and Palmer) stored at chilling and non chilling temperatures. Journal of Food Quality, 30 (2007), 104 – 120.

Zúñiga-Arias, G. & Ruben, R. 2007. Variability in Quality and Management Practices in the Mango Supply Chain from Costa Rica. In, Mediterranean Conference of Agro-Food Social Scientists. 103rd EAAE Seminar 'Adding Value to the Agro-Food Supply Chain in the Future Euromediterranean Space'. Barcelona, Spain, April 23rd - 25th, 2007.

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APPENDICES

APPENDIX 1 QUESTIONNAIRES FOR SURVEY

Please circle one answer for each question that best applies to your situation.

1. How many hectares of mango do you have?.....
2. In which district is your mango farm?

    a) Ga Dangme West

    b) Yilo Krobo

3. What is your average yield of mango in tonnes per hectare in the major season?.....
4. What is your average yield of mango in tonnes per hectare in the minor season?.....
5. To whom do you supply your mangoes?

    a) Trader only

    b) Open market only

    c) Exporter only

    d) Processor, Trader, Exporter

    e) Open market, Exporter

    f) Processor, Open market

    g) Trader, Exporter

    h) Other (specify)_____

6. What factors do you consider before harvesting your mangoes?

    a) Fully ripen

    b) Mature green

    c) Others (specify)_____

7. How do you store your mangoes on the farm?

a) In open air

b) Enclosed room

c) Under shed

d) Others (specify)_____

8. How are the harvested mangoes moved from your farm?

a) Open carts/trucks

b) Cooling vans

c) Container trucks without cooling

d) Others (Specify) _____

9. How long do you store your mangoes on average in days?.....

10. Do you have rejects from your buyers based on quality?

a) Yes

b) No

11. If **Yes**, what is the main reason for receiving rejects from your buyers?

a) Signs of mechanical damage

b) Uneven colour

c) Signs of decay and rot

d) Size

e) Maturity

f) Others (Specify)_____

12. What percentage of your mango production do you export?.....

13. Do you use any quality measures during the storage of mangoes?.....

a) Yes

b) No

14. If **Yes**, what are the measures?

a) Check temperature

b) Check for air circulation

c) Check for dryness (amount of water vapour in air)

d) Others (Specify)_____

15. Do you get post harvest losses after storage?

a) Yes

b) No

16. If **Yes**, quantify in percentage?

a) 0 – 5%

b) 6 – 10%

c) 11 – 15%

d) 16 – 20%

e) > 21%

19. In your opinion what are the reasons for the percentage losses after storage?

a) Too much heat

b) Too much cold

c) Disease infestation

d) I don't know

e) others (specify)_____

APPENDIX 2 INTERVIEW QUESTIONS FOR CASE STUDY

(Government Representatives)

1. What are your constraints in rendering services to mango producers in the area of post harvest storage?
2. What are the constraints faced by the mango export chain?
3. What are the quality standards and level of quality of mango for the export chain?
4. What are the future plans/improvements for the mango export chain in terms of storage?

(PAMPEAG Representative)

1. What are your constraints in the area of post harvest storage of mango for export?
2. What are the quality standards and level of quality of mango for the export chain?
3. What are the future plans/improvements for the mango export chain in terms of storage?
4. On average what are cost and selling price of mangoes from one actor to the other?

APPENDIX 3 LIST OF INTERVIEWEES

Table 7 List of interviewees

No.	Name	Title	Organisation	Date	Time	Place
1	Mr. David Crentsil	Project Officer	EMQAP - MOFA	16th July 2009	10:00 – 11:30 hrs	Accra
2	Mr. Victor Avah	Management /Information Systems Officer	Dangme West District Agric Office- MOFA	17th July 2009	13:00 – 14:00 hrs	Dodowa
3	Mr. Anthony Botchway	Exporter	Bomarts Farm	20th July 2009	10:00 – 11:00 hrs	Kpando

Transcript of Interviews

Researcher (R): What are the constraints faced by the mango export chain and future improvement plans?

Informant 1(I1): The limited number of cold chain and pack house facilities among mango producing areas has resulted in high post harvest losses and poor mango quality. This is coupled with the high cost and inconsistent supply of electricity to the pack house and storage facilities. There is limited number of alternative source of powering the storage facility.

Other constraints such as poor access road network from mango producing centres to ports of exports, high cost of certification for individual small scale producers, high cost of input supply and high cost of air and sea freight contributes to the challenges in the export chain. Other constraints encountered by the mango export chain was noted as lack of good planting materials, problems with pest and diseases such as fruit flies and anthracnose, poor production management such as poor pruning practices, and low production volumes by mango producers.

