UNIT 1

ANNUAL CROPS

REF: DAGP/2/1

INTRODUCTION

You are welcome to Unit 1 of this module. This unit is about the different groups of crops in agriculture. You will learn about the different crops in your region, why crops are classified in different ways and the importance of these crops to humans and animals. You will study the effects of these crops on the environment and learn how to grow selected crops in these groups. The groups include cereals, grain legume, root and stem tuber crops and field crops.

AIMS

By the end of this unit, you should have gained knowledge about the different annual crop groups. You will also be able to grow selected crops from the different groups. This is important for you the teacher, and the pupils because of the importance of these crops to the nutritional needs of farmers as well as to the economy of the country.

OBJECTIVES

By the end of this unit you should be able to:

1. classify annual crops according to their characteristics.
2. explain the importance of annual crops to humans and animals.
3. identify the constraints in the production of selected annual crops.
4. state the growth requirements of different crops.
5. explain the role of crops in the management of soils and the environment.
6. grow selected crops from different groups.

TOPICS TO BE COVERED

Topic 1 Cereal Crops

(a) Importance of cereals to humans and animals.
(b) Characteristics of cereals
(c) Production levels and constraints in the production of cereals.
(d) Growth requirements of cereals.
(e) Effects of cereals in the management of soils and environment.
(f) Growing maize.

Topic 2 Grain Legume Crops

(a) Importance of legumes to humans and animals
(b) Characteristics of legumes
(c) Production levels and constraints in the production of legumes
(d) Growth requirements of legumes
(e) Growing beans
(f) Growing groundnuts

Topic 3 Root and stem tuber crops

(a) Importance of root crops to humans and animals
(b) Characteristics of root crops to humans and animals.
(c) Production levels and constraints in the production of root and tuber crops.
(d) Effects of root and tuber crops in the management of soils and the environment.
(e) Growing cassava
(f) Growing Irish potatoes

Topic 4 Field Crops

(a) Introduction
(b) Growing cotton
(c) Growing tobacco
(d) Growing sunflower
(e) Growing simsim

STUDY REQUIREMENTS

In working through this Unit, you will require a pen and paper. For the cultivation of annual selected crops, you will need a hand hoe, a small plot of land, and the seeds of the crop that you have selected.

Enjoy reading and working through this unit.

TOPIC 1 CEREAL CROPS

Cereals are grain crops. The most valuable part of a cereal is the grain which is the same in structure in all cereals (Figure DAGP/2/1-1). The grains have a high starch content (over 90%) and the embryos in the grains contain oils. The most important cereal crops in Uganda include maize, rice, sorghum, and finger millet.

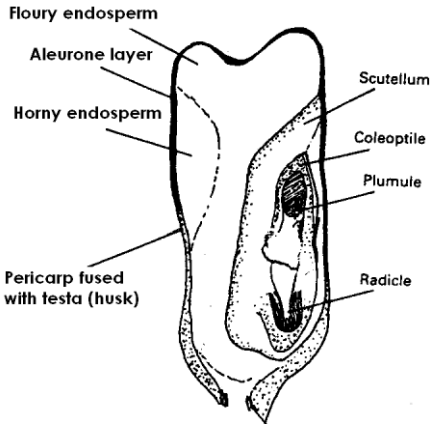
(a) Characteristics of cereal crops

You have probably seen a maize or finger millet plant. They are typical cereal plants. You will be able to relate the following characteristics with your observations.

Cereals are characterized by long narrow leaves. They have a seed head which produces numerous grains with a high starch content.

All cereals have round, erect stems, which have nodes. The leaves are arranged in two opposite vertical rows. Their roots are extensively branched and fibrous.

Grain crops are members of the grass family, graminiceae. Their fruit is called CARYOPSIS. The wall of the fruit is fused to the ovary wall to form the husk.



DAGP/2/1-1 Diagram of a cereal seed.

(a) Importance of cereal crops to humans and animals

Cereals are important to people and livestock because:

1. They are able to grow in a wide range of soils.
2. they are able to tolerate a wide range of climatic conditions e.g.
   temperate regions - wheat, barley, oats and rye.
   tropical regions - maize, sorghum, rice and finger millet
3. They are high yielding.
4. They are easy to cultivate and manage in the field.
5. They are easy to mechanise from planting to harvesting.
6. Cereal grains are easy to handle and store.
7. They are used for the manufacture of animal feeds, starch, glucose, sugar, syrup and oil.

(c) Production levels and constraints in the production of cereal crops

The average yield of the common cereals in Uganda is shown below:

Crop	Yield (kg/ha)
Finger millet	1,187
Maize	1,109
Sorghum	840

The major factor affecting farmer's yields in Uganda is that cereals are susceptible to shortages of water due to delayed rainfall. Since the rainfall in Uganda is seasonal, too little or too much rainfall affects the yields of cereals. The effects of weeds in fields of cereals is also great and reduces the yields of cereals in Uganda. Pests and diseases do not present as serious a problem as erratic rainfall to cereal production in Uganda.

ACTIVITY DAGP/2/1-1

1. Visit some farmers in your area and list some of the cereals grown.

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2. Why are cereals important to humans and livestock?

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✓ Check your answers with those given at the end of the Unit.

(d) Growth requirements for cereal crops

Cereals are located in all parts of the world. They are able to grow in wet and dry places. It is the rainfall distribution and soil fertility of an area that affect the distribution of cereals in East Africa. Maize and finger millet grow in areas of high rainfall and good soil fertility while sorghum is able to grow in areas with much less rainfall. Wheat requires cooler temperatures; therefore it is mainly grown in the Kenya Highlands and around Mt. Elgon.

Dry weather is only required when the crop is ripe. This is so because the grains should be dry before it is stored. Most of the cereals, with the possible exception of rice, require deep, well drained, fertile soils. However, they respond well to added fertilizers.

(e) Effect of cereals in the management of soils and the environment

When cereals are removed from the field during harvesting, this has a great effect on the soil. When the crop grows, it takes up nutrients such as carbon, nitrogen, phosphorus and other minerals from the soil. It also gives protection to the soil.

Harvesting removes the nutrients stored in the crop from the field and leaves the soil unprotected from the wind and rain. However, this may not be so severe if only the cob or head is removed and the straw or stubble are left in the field. But even the cob has some nutrients in it and these nutrients must be replaced by applying fertilizers and manure before the next crop is planted so that the soil may retains its fertility. The straw and stubble must quickly be turned into the soil because they become habitats for pests and disease pathogens. It is best to plough it back into the soil. If the straw is burnt, some nutrients such as nitrogen and sulphur are lost into the air. *Can you think of other ways in which the straw/stubble may be disposed of or utilized?*

Harvesting and removing the straw also removes the protective cover that leads to increased soil erosion by wind and rain. You may see from all this that for good agriculture, good management of cereals continues even after the crop has been harvested.

ACTIVITY DAGP/2/1-2

1. Why are cereals important to the soil and the environment?

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2a) What climatic conditions exist in your area?

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……..

c) What cereal is suited to these conditions? Why?

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✓ Check your answers with those given at the end of the Unit.

You will have learnt how to identify a cereal and describe some of their characteristics.

Now you will study the growing of maize as an example of a cereal crop. Also examine the maize plant and check if the characteristics of cereal crops discussed can be observed on it.

f) GROWING MAIZE.

Importance of the crop

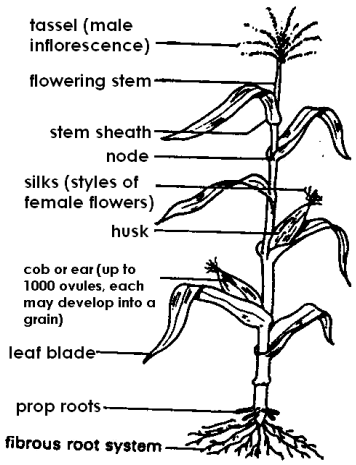
Maize is the most important cereal crop in East Africa. This is because it yields greater than other cereal crops and it is not easily damaged by pests, diseases and birds. It also requires less labour after planting compared to other cereal crops. Maize has a long storage life enabling it to be consumed when other staple foods are in short supply e.g. in times of famines. It is now a staple food in eastern regions, which traditionally rely on cassava and millet.

Plant characteristics

Maize is an annual crop which may grow up to a height of 4 metres. The plant puts on adventitious roots from the nodes above the soil as well as the characteristic "prop" roots for support. The roots may extend to a depth of 12 cm in deep soils.

The male inflorescence produce pollen before the female inflorescence is receptive and therefore self-pollination is rare in maize. There is usually one ear per plant but two or three ears per plant may be seen occasionally.

The period from planting to maturity varies according to the variety and the growth conditions. On average, the growth period is about 120-150 days. Some varieties may take up to 6 months to fully mature.



DAGP/2/1-2 Diagram of a maize plant

Growth requirements

Young maize plants are moderately drought resistant. The most critical period is at the time of silking when a little shortage of water causes incomplete pollination and therefore poor seed set. The optimum temperature for the growth of maize is about 30^0C and this is close to the temperatures that exist in East Africa. Maize needs well-drained soils that have a good supply of nutrients.

Seedbed preparation, spacing and planting depth

Maize may be planted in a rough seedbed since the seed is large. Nevertheless, a smooth seedbed is necessary when planting is done with a mechanical planter in order to plant at a uniform depth. In Uganda, the spacing used is 90 cm between rows and 30 cm between plants in the row. Two or three seeds may be planted per hole at a depth of 2-5 cm. The crop may be planted using a mechanical planter or hand-sown.

Weed control

Inefficient weeding is one of the factors that leads to low yields of maize in East Africa. Weed killers may be used in place of hand-weeding. Herbicides such as Atrazine and Simazine are used only in the early stages of maize growth, when the plants are about 10 cm in height. It is always advisable to control the weeds in the first 45 days of growth.

Fertilizer application

Nitrogen and phosphorus fertilizers may be applied when the crop is at knee height. Nitrogen should be applied as top-dressing while phosphorus may be applied in bands along the maize rows or even in the planting hole at the time of planting. The recommended rate of fertilizer currently is about 60 kgs of nitrogen and 45 kg of $P_2\ 0_5$ per hectare.

Varieties of maize

Until recently, most of maize varieties were introduced mainly from Southern Africa, Tanzania and Kenya. Research at Kawanda Agricultural Research Institute (KARI) has released new varieties such as Longe 1. Longe 1 was released in 1991; it matures in 110-115 days and yields between 2000-4000 kg/ha.

Also, hybrids UH 981 and UH 982 were released in 1998. They mature in 125 days and yield between 5000-7000 kg/ha. They are resistant to major pests and diseases.

Pest and disease control

Table DAGP 2/1.1 Pests and diseases of maize

Pest	Damage	Control
Maize stalk borer *(Busseola fusca)* (Chilo ssp.)	- Makes holes in your leaves - Destroys maize growing points - Plant dries up	- Crop rotation - spray with Endosulphan - Early planting - Crop rotation
Armyworm *(Spodoptera exempta)*	- Defoliate the plant	- Spray with Endosulphan DDT
American boll worm *(Helicoverpa armigera)*	- Attacks the silk - Bores into the cop	- spray with Dimecron
Birds/ Monkeys	- Eat ripening cobs	- scaring or mechanical control
Diseases	Symptoms	Control
Maize streak (Viral)	- Yellow and white stripes on leaf - stunting	- Plant resistant varieties - Remove affected plants
Rust (Fungal) (Puccinia ssp)	- Red/orange colouration on leaves	- Plant resistant varieties - Copper fungicide application

Read about other pests and diseases affecting maize.

Harvesting and storage

Maize is ready for harvesting when the seed contains about 35% water. When maize is ready, the silk is dry and the colour of leaves around the cob is slightly brown. If it is left to dry further in the field until a moisture content of 20% then it may be removed and safely stored on the cob in a maize crib. The crib should be rat-proof, dust free and raised off the ground. Storage pests of maize such as the maize weevil may be controlled using Actellic dust.

ACTIVITY DAGP/2/1-3

1. How would you improve maize yields in your garden?

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2. What other problems are you likely to encounter in producing maize in your area?

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✓ Check your answers with those given at the end of the unit.

Select at least one crop from one of the following cereals and study it in detail: *Millet, sorghum, rice and wheat.*

TOPIC 2 GRAIN LEGUMES (PULSES)

Legumes are important components in human and animal diets. The seeds of legumes have a high nutritive value. Legumes are a good source of protein. You are aware of leguminous plants whose seeds are used as food for humans. These are called pulses. The most important pulses in Uganda are:

Beans	*Phaseolus ssp*
Ground nuts	*Arachis hypogea*
Field and garden peas	*Pisum sativa*
Pigeon peas	*Cajanus cajan*
Soya beans	*Glycine max*
Cow peas	*Vigna unguiculata*

Legumes are commonly inter-planted with maize, cotton, millet, cassava, sweet potatoes and other crops. They are rarely grown in pure stands (monocropping).

(a) Importance of Legumes to humans and livestock

Legumes are important in the following ways:

They are a source of protein for human beings especially where animal protein is not available. Most legumes contain 20-30% protein while Soya beans contain 38-40% protein.

They are a source of protein for grazing animals. There are many palatable legume species found in pastures (Refer to Module DAGP/2, Unit 4).

Since they grow and cover the ground very fast they can be used as cover crops to check on soil erosion.

They are a source of green manure. They are fast growing and leafy hence they can be planted and ploughed into the soil at a correct stage.

They improve soil fertility by fixing nitrogen from the atmosphere to soil. The symbiotic bacteria in the root nodules of legumes fix atmospheric nitrogen, which later becomes available for use by the plants and increases soil fertility. They are therefore important in any crop rotation.

They increase aeration and water infiltration: Legumes being deep-rooted help to open up the soil hence increasing aeration and water infiltration.

They recycle nutrient: Deep rooted legumes help in bringing up nutrients from the deeper layers of the soil.

Some legumes are used in the manufacture of medicines, drugs and dyes.

Legume shrubs provide browse or fodder for animals especially in dry areas.

Industrial products from legumes are fed to livestock e.g. groundnut cake, Soya bean meal.

(b) Characteristics of Legumes

Most legumes are annual crops. Their leaves are compound, trifoliate, net-veined and have a pulvini at the base of the petiole. They bear pods, which contain grain seeds. The pod may be round or flat, thick or thin, straight or coiled, short or long. The flower resembles a butterfly. The corolla is made up of three partly joined petals, the standard, wings and keel. Most of the flowers are white. Most legumes have root nodules, which contain nitrogen-fixing bacteria (Rhizobia spp) *(Refer to Practical Guide for details).*

(c) Production Levels and Constraints in the Production of Legumes

From the table below you will notice that the yields of legumes in Uganda are not high compared with other crops. To ensure food security and poverty eradication the objective should be to increase production levels as well as hectarage under these crops (See Table DAGP/2/1-1)

Legumes are cultivated in Uganda on a large scale which involves large tracts of land, labour and time. However, yields have been disappointingly low in quantity and quality. There is need to focus on productivity increase based on multiplication and availability of high yielding varieties to exploit potential yields.

The farmer is faced with disease and pest problems. The disease problem may be reduced by use of good resistant varieties, timely planting, weeding, crop rotation and removal of crop residues from previous season before planting. The farmer needs education on these cultural practices.

Table DAGP/2/1.2 Current, targeted and potential yields (kg/ha)

Crop	Current Yields (1996 / 1997)	Targeted Yields At 7.5% p.a (2001 / 2002)	Potential Yields (Research Station)
Maize	1,570	2,224	4,000
Millet	1,559	1,717	2,800
Sorghum	1,501	1,654	2,800
Beans	652	1,008	2,500
Ground nuts	750	1,159	1,500
Cassava	6,688	7,742	18,000
Sweet Potatoes	4,499	5,208	10,000
Irish Potatoes	8,140	12,576	20,000
Bananas	5,840	6,473	12,000
Robusta Coffee	1,690	2,415	3,500
Cotton	310	672	1,500

Source: MAAIF (1998)

(d) Effect of legumes on the management of soils and the environment

Legumes are of benefit to the soil and the environment because of their ability to fix atmospheric nitrogen and being good cover crops. Legumes carry out biological nitrogen fixation (BNF) which maintains and improves soil fertility.

You may need to read about symbiotic fixation of nitrogen.

Legumes are also good cover crops. They are also used in green manuring.

(e) GROWING BEANS *(Phasaeolus Vulgaris)*

Importance

Beans are annual crops widely distributed and grown in Uganda. Beans are mainly grown for their seeds. Leaves and pods may also be eaten as vegetable when young. Beans are therefore an important source of protein, food security and income.

Varieties

There are two groups of beans basing on the growth habit.

