KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

INSTITUTE OF DISTANCE LEARNING (DEPARTMENT OF HORTICULTURE)

A SURVEY ON PRODUCTION AND POSTHARVEST HANDLING OF PEPPER IN THE UPPER MANYA KROBO DISTRICT IN THE EASTERN REGION OF GHANA

A THESIS SUBMITTED TO THE SCHOOL OF RESEARCH AND GRADUATE STUDIES, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF SCIENCE (MSc) DEGREE IN POSTHARVEST TECHNOLOGY

BY

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DECLARATION

STUDENT'S DECLARATION

I hereby declare that except the references to other people's work which have been duly cited, this dissertation is the result of my own work under the supervision of Prof. P.Y. Boateng and Dr. B.K. Maalekuu and that it has neither in whole nor in part been presented as a dissertation for a degree in this University **(KNUST)** or elsewhere.

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DEDICATION

To God be the glory, this work is dedicated to my sweet mother, Christiana Dede, My dear wife Benedicta Osei, my two lovely boys Shadrach and Meshach and my dearest friend Godfred Appiah.

God richly bless you all.

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ABSTRACT

The research work focussed on production and postharvest handling of pepper in the Upper Manya Krobo District in the Eastern Region of Ghana. The survey covered all the four agricultural zones in the District namely Asesewa, Anyabony, Sekesua and Sisiamang. The target groups for the research were large-scale producers, traders and consumers of pepper. The research aimed at identifying the various cultural practices adopted by producers; assess harvesting practices; assess the postharvest handling operations that are carried out; and to offer suggestions and recommendations with regards to postharvest handling of pepper. In all hundred (100) respondents were randomly sampled from all the four zones in the District. Data was collected from the respondents through the use of questionnaire backed by an interview. The results were analysed and put into frequencies, percentages and graphs. The results from the study revealed that Legon 18, Scotch Bonnet and sweet pepper were the main species cultivated by farmers; some farmers did not apply pesticides leading to insect infestation and disease infection which consequently affected the shelf-life of the fresh pepper. Traders often display their produce in the sun, which leads to an increased temperature hence faster rate of deterioration. The study further revealed that consumers and traders usually store their produce in refrigerators without washing them, leading to contamination with pathogens causing rot. It was suggested that good quality seeds should be obtained from Research Institutions and good agronomic packages disseminated to farmers to offset postharvest losses.

TABLE OF CONTENTS

CHAPTER 3

CHAPTER 4

CHAPTER 5

CHAPTER 6

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

1.0 INTRODUCTION

A number of species of the genus *Capsicum* were domesticated in Central and Southern America for their pungent fruits. They have become a component condiment as well as food by the indigenous Americas and form an essential part of human diet in Africa and other parts of the world (Tweneboah, 2000).

Pepper (***Capsicum annuum)***, is of the Solanaceae family, whose products are used as vegetables and spices (Luning *et al.*, 1995). A number of cultivated varieties are in existence in Africa including Ghana and species such as ***Capsicum frutescens***, ***Capsicum annuum,*** *and* ***Capsicum sinensis*** are found (Tweneboah, 2000). These peppers comprising sweet pepper with large fruits are used as vegetables in salads. The red elongated varieties with high level of pungency such as bird's eye chillies are also used as vegetable. Pepper may be classified as sweet, mild, or hot depending on the amount of capsaicin present(Walter, 1990).

Pepper is eaten as a raw and cooked vegetable and also used commonly in making paste, pickle, and salad. Red ground pepper are made by drying and pulverising the hot pepper and is used as a spice and flavour ingredients in the food industry (Isidoro *et al.*, 1995).Pepper has high nutritive value and is one of the vegetables consumed most by the households in Ghana (Watson,1971). As a result it is ranked high among the cultivated vegetables in Ghana. Uzo (1982) ranked chilli pepper third in importance among the cultivated vegetables in Nigeria. Howard *et al.* (1994) indicated that it is a good source of vitamins especially A and C which are important antioxidants. It has a wide range of

medical applications, from appetite, relieving pain associated with arthritis, to diuretic effects. (Bosland, 1994).

Some pepper varieties can be grown as annuals especially the sweet pepper (Sinnadurai, 1992). Some are also shrubby perennials which grow to a height of about 1.5m tall.

Pepper responds to NPK 15:15:15. However, a good dressing of animal manure before planting is sufficient for most varieties. (Kwarteng and Towler, 1994). Depending on the variety, the pepper fruit is harvested between 70-130 days after transplanting.

Pepper has a ready market locally and is all year round, especially in the dry season. Pepper has also gained an international market hence its export – potential (Norman, 1992).Togo, Ghana and Senegal export substantial quantities to Europe. In order to meet the requirements of the increasing population it has put pressure in the development of agricultural technology which has resulted in substantial increase in world food production in the last three decades (Salunke *et al*., 1991) although post harvest losses are also very high in fruits and vegetables with the losses ranging between 40-50% in the tropics and sub tropics (Kwaa, 1995).

In order to prolong the shelf-life and also meet the market requirements, harvesting should be done on time depending on the variety. It has been observed that cold storage slows down deterioration without predisposing the commodity to unnecessary ripening (Maalekuu, 2008). In addition to providing adequate refrigeration capacity to cool the produce to the required temperature, provision must be made for continuous removal of field heat and respiration. Post harvest handling operations or techniques such as sorting, grading packaging and storage should be strictly practiced to meet the market requirements and also extend the shelf life of pepper.

1.1 OBJECTIVE:

The main objective of the project was to assess the level of pepper production and postharvest handling operations in the Upper Manya Krobo District in the Eastern Region of Ghana.

1.2 SPECIFIC OBJECTIVES

The specific objectives are:

1. To identify the cultural practices carried out by pepper producers
2. To assess harvesting practices (harvesting method, harvesting stage, frequency of harvesting) and
3. To assess the post harvest handling operations carried out by pepper producers.

1.3 PROBLEM STATEMENT

According to Bosland and Votava (2000) pepper production is on the increase and may be an important source of vitamins for the world population. Salunke *et al*. (1991) reported that postharvest losses are very high in the fruit and vegetable sector as a result of their high moisture level. Farmers produce enough pepper but as a result of inadequate postharvest technology to extend the shelf life of peppers, their incomes are reduced when losses are incurred. It is in the light of these that this research was being carried out to asses the production and postharvest handling of pepper which will help to extend the shelf life of pepper in general.

1.4 SIGNIFICANCE OF THE STUDY

It was expected that the completion of the project will bring out the appropriate production practices and postharvest handling operations or activities which will help to increase the production of pepper to meet its the demand of the growing populace. The results will be recommended to farmers in and around Upper Manya Krobo District of Eastern region to ensure continuous production.

1.5 LIMITATION

The research was limited to only four (4) production zones in the district due to time and financial constraints. Secondly, as a result of high illiteracy rate in the area the effectiveness of the administration of the questionnaire was hindered. In addition, poor and in adequate record keeping by farmers also limited the research to some extent. Furthermore, accessibility to farmers was a problem due to the bad unmotorable roads since most of the farmers lived in remote areas.

CHAPTER TWO

LITERATURE REVIEW

2.1 ORIGIN AND DISTRIBUTION OF PEPPER

Norman (1992) and Tindall (1983) stated that the *Capsicum peppers* are indigenous to Central and Tropical America. From this place, various domesticated forms developed secondary centres with *Capsicum annum* located in the middle of America (Mexico), *Capsicum Chinese* and *Capsicum frutescens* from Northern half of South America to parts of Central America and the Caribbean. World book of Encyclopaedia (2000), reported that early America. Indians used pepper as seasoning. In the late 1400's and 1500's, Europeans explorers brought pepper from America to Europe and Asia.

Walter (1990) added that peppers were unknown in Europe until the sixteenth century, having been introduced into Spain by Columbus on his return trip in 1548 and to Central Europe by the close of the sixteenth century. The Portuguese carried *Capsicum* from Brazil to India prior to 1885 and cultivation was reported in China during the late 1700s.

Norman (1992) suggested that hot peppers in West Africa came from either another part of Africa or from overseas and or from hybridization of those introduced. It was thought that the Portuguese introduced peppers to West Africa in the 15th Century, (Norman, 1992) added and today, pepper is grown throughout the world, both the tropical regions and temperate regions.

However, Walter (1990) indicated that modern taxonomists recognize five major cultivated species namely *Capsicum annum* L., *Capsicum frutescens* L., *CapsicumChinese jacquin*, *Capsicum pendulum* Wildenow, and C*apsicum pubescens* Ruiz and Pavon. The five major cultivated species are derived from different ancestral

stocks found in three distinct centers of origin. Mexico is the primary for *Capsicum annuum*, with Guatemala a secondary center; Amazonia for *C. Chinese* and *C. frutescens,* and Peru and Bolvia for *C. pendulum* and *C. pubescens.*

2.2 BOTANY OF PEPPER:

Norman (1992) reported that *Capsicum frutescens* is a small perennial shrub which is characterised by greenish white corolla, more than one pedicel at a node, and not so large fruits. The hot perennial pepper belongs to this species, he added.

Capsicum annum is an herb or sub-shrub which has white corolla and produces only one pedicel per node. The fruits are variable in size, shape and pungency. The annual sweet and hot peppers belong to this species (Norman, 1992).

Pepper grows well on fertile loam soils with high level of organic material and reserves of essentials elements. Raemakers (2001) indicated that pepper thrive well at an average tolerance to acidity (pH 5.5- 6.8). Good drainage is important since water logging is likely to cause leaf shedding (Tindall, 1983). According to Walter (1990), peppers are a warm weather crop. Pepper flowers fall off when night temperature are below than 16°C or above 24°C. Plants do not grow when night temperatures are below 13°C. Raemakers (2001) reported that sweet pepper for instance grow best when the day time temperature lies between 21°C and 25°C. Any excessive heat a (greater than 30°C will inhibition development of fruits. Sinnadurai (1992) added that bright sunshine during the growing season causes sunscald in the fruits and this is common when the crop is grown during dry season.

Tweneboah (2000) reported that an adequate rainfall of 600-1200 mm per annum is required for pepper if grown as a rain fed crop; just very heavy rains may rot the leaves and fruits. Additionally, (Tindall, 1983) reported that excessive rainfall affects flowering and fruit set and may also encourage fruit rot and decay. Water deficit may also result in bud and flower abscission. Rice *et al*., (1990) further stated that excessive hot dry weather may produce infertile pollen and therefore reduce fruit set. Most cultivars are adapted to growing at altitudes up to 2000m (Rice *et al*.,. 1990). The optimum altitudes for growth are in range of 400-600m (Messiaen, 1992).

World book (2000) added that in tropical regions, the pepper plant is a perennial, while in temperate regions it is an annual. The fruit consist of a thick, fleshy as a vegetable. It can also be dehydrated, pickled, or canned for eating. Yamaguchi (1993) stated that the flowers of pepper are self-pollinated and the fruit is a pod-like berry with a cavity between the placenta and fruit wall. Obeng- Ofori (2007) however reported that sweet pepper is autogamous but the level of cross-pollination varies from 2-40%, depending on insect activity, Norman (1992) indicated leaves of capsicum peppers are usually broad oval, shiny and glabrous but certain forms have tomentose leaves. Usually the smaller fruited types have narrower leaves. Flowers are small 0.60 to1.3cm across, and are typically solanaceous. Usually fruit colour when ripe is reddish orange but the most pungent fruits are often green when small. Hot pepper, *Capsicum frutescens* bears an erect branch stems to a height varying 0.3m to1m or more, with slender foliage. Sweet pepper, however, is an herbaceous annual with erect branching stem and may attain a height of 0.5m to 0.8m. When grown in deep homogenous soil, Capsicum develops a root system that may extend to a depth of 0.4m to 0.7m. (Obeng- Ofori*et al.*, 2007).

Norman (1992) reported that the colour of *Capsicum* fruits is due to the presence of lycopene, xanthophylls and carotene, the latter being dominant in yellow types.

2.3 VARIETIES OF PEPPER GROWN IN GHANA

Tweneboah (2000) categorised pepper produced in Ghana into two main varieties that is *Capsicum annuum*, comprising the sweet peppers with large fruits, used mainly as vegetable in salads; and *Capsicum frutescens* including the local hot varieties used mainly as spices in various dishes.

All cultivars of sweet peppers are imported (exotic) and there is no local type (Olympio *et al*., 1977). Tweneboah (2000) recommended that the most suitable cultivars of sweet pepper include California wonder, World Beater, Florida Giant, Neopolitan and Cuban. Norman (1992) also reported that Cadice, Early Cal Wonder, Chinese Giant, Yolo Wonder and Yolo Wonder Improved B California Wonder and Yolo Wonder are cultivars suitable for export.

Tweneboah (2000) reported that many of the local varieties of hot peppers grown and used in West Africa have local names in recognition of particular features of the fruit. In Ghana, varieties such as "Kokromotie" (thumb), "Hwe-Nyame" (pointed upward), "Hwentia" (pointed nose), "Oheneba Nsansia" (Prince's sixth finger), "Mako hwam" (fragrant pepper), and "Basatia" (short arm), are the main ones grown in the forest and derived Savanna Zones. "Kpakpo shito", "Ogyenma" and "Legon 18" are popular in the Coastal savanna of Greater Accra region. Norman and Abotsi (1988) estimated the pungency of 17 West African cultivars of hot pepper by vanadium oxytrichloride test. They concluded that variations within the cultivars can be used for the classification of

West Africa hot pepper on the basis of the degree of pungency. Norman (1992) indicated that in Ghana, Legon 18 which was selected from an original cross from Sri Lanka, is not only, very high yielding, but also, is fairly resistant to leaf curl virus. Obeng-Ofori *et al*. (2007) added that several varieties of hot pepper such as Bird's eye, Legon 18, M12, Fresno, and Jalapeno are found in Ghana and the variety grown depends on factors such as ecological suitability, consumer preference, and market acceptability.

2.4 USES OF PEPPER

Pepper "the master spice" is the most used spice. Nutritionally beneficial and medically positive, pepper offers a unique flavour and a variety of uses. It is the third most common ingredient behind salt and water. Along with salt pepper is on nearly every table. (whatscookingamerica.net/../pepper.html).

Obeng-Ofori *et al.,* (2007) added that the uses of pepper range from salads, using *Capsicum* to add flavour, to cook dishes, using green and red chillies to add pungency, to using dried powder spice of paprika and chilli to sauces using for example Tabasco. Pepper have some insecticidal properties hence they are used in the formulation of insecticides to control some insects. Hot pepper especially the Birds eye is used in the preparation of tear gas (Timpo *et al*., 2010). Tindall (1983) reported that, pepper could be used for meat stuffing. Dupriez and De Leener (1989) mentioned that large chillies are more popular as a vegetable. Some, like the sweet pepper, are eaten raw in salads. They added that the leaves could also be eaten cooked and also the Bird chillies are used in many sauce recipes.

