CAOF VEGETABLES PRODUCTION MANAUAL

FACILITATORS GUIDE

This manual is to guide project officers and trainers in training CAOF vegetables farmers on Good Agricultural Practices (GAP). Organic principles are strictly advised in the delivery of this training.

ABSTRACT

These guidelines are produced by CAOF to help member organizations to guide their farmers to transition from inorganic agriculture to organic agriculture. It will provide project officers with hands-on information to help the farmers in the transition process. It is also to assist them to help the already existing organic farmers in their business.

These guidelines serve as complimentary materials to those manuals developed by CAOF on other agricultural best practices such as composting, IPM and others.

This document is a living document and is subject to yearly revisions as CAOF continue to develope, research and practice organic agriculture.

CHAPTER ONE

INTRODUCTION

1. 1 Socio-economic Importance of Indigenous African Vegetables

Vegetables including African leafy and fruit vegetables serve as the base of soups, a significant component of Ghanaian food recipes (Amagloh and Nyarko, 2012, AduAmankwa and Boateng, 2011). However, due to varying climatic conditions across Ghana and inefficient food distribution channels their availability and supply varies across different regions. In most parts of Ghana, vegetables such as cocoyam, okra, onion, garden egg, pepper, tomato, amaranths, roselle and pumpkin are essential component of diet and household income.

These vegetables are important cash crops particularly in the dry season where commercial production is carried out under irrigation conditions around dug-outs, small dams and along river banks. On arable lands, they may appear as sole crop, intercropped or as boarder plants. They are also essential component of peri-urban gricultural systems.

They are an essential component of human diet for the supply of vitamins, minerals and certain types of hormones precursors in addition to protein, energy and dietary fibre (Amagloh and Nyarko, 2012, Adu-Amankwa and Boateng, 2011, Kwenin *et al.,* 2011). Regular consumption of vegetables is known to decreased risk of chronic degenerative diseases due to the presence of different antioxidant molecules such as carotenoids, particularly lycopene, ascorbic acid and vitamin C and E, and phenol compounds, particularly flavonoids. Leafy vegetables in particular are known to be rich in iron pro-vitamin A.

1. 2 Food Safety Issues with Vegetables in Ghana

Food safety risk with vegetables is high since they are minimally processed prior to consumption. General safety issues relating to water quality, chemical residue, worker hygiene (from the field to kitchen), conditions of handling and transport and risk of microbial infection are often eminent.

1. 3 The Emerging Role of Organic Vegetables

Informed opinion suggests the importance of organic farming particularly in urban markets; due to its immense benefit to growers, consumers and the environment. Some reports suggest the demand for organic foods is growing steadily with specific interest in organic fruits, vegetables, oil products and meat (CAOF, 2010).

1. 4 Selected Vegetables

This manual will focus on some high demand vegetables such as Rosselle (Bito), Amaranthus (Aleefu), Onions, Okro, Tomatoes, Pepper and Cabbage. These vegetables were selected after an agronomic analysis of the vegetable value chain and verified by key stakeholders in the chain at a stakeholders meeting.

CHAPTER TWO

AMARANTH PRODUCTION

2.0 INTRODUCTION

Amaranth is a vegetable commonly used in Ghanaian dishes. Its scientific name is *Amaranthus* spp from the Amaranthaceae family. It has its common names as Amaranth (English) and Alefu (Dangbani, Gurune, Kusal)

Amaranth is a war warm-season, broadleaf plant grown as leafy vegetable in tropical Africa. There is considerable variation in leaf size, colour and stem structure green or purple, with slender stalks. The leaves are alternate, usually simple, with entire margins and distinct markings, depending on species.

2.1 USES OF AMARANTH

The main objective of this section is to enhance trainees' knowledge and understanding of the various uses of Amaranth both locally and internationally. At the end of the section, it is therefore expected that trainees would have broadened their understanding of the various uses that amaranth can be put into.

Activity 1

The facilitator should begin the session by asking trainees to:

1. Mention the various uses of Amaranth.

2. List the various uses as mentioned by trainees

3. List some common products of Amaranth in their local environment

The facilitator should then lead trainees in a practical and participatory discussion on the various uses as mentioned in addition to the following uses if not mentioned.

The leaves of Amaranth and the slender stems are cooked as part of soup or stew. Amaranth leaves are known to be very rich source of calcium, iron and vitamin C, a very rich source of potassium, vitamin A and riboflavin, a rich source of niacin and an above-average source of protein.

Amaranth can also be used to make medicine. It is used for ulcers, diarrhea and swollen mouth and throat. It can be used to treat high cholesterol.