The bush (determinate) type: stops growing at the onset of flowering (mostly grown in Uganda). The Determinate (bush) type varieties include: Banja 2, K20, Canadian Wonder, K132, Oba 1.

The climbing type (indeterminate) type: continues to grow after flowering.

The indeterminate (Semi-climbing) type include; Mutikke 4, Mexico 142, Bukala, K131, MCM 1015, MCM 2001.

To date K20 is the most widely grown variety in Uganda. It is named according to location e.g. Nambale in Mpigi, Kamenyamiggo in Masaka, Kachwekano in Kabale.

There has been intensive research in the bean crop in Uganda focusing on the most serious diseases. Since 1985 five varieties have been released i.e. K131, K132, OBA 1, MCM 2001, and MCM 1015.

Growth requirements

You can grow beans on a wide range of soils. However, the best growth is obtained on well-drained fertile loam soil. Bean plants are very sensitive to water-logged conditions. Beans require a lot of rain during the early days of growth and a relatively dry spell as they flower and form pods. A lot of rain at the flowering stage will lead to rotting of flowers and pods. High temperatures cause poor fruit set. Beans grow best between 1000 and 2100 metres above sea level.

Seedbed preparation and planting

Beans do not require a fine seedbed since they have large seeds. Where a tractor plough or an ox-plough is used, first and second ploughing followed by harrowing are enough.

Beans should be planted at the beginning of the main rains. Avoid bean seeds which are damaged and wrinkled. It is preferable to sow seeds which are dressed with Captan or Thiram. Where the bean fly is a problem the seeds should be dressed with Aldrin or Dieldrin.

Hand planting is common although ox-planters or tractor-drawn mechanical planters can be used on large scale farms. The most suitable spacing is 60 x15cm for hand planting and 66 x 7.5 cm for mechanical planting. About 50-60 kgs of seed will be needed for every hectare of land to be planted.

Fertilizer application

Apply 200 kg/ha of DAP along the rows several days before planting. At the beginning of flowering apply a top dressing of DAP at 200 kg/ha.

Weed control

Weeding is commonly done by the use of a hand hoe. Keep the field clear of weeds by shallow weeding. Weed early and avoid weeding during flowering or when the field is wet. One or two early weedings are adequate. Beans are susceptible to most herbicides.

Pest and disease control

Most of the pests and diseases that attack growing beans can be controlled by using clean commercial seeds or clean seeds selected by the farmer, early planting, destruction of crop residues and crop rotation. So good crop husbandry practices should be emphasized. In addition, pesticides (chemicals) can be used and instructions for their application should be strictly followed.

Table DAGP/1/2.3 The major pests of beans

Pests	Damage	Control
Bean fly (Melanagromyza Phaseoli)	- Larvae attack base of stem and pupate inside the stem: The stem swells and cracks (splits), - Weak and stunted plants. The plant dies; sometimes adventitious roots appear above the damaged region. Yellowing of seedlings that later die.	Seed dressing with Aldrin, Dieldrin or Endosulfan / Thiodlan - Early planting, mulching. Crop rotation, Clean culture (removal of crop residues), destruction of volunteer plants, use resistant varieties. -Spray with Diazinon, Dimethoate, Fenitrothion or Fenthion: repeat spraying after one week.
Bean aphid (Aphis fabae)	- Small soft black or green wingless insects cluster around the stems, branches, pods on the underside of leaves and growing points. - Suck cell sap from the plants and prevent normal growth, cause distortion and yellowing of leaves. Transmits bean mosaic virus.	- Spray with Menazon, Endosulfan, Diazinon, or Fenitrothion, Ambush, Pirimicab. - Early planting.
American bollworm (Heliothis armigera)	- Young caterpillars (larvae) feed on flowers, leaves, buds and bore into young pods. Eat most of the contents in the pod. - Older caterpillars bore into large pods and eat the seed; bored pod wilt.	- Spray with Endosulfan, Dimecron or Dichlorves. - Crop rotation.
Maruca (spotted borer) Maruca testularis)	Bore into the pods and damage seeds	Spray with Demecron or Endosulfan.

Read about more pests of beans in Common Agriculture Text Books listed in the references.

Table DAGP/1/2.4 The major diseases of beans

Disease	Symptoms / Damage	Control
Bean rust (Uromyces phaseoli)	- Small red-brown pustules (pimple-like) on the underside of leaves. Dark green hollow forms on the corresponding upper surface. Reduced leaf area for photosynthesis. Eventually causes leal drop. - Disease is spread by rain splash.	- Use of resistant varieties. - Destruction of infected crop residues. - Spray with Dithion-Carbamate or Mancozeb.
Bean anthracacnose (Colletotrichum lindemuthianum)	- Brown to black sunken marks (lesions) on pods, stems and leaves. Affected pods and seeds rot and are unsaleable. Lesions on stems and petioles reduce yields.	- Use resistant varieties. - Destroy or burry crop residues. - Crop rotation. - Spray with Benomyl, Mancozeb or Dithane M.45, a copper fungicide. - Dithiocarbamate sprays.
Angular leaf spot (Phaseisariop;sis griseola)	- Small brown angular spots develop on the upper leaf surface. - They have straight edges formed by the leaf veins. The under surface turns black and hairy. Causes leaf fall. Raided brown lesions on the pods damage seed and lowers the quality.	- Use resistant varieties. Burn crop residues, Crop rotation. Use clean seeds. Spray with Zineb, Benlate, Diathane M45 (though uneconomical).
Common bacterial blight (CBB) (Xanthomonas phaseoli)	- Many small dark brown spots on leaves whose centres may fall out leaving holes. - Pods may rot during wet conditions or fail to develop - Seed discoloration	- Uproot and burn infected pants. - Plant resistant varieties. - Practice crop rotation. - Use clean seed. - Eliminate weed reservoirs.
Bean mosaic (virus)	- Leaves are mottled and lose their green colour - Brittle and distorted leaves - Plants are stunted	- Uproot and burn infected plants. - Spray Aphids to prevent the disease - Use certified seeds.

Please refer to Principles and Practices of Agriculture Vol. 1, for more information on diseases of beans.

Harvesting and storage

Green beans: Harvesting of the pods begins about 9 weeks after sowing and continues for about 2 months. Pick at regular intervals to maintain quality. After the pods have been picked they should be graded and marketed as soon as possible.

Dry beans: Beans are usually left do dry out in the field. They are then uprooted whole and carried to a dust-free place where threshing is done. The threshed beans should be winnowed, sorted and thoroughly dried before storage. Treat bean seeds with storage pesticides if they are to be stored for a long period.

ACTIVITY DAGP/2/1-4

- Obtain certified bean seeds of different varieties and plant them separately.
- Prepare a one metre by one metre plot for study purposes.
- Plant the beans.
- Make observations about their characteristics as they grow.
- This activity gives you opportunity to follow the crop up to harvesting and put in practice what have learnt. (Weed control, fertilizer application, disease and pest control).

Discuss your observations with colleagues.

f) GROWING GROUNDNUTS *(Arachis Hypogea)*

Importance

Groundnuts are important as a protein source (soup), as a source of edible oil (about 45%) and as a confectionery. Groundnuts are highly nutritious food rich in protein, vitamins, minerals and oil. The residual groundnut cake can be fed to livestock as a concentrate. The foliage or haulms provide a valuable fodder (rich in protein) for livestock. Groundnuts sold in local markets are an important source of cash for households.

Plant characteristics

The Plant is an annual, herbaceous low growing legume. Flowers are produced above the ground and the fertilized ovary (peg) bends and grows into the ground. Groundnuts are self-pollinated.

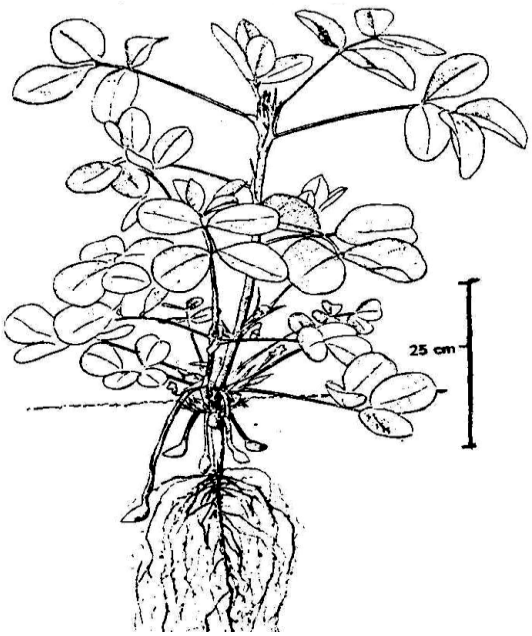


Figure DAGP/2/1-3 A groundnut plant

Varieties

According to the growth habit of the stem the varieties fall into two groups namely; the erect, bunchy type (erect bunch) and the spreading or runner type (recumbent with spreading branches)

The erect types have erect central stems and numerous lateral branches. These are known as the Spanish-Valencia type and generally mature earlier than the spreading type. They are easier to harvest with machines than the spreading ones. Varieties in this category include Bukene, Roxi, Natal Common, Acholi white.

The spreading types have short erect central stems with creeping lateral branches that grow horizontally along the ground. These are known as the Virginia type. Examples include Mani Pintar, Mwitunde, Mukulu Red, Homa Bay.

Currently there are three commercial varieties grown in Uganda namely: Roxi 531, Red Beauty (B1) and Igola.1.

Variety	**Example**	**Maturation Period**	**Mean oil content %**
Valenicia group (erect bunch)	B1	90 – 100	48 and above
Spanish Group	Bukene	100 – 110	44 of less
Virginia group (Spreading)	Igola 1	120 - 130	46 - 48

Growth requirements

Groundnuts grow well in almost any type of soil except heavy clay soils low in organic matter. Well-drained light, sandy, loamy, friable and fertile soils are preferred since they facilitate harvesting. Calcium deficiency leads to poor seed formation and empty shells or 'pops'.

Warm climate and ample sunshine during the maturing and harvesting time are required**.** Reliable well-distributed rainfall (100-1200 mm) is essential from planting to harvesting.

Seedbed preparation and planting

Ensure a well-tilled, clean soil that facilitates the close planting necessary for groundnuts. The seedbed is usually flat and level but elevated seedbeds are also used.
Sowing begins at the onset of the rains to avoid serious losses through diseases such as groundnut rosette. There is need to dress the seeds with a Thiram/Lindane mixture (113g for every 45 kg of seed) to improve seed emergence. Alternatively buy and use already dressed certified seed. Groundnuts can be broadcast by hand, sown by the chop and plant method or planted using a planter.

Spacing

Recommended spacing is 45 cm x 10 cm for the bunch types (B_1) and (Igola – 1) in row planted crops. Close spacing reduces the incidence of groundnut rosette, spread by aphids and increases yields. Close spacing also increases plant height, reduces spread, total size, and reduces number of mature pods per plant and undeveloped fruiting pegs. It also results in a decrease of average kernel size, lowers grading qualities, and reduces weed competition.

When hand sown, the seed rate is about 66 kg per hectare but when mechanically drilled a lower seed rate of 44-45 kg per hectare is sufficient.

Fertilizer application

Before planting, Single Super Phosphate (SSP) should be applied at a rate of 125-250 kg/ha. Farmyard manure applied before planting gives good results. Lime increases the shelling percentage hence reducing the proportion of pops.

Weed control

Careful clean weeding with a hoe is necessary in the early stages of growth before flowering. The soil should be loosened to facilitate easy penetration by the pegs. Weeding after flowering may interfere with the growth of the pegs and therefore should be avoided. Ox-drawn implements maybe used for weeding.

Pest and disease control

Table DAGP/1/2.5 The major pests of groundnuts

Pest	Damage	Control
Aphids *(Aphis Craccivora)*	- aphids suck the cell sap from young leaves and growing points. - Close spacing, - Cause abnormal growth and transmit groundnut rosette virus	- Early planting, - Spray with Menazon, Endosulfan, phosphamidon
Thrips *(Teaniethrips sjostedii)*	- suck the cell sap, - Cause leaf wrinkling, - May cause wilting in dry weather	

Other pests are millipedes, ants, leaf hoppers, beetles and leaf eating weevils. These cause damage to various parts of the plant. No effective control measures have been recommended against these pests.

Table DAGP/1/2.6 Major Diseases of groundnuts

Disease	Symptoms	Control
Groundnut Rosette (Virus disease transmitted by aphids)	Curling of leaves; leaf mottling / yellowing, shortening of internodes; severe stunting of the plant with little or no yield; the plant becomes dwarfed and bunched; the plant withers and dies.	- Early planting; close spacing in rows; destroying volunteer plants; - Spray with Menazon (APhex 70) Dimecron or Thiodan. - Use clean seed. Uproot and burn infected plants, grow resistant varieties e.g. Igola – 1.
Leaf spot (Fungal disease) *Cercospora personata*	- Dark brown to black spots on leaves of old plants. - Premature defoliation of the stems.	- Early planting. - Seed dressing with copper sulphate dust - Crop rotation - Uproot and burn infected plants / plant residues. -
Bacterial wilt *Pseudomonas, Solanacearum)*	Pale coloured leaves and general wilting of the plant.	Grow resistant varieties.
Aflatoxin *(Produced by Aspergillus flavus*	- The fungus grows inside the nut kernel especially in those damaged and incompletely dried. - The fungus secretes aflotoxin which can cause cancer of the liver. - It reduces the quality of the groundnuts.	- Rapid drying to a moisture content of 10%; Reduce damage to groundnuts during harvesting; harvest in good time.

Harvesting

A groundnut matures in 4-5 months. Harvest when the kernels are fully-grown and seed coat has turned pink or red.

Maturity is also indicated by shells turning dark brown.
The husks at this time should be hard to crack. Shedding of leaves also indicates maturity.

Harvesting is done by hand i.e. uprooting the crop; leave the crop for a few days to dry and remove the pods from the plants. Allow further drying of the pods before storage. Groundnuts with undamaged pods can be stored without risk of insect or fungal attack.

Shelling (decortication)

Groundnuts are shelled by hand, which is laborious and time-consuming. There are hand-operated machines, which can make shelling easier. The shelling percentage of groundnuts is 65-75%. The nuts are stored in the pots, packed into jute bags or granaries.

ACTIVITY DAGP/2/1- 5

1. What are the effects of close spacing in groundnut growing?
   ……
   ……..
   ……..
2. Obtain groundnut seeds of different varieties and plant them separately. Make observations and carry out cultural practices learnt as the crop grows.


Discuss your observations with colleagues.

Please select at least one of the following and study in detail:
Soyabean, garden peas, pigeon peas, cowpeas

TOPIC 3 ROOT AND STEM TUBER CROPS

These crops have swollen roots or underground stems in which large quantities of starch are stored. A root crop is one which is grown for its enlarged roots while a stem tuber crop is one grown for its enlarged stem. Cassava, sweet potatoes, yam and the Irish potatoes are the main root and stem tuber crops grown in East Africa. Would you identify the carrot as a root crop or as a vegetable? It is both!

Most of the root crops are eaten in the homestead but a few are sold in markets. They are the most important staple food in the tropics after cereals.

(a) Importance of root crops to humans and animals

Root crops are important to man and animals because:

1. they are able to grow in a variety of soil types and give good yields even under poor soil conditions.

2. they are cheap to produce since they do not require a lot of labour in their production.

3. they are good "reserve" crops in times of famine because they may be kept in the ground until required and are therefore available all year round.

4. They are fairly resistant to pests and diseases.

5. they require very little processing after harvesting.

6. they make good livestock feeds.

Now you may be able to determine those features of root and tuber crops that make them so important to man. Later on in this topic, you will have an opportunity to examine a root crop in detail and relate these features to that crop. Let us now examine the main constraints to production of root crops.

(b) Characteristics of root and tuber crops

The main storage organ of those crops is the root or stem tubers that are primarily filled with starch. These organs are cylindrical/ round in shape and increase in size as long as the plant is green and they are not harvested. The number of roots or tubers in cassava and the Irish potato vary from five to ten. The leaves of the crops vary in shape, size and colour depending on the variety. The leaves of cassava are compound and pinnate while those of the Irish potatoes depend on the variety cultivated.

(c) Production levels and constraints in the production of root and stem tuber crops

The constraints to increased production of root crops are that root and stem tuber crops are bulky and therefore difficult and expensive to transport. The high moisture content in the tubers and roots often means that they cannot be stored for long without getting spoilt. It is possible to get around this problem by drying the roots and stem tubers. They also have low levels of vitamins, minerals and fats that make these crops "incomplete foods" that require the addition of legumes and

other protein sources to make balanced diets. Planting materials are often difficult to prepare, obtain, transport and store since they are usually vegetative parts of the plant and not seeds.

