KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

KUMASI, GHANA

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

FACULTY OF AGRICULTURE

DEPARTMENT OF HORTICULTURE

ASSESSMENT OF POSTHARVEST HANDLING PRACTICES ON QUALITY OF ORGANICALLY PRODUCED BANANA (*MUSA SPP)* AND OKRA (*ABELMOSCHUS ESCULENTUS L)* IN TWO DISTRICTS IN THE EASTERN REGION OF GHANA

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (POST HARVEST TECHNOLOGY) DEGREE

BY

NARTEY NARH ANTHONY

OCTOBER, 2011

DECLARATION

I hereby do declare that except for literature reference, to other peoples work which I have duly acknowledged, this work submitted to the school of Graduate Studies, Kwame Nkrumah University of Science and Technology Kumasi Ghana as a dissertation for the Master of Science (Post Harvest Technology) Degree is the result of my own original work and that this thesis has not been presented for any degree in this University or elsewhe.

NARTEY, ANTHONY NARH ....

(ID PG 3121309) SIGNATURE DATE

(STUDENT)

CERTIFIED BY

PATRICK KUMAH ....

(SUPPERVISOR) SIGNATURE DATE

PATIENCE DZIFA KALEDZI ....

(CO-SUPPERVISOR) SIGNATURE DATE

DR. B.K. MAALEKUU ....

(HEAD OF DEPARTMENT) SIGNATURE DATE

ACKNOWLEDGEMENT

I am thankful to God Almighty for His mercies and grace showered on my life and which has brought me this far.

My most sincere thanks go to Ms. Patience Dzifa Kaledzi and Mr. Patrick Kumah, my supervisors, as well as Mr. Francis Appiah, Dr.B.K. Maalekuu (Head of Department) and all other Lecturers at the Horticulture Department, KNUST for their advice, guidance and insightful criticisms which aided in the writing of this thesis.

I thank the farmers, consumers, marketers and exporters within Kwahu South and Asuogyaman Districts in the Eastern Region of Ghana who offered their time to me during the study. Without their knowledge, experience and support, nothing that is described here could have been accomplished.

I am also very thankful to Mr. John Nketia Gyenfie, the District Director of the Ministry of Food and Agriculture, Kwahu South District for the logistics support he offered me during my research work.

Finally I wish to thank my wife K.K. and children Dede-Baake, Kwao Nartey and Ayongo for their prayers and support.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

ADRA - Adventist Development and Relief Agency

EMQAP - Export Marketing and Quality Awareness Project

EPA - Environmental Protection Agency

EU - European Union

FAGE - Federation of Associations of Ghanaian Exporters

GEPC - Ghana Export Promotion Council

GTZ - German Technical Cooperation

IFOAM - International Federation of Organic Agriculture Movement

HAG - Horticultural Association of Ghana

MiDA - Millennium Development Authority

MOFA - Ministry of Food and Agriculture

NGOs - Non Governmental Organizations

USA - United States of America

USDA- United States Development Agency

VREL - Volta River Estate Limited

ABSTRACT

A survey was conducted to assess the current postharvest handling practices of farmers, marketers, consumers, and exporters of organically produced banana and okra in the Kwahu South District and Asuogyaman District of the Eastern Region of Ghana. The research sought to assess the status of postharvest handling of organically produced banana and okra for the domestic markets and to identify ways of improving on these practices for appropriate recommendation to farmers, marketers, consumers as well as exporters of these crops. A survey was conducted on the actors and the stakeholders and data from the field study was collected and analyzed using Descriptive Statistics and Statistical Package for Social Sciences (SPSS) programme. Majority of the respondents (60%) had basic school education while 13%, who were mainly consumers and exporters of organically produced banana and okra, had tertiary education. Consumers' preference for organically produced banana and okra was based mainly on healthiness (75.0%), freedom from harmful chemicals (17.6%) and protection of the environment (21.4%). Result of the study showed that small scale farmers and marketers handled their organically produced banana and okra differently from that of the large scale producers (exporters). Small scale farmers practiced little or no improved postharvest methods such as proper harvesting, cooling, sorting, grading, treatment, packaging, labeling, good transportation and storage. It was observed that out that less than 20% of respondents carried out some form of storage and 100% of the small scale banana marketers used both nonchemical and chemical means to enhance ripening of banana while 17% of the okra farmers applied sugar solution to enhance fruit quality and extend shelf life. The study concluded the level of quality of organically produced banana and okra by the small scale

farmers was low as compared to that of the large scale producers/ exporters considering extrinsic attributes of fruit quality. The level of awareness of farmers, marketers and consumers on the effect of postharvest handling practices on quality of their produce was low. The study recommend among other things continuous training for the small scale fruit and vegetable farmers to improve upon their knowledge on postharvest handling practices of organic fruits and vegetables.

1.0 INTRODUCTION

Banana, *Musa spp*, and okra, *Abelmoschus esculentus L* are among the major fruits and vegetables produced and consumed in Ghana.These agricultural products are cultivated both on small scale for home consumption and on commercial basis for the local market and on large scale for export (MOFA 2007). Postharvest losses are extremely high in the fruit and vegetable production sectors and are estimated between 5% and 50 % in the tropics and sub-tropics (Salunkhe and Kadam, 1998).

Poor handling and inadequate storage facilities as well as lack of appropriate packaging techniques have resulted in the loss of vast quantities and quality of food. Factors affecting postharvest losses of perishable food crop produce vary widely from place to place and are dependent on the systems of cultivation, harvesting, field handling, packaging or packing, transportation, as well as storage or refrigeration and marketing of the produce and there is the need for the farmer to give maximum attention to these

processes (Mrema and Rolle, 2002). Pre-harvest production practices may seriously affect postharvest returns in quality and quantity and result in the rejection or downgrading of produce at the time of sale. The adoption of good postharvest practices can also extend the useful postharvest life of fruits and vegetables to the extent that the produce quality and condition at harvest permit. Proper postharvest practices ensure that the quality of the produce is preserved until it reaches the consumer and utilized (Olympio and Kumah, 2009).

Organic products are products which are produced under requirements of the Organic Foods Production Act (Diver *et al.,*1999). According to the USDA (1994), organic production systems exclude the use of synthetic fertilizers, pesticides including those used in postharvest handling and growth regulators.

Ghana's main organic export commodities include fruits such as banana *(Musa spp)*, and vegetables like, Okra *(Abelmoschus esculentus L*) (International Federation of Organic Agriculture Movements (IFOAM), 2003). Banana and Okra are also produced for the local market on certified and non-certified organic farms (Osei-Asare, 2009). Diver *et al.* (1999) reported that organically produced agricultural products attract high premium which is estimated between 10% and 300%. They stated further that, there are several motivating factors for organic production worldwide; there is high demand for organically produced agricultural produce on the international market, especially in Europe and the USA, Kavin *et al*. (2007) also reported that conventional agriculture has

negative impact on the environment and human health as compared to organic production.

According to Malik *et al*. (2005), 25 - 30% of fruits and vegetables produced are lost due to improper harvesting and postharvest operations including transportation and storage as a result there is considerable gap between the gross production and net availability of these products. 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 the consumers, ensuring higher returns.

Fresh agricultural produce can become infected before or after harvest by diseases and pests in the environment. The influence of non-disease disorders such as chemicals and other physical injuries also affect the perishable products at various stages of the pre-harvest and postharvest operations (Appiah and Kumah, 2009). Other studies have also concluded that poor agricultural practices are possible sources of contamination of fruits and vegetables produced in most parts of the country (Mougeot, 1994).

Banana and okra are among fruits and vegetables produced organically in the Eastern Region of Ghana, however, poor pre-harvest and postharvest handling practices may result in postharvest losses of these crops (Plates 1,2 and 3). The level loss as in quantity and quality of these produce as well as the various postharvest handling practices in the Kwahu South and Asuogyaman Districts are not known. According to the Ministry of Food and Agriculture (MOFA) Kwahu South District's Annual Report (2009), there is also little information available to producers, marketers, transporters and consumers on

proper postharvest handling of organically produced banana and okra in the Eastern Region of Ghana.

With Ghana's current quest to increase crop productivity, enhance food quality and safety as well as reduce postharvest losses, it is expedient to investigate the situation that pertains with regard to organically produced banana and okra and their postharvest handling activities in the study area since these crops are among the major fruits and vegetables produced for the export and local markets.

The objectives of the study were to determine the postharvest handling practices applied to these organically produced commodities in the major producing districts of the Eastern Region of Ghana and also to identify areas of intervention in terms of postharvest handling practices for the overall promotion of organic fruits and vegetables and safe food in Ghana

2.0. LITERATURE REVIEW

2.1 ORGIN, PRODUCTION, DISTRIBUTION AND USES OF BANANA

2.1.1 Origin of banana

Banana, *Musa spp,* originated in the hot tropical regions of Southern Asia but is cultivated in wide variety of climates ranging from the wet tropical to the subtropical regions (Samson, 1980).

2.1.2 Botany of banana

The banana plant is one of the largest herbaceous flowering plants (Samson ,1980). They reportered that stems of the banana plants are pseudostems and each pseudostem can produce a single bunch of bananas. After fruiting,the pseudostem dies,but the offshoots may developp from the base of the plant and its leaves are spirally arranged and may grow 2.7m long and 60 cm wide when cultivated on fertle soil (Samson, 1980).

2.1.3 Production and distribution of banana

Banana **(***Musa spp.***)** is among the world's leading fruit crops. FAOSTAT (2007) puts the world's and Africa's production at 73,175,419 and 7,848,906 respectively.Gowen (1995). reported that banana requires a tropical climate where the temperature is between 10 ^{o}C to 45 ^{o}C and a good rainfall throughout the year but is however grown in regions where irrigation is available to compensate for rainfall shortage.He further indicated that by modifying management, banana can be grown successfully in Western Australia at summer temperature of 40 ^{o}C – 45 ^{o}C and also in Israel at winter temperature of 1 ^{o}C – 8 ^{o}C .

2.1.4 Production areas of banana in Ghana

Banana grows naturally in the forest and the transitional zones of Brong – Ahafo,Western, Ashanti, Eastern, Central and Voltal Regions. A few farmers also interplant it on plantain farms around these areas. The Ghana Export Promotion Council's report (2009) showed that the Volta River Estate Limited (VREL) is the

largest producer and exporter of banana in Ghana. VREL farms are located along the Volta Lake in the Asuogyaman District of the Eastern Region.

According to Dankyi *et al.* (2007) among the freshly eaten horticultural crops export in Ghana, banana is second to pineapple as a foreign exchange earner. He explained further that, Ghana exported 2,972 tonnes of banana to the European market in 2007 which was an increament of 41% on what was exported in 2000. The fruit is also produced by many small scale farmers in the Kwahu area in the Eastern Region and the Ashanti Akim and Mampong areas in the Ashanti Region for the big domestic markets in Kumasi, Accra and Tema (Dankyi *et al*. 2007).