2.5 NUTRITIONAL COMPOSITION OF PEPPER

Norman (1992) reported that as food, the approximate nutrient value of pepper per 100g of edible portion which are essential for growth and development as follows:

Table: 2.1 **Nutritional Composition of Pepper**

NUTRIENT	NUTRIENT VALUE (MATURE GREEN SWEET PEPPER)	NUTRIENT VALUE (RIPE HOT PEPPER)
Moisture	93 %	84 %
Energy	22 calories	46 calories
Protein	0.9 g	2.0 g
Fat	0.3 g	2.0 g
Total Sugar	4 g	55 g
Other Carbohydrates	0.4 g	0.3 g
Vitamin A	530 I.U	11,000 I.U
Thiamin	0.06 mg	0.10 mg
Riboflavin	0.02 mg	0.10 mg
Nicacin	0.4 mg	1.0 mg
Vitamin C	160 mg	240 mg
Calcium	7 mg	18 mg
Iron	1.4 mg	1.0 mg
Magnesium	13 mg	27 mg
Phosphorus	22 mg	45 mg

Source: Norman, (1992)

Mayhew and Penny (1988) also reported that pepper is very nutritious and extremely good source of vitamin C as well as containing significant quantities of mineral, notably Iron.

2.6. IMPORTANCE OF PEPPER

2.6.1Nutritional Importance of Pepper

Pepper has a high nutritional value. It supplies vitamins such as vitahmins C, B_6, and E (Timpo *et al*., 2010). Yamaguchi (1986) indicates that peppers are excellent source of

vitamin A and C and are the second most important crop among the solanaceous fruits. He further indicated that peppers are by far superior to both tomatoes and egg plant in vitamin A and C. Mayhew and Penny (1988) also reported that pepper is very nutritious and extremely good source of vitamin C as well as containing significant quantities of mineral, notably Iron.

Pepper provides roughage of crude fibre which promotes a digestion and helps prevent constipation. Pepper provides a good source of energy (Calories) (Timpo *et al.*, 2010)

2.6.2 Medicinal Importance

(http://www.thespicehouse.com, (26/5/2011, 5:20am) gave an indication that pepper is supposed to help with the following ailments:

i. Abdominal pain; heart burn, inadequate stomach juices, indigestion and others stomach problems.
ii. Stimulates the taste buds which signals the body to produce hydrochloric acid which helps to break down foods not being digested by stimulating by intestinal pain, constipation, stiffness, cold, diabetes, dysentery, flu, fluid retention and mental exhaustion;
iii. Provides mild amount of energy, nicotine craving, and obesity by stimulating the breakdown of fat cells.
iv. Pepper aids so much in the digestive system, hence its use can correct flatulence and nausea.
v. Pepper is an aromatic stimulant, good for the urinary organs. It pepper is gargled with; it relaxes the uvula and paralysis the tongue.

2.6.3 Economic Importance of Pepper

Economically**,** exportations of pepper to Europe have provided foreign exchange; pepper provides source of income to farmers; Pepper contribute to Ghana's gross Domestic Product; and pepper like other vegetables provides market for inputs like fertilizer and insecticides. (Timpo *et al*., 2010)

2.7 SOWING AND PLANTING OUT

Addo - Quaye *et al*., (1993) stated that pepper is propagated by seeds obtained from the mature dried fruits. The seeds are best sown in boxes or nursery beds; and germinate in about seven days. The seeds may be sown at anytime of the year but as the plants do best in the dry season, sowing in the late rains are recommended. Seedlings are transported to well- prepared beds about one week after germination.

The use of partial shade, removed a week before planting harden them off, will give better, higher yielding plants, with larger leaves. Dupriez and Deleener, (1989) indicated that when seedlings have four to six leaves; they are transplanted with roots exposed, or with a ball of soil. The plants should be spaced about 30 – 40 cm apart. However Kwarteng and Towler (1994) added that pepper can also be sown directly in the field or garden.

Planting out density is higher than for tomato and eggplant, especially for varieties with a poor growth habit. It should be 40000- 80000 plants/ha (40-80plants/10m). No pruning is required. Varieties with short internodes, .e.g. "Yolo Wonder" do not need staking,

whereas the long-staked varieties should be trained on wires along each side of the row which are fixed to stakes.

2.8 NUTRITIONAL REQUIREMENTS OF PEPPER

According to Sinnadurai (1992), pepper especially sweet peppers respond greatly to organic manure and good yields have been obtained by using cattle manure alone as the source of plant nutrients. However the application of nitrogen and or preferably when applied in limited quantities are generally deemed necessary for good response of sweet pepper during the growing period. (Tindall, 1983).

Berke *et al*., (2001) stated that, in the tropics, common fertilizer application rates are 140-200kg N per hectare, 60-140kg P_2O_5 per hectare and 149-180kg K_2O per hectare. Application of 40% of the inorganic Nitrogen fertilizer should be done before transplanting. The remaining 60% should be applied in three (3) equal amounts at 2, 4 and 6 weeks after transplanting.

Sinnadurai (1992) submitted that for poor soil, 350kg of NPK 15:15:15fertilizer mixture per hectare should be applied at split dose, the first one, 10 days after transplanting and second application,10 days after the first.

Tindall (1983) indicated that the greatest response of vegetables to NPK fertilizer is usually obtained during the early stage of the plant. He (Tindall) further stated that the application of NPK 15:15:15fertilizer increase the vegetative growth of the plant when applied seven (7) day after transplanting. Karikari and Mathew (1990) indicated that potassium is essential for the manufacturing of sugar, protein, and also cell division in the plant.

Raemakers (2001) submitted that in improving the quality of fruits and helping them to ripen faster, pepper plants needs to get a good start with sufficient nitrogen until they reach the flowering stage, then afterwards, their phosphate and potash requirements increases.

Albin (1985) and Leonard (1986), reported that organic manures such as cow dung, poultry manure and others improve soil aeration encourage granulation, stabilize soil temperature, increases friability of the soil, support activities of soil organisms and serve as a storehouse of plant nutrients. Organic manure improves the structure of soil by acting as bulk diluents in compacted soil particles together, and thus improving the amount of water in the soil useful to crops (Fordham and Biggs, 1985).

Ghana - German Agriculture Development Project (1997) indicated that organic fertilizer could supply practically all the nutrients that plants required. However, organic manures release plants nutrients relatively more slowly compared to inorganic ones, resulting in their manural effect lasting longer than inorganic fertilizers. The report further indicated that long term use of ashes and inorganic fertilizers without animal manures could not lead to successful and permanent cultivation of land since those did not add any organic matter to the soil. Asiamah and Harker (1993) pointed out that crops response to inorganic fertilizer is erratic and have indicated that a mixture of organic and inorganic fertilizers is the best combination for the soil. Asubonteng (1997) was of the view that the combined effects of minerals fertilizers and poultry manure are better than either of them used separately at all rates of application. A study conducted at the Maryland Agricultural Experimental station showed a 20-33% yield increase when chemical fertilizer and organic manure were applied together as compared to applying double the amount of either alone (Leonard,1980). Berke *et al.*, (2001) in their study on sweet pepper

production were of the view that pepper plants should be fertilised with a combination of organic and inorganic (chemical) fertilizers to produce high yields.

2.9 IRRIGATION:

Irrigation is necessary because of uneven distribution of rainfall throughout the year especially during critical period of growth. Vegetables are 80-95% water; hence their yield and quality suffer rapidly when subjected to drought (Timpo *et al., 2010*).

Norman (1992) reported that hot pepper are grown under rain fed conditions in West Africa except an irrigated areas, hence yield are thus not as high as they should be, Supply of water to pepper plants should be enforced to give maximum yield. Pepper needs frequent watering, especially during fruiting. Any excess or lack of water may cause the flower to drop (Raemakers, 2001). Tindall (1983) added that water should be applied regularly during dry periods to avoid a soil water deficit but excessive irrigation can be harmful since the root system is particularly sensitivity to water logging.

Norman (1992) stated that for optimum production, the soil moisture supply must be reasonably uniform during the growing season. Dry soils may cause poor fruit set or dropping of flowers and young fruits. The plants must therefore be irrigated periodically (Norman, 1992). Norman (1992) further added that irrigation could be executed by hand, sprinkler or furrows. Irrigation is essential to maintain a steady growth rate, and that of sufficient foliage to product the fruits from sunscald the frequency of irrigation during production period will depend on the type of soil, atmospheric temperature and humidity of the area.

2.10 HARVESTING OF PEPPER

Sweet peppers are usually picked when they have reached a suitable size for the market and the flesh is still crisp. Hot peppers are allowed to ripen fully, by which time they are usually red and beginning to dry up. (Kwarteng and Towler, 1994). Obeng- Ofori *et al*. (2007) reported that sweet pepper is harvested 60 – 80 days after transplanting and may extend over a period of 30 to 70 days. Depending on the variety, sweet pepper fruits may be harvested when immature and green or when fully ripe, red, yellow. They further reported that most both annual and perennial hot peppers are ready for harvesting 8 to 9 weeks after planting. Most of the hot pepper grown in Ghana is harvested red-ripe, some cultivars, especially those for the export, market are harvested mature green.

Messiaen (1990) submitted that organic acids and vitamins C are higher in the ripe fruits, which are also more digestible. However, harvesting green fruits may achieve a more reliable profit to the grower. He further stated that if fruits are allowed to turn red or yellow on the plant, there are much greater risks of rots, caterpillar attacks, blossom end rot and sun scorch.

Peppers should be picked at the earliest maturity to increase and extend yields. Care should be taken when picking hot peppers to avoid getting pepper vils on skin. A knife or clippers can be used for harvesting to prevent damaging plants while harvesting. (**faq.gardenweb.com/faq/lists/pepper/….. 26/5/2011 6:00 am)**

Tweneboah (2000) indicated that fruits are wrenched from the plant so that a small piece of stalk and the calyx remain attached to them. This is usually of one when adopting hand picking of fruits.

Almost all peppers grown in the country are harvested by hand into pails that are then emptied into bulk bins for transport to the packing shed. Considerable mechanical damage can occur during picking and handling if care is not taken to minimizes scuffing and impact. Picker productivity should not be encouraged at the expense of pepper quality. **http://www.agrichill.com/info/Info_Cooling_Peppers.pdf 18/08/2011. 12:19pm**

Fruits and vegetables are very susceptible to mechanical injury. This can occur at any stage of the marketing chain and can result from poor harvesting practices such as the use of dirty cutting knives; unsuitable containers used at harvest time or during the marketing process, e.g. containers that can be easily squashed or have splintered wood, sharp edges or poor nailing; over packing or under packing of containers; and careless handling of containers. Resultant damage can include splitting of fruits, internal bruising, superficial grazing, and crushing of soft produce. Poor handling can thus result in development of entry points for moulds and bacteria increased water loss, and an increased respiration rate.

Peppers are considerably more susceptible to water loss, sun scald, and heat damage after they have been harvested than before. These problems are likely to occur if the bulk bins are allowed to sit for more than an hour in direct sunlight.

Harvested peppers should be placed in the shade immediately after harvest and cooled as soon as possible.

2.11 YIELD OF PEPPER.

Sinnadurai (1992) made a submission that pepper grown under rain fed conditions, without fertilizers, the yield is seldom from more than, 2,200 kg of fresh fruits per hectare. With fertilizers under rain fed conditions the yield can be as high as 6,000 kg, fresh fruits per hectare. With irrigation and good cultural practices the yield can go up to 22,000 per hectare. Tindall (19983) added that under favourable conditions, pepper harvested may range from 12-20 tonnes per hectare. Obeng-Ofori *et al*. (2007) stated that currently, hot peppers yield averages 6.5 tonnes per hectare in Ghana

2.12. WEED CONTROL

Hoe- weeding remains the most commonly used weed control method in pepper. Investigations have that two to three hoe weeding are required in this crop.

2.12.1 Chemical weed control

Several herbicides are available on the market. The weeds on a Capsicum pepper field must, however, first be identified. An appropriate herbicide can then be applied for weed control. . Herbicides which have promise are Galex 500 EC applied two to three days after transplanting (on clean seed bed) at 3 kg a.i./ha. Simazine at the rate of 1.5-2.0 kg a.i. /ha applied one to two days before transplanting is equally promising. (Karikari and Matthew, 1990) and Adigun *et al*., (1982b) indicated that herbicides could be used to reduce labour input which is one of the bottlenecks in hot pepper production in northern Nigeria. Herbicides they found to be promising include diphenamid and mitrobromuron at both 4.0+ 1.0 and 6.0 + 1.0 kg/ha; oxidation + linuron at 1.0 +1.5 and 2.0 + 0.5 kg/ha, and alahor + chlorobromuron at 1.0 + 1. (Norman, 1992).

2.13 DISEASES OF PEPPER

One of the limiting factors in pepper production is disease. Plant pathogens cause substantial losses of fruits and vegetables production. Typically pathological damage is apparent in the field and the affected object is discarded at harvest or during subsequent grading .Subsequent development of the organism and degradation in appearance does not occur until the postharvest period (Kays, 1998). Pathogen causing diseases include fungi, bacteria, virus, and nematodes.

Norman (1992) and Tweneboah (2000) identified the following fungal diseases affecting pepper:

Damping off: It caused by *Rhizoctonia solani* and *pythium* spp. present in the soil which is common in the nursery. Seedlings are usually sucueptible to the disease till they are about two weeks old. The seedling fails to emerge or collapse soon after emergence due to the breakdown of tissue at the collar. It can be controlled by disinfecting seeds; provision of good drainage; and spraying seed-beds with cheshnut compound.

Fruit rot: it is caused by *Colletotricum nigrum.* It is common in sweet peppers. It is responsible for the common dark-brown sunken spot or rot of over ripe fruits. Infection occurs only through wounds or injuries. The fungus also attacks premature fruits causing them to become red and fall off. The diseases are controlled by periodic spraying of a suitable copper spray such as Dithane M-45 and Bordeaux mixture.

Leaf spot: This is caused by the fungus *Ceriospora capsici*. The disease is characterised by regular brown circular spots on leaves common in wet areas. The spots later become dark brown at the margins and have light grey centres. Severely infected leaves turn

yellow and drop. The diseases can be controlled by spraying or dusting seedling in the seed-bed and field with copper compounds. It can also be controlled by applying Dithane M 45 and Zined.

Powdery Mildew: It is caused by *Leveillula taurica*. It was first recorded in Ghana in the Ashanti Region in 1958.The diseases is widespread on hot pepper during the wet season and is characterised by a white powdery fungal growth prematurely yellow, and the leaves may fall. Dithane M45 application is usually a control measure.

Sarath *et al.* (2011) identified **Wilt or Phytophthora blight** as one of damaging fungal disease. The disease is caused by Phytophtora capsici. Symptoms include root deterioration, lesians and the stem, willing, stunting and necrosis of the plant. It can be controlled by spraying Dithane M45.

Root rot caused by *Phytophtora capsici* is a common disease of sweet peppers. Infected plants wilt and die from rotting of the stems at the collar region and roots. The disease is severe during heavy rains and high temperatures. Control of the disease includes seed dressing, crop rotation and avoidance of over-watering in the dry season. (Obeng- Ofori *et al.,* 2007).

