Chapter four-Major tuberous root crops grown in Ethiopia

CHAPTER LEARNING OBJECTIVES

At the end of this chapter students are expected to:

- ✓ Informed with origin and distribution of cassava and sweet potato
- ✓ Acquainted with Taxonomy and Botanical character of cassava and sweet potato
- ✓ Identify the climatic and soil requirement of cassava and sweet potato
- ✓ Distinguish the planting materials used for cassava and sweet potato
- ✓ Identify the main diseases and insect pests affecting cassava and sweet potato

4.1. Cassava (Manihot esculenta Crantz) crop production and managemnt

4.1.1. Introduction

Cassava is the sixth most important crop (after wheat, rice, maize, potato and barley) in the world. It contributes consistently to food security because its mature edible roots can be stored in the ground for up to three years. It represents a household food bank that can be drawn upon when adverse climatic conditions limit the production of other foods. The variety of dishes made from the roots and the nutritious fresh leaves are reasons why cassava cultivation is expanding throughout the Tropics.

Origin and distribution

The cassava plant has its origin in South America. Portuguese explorers introduced cassava to Africa during the 16th and 17th centuries through their trade. Africans then spread cassava further, and it is now found in almost all parts of tropical Africa. In Ethiopia, the British are believe to introduce cassava. Its cultivation has become familiar since the 1984 famine.

Cassava production

Today Nigeria and Congo-Kinshasa are the biggest producers of cassava after Brazil and Thailand. In Ethiopia, cassava grows in vast areas mainly in southern part of the country such as Amaro, Gamogoffa, Sidama, Wolayta, Gedeo. The crop also grows in south, south west and western part of Ethiopia. The average total coverage and production of cassava per annum in Southern region of Ethiopia is 4942 hectars with the yield of 53036.2 tonnes (SNNPR, BoA, 2000).

Taxonomy and Botany

Common names: CASSAVA, Manihot, Manioc, Tapioca, Tapioka.

Botanical name: Manihot esculenta Crantz. B

Family: Euphorbiaceae

Genus: Manihot and Species: *M. esculenta*

Cultivars

Numerous cassava cultivars exist in each locality where the crop is grown. The cultivars have been distinguished on the basis of; morphology (that is leaf shape and size, plant height, petiole colour etc.), tuber shape, earliness of maturity, the content of cyanogenic glucoside of the root.

This last named characteristic has been used to place cassava cultivars into two major groups: “Bitter” and “sweet” are the two general types of cassava.

Sweet cassava- **Short season type**

The sweet varieties tend to have a short growing season; their tubers mature 6-9 months, and deteriorate rapidly if not harvested soon after maturity. The cyanogenic glucoside is confined mainly on the peel and is at low level. The flesh of the sweet varietiesis therefore relatively free from the glucoside, although it still contains some. The sweet type is more commonly grown because of its greater yields. The colour and texture of the root peel are often the only factors used in separating clones in the market.

Bitter cassava- Long season type

The bitter varieties are long season type, in which the cassava plants require 12-18 months to mature, and will not deteriorate if left unharvest for several months. The cyanogenic glucoside is distributed throughout the tuber and is at high level.

Botanical description

The cassava plant is a dicotyledonous, perennial woody and branched shrub that grows up to a height of 4 m. Cassava stems are cylindrical, with a diameter ranging from 2 to 6 cm. Stems vary considerably in color from whitish gray to brown or dark brown. When the plant develops, within 30 -60 days, some fibrous roots increase in diameter and become tuberous roots. As tuberization proceeds, tuberous roots swell as a result of starch accumulation. Tuberous roots do not absorb water or nutrients; they are physiologically inactive. Only a few fibrous roots develop into tuberous roots; the rest remain fibrous and continue to function as water- and nutrient-absorbing roots.

Leaves: Cassava has large, spirally arranged, have five to seven lobes borne on a long, slender petiole lobed leaves of very variable forms. The leaves grow only towards the end of the branches.