2.2 NURSERY MANAGEMENT

Objective of Session

The objective of this session is to enhance trainees' knowledge on sources of seed, seed selection and site selection for the production of Amaranth.

Activity # 2

The facilitator should begin the session by asking trainees to:

Mention the sources of Seeds available to them and describe the climatic conditions required for the growing of Amaranth focusing on:

- Temperature conditions
- Moisture levels and
- Seasonality

Mention the soil types required for growing Amaranth and the water requirements.

The Facilitator can then proceed to discuss the following in addition to the ones mentioned by trainees.

2.2.1 Source of seed and seed selection

2.2.2 Propagation

Amaranth can be propagated from seed. The seedlings are fragile, so it is important to have a fine, firm seedbed. Amaranth seedlings can easily be blocked from emergence by a thin crust on the soil which forms after rain.

2.2.3 Nursing of seeds

Seeds can be planted in seed trays or seed beds. Nursery bed should measure 1m x 6 m (width x length) while nursery box or tray measures 40 cm x 20 cm x 10cm (length x width x depth). Seeds may be nursed in drills made in seed trays or seed beds. Provide mulch using straw of 10 cm thickness to create conducive conditions for seedling emergence. The seed bed or tray must be watered twice daily until the seedlings emerge.

2.3 SITE SELECTION FOR FIELD PRODUCTION

2.3.1 Climatic requirements

2.3.1.1 Temperature

Amaranth is highly tolerant of an arid environment. Amaranth need soil temperatures of between 18 °C and 25 °C to germinate and an air temperature above 25 °C for optimum

growth. Lower temperatures and shorter days will induce flowering with a subsequent reduction in leaf yield.

2.3.1.2 Sunlight

Amaranth thrives well under conditions of full sunlight and shady conditions should be avoided. Trees with big canopies should be pruned to avoid shady conditions in amaranth fields.

2.3.2 Soil and water requirements

2.3.2.1 Water requirement

Amaranth is a drought-tolerant and well adapted to arid conditions. Waterlogged areas should be avoided. Fields with moderate moisture conditions should be selected. Although the plant is tolerant to drought, prolong exposure to drought conditions may induces early flowering and inhibit leaf production.

2.3.2.2 Soil requirements

Amaranth is well adapted to varied conditions of soil. Although fertile, well drained and loose soil condtions are preferred, the plant cans still do well in marginal soils, Loose and friable soils with high organic matter content are ideal for an early and heavy yield. Amaranth is very sensitive to soil pH changes. The ideal pH is 6.4.

2.4 FIELD AGRONOMIC PRACTICES

Objective of Session

This session is to increase trainees' knowledge on best agronomic practices for the production of amaranth

Activity # 1

The facilitator should put trainees into groups and task them to:

- Discuss land preparation, seeding, transplanting, weed control, fertilization, pest control, disease control and irrigation.

After 30 to 40 minutes of discussion, the facilitator should facilitate a plenary discussion for trainees to share the results of their group work. The facilitator should then lead a participatory discussion on the following issues encouraging participants to cite examples where possible.

2.4.1 Land preparation

Soil should be well prepared to improve, structure, water holding capacity, drainage, aeration, good microbial activity and good root penetration. The land should be cleared of vegetation,

ploughed and harrowed. Harrowing must be done at least two weeks after ploughing. In poorly structured and infertile soils the following organic materials could be used to improve soil conditions:

2.4.2 Fertilisation

Animal manure especially poultry manure at 1 ton/ha

Compost 2 ton/ha

Biochar 5 ton/ha

Organic materials should be incorporated into the soil 2 weeks before seeding or transplanting. In well drained soils seeding or transplanting of amaranth can be done directly when fine tilt conditions prevail after harrowing.

2.4.3 Seeding

Approximately 18.75 kg of seed is required per hectare. Seeds may be sown directly into the soil. For direct sowing, field should well harrowed and prepare into fine tilt. This is inportant to prevent difficulties in seed germination resulting from seed falling too deep into soil. Amaranthus seeds are very small and so to prevent over seeding, seeds may be mixed with sand to ensure even seeding during broadcasting.