One of the bacterial diseases affecting pepper is the **Bacterial leaf** spot caused by *Xauthomans campestris* PV. *Vesicatoria (*X CV). The disease is destructive and is characterised by leaf spot are: regular shaped and water soaked initially turning brown later. Affected leaves tend to turn yellow and drop. Yield is reduced and scab-like spots on fruit and dropping of leaves thereby reducing productivity and exposing fruit to

formation of sunscald. (Sarath *et al.,* 2011). Control is by practising crop rotation and seed dressing before swing.

Bacterial Wilt is another bacterial disease affecting pepper and is caused by *Pseudomonas solanacearum.* The disease is a soil- borne and in general is less virulent and develops less rapidly on *Capsicum annuum* than tomato or eggplants. (Messiaen, 1994). The disease can cause the plant death (aerial part) when the plant is in full production, after 2-3 months of growth in the field. The disease can be controlled by growing resistant varieties such as *Capsicum frutescens* and *C. chinese.* Obeng - Ofori *et al.,* (2007) highlighted some virus disease of pepper including **Mosaic disease** which is spread by aphids and beetles or mechanically by handling infected plants. Infected plants are stunted, with mottled green and yellow and curled leaves.

Another virus disease is leaf curl, which is transmitted by thrips and aphids. The symptoms of the disease include distribution, wrinkling, and curling of the leaves and stunted growth.

Also pepper **mottle virus** is transmitted by aphids or mechanically and causes severe foliage and fruit abnormalities. The whole plant turns yellowish green mottled and the leaves wrinkle and curl. Sarath *et al.* (2011) also stated addition virus disease of pepper including the peanut bud necrosis virus and tomato spotted virus (tospopinises); tobacco leaf curl virus (Gemini) ; Potyvineses (transmitted by aphids) and Cucumber mosaic virus – having a greater host range.

Messiaen (1994) highlighted the control of virus disease. These include elimination of insect vectors; promp removal and destruction of disease plants especially before next to tomatoes, cucumber or sunflower fields.

Mathew and Karikari (1990) mentioned **nematode** (*Root knot*) caused by *Meloidogyne arenaria, M. Incognita* cause galls and swellings of roots; reduce plant vigour and growth and poor yield.

Apart from the pathogenic disease affecting pepper, Physiological disorders such **Sunscald** and **Blossom end rot** (sweet pepper are more susceptible than hot peppers) and fruit drop have effect on pepper production, rendering losses. (Norman, 1992)

2.14 PESTS OF PEPPER

Tweneboah (2000) indicated that pepper plant is relatively free of insect pests but the hemipteran *Acanthocoris* sp (family Coreidae) and the mirid *Helopeltis bergrothis* have been recorded on the fruits and leaves. Obeng- Ofori *et al.*, (2007) identified the following as pest that cause significant losses in pepper production. They include leat beetle, lema spp; Coreid bugs, *Acanthocoris* spp and *Cletomorpha Lancigera* Fab, Cocoa mosquito and Termites, *Odontotermes*.

Norman (1992) also mentioned crickets and Cutworms, Green aphids (*Wyzus* spp) leaf hoppers *(Empoasca* sp) as pests of pepper. Karikari and Mathew (1990) made mention of white fly as a pest of pepper. He recommended spraying with rogar (dimethoate), pirimor (pirimicarb) and Synthetic pyrethriods (eg. Cymbush and decis) as chemical for control of white fly and aphicides such dimethoate, carbofuran and formation for control of aphids.

Karikari and Mathew (1994) highlighted the following as general methods of controlling disease and pests.

1. Legislation – quarantine laws
2. Sanitation - eradication, disinfection, crop rotation.
3. Resistance –use of resistant or tolerant cultivars
4. Mechanical means –handpicking, flaming, banding
5. Biological means – by predators and parasites
6. Chemical means – by spraying, dusting
7. Integration – a combination of methods.

Dupriez and De leener (1989) indicated that when seedlings have four to six leaves; they are transplanted with roots exposed, or with a ball of soil. The plants should be spaced about 30 – 40 cm apart. However Kwarteng and Towler (1994) added that pepper can also be sown directly in the field or garden.

2.15 FARM CREDIT

Anaman (1988) reported that credit is money or assets acquired from a third party with the intention of paying back, usually with interest in order to help finance a firm. Credit is needed in the period where income is insufficient especially between growing, harvesting and storage times. Sources of fund for the farm include the farmers own savings, the extended family, financial institute, money lenders , co-operative and credit union, friends etc. Akinsanmi (1994), reported that the most important and reliable source of capital for running the farm enterprise is the farmers own savings which come out from the profit of the farm or the business and this is used to invest in the farm.

2.16 POSTHARVEST HANDLING OF PEPPER

In agriculture, postharvest handling is the stage of crop production immediately following harvest, including cooling, cleaning, sorting and packing. The instant a crop is removed from the ground, or separated from its parent plant, it begins to deteriorate. Postharvest treatment largely determines final quality, whether a crop is sold for fresh consumption, or used as an ingredient in a processed food product.

The most important goals of post-harvest handling are keeping the product cool, to avoid moisture loss and slow down undesirable chemical changes, and avoiding physical damage such as bruising, to delay spoilage sanitation is also an important factor, to reduce the possibility of pathogens that could be carried by fresh produce, for example, as residue from contaminated washing water.

http//www.usask.ca/agriculture/vegetable/resources/factsheet/postharvest/peppers.pdf. 24/08/2011 18:23

Postharvest shelf life is typically determined by objective methods that determine the overall appearance, taste, flavor, and texture of the commodity. These methods usually include a combination of sensorial, biochemical, mechanical, and colorimetric (optical) measurements.

Producers would want their vegetables to have good appearance and few visual defects; market distributors want firm, ripened produce with long shelf life. Those that look good, are firm, have good flavour and nutritive value (good eating quality) are what consumers look out for. (Grierson and Kader, 1986). Product appearance is characterized by size, shape, form, colour, condition and absence of defects. Appearance of fresh produce is

utilised throughout the production- storage- marketing – utilization chain as the primary means of judging the quality of individual units of products. (Kays, 1998).

Many growers know how to increase yields but do not pay sufficient attention to the quality of the produce, leading to low market value. Many handlers unknowingly contribute to postharvest losses by using common practices or by not using certain practices known to reduce losses and help maintain produce quality and safety. Each example above is considered an improper practice since it has definite negative effects on fresh produce, leading either to increased waste and losses, quicker quality deterioration, or food safety problems. Most of improper practices and conditions cannot be labeled "technical problems," and they cannot be solved by initiating new research projects or simply by extending existing well-proven technical information. Often, postharvest losses take time to develop, and the specific cause of quality problems may not be fully understood by produce handlers along the chain. Other times, the handler may deliberately choose not to use a practice known to protect produce because of its cost or because consumers perceive the practice as undesirable. On occasion, a lack of reliable supplies, market information, or other infrastructural problems may make changes in handling impractical. Postharvest losses and changes in quality affect both the volume and perceived value of produce as it moves from the field to its final destination market, and any changes in practices will also have an effect.

2.16.1 Factors Affecting Postharvest handling of Pepper

Production Practices: Herner (1989) indicated that production practices have a tremendous effect on the quality of vegetables at harvest and on postharvest quality and

shelf life. Environmental factors such as soil type, temperature, and rainy weather at harvest can also have adverse effect on storage life and quality.

Management practices can also affect postharvest quality. For instance excessive irrigation at the nursery can cause the build up of *Rhizoctonia* (fungus) that causes damping off disease on pepper. High rates of nitrogen, application is particularly susceptible to postharvest diseases (Anderson, 1998).

Decay in storage: Decay of fresh produce during storage is mostly caused by the infection of mechanical injuries. Furthermore, many vegetables are attacked by decay organisms which penetrate through natural openings or even the intact skin. These infections may be established during growth of plant in the field but lie dormant until after harvest, after becoming visible only during storage. (Maalekuu, 2008).

Water loss: Maalekuu (2008) stressed that high temperature and injuries to produce beyond that unavoidably lost from natural causes. Maximum storage life can be achieved by storing only undamaged produce at the lowest temperature tolerable by the crop

Harvest handling: Wilson *et al.* (1995) stated that quality a produce cannot be improved after harvest, only maintained; therefore it is important to harvest fruits and vegetables at the proper stage and size and at peak quality. Immature or over mature produce may not last long in storage as that picked at proper maturity. Harvest should be completed during the coolest time of the day, which is usually, in the early morning, and produce should be kept shade in the field. Cares should be taken to avoid bruises since rots are prevailent in fruits and vegetables that are bruised.

2.16.2 Postharvest Handling Operations and Storage Considerations

Initial post-harvest storage conditions are critical to maintaining quality. Each crop has an optimum range for storage temperature and humidity. Also, certain crops cannot be effectively stored together, as unwanted chemical interactions can result. Various methods of high-speed cooling, and sophisticated refrigerated and atmosphere-controlled environments, are employed to prolong freshness, particularly in large-scale operations.

Regardless of the scale of harvest, from domestic garden to industrialized farm, the basic principles of post-harvest handling for most crops are the same: handle with care to avoid damage (cutting, crushing, and bruising), cool immediately and maintain in cool conditions, and cull (remove damaged items).

http//www.usask.ca/agriculture/vegetable/resources/factsheet/postharvest/peppers.pdf. 24/08/2011 18:23

Temperature Management:

Temperature is the single most important factor in maintaining quality after harvest. Refrigerated storage retards the following elements of deterioration in perishable crops:

i. Aging due to ripening, softening and textual and colour changes;
ii. Undesirable metabolic changes and respiratory heat production;
iii. Moisture loss and the wilting that results;
iv. Spoilage due to invasion by micro organisms eg. bacteria, fungus and virus
v. Undesirable growth (Hardenburg, 1986)

Wilson *et al*. (1995) added that refrigeration controls the crops respiration rate. Respiration generates heat, as sugars, fats and proteins in the cells of the crop are oxidized. The loss of these food reserves through respiration means decreased food value,

loss of flavour, loss of salable weight, and more rapid deterioration. The higher the storage temperature, the higher or faster the rate of respiration (Hardenburg, 1986) added. A grower who can cool and store produce has great market flexibility because the need to market immediately after harvest is eliminated.

Pre – cooling: Pre cooling is the first step in good temperature management. The field heat of a freshly harvested produce – heat the product holds from the sun and ambient temperature – is usually high, and should be removed as quickly as possible before processing and storage (Wilson *et al.*, 1995). Maalekuu (2008) added that three days is enough for a fully insulated room, but rooms without floor insulation should be pre cooled for a week to ensure that the floor has cooled equilibrium. The longer the produce stays on the field, the faster the rate of microbial and enzymatic reaction, hence produce should be pre cooled immediately after harvesting to avoid excessive shrinkage of the produce due to unsatisfactory temperature maintenance and slow cooling. Other cooling methods employed for pepper according to USDA agric marketing service, Kandas State University Co operative extension service include the following:

Room cooling:

This involves placing the produce in an insulated room equipped with refrigeration units to chill the air. This method can be used with most commodities, but is slow compared with other options. A room used only to store previously cooled produce requires relatively small refrigeration small refrigeration unit. However, if it is used to cool produce, a larger unit is needed. Containers should be stacked so that cold air can move around them. (Hardenburg, 1986)

However, this process is slow because it relies on natural convection and radiation to remove heat. It may take more than 12 hours to cool cartons of peppers sufficiently in a cooling room. **http://www.agrichill.com/info/Info_Cooling_Peppers.pdf**

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Forced air cooling: fans are used in conjunction with a cooling room to pull cool air through packages of produce. Although the cooling rate depends on the air temperature and the rate of air flow, this method is usually 75- 90% faster than room cooling. Maalekuu (2008) stated that the method is generally sufficient for keeping produce at a low temperature once it has been cooled, but it often does not remove field heat rapidly enough to maintain quality of highly perishable crops. Fans should be equipped with thermostat that automatically shuts them off as soon as the desired product temperature is reached. An advantage of force air cooling over room cooling is that it is often more energy efficient than room cooling when large volumes of produce must be cooled.

Evaporative cooling: this involves the control of storage condition and is achieved by evaporating of water from a wet surface or medium thus keeping down the temperature of or within the medium. Evaporative cooling reduces ripening and deterioration rates thereby maintaining the physical qualities of vegetables (Kwaa, 1995) reported that this technique is best adapted to areas where temperature are high, humidity is low and air movement is good.

Chilling injury: Most vegetable store best at temperature just above freezing, while others are injured by low temperature and will store best at 45 - 55°F(7.2 – 12.78°c). Howell (1993) mentioned that pepper is moderately sensitive to chilling injury. The crop may look sound when removed from low temperature storage, but after a few days of

warmer temperatures chilling symptoms become evident: putting or other skin blemishes, internal discoloration, or failure to ripen to decay such as *Alternarnia* rot.

2.16.3 Control of Moisture Loss

Excessive water loss during storage often limits the shelf life of fruits and vegetables. Bell peppers, for instance are mostly placed in card board boxes that are stored at a relative humidity (RH) below 90%. This results mainly in precocious desiccation of the peel, shown as superficial shrivelling. Depending on the species and the storage conditions, the environment can also be too humid. Incidences of fungal diseases, such as *Botrytis* rot (Yehoshua *et al*., 1997), is common at such high RH. Byczynski (1997) holds the view that most fruits and vegetables crops retain better quality at high relative humidity (80 -95%).

In view of this, there should be a control of moisture loss in the production processes of pepper to maintain the quality.

Packaging material:

Moisture loss in fruits and vegetables of only 5% of their weight is enough to make them limp and unattractive and also become more susceptible to pathogenic attacks (Bleasdale and Salter, 1991). This implies that some form of packaging is needed to reduce moisture loss. However, the packaging material should be acceptable to the farmer, middlemen and consumer, as well as extending the shelf life of the produce and be easy to handle.

Before deciding on what packaging material to use, the producer or packaging – house operator has to consider many factors to ensure that the cost does exceed the benefits.

Factors highlighted by FAO include the following:

i. The present level of produce losses that occur during the marketing process

ii. Expected reduction of losses it packaging is improved

iii. Expected increase in income from reduction of losses

iv. Will there be a regular supply of the new packaging?

v. Is the change in packaging acceptable to the market?

After the field, post-harvest processing is usually continued in a packing house. This can be a simple shed, providing shade and running water, or a large-scale, sophisticated, mechanized facility, with conveyers' belt, automated sorting and packing stations, walk-in coolers and the like. In mechanized harvesting, processing may also begin as part of the actual harvest process, with initial cleaning and sorting performed by the harvesting machinery.

http//www.usask.ca/agriculture/vegetable/resources/factsheet/postharvest/peppers.pdf.24/08/2011 18:23

Packing may significantly reduce packing costs. However, some changes in cultural practices may be necessary. Field packing requires greater training and supervision of pickers to ensure that the peppers they pack are of consistently high quality. Field packing will work only if cooling is immediately available either in the field by means of portable refrigeration units or a nearby cooling facility.

http://www.agrichill.com/info/Info_Cooling_Peppers.pdf 18/08/2011. 12:19 pm

Polyethylene:

Water loss can be reduced by placing a physical barrier around the produce to reduce air movement actions its surface polyethylene film can be considered to be relatively good vapour barrier because of their low rate of water transfer (Wills *et al.*, 1991).