(d) Growth requirements of root and tuber crops

All the root crops mentioned in this topic grow well in East Africa. Most of the root and tuber crops have similar growth requirements. Most of these crops have varieties that are adapted to growing conditions that range from swamps (yam) to semi-desert (cassava).

They are all fairly drought-resistant after planting and are usually grown in the humid regions of the tropics where temperatures range from 25^0C – 29^0C. These areas also have rainfall between 500-5000 mm of rain a year. They may be grown in a wide range of soils, but loose, deep friable soils with a lot of humus are the best for tuber development. Shallow or stony soils are not suitable for these crops because these conditions restrict tuber development. The soils should not also be too fertile since this leads to excessive vegetative growth and therefore poor yields of root / stem tubers. These crops are able to produce a reasonable yield in soils with less readily available soil nutrients. They all have a high requirement for the element potassium and will respond poorly to other fertilizers if the potassium content in the soil is low. Potash should be added at planting.

(e) Effects of root and tuber crops on management of soils and the environment

You may already know that root and stem tuber crops are not very demanding crops to grow. They do not use a lot of soil nutrients like cereals or even legumes. So there is little immediate effect in the fertility of the soil. Root crops could be one of the most environmentally friendly (or benign) crops to grow when the soil is covered by cover crops to prevent soil erosion.

One environmental problem with root crops that is important today is the disease problems brought about by the use of infected or susceptible planting materials, which spread to diseases. The African Cassava Mosaic Virus (ACMV) has been a big problem in Uganda in recent years. It maybe controlled through the planting of disease resistant varieties. The yam also suffers from a mosaic disease, which may be controlled in the same say. If these types of diseases are not controlled, epidemics of disease leading to great losses in yield can result.

(f) GROWING OF CASSAVA *(Manihot ssp)*

Cassava is a root crop of humid areas, although the crop itself is fairly drought resistant. It is a herbaceous perennial which lasts for several years. It may grow to a height of about 5m.

☞ **Note**: *Cassava has been discussed under annuals for convenience in classification and also because some varieties mature within a year.*

Growth requirements

The best soils for cassava are sandy loams, which are well drained. For good tubers, a temperature of 20^0C and an annual rainfall of 500-5000 mm is optimum. The cassava plant is sun-loving but the crop does not use a lot of nutrients from the soil.

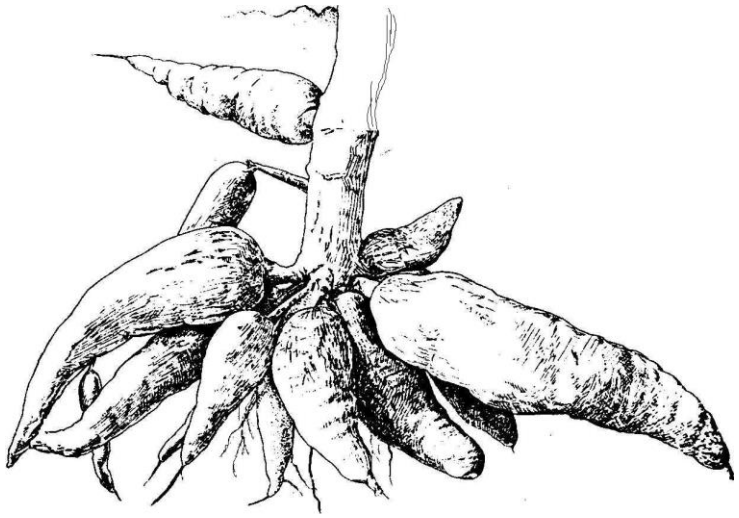


Figure DAGP/2/1-4 Cassava root tubers

Varieties

There are many varieties but they are often classified under two main groups:

(a)	*Manihot asculenta*	-	bitter poisonous type
(b)	*Manihot palmate*	-	generally called sweet e.g. Bukalasa 8, Bukalasa II, Nase 1

The most important factors when choosing varieties to grow in an area are the yield, dry matter content and disease resistance.

Seedbed preparation and planting

The seedbed should be deeply ploughed or dug and worked to a rough tilth. Cassava is usually grown from stem cuttings. Stems from a previous crop are retained and cut into 20-30 cm lengths. Each piece is planted at an angle, vertical or horizontal. They are planted a distance of 1 m x 1 m but closer distances may be used in more fertile soils. It is important that all planting materials are taken

from virus-free plants. It is best that planting is done at the start of the rainy season as this gives the best yields.

Fertilizer application

The application of fertilizers and manure is not recommended since the extra benefit does not justify their use.

Weed control

Cassava suffers from weeds in the early stages of its growth and clean weeding is important in the first 4 months of growth. Intercropping in the early stages can help to reduce weeds.

Pests and diseases

Cassava hardly suffers from pests but has several important diseases.

Table DAGP/2/1.7 Diseases of cassava

Disease	Symptoms	Control
Cassava mosaic (virus)	Stunted plants. Leaves Mottled, discoloured, Deformed.	- Use of resistant varieties. - Clean planting materials. - Uprooting and burning infected plants. - Use insecticide to control the white fly which spreads the disease.
Brown streak	Marks on stems, lesions On stems and roots	- Use of resistant varieties. - Clean planting materials.

Harvesting and storage

Harvesting is normally done piecemeal or by uprooting whole plants. The tuber is dug out using a jembe or a stick. The tubers may be picked and cut and then allowed to dry for about a week. The crop may be then stored.

(g) GROWING IRISH POTATOES *(Solanum tuberosum)*

This is an example of a stem tuber crop. Irish potatoes are sometimes called European or English potatoes to distinguish them from the sweet potatoes. Irish potatoes are grown in almost all districts in Uganda. However, intensive potato production is mainly in highland areas especially in the districts of Kabale, Kisoro, Rukungiri, Mbarara, Kasese, Kabarole, Mbale and Kapchorwa. Other low altitude districts such as Mubende, Masaka and Nebbi also grow a lot of Irish potatoes.

In Uganda, potatoes are grown as both food and cash crops. Nutritionally potatoes provide carbohydrates, vitamins and proteins.

Growth requirements of Irish potatoes

For good growth, potatoes require regular rainfall of about 25 mm per week. Moderate rainfall gives yields because too much rainfall encourages the spread of diseases. It is preferable to have rainfall for at least 3 months of the growing season. Potatoes prefer cool conditions; therefore they grow best above 1500 metres above sea level. They require fertile, free draining soils which are loose and easy to penetrate.

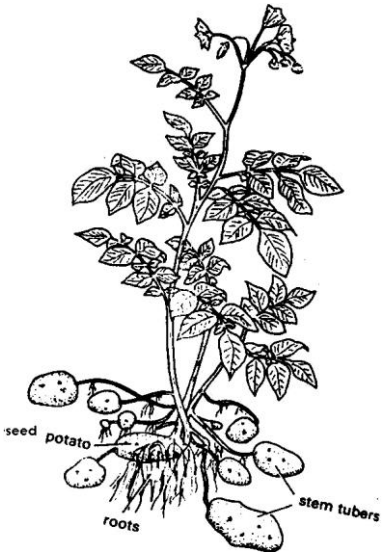


Figure DAGP/2/1-5 Irish Potato Plant

Varieties

The most common varieties grown in Uganda are:

- Victoria: with a red skin colour and oval shape.
- Kisoro: has a cream skin with pink specks and apical end.
- Kabale: skin colour is cream with purple specks and round shape.
- Uganda II: Red skin colour and round oval shape.
- Cruza: cream with purple specks on the skin and oval shape.
- Sangema: red skin colour and round shape
- Malirahinda: white/cream skin colour and round shape.

Planting

Potatoes are mainly propagated from seed tubers. To avoid serious diseases, use certified seed potatoes. It is better to plant at the beginning of the rainy season. Planting can be done on flat, ridges or furrows. When planted on flat ground, they should be earthed up later on to avoid the growing tubers to be exposed to light. If they are exposed to light they turn green and green potatoes are poisonous. Earthing up also protects the tubers from the potato tuber moth.

When planting on ridges, spacing should be 60 - 70 cm apart at the crest and the potatoes planted 25-30 cm apart in the ridge. They should be planted about 10 cm deep in the ridge but a little deeper if grown on a flat land.

Fertilizer application

Potatoes respond well to fertilizers and manures. However, manure should be mixed well with soil before planting. Apply 500 kg/ha of DAP before planting. On acid soils apply 200 kg/ha of DSP and 300 kg/ha of CAN instead of DAP.

Weed control

Weeding is usually by hand and is only necessary during the first weeks of growth. After this the crop's leaves shade the ground and suppress weed growth.

Harvesting and storage

Potatoes take between 18 to 22 weeks to mature, depending on the variety and growth conditions. Harvesting is by loosening the soil with a digging fork/forked hoe or a blunt stick and carefully raising the plants.

Potatoes should be stored in a cool dark place. If kept in light they turn green and such potatoes should not be eaten as they are poisonous.

Pests and disease control

Pests

There are many pests that attack the Irish potatoes. All these pests feed on the leaves of the potato. When the leaves are destroyed the plant is unable to make food for storage in the tubers. These pests can be controlled by using insecticides such as Thiodan.

Another important pest of Irish potatoes is the potato tuber moth. The moth lays eggs on potatoes in the field or in the store. The caterpillars burrow into the tubers, making black tunnels.
It can be controlled by:

- Planting the potatoes as deeply as possible and earthling up to at least twice during the growing season.
- Harvesting and storing potatoes in the morning or early afternoon.
- Keeping tubers in clean cool store.
- Spraying with Ambush, Tenitrothion, Malathion or Actellic.

Table DAGP/2/1.8 Diseases of Irish potatoes

Disease	Symptoms	Control
Potato Blight (Fungal disease) Also called Late Blight	Brown spots on the leaves which eventually rot. Tubers may also be damaged	- Plant resistant varieties - Spray routinely with copper fungicides e.g. Dithane M45.

Table DAGP/2/1.8 Diseases of Irish potatoes(ct'd)

Disease	Symptoms	Control
Bacterial wilt	The plant wilts suddenly and dies. A tuber from an infected plant when cut open and squeezed produces white juice.	- Uproot and burn infected plants. - Crop rotation. - Plant resistant varieties. - Use certified seeds.
Early (dry) Blight (fungal disease)	Brown, ringed spots develop on the leaves.	- Spray with copper fungicides

ACTIVITY DAGP/2/1-6

1. For a named root or tuber crop:

   (a) Describe how it is important to humans and animals.

   ……..
   ……..
   ……..
   ……..

   (b) How it is propagated and planted.

   ……
   ……
   ……
   ……

✓ Check your answer with those given at the end of the Unit.

You are half way though the Unit. Good progress!

TOPIC 4 FIELD CROPS

(a) Introduction

Field crops are a group of crops, which may not be related biologically, but they are grown mainly for sale. In a farming system, field crops normally occupy a larger acreage than food crops. Most of the crops in this group are grown as annual crops although some of them have perennial characteristics. You are going to cover growing of cotton as an example of fibre crops; sunflower and simsim as oil crop and tobacco.

In this topic you will able to learn how to grow these crops and thereby be in a better position to teach your pupils how to grow these crops. You should also be able to demonstrate the skills involved in the grouping of these crops.

(b) GROWING OF COTTON *(Gossypium hirsutum)*

Importance of cotton to humans and animals

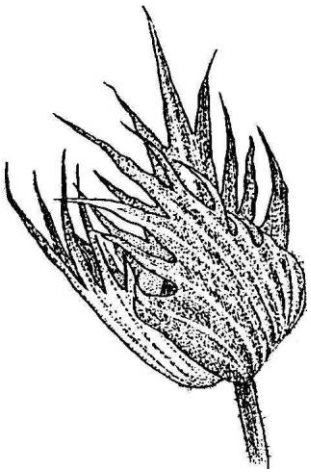
1. Cotton is the most important fibre crop in the world. It produces lint which can be spun into yarn and used for the manufacture of cloth.
2. Oil extracted from the cotton seed is used for the manufacture of cooking oil, margarine, soap and other by-products.
3. Cotton seedcake, which is the residue, left after the extraction of oil from the cottonseeds has a high protein value and is used as a livestock feed.
2. The short hairs called Fuzz or Linters removed from the seed coats can be used for the manufacture of carpets, rugs, mattresses etc.
3. Cotton lint is used in hospitals for a variety of purposes.
4. Cotton is a traditional cash crop grown in most of northern and eastern regions of Uganda.

Can you think of any more uses of cotton?

Plant Characteristics

Cotton belongs to the family of plants known as *Malvacae*. The cotton plant is a biennial plant but it is grown as an annual crop. After harvesting, the stems are often cut and burnt. The tap root can grow up to a depth of 2 metres or beyond. However, most of the lateral roots of the cotton plant is concentrated within the top 30 cms of soil.

Cotton has two types of branches, namely the vegetative branches , also called *monopodia,* arising from lower down the plant and reproductive branches called *sympodia* produced by the upper nodes. Vegetative branches also produce reproductive branches at their nodes. The reproductive branches (sympodia) give rise to flowers which develop into fruits called bolls. Immature flowers are known as squares. At maturity, the bolls split to expose the lint which is picked as the cotton crop.



A cotton square

A cotton flower

An unopened cotton

An open cotton boll. *Figure DAGP/2/1-6*

In Uganda, two types of cotton have been developed namely; SATU (Serere Albar Type Uganda) for the areas with mono-model pattern of rainfall and BPD (Bukalasa Pedigree Albar) for areas with bimodal pattern of rainfall.

Growth Requirements

Cotton is a tropical crop which requires a long dry season for ripening and drying of the bolls. It does well in areas with 750-1200 mm of rainfall per year. Cotton grows well on a wide range of soils but prefers well-drained and deep soils that are high in natural fertility.
Slightly acidic (pH 6.5-6.9) and slightly alkaline soils (pH 7.0-7.5) are needed before planting cotton.

Field maintenance

Seedbed Preparation

Cotton is often grown as a first crop after clearing the field. The land must be prepared in time for planting and should be free of perennial needs.

In Uganda, cotton is planted on a flat seedbed but it can also be planted on ridges that run approximately along the contours. Planting on ridges is good where the soil is likely to be easily eroded by water as it runs down the slope.

Planting

The optimum time for planting cotton in Uganda varies. In the monomodal rainfall areas, the optimum time for planting cotton is mid April to mid June. In the bimodal rainfall areas, the optimum planting date is mid May to July. This is because the plants would still be young and their moisture requirement is still low by the time the June/July dry season sets in. They are therefore more able to survive the dry season.

Spacing

Cotton is planted in rows of 90 cm apart with plants spaced at 30 cm apart within the rows. Two plants are allowed in one hole with this spacing. Where only one plant is left per hole, as it is recommended for Northern and Eastern Uganda, the spacing is 60 cm between the rows and 15 cm within the rows.

Thinning

Thinning is the removal of excess plants from each hole to leave one or two healthy plants per hole. Thinning must be done as soon as possible after the first weeding. The plants at this stage would be 10-15 cms high. Delay in thinning leads to unnecessary competition among the plants leading to weaker plants that inevitably give poor yields. Thinning should be done when the moisture contents of the soil is right. In very dry soils, the roots of the plants left behind may be damaged as the unwanted plants are removed.

Weeding

Weeding must be done as soon as possible after the plants have produced true leaves. Cotton is a slow growing crop and suffers greatly from competition if left to stay in weeds. The first weeding often coincides with thinning. Two or three more subsequent weedings are necessary before the crop is harvested. If weeds are poorly controlled, harvesting may become difficult and weed seeds or parts may get mixed up with the lint making sorting very difficult. Weeding is often done by hand using hand hoes. Ox-drawn weeders are also being introduced especially in places where ox-cultivation has been developed. Herbicides may also be used but the use of herbicides in control of weeds in cotton is not yet popular.

Fertilizer & Manure Application

Most of the cotton in Uganda is grown without the use of manures or artificial fertilizers. This is probably because cotton is grown as a first crop after virgin or fallow land has been cleared and the nutrient status of the land is still high.

Generally cotton responds quite well to added nitrogen and phosphate. Too much nitrogen encourages vegetative growth at the expense of lint production. Phosphatic fertilizer e.g. Single Super Phosphate should be applied at planting at the rate of 250 kg/ha followed by nitrogenous fertilizers used as a top dressing at

a rate of 125-250 kgs/ha. Compound fertilizers such as NPK or DAP (Di-ammonium Phosphate) may also be used at planting.

Cotton responds very well to application of farm yard manure applied at the rate of 7-15 t/ha. However, few farmers use manure possibly because of the difficulty of obtaining sufficient manure and transporting it to the garden.

Pest and disease management

Cotton is attacked by many pests and diseases. The damage to cotton is greatest after flowering.