2.4.4 Transplanting

Transplanted should be done about four weeks after nursing when the plants are about 15 cm tall. Transplant into rows 30 cm apart and with a spacing of 30 cm in the row. The following procedure should be adopted when transplanting seedlings:

i. Make a hole that is big enough to contain the root without forcing in.

ii. If possible, put a little compost into the planting holes

iii. Lift seedling with a ball of soil and place the seedling gently into the hole and make sure that at least all parts that were down the soil before transplanting are maintained

iv. Put earth around the roots and firm creating a basin around a plant for water conservation

v. Water immediately after transplanting

vi. Mulch and shade the transplant with twigs leaves if temperature is high or may be high later

2.4.5 Irrigation

Amaranth will grow optimally under irrigation especially in the dry season. Irrigation frequency is higher in the dry season than in rainy seasons. In Ghana Amaranth fields are rarely more than an acre and hence irrigation is done either with furrow irrigation, sprinkler

irrigation with motorized pumps and lifting and applying with watering cans. The amount of water required depends on several factors including climate and soil type. Watering should therefore be done as anw when soils conditions suggest the surface is drying up.

2.4.6 *Weed control*

Weeds are the biggest pest in amaranth production. Early weeds can be controlled by hand weeding. At least three cycles of weeding are required for rapid growth of amaranth. Timely weeding is essential for the following reasons:

- Weeds compete with amaranth for light, nutrients space and water.
- Weeds may serve as alternate host for pest and diseases
- Weed seeds may mix up and reduce the quality of amaranth seeds

2.4.7 Pest control

Critical pest of amaranthus include

- Snout beetles
- Moth larvae
- Fleas,

Tarnished plant bug and amaranth weevil are regarded as potentially significant insect pests of amaranth. The insect most likely to affect yields is the tarnished plant bug, a sucking insect which often reaches high populations in the seed head during the critical seed-fill stage. Flea beetles damage the young leaf tissue. The adult amaranth weevil feeds on leaves, but the larval stage is more damaging because they bore into the central tissue of roots and occasionally stems, causing rotting and potential lodging.

2.4.8 Disease control

No significant disease problems have been conclusively identified. One possible problem is a damping-off fungus, which can kill seedlings. Therefore use disease-free seeds and avoid both overwatering and dense planting. Leaf amaranth suffers damage from the armyworm and the curly top virus disease, which is transmitted by the beet leafhoppers (*Circulifer femellus)*

2.5 HARVESTING AND POST-HARVESTT HANDLING

Objective of Session

This session is to improve trainees' knowledge on harvesting and post-harvest handling of amaranthus.

The facilitator, in a participatory manner, should generate discussion among trainees on:

- Harvesting methods
- Preservation methods
- Marketing

Harvest maturity: Most amaranth cultivars grow rapidly and may be harvested from 30 to 55 days from sowing, when they reach a height of 0.6 m. Timing of harvest is not as straightforward as with the commodity crops.

2.5.1 Harvesting methods:

The plants are harvested by hand only. Young plants can be pulled up or cut with a sharp knife six to eight weeks after sowing when they are about 20 cm tall. This is done in cases where seeds were broadcasted. Plants may be cut back to 15 cm to encourage lateral growth for successive harvesting. When the plants are harvested at regular intervals, start picking the leaves eight weeks after sowing or four weeks after transplanting. Small quantities of leaves can be harvested on a daily basis.

In the case of large quantities, intervals of two weeks are recommended. Leaf production can be sustained by the removal of flowers. Leaves can be harvested in two ways:

• Picking of individual leaves when these are the size of the palm of your hand.

• Breaking off the leaves around the terminal growth tips of the stems.

2.5.2 Preserving methods

Washed leaves may be dried in the shade and stored for up to a year for consumption during winter. Cooked leaves may be dried and stored. Fresh leaves may be kept in the refrigerator.

2.5.3 Marketing

Thorough planning in terms of handling, grading, packing and storage of products should be done. Both local and export markets are flooded by exotic crops, making it difficult for the introduction of indigenous crops. As a result, indigenous crops such as amaranth remain largely a crop of small producers, consumed largely in areas where these are produced. The leaves of the crops are sold by street hawkers, market women etc. Growers also sell to the local market or regional health food stores or restaurants.

CHAPTER THREE

3.0 ROSELLE PRODUCTION

3.1.1 Introduciton

The scientific name for roselle is *Hibiscus sabdariffa* L from the family Malvaceae. Its common names include Roselle (English), Bra (Dangbani) and Bito (Gurune).

3.1.2 Importance of crop

The main objective of this section is to enhance trainees' knowledge and understanding of the various uses of Roselle both locally and internationally. At the end of the section, it is therefore expected that trainees would have broadened their understanding of the various uses that Roselle can be put into.

Activity 1

The facilitator should begin the session by asking trainees to:

1. Mention the various uses of Roselle.

2. List the various uses as mentioned by trainees

3. List some common products of Roselle in their local environment

The facilitator should then lead trainees in a practical and participatory discussion on the various uses as mentioned in addition to the following uses if not mentioned.