Dduring glut of mangoes there are low pricing and the lack of storage facilities cause farmers to lose huge sums of money hence discouraging farmers to produce less. The fragmented land system in the farming areas leads to the low application of mechanization hence contributes to the low production volumes.

The bureaucratic export documentation procedure at the ports of export is a constraint in the mango chain. Exporters have to fulfil all documentation before exports are made hence increasing the storage life of the mangoes that have to stay at the port without the adequate storage facility resulting in the loss of quality of mangoes.

The Ministry is building and strengthening the private and public institutions surrounding the horticultural industry. As an outgrowth of MOFA's HEII programme, the five years EMQAP under the ADB continues to train extension officers in post harvest handling and management of mangoes including storage. So far over 200 AEAs have benefited from these trainings.

EMQAP in collaboration with the private sector continues to establish demonstration centers and farmer model farms on commercial farms for farmers to learn new and updated techniques of farm practice including post harvest management.

EMQAP in collaboration with a well established mango commercial scale producer – exporter BOMART farms has demonstrated the use of pack house and storage facilities to farmers and AEAs within the mango growing areas. The Ministry is thus building extension capacity in post harvest management using the existing facilities of the private sector who are leading the development of the horticultural industry.

To further improve the mango export chain the EMQAP is constructing 2 pack house and storage facilities at concentrated horticultural producing areas. The pack house and storage facilities will be used for both pineapples and mangoes. The project has refurbished a first class fruit terminal at the Tema Port (shed 9) to support the post harvest cold chain system in the country.

EMQAP has also procured several temperature control vans which are being used for demonstration exercises and promotion of cold chain facilities among horticultural producers.

MIDA under the MCA as part of its objective of developing the entire horticultural supply chain in an integrated fashion to improve the economy of the country, MIDA is constructing first class roads from mango producing centers to ports of exports to facilitate the smooth transportation of produce from farms to export ports. MIDA is also constructing pack houses and storage facilities at mango growing centers and ports of exports. In addition to devoting more than USD 200 million to the construction of the country's horticultural cold chain system, MIDA has earmarked USD 66 million for the development of farmers' commercial skills by working with 1200 FBOs involving 120 enterprises and 60,000 individual farmers.

As part of government efforts to further improve the export chain the government through MIDA is augmenting the credit services available for on farm and value chain investments. The government through its extension directorate is promoting and creating awareness on mango processing as a value addition for the export market.

R: What are your constraints in rendering services to mango producers in the area of post harvest storage?

I2: The ministry in the past has done little work in the horticultural industry of which the mango sector is part. Government in the past had paid little attention to the industry in the area of infrastructure, technology, production systems and technical expertise in the area. It rather focused more on the development of food crops such as maize, cassava, millet, sorghum etc and other cash crops such as cocoa and timber. Therefore the absence of post harvest infrastructure such as harvesting crates, cold chain facilities and pack house facilities has rendered the Ministry of Food and Agriculture helpless in training and transferring technologies on post harvest storage of mangoes to farmers through demonstrations. The lack of technical expertise in the area of post harvest handling management of mango has also incapacitated the District Agric Office to train and give the required technical assistance to mango producers. Inadequate number and non-functioning motor cycles allocated extension officers in the districts renders the extension staff immobile and less motivated to carry out their duties in the hinterlands of the mango producing areas.

R: What are the constraints faced by the mango export chain and future improvement plans?

I3: The mango export chain is encountered with numerous setbacks which cripples the further development of the export chain. The issue of lack of adequate cold chain facilities and storage facilities within the immediate surroundings of mango producing areas do not allow the post harvest mangoes to maintain their quality.

The high freight cost and irregular movement of vessels from the ports of Ghana coupled with the poor cold chain and storage facilities at the ports causes the mangoes to loss quality. The irregular movement of vessels further delays the export of mango thus exporters are not able to deliver their consignment at the agreed times with importers. This deteriorates the relationship between exporters and importers.

The lack of good planting material in the country causes producers and exporters to access planting materials from neighbouring countries such as Togo, Burkina Faso and Ivory Coast resulting in high cost of production.

Commercial producers and exporters largely depend on small scale producers to meet their export volumes however the poor production management practices such as pruning among small scale producers' results in low quality fruits which are rejected by importers. Other constraints are the lack of pack house and storage facilities at the mango producing areas which results in high post harvest losses at the farm gate. The absence of these post harvest facilities also contributes to low quality of fruits from producers. The lack of mistrust among producers and exporters poses a great danger in the supply chain of mango for export. Producers turn to sell their mangoes to the open market and processors when world market prices fall for better prices. This is however not the case for organic and fair trade mangoes because producers are paid premium prices at all times. There is little legal support for signing of agreement contracts in the area of supply chain hence producers and exporters turn to violate contracts agreements often. These factors have led to the mistrust between producers and exporters.