2.1.5 Uses of banana

Banana may be eaten fresh, baked, mashed and chilled in pies and also in pudding. However in Ghana, banana is mainly consumed at the fresh riped stage. Banana is rich in vitamin, minerals and other nutrients, also the ripe banana fruit contains about 22% carbohydrate, mainly as sugar and the fruit is also high in potassium but low in protein and fat and contains vitamins A and C and about 75% water (Dankyi *et al*. 2007).

2.2 Origin, Production, Distribution and Uses of Okra

2.2.1 Origin of Okra

Okra [*Abelmoschus esculentus (L.)],* is a member of the *Malvaceae family*. The species apparently originated in the Ethiopian Highlands, though the manner of distribution from there is undocumented. The Egyptians and Moors of the 12th and 13th centuries used the

Arab word for the plant, suggesting that it had come from the east. The plant may thus have been taken across the Red Sea or the Bab-el-Mandeb strait to the Arabian Peninsula, rather than north across the Sahara. One of the earliest accounts is by a Spanish Moor who visited Egypt in 1216, who described the plant under cultivation by the locals who ate the tender, young pods with meals (Annonymous, 2004).

2.2.2 Botany of Okra

Okra is an annual herb growing to a height of 2m tall. Kumar, (2006), indicated that, okra is a polyploid, a self-pollinated crop. Occurrence of out crossing to an extent is noticed with the insect assisted pollination. Most okra cultivars produce green pods, but a few varieties are yellow or dark in colour.

Most varieties are ready to pick 55 to 60 days after planting. Pods should be harvested when they are 2-1/2 to 3-1/2 inches long .Generally, pods should be picked 4 to 6 days after flowering. Pods can be snapped off or cut. Cutting takes longer but produces a nicer product.

2.2.3 Production and Distribution of Okra

Being native of tropical Africa, okra is the choicest fruit vegetable grown extensively in the tropical, subtropical and warm areas of the world like India, Turkey and Africa (Annonymous, 2004). In Ghana it is the fourth most popular vegetable after tomatoes, capsicum (peppers) and garden eggs. It is mainly produced for local consumption with a few farmers now producing for the export market in all the ecological zones (Tweneboah, 1998).

The fruits are harvested before it matures for eating or cooking purposes. At this stage, the fibres have not yet differentiated and when cooked, the young fruit is mucilaginous, the cooking water being thick and free-flowing (Annonymous, 2004).

2.2.4 Uses of Okra

Tender green fruits are cooked in curry and soup, while the crop has adapted in some countries as leafy vegetable. Okra leaves may be cooked as the green.The leaves are also eaten raw in salads. Okra seeds may be roasted and ground to form a non-caffeinated substitute for coffee. In the U.S., Mexico and Japan, the young fruiting pods are the edible portion, while young leaves and mature seeds may be consumed in other countries (Duzyaman, 2002)

2.3 Organic fruits and vegetables production and marketing

IFOAM (2003), explained that organic production is increasing in Africa and Ghana and about 19,132 hectares of land are under organic cultivation. IFOAM and FiBL, (2006) also meantioned Ghana's main organic export commodities which include fruits such as banana *(Musa spp)*, and vegetables like, Okra *(Abelmoschus esculentus L*). Banana and Okra are also produced for the local market on certified and non-certified organic production farmers

Osei-Asare (2009), asserted that there are several motivating factors for organic production world wide.There is high demand for organically produced agricultural produce on the international market, especially in Europe and the USA; Diver *et al*

(1999) reported that organically produced agricultural products attract high premium which is estimated between 10% to 300%; Kavin *et al*. (2007) also reported that conventional agriculture has negative impact on the environment and human health as compared to organic production.

According to Brummond (2001), producers of organically produced produce were characterized as individuals seeking safer foods and a better environment; were usually more observant and more patient than conventional growers, and had a better understanding and interpretation of biological systems, and, often incorporated their personal beliefs into their production systems. Brummond (2001) again explained that the degree to which a producer is able to achieve success with organic production is directly correlated to his or her ability to understand and manipulate the natural inputs in the characteristics of an organic farm.

2.4 Postharvest losses of fruits and vegetables in developing countries.

The majority of rural populations in developing countries has limited and solely depends on theagricultural sector for their substistence, livelihood and revenue.Therefore postharvest losseses are often felt with greater magnitude than in developed nations. Goletti and Wolff (1999), indicated that while in developing countries the share of postharvest activities in total value added of food products tends to be lower, there is a tendency towards greater importance of postharvest operations. Careful postharvest handling is the major but often neglected step towards offering a greater volume of

nutritious food to the planet and to prevent loss between harvesting and consumption. Kader and Rolle (2004) explained that during the past thirty years less than 5% of the funding provided for horticultural development efforts has gone towards postharvest areas of concern, while more than 95% has gone towards trying to increase production. Kader (2002) indicated that, reducing postharvest losses for fresh fruits and vegetables, reported to be in the 30 to 50% range, has been demonstrated to be an important part of sustainable agricultural development efforts meant to increase food availability. International agencies that monitor world food resources have acknowledged that one of the most feasible options for meeting future food needs is reduction of postharvest losses (Kelman, 1984). Kader (2002) argued that it is impossible and uneconomical to completely eliminate postharvest losses but it is possible and desirable to reduce them by 50%. He went on to say that minimizing postharvest losses of food that has already been produced is more sustainable and environmentally sound than increasing production areas to compensate for these losses.

2.5. Fruit and vegetable quality attributes and grade standards for marketing

Appearance is the most important quality attribute of fresh and minimally processed produce, with primary concern for size and colour uniformity, glossiness, and absence of defects in shape or skin finish (Aked 2000). According to 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 and Ruben.*(* 2007), also suggested 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 pest 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 and Ruben, (2007) supported what Zind (1989), described about consumers.

According to Kader (1999) and Zuniga – Ariasa and Ruben, (2007), quality,which 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 stated 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. Romano *et al*. (2006) and Kader (1999) reported that quality has different meanings for different stakeholders (producers, distributors, consumers, etc) but consumer acceptance seems to be the most important factor to consider. 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. 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 (Kader 1999).

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 fruit quality in terms of flavour is influenced by the cultivar, maturity stage at harvest, postharvest handling procedures and environmental conditions (for instance avoiding mechanical damage and chilling injury), ripeness stage at the time of eating the fruit.

2.6. Pre-harvest factors that contribute to postharvest losses of fruits and Vegetables

There are numerous pre-harvest factors affecting the postharvest quality and shelf life of fruits and vegetables, including harvest maturity, cultivar or variety, climate, soil used for production chemicals applied, and water status (Thompson 2003). Within each commodity there is a range of genotypic variation in composition, quality, and postharvest life (Kader 2002). Knowles *et al.* (2001) indicated that the soil type and its fertility also affect the chemical composition of a produce. Rabus and Streif (2000) also explained that in some cases, the mineral content of fruits, such as phosphorus potassium and calcium can be used to predict their postharvest quality.

Rootstocks used in fruit production vary in their water and nutrient uptake abilities and in resistance to pests and diseases, and thus have a profound effect on the postharvest life of the produce (Tomala *et al.*, 1999). Ferguson *et al.*, (1999) also cited climate factors, especially light intensity and temperature, as having strong influences on the composition and nutritional quality of fruits and vegetables. Those constantly exposed to the sun may have different quality and postharvest characteristics from those growing on the shady side.

2.7.1 General postharvest factors that contribute to postharvest losses of fruits and vegetables

Fruits and vegetables remain as living tissues up until the time they are consumed fresh, cooked for consumption, or processed for preservation. Controlling respiration of these living produce would improve storability and extend shelf life of the fresh produce. Meanwhile, a certain level of respiration activity is required to prevent plant tissues from

senescing and dying. Minimally processed produce such as fresh-cut fruits and vegetables are essentially wounded tissues, leading directly to tissue softening and browning discoloration on cut surfaces. The intensity of the wound response is affected by a number of factors, including species and variety, O_2 and CO_2 concentrations, water vapor pressure, and the presence of inhibitors (Brecht et al.,2004).

Fruits and vegetables undergo many physiological changes during postharvest handling such as storage and transportation, including tissue softening, increase in sugar level, and decrease in organic acid levels, degradation of chlorophyll accompanied by the synthesis of anthocyanins or carotenoids upon maturation, production and losses of volatile flavor compounds, decrease in phenolic and amino acid contents, and breakdown of cell materials due to respiration (Sharma and Singh 2000)

2.7.2 Harvesting factors that affect quality of fruits and vegetables.

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 fruits. 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) asserted that the eating quality of fruits when ripe depends upon maturity at harvest, avoiding physical damage and chilling injury during postharvest handling that minimized disease incidence. Sharma and Singh (2000) and Kader (2002) explained that harvesting practices determine the extent of variability in maturity and physical injuries. Physical injuries lead to accelerated loss of

water and vitamin C and increased susceptibility to decay by fungi or pathogens during storage.

2.7.3 Temperature and relative humidity factors that affect quality of fruits and vegetables

Temperature and relatively humidity (RH) directly affect postharvest respiration and transpiration of fruits and vegetables. Kader (1985) asserted that elevated temperature would speed up respiration, leading to increased ethylene production and high carbon dioxide level and thus changes in flavor, taste, color, texture, appearance, and nutrients of the produce. Jobling (2000) stated that, at extremes of temperatures products get damaged. He explained that some products suffer chilling injury whiles others suffer damage at very high temperatures. He concluded 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 stated that correct and careful temperature management throughout harvest, storage,transportation and marketing chain is essential if the quality of the product is to be assured. Sharma and Singh (2000) and Kader (2002) indicated that appropriate postharvest handling operations that should be applied, must include controlling temperature (cooling) and RH, atmosphere (O_2 and CO_2 levels). Sharma and Singh (2000) and Kader (2002) also mentioned it as a very important factor for determining fruit quality at delaying ripening by modified or controlled atmospheres and/or treatment with 1-methylcyclopropene (1-MCP; Smart fresh) but cannot substitute for keeping banana at the optimal range of temperature and relative humidity.It 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 (Sharma and Singh, 2000). Temperature of fresh produce should be reduced immediately after harvesting and controlled right above where the chilling injury may occur. Thompson, (1996) reported that tropical fruit and vegetable crops often are susceptible to chilling injury when cooled below 13°C which reduces the quality of the product and shortens shelf life.

Kader (2002) indicated that modified atmospheric (MA) environments with reduced O_2 and increased CO_2 levels up to 10% have shown reduced ascorbic acid loss and extended postharvest life of many different varieties of fruits and vegetables. However, the responses to MA environment vary greatly among plant species, maturity stage, and duration and temperature of exposure.