Roselle is an annual or biennial plant cultivated in tropical and subtropical regions for stem fibers, paper pulp or edible calyces, leaves and seeds. Roselle is an annual plant which takes about six months to mature. Roselle is a short-day plant. Roselle has drawn the attention of food, beverage and pharmaceutical manufacturers because of its commercial potential as a natural food and colouring agent that can replace some synthetic products. Traditionally, the fleshy calyces are used for the preparation of a drink during ceremony.

3.2 SITE SELECTION FOR FIELD PRODUCTION

The objective of this session is to enhance trainees' knowledge on sources of seed, seed selection and site selection for the production of Roselle.

Activity # 2

The facilitator should begin the session by asking trainees to:

Mention the sources of Seeds available to them and describe the climatic conditions required for the growing of Roselle focusing on:

- Temperature conditions
- Moisture levels and
- Seasonality

Mention the soil types required for growing Roselle and the water requirements.

The Facilitator can then proceed to discuss the following in addition to the ones mentioned by trainees.

3.2.1 Climatic requirement

3.2.1.1 Rainfall and Relative humidity

Roselle requires a monthly rainfall ranging from 130 –250 mm in the first three to four months of growth. Dry weather is well tolerated, and is desirable in the latter months of growth. Rain or high humidity at harvest and drying times can downgrade the quality of the calyces and reduce the yield.

3.2.1.2 Temperature

The warm and humid tropical climate is suitable for Roselle plants as it is exceptionally susceptible to frost and mist. The temperature range within which Roselle thrives is between 18 and 35 ºC, with an optimum of 25 ºC. In tropical and subtropical regions, an altitude 3000 ft. (900 m) above sea level is suitable for growing this plant.

3.2.2 Soil and water requirements

Roselle prefers a well-drained humus rich fertile soil in full sun, though it adapts to a variety of soils. Roselle plants prefer well-drained humus and rich-fertile soils with a pH of 4.5 to 8.0. It tolerates floods and heavy winds.

3.3 FIELD AGRONOMIC PRACTICES

This session is to increase trainees' knowledge on best agronomic practices for the production of Roselle.

Activity # 1

The facilitator should put trainees into groups and task them to:

- Discuss land preparation, seeding, transplanting, weed control, fertilization, pest control, disease control and irrigation.

After 30 to 40 minutes of discussion, the facilitator should facilitate a plenary discussion for trainees to share the results of their group work. The facilitator should then lead a participatory discussion on the following issues encouraging participants to cite examples where possible.

3.3.1 Land preparation

Soil should be well prepared to improve, structure, water holding capacity, drainage, aeration, good microbial activity and good root penetration. The land should be cleared of vegetation, ploughed and harrowed. Harrowing must be done at least two weeks after ploughing. In poorly structured and infertile soils the following organic materials could be used to improve soil conditions:

3.3.2 Fertilisation

Roselle is grown traditionally, without chemical fertilization. Although Roselle reacts favorably to nitrogen application by growing more vigorously. Compost and poultry manure significantly increased growth, biomass, and economic yield of Roselle. Organic compost wastes may be utilized in the soil as a source of nutrients for crop production.

Animal manure especially poultry manure at 1 ton/ha

Compost 2 ton/ha

Biochar 5 ton/ha

Organic materials should be incorporated into the soil 2 weeks before seeding or transplanting. In well drained soils seeding or transplanting of amaranth can be done directly when fine tilt conditons prevail after harrowing. This is desirable, and the practice can be amended for commercial application.

3.3.3 Seeding and planting

Roselle is commonly propagated by seeds, but it is also readily grown from cuttings . Sowing is at the beginning of the rainy season. There are two approaches for sowing: sowing directly in the field and sowing in seed beds.

The plants are grown on ridges with spacing of 0.80 m between the plants and 0.70 m between the rows. Seeds are planted at a rate of 6–8 kg/ ha and approximately 2.5 cm deep. On seed beds, seeds are usually planted at the beginning of the rainy season, 60 cm – 100 cm between rows and 45–60 cm apart. Sowing is done by hand or using a modern grain drill. A

good alternative tool would be a corn planter small enough to accommodate the hibiscus seeds. Thinning is also done by hand.

3.3.4 Pest and weed control

Major diseases of hibiscus are stem rot and root rot.

- Pests include:
- Stem borer
- Flea beetles
- Moth
- Cotton bollworm
- Cutworm

Minor Pest include:

- Mealy bugs
- Leafhoppers

Cotton stainer Plants extracts have been widely used to control agricultural pests in order to achieve an ecologically based pest management strategy.