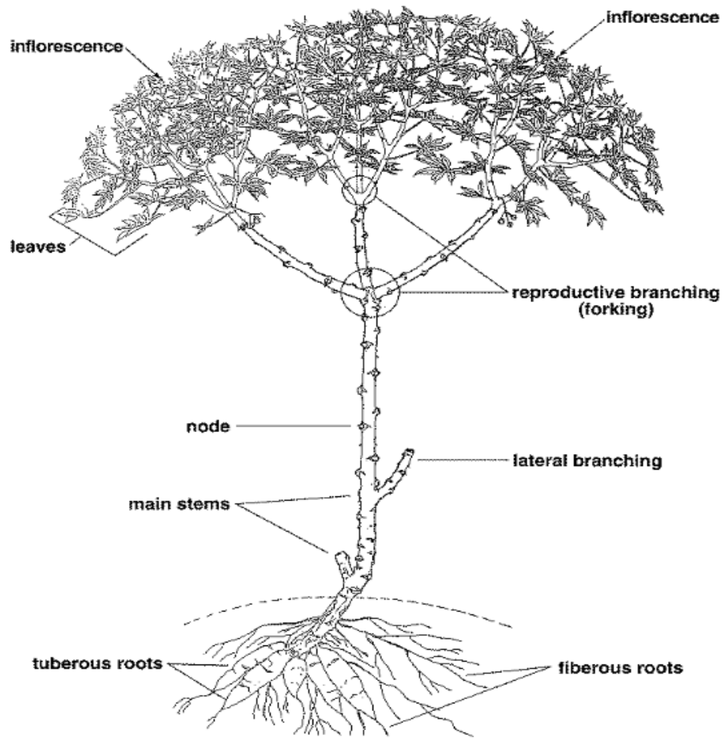


Figure 4.1 Cassava plant

Roots: Roots are the main storage organ. Cassava roots could be fibrous or tap root, depending on the planting material used (seeds or cuttings). Cassava plants propagated from seeds first develop a tap root system and adventitious roots from cuttings. The roots vary in shape, number, and size.

After a few months of planting, certain roots near the stalk base become swollen with starch deposition. The process is tuberization. Root tubers (storage roots) develop by a process of secondary thickening as swellings on adventitious roots a short distance from the stem. There are usually 5-10 storage roots per plant, cylindrical or tapering, 3-15 cm in diameter, 15-100 cm long and may weight up to 2 kg. Hydrocyanic glycoside is present in varying quantity.

Figure 4.2 Cassava tuber

Flowers and seeds: Cassava is *monoecious* which produces small, regular female and male flowers in small clusters. Some varieties flower frequently and regularly, while others flower rarely or not at all. The shrub produces a form of non-fleshy fruit capsule. Each capsule contains three seeds. Seeds can be light gray, brownish or dark gray, with darker blotches. The fruit matures in 70 -90 days.

Composition and Importance

Economical parts

The tubers and leaves are the essential parts of cassava. The young leaves of the "sweet" varieties are edible as a green vegetable, and are a much better source of minerals and vitamins than the tubers. The leaves are considerably higher in protein and lower in carbohydrate than the tubers. The leaves average from 3.7 to 10.7 % protein on a fresh weight basis and 21 to 36 % on a dry weight basis. Of the essential amino acids, only methionine is deficient. The use of edible cassava leave is popular in Africa and Madagascar.

Cassava is one of the most important food crops that constitute a considerable portion of the daily diet of the people and also serves as a major source of carbohydrate in Southern Ethiopia. Cassava tubers are very rich in starch, and contain significant quantities of vitamins and minerals like calcium (50 mg/100 g), phosphorus (40 mg/100 g) and vitamin C (25 mg/100 g). However, they are low in protein and other nutrients.

It is both a food security crop and a source of household income. It is increasingly becoming a source of industrial raw material for production of starch, ethanol, waxy starch, bio-plastics, glucose, bakery and confectionery products, glue among others. It is also used as a good roughage source for dairy and beef cattle, buffalo, goats, and sheep by either direct feeding or as a protein source in the concentrate mixtures.

4.1.2 Climatic and soil requirement

Cassava is a typical tropical plant. Cassava growth is favorable under temperatures ranging from 25 to 29° C, but it can tolerate temperatures as low as 12° C and all growth stops at about 10 °C. The highest tuber production can be expected in the tropical lowlands, below an altitude of 1500m. Cassava can be successfully cultivated in areas with annual rainfall between 1000 and 2000 mm but it can tolerate lower rainfall up to 500 mm. It tolerates long dry seasons (6 to 7 months) as well as reduced precipitation. As a tropical crop, it is a short-day plant. More than 12 hours of daylight can cause delays in tuberization (starch storage) and eventually low yields, while short light periods enhance flowering.