2.7.4 Postharvest diseases of banana and okra

Fruits and vegetables are susceptible to spoilage by microorganisms. Salunkhe and Kadam (1998) explained that, the survival and growth of pathogenic microorganisms are the major food safety concerns in fresh and minimally processed fruits and vegetables due to possible contamination during preparation and increased nutrients and cellular fluid on the fresh-cut surface. Postharvest diseases destroy 10-30% of the total yield of

crops and in some perishable crops especially in developing countries; they destroy more than 30% of the crop yield (Agrios, 2005; Kader, 2002). Fruits and vegetables are highly perishable products; the quality is affected by postharvest handling, transportation, storage and marketing. Kader (2002) explained that improper handling; packaging, storage and transportation may result in decay and production of microorganisms, which become activated because of the changing physiological state of the fruits and vegetables. Two primary postharvest diseases of banana are anthracnose caused by *Gloeosporium musae* and crown rot caused by *Colletotrichum musae*, *Fusarium sp.* The diseases usually appear on ripening fruits either at points of sale (farmers' markets, grocery stores) or later, after purchase. Their occurrence is closely linked to poor cultural and disease management practices in the banana field, unclean packinghouses and improper postharvest handling.The infections reduce fruit quality, shelf life, and marketability (Timpo and Idun 2010). Timpo and Idun, (2010) indicated that, powdery mildew caused by *Oidium abelmoshi,* cercospora leaf spot caused by *Cercospora abelmoschi and* fusarium wilt caused by *Fusarium oxysporum* f. *vasinfectum are pre- harvest diseases of okra, however,* they can be serious postharvest problems for growers who fail to manage them with a combination of integrated practices.

2.7.5 Biological control and plant growth regulators

Adaskaveg, *al et.*(2002), indicated that, two biological control products (antagonistic organisms) are currently used as complementary tools (to chemical and/or heat treatments) for the management of postharvest decays together with other strategies as part of an integrated pest management program for a few fruits and vegetables.

Kader,(2000) also aserted that there were plant growth regulators that can also be used to delay senescence of fruits such as citrus and banana and consequently delay their susceptibility to decay . The commercially available biological control materials and plant growth regulators need registration as postharvest treatment materials (Kader,2000).

2.7.6. Sorting and grading of fruits and vegetables

Sorting is defined by Appiah and Kumah (2009) as the separation of raw materials and food slurries into categories on the basis of shape, size, weigh, image and colure. Sorting is done in the fruit and vegetable industry for rejects, and removal of any product that is too small, too big decayed or damaged before the product is put up for sale.

Appiah and Kumah (2009) also defined grading as the assessment of a number of characteristics of a food to obtain an indication of its overall quality. Grading is best carried out by trained personnel. Modern improved marketing systems require precise grading standards for each kind of product (Appiah and Kumah, 2009). However, local small scale markets may not use written graded standards but the products are sorted to some extent based on size, colour, weight among others. Sizing produce is optional but may be worthwhile if certain size grades receive a higher price than others (Appiah and Kumah 2009).

2.7.7. Cleaning and treament of fruits and vegetables.

According to Thompson (2003), in some commodities, such as kiwifruits and avocadoes, dry brushing may be sufficient to clean the produce but others such as bananas , carrots, and okra require washing to remove latex, dirt and reduce staining. They explained further that the choice of brushing and/or washing will depend upon both the type of commodity and the type of contamination.

Sanitation is essential, both to control the spread of disease from one item to another, and to limit spore buildup in wash water or in the packinghouse this calls for regular changing of the washing or cleaning medium.

Sharma and Singh (2000) indicated that waxing of immature fruit vegetables such as cucumbers and summer squash; mature fruit vegetables such as eggplant, peppers and tomatoes; and fruits such as apples, peaches and banana is common. They further explained that food grade waxes are used to replace some of the natural waxes removed in washing and cleaning operations, and can help reduce water loss during handling and marketing. If produce is waxed, the wax coating must be allowed to dry thoroughly before further handling.

2.7.8. Packaging of fruits and vegetables.

Appiah and Kumah (2009) stated that packaging is the art, science and technology of enclosing or protecting products for distribution, sale, storage and use. They explained that packaging is a means of making the product handy by putting the product in appropriate containers to enhance mobility, prevent contaminates such as pathogens, dirt

and undesirable reaction with the environment. Packaging improves the quality and the shelf-life of the product and makes it presentable to the consumer.

Produce can be hand-packed to create an attractive pack, often using a fixed count of uniformly sized units. Packaging materials such as trays, cups, wraps, liners and pads may be added to help immobilize the produce. Simple mechanical packing systems often use the volume-fill method or tight-fill method, in which sorted produce is delivered into boxes, then vibration settled. Most volume-fillers are designed to use weight as an estimate of volume, and final adjustments are done by hand (Kader, 2002).

Kader, (2002) pointed out that ethylene usually promotes the ripening process of fruits and vegetable. Exposure of fruits and vegetables to unwanted ethylene should be avoided by separating ethylene-producing commodities from ethylene-sensitive commodities, by using ethylene scrubbers, or by introducing fresh air into storage rooms. Explaining further, he said ethylene absorber sachets placed into containers with ethylene sensitive produce can reduce the rate of ripening of fruits, de-greening of vegetables or floral wilting. Packaging in plastic films can modify the atmosphere surrounding the produce (modified atmosphere packaging or MAP).

2.7.9 Labeling of fruit and vegetable products

According to McGregor, (1989), labeling packages helps handlers to keep track of the produce as it moves through the postharvest system, and assists wholesalers and retailers in using proper practices. He explained that labels can be pre-printed on fiberboard boxes, or glued, stamped or stenciled on to containers. Appiah and Kumah (2009) aserted

that brand labeling packages can aid in advertising for the product's producer, packer and/or shippers. Some shippers also provide brochures detailing storage methods or recipes for consumers. Shipping, transporting and marketing labels can contain some or all of the following information:

Common name of the product, net weight, count and/or volume, brand name, name and address of packer or shipper, country or region of origin, size and grade, recommended storage temperature, special handling instructions,names of approved and waxes and/or pesticides used on the product. Labeling of consumer packages is mandatory under the Food and Drug Adminstration regulations (USA) and the cabels must also contain the name of the product, net weight, and name and address of the producer, packer or distributor (McGregor, 1989).

2.7.10 Storage of fresh fruits and vegetables

Storage as applied to fresh fruits and vegetables, is defined by the FAO (2000) as holding fresh fruit and vegetable under controlled condition. According to Kader (2002), if produce is to be stored, it is important to begin with a high quality product. The lot of produce must not contain damaged or diseased units, and containers must be well ventilated and strong enough to withstand stacking. Explaining further, he said proper storage practices include temperature control, relative humidity control, air circulation and maintenance of space between containers for adequate ventilation, and avoiding incompatible product mixes. Commodities stored together should be capable of tolerating the same temperature, relative humidity and level of ethylene in the storage environment.

High ethylene producers (such as ripe bananas, apples, cantaloupe) can stimulate physiological changes in ethylene sensitive commodities (such as lettuce, cucumbers, carrots, potatoes, sweet potatoes) leading to often undesirable colour, flavour and texture changes (Thompson 2003 a).

Temperature management during storage is important and can be aided by constructing square rather than rectangular buildings. Rectangular buildings have more wall area per square feet of storage space, so more heat is conducted across the walls, making them more expensive to cool. Temperature management can also be aided by shading buildings, painting storehouses white to help reflect the sun's rays, or by using sprinkler systems on the roof of a building for evaporative cooling.

Modified atmosphere (MA) storage retards ripening and senescence, reduces post-harvest losses and extends storage life of some horticultural crops (Kader 2002). The primary effect of modifying the concentration of O_2 and CO_2 in the storage atmosphere was thought to be the reduction in rate of respiration and associated processes. Reduction of partial pressure of O_2 and elevation of partial pressure of CO_2 can reduce the rate of natural ethylene production by the fruit and decrease the sensitivity of the fruit to ethylene action (Kader 2002).

2.7.11 Transportation of fresh fruits and vegetables.

Kader (2002) stated that fresh produce is primarily transported by road, from farmer to consumer and marketing centers, that fresh produce should be of the highest quality and should be kept in the best condition during transportation. He further pointed out that

minimizing losses during transportation, necessitates that special attention be given to vehicles, equipment, infrastructure and handling. Fresh fruits and vegetables are transported using both refrigerated and non-refrigerated vehicles. Non-refrigerated vehicles are generally open trucks, container vans and other public vehicles.

Fresh fruits and vegetables are increasingly demanded in international markets. Meeting the requirements of these international markets, presents a considerable challenge to the postharvest handling of fresh produce. Refrigerated vehicles and packaging plays a major role in meeting this challenge. Modified atmosphere (MA) packaging and controlled atmosphere (CA) packaging can be used for different fruit and vegetables. MAP creates a steady atmosphere of O_2 and CO_2 around the produce within the MAP package, while CA provides an optimum atmosphere of oxygen and carbon dioxide around the packaged produce (Kader 2002).

2. 8. Quality, food safety, GhanaGAP and Certification of organic fruit and vegetable production in Ghana

Sefa - Dedeh (2006) reported 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. He further stated that GlobalGAP certification of farms has been on going in the Ghanaian industry and over 60% of major exporters are currently GlobalGAP certified and many more are in the process of being certified.

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.

2.9. Value Chain Development Concept as it enhances postharvest handling of fruits and vegetables.

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, stored 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.

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 (Roduner, 2007).

Produce 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.

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, storage or warehousing 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.

2.10. Food safety issues in fruit and vegetable production and marketing

The joint Food and Agriculture Organization and World Health Organization (FAO/WHO) expert committee on food safety defines food safety ,as "all conditions necessary during production,processing, storage, distribution and preparation of food to ensure that it is safe, sound, wholesome and fit for human consumption (Codex Alimentarius,1995).The Ghana Food and Drugs Board (GFDB) considres food safety as a componet of food quality which refers to all aspect on the quality of food,including

nutrent content, aesthetic properties, safety and accurate labeling and advertising (GFDB,2005).

This shows that food safety must always begin from the source of production through the various channels to the point of consumption since contamination of any kind could occur at any point in the food supply chain.

2.10.1 Institution and Agencies involved in food safety awareness and regulation in Ghana.

According to FAO (2002), a comprehensive food system involves the dynamic interdependence of a number of players: government authorities; private sector parter, including farmers and other producers, processors, marketers and distributors; consumers; and organisations or instituitions specialised in scientific and technological research, education and information. Although these players have independent functions, the system should be construed so as to provide a framework for the development of strong partnership, co-ordination and cohesiveness of actions, communication and collaboration among public and private interests. Partnerships functions in an open and transparent process. Partners must have clear delineation of responsibility and the authority to make decisions for meeting their responsibilities. They must have, or be given, the resources to effectively participate in the institutional debate and to work effectively.

The Food and Drugs Board and the Ghana Standard Board are two major regulatory institutions in Ghana responsible for ensuring the safety and quality of the food and other products that we consume. Other regulatory institutions include; the Environmental Protection Agency (EPA) responsible for the regulation of the importation of chemicals of all forms including pesticides for agricultural purposes; Plant Protection and Regulatory Service Divisions (PPRSD) of the Ministry of Food and Agriculture (MOFA) also mandated to ensure the approriate use and sale of agro-inputs especially agrochemicals.