One of the mostly used plastics and film is the low density polyethylene (LDPE) bags. It has used to improve the shelf life of some fruits and vegetables which significantly, reduces moisture loss and maintain overall customer demand or acceptance (Efiuwevwere and Uwanugho, 1990).

2.16.4 Sorting

It is defined as the separation of raw materials and food into categories on the basis of shapes, size, weight, image and colour. Sorting is carried out in vegetables before sending them to the market because most of the raw materials contain some components which are inedible or have variable characteristics. It is done to achieve the requirement uniformity for processing or for direct fresh vegetables and fruits sale to consumer. Sorting allows the separation at first sight of some (undesirable) additional materials such as stones and leaves or inappropriate raw materials and aims at ensuring that only good quality fruit is preserved and passed through for further processing. (**www.hyfoma.com/en/content/processing... 26/08/2011 9:46 pm).** For size sorting, various types of screens and sieves with fixed or variable apertures, can be used. The screens may be stationary, or rotating or vibrating.

Shape sorting can be accompanied manually or mechanically with, for example a belt-or-roller sorter.

Image processing is used to sort foods on the basis of length, diameter, and appearance, ie surface defects and orientation of food in a conveyor. Colour sorting can be applied at high rates using microprocessor controlled colour sorters.

2.16.5 Grading

Grading is the assessment of a number of characteristics of a food to obtain an indication of its overall quality. Grading of food is based on laboratory analyses results. Many characteristic cannot be examined automatically and trained operators are employed to simultaneously assess several characteristics in order to produce a uniform high-quality product. (**www.hyfoma.com/en/content/processing...23/08/2011 12:20 pm)**

In some cases the crop weeds to be grade, e.g. high quality packaged product. Pepper is grade by size, colour and relatively density. Colour grading will have to be done by hand. Machines can be bought or made that will grade the pepper according to its size or relative density. However, a trained person with a winnowing basket is more appropriate for small scale production.

2.16.7 Cleaning

The major problem for the export or pepper by small scale farmers is the production of a sufficiently clean product. The first step is to remove dust, dirt and stones using a winnowing basket. This can be done in the same way as for rice. The winnowing method can clean over 100kg of pepper in an eight –hour day.

After winnowing the crop needs to be washed in water, for quantities of up to 50kg a day. For larger quantities a 1m sink/basin with a plug hole needs to be constructed by using

concrete. However the water must be changed regularly to avoid recontamination by dirty water **(en.how topedia.org/wiki/How to process pepper)**

2.16.8 Transportation of pepper

Transportation is often the most important factor in the marketing of fresh produce. Ideally, transport would take produce from the grower directly to the consumer, as in many developing countries. In complex marketing systems (serving towns, cities or distant countries) the cost of transport contributes significantly to the price paid by the consumer, and sometimes exceeds the value of the raw produce. (Maalekuu and Appiah, 2010)

Losses directly attributed to transport can be high, particularly in developing countries. Damage occurs as a result of careless handling of packed produce during loading and unloading; vibration (shaking) of the vehicle, especially on bad roads; and poor stowage, with packages often squeezed in to the vehicle in order to maximize revenue for the transporters. Overheating leads to decay, and increases the rate of water loss. In transport it can result from using closed vehicles with no ventilation; stacking patterns that block the movement of air; and using vehicles that provide no protection from the sun. Breakdowns of vehicles can be a significant cause of losses in some countries, as perishable produce can be left exposed to the sun for a day or more while repairs are carried out. Produce should be kept in the best possible conditions during transport and that the haulage of produce be quick and efficient, hence produce should be properly packaged and loaded on a suitable vehicle.

Causes of loss during non-refrigerated transport include mechanical damage and by over heating.

Mechanical Damage:

Examples of mechanical damage include:

i. Packages stacked too high
ii. The movement of produce within a package increases in relation to height in the stack
iii. Vibration(shaking) of the vehicle, especially on bad roads
iv. Fast driving and poor condition of the vehicle.
v. Careless handling of packed produce during loading unloading.

Overheating

i. It can be from (External sources but also from heat generated by the produce within the package itself. Instances include
ii. The use of closed vehicles without ventilation
iii. Exposure to the sun while awaiting transport or whole trucks are queuing to unload at their destination.
iv. Close –stow (load) stacking patterns, blocking the movement of air between and through packages, thus hindering the heat dispersal (Maalekuu and Appiah, 2010).

2.16.9 Marketing of pepper

Pepper has a ready market in the country all the year round, especially in the dry season. Pepper has also gained an international market hence export - potential. Norman (1992)

indicated that, sweet peppers are grown in West Africa for both local consumption and export. Togo, Ghana and Senegal export substantial qualities to Europe. Chili peppers have been widely produced in Ghana for local consumption but have been increasingly exported to the European market in accordance with the development of Legon 18 in recent years.

Currently, Ghana is the fifth largest exporter of chili peppers to the European Union, where the demand for chili peppers has been growing annually by 17 percent on average since the year 2000. Ghanaian chili peppers have a good reputation in the European markets compared with chili peppers from other countries. Legon 18, in particular, has a great taste and a longer shelf life. Additionally, Bird's Eye chili represents a new and growing opportunity for higher values chili export.

(www.mcc.gov/documents/investmenttopps/bom-ghana-english-chili-pdf)

The most propitious period for export of sweet peppers is during the winter months from early November till March, it is therefore seen for export purposes, large scale production should start early September.

Table 2.2 World Chili and Bell pepper production (in tonnes)

Country	2004	2005	2006	2007
China	12,031,031	12,530,180	13,031,000	14,033,000
Mexico	1,431,258	1,617,264	1,681,277	1,690,000
Indonesia	1,100,514	1,058,023	1,100,000	1,100,000
Turkey	1,700,000	1,829,000	1,842,175	1,090,921
Spain	1,077,025	1,063,501	1,074,100	1,065,000
United States	978,890	959,070	998,210	855,870
Nigeria	720,000	721,000	721,500	723,000
Egypt	467,433	460,000	470,000	475,000
Ghana	270,000	270,000	277,000	279,000
Algeria	265,307	248,614	275,888	233,000
Hungary	126,133	113,371	206,419	207,000
Morocco	182,340	190,480	235,570	192,000
Serbia	159,741	167,477	177,255	150,257
Japan	153,400	154,000	146,900	150,000
Israel	129,100	134,700	150,677	136,000
World	24,587,124	25,261,259	26,252,907	26,056,900

Source**: USDA 2011**

In relation to postharvest consideration, the retail, marketing stage losses can be significant, particularly in poorer countries. Poor-quality markets often provide little protection for the produce against the elements, leading to rapid produce deterioration. Sorting of produce to separate the saleable from the unsalable can result in high percentages being discarded, and there can be high weight loss from the trimming of leafy vegetables.

2.16.10 Controlled Atmosphere Storage

This method is combined with refrigeration, markedly retards respiratory activity and delays softening, quality changes and other breakdown processes by maintaining an atmosphere with more Carbon dioxide (CO_2) and less Oxygen (O_2) than in normal air (Karikari and Mathew, 1995).

Controlled atmosphere (CA) storage involves altering and maintaining an atmospheric composition that is different from air composition (78% N, 21%O and 0.003% CO); generally O_2 below 8% and CO_2 above 1% is used. Atmospheric modification should be considered as a supplement to maintenance of optimum ranges of temperature and relative humidity for produce in preserving quality and safety of fresh fruits and vegetables and their products throughout postharvest handling. The exposure of fresh produce to low O_2 and/ or elevated CO_2 atmospheres within the range tolerated by the produce reduces their respiration and ethylene production rates; however, outside this range respiration and ethylene production rates can be stimulated indication a stress response. The stress contributes to contribute to incidence of physiological disorders and increased susceptibility to decay. (**www.bq.ars.usda.gov/hb66/0.13ca.pdf 27/07 /2011 2:30 pm)**.

Commercial application of CA include creating nitrogen by separation from compressed air using molecular sieve beds or membrane systems, low O_2 (1.0 to 1.5%) storage, low ethylene (<l, µLL) CA storage; rapid CA (rapid establishments of optimal levels of O and CO_2 and programmed) CA storage, eg. storage in 1%O for 2-6 weeks followed by storage in 2 to 3 % O_2 for the remainder of the storage period.

Beneficial Effects of CA (optimum composition for the commodity);

i. Retardation of senescence (ripening) and associated biochemical and philological changes.
ii. Reduction of sensitivity to ethylene action at O_2 levels <8% and/ or CO_2 level >1 %
iii. Low O_2 (< 1%) and/ or elevate CO_2 (40 to 60 % serves as a tool for insect control in vegetables.
iv. Inhibition of the development of postharvest pathogens (bacteria and fungi).
v. Detrimental effects of CA (above or below optimum composition)
vi. Increased susceptibility to decay when the fruits are physiologically injured too-low O_2 or too – high CO_2 concentration.
vii. Initiation of certain physiological disorders.
viii. Development of off- odours at low O_2 concentration (as a result of anaerobic respiration) and very high CO_2 levels.

2.16.11 Control of Ethylene

Ethylene gas ($H_2C = CH_2$) is an odourless, colourless gas that has gained a lot of attention in the produce industry the last few years. Ethylene may be produced from natural sources, plant and plant products (i.e. fruits and vegetables), or from man-made sources such as combustion. (**http://www/4theeg.com/ethylene_story**)

Ethylene promotes ripening, aging or senescence and rotting as they are produced from vegetables and fruits. Pepper is sensitive to ethylene; as a result, there is the need to control ethylene so that the shelf-life of it could be extended. The old adage that one bad apple spoils the whole bushel is true. Diseased or bruised fruits should be removed since bruised accelerate respiration and deterioration. It is therefore a necessary not to mix up loads especially the climacterics and non-climacterics. Control is by removing ripe or rotting fruits from storage and handling area; increasing ventilation rate of the storage area. **(http://attra.ncat.org/..postharvest.html06/07/2011 2;22 PM)**

Peppers are sensitive to the natural ripening hormone ethylene, a colorless and odorless gas produced as a natural byproduct of ripening by some fruits and vegetables. The presence of even minute quantities can hasten ripening. The combination of high temperatures and ethylene can increase the ripening rate twentyfold or more. Thus, ethylene producing crops such as apples, pears, and tomatoes should never be stored or shipped with peppers (**http://www.agrichill.com/info/Info_Cooling_Peppers.pdf 18/08/2011. 12:19 pm)**

Chemical control of ethylene include the use of potassium permanganate (traditional) $KMnO_3$ + ethylene = CO_2 +H_2O. This should be spread over a large area. (Maalekuu and Appiah, 2010). Through the proper control of ethylene gas in the storage environment or

atmosphere, the produce industry can deliver their product to the grocery at its peak of goodness.

2.17 Avoiding loss

Losses can be avoided by following good practices as indicated above. There is also a wide range of post-harvest technologies that can be adopted to improve losses throughout the process of pre-harvest, harvest, cooling, temporary storage, transport, handling and market distribution. Recommended technologies vary depending on the type of loss experienced. However, all interventions must meet the principle of cost-effectiveness.

CHAPTER THREE

3.0 METHODOLOGY

3.1 THE STUDY AREA

The Upper Manya Krobo District is one of the twenty-one districts in the Eastern Region of Ghana. It was carved out of the then Manya Krobo District in February, 2008 by Legislative Instrument 1842 in pursuance of the Government's Decentralization policy with its capital as Asesewa. The district capital, Asesewa is about 45 minutes (forty km) drive from Koforidua which is the regional capital of Eastern Region.

The district shares common boundaries with the following districts;

To the North	-	Afram Plains District
To the South	-	Lower Manya Krobo and Yilo Districts
To the East	-	Asougyaman District
To the West	-	Fanteakwa District

The district covers an area of 885 square kilometers constituting about 4.8% of the total land area within the region (18,310km). The 2000 population and Housing Census indicates a population size of 154,301 for the then Manya Krobo District. This comprises 76,070 males (49.3%) and 78,231 females (50.7%)**(mofa.gov.gh›home›Districts-Eastern Region)**

The economy of the district is agricultural based. Apart from farming, the inhabitants are also engaged in petty trading and draughtsmanship (carpentry, masonry etc) to augment

their incomes. About 80% of the population is engaged in farming and the main crops cultivated include oil palm, maize, vegetables (pepper, tomato, garden eggs etc) as well as cassava. Livestock reared in this locality include cattle and small ruminants (goats, sheep), pigs, and poultry (basically local fowls)

3.1.1 Ethnicity and Religion

The district population is made up of various ethnic groups having different religious background(Table 3.1)

Table 3.1 Ethnicity and Religion Composition

ETHNICITY	PERCENTAGE (%)	RELIGION	PERCENTAGE (%)
Krobos	70.5%	Christians	76.4%
Ewes	18.2%	Muslims	17.5%
Akans	7.7%	Traditionalist	6.1%
Others	3.6%	-	-
TOTAL	**100**	**-**	**100**

Source: Manya Krobo District Medium Term Development Plan (2006-2009)

3.1.2 Relief and Drainage

The topography of the district can be generally described as undulating. The highest point in the district is over 660 meters above sea level located in the southern part of Sekesua. The lowest area which is located in the south- eastern part of the district is about 50 meters above sea level. The average height of the land is about 452 meters above sea level. Underlying these landmasses are several rocks or parent rocks from which several

rocks have developed. Some of the hills are capped with mineral which can be tapped to generate employment and help in the overall development of the district.

The district is drained with several rivers such as the Volta, Dawado and Anyaboni. With the exception of the Volta River, almost all these rivers are seasonal with most of them overflowing their banks during the rainy season**(mofa.gov.gh›home›Districts-Eastern Region)**

3.1.3 Climate

The district lies within the semi-equatorial climate belt with a mean annual rainfall ranging between 900mm to 11,500mm. Relative humidity is high during the wet season, between 70% and 80% and low in the dry season with about 55% to 60%. The district experiences two major seasons, namely Dry and Wet seasons. April to early August as well as September to October are the wet seasons whereas the dry and warm season is experienced from November to March. Temperatures are generally high with average temperatures ranging between 26^0C to 32^0C.

The district falls under the influence of two winds: the wet southwest monsoon winds which blow across the district from the Atlantic Ocean between March and July and the North-eastern trade winds (Harmattan) from the Sahara Desert which blows between November and early March.

The pattern of temperature, winds, and rainfall distribution in the district present a climate that is conducive for agricultural production throughout the year **(mofa.gov.gh›home›Districts-Eastern Region)**

3.1.4 Vegetation and Soils

The district lies within the semi-deciduous forest and savanna zone with the former being divided into 'Fire' and 'inner' zones. The fire zone (dry semi-deciduous) stretches from Yolo Krobo District. Trees commonly found on such vegetation are the Palm, Mango Ceiba, Neem and Acacia. The inner zone has in abundance trees such as Acasia, Neem and Ceiba.