Cassava can grow in a wide range of soil types; with the exception of heavy or saturated soils. It prefers light, sandy loams, well-drained, deep soils that are rich in organic matter but it also does well on soils ranging in texture from sands to clays and on soils of relatively low fertility and acidic soils. Cassava plant can grow best at a pH of 5 to 6.5. Soil with high fertility will be encourages vegetative growth at less storage root growth and produce high Cyanogenic glucoside(CGs) content. It can't tolerate water logging, drainage is important for better storage root development.

4.1.3 Production and management practices

- **Preparation of planting land**

Bed formation

The physical property, drainage condition and topographical of fields determine the level of tillage and type of seedbeds required for cassava cultivation.

A. Mounds or ridge beds

In the areas with shallow soils or poorly drainage clayey soils, it is important to make mounds or ridges onto which the cassava is planted to encourage better root development and yields. The soil ploughs to depth of 30 cm than harrow, so that the root can get well down. The size of the mounds or ridges and space between mounds varies with respect to soil drainage condition. Big ridges and mounds enable the plant to grow above water in saturated soils.

B. Preparation of flat beds

In well drained and good physical properties areas, minimum tillage and planting cassava on flat are appropriate because the soil is sufficiently loose to allow for faster drainage and normal storage root development.

- **Propagation**

Planting material: Stem cuttings and Botanical seeds

Root: Cassava root cannot be used as a means of vegetative propagation. It is physiologically inactive and it has no buds and eyes on the root. So cannot be used as a propagation material, since it does not give rise to new plants.

Seed: Seed germination is difficult and usually improved by scarification. Seed is used for hybridization program for the development of new varieties and selection purposes. Seeds produce plants with fewer and smaller tubers than cuttings and fail to germinate.

Cutting: Cassava is commonly propagated by stem for commercial production. It is a better method as the cuttings rapidly and easily take root, producing plants that have identical characteristics to the parent plants.

- **Preparation of planting materials**

Planting materials should be taken from the central portions of the brown healthy stems that are 10- 12 months old plants. Stem a cutting that is about 20-30 cm long, 2.5-3.75 cm thick and with at least 5 buds is generally recommended. The longer the cutting used for planting, the greater the yield expected from it. It is due to the greater number of nodes from which roots or shoots can spring and contains a greater amount stored food material which the young plant can utilize before it becomes self-sufficient. Stems used to prepare cuttings should be sufficiently lignified. The young branching tips should be avoided because they produce plants with early branching and flowering and are fragile, presenting difficulties to get established in the field. Over-lignified portions from the basal stems of old plants should also be avoided as they are poor in nutritive reserves and more prone to infection with virus.

- **Method of planting**

Depending on the growing conditions such as rainfall, flatness and soil types of the production field, there are three planting methods used in cassava production. Those are:

A. **Horizontal method**

The entire stake is placed horizontally and buried at a depth of 5(heavy soil) to 20 cm (light soil) in the ground. Planting at a depth of 10cm is common. This method produces shallower roots than slanted and vertical planting.

B. **Inclined method:** The stake is placed 2/3 of its length in the ground and at an angle ranging from about 45º to 60º.

C. **Vertical method**: The stake is pushed vertically and about 1/2 of its length into the ground. With this method the stake sprouts quicker than with the other two methods, but it produces deeper roots than the horizontal or inclined planting methods.

- **Planting time**

Generally, planting time varies depending on the availability of water. Cassava planting is best done in the early rainy season from Mach to June.

- **Planting space**

The optimum plant spacing depends on the area, cultivar used and whether cassava is a sole crop or is intercropped with other crops. In mono cropping, the spacing of cassava is usually between 1mx1m within and between rows and 2mx2m with intercropping. The closer spacing gives higher yields but smaller roots and tends to encourage certain fungal diseases. Cassava grown on very fertile soils will need wider spacing compared to cassava grown on infertile soils.