2.10.2 Food and Drugs Board

The Food and Drugs Board has two main divisions, these are inspectorate drugs and inspectorate foods. The operations of these two divisions are guided by the Food and Drugs law, which has various sections. For example under section 1, the law states that any person who sells or offers for sale any food that;

a. has in or upon it any poisonous or harmful substance,
b. is unwholesome or unfit for human consumption,
c. consist in whole or inpart of any filthy, putrid, rotten, decomposed or diseased sudstance,
d. is injurious to health or is not of the nature, substance or quality prescribed by standards commits an offence.

These provisions of the law are made to ensure that the health of the citizenry is safe enough to impact positively on the productivity of the nation. The board, is to ensure that all manufactured food product meant to be eaten safe and devoid of unacceptable level of

material that are harmful to human health. They are also to make sure that food industries and drug manufacturing industries maintain acceptable standards to promote good health of the citizenry. Occasionally, they carry out awareness creation activities to educate the general public about food safety issues to enable consumers to make informed decisions.

2.10.3 Ghana Standard Board

The Ghana Standard Board (GSB) was established by NRCD 1973 and was solely vested with the responsibility for preparing standards for products and processes for ensuring compliance with government policies on standards. Methodology, Standardization, Testing and Quality Assurance of both locally manufactured and imported products are complied with throughout the country.

Besides safety, quality attributes include: nutritional value organoleptic properties such as appearance, colour, texture, taste; and functional properties. Consumers, the food industry and government regulators are also concerned with these quality criteria. Quality can be considered as a complex characteristics of food that determines its value or acceptability to a consumer and it is important to realise that consumers' evaluation of quality is often subjective. From a regulatory or consumer protection point of view, "quality" refers to the basic objective requirements which must be met under existing laws and regulations to ensure that foods are safe, not contaminated, adulterated or fraudulently presented. Safety requirements for foods are neither optional or negotiable. Furthermore, recent international agreements emphasize the need for food safety

measures to be based on risk analysis following principles and procedures elaborated by relevant international organization, (FAO, 2000)

By virtue of their role of ensuring the safety and quality of products of which fruits and vegetables are no exception, the board in collaboration with other agencies like Food Research Institute (FRI), Food and Drugs Board (FDB), Plant Protection Regulatory Services Directorate (PPRSD) and the Vegetable Producers and Exporters Association of Ghana (VEGPAG) have developed standards for most importable vegetables and fruits. These standards for quality are to ensure that whatever fresh vegetables the consumer buys is safe and meets the standards expected by the consumer. The board usually organizes seminars, workshops and ratio talk shows to creat awareness and educate the general public on quality, standards and safety of food (GFDB,2005).

2.10.4 Plant Protection and Regulatory Service Directorate (PPRSD)

The Plant Protection and Regulatory Service Directorate (PPRSD) of the Ministry of Food and Agriculture was esteblished in 1965 by an Act of parliament "The prevention and control of pest and diseases of plants Act, 307" and the pesticides control and management Act (Act 528, 1996). According to the guidelines for the National Plant Protection Policy (Ministry of Food and Agriculture, 2007), the division nationally mandated and given capacity to organize, regulate, monitor, implement and co-ordinate the plant protection services need for the country in support of sustainable growth of agriculture in the country.

Gerken and Suglo (2002), have suggested that, government intervention in crop protection faces a policy dilemma. The objectives of increasing agricultural production should be reconciled with an effective control of negative external effects. They explained that the availability of inputs, such as pesicides should be improved and the current bias towards chemical pesticides should be counter balanced by the introduction of alternative crop production stategies. This presumably has been necessitated by insistence of European countries on appropriate maximum residue levels (MRL) of pesticides used in the production of fruits and vegetables imported into these countries and probably recent concerns reported in the media about improper use of pesticides in the system. As a result of this, integrated pest management strategies are being designed by the directorate on pilot basis in certain crops to ensure a reduction in the use of pesticides.

2.11 Organic fruit and vegetable production areas in Ghana

2.11.1 Kwahu South District in the Eastern Region of Ghana

The Kwahu South District is one of the twenty one districts in the Eastern Region. The Kwahu South District has Mpraeso as its District Capital, and is located in the north-central part of the Eastern Region. It shares common boundaries with Sekyere East District to the north, Asante Akim North and Asante Akim South Districts to the West, Afram Plains District to the East and Kwahu West , Fanteakwa and Atiwa Districts to the South. Specifically it lies between latitude 6^0 30 'N and longitude 0^0 30' W 1^0 W. The district has a total land area of 1,462 square kilometers with a population of 74,124 (2000 Population Census).

Crop farming is the principal agricultural activity in the district. Principal agriculture produce are maize, yam, cassava, cocoyam and fruit (tree) crops like banana, pineapple, mango, cocoa, oil palm and coffee as well as vegetables such as tomato, pepper, okra,onion and cabbage. 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. Crops such as organic banana, organic okra, onion, pepper and 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. MiDA, ADRA and others). 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.

2.11.2 The Asuogyaman District in the Eastern Region of Ghana

The Asuogyaman District has Atimpoku as its capital town. According to the district agriculture profile MOFA (2011), the approximated size of the district is 1507 sq. km

(Approx. 580 sq miles**)** and is located on Latitude 6°34°N and 6°10°N; :Longitude 0°1°W and 0°14°E with a population of 56,230 (2000 Population Census). 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 has the Lower Volta River running through the district from the Northern to South boundaries. Main agricultural activities undertaken are livestock and crop production, fish production, fishing and fish processing and other agro - processing activities**.** Principal agriculture produce are Maize, Yam, Cassava, Cocoyam and fruit crops like Banana, Pineapple and Mango as well as vegetables such as Tomato, Pepper ,Okra. Among the farmers in the district are two companies Volta River Estate Limited (V.R.E.L.) Tack's Farm that produce organic Pineapple Banana and okra along side other crops on large scale for export and the local market. By virtue of its strategic location, that is the nearness to the urban cities of 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. The District is also home to a prolific beekeeping activity that produces arguably the best honey in the country. The District, in spite of housing the Akosombo Dam is basically rural with a poor state of socio-economic and infrastructure development.

The District Assemblies are also institutions that have the responsibility of ensuring that food produced within their jurisdictional boundaries receive the best of wholesomeness. For example, the 1995 Accra Metropolitan Assembly (AMA) Growing and Sale of Crops

bylaws, state that it is an offence to water crops with effluent from drain. Although these bylaws and others by EPA and other agencies are meant to ensure total wholesomeness food products, both the enforcement and compliance are virtually non-existence.

3.0 METHODOLOGY

3.1 Study area and scope of the study

For the purpose of the study, the level of organic banana and okra production and sale in the Eastern Region was used to select two districts namely: Kwahu South and Asuogyaman Districts out of the other banana and okra producing districts, based on the fact that the bulk of organic banana and okra farmers and marketers operate within the two districts (MOFA, 2008). The data for the study was generated from a survey of farmers, consumers, marketers and exporters of organically produced banana and okra in the Kwahu South and Asuogyaman Districts. From the Kwahu South District, Mpraeso, Bepong, Ntomen, Asakraka, Atibie and Obomeng were selected based on the fact that, these communities are traditionally banana and okra production and marketing areas. From the Asuogyaman District ,Senchi, New Akrande and Atimpoku were selected because, two of the firms that produce banana and okra organically for export in Ghana have their farms located in these communities.

The study focused on effect of postharvest handling practices on the quality of organically produced banana and okra and depended on the information provided by

farmers, consumers, marketers, exporter on these crops. have about organic crop production and postharvest handling of the study crops.

3.2 Questionnaire design

The study used questionnaires to gather data from respondents in the two districts. Secondary data and other relevant information and literature were also gathered from official sources and statistical materials.

Structured questionnaires made of open and close-ended questions were designed and used to gather the following data: bio data of respondents including age, sex , education, marital status, location, occupation , experience in farming or trading, household size. Banana and okra cultivation practices included variety selection, planting, nutrient management and disease, weed and pests management. Postharvest handling practices included data on harvesting, sorting, treatment, storage, packaging, transportation and certification, level of food safety education and awareness of organically produced banana and okra in the Eastern Region as well as consumers' awareness of organic banana and okra production and their postharvest handling practices.

The questionnaires were pre-tested on very small sample of respondents at Abetifi in the Kwahu East District for content validity as specified by Rogers (1995). The questionnaires administered to the institutions engaged in food safety issues were meant

to obtain information on the constraints faced by these organizations in awareness creation.

3.3 Sampling procedure and data collection

In all, 185 respondents were selected for the study and was made up of 60 farmers , 80 consumers, 40 marketers of banana and/or okra in the two selected districts and 2 producers/exporters of organic banana and/or okra as well as three (3) institutions involved in food safety in the Eastern Region. A purposive sampling procedure was used to select the respondents for farmers, marketers and exporters based on respondents involvement in organic farming and/or mrketing of organically produced fruits and vegetables.The respondents for consumers were randomly selected from the two districts. Interviews were also conducted with two transporters of fruits and vegetables and a representative of banana and okra sellers in Accra.

3.4 Data analysis

Data input and analysis of data on the set objectives was done using Descriptive Statistics and Statistical Package for Social Sciences (SPSS) programme.

4.0 RESULTS

4.1 Introduction

The result of the study data is presented in this chapter. The results as presented in this section shows the distribution of respondents in the districts (Kwahu South and Asuogyamam) category (farmers, consumers, marketers, exporters and consumer awareness institutions) as well as background information of respondents. Production (pre-harvest) and postharvest handling practices by the farmers and the marketers were also presented.

4.2. Distribution of respondents

The study covered five different categories of respondents which consisted of 60 farmers (32.43%), 80 consumers (43.24%), 40 marketers (21.62%), 2 exporters (large scale producers) (1.08%) and 3 institutions (1.62 %). A total of 182 respondents were sampled from the two districts and 3 respondents from Koforidua for the institutions involved in food safety issues (Table 4.1).