3.3.5 Weed control

Weeding can increase yield and calyx size. Roselle fields are generally weeded if necessary.

leaf beetle insect transmit mosaic virus resulting in 20-50% yield reduction. *Zonocerus variegatus* (Variegated grasshopper) cause economic damage, attacking the lamina of the young foliage and matured leaves which result in reduction of the photosynthetic ability of the crop. Pest complex of roselle includes *Bemisia tabaci* (Genn.) *Aphis gossypii* Glover, *Earias insulana* (Boisd.) *Empoasca spp*.

Biological pest control: the control pest through the control and management of natural predators and parasites.

Mechanical pest control is the use of hands-on techniques as well as simple equipment and devices that provides a protective barrier between plants and insects. For example: weeds can be controlled by being physically removed from the ground. This is referred to as tillage and is one of the oldest methods of weed control.

Physical pest control is a method of getting rid of insects and small rodents by removing, attacking, setting up barriers that will prevent further destruction of one's plants, or forcing insect infestations to become visual.

3.4 HARVESTING AND POST-HARVEST MANAGEMENT

This session is to improve trainees' knowledge on harvesting and post-harvest handling of Roselle.

The facilitator, in a participatory manner, should generate discussion among trainees on:

- Harvesting methods
- Preservation methods
- Marketing

Harvesting is done/timed according to the ripeness of the seed. The fleshy calyces are harvested after the flower has dropped but before the seed pod has dried and opened. The longer the capsule remains on the plant after the seeds begin to ripen, the more susceptible the calyx is to disease and sun cracking.

The calyces ripen about three weeks after the start of flowering, which are 100 –160 days after the plants are transplanted outdoors.

The fruit ripens progressively from the bottom of the plant to the top. Harvesting is carried out by intensive hand labor, the calyces being picked singly at the appropriate stage. The fruit may be harvested when fully grown but still tender, when they can be easily snapped off by hand; Later harvesting requires clippers

The fruit is easier to break off in the morning than at the end of the day. On average, each fruit yields about 7–10 g of sepals.

3.4.1 Handling

Drying is the traditional method for preserving foods. Roselle drying is done in one of two ways: by harvesting the fresh fruit and then sun-drying the calyces, or by leaving the fruit to partially dry on the plants and harvesting the dried fruit, keeping the crop well protected during the process. Dehydration depends on the two fundamental processes of heat transfer (heat is transferred into the fruit) and mass transfer (subsequent removal of moisture from it.

3.4.2 Postharvest treatment

After harvesting, dried calyx of Roselle undergoes the steps of shelling, drying, packaging and storage.

CHAPTER FOUR

4.0 OKRA PRODUCTION

4.1 Introduciton

Scientifically named *Abelmoschus esculentus* (L.) Moench. Synonym *Hibiscus esculentus* L of the Family: *Malvaceae* with Common names Okra (English), Mana (Dagbani and Gurune).

Okra is an annual herb typically reaching 2 m in height, but some African varieties may grow up to 5 m tall, with a base stem of 10 cm in diameter. The heart-shaped, lobed leaves have long stems and are attached to the thick woody stem. They may reach 30 cm in length and are generally hairy. Flowers are borne singly in the leaf axils and are usually yellow with a dark red or purple base.

It is largely to wholly self-pollinated, though some out-crossing is reported and it is often visited by bees. The pod (capsule, or fruit) is 10-25 centimeters long (shorter in the dwarf varieties). Generally, it is ribbed or round, and varying in color from yellow to red to green. It is pointed at the apex, hairy at the base, and tapered toward the tip. It contains numerous oval seeds that are about the size of peppercorns, white when immature and dark green to gray-black when mature

4.1.2 Importance of crop

The main objective of this section is to enhance trainees' knowledge and understanding of the various uses of okra both locally and internationally. At the end of the section, it is therefore expected that trainees would have broadened their understanding of the various uses that okra can be put into.

Activity 1

The facilitator should begin the session by asking trainees to:

1. Mention the various uses of Roselle.

2. List the various uses as mentioned by trainees

3. List some common products of Roselle in their local environment

The facilitator should then lead trainees in a practical and participatory discussion on the various uses as mentioned in addition to the following uses if not mentioned.

Very low calorie vegetables, they provide just 30 calories per 100 g besides containing no saturated fats or cholesterol.

Rich sources of dietary fiber, minerals, and vitamins. cholesterol controlling and weight reduction. High compose healthy amounts of vitamin A, and flavonoid anti- oxidants such as beta-carotene, xanthin and lutein.