- **Weed management**

Early weeding prevents weeds from competing with the crop for nutrients, water, light and space. Hand weeding is recommended if labor is available and economical. Earth up the plants at the same time; this greatly promotes the formation of tubers.

- **Fertilization**

Cassava plant grows on relatively infertile soils which are unsuitable for other crops. It responds well to fertilization, it removes considerable quantities of nutrients from the soil. The general recommendation is to use about 60:60:90 kg/ha of a (NPK) fertilizer. Cassava has a high potassium requirement. Response to Nitrogen and Phosphorous is poor in areas where potassium level in the soil is low. Nitrogen fertilizers should be applied periodically every 3 months during actual growth. Excessive nitrogen may be dis advantageous, since it favour shoot grow that the expense of root and tuberous root growth and it results in a high level of cyanogenic glucosides in the storage root.

- **Diseases and Pest management**

Management of diseases

The main diseases affecting cassava are mosaic disease and bacterial blight

Cassava mosaic virus: It is the most common disease in different parts of the world. In the early stages of infection, chlorotic specks appear on the leaf lamina; gradually turning bright yellow, intermixed with pale green and giving a typical mosaic pattern. Selecting only healthy planting material and use of resistant variety can considerably reduce the spread of the disease.

Cassava bacterial blight: Symptoms may be leaf blight or brown leaf burn, wilt, dieback, and a gummy exudation in infected young stems, petioles, and leaf spots.

It can be controlled by using varieties with good tolerance, soaking stakes in hot water before planting, sterilizing tools with disinfectant, and intercropping to reduce plant-to-plant dissemination.

Management of major insects

Cassava mealybug. appears on the ends of cassava stems, the underside of the leaves and the stems. They are covered with a white, powdery, or mealy wax and feed by inserting their slender mouth parts into the plant tissues and sucking cell contents.

Mealybugs can be effectively controlled by carry out crop rotations, plant early in the rainy season, keep the plot clean and the proper employment of biological control agents, especially parasitoids as Anagyrus lopezi. The use of chemical pesticides control can be both difficult and costly'.

Animals: Rats, goats and wild pigs are probably the most troublesome because they feed on the tubers, especially in areas adjacent to forests.

- **Harvesting**

Depending on the cultivar and growing conditions, cassava tuber reaches maturity in 9-24 month after planting. The early varieties may mature at between 6 and 8 months on average after planting, whereas the late varieties require 12 and 19 months under optimal condition. Too early harvest will result in low starch content and too late harvesting produces fibrous or woody tuberous roots and increases the risk of yield loss due to decay or pest.

Cassava tubers harvesting can be done by using machines or hand. In Ethiopia harvesting is still a manual operation, although equipment to facilitate this operation is being considered. The day before harvesting, the plants are topped—the stalks are cut off manually 40 to 60 cm above ground. The 40 to 60 cm length of stalk is left as a handle for pulling the tubers from the soil.

4.1.4 Postharvest Handling

Cassava tubers harvested are highly perishable due to the physiological and microbial changes. The harvested tubers should be used with in a day or two in the absence of long term storage method. Farmers overcome this problem to some extent either by delaying the harvest or by slicing the tubers and sun drying as dry chips. Keeping the tubers in moist sawdust or moist sand or providing wax coating may prolong the shelf life by 10-15 days. It can be stored as form of flour for several months.

Cyanide in cassava

Cassava should never be eaten raw as the root composes small quantities of cyanogenic glycosides, especially hydroxycyanic acid. The amount of these toxic compounds varies according to cultivars and growing conditions. There are many types of cassava based on the amount of cyanide content of the tubers: sweet cassava contains 40 – 130 ppm cyanide; non-bitter cassava, 30 - 180 ppm; bitter cassava, 80 – 412 ppm; and very bitter cassava, 280-490 ppm. At concentrations less than 50 ppm, the cassava products are considered harmless. For all types, cyanide content is mainly located in the skin of tubers.

How to reduce Cyanide content of tubers?

1. Peeling and boiling above 150 C ^{0}
2. Retting i.e. grated or chopped the tubers finely and allowed to soak in water
3. Sun drying (oven dry) detoxify about 80% of cyanide.