Table 4.1. Distribution of respondents by location and category

DISTRICT		Farmers		Marketers		Consumer		Exporter		Institution		Total	
		Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Kwahu South	Mpraeso	13.4	8	7	28.0	21	26.3	0	0.0	0	0.0	34	19.4
	Bepong	18	30.0	19	47.5	13	16.3	0	0.0	0	0.0	50	27.0
	Obomeng	4	6.6	0	0.0	11	13.8	0	0.0	0	0.0	15	8.1
	Asakraka	9	15.0	**4**	10.0	7	8.8	0	0.0	0	0.0	20	10.8
	Ntomem	20	35.0	11	27.5	8	10.0	0	0.0	0	0.0	40	21.6
	Sub-Total	**60**	**100**	**40**	**100**	**60**	**75**	**0**	**0.0**	**0**	**0.0**	**160**	**86.5**
Asuogyaman	Atimpoku	0	0.0	0	0.0	9	11.25	0	0.0	0	0.0	9	4.8
	Senchi							1	50.0			8	10.0
	Akrande	0	0.0	0	0.0	7	8.75	1	50.0	0	0.0	5	2.7
		0	0.0	0	0.0	4	5.0			0	0.0		
	Sub-Total	**0**	**0.0**	**0**	**0.0**	**20**	**25.0**	**2**	**100**	**0**	**0.0**	**22**	**7.51**
Koforidua		0	0.0	0	0.0	0	0.0	0	0.0	3	100	3	1.6
Total		**60**	**100**	**40**	**100**	**80**	**100**	**2**	**100**	**3**	**100**	**185**	**100**

Source: Survey Result, 2011

4.2.1. Bio-data of respondents

Table 4.2 shows the bio data of the respondents (farmers, consumers and marketers) in the two districts. Majority of the famers were male (82%) while majority of ssellers (95%) were females. Generally, there were more female respondents (50.6%) than there were males. About 59% were married and mean household size was 3. Basic schools (the Middle School, Junior High or Primary) representing (60%) was the highest for the level of education of the respondents. Respondents with tertiary level education was 13% with a large number of consumers and all the large scale producers/ exporters belonging to this category.

Table 4.2 Bio-data of Respondent

Respondent	Farmer		Consumer		Marketer		Exporter		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Sex										
Male	49	82	37	46.3	2	5.0	2	100	90	49.4
Female	11	18	43	53.7	38	95	0	0.0	92	50.6
Total	**60**	**100**	**80**	**100**	**40**	**100**	**2**	**100**	**182**	**100**
Marital Status										
Married	34	56.7	49	61.2	23	57.5	2	100	108	59.3
Single	22	36.7	25	31.3	12	30.0	0	0.0	59	32.5
Divorced	3	5.0	4	5.0	2	5.0	0	0.0	9	4.9
Widow	1	1.6	2	2.5	3	7.5	0	0.0	6	3.3
Total	**60**	**100**	**80**	**100**	**40**	**100**	**2**	**100**	**182**	**100**
Educational Background										
Primary	13	21.6	17	21.2	16	40.0	0	0.0	46	25.3
JSS/MSLC	25	41.6	23	28.7	15	37.5	0	0.0	63	34.6
SSS	7	11.6	13	16.3	2	5.0	0	0.0	22	12.2
Tertiary	3	5.0	19	23.8	0	0.0	2	0.0	24	13.2
No Formal	11	18.3	8	10.0	7	17.5	0	0.0	26	14.3
Education	1	1.6	0	0.0	0	0.0	0	0.0	1	0.5
Other	**60**	**100**	**80**	**100**	**40**	**100**	**2**	**100**	**182**	**100**
Tota										

Source: Survey Result, 2011

4.2.2. Age Distribution of Respondent

The results of the study shows that all the adult age groups targeted were covered. Three students between the ages of 15 and 19 were under the consumer category as shown in Table 4.3.

Table 4.3.Age Distribution of Respondent

Age of Respondent	Farmer		Consumer		Marketer		Exporter		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
15-19	0	0.0	3	3.8	0	0.0	0	0.0	3	1.6
20-29	9	15.0	16	20.0	8	20	0	0.0	33	18.1
30-39	11	18.3	24	30.0	12	30	0	0.0	47	25.8
40-49	17	28.3	19	23.6	16	40	1	50.0	53	29.1
50-59	10	16.8	11	13.7	3	7.5	1	50.0	25	13.7
60-69	8	13.3	5	6.3	1	2.5	0	0.0	14	7.6
70 and above	5	8.3	2	2.5	0	0.0	0	0.0	7	3.8
Total	**60**	**100**	**80**	**100**	**40**	**100**	**2**	**100**	**182**	**100**

Source: Survey Result, 2011

4.3 Respondents preference for organically produced banana and okra

The question was set to understand the attitude and buying motivation for organic products such as banana and okra. The responses showed that, more than 90% relied on healthiness, freedom from chemicals, environmental protection and food safety as their reason for buying organically produced banana and okra(Table 4.4)

Table 4.4. Consumers' preference for organically produced banana and okra

Characteristic	Reason for preference of organically produced banana and okra	Frequency	Percentage
Main reasons for buying organically produced banana and okra	Products are healthy Products are natural and free from harmful chemicals Products are healthy and saves the environment	60 14 17	75.0 17.6 21.4
How much would you be willing to pay for organically produced banana and okra as compared to the inorganic ones?	Same price 5-25% more: 26-50% more above 50% more Pay less	0 29 47 19 5	0 36.3 57.5 34.0 6.3
Is there enough information about organically produced fruits and vegetables in your community	YES NO	57 23	71.0 29.0
Through which medium do you get the information on organically produced fruits and vegetables?	MOFA TV, radio and Newspapers Friends, Other farmers,Marketers NGOs Others	67 41 38 16 22	36.8 22.5 20.8 8.8 12.1
Do you believe that a campaign to educate the consumer to use/ buy such organically produced fruits and vegetables could be realized?	YES NO	80 0	100 0

Source:Survey Result, 2011(Multiple response)

4.4 Time of harvest of banana and okra

The result as shown in table 4.5 indicated that 65% of banana farmers in the Kwhau South District harvested in the afternoon while 41.3% harvested at any time of the day. Majority of the okra farmers (88.0%) harvested in the mornings and evenings. Only 3.8% of the okra farmers harvested in the afternoon while 26.6% harvested any time of the day.

Table 4.5 Time of harvest of banana and okra in the Kwahu South District.

Time of harvest	**Banana**		**Okra**	
	Frequency	**%**	**Frequency**	**%**
Morning	37	61.6	21	35.0
Afternoon	39	65.0	5	3.8
Evening	21	35.0	32	53.0
Any time of the day	19	41.3	16	26.6

Source: Survey Result, 2011(Multiple response)

4.5 Some postharvest practices carried out in the production and marketing of organic banana and okra

As shown in table 4.6, the study revealed that 86.6% and 79.2% of the small scale farmers in the Kwahu South District practiced some form of sorting and packaging, respectively while 81.2% do transport their produce from one point to another. Less than 50% of the respondents practiced some form of cooling, grading, treatment and storage. None of the small scale organic farms is certified. However, the two large scale farmers in the Asuogyaman produced on certified farms and practiced

all the basic postharvest practices needed to maintain fruit quality. The result also indicated that 100% of the marketers enhanced ripening of banana with either organic or inorganic substances before marketing.

Table 4.6: Summary of various postharvest practices carried out by respondents on organically produced banana in the study area

Postharvest practice	**Kwahu South(Small scale farmers and marketers)**		**Asuogyaman (Large scale farmers and exporters)**	
	Frequency	**(%)**	**Frequency**	**(%)**
Cooling (Washing)	0	0.0	2	100
Sorting	30	50	2	100
Grading	8	13.3	2	100
Enhancement of ripening of banana	40	100	-	-
Quality enhancement treatment			2	100
Packaging	28	47.2	2	100
Storage	11	20.0	2	100
Refrigeration	0	0.0	2	100
Transportation	23	38.2	2	100
Certification	0	0.0	2	100

Source: Survey Result,2011(Multipl response)

Table 4.7: Summary of various postharvest practices carried out by respondents on organically produced okra in the study area

Postharvest practice	Kwahu South(Small scale farmers and marketers)		Asuogyaman (Large scale farmers and exporters)	
	Frequency	(%)	Frequency	(%)
Cooling (Washing)	14	23.3	2	100
Sorting	22	36.5	2	100
Grading	11	18.3	2	100
Quality enhancement treatment	12	20.0	-	-
Packaging	19	32	2	100
Storage	11	20.0	2	100
Refrigeration	0	0.0	2	100
Transportation	26	43.1	2	100
Certification	0	0.0	2	100

Source: Survey Result,2011(Multipl response)

4.5.1 Enhancement of ripening of oragnic banana in Kwahu South

The survey result showed that 100% of the marketers used some means to enhance the ripening of green banana. Respondents mentioned ripe palm fruits 37%, ripe pawpaw 46%, cassava 66% and a local fruit in the forest they named as *atoo* 83%. When respondents were questioned about the use of inorganic chemicals to fasten the ripening of banana 83% said they heard about the use of calcium Carbide (CaC) but have not

practiced its use while 17% indicated that they used it in the past but has since stopped using it (Fig 4.1).

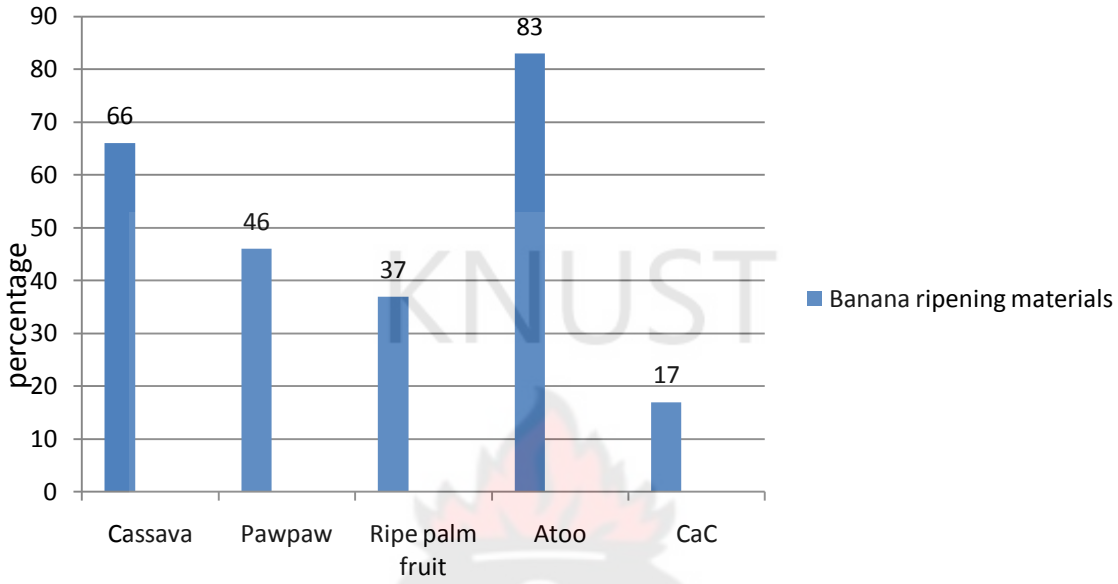

Fig 4.1 Materials used to enhance ripening of banana in the Kwahu South District

4.5.2 Quality enhancement treatment

Twenty percent of respondents indicated that they enhanced quality by washing okra fruits with sugar solution before sale. They however stated that no quality enhancement treatment is given to the banana fruit before sale.