The predominant soils in the area can be divided into two major groups. These are;

Soils developed over sandstone (Yaya-Pimpimso-Bejna association). This group is the predominant soils in the district. They stretch from the northern part of the district through Asesewa to Otrokper. With suitable drainage, the soils are considered good for the cultivation of rice, sugarcane and vegetables.

Soils developed over Buem Series such as shales and mudstones (Dewasi-Wayo association) are generally found around the Apimsu area. There is Wayo series which are poorly drained and are not suitable for most crops(s**mofa.gov.gh›home›Districts-Eastern Region)**

3.2 TARGET POPULATION AND SAMPLING PROCEDURE

The target population for the research covered all the large-scale producers, traders and consumers of pepper in the Upper Manya Krobo District. The district consists of four agricultural production zones namely, Asesewa, Anyabony, Sekesua and Sisiamang. In all hundred (100) farmers were sampled for the research. Out of the 100, fifteen (15) farmers were selected randomly from each of the four zones covering all the operational areas where pepper production is prominent totalling sixty (60) farmers. Also twenty

traders and twenty consumers comprising fast food operators and chop bars (restaurants) within the locality were randomly sampled for the research.

3.3 Data Collection

The main instrument for data collection was questionnaire backed by an interview. In all about 45 (forty five) questions were constructed. In the construction of the questionnaire, issues like biodata of the farmers, varieties of pepper under cultivation, cultural practices adopted for production harvesting and storage were taken into consideration. Most of the questions contained in the questionnaire were the close ended type while few of them were open ended questions.

3.4 Reliability and Validity of Questionnaire

In the construction of the questions, care was taken to meet the objectives of the study To ensure reliability and validity the questionnaire will was given to the research supervisor(Prof. P.Y. Boateng) for scrutiny and offered suggestions after which it was tested on twenty (20) farmers randomly selected in the Birim Central Municipality. Results obtained were satisfactory and it was indicative of the readiness of the questionnaire for execution in the next stage of the research.

3.5 Questionnaire Administration

Questionnaire was administered to producers, traders and consumers of pepper in the four agricultural production zones by researcher and extension agents of Ministry of Food and Agriculture (MOFA) in the Upper Manya Krobo District. The researcher collected the

questionnaires back through the extension officers after the respondents had finished answering the questions.

3.6 Statistical Analysis

The data obtained from the survey were analysed with the use of analytical package - Statistical Package for the Social Scientist (SPSS). The results were presented as frequencies, pie charts and graphs.

CHAPTER FOUR

4.0 RESULTS

This chapter seeks to analyze the results gathered through the use of questionnaire on the field on production and postharvest handling of pepper.

4.1 BIODATA OF RESPONDENTS

4.1.1 Gender distribution

Table 4.1 reveals that out of the hundred (100) sampled for the study forty three (43) and seventeen (17) for male and female respectively, representing 71.7% and 28.3%, respectively. Also three males (3) forming 15% and seventeen females representing 85% were traders. Furthermore, six (6) males and fourteen (14) females were consumers representing 30% and 70%, respectively.

Table 4.1: Gender distribution

Sex	Producers		Traders		Consumer	
	Freq.	**Percentage (%)**	**Freq.**	**Percentage (%)**	**Freq.**	**Percentage (%)**
Male	43	71.7	3	15.0	6	30.0
Female	17	28.3	17	85.0	14	70.0
Total	**60**	**100.0**	**20**	**100.0**	**20**	**100.0**

Source: Field Survey 2011

4.1.2 Age distribution

From the Table 4.2, thirty(30) out of sixty (60) sampled (50%) for producers were of ages above forty one (41), while ten (10) out of twenty representing 50% of traders, eleven (11) out of twenty (20) consumers were of ages between 21 – 30 years, representing 55%.

Table 4.2: Age distribution

Age	Producers		Traders		Consumer	
	Freq.	**Percentage (%)**	**Freq.**	**Percentage (%)**	**Freq.**	**Percentage (%)**
21-30 years	10	16.7	8	40.0	11	55.0
31-40 years	20	33.3	2	10.0	6	30.0
41years and above	30	50.0	10	50.0	3	15.0
Total	**60**	**100.0**	**20**	**100.0**	**20**	**100.0**

Source: Field Survey 2011

4.1.3 Family size

In the case of the producers, thirty (30) representing 50% had their family size between 4 and 7; nine (9) representing 45% of the traders had their family size above seven (7) and thirteen (13) that is, 55% of the consumers had their family size ranging between 1 and 3(Table 4.3).

Table 4.3 Family size

Family size	Producers		Traders		Consumer	
	Freq.	Percentage (%)	Freq.	Percentage (%)	Freq.	Percentage (%)
Between 1-3	21	35.0	8	40.0	11	55.0
Between 4-7	30	50.0	3	15.0	8	40.0
Above 7	9	15.0	9	45.0	1	5.0
Total	**60**	**100.0**	**20**	**100.0**	**20**	**100.0**

Source: Field Survey 2011

4.1.4 Type of education received

Table 4.4 shows that forty one (41), representing 68.3%, of the producers have had access to formal education. Eleven (11), representing 55% of the traders had formal education while 45% had informal education. Eighteen (18) of the consumers, representing 90% have had formal education with only 10% with informal education.

Table 4.4: Type of education received

Type of Education Received	Producers		Traders		Consumer	
	Freq.	Percentage (%)	Freq.	Percentage (%)	Freq.	Percentage (%)
Formal Education	41	68.3	11	55.0	18	90.0
Informal Education	9	15.0	9	45.0	2	10.0
Non-Formal Education	10	16.7	-	-	-	-
Total	**60**	**100.0**	**20**	**100.0**	**20**	**100.0**

Source: Field Survey 2011

4.1.5 Level of education received by respondents

Table 4.5 reveals that fourteen (14) producers, representing 23.3%, had completed JHS/JSS while 16.7%, 21.7%, 5% and 1.7% had completed Primary education, Middle School Leaving Certificate, Secondary and tertiary education respectively. In the case of the , six (6) representing 30% had M.L.S.C while five (5) representing 25% of the consumers had completed Junior High School (JHS) and 15% each for primary education and MSLC.

Table 4.5: Level of education received by farmers

Level of Formal Education Received	Producers		Traders		Consumer	
	Freq.	**Percentage (%)**	**Freq.**	**Percentage (%)**	**Freq.**	**Percentage (%)**
Primary Education:	10	16.7	3	15.0	3	15.0
M.S.L.C.	13	21.7	3	15.0	6	30.0
JHS / JSS	14	23.3	5	25.0	5	25.0
Secondary	3	5.0	-	-	3	15.0
Tertiary	1	1.7	-	-	1	5.0
No formal education	19	31.7	9	45.0	2	10.0
Total	**60**	**100.0**	**20**	**100.0**	**20**	**100.0**

Source: Field Survey 2011

4.1.6 Main occupation of respondents

Fifty five (55) people forming 91.7% of the producers are in full time farming business while others such as traders (2) civil servants (1), tractor operator (1), artisan (1) are engaged in farming as their second occupation. In the case of the traders, all the twenty

(20) representing 100% trade in pepper and thirteen (13), representing 65%, of the consumers are into trading while 1, 4 and 2 consumers are in farming, civil service and food vendor business respectively (Table 4.6).

Table 4.6: Main occupation of respondents

Main Occupation	Producers		Traders		Consumers	
	Freq.	Percentage (%)	Freq.	Percentage (%)	Freq.	Percentage (%)
Farming	55	91.7	-	-	1	5.0
Trading	2	3.3	20	100.0	13	65.0
Civil Servant	1	1.7	-	-	4	20.0
Tractor operator	1	1.7	-	-	-	-
Artisan	1	1.7	-	-	-	-
Food Vender	-	-	-	-	2	10.0
Total	**60**	**100.0**	**20**	**100.0**	**20**	**100.0**

Source: Field Survey 2011

4.1.7: **Duration into farming business**.

Figure 1 indicates that out of the sixty (60) respondents sampled for the study, 21 representing 35%, have spent less than ten (10) years in farming while twenty (20) representing 33.3%, have spent eleven to twenty (11-20) years in farming and nineteen (19) representing 31.7%, have also spent more than twenty years in the farming enterprise.

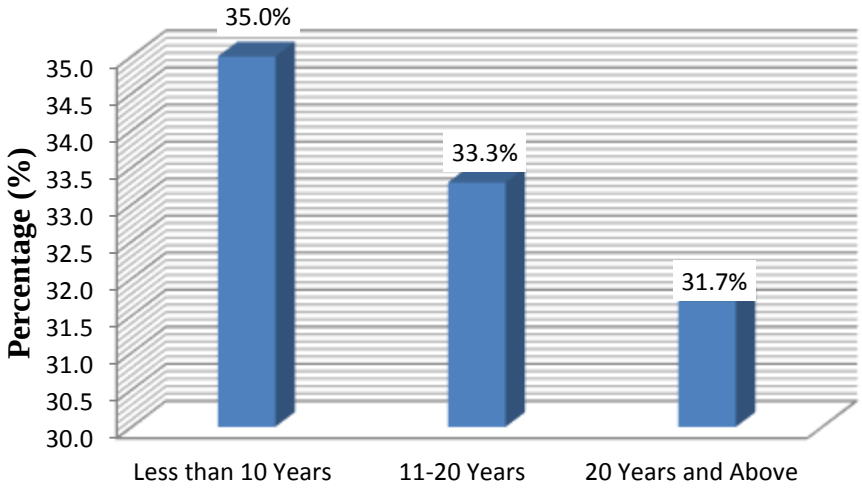


Figure 1 Duration Into Farming Business

4.2 PRODUCERS

4.2.1 Species of pepper cultivated

Table 4.7 reveals that the commonly grown species of pepper is the Legon 18 (58.3%) followed by Scotch Bonnet (41.7%) and sweet pepper, (8.3% ranking)

Table 4.7: Species of Pepper Cultivated.

Rank	Legon 18	Scotch Bonnet	Sweet Pepper
1	35 (58.3%)	25 (41.7%)	-
2	5 (8.3%)	21 (35.0%)	5 (8.3%)
3	-	2 (3.3%)	4 (6.7%)
No ranking	20 (33.3%)	12 (20.0%)	51 (85.0%)
Total	60 (100.0%)	60 (100.0%)	60 (100.0%)

Source: Field Survey 2011

4.2.2: Reasons for cultivation of species

Table 4.8 indicates that a number of reasons were given by the respondents for growing pepper. Sixty (60) representing 100%, reported that, they cultivated the species ranked for sale on commercial basis. In addition to that fifty four (54) and forty eight (48) reported that they cultivate the specie for consumption due to the long harvesting period.

Table4.8: Reason for cultivation of species

Reason	Frequency
For consumption	54
You can harvest over a longer time	48
The specie most cultivated in the area	45
Shows more resistance to diseases	14
For sale on commercial basis	60
Early maturity and bear fruits early	33
More durable/Does not spoil easily after harvesting	23

Source: Field Survey 2011

4.2.3 Sources of planting materials

Table 4.9 shows that twenty two (22) out of sixty (60) mentioned agro-chemical stores as a source of obtaining their planting materials while 28 and 24 out of 60 respondents each obtained their planting materials from friend and personal preserved seeds, respectively

Table 4.9: Source of planting materials:

How Planting Material is obtained	Frequency
Buying them from agro-chemicals	22
Friends / Relatives	28
Preserved personal materials	24

Source: Field Survey 2011

4.2.4 Sources of funds for farming

Figure 2 indicates that as many as 88.3% of the farmers sampled obtained their fund from their personal savings while 8.3 and 3.3% obtained their fund from credit unions and through grants, respectively.

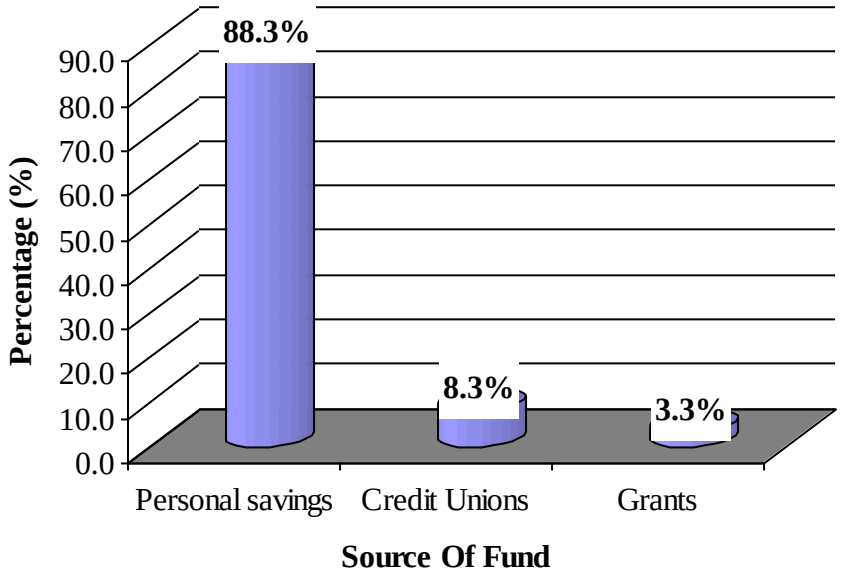


Figure 2 Sources of funds for farming

4.2.5 Methods of weed control

Table 4.10 shows that most of the farmers, that is fifty nine (59) out of sixty (60), responded that they controlled weeds manually with hoe or cutlass while eleven (11)out of 60 used herbicide or weedicide**.**

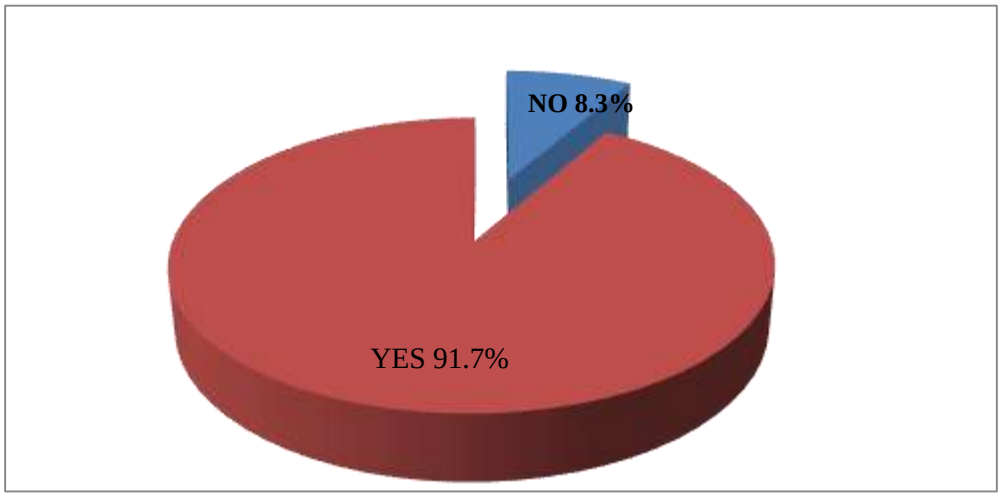
Table 4.10: Methods of weed control

Response	Frequency
Manually with hoe/cutlass	59
The use of weedicide /herbicide	11

Source: Field Survey 2011

4.2.6 Response on whether farmers experience pests and disease infestation

Figure 3 shows that 91.7% of the respondents answered in affirmative that disease and pest infestation is a serious problem in the production of pepper.