    - No matter how carefully cassava has been processed traces of cyanide invariable remain in the tubers

4.2 Sweet potato (*Ipomaea batatas* L)

4.2.1 Introduction

Sweet potato, Ipomoea batatas L. (Lam.), is an important economic crop. In terms of annual production, sweet potato ranks as the seventh most important food crop in the in the world food production after wheat, rice, maize, potato, barley, and cassava. Sweet potato fulfills a number of basic roles in the global food system, all of which have fundamental implications for meeting food requirements, reducing poverty, and increasing food security.

- **Origin and Distribution**

Sweet potato originated from tropical Central America. This crop is now grown throughout the tropics for its edible tubers, which are an important food source in many countries. It is an important tuber crop in tropical and sub-tropical countries. The exact time of introduction of sweet potato into the Ethiopian traditional farming system is not clearly known. However, the crop has become popular for centuries particularly in the densely populated areas of the south, south western and eastern parts of the country where it has remained an important co-staple food among the communities. In Ethiopia, Sweet potato is the second most important root crop next to enset.

- **Taxonomy and Botany**

Classification

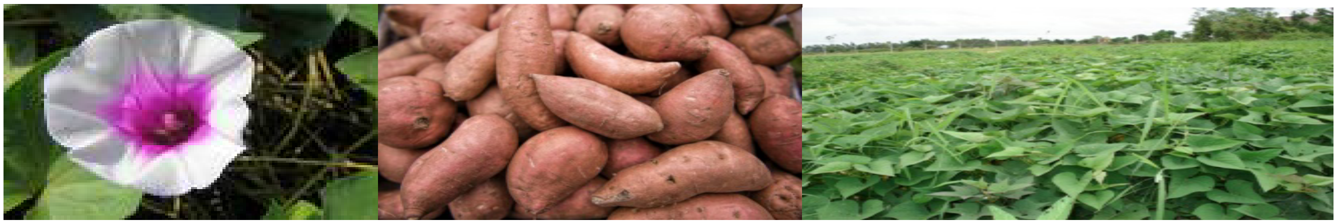
Sweet potato (*Ipomaea batatas* L.) is a member of the Convolvulaceae family. This family includes 45 genera and 1000 species, but only Ipomaea batatas is of economic importance as food.

Common names: Sweet Potato and 'Sikuar Dinich' (Amharic)

Botanical name: Ipomaea batatas (L.) Lam.

Botany

The sweet potato plant is a dicotyledonous herbaceous trailing vine up to 4 m long, which sends roots into the soil at the nodes. It is a perennial but is cultivated as an annual by stem cuttings or plant sprouts from storage roots. Sweet potato leaves are simple, alternate and stipulate. They vary in size and shape. The general form of the leaf is heart-shaped or halberd-shaped and classification of varieties is usually based upon the shape of the leaves. Large, fleshy, edible storage roots are formed on the underground stem node. Storage roots may be fusiform, spindle or globular in shape and surface is smooth. Skin has white, red or light copper colour. The storage roots, not to be confused with tubers, which are modified stems. The crop has bisexual and Self-incompatible (if self-pollinated, no viable seed), funnel shaped flowers. Flowers are solitary or cymose and vary in colour from white to purple. Fruit is a capsule with false septa. Seed coat is hard and impervious to water. Hence, scarification is required for promoting germination.



4.3 flower, tuber and vine of sweet potato

Cultivars A very large number of sweet potato cultivars exist. Most of the existing cultivars are from clonal selection and self-incompatible. There are large variations in the skin and flour color, shape and size of the tubers, and morphological characters.

In Ethiopia, after evaluation at Awassa and Areka, some promising lines have already been released. Clone TIS-1499,I-4444 and TIS-3017 were officially released in 1996/97.

- **Importance**

Sweet potato is primarily used as food. Generally it is consumed directly- the main type of preparation being boiling, baking or frying. In processed form, the tubers can be prepared in many ways for human consumption (canned, frozen, dehydrated or made into flour or starch). For industrial uses, the tuber is a source of starch, glucose, syrup, vinegar and alcohol. The tuber and plant tops are also a source of animal feed. The tuber is fed directly or in processed form and the leaves are fed to livestock as fresh fodder or in the form of silage.