Table DAGP/2/1.9 Pests of cotton

Pest	Damage	Control
American bollworm *(Helicoverpa armigera)*	Feed on squares, flowers, young bolls, bore into older bolls destroying the content of bolls	Spray with appropriate insecticides e.g. Endosulfan
Bollworms e.g. Spiny bollworm, Pink bollworm, False codling moth	Bore into mature bolls eating and destroying the contents of the bolls i.e. lint and seeds.	Spray with insecticides e.g. Endosulfan at the onset of flowering and during boll development
Cotton stainers *(Dysedcus sp)*	Lint stained yellow and destroyed	Insecticidal sprays.
Cotton Aphids *(Aphis gossypii)*	Suck sap from leaves and growing pods causing leaf curl and stunting.	Insecticidal sprays

Table DAGP/2/1.10 Diseases of cotton

Disease	Symptoms	Control
Bacterial Blight/Black arm/Angular leaf spot *(Xanthomanas)*	Seedling collapse, Dark angular sports on leaves, death and blackening of branches, rotting of bolls.	-Seed dressing with fungicides. -Use of resistant varieties e.g. SATU & PBA
Wilts: Fusarium wilt *(Fusarium oxysporium)* Verticilium wilt *(Verticilium dahliac)*	Plants wilt and die. Yellowing of leaves.	-Seed dressing -Use of resistant varieties
Anthracnose *(Glomerella gossypii)*	Red spots on leaves, Stems and bolls. Bolls may not open.	- Fungicidal seed dressing - Crop rotation.

Harvesting, Processing & Marketing

Harvesting begins when the first bolls open to reveal the lint. Most of the crops in East Africa is picked by hand. The lint is picked as and when the bolls open. Care must be taken not to mix the clean lint with dried leaves or weed parts,

otherwise sorting these foreign materials from the clean cotton lint can be very tedious.

Separation of the clean lint from the stained lint and foreign materials is known as sorting. The damaged lint is known as "Fifi" and it fetches very little on the market. The clean lint or "Safi" is sold at a higher price.

Seed cotton i.e. cotton lint together with the seeds is sold to private buyers who transport it to ginneries where the cotton is ginned; that is the lint is separated from the seed. The lint is then baled and exported or used in the textile industry.

ACTIVITY DAGP/2/1-7

1. Explain what is meant by the following terms:

   Monopodial branch
   ……..
   ……

   Sympodial branch ……..
   ……

2. Why is the optimum planting season for cotton different in Northern and Eastern Uganda from that in the Southern parts of Uganda?

   ……
   ……
   ……

3. Give reasons why cotton fields must be kept weed free?

   ……
   ……
   ……

✓ Check your answers with those given at the end of the Unit.

Effects of cotton on management of soils and the environment

Cotton is a crop that is often grown as a sole crop, simply because the lint is easier to harvest this way. This however, leaves the soil exposed to intense wind and rain. This could lead to soil erosion and a fall in soil productivity.

How might this problem be solved?

Cotton is also a demanding crop in terms of nutrients. Reasonable amounts of nitrogen and phosphate (up to 250 kg per hectare) are needed to get good yields. Cotton also requires large amounts of calcium and sulphur. Therefore the cultivation of cotton over many seasons in the same piece of land could lead to a decline in soil fertility if fertilizers are not used.

Another reason for not cultivating cotton continuously in the same piece of land is that pests and diseases build up very quickly if this is done. Some cotton pests easily attack other crops if cotton is not present. For example, the American bollworm which is a caterpillar that easily attacks other crops e.g. maize.

You may now see that cultivation of cotton for long periods of time leads to problems of soil fertility and pests and diseases. This is not good for the environment and the farmer.

c) GROWING TOBBACO *(Nicotina tabacum)*

Introduction

Tobacco is an important cash crop in Uganda. There are two main varieties grown namely Flue-cured and Fire-cured tobacco. Flu-cured tobacco is the main type of tobacco grown on commercial scale although in some areas of southern Uganda, fire-cured varieties are still grown at subsistence levels.

The production of tobacco is facing a threat from the worldwide campaign against smoking. Smoking has been shown to be associated with development of cancer in human beings apart from causing a number of respiratory diseases. In spite of this, tobacco production is still being encouraged in Uganda and the country earns good revenue from the exportation and local consumption of tobacco.

(a) Plant characteristics

The tobacco plant is annually grown to a height of 1.2 – 2.4 metres high, depending on the variety. The rooting system is concentrated within the top soil and rarely goes deeper than 1.2m. The plant produces from 20-30 large leaves. The hairs on the leaf surfaces secrete oils and gums which are responsible for the flavour of tobacco when it is processed.

New suckers can develop from the lower leaf exits when the top part of the plant is removed during harvesting. However, these suckers do not produce a good crop.

Figure DAGP/2/1-7 Tobacco Plant

Growth Requirements

Tobacco requires well-distributed rainfall especially in the first 3 ½ months after transplanting. Rainfall must however not be excessive or unreliable if a good crop is to be obtained. Tobacco is a medium altitude crop (900m – 1500m).

Sandy loamy soils are ideal for tobacco. Heavy soils must be avoided. There must be a reasonable supply of Nitrogen during the early stages of growth but excessive Nitrogen at ripening destroys the quality of the leaves. The ideal pH is 5.5 – 6-5.

Planting in a nursery bed

Tobacco seedlings are raised in a nursery. Tobacco seeds are very tiny and it is difficult to control the seed rate. The seeds are therefore often mixed with sieved wood ash or fine sand and then sown in the nursery. Ten (10) g of seed should be enough to plant one hectare.

Do you still remember how nursery beds are sited and prepared? The same procedure is followed in preparing the nursery bed for tobacco.

Can you explain the processes involved in Nursery bed preparation?

Germination takes place within 6-7 days and the seedlings should be ready for transplanting into the field when they are 6-7 weeks old (about 2 months). Before transplanting the seedlings should be thoroughly watered to avoid danger to the roots. Transplanting should be done in the morning hours and plenty of water supplied after the operation. The plants should be protected from the sun heat.

Planting in the field

Tobacco is planted on ridges which, as much as possible, should be constructed across the slope along the contours at a spacing of 1m (100 cm) apart. The plants are placed at 60 cm apart along the ridges.

Seedlings should be buried into the soil to such a depth that their buds are only about 2.5 cm above the ground. Watering must continue especially where there is little rainfall. Tobacco does best when they are transplanted at the beginning of the rains.

ACTIVITY DAGP/2/1-8

1. List the advantages of planting tobacco on ridges?
   ……
   ……..
   ……..
   ……..
   ……..

2. Why is it very important to ensure that there is sufficient moisture in the soil where tobacco is transplanted?

   ……..
   ……..
   ……..
   ……..
   ……..

3. Do you still remember how nursery beds are sited and prepared? The same procedure is followed in preparing the nursery bed for tobacco.

   Can you explain the processes involved in nursery bed preparation?
   ……
   ……
   ……
   ……

✓ Check your answers with those given at the end of the Unit.

Fertilizer and manure application

Tobacco responds well to application of Phosphate and Nitrogen fertilizers. Nitrogen fertilizers however must be applied in regulated amounts especially for flu-cured tobacco. Too much Nitrogen applied towards the time when the leaves are about to be harvested leads to poor quality tobacco. Twenty to thirty five (20-35) kgs/ha of Sulphate of ammonia is applied within a week of planting. As much as 110 – 170 kg/ha of Single Super Phosphate (SSP) is also applied at planting. Fertilizers should be placed at least 10cm away from the plants to avoid scotching.

Topping or Desuckering

When about 20% of all the plants have started flowering, the tops of the plants should be cut off leaving 16-20 leaves on each plant. This is known as topping. Topping stimulates the production of wider leaves which are of good quality. Suckers that are also stimulated to grow from the leaf axils after topping should be removed from time to time. They should not be allowed to grow longer than 10-15 cms or else they will lead to production of poor leaves.

Weed Control

It is essential that the tobacco crop is kept weed free throughout its growth period (8-9 weeks). Weeding is generally done using hand hoes. During weeding, the ridges are reshaped by heaping the soil around the bases of the plants.

Table DAGP/2/1.11 Pest and Disease Management

Pest	Damage	Control
Nematodes *(Meloidogyne sp*)	Causes roots to swell forming knots interfering with the functions of the roots. Causes poor growth of plants and wilting.	-Fumigate the seedbeds with Nemiticides.
White fly *(Bemisia sp)*	Important in nurseries. Transmits a virus which causes the leaves to curl.	- Control the white fly using Insecticide sprays.
Cutworms *Agrotis sp)*	Cut young seedlings and destroy them.	- Treat the soil with a soil Insecticide e.g. Aldrin or Furadan.
Crickets	Eat the leaves of newly transplanted seedlings.	- Treat soil with soil insecticides.
Frog-eye or Barn-spot *(Cercospora nicotinae)*	Spots on the leaf with pale coloured centres with dark margins.	-Early planting to avoid excessive rains. -Removal of affected leaves. -Spray with fungicides in the nursery.
Brown spot *(Alternaria sp)*	Circular, brown spots on the leaf forming concentric cycles. Spots can also be found on veins and petioles.	-Remove infected leaves. -Control fertilizer application especially Nitrogen.
Damping off *(Pythium spp)*	Sudden death of seedlings in the nursery.	-Control seed population in the nursery. -Avoid excessive moisture in the nursery.
Granville wilt *(Pseudomonas solanacearum)*	A bacterial disease causing wilting starting with the lower leaves and moving upwards. Vascular tissues appear blackened when cut and a milky exudates comes out when squeezed.	Use of resistant varieties.
Mosaic *(Virus)*	Yellow mottling of leaves. Virus is transmitted mechanically.	Avoid smoking when working in the nursery.

Harvesting

The period from transplanting to final harvesting is 4 – 4 ½ months.

Tobacco leaves ripen from the base of the plant upwards. The leaves are removed as they ripen. This is known as **priming**. Ripeness is indicated by the leaves becoming lighter in colour and the mid ribs become whitish.

In flue-cured tobacco up to 3 leaves are removed at a time and this is done at weekly intervals as the leaves become ripe. The first priming is done at about the time of topping i.e. 2-2 ½ months after planting.

Curing

Curing refers to the process of drying the harvested tobacco leaves. There are four main methods of curing namely; air curing, fire curing, sun curing and flue curing.

Air Curing

Air curing involves hanging freshly harvested tobacco leaves in a shed with adequate ventilation. The leaves wilt and later dry naturally without additional source of heat. The process can last from 2-4 weeks.

Figure DAGP/2/1-8 Tobacco leaves hung from a rail.

Fire Curing

This involves the use of smoke to dry the leaves. The leaves are killed relatively slowly to allow the development of the brown colour of the leaves. To achieve this, fresh tobacco leaves are hung in a shed (known as barns) without fire for 4-7 days to allow them to wilt and become yellow. Later, fire is then introduced in the hole on the floor of the barn. The fire should give much smoke and less heat. Fire curing takes from 4-7 weeks.

Sun Curing

Freshly harvested leaves are hung in a shed to allow them to wilt and become yellow before they are exposed to full sun rays. The leaves are put out during the day but put back into the shed at night to prevent them from being wetted by dew or rain.

Sun drying is faster but the leaves tend to be brittle and should be allowed to regain some moisture by hanging them in a shed with moisture supplied on the floor. This prevents breakage of the leaves.

Flue Curing

Flue curing is a relatively rapid process using smokeless heat. Heat is passed through pipes called flues that line the floor and walls of a specially constructed shed known as a barn.

Heat and smoke from a fire outside the barn (See diagram) enters into the flues and circulates round the barn.

The smoke eventually finds its way out through a chimney. The flues are metallic and get heated. This heat is then used to heat up the whole gar by radiation. The temperature and humidity in the barn is controlled by opening and closing the ventilators as necessary. There are 3 stages in the curing process namely,

- Yellowing of the leaf
- Fixing the colour
- Drying the leaf

ACTIVITY DAGP/2/1-9

1. Explain briefly the processes involved in Flue-curing of tobacco.
   ……
   ……

2. Explain what is meant by the following:

   (i) Topping ……
   ……

   (ii) Desuckering…….....
   ……

   (iii) Air curing of tobacco ……..
   ……..
   ……..

   (iv) Fire curing of tobacco …….
   ……
   ……

   (v) Flue curing ……
   ……

✓ Check your answers with those given at the end of the Unit.

d) GROWING SUNFLOWER *(Helianthus annus)*

Sunflower *(Helianthus annus)* is an annual crop with a large flower head which matures to give a mass of oil-rich seeds. Sunflower is able to grow under a wide range of climatic conditions from the tropics to temperate regions. The plant is deep rooting and can grow in areas with rainfall as low as 500 mm a year. The crop needs a dry period in order for the seeds to ripen. Varieties are usually determined by height, yield and oil-content. .

Field operations

The seed may be sown in a fine seedbed in rows 60-90 cm apart at 20-30 cm intervals within a row, at a depth of 4 cm. The crop is susceptible to weed competition and it is important for the seedlings to establish themselves in a weed-free environment. Hand hoeing is often used to carry out weeding. Where available, pre-emergence herbicides are effective against broad-leaved weeds. The plants respond well to additions of nitrogen, phosphorus potassium and fertilizers but it should not be supplied with excess nitrogen as this may encourage lodging

Table DAGP/2/1.12 Pests and diseases of sunflower

Pest / Disease	Symptoms	Control
Birds *(Quelae quelea)*	Depleted flower heads	- Birds scaring method - Timely harvesting
Caterpillars	Defoliation	Chemical sprays
Rust *(Puccinla helianthi)*	Lesions on leaves	- Destruction of crop residues

Harvesting and storage

Sunflowers are harvested when the centres of the heads have turned brown and the outer parts show signs of drying off. Most crops are harvested by hand; the head is cut off and left to dry in the sun after which the seeds are removed manually. The seeds are crushed to extract the oil. The seed residue may be used as a feed for livestock.

e) GROWING SIMSIM *(Sesamum indicum)*

Simsim, also known as Sesame or Veniseed is one of the oldest oil crop cultivated by man. It is an erect herb which grows to a height of 0.5-3 m depending on the variety and the fertility of the soil. Simsim takes from 3-6 months from planting to maturity, depending on the variety grown.

In Uganda, simsim is grown in the warmer parts of the north and eastern regions. It is a crop that is gaining importance as a cash crop although originally it was grown on a subsistence scale.

Growth Requirements

Simsim is moderately drought resistant 400-500 mm of rainfall is required during the growing period. A dry period is required for drying of the pods to allow them to split and release the seeds.

Simsim grows only in warm climate i.e. from sea level up to 1500 m above sea level. Soil must be well drained because simsim does not tolerate water logging. The nutrient content of the soil should be high. As a result simsim is often grown as a first crop after the field has been cleared.

Land preparation and planting

A rough seedbed is preferred for simsim although it must be free of weeds. Germination is often poor if a very fine seedbed is used because during heavy rainfall a fine seedbed tends to cap and make it difficult for the small seeds to germinate.

Simsim must be sown as early as possible in the first rains. In most parts of Uganda, simsim is intercropped with maize, pigeon peas or sorghum. The seed rate is 5.5-9.0 kgs of seed for 1 hectare.

Broadcasting method is generally used and an optimum population of 170,000-200,000 plants/ha is targeted.

Weed control

Weed control must be started early as simsim cannot tolerate high weed competition when it is still young.

Fertilizer

Fertilizers application is not normally required. In very poor soils however, simsim will respond to moderate application of Nitrogen fertilizers (25-30 kg/ha).

Table DAGP/2/1.13 Pest and disease control

Pests	**Damage**	**Control**
Simsim web worm *(Antigastra sp)*	The larvae spin silken webs around the terminal leaves as it feeds on the foliage	Spray with appropriate insecticides.
Gall midge *(Asphondylis sp)*	The larva feed on the contents of the ovary resulting into the formation of galls on the pods.	Spray with an insecticide at flowering e.g. Dimethoate.
Flea beetle *(Aphthona bimaculata)*	Eat up the foliage during the early stages of growth.	Seed dressing with insecticide.

Disease	**Symptoms**	**Control**
Bacterial leaf spot (Pseudomonas Sesami)	Dark brown or black spots in leaves.	No specific control.
Fungal leaf spots *(Alternari sesami; Corcospora sesami); Cylindrosporium sesami).*	Brown leaf spots on all the aerial parts of the plant.	Control is not economic.

Harvesting

Once the fruits are mature plants are cut with a sickle and stacked in a threshing yard for the pods to dry and open.

Seeds are removed from the pods by threshing the dried stems using a stick. The seeds, which are very small, are often collected on mats. They are later cleaned by winnowing.

SUMMARY

In this unit you have learnt about the following:

(a) Various crops and the groups in which they fall.
(b) The constraints in the production of these crops.
(c) Importance of crops to humans and livestock.
(d) How to grow selected crops.