The good source of folates; helps decrease the incidence of neural tube defects in the offspring. The okra pods are also an excellent source of anti-oxidant vitamin, vitamin-C, providing about 36% of daily- recommended levels. Are rich in B-complex group of vitamins like niacin, vitamin B-6 (pyridoxine), thiamin and pantothenic acid.

Also contain good amounts of vitamin K. Vitamin K is a co-factor for blood clotting enzymes and is required for strengthening of bones. 8.The pods are also good source of many important minerals such as iron, calcium, manganese and magnesium.

4.2 SITE SELECTION

The objective of this session is to enhance trainees' knowledge on sources of seed, seed selection and site selection for the production of Okra.

Activity # 2

The facilitator should begin the session by asking trainees to:

Mention the sources of Seeds available to them and describe the climatic conditions required for the growing of okra focusing on:

- Temperature conditions
- Moisture levels and
- Seasonality

Mention the soil types required for growing okra and the water requirements.

The Facilitator can then proceed to discuss the following in addition to the ones mentioned by trainees.

4.2.1 Climatic requirement

4.2.1.1 Rainfall and Relative humidity

The plant is immensely adaptable and is widely distributed in the tropics, subtropics, and warmer temperate zones. The plant tolerates a wide variation in rainfall. Most selections are adapted to the lowland humid tropics, ranging up to at least 1,000m

4.2.1.2 Temperature

Most cultivars are adapted to consistently high temperatures. Minimum soil temperature for germination is 16 °C. For good growth, night temperatures should not fall below 13°C. An average temperature of 20-30°C is appropriate for growth, flowering, and pod development.

4.2.1.3 Soil and water requirements

A range of soil types give good economic yields but (not unexpectedly) well-drained, fertile substrates with adequate organic material and reserves of the major elements are ideal. Some cultivars are sensitive to excessive soil moisture, so well-drained, sandy locations are preferred. Neutral to slightly alkaline conditions, pH 6.5-7.5, seem best. In essence, it grows almost everywhere anyone tries to plant it. Okra is a warm-season annual well-adapted to many soils and climates. The plant shows remarkable tolerance to drought and heat and can generally perform reliably in Africa's savanna regions.

4.3 FIELD AGRONOMIC PRACTICES

This session is to increase trainees' knowledge on best agronomic practices for the production of okra.

Activity # 1

The facilitator should put trainees into groups and task them to:

- Discuss land preparation, seeding, transplanting, weed control, fertilization, pest control, disease control and irrigation.

After 30 to 40 minutes of discussion, the facilitator should facilitate a plenary discussion for trainees to share the results of their group work. The facilitator should then lead a participatory discussion on the following issues encouraging participants to cite examples where possible.

4.3.1 Land preparation

Soil should be well prepared to improve, structure, water holding capacity, drainage, aeration, good microbial activity and good root penetration. The land should be cleared of vegetation, ploughed and harrowed. Harrowing must be done at least two weeks after ploughing. In poorly structured and infertile soils the following organic materials could be used to improve soil conditions:

4.3.2 Fertilisation

Compost and poultry manure significantly increased growth, biomass, and economic yield of Roselle. Organic compost wastes may be utilized in the soil as a source of nutrients for crop production.

Animal manure especially poultry manure at 1 ton/ha

Compost 2 ton/ha

Biochar 5 ton/ha

Organic materials should be incorporated into the soil 2 weeks before seeding or transplanting. In well drained soils seeding or transplanting of amaranth can be done directly when fine tilt conditons prevail after harrowing. This is desirable, and the practice can be amended for commercial application.

4.3.3 Seeding

Mostly is direct seeded. Owing to the thick seed coat, the seed is first soaked overnight to improve germination. Seedlings can also be transplanted from a nursery. Warm temperatures are needed both for good germination and good growth. Okra is similar to cotton in its temperature requirements. Commercial okra in the United States is planted at a population of 20,000-30,000 plants per hectare.Nursery/planting

Sowing by direct seeding on the field at the rate of 2 seeds per hill. Seedlings are sometimes thinned to one plant per stand two weeks after germination.

4.3.4 Weed control

Weeding was done with a hoe at 2 and 4 weeks after emergence and at early flowering respectively and when necessary.

4.3.5 Pest and Disease control

The crop is relatively free from pests and requires only minimal maintenance. However, in the it can be subject to Verticillium and Fusarium wilts, and aphids, corn earworm, and stinkbugs can be major insect pests.

4.4 HARVESTING AND HANDLING

This session is to improve trainees' knowledge on harvesting and post-harvest handling of okra.