The lack of transportation companies providing services in the area of adequate cold chain and modern temperature controlled and storage facilities puts much pressure on the small and medium scale exporters who often do not have the capacity to invest in the transportation part of the supply chain. These exporters therefore turn to the use of open trucks and carts to transport their mangoes from producing areas to ports resulting in the reduction of mango quality.

The poor road networks from producing centres to ports cause delays in the supply chain of mangoes. The bureaucratic export documentation procedure at the ports coupled with the inadequate cold chain and storage facilities at the ports also contributes to the delay in the supply of mangoes to importers resulting in exporters not be able to supply their importers at the right time.

PAMPEAG is working closely with the government and other international organizations such as USAID under TIPCEE, ADRA and GTZ under MOAP to further develop and improve the mango export chain in terms of post harvest storage.

Several commercial producers and exporters are investing in infrastructure such as cold chain and storage facilities and cold chain trucks and vans to improve the supply chain.

APPENDIX 4 HARVESTING FACTORS OF PRODUCERS

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
mangofarmsize * What factors do you consider before harvesting your mangoes?	40	100.0%	0	.0%	40	100.0%

mangofarmsize * What factors do you consider before harvesting your mangoes? Crosstabulation

Count

		What factors do you consider before harvesting your mangoes?		
		fully ripen	mature green	Total
mangofarmsize	small scale	15	5	20
	commercial scale	1	19	20
Total		16	24	40

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	20.417(b)	1	.000		
Continuity Correction(a)	17.604	1	.000		
Likelihood Ratio	23.407	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	19.906	1	.000		
N of Valid Cases	40				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.00.