Source: Field Survey 2011

Figure 3: Response on whether farmers experience pests and disease infestation

4.2.8 Application of pesticide to control pest and disease

Table 4.11 shows that Fifty three (53) representing 88.3% of the respondents applied pesticide to control pest (insects) and disease causing organisms while seven (7) representing 11.7% did not.

Table 4.11: Application of Pesticide to control Pests and diseases

Response	Frequency	Percentage (%)
Yes	53	88.3
No	7	11.7
Total	**60**	**100.0**

Source: Field Survey 2011

4.2.9 Response on the type insecticide/pesticide

A wide range of pesticides were mentioned by the respondents. Table 4.12 shows that the most common pesticides used by farmers included Dursban and Kombat constituting (21.7%) top cop, (11.7%), Termex (3.3%), and Pawa and Champion (3.3%).

Table 4.12: Response on the type of insecticide/pesticide used

Type Of Pesticide	Frequency	Percentage (%)
Dursban	13	21.7
Kombat	13	21.7
Cydim super	3	5.0
Decis and Delta paz	3	5.0
Topsin	1	1.7
Cymethoate	1	1.7
Karate and Koside	5	8.3
Funguran	3	5.0
Pawa and Champion	2	3.3
Termex	2	3.3
Top cop	7	11.7
No application of pesticide	7	11.7
Total	**60**	**100.0**

Source: Field Survey 2011

4.2.9 Reasons why farmers don't apply pesticide

Table 4.13 indicates that out of the seven (7) respondents representing 11.7%, 6.7% reported of financial constraints as a reason why they don't apply the pesticide while 1.7% reported of not receiving education from extension officers as to the type of insecticide to use and inadequate spraying culture.

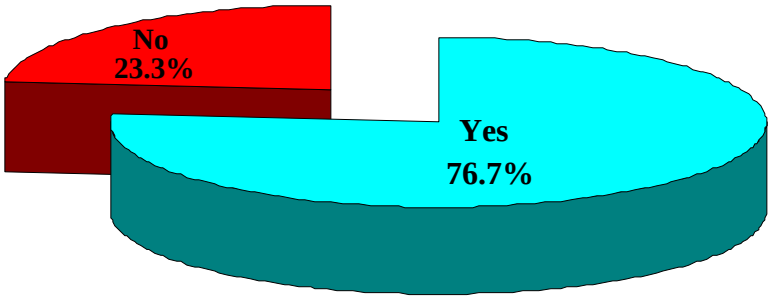
Table 4.13 Reasons why farmers don't apply pesticide

Reason	Frequency	Percentage (%)
Financial constraints	4	6.7
Lack of spraying culture	1	1.7
Intercropped with maize	1	1.7
Did not receive education from exension officers	1	1.7
No application of pesticide	53	88.3
Total	**60**	**100.0**

Source: Field Survey 2011

4.2.10 Response on whether farmers apply inorganic fertilizer

Figure 4 reveals that 76.7% apply inorganic fertilizer in production while 23.3% did not.



Source: Field Survey 2011

Figure 4: Response on whether farmers apply inorganic fertilizer

4.2.11 Type of fertilizer applied

Table 4.14 reveals that 48.3% used N.P.K 15:15:15 fertilizer 13.3%, 8.3% and 1.7% applied algua, ammonia and Sidalco 1990, respectively.

Table 4.14 Type of fertilizer applied

Type of Fertilizer	Frequency	Percentage (%)
NPK, 15:15:15	29	48.3
Sidalco, 1990	1	1.7
Algua	8	13.3
Million More	3	5.0
Amonia	5	8.3
No application of fertilizer	14	23.3
Total	**60**	**100.0**

Source: Field Survey 2011

4.2.12 Reasons for fertilizer application

Information gathered (Table 4.15) indicates that forty six (46) out of the sixty (60) respondents reported that the main reason for application of fertilizer is to increase yield or production; while 11 out of 60 indicated that they applied the fertilizer to improve the yield.

Table 4.15: Reason for fertilizer application

Reason for Application of Fertilizer	Frequency
To increase the yield	46
To improve the appearance	11

Source: Field Survey 2011

4.2.13 Response on whether farmers practice irrigation or not

Figure 5 indicates that as many as 75% of the respondents do not irrigate their crops while only 25% of the respondents practice irrigation

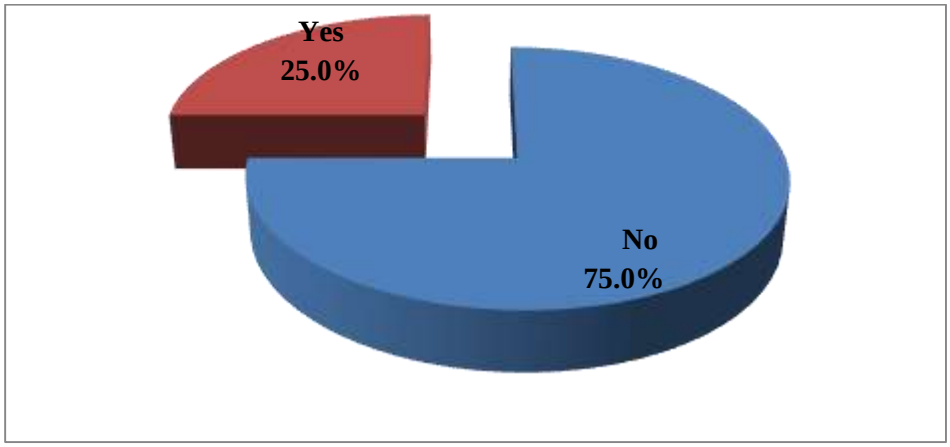


Figure 5: Response on whether farmers practice irrigation or not

4.2.14 Reasons for irrigation

Table 4.16 indicates that ten (10) representing 16.7% of the 15 farmers irrigated their farms due to the unreliable rainfall pattern while the remain five (5) representing 8.3% indicated that they irrigated for optimum production.

Table 4.16: Reasons for irrigation:

Reason for Irrigation of Crop	Frequency	Percentage (%)
Due to unreliable rainfall pattern	10	16.7
For optimum production	5	8.3
No practicing of irrigation	45	75.0
Total	**60**	**100.0**

4.2.15 Source of Water for Irrigation

Table 4.17 shows that one (1) out of the 15 who practiced irrigation stated that he obtain his water for irrigation through the municipal water; eight (8) representing 13.3% also obtained their water from the Volta lake, while five (5) representing 8.3% obtained their water from the streams and rivers.

Table 4.17: Source of water for irrigation:

Source of Water	Frequency	Percentage (%)
Municipal water	1	1.7
Streams	8	13.3
From the Volta Lake	5	8.3
Wells	1	1.7
No practicing of irrigation	45	75.0
Total	**60**	**100.0**

Source: Field Survey 2011

4.2.16 Time of day of harvest of produce

Figure 6 show that 51.7% harvested their produce in the morning. Also 13.3% harvested their produce in the afternoon; 81.3% harvested in the evening, prior to the next morning to the market while 16.7% harvested based on demand.

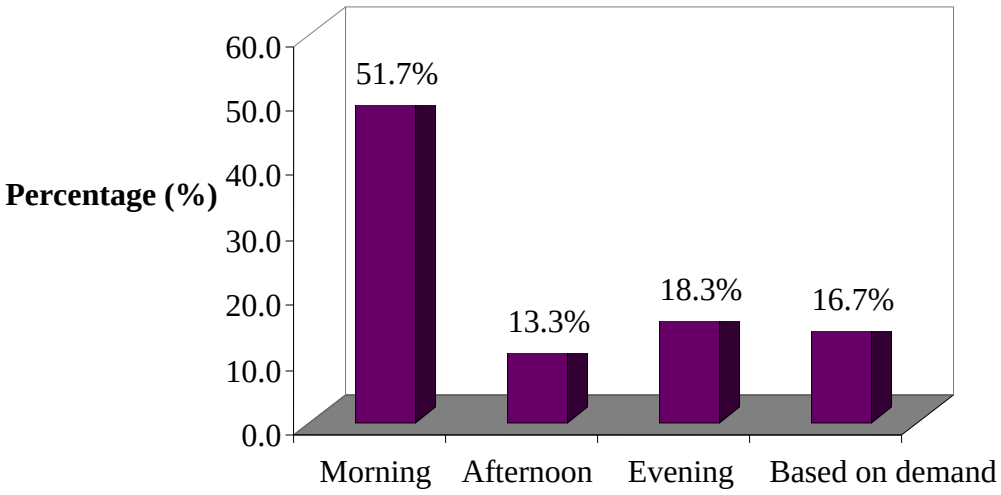


Figure 6 Time of day of harvest of produce

4.2.17 Stage of maturity for harvesting pepper

Table 4.18 indicates by ranking that 37 out of the 60 respondents (producers) harvested their produce when fully ripe. Also 31 out of the 60 respondents stated that, they harvested their produce when green, while 12 did so when the fruits were half-ripe.

Table 4.18 Stage of maturity for harvesting pepper:

Stage of Harvest	Frequency
Half ripe	12
Fully ripe	37
Green(depending on the variety)	31

Source: Field Survey 2011

4.2.18 Response on whether farmers experience bruises on their produce after harvesting

Out of the 60 respondents (100%), 58.3% stated that they encounter bruises on their produce while 41.7% stated no implying that they have their produce in a very good state. This is illustrated in Table 4.19.

Table 4.19 Response on whether farmers encounter bruises after harvesting:

Response	Frequency	Percentage (%)
Yes	35	58.3
No	25	41.7
Total	**60**	**100.0**

Source: Field Survey 2011

4.2.19 Causes of bruises experienced

Table 4.20 illustrates that 30 respondents representing 50% attributed the bruises to insect attack and this might be due to the failure of some of the farmers to apply pesticide to their crops. Five (5) representing 8.3% also attributed the bruises to infestation due to poor harvest handling.

Table 4.20 Causes of the bruises experienced:

Cause of bruises	Frequency	Percentage (%)
Insect attack	34	56.7
Infestation and lack of proper handling during harvesting	1	1.7
Those who don't experience bruises.	25	41.7
Total	**60**	**100.0**

Source: Field Survey 2011

4.2.20 Response on whether producers do pre-cooling after harvesting:

Table 4.21 indicates that 63.3% pre-cooled their produce while 36.7% did not pre-cool their produce.

Table 4.21: Response on whether producers do pre-cooling after harvesting:

Response	Frequency	Percentage (%)
Yes	38	63.3
No	22	36.7
Total	**60**	**100.0**

Source: Field Survey 201

4.2.21 Place for pre-cooling produce:

Table 4.22 reveals that all the 38 respondents representing 63.3% pre-cooled their produce under shade on the farm.

Table 4.22 Place for pre-cooling produce:

Pre-cooling Place	Frequency	Percentage (%)
Under shade	38	63.3
No pre-cooling	22	36.7
Total	**60**	**100.0**

4.1.13 Source: Field Survey 2011

4.3 MARKETING OF PEPPER

4.3.1 Means of Transport of Pepper to the Market

Table 4.23 indicates that seven (7) representing thirty five 35% of the sample size transport their produce to the market, especially, the assembling point by walking. Ten (10) representing 50% also transported their produce to the market by commercial vehicles or by taxis while only three (3) representing 15% transported their produce by carting with 'trucks' pushers.

Table 4.23 Means of Transport of pepper to the Market.

Means of Transport	Frequency	Percentage (%)
Walking(head load)	7	35.0
Public / Commercial vehicle/Taxi	10	50.0
Carting	3	15.0
Total	**20**	**100.0**

Source: Field Survey 2011

4.3.2Packaging material of pepper for transport

Table 4.24 shows that eight (8) representing 40% of the marketers used sacks as packaging material for the pepper while twelve (12) representing 60% used basket as packaging materials.

Table 4.24 Packaging material of pepper for transport

Package	Frequency	Percentage (%)
In sacks	8	40.0
Baskets	12	60.0
Total	**20**	**100.0**

Source: Field Survey 2011

4.3.3 Place of selling pepper

Table 4.25 reveals that fifteen (15) traders indicated that they sell their produce in the market within the locality while five (5) forming 25% of the marketers did hawking as a way of selling their produce.

Table 4.25 Place of Selling the Pepper:

Selling Place	Frequency	Percentage (%)
Market within locality	15	75.0
NA	5	25.0
Total	**20**	**100.0**

Source: Field Survey 2011

4.3.4 Display of produce for sale

Table 4.26 indicates that nine (9) forming 45% of the marketers in the district display their produce on trays in the sun; four (4) representing 20% also display their produce in small-size baskets and seven (7) representing 35% also display their produce in transparent polyethylene bags in the sun, especially, the hawkers.

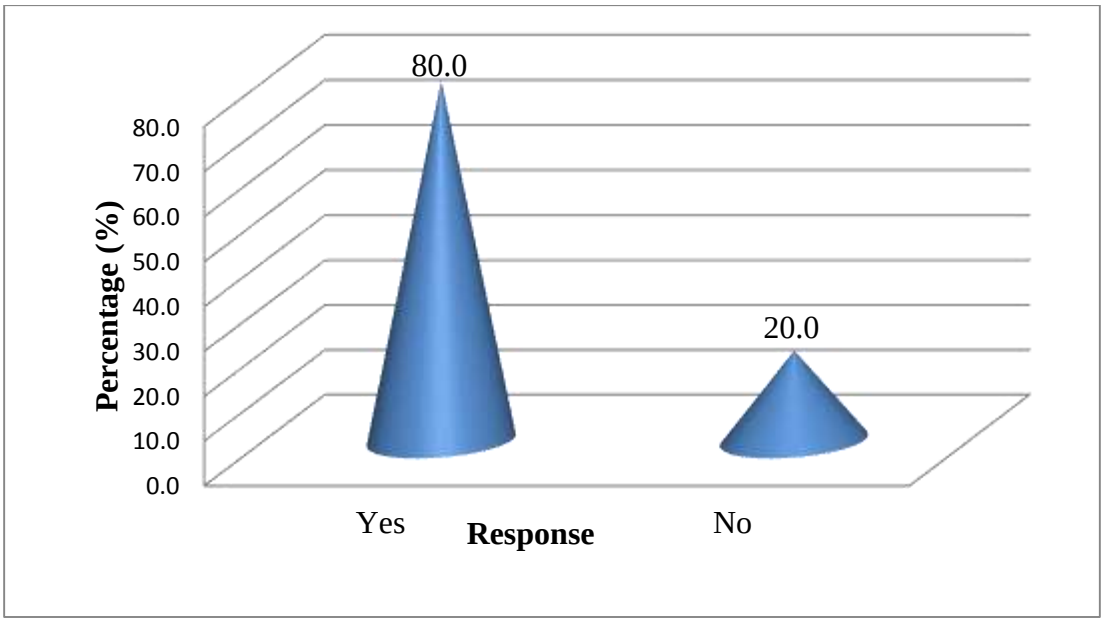
Table 4.26 Display of Produce for Sale:

How Produce is Displayed	Frequency	Percentage (%)
On trays in the sun	9	45.0
Baskets	4	20.0
Polythene(Transparent)	7	35.0
Total	**20**	**100.0**

Source: Field Survey 2011

4.3.5 Response on whether traders sort their produce or not

Figure 7 indicates that 80% of the respondents sorted their produce for obvious reasons while 20% of the traders don't perform any sorting operations.