GLOSSARY

Annual	-	a plant that takes up to one year from planting to maturity.
Constraints	-	something that controls what you do.
Cover crop	-	a crop that is planted to protect the soil from erosion by rain or wind.
Embryo	-	the plant that is developing inside the seed.
Environment	-	the quality of the air, water and land.
Fodder	-	food that is given to cows and other farm animals.
Herbaceous	-	soft fleshy plants that are not woody.
Lubricants	-	a substance such as oil that enables a machine to operate more easily.
Lodging	-	falling over of a crop.
Manure	-	wastes from animal and plants that is spread on gardens to make plants grow well.
Oil	-	high energy substances of carbon and hydrogen that are needed by animals as an essential part of their diet.
Perennial	-	plant that live for a long time, more than two years.
Perishable	-	something that decays or gets spoilt quickly.
pH	-	a number that shows how strongly acidic or alkaline substance is.
Pods	-	that part of legume plants that contain or enclose the seeds.
Protein	-	nitrogenous substances used in the growth of plant and animals.
Roughage	-	fibre in animal diets that are essential for the digestion of eaten materials.
Saline	-	containing or consisting of salt.

ANSWERS TO ACTIVITIES OF UNIT 1

ACTIVITY DAGP/2/1-1

1. Some of the cereals you will see will be:
   Maize (Zea mays)
   Sorghum (Sorghum bicolor)
   Finger millet (Eleusine coracana)
   Rice (Oryza sativa)

2a) They are high yielding
 b) They are easy to cultivate and manage
 c) They are easy to mechanise
 d) They are easy to harvest, handle and store.
 e) They are important sources of energy, protein and vitamins
 f) They are used in the manufacture of many products such as animal feeds, beer, starch etc.

ACTIVITY DAGP/2/1-2

1. Cereals remove a lot of nutrients from the soil while they are growing in the field. It is important to replenish these removed nutrients if the soil fertility is not to decline. These nutrients may be replaced by fertilizers or farm yard manure.

   The straw and stubble left in the field after harvest become a source of pests and diseases for the next crop and this is not good for the environment. They should be ploughed into the soil. This also adds nutrients to the soil.

2a) Depending on where you live, the climatic conditions in your area would be either: wet, humid with high temperatures, two rainfall seasons or dry conditions with high temperatures with one rainfall season.

 b) Maize and rice are suited to the wet; humid, high temperature conditions while finger millet and sorghum are suited to the dry, high temperature conditions with one rainy season. This is because finger millet and sorghum are more drought-resistant than maize and rice.

ACTIVITY DAGP/2/1-3

1. - sow the maize in time
   - use the correct spacing
   - apply nitrogen and phosphorus fertilizers or manures
   - control weeds
   - control pests and diseases

2. poor rainfall
   poor soils (not fertile/not deep)
   pest and disease problems
   problems with birds
   lack of fertilizers/agricultural chemicals

ACTIVITY DAGP/2/1-4

1. Some of the legumes you will encounter in your area are:
   Beans *(Phaseolus vulgaris)*
   Groundnuts *(Arachis hypogaea)*
   Pigeon peas *(Cajanus)*
   Soya beans *(Glycine max)*
   Cow peas *(Vigna unguicalata*)
   Grams *(Vigna aureus)*

2. - Erect height
   - Compound leaves, triplicate
   - Presence of pulvin
   - Flower structure (wings, keel and standard)
   - Pods (presence of)
   - Nodules on roots

ACTIVITY DAGP/2/1-5

- The variety that you planted is either the bush type or the erect type.
- The plants have the following characteristics.
- Bush varieties that are determinate and erect.
- Climbing varieties that are indeterminate and not erect.
- Large, smooth leaves arranged in groups of three (trifoliate).
- Flowers are usually white but may also be pink, yellow, purple, etc.
- Seeds are in many shapes and sizes, colours etc (i.e. red, brown, black, white, etc).
- Pods are long, slender and green in the case of beans; short, hardy and brown in the case of ground nuts.
- Roots will have nodules on them.

ACTIVITY DAGP/2/1-6

1(a)
- It is easy to produce since it does not require a lot of labour.
- They are a good "reserve" crops in times of famine.
- They are fairly resistant to pests and diseases.
- They require little processing.
- They make good livestock feeds.

(b) Most of the root crops are propagated from cuttings, cuttings from previous crop trees planted on the flat or on ridges, free cuttings are used. The ground in which the planting is done should be moist.

UNIT 2

PLANTATION CROPS

REF DAGP/2/2

INTRODUCTION

You are welcome to this unit, which deals with growing of common plantation crops in Uganda. You will study the importance of plantation crops and how they affect the environment.

You will study the growing of coffee, bananas and tea in details. Growing of cocoa and sugarcane will be discussed briefly.

AIM

By the end of this unit, you should have gained knowledge about growing different plantation crops. You will also be able to grow selected plantation crops. This is important for you as the teacher and the pupils because of the importance of these crops to the economy of the country and to the farmers.

OBJECTIVES

By the end of this unit you should be able to:

- explain the importance of plantation crops to farmers and the country.
- identify the constraints in the production of plantation crops.
- explain the role of plantation crops in the management of soils and the environment.
- grow selected plantation crops.

TOPICS TO BE COVERED

Topic 1 Introduction

(a) Importance of plantation crops

(b) Production and plantation crops

(c) Effects of plantation crops on the management of soils and the environment.

Topic 2 Growing Coffee

Topic 3 Growing Bananas

Topic 4 Growing Tea

STUDY REQUIREMENTS

You will need a pen and paper as you read this unit to note down the main points. You will also need to visit farmers and plantations to observe crop management practices carried out when growing different plantation crops.

TOPIC 1 INTRODUCTION

Coffee, tea, bananas, sugarcane and cocoa are perennial plantation crops. These crops take more than one year from the time of planting to the first harvest. Coffee, tea and cocoa are grown for the non-alcoholic beverages that are obtained from them. They produce refreshing and popular beverages due to the variable amounts of the chemical, caffeine. They are mainly grown for export. Banana is an important food crop in Uganda.

Coffee is the most valuable commodity in international trade after petroleum and is the most important earner of foreign exchange for developing countries.

(a) Importance of plantation crops to humans and animals

1. They are an important source of foreign exchange through the export of their products.
2. They are often the backbone of a country's economy.
3. They are a source of employment for the labour force.
4. They are an important source of tax revenue for the government.
5. Bananas are a source of food.

(b) Production and constraints in the production of plantation crops

In East Africa, the productivity of plantation or estate crops has been low. This is because the estates are planted with low-yielding seedlings that have not had their breeding improved. Erosion in the estates due to inadequate soil conservation measures have led to declines in soil fertility.

Fertilizers have also not been useful because they have been used at levels that are too low to be profitable. Lastly, the cultural practices needed for good estate management such as transplanting, spacing, pruning, weeding and shade management have not been done optimally.

(c) Effect of plantation crops on management of soils and the environment

Plantation crops need to be cultivated on the same piece of land for a longer period of time than other crops. Because of this, they have greater effects on the soil and the environment than other crops. They primarily affect soil pests and diseases.

Most of the plantation crops remove a lot of nutrients from the soil over time. This leads to greater soil acidity. Other crops find it difficult to grow in acid soils. Lime is required after a plantation is cleared, to remove excess soil acidity.

The level of organic matter in plantations is lower than the levels found in fields of annual crops. This leads to a decline in overall soil fertility. This may be reduced by minimum tillage, mulching, organic manuring and the use of fertilizers.

When land is cleared using heavy machinery in preparation for a plantation crop, severe soil compaction and a decline in soil structure may result. This severely reduces the ability of water to penetrate into the deeper layers of the soil.

The presence of plantation crop on the same piece of land for a long period of time allows for the rapid build up of weeds, pests and diseases. This results in a shift in the ecological balance between host and pathogens.

TOPIC 2 GROWING COFFEE

Importance of coffee

Coffee is a perennial crop used largely to make a beverage. The coffee beans contain caffeine which is a stimulating and mood elevating non-alcoholic beverage.

Coffee is the main export commodity for Uganda hence a source of foreign exchange earnings.

Production of coffee provides employment to rural families and many people are employed in the factories that process coffee.

The pulp and hulls make good manure after decomposition. They can also be used directly as mulch when dry or fed to livestock when wet. Parchment husks are used in charcoal making.

Plant characteristics

There are two types of coffee; Arabica and Robusta. They differ in a number of ways as shown in the table below:

Table DAGP/2/2-1 Characteristics of Arabica and Robusta

Arabica Coffee *(Coffea arabica)*	**Robusta Coffee *(Coffea canaephora)***
- Origin: Arabia; highlands of Ethiopia - Highland species, grows better at cooler temperature (10^0 - 15^0C)	Origin: The Lake region of East Africa Lowland species, grows better in warm climate (15-20^0C).
- A less vigorous slender shrub with slow growth; fruiting starts when 3-4 years old.	- a more vigorous shrub with faster growth. Fruiting starts 2 1/2 -3 years old.
- Self-fertile with compartible flowers.	- Self-sterile with non-compartible flowers
- Produces a higher quality coffee.	- Produces poorer coffee.
- Smaller, smoother, dark green and flat leaves.	- Larger, coarser, pale green and slightly corrugated leaves.
- Fewer flowers develop at each node.	- More flowers and berries develop at each node given adequate water and nutrients.
- Sublateral usually grow from the main lateral branches.	- Sub-laterals very rarely grow from the main lateral branches.
- More susceptible to diseases, antestia bugs and leaf miners.	- Resistant to most pests and diseases except coffee berry disease.
- Dead branches remain on the plant and have to be cut off.	- After bearing the crop for about 3 years the laterals die back and are later shed; hence self- pruning.

Arabica Coffee

Growth Requirements

Arabica coffee grows best at high altitudes (1400-1900 metres above sea level) with low temperatures and humidity. It grows in areas with evenly distributed rainfall throughout the year. Annual rainfall of 1500-2500 mm is ideal. It in requires well-drained, deep and fertile soils and preferably of a volcanic nature, soils with pH 4.2-6.2.

Land Preparation

Requires soils with a good structure, adequate drainage, slightly acidic in nature and preferably of lateritic or volcanic origin. Flat land or undulating slopes are suitable.

The bush should be cleared, land ploughed and planting sites marked and pegged before the holes are dug. Remove all the tree stumps and their roots since they can be a source of infection of the young coffee by the fungi such as *Armillaria*.
The spacing is usually 2.7 x 2.7 m for a pure stand or 3m x 3m for intercropped coffee. After marking out the planting positions, holes of about 60cm square and 60cm deep (60x60x60cm) are dug preferably 2-3 months before transplanting. The fertile topsoil is kept separated from the subsoil. The holes are left open for 3 months.

Holes should be refilled with a mixture of topsoil, organic manure and about 60g of Double Super Phosphate 3-4 weeks before transplanting. Add well rotted compost about 20 litre kerosene tin/debe of compost per hole. SSP may be added.

Top soil plus 1 or 2 debes of well rotten farm yard, compost or coffee pulp plus 100 gms or 5 tea spoonfuls of DAP or SSP

Planting

Arabica coffee is either propagated by seed or by vegetative methods such as cuttings or budding but seed propagation is still widely used. The seedlings are raised in nurseries from seeds obtained from healthy, disease resistant and high yielding trees.

Reflect on how you would successfully raise coffee seedlings in the nursery up to the time of transplanting.

Transplanting should be done at the beginning of the long rains; 2-4 weeks from the onset of rains. Transplant only healthy seedlings. Follow the proper procedure while transplanting. Mulch and provide shade/shelter to transplanted seedlings.

Field management of plantations

Mulch and shade trees

Mulching with dried grass is necessary especially during the dry season. Mulching promotes the growth of feeder roots in the top soil, inhibits weed growth, conserves moisture and improves soil condition and structure. Shade trees may be planted at a spacing of 12 metres after clearing the land to provide shade.

Recommended shade plants/trees include bananas, *Albizzia spp; Grevillea spp; Leucaena ssp, Gliricidia ssp, Tephrosia spp*. Shade prevents overbearing which leads to dieback.

Weed Control

It is necessary to remove weeds, which compete with the seedlings for nutrients and harbour pests and diseases.

Weed regularly taking care to avoid excessive disturbance of soil in the root zone of the plant. The most damaging weeds are perennial grasses such as couch grass. Apart from cultural control of weeds (slashing and digging), herbicides such as Round Up, Touchdown, Basta are effective.

Fertilizer Application

Coffee trees benefit from the application of organic manures. Apply compost or well decayed Farmyard manure around the base of the coffee plants once per a year. Applying Nitrogen, Potassium and Phosphorus fertilizers gives good yields. NPK should therefore be applied in a band about one metre from the base of the main stem.

Nitrogen fertilizers such as Ammonium Sulphate Nitrate (ASN), CAN, SA, Urea, are applied to increase vegetative growth.

Pruning

Pruning is done to remove unwanted suckers from the main stem near the ground. It is also done to remove some of the primaries to avoid overbearing; lateral branches, leaves and primaries touching the ground; old stems which are so high that their crop cannot be reached by pickers and broken, diseased, dead, bare and crossing branches.

What are the benefits of pruning coffee?

Methods of Pruning

There are two common methods of pruning coffee namely; single stem and multiple stem pruning.

(i) ***Single stem pruning:*** This method consists of 'capping' or 'topping' the main stem so as to have one permanent stem. It stimulates the growth of primary branches and sub-laterals on which the crop is borne.

(ii) ***Multiple stem pruning:*** The objective of this method is to train the coffee bush so as to encourage the growth of two or more main branches; unproductive branches re removed. The crop is borne mainly on laterals.

Harvesting

Harvesting (picking) is done when the berries (cherries) are red (mature) and ripe. Picking unripe fruits increases the percentage of shriveled, black, and other defective beans of poor quality. The fruits mature 7-9 months after flowering has taken place. Hand-picking is recommended to ensure high quality coffee. For

taller trees, ladders and hooks to bed down the branches may be required. Harvesting at 2-3 week intervals is expected. The harvested cherries should be processed immediately.

Processing

Coffee is processed in two ways, by the wet method and dry method.

Wet Method

Wet processing involves pulping the fruits as soon as they are harvested. The cherries are first pulped to remove the red, fleshy outer skin, the exocarp and part of mesocarp. This leaves the two beans covered in a tough husk called the parchment which are later fermented, washed and dried.

Details are in the Practical Guide.

Dry Method

Nearly one-third of Arabica coffee in Uganda and all Robusta coffee is dry processed to produce Kiboko. The harvested cherries are dried in the sun, either on cemented drying yard (platforms), wire trays or tarpaulins but not on the ground.

Is this true with farmers in your community? Why shouldn't we dry coffee on the ground.

Pest and disease control

The common pests and diseases of coffee are summarized in the table below:

Table DAGP/2/2.2 The Major pests of coffee

Pest	Damage	Control
Antestia bugs *(Antestiopsis spp)* Dark brown with white speckeles	- Suck old berries causing longitudinal zebra-striping on the parchment. - Suck the flower buds, young berries and growing points. - Feed on the terminal buds of branches causing fan-branching.	- Open pruning. - Spray with insecticides such as Parathion, Dicrotephos, Fenthion and Fenitrothion.
Leaf Miners (*Leucoptera meyricki*) - Small, white, nocturnal moths.	- Larvae feed on leaf tissues by boring - Form communal mines seen as brown blotches on the ripen surface of leaves. - Reduce the photosynthetic tissue. - May cause leaf fall.	- Spray with Parathion and Fenitrothion.
Coffee berry borer *(Hypothenemus hampei)* A low altitude pest	- Larvae feed in the beans boring tunnels and imparting a blue colour to the beans. - Mature beetles survive from season to season by hiding in the dry berries.	- Regular picking. - Field hygiene. - Dieldrin sprays. - Endosulfan (Thiodan) spray.
Mealy bugs *(Plannococcus Kenyae)*	- Form a white mealy mass around flower clusters, fruits and growing tips.	- Apply Dieldrin on the affected parts before onset of rains. - Biological agents (Predators). - Diazinon, Dimethoate or Fenitrothion.

☞ **Note**: It is important to read about other pests not included in the above table from the books recommended as references.