The facilitator, in a participatory manner, should generate discussion among trainees on:

- Harvesting methods
- Preservation methods
- Marketing

Flowering begins about 2 months after planting. Each flower then develops rapidly into a pod, which is typically harvested just 3-6 days after the flower formed.

Pods harvested at this stage are tender, flavorful, and about half grown. Any that remain on the plant quickly turn fibrous and tough.

With proper field management, continuous flowering and high production can be maintained. Yields approaching 500 kg per picking per hectare (0.5 kg per plant) may be produced during a harvest period of 30-40 days. Okra is usually harvested at least three times a week.

The pods have a high respiration rate and should be cooled quickly. Those in good condition will keep satisfactorily for 7 to 10 days at 7 to 10°C. A relative humidity of 90 to 95 percent helps prevent shriveling.

4.4.1 Postharvest treatment

The most important step in any okra operation is harvesting the pods correctly and regularly picking the pods every few days. That induces more production and greatly increases yield.

Fresh okra pods bruise easily, blackening within a few hours. A bleaching type of injury may also develop when they are held for more than 24 hours without cooling.

Some okra plants and pods have small spines to which some people are allergic. Picking the crop can produce itchy arms.

4.4.2 Seed Processing

The okra pods mature in a sequence from the base of the plant toward the top (Fig. 2). The pods have tendency to split along the suture when they are dried out. Exposed seeds may be damaged by rain or may drop to the ground; therefore, the pods must be harvested as soon as they have become fully mature (brown color) and before shattering. Pods are easily hand threshed

CHAPTER FIVE

5.0 CABBAGE PRODUCTION

5.1 Introduciton

This crop goes by the scientific name: *Brassica oleraceae* from the Asteraceae family with Common name, cabbage (English).

Cabbage is well known and consumed leafy vegetable. The part which is mostly consumed is the leafy head. The cabbage head is a spherical cluster of immature leaves. Cabbage is a popular vegetable throughout the world because of its adaptability to a wide range of climatic conditions and soil, ease of production and storage, and its food value.

5.1.2 Importance of crop

The main objective of this section is to enhance trainees' knowledge and understanding of the various uses of cabbage both locally and internationally. At the end of the section, it is therefore expected that trainees would have broadened their understanding of the various uses that cabbage can be put into.

Activity 1

The facilitator should begin the session by asking trainees to:

1. Mention the various uses of cabbage.

2. List the various uses as mentioned by trainees

3. List some common products of cabbage in their local environment

The facilitator should then lead trainees in a practical and participatory discussion on the various uses as mentioned in addition to the following uses if not mentioned.

In Ghana cabbage is usually consumed raw and cooked. it is an excellent source of vitamin c. It also contains a significant amount of glutamine, an amino acid that has anti –inflammatory properties.

5.2 NURSERY MANAGEMENT

The objective of this session is to enhance trainees' knowledge on sources of seed, seed selection and site selection for the production of cabbage.

Activity # 2

The facilitator should begin the session by asking trainees to:

Mention the sources of Seeds available to them and describe the climatic conditions required for the growing of cabbage focusing on:

- Temperature conditions
- Moisture levels and
- Seasonality

Mention the soil types required for growing cabbage and the water requirements.

The Facilitator can then proceed to discuss the following in addition to the ones mentioned by trainees.

5.2.1 Seed selection

It s very important to obtain cabbage seeds from certified dealers. Cabbage does not produce seeds in the tropics and hence there is no chance for farmers to save and utilize own seeds.

Points to remember about when nursing cabbage seeds

- After deciding on the seed source, the site for the nursery should be carefully selected.
- Seeds can be nursed either on nursery beds or seed boxes and containers.
- If seeds are to be nursed on beds, higher grounds should be selected to protect the seeds and seedlings against potential floods.
- The nursery site needs to be fenced to provide protection against birds and livestock.
- When nursing seeds on nursery beds, the beds should have the following dimensions:

1 m – 1.5 m wide, 6 m – 10 m long and about 15 cm high.

- The beds should be properly constructed using lining and pegging.
- The top of the bed should be much levelled to avoid water accumulation at some spots.
- Sterilized nursey beds to eliminate pathogens and weed seeds
- Prickout seedlings to harden and avoid over crowding before transplanting to the field

5.2.2 Good practices in nursing seeds

Prepapre the soil on nursery beds of containers to a fine tilt. Water and cover beds with at least 5-10 cm thick dry straw, and then burnt after 2-3 days to sterilize the soil ; this get rid of reactivate spores of disease pathogens and weed seeds. Allow soil to cool for 2-3 hourss

before sowing. Thin drills should be made at a row spacing of 10cm apart. In nurser seed trays or plugs it is advisable to use one seed per cell. Mulching of seeds should be done either with dry grass, palm fronds or transparent plastic sheet. Seeds emerge within 5-7 days after sowing. Nursery management should continue for 3-4 weeks with the following good practices