Source: Field Survey 2011

Figure 7 Response on whether Traders sort their produce or not

4.3.6 Reasons for Sorting

Table 4.27 indicates that seven (7) representing 35% of the respondents sort their produce based on fruit size; six (6) representing 30% sorted their produce based on ripeness while three (3) representing 15% sorted their produce based in fruit uniformity.

Table 4.27 Reasons for Sorting

Reason for Sorting	Frequency	Percentage (%)
Sorting based on fruit sizes	7	35.0
Sorting based on ripeness	6	30.0
Sorting based on fruit deformity	3	15.0
No sorting	4	20.0
Total	**20**	**100.0**

Source: Field Survey 2011

4.3.7 Problems facing traders

Table 4.28 indicates that 80% of the respondents ranked rotting as the main problem in pepper production.

Table 4.28: Nature of problems facing traders

Rank	Rotten	Lost of income
1	16 (80.0%)	4 (20.0%)
2	4 (20.0%)	9 (45.0%)
3	-	-
No ranking	-	7 (35.0%)
Total	**(100.0%)**	**(100.0%**

Source: Field Survey 2011

4.3.8 Storage of excess produce

From table 4.29, 40% of the respondents stored their excess produce in room on the cold floor while 60% stored their produce in basket in cool and dry room.

Table 4.29 Storage of Excess Produce

Storage	Frequency	Percentage (%)
In cool room on floor	8	40.0
In baskets in cool and dry room	12	60.0
Total	**20**	**100.0**

Source: Field Survey 2011

4.3.9 Traders intention to switch from the sale of pepper to other vegetables

Results from the table 4.30 reveals that only 15% (3 of the respondents) want to switch from the sale of pepper to other vegetable crops due to problems they encountered while as much as 85% had are willing to stay in the pepper marketing business.

Table 4.30 Traders intention to switch from the sale of pepper to other vegetables

Response	Frequency	Percentage (%)
Yes	3	10.0
No	17	90.0
Total	**20**	**100.0**

Source: Field Survey 2011

4.0 CONSUMERS

4.4.1 Species of pepper consumed most

Table 4.31 illustrates that out of the twenty (20) respondents sampled for the survey, ten (10) each representing 50% each reported of consuming the Chili and Bell pepper

Table 4.31 Species of pepper consumed most.

Species	Frequency	Percentage (%)
Chili	10	50.0
Bell Pepper	10	50.0
Total	**20**	**100.0**

Source: Field Survey 2011

4.4.2 State or form at which pepper is consumed

Figure 8 shows that pepper is consumed in the fresh state (45%) while 45% reported eating pepper in the cooked form while only 10% of the respondents reported eating pepper as salad.

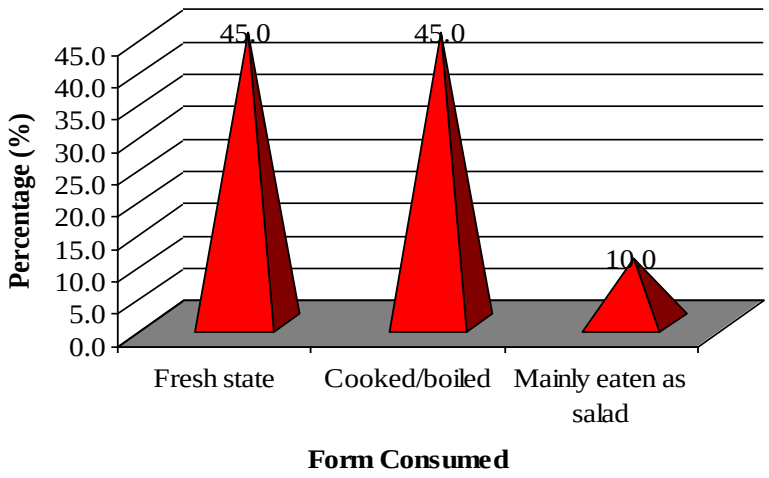


Figure 8: State or form at which pepper is consumed

4.4.3 Sources of pepper for consumption

Study from figure 9 reveals that 60% of the consumers obtained pepper from the local market while 15% and 25% bought it from the farm gate and hawkers, respectively

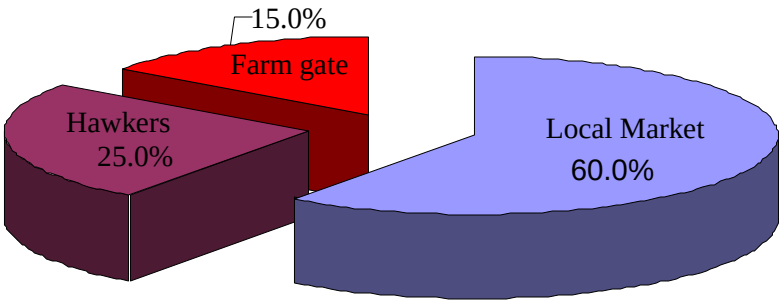


Figure 9: Sources of Pepper for Consumption

4.4.4 Storage of pepper by consumers.

Table 4.32 shows that fourteen (14) representing 70% stored pepper in the refrigerator while six (6) stored it in cool rooms with enough ventilation.

Table 4.32: Storage of Pepper by consumers

Storage	Frequency	Percentage (%)
Refrigerator	14	70.0
Cool room	6	30.0

4.4.5 Washing of pepper before storage

Table 4.33 illustrates that seven (7) respondents representing 35% indicated that they washed their produce before storage while 65% do not wash fruits before storage.

Table 4.33 Washing of pepper before storage.

Response	Frequency	Percentage (%)
Yes	7	35.0
No	13	65.0
Total	**20**	**100.0**

Source: Field Survey 2011

CHAPTER FIVE

5.0 DISCUSSION

5.1 BIODATA OF RESPONDENTS

From table 4.1 it could be seen that as far as production of pepper is concerned, males dominate farming (71.7%). Females are gradually putting themselves into the farming business. Pepper production in the District is mainly dominated by males due to perhaps its strenuous nature and time consuming especially the harvesting, whereas marketing is dominated by female population in an efficient manner for sustainable income generation.

It was observed that larger number of producers were forty one (41) years and above. The impression created is that active age population dominate agricultural business thus forty one years (41) and above. This confirms report by FAO, (1990) that a higher percentage of the active population is engaged in agricultural business. This may be due to lucrative nature in the pepper business in the community.

In the case of the family size, thirty (30) producers representing 50% had their family size between 4 and 7; Farmers in the district use family labour to augment the production and post-harvest handling of pepper apart from hired labour.

Most of the farmers are literate (Table 4.3). Olaitan (1984) indicated that education is vital to agriculture, in that it enables the farmer to accept and understand innovation which will help him acquire the needed skills and knowledge to increase agricultural productivity. A large number of population are into full time trading (Table 4.6). This

implies that vegetables and for that matter pepper farming is a very lucrative business in the district that is why most of the farmers are into full time farming.

5.2 PRODUCTION AND POSTHARVEST PRACTICES

5.2.1 Species of Pepper Cultivated.

Legon 18 is ranked the highest (Table 4.7) 58.3% followed by Scotch bonnet 41.7% and sweet pepper (8.3%) This is as reveals by a report published by (MiDA, 2011) which states that chili pepper has been widely produced in Ghana for local consumption but have increasingly been exported to the European market in accordance with the development of Legon 18 developed by the researchers of the University of Ghana, Legon in recent years. This accounts for the cultivation of Legon 18 widely in Ghana especially in Asesewa.

5.2.2 Reason for Cultivation of Species

From table 4.8, it could be realized that range of reasons were given by the respondents. Sixty (60) representing 100% reported that, they cultivated the species ranked for sale on commercial basis confirming what was reported by (Timpo *et al.*, 2010) that pepper provides some income to farmers and it contributes to Ghana's gross domestic product (GDP). This gives an indication that pepper is widely cultivated in Asesewa on the basis that pepper production is an income generating activity for the inhabitants.

5.2.3 Source of planting materials

Agro-chemical stores were mentioned as the main source of obtaining planting materials (Table 4.9) and from friends and farmers saved seeds. This indicates that local seeds or

auto-propagated/volunteered seeds are used for production instead of obtaining it from a reputable source to boost production. Farmers usually don't buy seeds from reputable source for propagation. This might be due to financial constraints; hence optimum productivity is not achieved.

5.1.10 Source of funds for farmers

Analysis in figure 2 indicates that as many as 88.3% of the farmers sampled obtained their funds from their personal savings. This indicates that a lot of farmers don't have access to credit facilities. This is in line with what Akinsanmi (1994), who reported that the most important and reliable source of funds or capital for running the farm enterprise is the farmers savings which come out from the profit of the farm or the business, and this is used to invest in the farm. This usually, limited their production.

5.1.11 Methods of Weed Control

Most of the farmers, that is, 59 out of 60 responded by saying that weeds are controlled manually with hoe or cutlass. Karikari and Mathew (1990) indicated that hoe-weeding remains the most commonly used weed control method in pepper production, and added that two to three hoe weedings are required in pepper weed control; this confirms the dominance of hoe weeding in pepper production.

5.2.6 Response on whether farmers experience disease and pest infestation on the farm

It was observed that 91.7% (Figure 3) of the respondents answered yes indicating diseases as serious problems in the production of pepper. Kays (1998) reported that one of the limiting factors in pepper production is diseases and added that plant pathogens

cause substantial losses in fruits and vegetable production which is the confirmation of the report made by the farmers. This could be due to the fact that farmers don't apply the recommended chemicals or they don't give much attention to the application of pesticide.

5.2.7 Response on the type of insecticide or pesticide used

A wide range of pesticides were mentioned by the respondents, with Dursban and Kombat dominating the pesticides used by farmers. Application of pesticide leads to the control or prevention of diseases and pests which cause losses of fruits and vegetables Chili pepper are mostly infected by fungi as suggested by Kays (1998) that pathogens causing disease include fungi, bacteria, virus and nematodes and they must be controlled effectively to obtain good yield.

5.2.8 Reasons why farmers don't apply pesticide

Table 4.13 indicated that out of the seven (7) respondents representing 11.7%, 6.7% reported of financial constraints as a reason why they don't apply the pesticide while 1.7% each reported of not receiving education from extension officers as to the type of insecticide to use and inadequate spraying culture. This may lead to postharvest losses as failure of the application may lead to insect infestation on the fruits.

5.2.9 Type of fertilizer applied

A greater number of producers applied NPK fertilizer to their crops. Kwarteng and Towler (1994) reported that pepper respond to NPK fertilizer. This might be the reason why greater percentages apply N.P.K to their crops to ensure high yield. Sinnadurai (1992) reported that for poor soil, 350kg of NPK fertilizer mixture per hectare should be

applied at split dose. Tindall (1983) also added that vegetables respond greatly to NPK fertilizer especially to increase the vegetative growth of plant when applied seven days after transplanting.

5.2.10 Reasons for fertilizer application

From the table 4.15 forty six (46) out of the 60 respondents reported that the main reason for application of fertilizer is to increase yield or production. The response from farmers revealed that application of NPK fertilizer on pepper gives a significant increase in yield hence the use on their crops. Inorganic fertilizer use has significantly supported global population growth - it has been estimated that almost half the people on the earth are currently fed as a result of synthetic nitrogen fertilizer use, hence increase in yield (Erisman *et al*., 2008)

5.2.11 Response on irrigation

Most farmers in the district rely on rainfall for their production. Few of the producers irrigated their farms. Norman (1992) reported that for optimum production, the soil moisture supply must be reasonably uniform during the growing season; hence the plant (pepper) must therefore be irrigated periodically.

5.2.13 Time of day for harvesting of produce

Maalekuu (2008) reported that harvest should be completed during the coolest time of the day, which is usually, in the early morning and the produce should be kept shaded in the field which is the confirmation to the report made by 51.7% of the respondents.. The reasons for the early morning harvesting according to the farmers, were that buyers

arrived early in the morning to purchase vegetables, early harvesting gave them enough time to attend to other farming activities such as weeding, availability of vehicles in the morning (as farmers had to negotiate with drivers the previous day to convey vegetables from their farm to the market centres). Also harvesting in the afternoon leads to heat accumulation which hastens deterioration. Some farmers harvest their produce in the evening and some harvest their produce based on demand, which implies that farmers can harvest their produce at anytime of the day irrespective of the temperature conditions prevailing in the environment.

5.2.14 Stage of maturity for harvesting pepper:

Fruits are harvested when fully ripe. Kwarteng and Towler (1994) reported that hot peppers are allowed to ripen fully, by which time they are usually red and beginning to dry up. Messiaen (1990) added that organic acids and vitamins C are higher in the ripe fruits, which are also more digestible; this might be the reason why producers harvest their produce when fully ripe. Also 31 out of the 60 respondents stated that, they harvest their produce when green, while 12 reported of harvesting their produce when half-ripe. Wills *et al*. (1995) stated that quality of produce cannot be improved after harvest; therefore it is important to harvest vegetables and fruits at the proper stage and size and at peak quality.

5.2.15 Cause of bruises encountered after harvesting:

Table 4.20 illustrated that 30 respondents representing 50% attributed the bruises to insect attack and this might be due to the failure of some of the farmers to apply pesticide to their crops. Five (5) representing 8.3% also attributed the bruises to infestation due to

poor harvest handling. Decay of fresh produce during storage is mostly caused by the infection through mechanical injuries. Furthermore, many fruits and vegetables are attacked by decay organisms which penetrate through natural opening or even through the intact skin. And these infections may be established during growth of plant in the field until after harvest that they begin to manifest since farmers do not apply insecticides to their crops (Maalekuu, 2008).

5.2.16 Response on whether producers do pre-cooling after harvesting:

Wilson *et al.* (1995) indicated that pre-cooling is the first step in good temperature management. The field heat of a harvested produce (heat the produce holds from the sun at ambient temperature) is usually high, and should be removed as quickly as possible before processing and storage.

The longer the produce stays in the field, the faster the rate of microbial and enzymatic reaction, hence produce should be pre-cooled immediately after harvesting to avoid excessive shrinkage of the produce due to unsatisfactory temperature maintenance and slow cooling. Personal interaction with those who do not practice pre-cooling revealed that, normally the produce are sold off immediately after harvesting, hence, there is no need for pre-cooling.