4.5.3. Packaging materials used by respondents in Kwahu South

Most respondents (62%) indicated that they used baskets to package banana while 37.1 used poly sacks to package okra. Usage of cartons and other materials such as plastic boxes, wooden boxes and plastic bowls formed only 3.8% and 0.6% respectively and were mainly used to package okra.

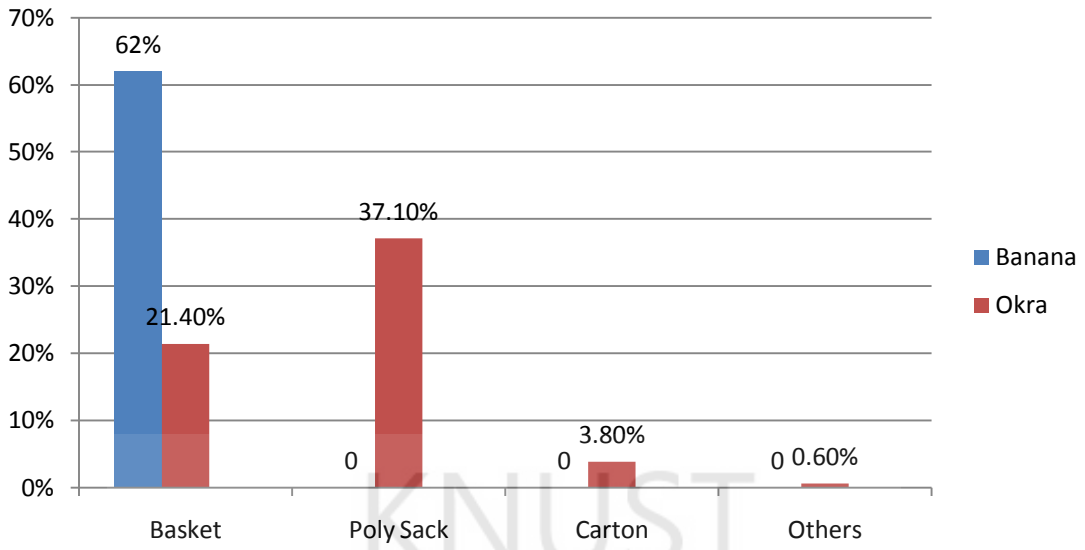

Fig.4.2. Packaging materials used to package organically produced banana and okra in Kwahu South (Small scale producers)

4.5.4 Means of transportion used for organically produced banana and okra in the Kwahu South District.

Figure 4.3 shows the summary of the means of transportion for organically produced banana and okra from farm to the consumer respodents identified in the Kwahu South District. It could be observed from figure 4.3 that 83%, 34% and 18% of farmers transported their banana in open tracks, passenger vehicles and container vehicles respectively. Majority of respondents (67%) transport their okra in passenger vehicles, 46% and 31% transport their okra in open tracks and containers. None of the respondents used cooling vans(vehicles) to transport any of their organic banana and okra.

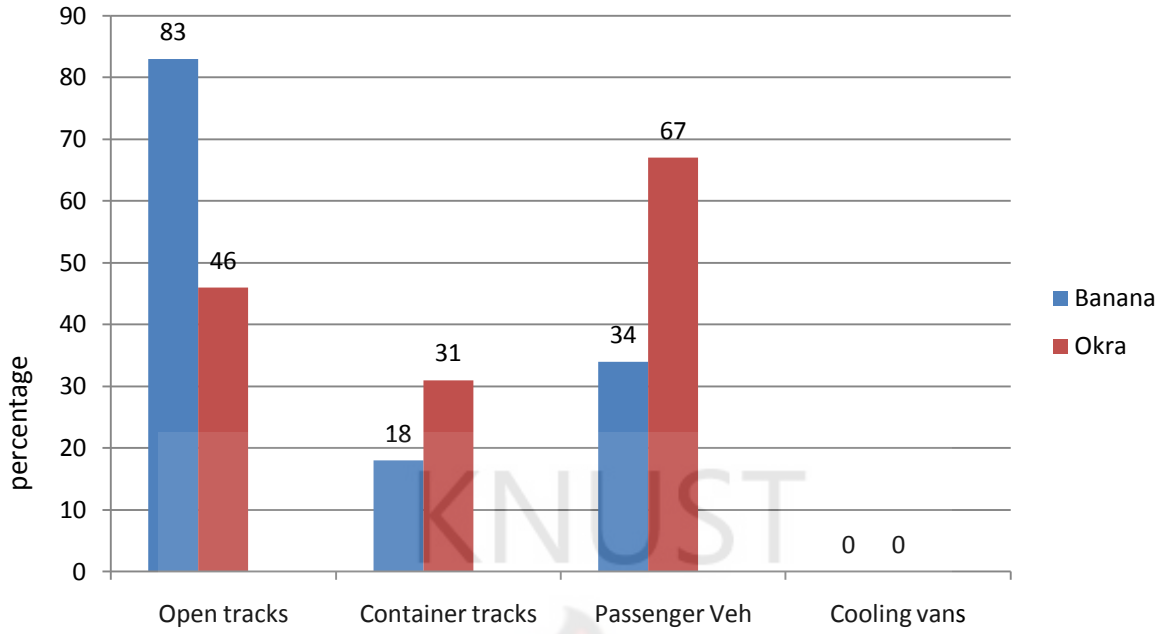

Figure 4.3. Means of transportion for organically produced banana and okra in the Kwahu South District.

4.5.5 Means of storing banana and okra in the Kwahu South District

Only 22 respondents stored their banana and okra. Baskets 31%, sacks 22% ,plastic bowls 16% were the major means of storage identified. Eleven percent of the farmers stored their banana and okra in the refrigerator, 10% on the shelf while 9% kept them on the floor in their rooms.

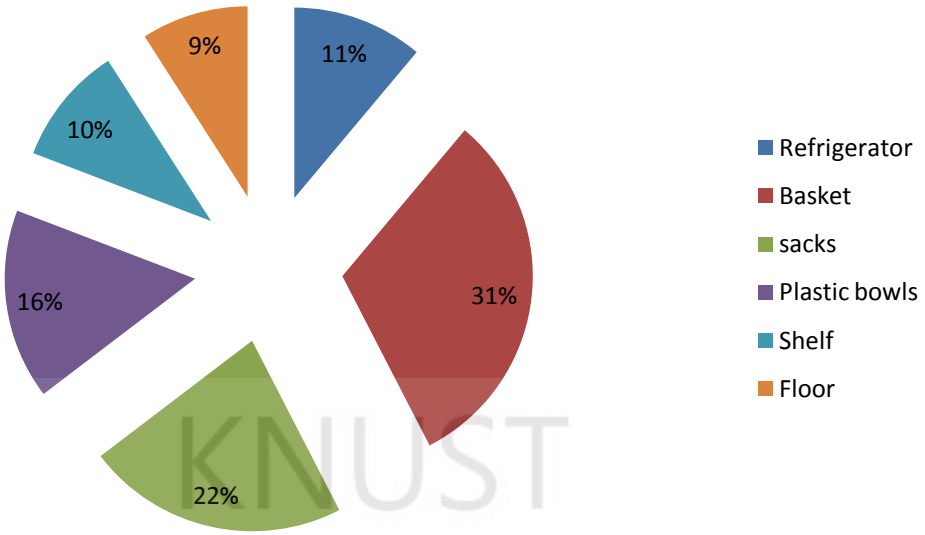

Fig. 4.4 Means of storing banana and okra in the Kwahu South District

4.6. Rejection from buyers based on quality issues.

The results from the data analysis indicated that all 40 respondents in the marketers category received some form of produce rejects from their buyers based on quality issues. Conversely 100% of the commercial producers (exporters) did not receive rejects from local buyers.

4.7.Constraints of institutions engaged in the creation of food safety awareness.

Ghana Standards Board, Food and Drugs Board and Environmental Protection agency were interviewed about constriants to their effort in ensuring consumer food safety. The identified constraints are presented in Table 4.8

Table 4.7. Constraints facing institution involved in consumer awareness creation on food safety issues.

Constrain	GSB	FDB	EPA	Frequency
Lack of funding	*	*	*	3
Lack of personnel		*	*	2
Inadequate logistics	*	*	*	3
Consumer attitude	*	*	*	3

5.0 DISCUSSIONS

5.1. Distribution of respondents by category

The study covered five different categories of respondents and consisted of 60 farmers (32.43%), 80 consumers (43.24%), 40 marketers (21.62%), 2 exporters (large scale producers) (1.08%) and 3 institutions (1.62 %) (table 4.) This implies that postharvest issues as related to quality and food safety involue many players in the industry.

5.2.1 Bio-data of respondents

The bio-data of the respondents (farmers, consumers and marketers) in the two districts showed that majority of the famers were male (82%) while most of the marketers females (95%) as respondents.This was expected since farming is mostly underken by males while marketing is undertaken by women. However, this might account for some major quality loss or contaminations that occured along the postharvest chain of the organically produced banana and okra from the farmer to the consumer because the survey showed that 93% of the postharvest activities are done by the women marketers.

Generally, about 59% were married and mean household size as found in the areas is 3 which is comparatively low as compared to other districts in the country.

Education plays a crucial role in decision making. Basic schools (the Middle School, Junior High or Primary) representing (60%) was the highest level of education of the respondents. Tertiary level education had only 13% with a large number of the consumer respondents and all the large scale producers/exporters falling in that category. Quite a relatively large number (14.2%), majority being farmers had no formal education.This implies that any postharvest technology education for the farmers should be done in the local languages. The large scale producers (exporter) had tertiary level education and this might be the result for their adoption of improved postharvest practices.

5.2.2. Age Distribution of respondent

The result of the study showed that majority of respondents (73%) were in the 20 to 49 year group an indication that people in their active years engaged in either banana or okra farming or trading in the commodity.

5.3 Respondents preference for organically produced banana and okra

The responses from the study showed that more than 90% mention health, free from chemicals and environmental safety as their simple motivation, in that these products do not interfere with natural, biological processes and being good to the human organism (table 4.4).

The result proved that respondents were awaere of the benefits of consuming organically produced fruits and vegetables and might account for more than 87% of the respondents indicating that they would pay more to buy organically produced banana or okra and all the respondents, (100%) agreeing that educational campaigns on

the need for consumption of organically produced banana and okra should be encouraged. The result also proved that product quality and food safety issues were very important to consumers, farmers and marketres in the study area..

5.4. Pre- harvest factors that contribute to postharvest losses of fruits and Vegetables

According to Thompson (2003) there are numerous pre-harvest factors affecting the postharvest quality and shelf life of fruits and vegetables, which include cultivar or variety, climate, soil used for production nutrient applied, and water status. Kader (2002) also indicated that, within each commodity there is a range of genotypic variation in composition, quality, and postharvest shelf life. Result from the data showed that majority of the small scale organic farmers in the Kwahu South District do not acquire their planting materials from approved sources which ultimately affect the quality and shelf life of produce.