$p < 0.05$. Hence there is a difference

APPENDIX 5 TRANSPORTATION PRACTICES

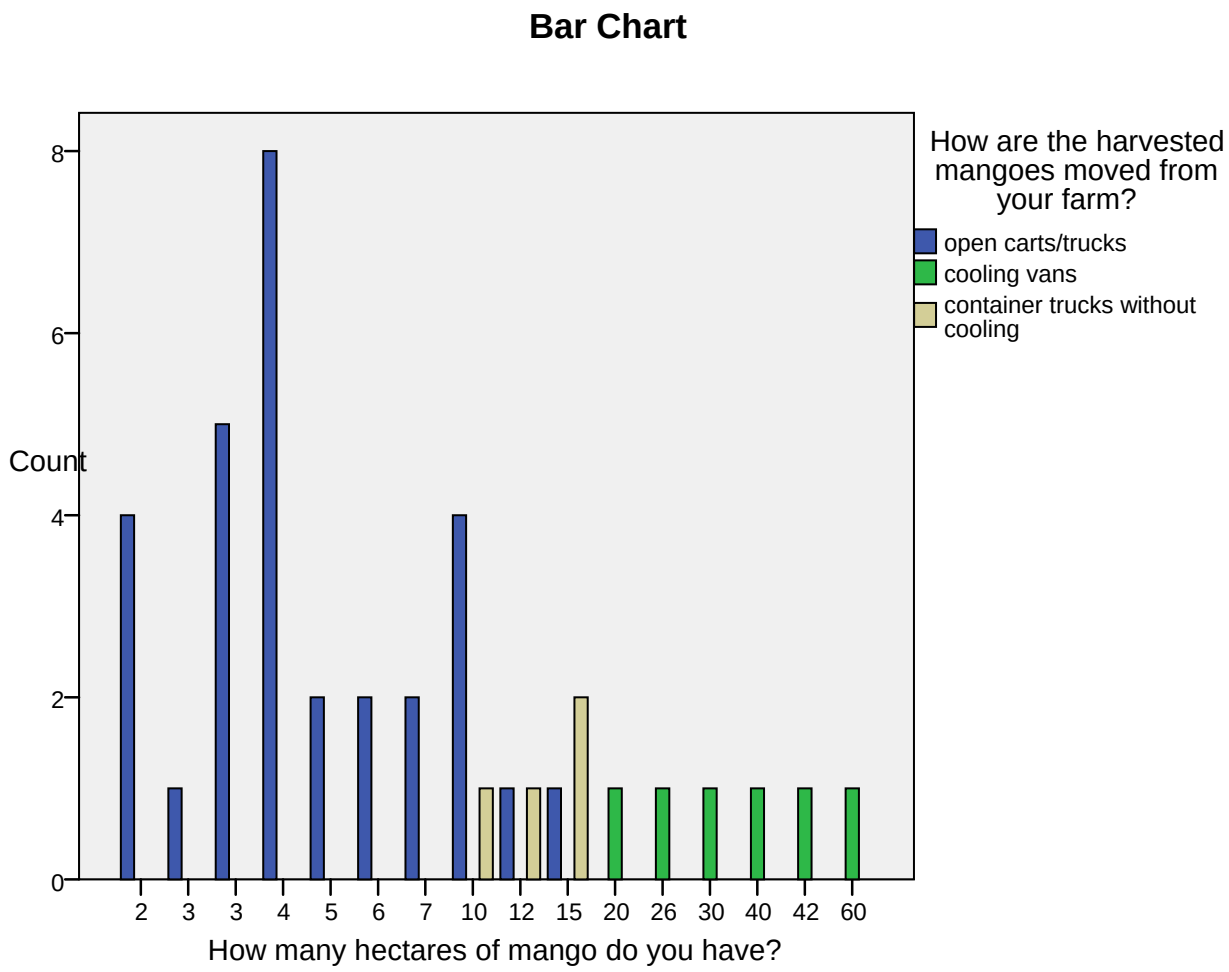

Figure 24 Relation between transportation practices and number of hectares

APPENDIX 6 PRODUCTION AND EXPORT VOLUMES

Table 8 Production and export volumes

Yilo Krobo District					
No. of respondent	farm size (ha)	yield in tons/ha	total yield (tons)	Percentage of mango exported (%)	Volumes exported (tons)
1	7	10	70	0	0
2	6	15	90	0	0
3	4	10	40	60	24
4	3	10	30	0	0
5	20	18	360	40	144
6	4	10	40	10	4
7	7	12	84	0	0
8	3	12	36	0	0
9	20	15	300	40	120
10	4	8	32	0	0
11	10	16	160	20	32
12	4	10	40	0	0
13	5	12	60	0	0
14	3	8	24	0	0
15	4	8	32	0	0
16	10	10	100	40	40
17	20	12	240	30	72
18	15	10	150	60	90
19	20	14	280	40	112
20	2	8	16	0	0
			2184		**638**
Ga West District					
21	3	10	30	0	0
22	30	15	450	40	180
23	20	12	240	50	120
24	10	12	120	20	24
25	4	8	32	0	0
26	15	10	150	50	75
27	4	13	52	0	0
28	6	10	60	10	6
29	2	8	16	0	0
30	12	15	180	5	9
31	5	10	50	0	0
32	10	12	120	5	6
33	4	10	40	0	0
34	2	8	16	0	0
35	3	10	30	0	0
36	2	12	24	0	0
37	10	10	100	5	5
38	3	10	30	0	0
39	15	10	150	30	45

40	12	10	120	20	24
			2010		**494**

APPENDIX 7 DIFFERENCE OF REJECT REASONS OF BETWEEN PRODUCERS

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
mangofarmsize * If yes, what is the main reason for receiving rejects from your buyers?	34	85,0%	6	15,0%	40	100,0%

mangofarmsize * If yes, what is the main reason for receiving rejects from your buyers? Crosstabulation

Count

		If yes, what is the main reason for receiving rejects from your buyers?		
		signs of mechanical damage	signs of decay and rot	Total
mangofarmsize	small scale	6	14	20
	commercial scale	13	1	14
Total		19	15	34

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	13,198[a]	1	,000		
Continuity Correction[b]	10,771	1	,001		
Likelihood Ratio	15,023	1	,000		
Fisher's Exact Test				,000	,000
Linear-by-Linear Association	12,810	1	,000		
N of Valid Cases	34				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.18.

b. Computed only for a 2x2 table

APPENDIX 8 AWARENESS LEVEL OF PRODUCERS ON QUALITY

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
mangofarmsize * Do you use any quality measures during storage of mangoes?	40	100,0%	0	,0%	40	100,0%

mangofarmsize * Do you use any quality measures during storage of mangoes? Crosstabulation

Count

		Do you use any quality measures during storage of mangoes?		Total
		yes	no	
mangofarmsize	small scale	6	14	20
	commercial scale	18	2	20
Total		24	16	40

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	15,000[a]	1	,000		
Continuity Correction[b]	12,604	1	,000		
Likelihood Ratio	16,403	1	,000		
Fisher's Exact Test				,000	,000
Linear-by-Linear Association	14,625	1	,000		
N of Valid Cases	40				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.00.