Table DAGP/2/2.3 The Major diseases of coffee

Disease	Symptoms	Control
Coffee berry disease (CBD) – Fungal disease *(Colletotrichum coffeanum)*	-Small, dark brown sunken patches on the flowers, green berries and ripe berries and along the leaf margins. -May cause dieback i.e. blackening and death of laterals from the tips towards the main stem.	- Pruning - Spraying with copper fungicides such as Perenox, Benlate or Captafal.
Coffee leaf rust - Fungal disease *(Hemileia vastatrix)*	- Circular (round) lesions or patches which have orange postules on the lower surface of the leaf. - Reduces photosynthetic tissue. - Causes leaf fall	- Open pruning - Proper weeding - Spraying with copper fungicides such as Diathane M45, Orthodifolata - Growing resistant cultivars.
Coffee wilt disease - Fungal disease *(Fusarium xylaricoides)*	-Leave curl inwards, wilt and become yellow. - Sudden leaf fall - Black or brown videt streaks/bands on the stem when the bark is peeled off. -Cracks of cankers at the collar region.	- Observe sanitary measures - Cut / uproot and burn infected plants - Quarantine

Note: Other minor disease of coffee include Fusarium bark disease, crinkle leaf, hot-and-cold, Elgon die-back, and Armillaria root rot. It would be good if you read about these diseases.

ACTIVITY DAGP/2/2-1

1. What are the beneficial effects of mulching coffee with crop residues, dry grass and coffee husks?

…….
……
……

2. What are the advantages of shade trees for coffee plantations?

……..
……..

3. Outline coffee production constraints in Uganda.

……..
……..

✓ Check your answers with those given at the end of the Unit.

TOPIC 3 GROWING BANANA *(Musa ssp)*

Introduction

Bananas are staple food for most parts of Uganda around Lake Victoria, western Uganda and Eastern Uganda around Mt. Elgon . Bananas are perennial crops therefore they are grown in areas that receive rainfall most of the year. Bananas provide food and income to farmers throughout the year.

Banana production in Uganda is being constrained by declining soil fertility, pests and diseases, marketing and management.

Plant characteristics

The banana plant is a perennial herb and has shallow adventitious roots, arising from the rhizome/corm. The above ground 'stem' is pseudo (false). The true stem grows from the rhizome through the middle of the pseudostem and bears one inflorescence. Many cultivated varieties lack pollen and do not produce seeds when grown in pure-stands Therefore fruits of cultivated varieties develop without pollination. The rhizome has buds which develop in suckers. The suckers that originate from the lower part of the rhizome are called sword suckers while those that originate near the soil surface are called water suckers. Suckers are produced to replace the dead stem. The whole group of stems arising from the corm is a stool, mat or clump of bananas.

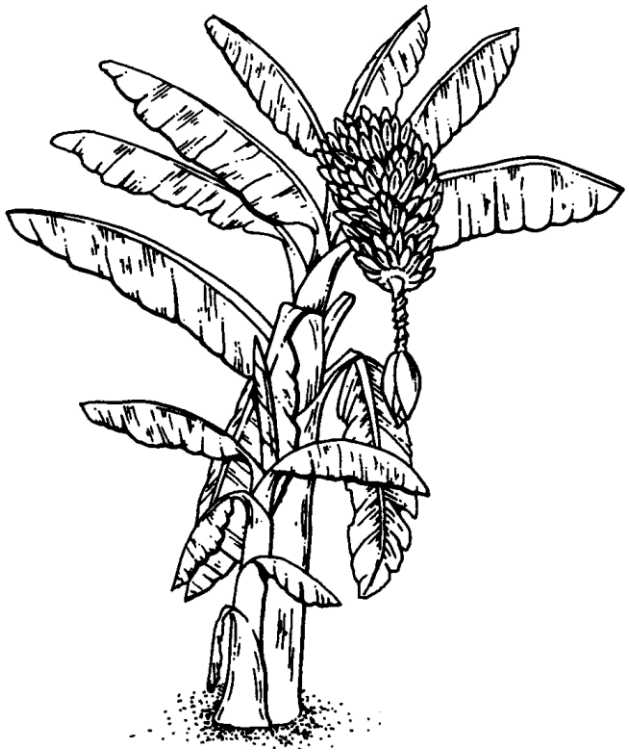


Figure DAGP/2/2.1 Diagram of a banana plant

Varieties

A number of banana varieties exist in Uganda. We have the cooking (matooke), beer juice (mbidde) and dessert bananas. The local varieties have different names depending on the locality.

Note: *If you come from a banana growing area, think of the names of the local varieties.*

A number of new varieties have been introduced and developed by the National Banana Programme. They include Rabara (FHIA 01) and Kabana 2 (FHIA 02) mainly for cooking but when ripe can be used for dessert. FHIA 03 (Kabana 3) and FHIA 23 (Kabana 4) are for mainly dessert but can also be cooked when green. Kabana 5 (Yagambi KM5) is for juice extraction but can be cooked or eaten as dessert.

The new varieties / hybrids are resistant / tolerant to most or all pests, diseases and stress conditions.

Growth requirements

Bananas grow best in areas that receive high amounts of rains, well distributed throughout the year. Optimum average annual rainfall is 1500-2500 mm. When rainfall is not adequate bananas should be irrigated.

Bananas grow best below 1000 m above sea level although they can grow up to altitudes of 2000 m.

Bananas require warm conditions of about 27^0C. They grow in a wide range of soils given good drainage, depth and fertility. The ideal pH is 5.6- 7.5. They can easily be damaged by wind therefore they should be planted in sheltered sites.

Seedbed preparation and planting

Dig or plough land at least twice and control all perennial weeds. Dig holes of about 45-60 cm deep and 45-60 cm in diameter. As you dig the hole, separate the topsoil from the subsoil.

Spacing depends on soil fertility, the variety and rainfall. It ranges from 2m x 2m to 6 m x 6 m. The recommended spacing in most places is 3 m x 3 m. The main planting materials are suckers. Use sword suckers or maiden suckers (about 2 m high and not yet flowered). Avoid using water suckers (suckers with broad leaves). Tissue culture plantlets can also be used for propagating bananas. Tissue cultured plantlets can be obtained from Kawanda Agricultural Research Institute.

Planting materials should be obtained from healthy plantations (free of soil-borne diseases and pests). All planting materials should first be treated to remove or kill pests in the corm and roots.

Planting should be done at the beginning of a rainy season. The sucker is placed in the hole and its corm is covered first with top soil, mixed with manure and then topped up with sub-soil. Bananas can be planted in pure-stands or intercropped especially with coffee.

Fertilizer application

Although bananas are commonly grown on fertile soils, manuring is very beneficial. Bananas require considerable amounts of Nitrogen and Potassium to maintain high yields. Apply 75g of Urea per stool four (4) times a year, 85g of Muriate of Potash per stool two (2) times a year and 50g of NPK per stool once a month (during the wet season).

Weed control

Perennial grasses are the most serious weeds of bananas, therefore they should be controlled during seedbed preparation. If land is properly prepared before planting and correct spacing is adopted, weed control in banana plantations will be easy. Weeds can be controlled by slashing, shallow weeding to minimise damage to roots or by the use of herbicides e.g. Round Up and Gramoxone.

Cover cropping and mulching help to control weeds in addition to soil and water conservation. Mulches also add nutrients to soil.

Pruning

The number of suckers per stool should be controlled in order to increase the bunch size. Leave three to six stems on each stool. These should be at different stages of development to ensure better spread of fruit production. Cut off old leaves, petioles and sheaths and use them as mulch.

Pest and disease control

Banana weevil (*cosmopolites sordiclus*)

This is the most important pest of bananas. The adult weevil lays eggs at the base of the corm. When the eggs hatch, the larvae borrow into the stems making tunnels which weaken the stems, making them liable to wind damage. The leaves turn yellow, wither and die prematurely. Yields are reduced but if the attack happens after flowering less damage occurs.

Weevils are controlled by:

- using clean planting materials.
- treating suckers with insecticide such as Dieldrin before planting.
- trapping and killing the weevils.
- Proper field sanitation.
- Using insecticides e.g. Dursban, Primiad and Furadan.

Nematodes

These are very small worms and cannot be seen with naked eyes. They attack and damage banana roots and corms, leading to a reduction in yields. The most obvious symptoms of nematode damage is the toppling over of the entire plant, particularly those bearing fruits. Nematodes cause rapid deterioration of the plantation.

Nematodes can be controlled by use of clean (nematode-free) suckers in clean soil and use of chemical nematicides of Furadan (Carbofuran)

Diseases

Bananas are affected by several diseases. The most important ones include leaf spots, cigar end rot, fusarium wilt and bacterial wilt.

1. Leaf spots

The economically important leaf spot diseases are the black sigatoka and the leaf speckle. They are both caused by fungus. The first symptoms are minute yellowish green spots on young leaves which develop into yellowish green to brown streaks. The brown streaks enlarge and fuse to form black patches which later develop spots with grey centres. Finally the leaf edges die, reducing the leaf area.

The main symptomatic difference between leaf speckle and sigatoka is absence of round spots in leaf speckle.

Leaf spot diseases can be controlled by:

- planting resistant varieties e.g. FHIA 01, FHIA 3, FHIA 17 and FHIA 23.
- use of fungicides.
- correct spacing, weed control, good drainage and good field sanitation. Fertilisation reduces the impact of the diseases.

2. Fusarium wilt /Panama wilt

It is caused by fungus. It is known to be the most destructive disease of bananas in Uganda. It mainly attacks Bogoya, Sukari-Ndiizi (Apple banana), Kisubi and Kayinja.

The symptoms include yellowing of leaves or premature collapse of leaves.
A cross-section of a pseudostem and/or corm shows purplish vascular staining.

Fusarium wilt is controlled by using resistant varieties and using clean planting materials.

3. Bacterial wilt

It is caused by bacteria. It affects all cultivars and causes a lot of losses in Uganda. It was first reported in Uganda in 2001 on bananas in Mukono and Kayunga districts. It has rapidly spread to other districts. In flowered plants, shriveling of the male flower is often the first symptom. There is also uneven and premature ripening of the fruit and when the fingers are cut, the sections show unique yellowish discoloration and cannot be eaten. Cross sections of diseased stem show yellowish to brown discoloration.

The diseases is controlled by:

- decapitation/removal of male flower bud after flowering.
- disinfecting the farm tools, hands and feet after working in an infected plantation.
- destruction of affected banana stools.
- restriction of movement of banana plant material from infected areas to other areas.

There are other diseases of bananas such as fruit anthracnose, and cigar end rot but they are not known to cause losses of economic importance.

ACTIVITY DAGP/2/2-2

1. What is the recommended spacing of bananas in Uganda?
   .....
   ……

2. Explain why top soil and sub-soil is separated when digging holes for planting bananas.

   ……
   ……
   ……

3. Give reasons why the following management practices are carried out when growing bananas.

   (a) Mulching ……
   ……

   (b) Sucker removal ……
   ……

   (c) Staking/propping up ……
   ……

4. Suggest problems that are limiting banana production in Uganda.
   ……..
   ……
   ……
   ……..

✓ Check your answers with those given at the end of the Unit.

TOPIC 4 GROWING TEA

Tea was introduced in Uganda from China around 1900. Several cultivars were introduced between 1900 and 1925 when planting on economic scale started, and by 1945 it had become one of the major cash crops.

Growth requirements

In the tropics the cultivation of tea occurs mainly at higher elevations. When rainfall is adequate, low land tea produces higher yields although quality, root growth and longevity are reduced.

Temperature is very important to tea plants since the leaves only expand when temperatures are above 21^0C. Tea trees grow best on soils which are free-draining. The crop is sensitive to strong winds and the planting of windbreaks along the hillsides of the plantation has been known to increase yields.

The crop needs a well distributed mean annual rainfall of 1200 mm received in at least 100 days. It also requires sunshine of at least 5 hours per day and an optimum temperature of 18-20^0C. Tea does well in a wide range of soils but preferable acidic type, with a pH value between 5.5 and 6.0.

Preparation for planting

During seedbed preparation, all trees and bushes should be cleared. Soil conservation measures should be put in place especially in sloppy areas.

Provision of shade and windbreaks may not be necessary as for the case in Uganda. However, in other parts of the world such as South India, shade is provided. The use of shade is associated with the following benefits:

- minimizes the ill-effects of drought which are common in areas with prolonged dry spell.
- checks the speed of winds otherwise fatal to the plants.
- protects tea leaves from the scorching effects of direct sunshine.
- lowers the leaf temperature at the plucking table.
- minimises loss of soil moisture.

Planting

The planting materials can be either seed or cuttings. Seed is planted 12.5-15.0 cm apart and 2.5 cm deep in a nursery bed. The recommended size of planting holes is 40 cm deep and 30cm diameter. The spacing commonly used is 1.5 x 0.7m or 1.5m square. However, spacing depends on climate, soil fertility and growth form.

Pruning

This is done by repeated cutting-back to maintain a convenient height for plucking. It also induces vigorous growth and ensures a continuous supply of flushes.

Plucking / harvesting

This is done periodically by hand or machine. The crop is ready for harvesting after about 2.5 – 3 years after planting. Normally 3 leaves and the apical bud are picked at an interval of 1-2 weeks.

Fertilizer application

Either organic or mineral fertilizer can be applied by directly adding it to soil or foliar spray for the case of mineral nutrients. Various types of fertilizers can be used depending on the nutrient requirement, type of planting materials and stage of growth. For example, cuttings require Single Super Phosphate or Double Super Phosphate, young plants, from transplanting to 3rd year of plucking may receive NPKS (25:5:5:5) at a rate of 230 kg/ha/year.

Weed Control

Weeds are usually controlled by hand cultivation, mulching or suppressed by the canopy of the tea. The most serious weeds may be controlled by use of herbicides. Roundup (glyphosate 36%) for controlling most annual weeds and Dalapon (paraquat 74%) for perennial weeds such as couch grass *(Digitaria scalarum).*

Table DAGP/2/2.4 Major pests

Pest	**Damage**	**Control**
- Capsids *(Helopeltis bergrothi.)* and *H. Schoutedeni.*	- cause stem canker - damage tips of young tea	-Use of Fenitrothion, 5%
- Yellow mite *(Hermitarsonemus latus)*	- Attack young leaves in nurseries and cause them to curl inwards	- Use of Dicofol 18.5% WP.
- Red crevice mite *(Brevipalpus phoenicis)*	- Produce brown corky coloration on under surface of leaves	- As for yellow mite.
- Red spider mite *(Oligonychus coffeae)*	- Spin fine webs over leaf surface. - Produce red spots as a result of sucking.	- Proper shading, - pruning - Use Dicofol 18.5% spray

Other pests include Thrips: Black tea thrips *(Heliothrips, haemorrhoidalis),* yellow tea thrips *(Scirtothrips kenyensis),* Termites *(Microtermes natalensis)*

Table DAGP/2/2.5 Diseases.

Diseases	**Damage**	**Control**
- Armillaria root rot (caused by *Armillaria mellea)*	- dieback of branches - sudden death of bushes - root rot	- remove and burn tree stumps, debris and roots.
- Branch and collar canker clones (caused by *Phomopsis theae)*	- cankers and lesions develop on the stem at the collar region	- use resistant - mulch to reduce water stress - avoid injuries to young plants.

ACTIVITY DAGP/2/2-3

1. Why are plantation crops important to man?

   ……..
   ……
   ……
   ……

2. What conditions do coffee and tea require in order to grow?

   Coffee

   ……
   ……
   ……
   ……

   Tea

   ……
   ……
   ……

3. What is affected in the environment when plantation crops are grown?

   ……..
   ……..
   ……..

✓ Check your answers with those given at the end of the Unit.

Read about growing sugarcane and cocoa as they are also important plantation crops.

NOTES AND ANSWERS TO ACTIVITIES

ACTIVITY DAGP/2/2-1

1. Suppresses weed growth; improves moisture retention, releases nutrients during decomposition; improves soil structure; enhances microbiological activities; improves rain water penetration, reduces run off and erosion; encourages root development in feeding zone of coffee.

2(i) Reduce air temperatures; surface soil temperature and reduce air movement.

(ii) Reduce incidence of 'hot and cold effect' and crinkle leaf of Arabic coffee.

(iii) Reduce overbearing and dieback.

(iv) Leaves from shade trees are used as mulches.

(v) Protect cherries from hailstorms.

(vi) Depress weed growth.

(vii) Money from wood or bark.

3. Lack of adequate resources to provide farmers with adequate farm inputs; diseases such as CBD, leaf rust, coffee wilt; high cost of farm inputs; lack of organized marketing; poor infrastructure; decline of international coffee prices; quality of coffee and total output per acre, lack of land and processing facilities.

ACTIVITY DAGP /2/2-2

1. Spacing of bananas in Uganda is 3m x 3m.

2. Top soil and sub-soil are separated when digging holes for planting bananas because; the top soil is more fertile than the sub-soil. When filling the hole when planting you use the top soil which is fertile.

3. Mulching:

   - To control weeds.
   - To control soil erosion.
   - To conserve moisture in soil.
   - To increase water infiltration.

   Sucker removal:

   - To increase bunch size
   - To control pests such as banana weevils
   - To enable banana plants to fruit early.