5.5. Effect of time of harvest on fruit quality of banana and okra

Temperature and relative humidity (RH) directly affect postharvest respiration and transpiration of fruits and vegetables. Kader (1985) asserted that elevated temperature would speed up respiration, leading to increased ethylene production and high carbon dioxide level and thus changes in flavor, taste, colour, texture, appearance, and nutrients of the produce. Sharma and Singh (2000) and Kader (2002) indicated that appropriate postharvest handling operations that should be applied, must include controlling temperature (cooling) and RH, atmosphere (O_2 and CO_2 levels). However, the result (table 4.5) indicated that 65% of banana farmers in the Kwhau South District harvested in the afternoon while 41.3% harvested at any time of the day.

Majority of the okra farmers harvested in the mornings and evenings. Only 3.8% of the okra farmers harvest in the afternoon. The implication is that the banana farmers in the Kwahu South District expose their banana fruits to higer tempeatures resulting possibly early deterioration.

5.6. Sorting, grading and labeling of banana and okra

The result from the study indicated that less than 53% of the respondents practice some form of sorting while only 19% graded their produce. Farmers and marketers labeled produce only to identify their produce when respondents transport in the same vehicle with other farmers and marketers.

Appiah and Kumah (2009) defined sorting as the separation of raw materials and food slurries into categories on the basis of shape, size, weigh, image and colour. Sorting is done in the fruit and vegetable industry for rejects, and removing any product that is too small, too big, decayed or damaged before the product is put up for sale. Again Appiah and Kumah (2009) defined grading as the assessment of a number of characteristics of a food to obtain an indication of its overall quality According to McGregor,(1989), labeling packages helps handlers to keep track of the produce as it moves through the postharvest system, and assists wholesalers and retailers in using proper practices. Appiah and Kumah (2009) also asserted that brand labeling packages can aid in advertising for the product's producer, packer and/or marketer.

5.7 Packaging of banana and okra.

The result indicated majority of respondents in the Kwahu South District used baskets 67% and poly sacks 37.1% to package their produce. Banana is packed in baskets and covered with rags. The packaging materials were not washed before the next use and

this might expose the produce to contaminants such as pathogens, dirt and undesirable reaction with the environment. Banana and okra packaging practices in the Kwahu South District did not improve the quality and the shelf-life of the produce.

5.8. Enhancement of ripening of oragnic banana in Kwahu South

The result showed that 100% of the marketers used some means to fasten the ripening of the green banana. Respondents mention ripe palm fruits, ripe tomatoes, pawpaw, cassava and a local fruit in the forest they named as **ato** in Twi. When respondents were questioned about the use of inorganic chemicals to hasten the ripening of banana, 83% said they heard about the use of Calcium carbide **(**CaC **)** but have not practiced its use while 17% indicated that they used it in the past but has since stopped using it.

According to the FAO (1986), before a pesticide or chemical can be registered for use on a food crop, a tolerance (legal amount of pesticide residue which may remain on the crop) must be established on that particular crop. Residue data must demonstrate that the proposed use pattern will result in residue levels well within the established tolerance.) However, this is not the case in the Kwahu South Districts, one of the study areas; personal interraction with none respondents revealed that the calcium carbide is being used in secrecy on organically produced fruits especially during the raining season. Meanwhile, these fruits were supposed to be consumed as such in their natural form.

5.9. Storage of fresh banana and okra.

Storage as applied to fresh fruits and vegetables, is defined by the FAO (1986) as holding fresh fruit and vegetable under controlled condition. According to

Kader,(2002) if produce is to be stored, it is important to begin with a high quality product, the lot of produce must not contain damaged or diseased units, and containers must be well ventilated and strong enough to withstand stacking. However, the result indicated that only the marketers do some form of storage of the fresh banana and okra in improvised structures. Temperature management during the storage is not managed in any form. Observstions from the study led to the conclution that some level of loss both in quantity and quality could occur through the storage practices in the study area.

5.10. Means of transporting organically produced banana and okra in the Kwahu South District.

The result showed improper means of transporting organically produced banana and okra from farms to the consumers in the Kwahu South District. The result showed that 83%, 34% and 18% as transported their banana in open tracks, passeger vehicles and container vehicles respectively. Majority of respondents (67%) transported their okra in passeger vehicles, 46% and 31% transporting their okra in open tracks and containers. None of the respondents used cooling vans (vehicles) in transporting any of their organic banana and okra (Figure 4.2).

Kader (2002) stated that fresh produce is primarily transported by road, from farmer to consumer and marketing concern is that fresh produce should be of the highest quality and should be kept in the best condition during transportation. He further pointed out that minimizing losses during transportation, necessitates that special attention be given to vehicles, equipment, infrastructure and handling. Fresh fruits and vegetables are transported using both refrigerated and non-refrigerated vehicles. The type of vehicles generally used to transport the fresh fruits and vegetables do not meet the requirements of the international markets and presents a considerable challenge to the postharvest

handling of the fresh produce. Athough this type of transportation is inexpensive, convenient and easy, it results in over loading without separation of produce which leads to overheating and mechanical injury to produce at the bottom of the stack. The same trucks are used for the delivery of fresh produce, other goods and passengers . Layers of the produce are not, however, separated in order to prevent heat generation. Often the produce was stacked too high which eventually reduce shelf life, retaining fresh produce quality and increase losses.

5.11 Temperature management for fresh fruits and vegetables

Jobling (2000) stated that, at extremes of temperatures products get damaged. He explained that some products suffer chilling injury while others suffer damage at very lowand high temperatures respectively and concluded 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. The correct and careful temperature management throughout harvest, storage,transportation and marketing chain is essential if the quality of the product is to be assured.

It is obvious from the current harvest and postharvest practices of small scale respondents in the study area that their practices have negative effect on the organically produced banana and okra.

5.12 Rejection from buyers based on quality issues.

The results from the data analysis indicated that all 40 respondents under the marketers received some form of rejects from their buyers based on quality issues. Conversely 100 % of the commercial producers (exporters) do not receive rejects from local buyers based on quality issues. It is worth noting that the commercial producer (exporters) who do not receive rejects are producers who do proper harvest, good postharvest

handling and use cooling facilities for storage and transportation of their banana and okra. Additionally these commercial producers cultivate banana and okra on large tracts of land and have the manpower needed for effective postharvest practices. Results from the study shows that (92%) respondents under small scale organic banana and okra producers do not experience rejects. However (81%) of marketer respondents, representing 50% of the survey size experienced rejection as result of quality loss. This can be attributed to the fact that small scale farmers especially the banana farmers sold their produce soon after harvest to the marketer who carry out all the postharvest activities such as ripening, packaging and transportation. It is worth noting that marketers who sold their banana and okra within the Kwahu South District experienced rejection as compared to those who transported their produce to Accra for sale. This can be attributed to the use of poor packaging materials (baskets which were never washed) for packaging and the use of open truck for transportation and mixed loading of produce.

5.13 Certification of organic farms

Sefa - Dedeh (2006) reported 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. The study however showed that none of the small scale organic farms in the Kwahu South District was certified.This posed the challenge of determining the maximum residue levels in the organic produce from the area. However the two large scale farmers in the Asuogyaman produce on certified farms and practiced all the basic postharvest practices needed to maintain fruit quality. 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 more farmer groups in the Afram Basin Zone to the pre – certification level by MiDA which the small scale organic horticultural producers in the Kwahu South District can take advantage of .

5.14 Value Chain Development Concept as it enhances postharvest handling of fruits and vegetables.

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, stored displayed etc, before reaching the final consumer. 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). The study revealed that there were various actors and stakeholders who played various direct and indirect roles and functions in the postharvest handling of banana and okra in the study areas. The main actors who directly handled the banana and okra from harvest to consumption were the small and commercial producers, marketers, exporters, transporters and consumers. However, it was observed that lack of coordination was hindering their effective operation which is a major contributing factor to the poor postharvest practices in the study area.

\

5.15.Constraints of institution involved in food safety awareness.

Ghana Standard Board, Food and Drugs Board and Environmental Protection agency were interviewed about constriants hindering their effort in ensuring consumer food safety. The identified constrains is presented in table 4.6 showed that all the three institutions were constrained by lack of funding, inadequate logistics and consumer attitude .Two of institution (67%) indicated that lack of personnel draws back their effort on consumer aweraness of food safety issues.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The study examined the status of the current postharvest practices of organically produced banana and okra by sampling the view of producers, marketers, consumers and exporters. Majority of respondents in the three broad categories were aware of what organically produced banana and okra were. After a thorough study of the postharvest handling practices a number of conclusions are drawn.

The study revealed that postharvest activities of the fresh organically produced banana and okra in the study districts were organized in different ways with the players playing different roles such as harvesting, packaging, transporting, marketing at open markets and exporting. Small scale farmers and marketers were linked to the domestic

market that is, retailing at open market while commercial scale producers were linked to the export market and other markets even though to some extent they were also involved in the domestic market.

The study also revealed that more than half of the small scale farmers and marketers do not consider proper postharvest factors, they harvested at any time of the day, leave their produce in the open air exposed to direct sunlight and use means of open trucks or passeger buses and salon car to transport their produce whiles the two commercial scale producers employed several means of transportation ranging from open trucks, container trucks without cooling and cooling vans. The study also revealed that the quality of the organic banana and okra from small scale farmers and marketers might be low based on rejects received from buyers and the amount paid per a unit volume. Quality standards used for the fruit and vegetable market based on international quality standards such as GlobalGAP, GhanaGAP and HACCP were not followed by the small scale organic farmers and marketers. The quality factor signs of mechanical damage, decay and rot affect banana and okra produced by small scale farmers and marketers. Small scale farmers and marketers had little or low level of awareness on measures for preventing mechanical damage, decay and rot while commercial scale producers had high level of awareness on measures for preventing postharvest losses in general.It was observed that poor postharvest practices were not only the result of the low level of knowlege on postharvest practices on banana and okra but also other several factors such as the lack of appropriate storage facilities linked to the storage practices, lack of developed infrastructure such as adequate access road network from producing areas to marketing centres, lack of appropriate transportation as well poor production management such as inadequate control of pests and diseases (organically), access to

good planting materials and erratic rainfall that affect quality of the organically produced banana and okra before harvest.

6.2. Recommendations

For the organically produced banana and okra to be well developed and compete favourably on the international and local markets following recommendations on the appropriate postharvest practices are made:

The Export Marketing and Quality Awareness Project (EMQAP) under the Ministry of Food and Agriculture should support the small scale organic fruit and vegetable farmers with adequate improved planting materials, packaging materials and proper transportation and storage facilities.

To increase the level of awareness of producers and marketers especially, small scale farmers and marketers on the effect of good postharvest practices on quality of organic fruits and vegetables, the Directorate of Crop Services is recommended to organize regular in service training for Agric. Extension Agents in the fruit and vegetable producing districts with up to date knowledge and skills on postharvest management of these produce.