4.2.2 Climatic and soil requirement of the crop

The crop is highly adaptable and is able to grow in a wide range of agro-ecological zones but it grows best in the warm climates. Sweet potato is cold sensitive. The optimum temperature to achieve the best growth of sweet potato is between 24 and 29 0C. Growth is restricted by cool weather and the plant damaged by temperatures below 10°C. The optimum temperature for tuber growth is about 25 °C.

Sweet potato is a sun-loving crop, and does best where the light intensity is relatively high. High light intensity promotes the production of a higher number of storage roots, and an increase in dry weight of fibrous roots and total foliage. But if the storage roots are exposure to light, they will stops enlargement, decreases starch content and increases fiber content and roots become dark. Sweet potatoes grown under shady conditions or low light produce poor yields. Short day with low light intensity promote tuber formation, while long days tend to favour vegetative growth and development at the expense of the root tubers. Day-length of 11 hours or less promotes flowering; at day length greater than 13.5 hours, flowering fails to occur but tuber yields do not appear to be affected.

A crop of sweet potato crop grows well from sea level up to 1,700m.a.s.l. Some varieties even grown in the high land but have poorer taste and lower dry matter. The optimum rainfall is considered to be around 500-675 mm; it can thrive best up to 1000 mm rainfall.

Sweet potato crop can be grown on many types of soil but does best on deep, moderately fertile, sandy loam soils, which produce high quality storage roots with an attractive shape and appearance. Adequate drainage and soil aeration are important. Sweet potato does best on slightly acidic soils, with optimal pH 5.6- 6.6.

4.2.3. Production and management practices

- **Land Preparation**

The soil should be ploughed and harrowed and adequate drains made. Sweet potato is usually planted on ridges, mounds or flat soil. Ridges are usually 75 -90cm wide and 30-45cm high and mounds 40 cm at the base and 20-30 cm high. Planting on the flat bed yield lower than the rest and are difficult during harvesting. For lighter soils flat planting can be done but heavier soils should be ridged to facilitate drainage. Mounds and ridges ensure good drainage, and temporarily lower soil bulk density, providing more uniform root development and make it easier to harvest the mature roots.

- **Propagation**

Sweet potato can be propagated in a variety of ways; seeds, sprouting (tubers), and vine cuttings.

1. **Seeds:** sweet potato true seeds are mainly used for breeding.

2. **Storage roots**: It is not common practice. Small pieces of tuberous roots are planted directly into the field. The storage root (sett) should be derived from robust, healthy tuberous roots. The size of the sett should be small (20-50 g) and should be planted only about 3 cm deep. Yields are usually low and the quality is poor so it is not the recommended practice.

Sprout production

Sprouts are produced from the conditioned roots in cold frames, heated beds, or field beds of clean sand or fumigated sandy soil. Conditioned roots are covered by more soil sand, though not too much. Four to five weeks are needed to develop strong plants. Pre-sprouting requires temperatures between 23 to 26 c^0 and relative humidity of 85-90% with good air movement provided. It will shorten the amount of time required for slip production by about a week, and increase the number of slips by two or three times, compared to roots that are not pre-sprouted.

Planting the sprouts

Sprouts should be taken from the plant beds when 6 to10 leaves and a strong root system have developed on each one. They are set out into the field as early as possible when the soil has warmed and the risk of frost or a cold weather period has passed.

3. Vine cuttings

It is the recommended commercial method of propagation. It is better than the use of sett for several reasons. Plants derived from vine cuttings are free from soil-borne diseases. The entire root harvest can be saved for consumption or utilization instead of reserving some of it for planting purpose. It yields more heavily than setts, and produce roots of more uniform size and shape. Apical cuttings are generally used as they give better growth and yields than basal or middle cuttings. Where planting materials are in short supply the use of middle and basal portion of the vine is common. The yield of root tends to increase with increase in the length of vine cutting used, Generally the length of cutting used varies from 20 to 45 cm; cuttings with seven or more nodes are favoured since they normally give higher yields than cuttings with only a few nodes. A length of about 30 cm is recommended. Longer are wasteful of planting material while shorter cuttings establish more slowly and give poor yields. It is generally recommended that 2/3 of the cutting is placed below the soil surface at an angle.