- Continue to water beds regularly
- Provide insect prove lutracil nets ; this is done after the mulch is removed after emergence
- Manually pick weeds regularly
- Pricking out should be done about two weeks after sowing.
- Thin out weak, malformed and oversized seedlings and in case of overcrowding too.
- Seedlings should be hardened by gradual exposure to sunlight or reduce in water supply

5.3 SITE SELECTION

5.3.1 Climatic requirements

The following should be considered in selecting a site for cabbage cultivation

- The land should be fairly flat and not sloppy
- It area should be sunny and without huge trees.
- The land should be well drained and fairly aerated
- Easily accessible to permanent source of water
- The pH of the soil should range from 5.5-6.5 for higher production

5.3.2 Soil and water requirement

Deep well drained, medium textured sandy loam or loamy soil that contain organic matter and has higher water holding capacity is required for cabbage production.

- The soil should be clean
- The land should be ploughed and harrowed.
- The field must be ploughed deeply before transplanting, to about a depth of 450- 600 mm

In areas with about 1,200 mm of rainfall, irrigation may not be required provided the rainfall is well distributed. In more dryer areas with poor rainfall distribution access to perennial source of water for irrigation is critical.

5.4 FIELD AGRONOMIC PRACTICES

This session is to increase trainees' knowledge on best agronomic practices for the production of cabbage.

Activity # 1

The facilitator should put trainees into groups and task them to:

- Discuss land preparation, seeding, transplanting, weed control, fertilization, pest control, disease control and irrigation.

After 30 to 40 minutes of discussion, the facilitator should facilitate a plenary discussion for trainees to share the results of their group work. The facilitator should then lead a participatory discussion on the following issues encouraging participants to cite examples where possible.

5.4.1 land preparation

Soil should be well prepared to improve, structure, water holding capacity, drainage, aeration, good microbial activity and good root penetration. The land should be cleared of vegetation, ploughed and harrowed. Harrowing must be done at least two weeks after ploughing. In poorly structured and infertile soils the following organic materials could be used to improve soil conditions:

5.4.2 Fertilisation

Compost and poultry manure significantly increased growth, biomass, and economic yield of Roselle. Organic compost wastes may be utilized in the soil as a source of nutrients for crop production.

Animal manure especially poultry manure at 1 ton/ha

Compost 2 ton/ha

Biochar 5 ton/ha

Organic materials should be incorporated into the soil 2 weeks before seeding or transplanting. In well drained soils seeding or transplanting of amaranth can be done directly when fine tilt conditons prevail after harrowing. This is desirable, and the practice can be amended for commercial application.

5.4.3 Transplanting

- Seedlings should be transplanted at five true leaves stage
- It is preferred to transplant in the evening.
- Seedlings should be watered planting
- Seedlings should be at reasonable depth and firm after planting.
- Seedlings should spaced 45cm in double rows of 45-60cm apart on each bed of 1-1.2 m wide
- Early maturity- row to row: 45cm, plant to plant: 30cm and late maturity – row to row: 60cm, plant to plant: 45cm.

5.4.4 Weed control

- Good site selection and bed preparation
- Weeding should be done anytime there is the need.
- Weeding can be done manually with a hoe.

5.5 HARVESTING AND HANDLING

This session is to improve trainees' knowledge on harvesting and post-harvest handling of Roselle.

The facilitator, in a participatory manner, should generate discussion among trainees on:

- Harvesting methods
- Preservation methods
- Marketing

5.5.1 Harvesting

Full sized heads, firm, hard but tender are usually harvested. Matured cabbages usually are lighter shade of green in colour. Harvesting should not be delayed as early harvesting prevents cracks lead to softer heads. Harvesting should be done using a knife or sickle preferably done at the early hours of the morning or late evening. Harvest with a few of the open leaves left around the head for it protection. Avoid bruising the head during harvesting as this becomes entry points for pathogens and as well makes it unattractive. It advisable to

leave most of the stem on the head, if the crop is to store. It is important to consider the following during post-harvest handling and storage:

- Cabbage heads should be immediately removed from direct sunshine and high temperatures.
- Sorting should be done; here injured heads are separated from healthy ones and smaller heads from bigger ones.
- The optimum storage temperature and humidity for cabbage is 0 degree Celsius and 90-95 % respectively.
- Stored cabbage should be matured, disease free and should not be exposed to prolong frost or cold.