To ensure that producers supply regular and high quality organic banana and okra to the consuming public, it is recommended that small scale farmers and marketers linking with the large scale organic producers/ exporters such as Volta River Estate Limited (VREL) and Tack Farms to learn more about improved practices especially the

postharvest aspect on organic fruits and vegetable management on their fields and also serve as out growers for the large scale producers and exporters.

It is also recommended that, further studies be carried out in Kwahu South District to determine the effect of verious methods of enhancing ripening of banana on the quality of the fruit.

REFERENCES

Accra Metropolitan Assembly, (1995) Growing and sale of crops by laws.Local Government

Bulletin 19 (1 September).190 – 190-191 Accra, Ghana.

Adaskaveg, J.E., H. Forster, N.F. Sommer. (2002). Principles of post-harvest pathology and

management of decays of edible horticultural crops. University of California Publication, California, pp. 163-195.

Agrios, G.N. (2005). Plant Pathology, Academic Press, New York.

Aked, J. *(*2000). Fruits and vegetables. *In:* Kilcast D, Subramaniam P, *editors.* The stability and shelf-life of food. *Boca Raton , Fla. : Woodhead Publishing Ltd. and CRC Press LLC. p* 249–78.

Annonymous, (2004). Annual report of National Horticulture Board, August, p-51.

Appiah, F and Kumah P.(2009) Processing and Packaging Technology

IDL, KNUST Kumasi, Ghanan

Brecht, J.K.*;* Felkey K.*;* Bartz, J.A.*;* Schneider, K.R.*;* Saltveit M.E. and Talcott, S.T. *(*2004). Fresh-cut vegetables and fruits. Hort Rev 30*:*185–251.

Brummond, Brad. (2001). Organic Farming Gaining Ground but beware. NDSU Ag. Com

Release http://www.aces.edu/counties April 2011

Codex Alimentarius (1995). General Reguirements (Food Hygiene) Volume 1B. Joint FAO/WHO Food standard Programme Rome.

Dankyi,A. A.; Banful,B., Anno- Nyako, F.O.; Dzomeku,B. M.; Asafu-Agyei,J.N.; and Haleegoah J.(2007). Postharvest handling,processing, marketing trends and routes of

plantains and bananas in Ghana.Final Report submitted Council for Scientific and Industrial Research (CSIR),Accra.

Diver S.; Kuepper, G.; and Born, H., (1999). Organic Tomatoes Production, NCAT 1999

Duzyaman, E. and Vural, H., (2002), A study on heterosis in yield among okra genotypes

from different eco-geographic origin. Ege Universitesi Ziraat Fakultesi Dergisi.

Environmental Protection Agency, (2006). Environmental Protection Agency Law. [Online].

Available at http://www.epa.gov.gh/ [accessed 22/05/2011].

Food andAgriculture Organization, (2002), World Food Summit Five Years Later: Safe food and nutrition for the Consumer.Food and Agriculture Organization,Rome.

Food andAgriculture Organization, (2000), Twenty second Regional Conference for Europe: Food safety and Quality as affected by organic Farming,Porto, Portugal 24-28

July.

Food andAgriculture Organization (FAO), (1986). Improvement of Post-Harvest Fresh

Fruits and Vegetables Handling- A Manual. Bangkok: UNFAO Regional Office for Asia

and the Pacific.

Food andAgriculture Organization Statistics (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 May 2011]

Ferguson, I*;* Volz, R*;* Woolf, A*; and* Cavalieri, R.P. *(*1999). Preharvest factors affecting

physiological disorders of fruit. Postharvest Biol Technol 15*; p* 255*–257*

Food and Drugs Board (2005).Overview of the food and druga law with reference to food.

Food and drugs Board, Accra, Ghana.

Gerken A.and Suglo V (2002),Crop protection policy in Ghana ; Pest management in West

Africa Number 3,January.Food and Agriculture Organization Regional office for Africa.

Ghana Export Promotion Council (2009): Ghana Export Bulletin 2009

Goletti,F. and Wolff, C.(1999).The Impact of Posthrvest Research.International Food Policy

Research Institute (IFPRI), 29,1-109. Retrieved from

http://www.ifpri.org/sites/default/files/publications/pubs divs mtid dp papers dp29.pdf

Gowen S.(1995). Modifying management for banana cultivation under different

temperature. Banana and Plantains.

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 2011].

International Federation of Organic Agriculture Movements (IFOAM), and FiBL, (2006).

The World of organic Agriculture. Statistics and Emerging Trends 2006. Bonn and Research Institute of Organic Agriculture FiBL, Frick pp 27 – 35.

International Federation of Organic Agriculture Movements (IFOAM), (2003). Organic and

Like-Minded Movements in Africa. IFOAM Born, pp 102 – 108.

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 2010]

Kavin, M. M, Steven, R. L. and Stephen, S. J. (2007). Evidence of varietal adoption to organic farming systems. Field Crops Research, 102 (2007), 172 – 177.

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 2010]

Kader, A.A. (Tech. Ed.). (2002) Post-harvest Technology of Horticultural Crops.

University of California, Agriculture and Natural Resources. Pub. 3311.

Kader AA.(2002a). Quality parameters of fresh-cut fruit and vegetable products. *In:*

Lamikanra, *editor*. Fresh-cut fruits and vegetables. *Boca Raton , Fla. : CRC Press LLC.*

p 11–20.

Kader, A. A., (2002b). 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., (1999). Fruit maturity, ripening, and quality relationships. International Symposium on Effect of Pre and Post Harvest Factors on Storage of Fruit, (ISHS), p. 203-204.

Kader AA. *(*1985). Quality factors: definition and evaluation for fresh horticultural crops.

In: Postharvest technology of horticultural crops. *Davis , Calif. : The Regents of the Univ. of California, Division of Agriculture and Natural Resources. p* 118–21.

Kavin, M. M, Steven, R. L. and Stephen, S. J. (2007). Evidence of varietal adoption to organic farming systems. Field Crops Research, 102 (2007), 172 – 177

KIT, Faida M; 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.

Kumar, N., (2006). Breeding of Horticultural crops. New India Publicashing Agency, New Delhi, pp 173-177.

Malik, W.; Farooq, U. and 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

http://www.pide.org.pk/pdf/PDR/2005/Volume4/673-694.pdf

[accessed 15 August 2011]

McGregor, B. 1989. Tropical Products Transport Handbook. USDA, Office of Transportation, Agricultural Handbook Number 668.

Mitra, S. K., & Baldwin, E. A., (1997). Postharvest physiology and storage of tropical and

subtropical fruits. CAB International, Wallingford, UK, pp. 85-122

Mrema,C.G.and Rolle, S.R.,(2002). "Status of the postharvest sector and its contribution to

agricultural development and economic growth." 9th JIRCAS International symposium –

Value addition to Agrcultural Products,pp 13-20.

MOFA, (2011a). District Agriculture Prolie Atimpoku: Ministry of Food and Agriculture

MOFA, (2011b). District Agriculture Prolie Mpraeso: Ministry of Food and Agriculture

MOFA, (2009). Annual Report Mpraeso: Ministry of Food and Agriculture

MOFA, (2008). Ghana IPM News Newsletter of the Ghana National IPM oversight Committee: Ministry of Food and Agriculture 2008

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

Mougeot, L.(1994),Urban food production; evolution,official support and significance.Cities Feeding People Series Report.Ottawa:IDRC.

Nunes, M. C.;Tommy A. and Palmer, N. (2007). Quality curves for mango fruit stored at

chilling and non chilling temperatures. *Journal of Food Quality*, 30 (2007), pp 104 – 120

Osei-Asare, Y.B.,(2009). Status of Organic Agriculture in Ghana: A Survey of Consumers,

Producers and Marketers. An FAO/GOAN/ MOFA Project on Organic and Fair Trade Export from Africa

Olympo, N.S.and Kumah, P.(2009) :Quality Control of Horticultural Crops,

KNUST IDL Kumasi, Ghana

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.

Rabus ,C *and* Streif, J. *(*2000). Effect of various preharvest treatments on the development of

internal browning disorders in 'Braeburn' apples. Acta Hort 518*:*151–7.

Roduner, D., (2007). Donor Interventions in Value Chain Development. 1st Edition.

Switzerland: VCRD CoP.

Roger,T. B. (1995). The psychological testing enterprise: An introduction. Pacific Grove,

C.A.Brokes code.

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.

Salunkhe DK, Kadam, S.S. *(*1998). Handbook of vegetable science and technology:

production, composition, storage, and processing. *New York : Marcel Dekker.*

Samon(1980) Modifying management for banana cultivation under different temperature, Banana and Plantains.

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 May 2011

Sharma, R.M *and* Singh, R.R.*(* 2000). Harvesting, postharvest handling and physiology of fruits and vegetables. *Tagore Garden, New Delhi : Indus Publishing Co. pp* 94–147.

Thompson, A.K. *(*2003a). Preharvest factors on postharvest life. *In:* Fruit and vegetables. *Ames , Iowa : Blackwell Publishing Ltd. pp* 1–8.

Thompson, A.K. *(*1996). Postharvest treatments. *In:* Postharvest technology of fruit and vegetables. *Cambridge , Mass. : Blackwell Science Ltd. pp* 95–128

Timpo, G.M. and Idun, I.A.(2010). Diseases and Pests of Horticultural crops, KNUST IDL

Kumasi, Ghana

Tomala, K.*;* Andziak, J*;* Kobusinski, K*;* Dziuban, Z. *and* Sadowski, A. *(*1999). Influence of rootstocks on fruit maturity and quality of 'Jonagold' apples. *In: Proceedings of the International Seminar,* Apple Rootstocks for Intensive Orchards*, Warsaw Ursynow Poland , 18–21 August 1999.*

Tweneboah, C.K.,(1998). Vegetable and Spices in West Africa:Co-Wood publisers, 1998.

USDA (1994). Report and Recommendations on organic Farms (USDA study Team on Organic Farming US Department of Agriculture, Washington DC,1994.

Wilson, C.L.;Wisniewski, M.E; Biles, C.L; McLaughlin, R;. Chalutz, E.and S.Droby. 1991.

Biological control of post-harvest diseases of fruits and vegetables: alternative to synthetic fungicides. Crop Prot., 10: pp 172-177.

Zind, T. (1989). Fresh trends '90: A profile of fresh produce consumers. Packer Focus 96.

Zúñiga-Arias, G. and 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.

APPENDIXES

Plate 1. Odotso variety of banana on an organic farm at Bepong.

Source:Survey Result,2011

Plate 2. Protected organic banana on an exporter's farm in the study area.

Source: Survey Result,2011

Plate 3. Sorting and ripening enhancement of banana in the Kwahu South District.

Source: Survey Result,2011

Plate .4 Organically produced banana been transported in a track and a car at Bepong in the Kwahu South District.

Source: Survey Result,2011

Methods of packaging organically produced banana in the Kwahu South District

Plate .5 Source:Survey Result, 2011

Plate 7 Organically produced okra sorting and packaging in the Kwahu South District

Source: Survey Result,2011