Planting time; Planting should be made early in the rainy season. Where the rainy season is very long, planting may be delayed and timed so that the crops mature just as rainfall begins to decline.

Spacing: Optimum spacing is depending on cultivar, environment, soil and length of growing season. The spacing is affected by several factors including;

- ✓ Growth habit: for instance branchy and leafy varieties are planted in wider spacing
- ✓ Tuberous root to stay for more bulk is planted in wider spacing.
- ✓ Soil fertility: in fertile soil closer spacing is used and moisture stress - wider spacing
- ✓ Length of growing season: For early harvest (3.5 – months) closer spacing is used while for

medium (5-6 months) and late (7- 8 months) wider spacing is used.

- ✓ Purpose of the crop: for canning small tuber size are used therefore harvested in shorter days. For starch larger sized tubers are used hence take longer time. For fresh market in general medium size is preferred.

There is great variation in the number of vine cuttings planted to the hectare, depending upon whether they are planted singly, in pairs, one each side of the ridge, or two or more cuttings per hole. The general recommended spacing of sweet potato is 100cm x 30 cm and the number of cuttings required to plant one hectare is 33,333, depending on the space used.

- ➢ **Fertilizers application**

Exactly not known for it depends on nature of climate, soil and cultivar etc., but the crop responds well to organic manure and inorganic fertilizers. Sweet potatoes require nitrogen, phosphorous, potassium and small quantities of boron, calcium and magnesium. Nitrogen is required for the initial growth of the plant but excess application leads to abundant vine growth and reduced storage root formation. Potassium is critical for storage root development whereas phosphorous is linked to yield. The common practice is to apply DAP all at planting and Urea in split. Usually, two applications are sufficient. The first one is applied at, or immediately after planting, while the second application is made one month after planting.

- ➢ **Pruning of Vines**

The retardation of vegetative growth of vines reduce rotting of new vigorous shoots capable of photosynthesis and also reducing wastage of photosynthesis, which are in turn translocated to roots. The vines are pruned back to 20-30 cm after one month to increase root yields.

- ➢ **Turning of Vines**

The vines, due to their ability to grow rapidly, can create a favorable microclimate for insect pests to hibernate or conditions conducive to bacterial or fungal growth. The vines produce roots at nodes when they come in contact with the soil, thereby affecting the growth of the main root system. It is customary to turn back the vines from time to time to prevent rooting at the nodes of the plant. This is to ensure a more even crop and fewer smaller tubers. Therefore, vines should be turned at least once or twice before they are fully grown.

- **Weeding**

Weed control is important during the early stage of this crop before the vines begin to spread. Regular hoeing and weeding are necessary to check weed growth and to maintain soil aeration. First weeding should coincide with the onset of rapid growth of vines, which takes place 3 weeks after planting.

- **Diseases and Pest management**

Diseases of sweet potato

Soil rots (Streptomyces ipomoea)

The most common sweet potato diseases are soft rots, scurf, stem rot (wilt), nematodes, and black rot. These and other diseases can cause heavy losses in the field and in storage.

Soil rots are bacterial diseases of sweet potato. Symptoms are quite distinct and include roots developing a black necrotic lesion which sometimes breaks off when the roots are harvested. Infected plants may be wilted and/or severely stunted with lower leaves bronzed or yellow.

Soft rots and other storage disease problems can be reduced by sanitation and disinfection of the storage house, Removal of old storage roots, proper curing, and careful handling of the sweet potatoes during harvesting, curing and storage.

Scurf, black rot and stem rot usually come from disease-infested seed stock and can be controlled by a fungicide dip before bedding seed roots.

Nematodes can come from infested growing beds or soil. Fields known to be infested with nematodes or other sweet potato diseases should be avoided. A three- to five-year rotation should be practiced.

Insects

Sweet potato weevil

The larvae of weevil burrow into the roots, making them unmarketable. Destroying all crop residues after harvest and crop rotations, Eradication of Ipomoea weeds,Use of clean planting material, Deep planting, Regular hilling to fill soil cracks around plants and Use of sex pheromone are the best ways to keep weevil numbers down.