5.2.17 Place for pre-cooling produce:

Table 4.22 revealed that all the 38 respondents representing 63.3% who did the pre-cooling did it under shade in the farm. This indicates that no advance form of pre-cooling method is employed in the area talking of room cooling, forced-air cooling, evaporating

cooling etc. They only adhere to putting produce under shade i.e. under trees, shed or covered with leaves to remove the field heat after harvesting.

5.3 MARKETING OF PEPPER

5.3.1 Means of Transport to the Market.

Means of transport of produce to the market is by walking due to the short distance from the farm gate to the market. Maalekuu and Appiah (2010) indicated that transporting is often the most important factor in the marketing of fresh produce and that losses directly attributed to the transport conditions can be high, hence produce should be kept in the best possible conditions during transport.

5.3.2 Packaging of produce for transport to the market

The packaging material used should be acceptable to the farmer, middle-man and consumer, as well as extending the shelf life of the produce and should be easy to handle (Bleasdale and Salter, 1991). However, personal interaction with the traders and my own observation revealed that pepper packed in sacks and loaded in vehicles encountered bruises and deformities when loaded due to stacking, this reduces the shelf life.

5.3.3 Place of Selling the Pepper:

Majority of the traders responded yes indicating that they sell their produce in the market within the locality. In the marketing of pepper, Norman, (1992) reported that pepper has a ready market locally and is all year round, especially in the dry season. This confirms the marketing of pepper in the district as almost all the marketing is done locally.

5.3.4 Display of produce for sale

The produce is displayed in the sun which leads to accumulation of heat (rise in temperature) of the produce leading to faster rate of deterioration of the produce. Hardenburg (1986), reported that the higher the storage temperature, the higher or faster the rate of respiration hence deterioration. Wilson *et al.* (1995) added that respiration generates heat as sugars, fats and protein in the cells of the crop are oxidized. The loss of these food reserves through respiration means decreased food value, flavor, loss of salable weight, and more rapidly, deterioration .

5.3.5 Reason for Sorting

Table 4.27 indicated that seven (7) representing 35% of the respondents sort their produce based on fruit size of the respective variety; six (6) representing 30% sorted their produce based on ripeness while three (3) representing 15% sort their produce based on fruit uniformity. This gives an indication that traders have the idea of sorting to achieve the required uniformity for processing or for direct fresh vegetable and fruit sale to consumers.

5.3.6 Problems traders encounter.

Problems traders encounter might be due to poor postharvest handling practices adopted by the sellers, since 80% of the respondents ranked rotting as the number one problems they encounter while 20% ranked rotting as number two. On the other hand 45% of the respondents ranked loss of income second while 20% ranked it 4. This gives an indication that traders usually encounter problems and this could be attributed to insufficient knowledge on temperature management of the produce.

5.3.7 Storage of Excess Produce

In the case of storage of excess produce by traders, it was observed that many of the traders stored their excess produce in basket in cool and dry rooms. This could be perhaps due to financial constraints to purchase refrigerators or employ other cooling methods to keep their produce under the require temperature to reduce the rate of respiration hence, deterioration. The produce are then sent to the market the next day for sale.

5.3.8 Traders intention to switch from the sale of pepper

From the study few of the traders declared their intention to switch from the sale of pepper to other vegetable crops due to problems they encountered while others expressed their willingness to stay in the pepper marketing business in spite of the problems they encountered. This implies that despite the difficulties surrounding the sale of pepper, traders are still expressing the desire to continue the business and implies production will continue and consumers will also be satisfied.

5.4. CONSUMERS

5.4.1 Species of pepper consumed most

Tweneboah (2000) reported that pepper produced in Ghana can be categorized into two main species namely *Capsicum annuum* (Bell Pepper) and *Capsicum frutescens* for the chili pepper. This accounts for the reason why Legon 18, sweet pepper and Scotch Bonnet were the main species cultivated by farmers most in order to balance demand and supply. The consumptions of the two species may be due to the fact that they are most

common species produce by farmers in the district hence any species outside the two will be difficult to come by.

5.4.2 The state at which Pepper is consumed and their source.

Figure 8 revealed that pepper is consumed at its fresh state by a greater number of consumers in the district. Consumers eat the fresh pepper most, and this accounts for the reason why traders often sell the fresh produce. This is in line with Isodoro *et al*. (1995) who reported that pepper is eaten raw (fresh) and cooked and also used commonly in salad The local market in the district serves as the most reliable source of pepper to be bought from the retailers.

5.4.3 Storage of Pepper by consumers

Few consumers stored their produce in cool rooms as revealed in Table 4.32. This might be that they don't have the means to acquire refrigerators. The higher percentage of consumers storing their produces in refrigerators might be that, refrigerators are more convenient as compared to other sources of storage.

5.4.4 Washing of Pepper before Storage

The study revealed that a large number of consumers don't wash their produce before storage. This might be due to the fact that consumers only wash their produce when they are about to use them for cooking or for dish preparation. However the produce should also be washed before storage to avoid contamination with pathogens. With this, contamination with the produce can easily occur which may lead to infection due to contamination of produce on the market or harvesting and packaging and hence rapid deterioration.

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 SUMMARY

The main objective of the research work was to assess the level of pepper production and postharvest handling operation carried out in the Upper Manya Krobo District in the Eastern Region of Ghana that would prolong the shelf life of pepper. Also the research aimed at identifying cultural practices adopted by farmers in the district; assess harvesting practices; and postharvest practices farmers, marketers and consumers carry out to enhance the shelf life of fresh pepper.

Hundred (100) respondents made up of 60 producers, 20 traders and 20 consumers were randomly selected covering all the four agricultural zones in the district. Questionnaires were given to the respondents to complete after which the results were collated, analyzed and put into frequencies, percentages and graphs.

Findings from the research revealed that rotting and pest infestation were major problems confronting the respondents.

6.2 CONCLUSION

From the analysis and discussion of the results gathered, the following conclusions were drawn from the research.

- Pepper s one of the vegetables cultivated most by farmers in the district and has contributed greatly in income generation among the inhabitants.
- Species of pepper cultivated most by farmers in district include Legon 18, Scotch Bonnet and sweet pepper.
- Irrigation was poorly practiced by farmers in the district. Most farmers rely on rainfall for their production leaving the practice to the hands of few.
- Some farmers did not apply pesticide leading to insect and disease infestation which consequently affects the shelf life of the fresh pepper.
- Farmers had no access to credit facilities since they depended on their personal savings from their profit made for the subsequent production. This has limited their production since the average size of the farm was 0.6 hectare and also acquisition of inputs for production.
- Producers packaged their produce in sacks and baskets heavily stacked and transport to the market for sale by foot (carrying them) or vehicles leading to accumulation of heat hence deterioration.
- Producers did not pre-cool their produce. They send the produce to the market just after harvesting irrespective of the time they harvest their produce. This leads to accumulation of field heat in the produce resulting in faster rate of respiration, hence deterioration.
- Traders usually displayed their produce for sale in the sun without shading the produce. Some even go to the extent of packaging their produce in polyethylene

bags and display in the sun leading to heat retention in the packaging material hence rotting.

- ❖ Consumers often stored their produce in refrigerators without washing them, leading to contamination.
- ❖ The main causes of postharvest losses are attributed to the use local seeds or auto-propagated/volunteered seeds for production, excessive use of fertilizer, poor harvesting practices and poor transportation system.

6.3 RECOMMENDATIONS

From the findings of this study it is recommended that:

i. Farmers should be assisted to obtain improved high quality seeds from Agricultural Research Institutions through Ministry of Food And Agriculture to boost their production.

ii. Farmers should be encouraged to form production co-operatives to assist each other financially with respect to production.

iii. There should be thorough research into postharvest handling of pepper in the various crop research institutions and the result disseminated to farmers in order to losses and use agricultural products more efficiently to meet the increasing demand for food.

iv. There should be adequate education on packaging and storage technology to extend the shelf life of pepper.

v. There should be an improved transportation practices, packaging technology and improved storage infrastructure.

vi. Producers should pre-cool their produce before sending them to the market for sale. This will help to reduce field which leads to faster rate of deterioration.

vii. Farmers should be trained on appropriate use of fertilizers and pesticides, the appropriate marketing and production planning methods.

viii. Immediate follow-up actions aimed at safeguarding and improving the exploitation of pepper should be focused on the priorities of species identified. In view of this similar or action research should be conducted on other parts of the regions since the research did not cover the entire region.

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APPENDIX

QUESTIONNAIRE ON THE SURVEYOF THE PRODUCTION AND POSTHARVEST HANDLING OF PEPPER PRODUCTION IN THE UPPER MANYA KROBO DISTRICT OF EASTERN REGION OF GHANA

Please tick the appropriate box and provide information if any in the spaces provided in the questions below

BIO DATA

1. Gender:
   - (a) Male: [ ]
   - (b) Female: [ ]

2. Age:
   - (a) Less than 20years [ ]
   - (b) 21 – 30 years [ ]
   - (c) 31 – 40 years [ ]
   - (d) 41years and above: [ ]

3. Marital Status:
   - (a) Married [ ]
   - (b) Single [ ]

4. Family Size:
   - (a) 1 – 3 [ ]
   - (b) 4 – 7 [ ]
   - (c) 7 and above: [ ]

5. Type of Education Received:

   (a) Formal Education: [ ]

   (b) Informal Education: [ ]

   (c) Non-Formal Education: [ ]

6. Level of Formal Education Received:

   (a) Primary Education: [ ]

   (b) M.S.L.C. : [ ]

   (c) JHS / JSS: [ ]

   (d) Secondary: [ ]

   (d) Tertiary: [ ]

7. Main Occupation:

   (a) Farming: [ ]

   (b) Trading: [ ]

   (c) Civil Servant: [ ]

   (d) Others (Specify)……

8. If farming how long have you been into farming business?

   (a) Less than 10 years [ ]

   (b) 11 – 20 years [ ]

   (c) 20 years and above [ ]

   (d) Others (Specify)……

QUESTIONS TO PRODUCERS

9. What specie(s) of pepper do you grow? Rank them in order of importance if you grow more than one pepper species :

(a) ……

(b) ……

(c) ……

(d) ……

(e) ……

10. Why do you cultivate specie(s) named above?

(a) As a hobby [ ]

(b) For consumption [ ]

(c) For sale on commercial basis [ ]

(d) Others (Specify)……...……..

11. How do you obtain the planting material (seed) for your production?

(a) Buying them from agro-chemicals: [ ]

(b) Friends / Relatives: [ ]

(c) Preserved personal materials: [ ]

12. What is the size of your vegetable farm? (ha).....

13. Where do you obtain fund for your production?

(a) Personal savings: [ ]

(b) Financial Institution (Bank): [ ]

(c) Credit Unions: [ ]

(d) Grants: [ ]

(d) Others (specify): …….

14. How do you prepare the land for cultivation?

(a) Ploughing: [ ]

(b) Ridging: [ ]

(c) Bed preparation: [ ]

(d) Other (specify):

……

……

……

15. How do you get rid of weeds on your farm?

(a) Manually with hoe/cutlass: [ ]

(b) The use of weedicide /herbicide: [ ]

16. Do you experience diseases and pests infestation on your farm Yes [ ] No [ ]

17. Do you apply agrochemicals to your crop to control pests and diseases:

Yes [ ] No [ ]

(a) If yes, state the type used: ……

(b) If no, give reason(s)…….

……...

……...

18. (a) Do you apply organic manure or inorganic fertilizer? Yes [ ] No [ ]

(b) If organic fertilizer, state the type used.…….

(c) If inorganic fertilizer, state the type used……...

19. Why do you apply fertilizer to your crop?

(a) To increase the yield [ ]

(b) To improve the taste [ ]

(c) To improve the appearance [ ]

(d) Other(specify)……

…….....

20. Do you irrigate your crops? Yes [ ] No [ ]

21. If yes where do you obtain water for irrigation?

(a) Municipal water: [ ]

(b) Well: [ ]

(c) Streams: [ ]

(d) Rivers: [ ]

(d) Others (specify)……

22. Why do you irrigate your crop?

(a) Due to unreliable rainfall pattern [ ]

(b) Abundance of water [ ]

(c) To ensure constant of produce [ ]

(d) Other (Specify)……

23. At what stage of maturity do you harvest your produce?

(a) Half ripe [ ]

(b) Fully ripe [ ]

(c) Green (depending on the variety) [ ]

24. Do you notice any bruises on the fruits after harvesting? Yes [ ] No [ ]

25. If yes what do you think might be the cause of the bruises…….

……...

26. Do you pre-cool your produce after harvesting Yes [ ] No [ ]

27. If yes, where do you do the pre-cooling?

(a) Under shade, [ ]

(b) Forced air cooling [ ]

(c) Vacuum cooling [ ]

28. Do you store your produce? Yes [ ] No [ ]

29. If yes where do you store your fresh produce?

(a) Refrigerators [ ]

(b) Open space in the house /dwelling [ ]

(c) Air conditioners [ ]

(d) Other (Specify)……

30. If no give reason(s)

……

……

……

31. What constraint(s)/problems do you encounter as far as production is concerned? Rank them.

(a) ……

(b) ……

(c) ……

(d) ……

QUESTIONS ON MARKETING

32. Do you sell your pepper in the market? Yes [ ] No [ ]

33. If yes where do you sell your produce

(a) Market within locality [ ]

(b) Market outside locality [ ]

(c) Export [ ]

(d) Other (Specify)…….……..

34. How does your produce reach the market? Tick the means of transport.

(a) Walking [ ]

(b) Private vehicle [ ]

(c) Bicycle / motor bike [ ]

(d) Public / commercial vehicle [ ]

35. How do you pack the produce before transporting

(a) In sacks [ ]

(b) Baskets [ ]

(c) Wooden trays/box [ ]

(d) Polyethylene sacks. [ ]

(e) Other (Specify)……

36. How do you display your produce for sale at the market?

(a)On trays in the sun [ ]

(b)Baskets [ ]

(c)Polyethylene bags (transparent) [ ]

37. Do you sort your produce? Yes [ ] No [ ]

38. If yes give reason why you do sorting

……

……

……

39. Do you face problems in the marketing of the pepper Yes [ ] No [ ]

40. If yes state the problems by ranking them.

(a) ……

(b) ……

(c) ……

(d) ……

41. Would you like to switch to marketing of other vegetable(s) because of the problems you encounter? Yes [ ] No [ ]

CONSUMERS

42. What species of pepper do you consume most? .....

43. How do you consume the pepper?

    (a) Fresh state: [ ]

    (b) Cooked / boiled: [ ]

    (c) Served with main meal: [ ]

    (d) Mainly eaten as salad: [ ]

44. Where do you obtain your pepper for consumption?

    (a) Farm gate

    (b) Hawkers

    (c) Local market

45. Where do you store your produce?

    (a) Cool room

    (b) Refrigeration

46. Do you wash your pepper before storing them?

    Yes [ ] No [ ]