b. Computed only for a 2x2 table

$p < 0.05$, hence there is difference

APPENDIX 9 QUALITY MEASURES EMPLOYED BY PRODUCERS

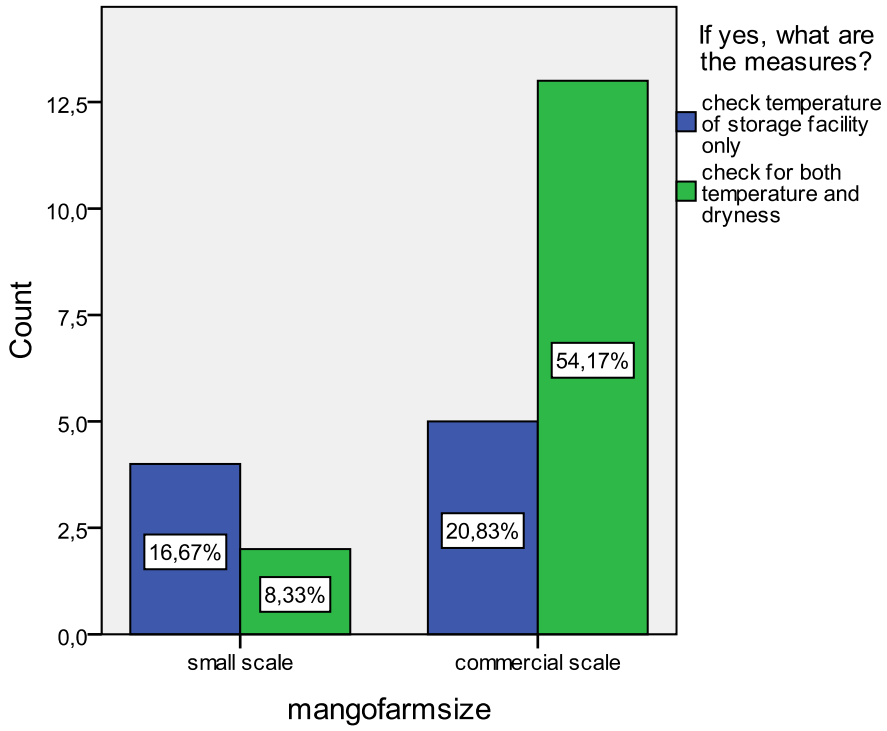

Figure 25 Quality measures used between clusters of producers

APPENDIX 10 POST HARVEST LOSSES BETWEEN DISTRICTS

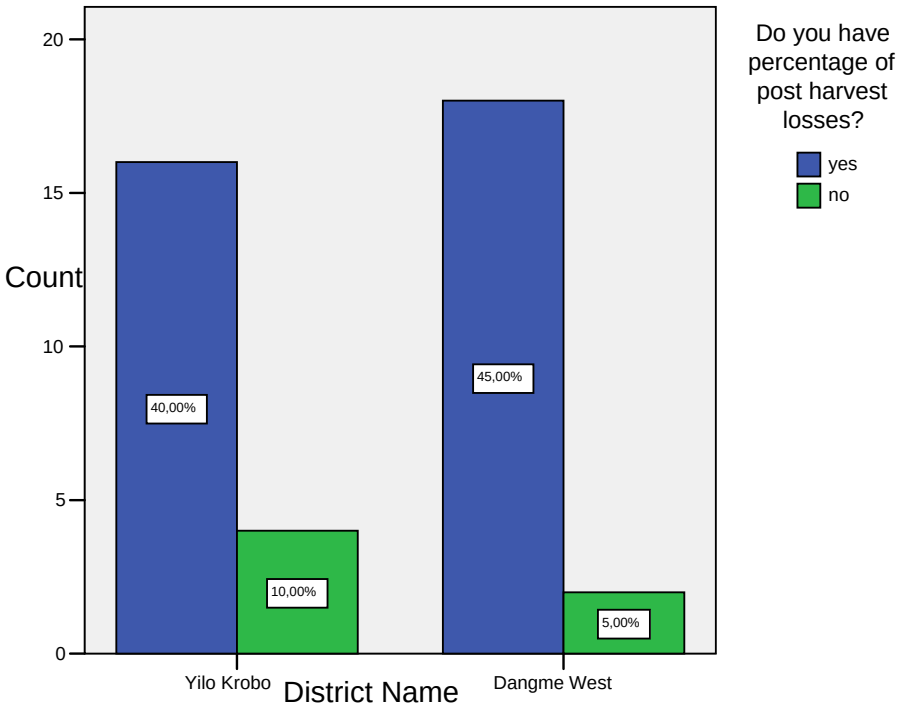

Figure 26 Difference in post harvest losses between districts