Vine Borer (Omphisa anastomosalis)

O. anastomosalis adults are white with a brownish-yellow pattern on the wing. They lay slightly domed, greenish eggs with a flat base, on the upper and lower surfaces of the leaf and on petioles. The larvae bore into the stems and gradually eat their way down the vines. Full-grown larvae are 30 mm long and light purple, although they may also be yellowish-white. The head capsule is brown, the ventral surface and legs are white, and the back and lateral sides have yellowish-brown grooves. Crop rotation and Systemic insecticides such as Carbofuran are the effective ways of controlling this insect.

Harvesting and maturity

The crop is normally harvested 3-8 months after planting, depending upon the cultivar and climatic conditions. The crop is ready for harvesting when the leaves turn yellow. Maturity can also be assessed by cutting sample roots in the field and examining the colour of the latex exudation. Latex from mature storage roots remains creamy white, while in immature storage roots when cut, the latex colour rapidly turns black.

All roots on a given plant do not reach at the same time, so that harvesting is done at a time when a reasonable number of them are mature. If harvesting is done too early, yields are low and if harvesting is too late, the roots become fibrous, unpalatable, and are prone to attack by sweet potato weevil and various rots

Harvesting methods

Vines should be removed before digging to allow the root skin to toughen and facilitates harvesting. After vine removal, the sweet potato roots can be dug by hand or by machine. Manual harvesting of sweet potatoes typically involves the use of a metal spade, pick, or fork which is used to loosen the soil and undercut the roots. Where there is large-scale production, the tubers harvested by combine-type harvester units. Care must be taken to avoid cutting or injury to the roots. The roots are then lifted out of the ground, separated from the main stem, and temporarily left on top of the soil or put directly into a field container. The roots should be handled gently to avoid skinning and bruising and do not wash the roots.

4.2.4 POSTHARVEST HANDLING

Selection and grading: All decaying roots should be discarded. Slightly damaged roots can be used for immediate consumption, and those which are undersize or badly damaged may be fed to animals. Tubers which are to be stored should be fully mature and free from visible injury.

Post-harvest treatments

Chemical treatment: Pre-harvest spraying with maleic hydrazide or treating the harvested tubers with acetone inhibited sprouting when the tubers were stored for 4-8 weeks.

Physical treatment –Curing: Sweet potatoes to be stored for later marketing or for seed stock must be cured immediately after harvest to minimize storage losses. Curing involves controlling temperatures and relative humidity and providing ventilation to remove co2 for seven to ten days. Curing is accomplished by subjecting the tubers to high temperature and high relative humidity immediately after harvesting. A temperature of 27-29.5 °C and a RH of 85-90 %, applied for 4-7 days.

The purpose of curing is to heal the skin abrasions and wounds inflicted during harvest and handling, increase the toughness of the skin of the storage root, reduce moisture loss, and provides a barrier (suberin, a waxy material, is deposited) to prevent bacteria and fungi from entering. Curing can also improve eating quality by increasing sweetness.

Storage

Following curing, the roots should be stored carefully to a well-ventilated room at a temperature of 13-16 °C, and 85-90% RH and it requires refrigerator in tropics. A storage life of 6-10 months can be expected under these conditions, although sprouting may begin to occur after about 6 months, depending on the cultivar. If stored below 10 °C, chilling injury occurs and resulting in internal breakdown of the root tissue and Storage at above 16 °C drastically increase the respiration rate with consequent heat production, lead to more rapid sprouting and loss in dry matter. It also causes pithiness (an increase intercellular space). Roots can be stored up to a year without sprouting under optimal conditions.

Physiological Disorders of sweet potato

Physiological disorders of sweetpotato can be caused by a range of environmental, physiological a nd genetic factors, and are often misidentified as pathological diseases.
Some common physiological disorders are:

Water blisters (edema)

Small lumps (enlarged lenticels) develop on the outside of the roots due to prolonged exposure of roots to very wet soils, leading to lack of oxygen. Planting sweet potato in well-drained soil and Ensure ridges or mounds high in wetlands

Sun scalding

Scalded areas are purplish brown, due to exposure of roots to direct sun at high temperatures. Place sweet potato roots in shade immediately after harvest.

Growth cracks

Cracks in root skin, Cracks develop due to uneven growing conditions, especially uneven watering. Irrigation during dry spells to reduce the problem.