Staking:

To prevent the plants from falling due to wind and extra weight of the bunch.

4. Constraints to banana productions:

- Declining soil fertility.
- Poor marketing channels.
- Poor storage.
- Disease and pest attack.

ACTIVITY DAGP/2/2-3

1
- Important sources of foreign exchange.
- Backbone of a country's economy.
- Source of employment for labour force.
- Source of tax revenue for the government.

2. Coffee
- Moderate amounts of rainfall (1800 mm)
- Temperatures in the range $13^0 – 28^0$ C.
- Not too strong winds therefore need for windbreaks.
- Well-drained soils that are deep.
- Soil pH between 5 and 7.

Tea
- High elevations therefore cooler temperatures.
- Acidic soils (Ph 4.5 – 5.5) which are free-draining
- Not too strong winds therefore need for windbreaks.
- Well-drained soils that are deep.

3. Plantation crops mainly affect:

(a) Soil acidity.
(b) the organic matter in the soil.
(c) the mineral content of the soil.
(d) soil structure
(e) they influence weeds, pests and diseases.

UNIT 3

HORTICULTURE

REF. DAGP/2/3

INTRODUCTION

Welcome to this unit, which introduces you to horticulture. Horticulture is the growing of vegetables, fruits, flowers and ornamental plants. Horticulture is a very promising field of activity in Uganda. Horticultural crops are very high value crops, which take a relatively shorter time to mature. They can therefore be a good source of income to the farmer. In this unit you will learn about the importance of these crops. You will also be able to learn how to grow some of these crops.

AIM

As a teacher, this unit should prepare you to provide adequate information about, and demonstrate the skills required in the growing of horticultural crops.

OBJECTIVES

By the end of this unit, you should be able to:

i) explain the importance of growing horticultural crops.
ii) Explain the constraints in the growing of horticultural crops.
iii) practice raising vegetable and fruit seedlings in a nursery.
iv) practice field skills in growing vegetables and fruits.

TOPICS TO BE COVERED

Topic 1 Scope and importance of horticulture

(a) What is horticulture
(b) Importance of horticultural crops.

(i) Advantages of growing horticultural crops.
(ii) Problems associated with horticultural products.

Topic 2 Growing vegetables

(a) (i) Vegetable rotation
(ii) Local vegetables
(iii) Harvesting vegetables
(iv) Processing vegetables
(v) Storage of vegetables
(vi) Marketing vegetables

(b) Growing selected vegetables

(i) Cabbages
(ii) Tomatoes
(iii) Onions
(iv) Other vegetables

Topic 3 Fruit Growing

(a) (i) Propagation of fruit crops
(ii) Establishing and maintaining an orchard

(b) Growing of selected fruits

(i) Pineapple
(ii) Citrus

SUBJECT ORIENTATION

Horticultural crops are the most practical crops to grow in your school garden. The crops supply a variety of vitamins, minerals and other food nutrients which could be very useful in combating malnutrition. Apart from this, horticultural crops take relatively shorter time to yield and are therefore easy to grow during the school term. Horticultural products (e.g. vegetables and fruits) are easily sold off at the end of the growing season and this could help you to demonstrate to your pupils that agriculture can be profitable.

This unit is intended to stimulate you into production. Most of the knowledge and skills you will acquire should be converted into practical application during practical classes with your pupils.

STUDY REQUIREMENTS

As you study this unit you will need to visit progressive farmers in your locality to identify the types of horticultural crops they grow. You should also prepare to start a vegetable or fruit garden at home and in your school. This will give you the opportunity to practice the skills and perfect them as you teach these to your pupils.

Once again we encourage you to have a hands-on experience with the information given to you in this unit.

TOPIC 1 SCOPE AND IMPORTANCE OF HORTICULTURE

(a) What is Horticulture?

Horticulture is a branch of agriculture that deals with the growing of vegetables, fruits, flowers and ornamental plants. In Uganda vegetables, especially the local ones, are rarely grown on commercial scale. In fact most vegetables and fruit trees grow on their own. They are often eaten coincidently and are rarely emphasized in the diet.

Horticulture is however a promising field of activity in Uganda as more people get better sensitized about the importance of horticultural crops. Before we proceed further, it is important to ask: What is the difference between a vegetable and a fruit?

Horticultural crops are often classified according to the ways they are used. What is the difference between bogoya (edible ripe banana) and matoke (cooking bananas)? You might know that one is a fruit and the other is a vegetable. One is eaten raw when ripe while the other has to be cooked before it is eaten. Fruits require very little processing before they are eaten while vegetables require more thorough processing.

(b) Importance of horticultural crops

(i) Advantages of growing horticultural crops

Horticultural crops have the following advantages:

- Horticultural crops especially vegetables and fruits are a rich source of vitamins A, B and C. They also supply large amounts of minerals such as calcium, phosphorus, chlorine, iron, iodine and potassium, all of which are necessary for healthy growth and development of our bodies.

- Horticultural crops give a very high rate of returns per hectare of land. Vegetables normally take a short time to yield and can therefore be planted and harvested several times within the year. Once the fruit trees start bearing, they continue to yield every year if they are well managed. A large number of fruits can be produced by one single tree occupying a very small area of land.

- Vegetables and fruits provide roughage in the diet and therefore help in proper digestion and prevention of constipation.

- Some vegetables and fruits are grown for their medicinal values and are used widely for curing various diseases and ailments.

- Some fruits are used to preserve and tenderize foods e.g. pawpaws, lemons, etc.

- Vegetable, fruit and flower growing can provide self-employment. It is a money generating activity, which can be very profitable since horticultural crops are often highly priced.

- Some of these crops help in soil and water conservation. They act as cover crops to control soil erosion; some of them are leguminous and fix nitrogen in the soil and thereby improving the nitrogen content of the soil for the benefit of other crops in a rotation.

- Some fruits and vegetables are used to feed domestic animals e.g. cabbages, spinach, amaranthus, etc.

- Some fruit trees can be grown as windbreaks and dry ones can be used as fuel wood.

- When exported, vegetables, fruits, and flowers can earn foreign exchange for the country.

- Fruit trees and flowers are good ornamental plants as they improve the landscape. In addition fruit trees provide shade.

- They are deep rooted and help in nutrient recycling.

- They also influence the ecosystem thereby conserving the environment.

(ii) Problems associated with horticultural production

In spite of the many advantages we have already identified above, the growing of horticultural crops also have some problems, which are cited below:

- Many horticultural crops are perishable and must be sold off or consumed as soon as possible after harvest. If this is not done the quality of the product deteriorate rapidly. There must therefore be a well-organized marketing facility for horticultural crops.

- Commercial production of horticultural crops requires particular farming skills which most of our farmers do not yet have.

- People's attitude towards horticultural crops is still negative. Vegetables are often eaten only during times of food shortage. Fruit trees often grow unattended to and the fruits rarely form part of the diet.
- The production of some horticultural products requires heavy capital investment which most of the farmers cannot afford e.g. floriculture, fruit production.

- There is competition between the commercially grown vegetables and fruits, with those products on subsistence scale, which in most cases requires little or no financial input. Marketing of vegetables and fruits can therefore become difficult locally.

- Improved vegetables and fruits are very susceptible to attack by diseases and pests, which can reduce yields drastically, e.g. tomato blight.

ACTIVITY DAGP/2/3-1

1a) Identify as many vegetables and fruits as you can which are grown in your locality. Write down the details of each vegetable / fruit using the table below:

	Local Name	**English name**	**Uses**
1.	……	……	……...
2.	……	……	……...
3.	……	……	……...
	……	……	……..
4.	……	……	……..
5.	……	……	……..
6.	……	……	……..
7.	……	……	……..
8.	……	……	…….
9.	……	……	…….
10.	……	……	…….
11.	……	……	…….
12.	……	……	…….

b) What problems do farmers in your area get when growing vegetables and fruits for food and for sale?

……..
……..
……..
……

TOPIC 2 GROWING VEGETABLES

(a) i) Vegetable Rotation

This is when different types of vegetables are grown on the same piece of land one after the other following a well-planned sequence. Vegetable rotation helps to preserve soil fertility and ensures that the crops are healthy and therefore able to give high yields.

In planning a vegetable rotation, the following points should be considered:

1. Vegetables that require a lot of nutrients such as cabbages should be planted first in the rotation. This enables them to get enough nutrients for proper growth.

2. Vegetables with shallow rooting system that extract plant nutrients from the upper layers of soil should be followed with deep rooted vegetables which can get nutrients from deeper down the soil.

3. Vegetables, which are attacked by the same kinds of pests and diseases, should not follow each other in a rotation.

4. Plant legumes in a rotation to maintain soil fertility.

Using examples of vegetables in your area, design a 4-season rotation for growing vegetables in your school garden.

(ii) Local Vegetables

Local vegetables are indigenous vegetables used as food by many of our people. They often grow wild or are grown on very small scale. There is need for us to modernize and promote the production of these vegetables. This is because of the following reasons:

1. They require little labour during their production i.e. seedbed preparation, weeding and general care of local vegetables is less rigorous than those for introduced vegetables. They are therefore cheap to grow.

2. Local vegetables generally have a higher nutrient content than the introduced ones.

3. They can withstand poor growing conditions such as poor soils, drought and poor weather conditions better than introduced vegetables.

4. They are less attacked by diseases and pests.

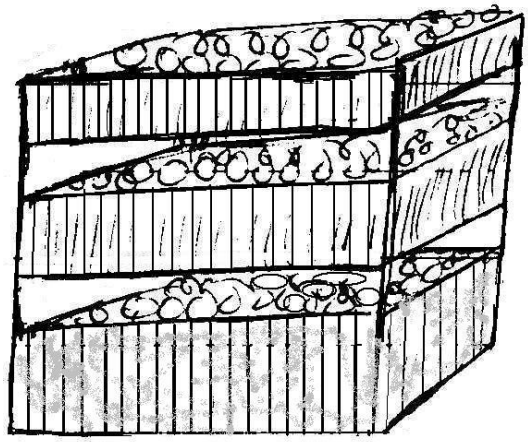
5. Seeds and other planting materials are locally available. In fact some of them grow on their own.
6. They require a small acreage of land for growing.

(iii) Harvesting vegetables

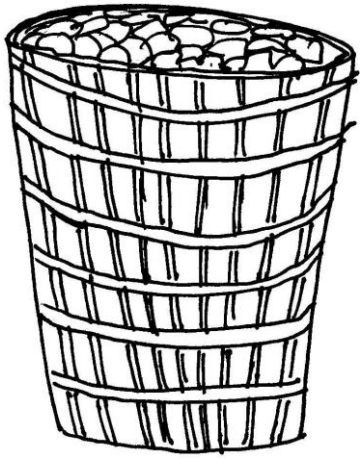
The time and the methods of harvesting varies with different vegetables. Most vegetables are harvested piece-meal because the products do not get ready at the same time. Tomatoes, for example, can only be picked a few at a time when they are ripe. Similarly, leaves of spinach and kale are picked when they have reached the correct size, leaving those, which are still small to grow. Some vegetables are harvested whole. For example ready heads of cabbage plants are harvested only once from plant. Whichever method is used for harvesting, it is very important that vegetables are harvested at the correct stage of ripeness / maturity.

Clean harvest is important for maintaining the quality of vegetables. Most vegetables are eaten raw or cooked for very short periods of time before they are eaten. The nutrient content of vegetables decline very rapidly where vegetables are cooked for a long time. Overgrown or soiled leaves on leafy vegetables should be removed and used to make compost manure. Fruit vegetables such as tomatoes, egg plants damaged by pests and diseases or blemishes should be sorted out. Besides their poor quality, they can contaminate the good ones, which they come into contact.

Vegetables should be carried in suitable containers. These can be racks, baskets or plastic bags to prevent crushing of the vegetables. If plastic bags are used, they should be perforated so that the vegetables are aerated.



Rack for transporting fruits e.g. tomatoes
Figure DAGP/2/3.1



Basket for carrying Fruit vegetables
Figure DAGP/2/3.2

(iv) Processing of vegetables

Processing of vegetables differ from other crops because more care must be taken in order to produce high quality products and maintain their nutritive values.

As soon as possible after harvesting, all vegetables need to be cleaned. All foreign materials mixed with the vegetables and damaged vegetables removed. The vegetable product should then be washed with clean water.

The products are then sorted out according to size, level of ripeness, texture, colour etc and graded. The different grades of vegetables should then be packed separately, ready for marketing.

(v) Storage of vegetables

Vegetable products get spoilt quite quickly if they are stored under hot dry conditions. It is therefore essential that vegetables are stored on raised platforms in a fairly moist surrounding. Vegetables should be sprinkled with water at regular intervals to keep them turgid and in good form. The room in which vegetables are stored should be well aerated. Remember, vegetable products are still alive even after they have been harvested. They therefore need to respire to keep fresh for a longer time.

(vi) Marketing of vegetables

Large-scale vegetable production requires a big market. This is because vegetables are perishable and must therefore be consumed or sold off as quickly as possible. It is therefore advisable to survey the market so that you can grow vegetable, which are in demand in the area.

Transportation of vegetables to the market must be well organised. A lot of the product can be crushed and wasted during transportation if inappropriate containers are used or if the product is packed badly.

ACTIVITY DAGP/2/3-2

1. How do the farmers in your area harvest, process, store and market locally produced vegetables?

   ……..
   ……..

2. Can you suggest improvements in the methods that they use to harvest, process, store and market their vegetables.
   ……
   ……
   …….

(b) GROWING SELECTED VEGETABLES

(i) Growing Cabbages *(Brassica oleracea)*

Cabbage is one of the most popularly grown introduced vegetables in Uganda. It is commonly grown for sale although some farmers grow it for domestic consumption. Cabbage is a leafy vegetable belonging to the family Brassicaceae. Other members of the same family include; cauli flower, kale, turnip and radish.

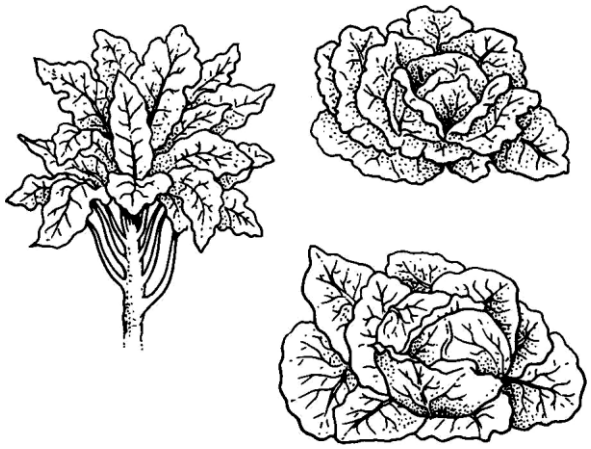


Figure DAGP/2/3.3 Cabbage plants

Varieties

The common varieties grown are Drumhead, Primo, Copenhagen Market and Tom Thumb.

Growth Requirements

Cabbage requires well-drained fertile soils. It does not grow well in acidic soils. The crop yields best at altitudes over 800m above sea level. Nevertheless, cabbages do well in most parts of Uganda.

Cabbages require plenty of rainfall and warm temperatures. However, very high temperatures reduce yields and encourage attack by pests and diseases.

Planting

Cabbage seedlings are raised in a nursery and transplanted to the field when they are ready. *Do you still recall the steps involved in raising seedlings in a nursery? If you are not quite sure it will help to turn back to Module 1, Topic 2 section on Nursery bed preparation and Nursery work.*

Spacing of cabbages depends on the variety, but most varieties of cabbage should be spaced at 90x60 cm.

Manure and fertilizer application

Cabbages will respond well to liberal application of organic manure. Ensure that the organic matter is well rotted before you spread it and incorporate it into the soil.

Commercial fertilizers especially NPK, DAP (Diammonium phosphate) sulphur or ammonium or CAN (Calcium Ammonium Nitrate) which supply sufficient nitrogen to the soil can improve cabbage yields greatly.

Take care not to apply nitrogen fertilizers directly onto the plants, otherwise the leaves maybe scotched or the whole plant killed. Nitrogen fertilizers should be applied at least 15 cms away from the plant in rings or in bands.

Mulching

After the garden of cabbage has been weeded, clean mulch should be applied. This reduces water loss and suppresses weed growth. During weeding the soil should be drawn up round the stems of the plants.

Harvesting

Cabbages are ready for harvesting when the heads have formed and they are firm. Harvesting is done by cutting off the head at the base and removing a few excess old leaves that cover the cabbage heads. Cabbages store for a short time and should therefore be sold off as soon as possible after harvest.

Table DAGP/2/3.1 Pest and disease control

Pests	Damage	Control
Cutworms *Agrotis* sp	Cut cabbage seedlings at the base and destroy the seedlings	Soil treatment with soil insecticides e.g. Aldrin or dieldrin.
Cabbage aphids *Brevicoryne brassicae*	Greenish yellow sucking insects feeding mainly on the underside of leaves which become curled and stunted.	Spray with appropriate insecticides e.g. Menazon, Diazinion, Formothion.
Diamond back moth *Plutella maculipennis*	Pale green caterpillars eat the underside of the leaf making holes through it.	Spray with insecticides e.g. Cypermethrin, Carbaryl or Permethrin.
Cabbage sawfly *Athalia* sp	Yellowish green caterpillars feeding in groups under a web in the middle of the cabbage head preventing the heads from forming.	Spray with appropriate insecticides especially as the heads begin to form.

Table DAGP/2/3.2 Diseases

Diseases	**Symptoms**	**Control**
Damping off (fungal disease) by *Rhizoctonia salani*	Seedling die at ground level	Copper and sulphur sprays or dust.
Downy mildews (Fungus) called *Perenospora parasitica*	Brown patches on leaves and stem. Occurs most in cool, wet conditions	Good field sanitation, weekly application of Diethane M45.
Bacterial wilt *(Pseudomonas solanacearum)*	Plants are stunted and wilt starting from the terminal buds downwards.	Planting resistant varieties.
Stem rot *Rhizoctonia solani*	The main stem constricts at soil level – Young plant may be killed. Also known as "wirestem" disease.	Field sanitation. Spray with fangicides.

(ii) Growing Tomatoes *(Lycopersicon lycopersicum)*

Tomatoes are usually eaten raw, often in salads. They are also used as condiments in stews and soups i.e. used to improve the flavour of cooked food.

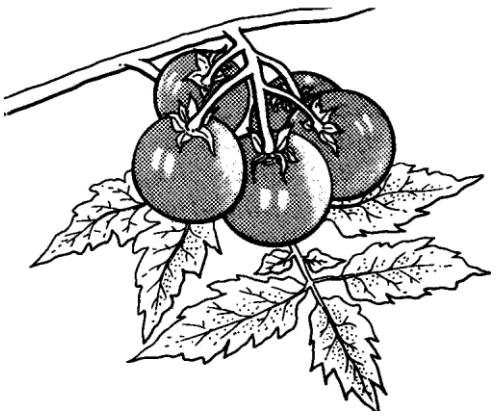


Figure DAGP/2/3.4 Tomato fruits

Tomatoes belong to the family Solanacae. The common varieties grown in Uganda include Moneymaker, Marglobe, Bonny Best.

Growth requirements

Tomatoes can grow in most types of soil as long as it is well drained with constant supply of moisture. The best soils are loamy, non-acidic, fertile and well drained with sufficient amount of organic matter. Moderate rainfall is required i.e. 900-1500 mm per year. Warm conditions (i.e. 15-25^{0}C) are essential for optimum growth.

Field operations

Tomato seedlings are raised from seed, usually in single pots, soil blocks, seed boxes or directly in nursery beds. They are transplanted into the field when they are 15-20 cms tall.

Most tomatoes in Uganda are planted on raised seedbeds to ensure good drainage. The spacing of tomatoes will depend on the growth habit of the variety. For

pruned varieties the spacing is 90cm x 45 cms. Tomatoes, which are spaced too closely, encourage the spread of fungal diseases and are difficult to spray.

Mulching should be done using dry grass between the rows. Mulching comprises water infiltration in the soil and conserves water in the soil. Mulching also suppresses weed growth and rotten organic matter from the mulch improves soil fertility. In unmulched plots weeding should be done regularly and the lower part of the stem should be covered with soil up to 15-15 cms.

Staking

Most of the tomatoes varieties grown in Uganda are the tall type of tomatoes. These plants give high yields and good quality tomatoes fruits, but need regular attention during their cultivation. They need to be supported with "stakes" so that the fruits do not tough the ground. Single or cross-pole or tripod staking can be used. *Do you still remember the methods of staking which we considered in Unit 2 of Module 1?*

Pruning

In order to obtain quality fruits, it is essential to remove side shoots that would develop into too many branches resulting into a very bushy plant. Two to three stems should be left to grow and these are trained by tying them loosely onto the stakes. Unpruned tomatoes are often difficult to spray and are more readily attacked by fungal diseases. They also produce smaller fruits compared to the pruned ones.

Harvesting

Tomato fruits should be picked when they are mature with their calyx intact. Maturity is shown by a change of colour around the base of the fruit.

Harvested tomatoes should be stored in a cool place and handled with care so as to prevent the fruit from getting damaged.

Table DAGP/2/3.3 Pest control

Pest	**Damage**	**Control**
Nematodes *(Meloidogyne spp))*	Roots swell and form knots which can result into plants wilting and growing poorly	Soil treatment using nematiades
American bollworm *(Helicoverpa armigera)*	Eats fruit buds and bores into the fruit	Pray with appropriate insecticides

Table DAGP/2/3.4 Disease control

Disease	Symptoms	Control
Late Blight *(Phytlophthora infestans)*	Leaves rapidly wither and dry out. Stems rot and the fruits also rot. Encouraged by wet weather	As a preventive measure spray seedlings with copper fungicides e.g. Mancozeb, Propineb at 2 weeks interval and at 4-7 days interval in wet weather. On infected plants spray with Metalaxyl.
Early Blight *(Alternaria solani)*	Stem cankers develop on the seedlings with brown spots on the leaves. Leaves and fruits fall off.	Treat as in late Blight
Bacterial wilt *(Pseudomonas solanacearum)*	Plants wilt badly even when there is sufficient water.	Use resistant varieties. Buy certified seeds – crop rotation.
Leaf curl (Virus)	Leaves are mottled, streaked and curled. Virus spread by Aphids and white fly	Uproot and burn affected plants. Use resistant varieties. Spray against aphids and the white fly.
Blossom End rot (a physiological diseases)	Water soaked spots develop on the fruit. It turns brown and enlarges to cover half of the fruit.	Caused by: Irregular watering Too much nitrogen in the early stages or calcium deficiency hence water regularly and avoid too much nitrogen application in the early stages. Apply less nitrogen fertilizers (CAN)

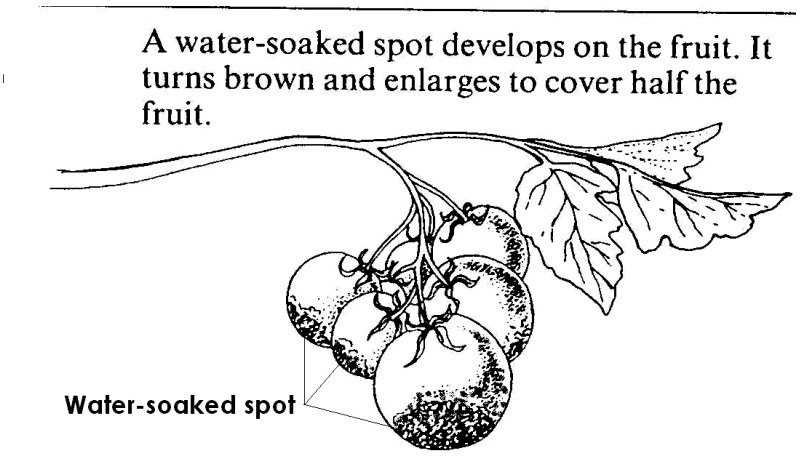


Figure DAGP/2/3.5 Blossom End Rot of Tomatoes (Mac Donald & Low 1984)

(iii) Growing of Onions *(Allium cepa)*

Onions belong to the family *Alliaceae.* They are used as vegetables added to soups or stew to improve the flavour of food. The bulb which consists of a group of modified swollen leaves are found underground. The aerial part consists of green cylindrical leaves. Both the bulb and the leaves can be used for flavouring food.

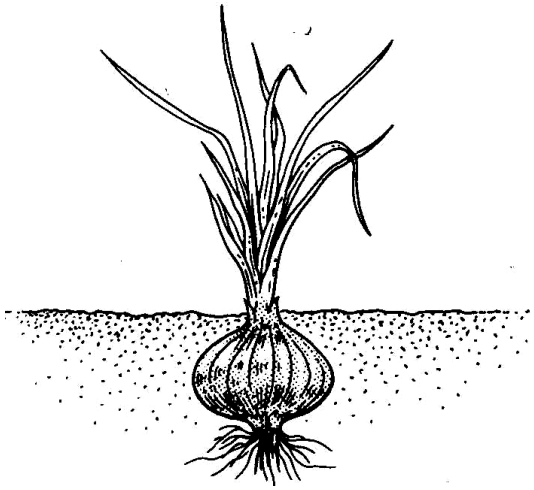


Figure DAGP/2/3.6 An onion plant

Varieties

Varieties commonly grown in Uganda include Red creole, White creole, Texas Grant, Bombay red, Shallots.

Growth requirements

Alluvial and sandy loam soils are suitable for growing onions. The soils should however have relatively high levels of organic manure and must be deep and well drained.

Onions require rainfall through their growing period. There must be sufficient rainfall during the time of bulb formation. If there is inadequate rainfall at this stage irrigation must be done.

Field operations

Onion seeds are planted in a nursery bed. Raised nursery beds are made about one meter wide and of any convenient length. The seeds are sown 15 cm apart and covered lightly with soil. Shed is provided and watering done appropriately. Thinning is done when the seedlings are large enough to leave healthy seedlings about 4-5 cm apart.

Seedlings are transplanted when they are pencil thick at their bases. The soil in the field should be well prepared but made firm. The spacing is generally 30 cms between the rows and 8-15 cms between plants. Onion seedlings need not be planted too deeply; the base of that plant should be only about 1 cm below the surface. This encourages faster growth.

Fertilizers should be applied in the field before onions are planted at a rate of 200-250 kg / ha of NPK. Organic matter should also be worked into the soil at planting.

Weeding must be done carefully because onions have a very shallow rooting system and the roots can be easily damaged during weeding.

Harvesting

Onions should be ready for harvesting 14-18 weeks after planting. When fully mature, the leaves turn brown and die. At this state the onions should be pulled out of the ground and left on the surface to dry for 5-6 days before they are bundled, tied and hung in a shade to continue drying. Inspect the bundles regularly and remove the rotten ones.

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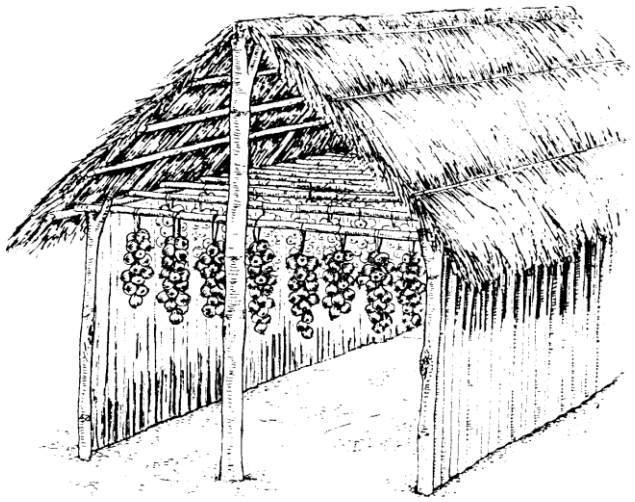


Figure DAGP/2/3.7 Onions hung in a shed to dry.(MacDonald & John Low (1984)

Alternatively onions can be dried in the sun but protected from rain or excessive moisture until the outer leaves are dry. This may take 3-7 days depending on the weather. They are then stored in slatted boxes.

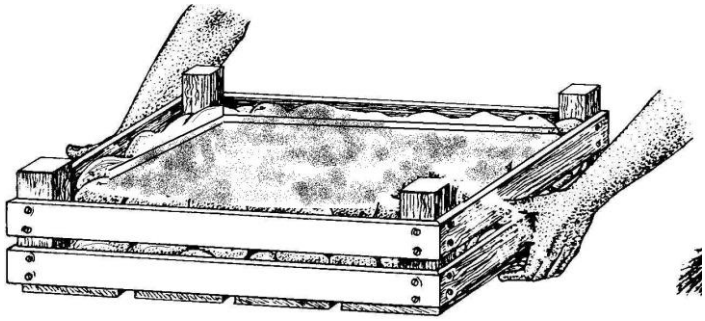


Figure DAGP/2/3.8 Onions are stored in a slatted box as shown above (

Table DAGP/2/3.5 Pest

Pests	Damage	Control
Onion thrips *(Thrips tabaci)*	Scratch and suck the leaves causing silvering and bending of the leaves downwards. Thrips are common in dry weather. They are very small and difficult to see	Spray with appropriate insecticides e.g Diazinon, Ferutrothion or Fenthion.

Table DAGP/2/3.6 Diseases

Disease	Symptoms	Control
Downy mildews *(Perenospora destuctor)*	Forms a white covering on the leaves which eventually die. It is serious in humid conditions	- Crop rotation. - Spray with copper fungicides
Bacterial soft rot *(Erwinia caratovora)*	Attacks the bulbs that have not been properly dried or when the onions are wetted during storage. The bulbs rot.	Dry the onions properly and keep stored onions away from excessive moisture.

ACTIVITY DAGP/2/3-3

1. Compare the growing of the following vegetable crops starting from nursery bed up to harvesting with the recommended practices you have studied in this section:
   (a) Cabbage
   (b) Tomatoes
   (c) Onions

2. What improvements can you recommend on the growing of vegetables in your area?
   ……
   ……
   ……

TOPIC 3 FRUIT GROWING

Introduction

At the beginning of this Unit we learnt about the importance of fruits and vegetables in our nutrition and in the improvement of human welfare through the sale of these products. In addition we also discussed the constraints in the production of fruits and vegetables.

Let us remind ourselves. We said that fruits were important because they:

- contain large quantities of vitamins A, B and C which are not abundant in most of our staple foods.
- contain sugars, carbohydrates and roughages which aid digestion.
- are eaten fresh and the vitamins they contain are not destroyed by cooking or prolonged processing.
- improve appetite because of their good flavors.
- can be sold to generate income for the farmer.
- are deep rooted and help in nutrient recycling in addition to providing shade and improving the environment.
- Some can be used as fuel wood when the branches are pruned off.
- Occupy a small area and yet yield highly i.e. only one tree can yield a large amount of fruits.

The constraints in growing fruits include:

- The consumption of fruits is not taken seriously by most of our communities.
- The group of fruit trees is in most cases incidental and not taken as a serious commercial undertaking.
- Fruits are perishable and must be sold off quickly otherwise they get spoilt. There are no fruit processing factories which could have improved fruit preservation.

Can you think of any more reasons why the growing of fruits is not quite popular among the Uganda farmers? Include these reasons here.

(a) (i) Fruit propagation

Fruit propagation is the multiplication of fruit plants. This can be done through seed or by using the vegetative parts of the plant. Vegetative propagation is preferred in the production of fruits because of the following reasons:

1. The new plants resemble the parent plant in terms of yields and quality of products, resistance to pests and diseases, etc.

2. Vegetatively propagated plants mature and yield earlier than those propagated by seed.

3. The height of vegetatively propagated trees is often reduced making it easier to pick the fruits and spray against diseases and pests.

3. The yields are uniform if the trees have been propagated from the same mother plant (clone).

4. It is possible to produce one or more varieties of crops on the same plant through grafting.

Propagation can also be done by seed. This is known as sexual propagation. In fruit growing, sexual propagation is mainly used now for the production of rootstocks onto which desirable fruit varieties are grafted. However, seeds can also be used to raise fruit trees or plants directly.

Can you think of some advantages of using seeds in propagation of plants?

Methods of vegetative propagation

Stem cutting

Stem cuttings are pieces of stem cut and allowed to develop roots and buds, which later grow into whole plants. Stem cuttings are rarely used in the propagation of fruits. They are more commonly used in the propagation of root crops such as cassava, sweet potatoes, and field crops such as sugar cane. Stem cuttings are also used a lot in the propagation of ornamental plants and flowers such as roses.

When using stem cuttings you should ensure that the cuttings:

- are taken from a mature part of the stem or branch.
- have a number of buds on them that can develop into new plants.
- Have no signs of pest and disease attack.
- Are taken from a plant that has no signs of viral infection.

Stem cuttings should be put in a rooting medium first to allow the buds and the roots to develop before they are transferred into polythene sleeves where they can develop further.

It is important that the cuttings are planted the right way up to ensure that the upper end of the skin is cut in a slanted way while the lower end is cut flat

The cuttings are inserted into a rooting medium, which consists of moistured sawdust. A small amount of rooting chemical e.g. Indole Acetic Acid (IAA) or Seradix is added to the medium to encourage rapid rooting. The cuttings are covered with polythene to conserve water and keep the atmosphere moist. This encourages root and bud development.

The rooted cuttings are then transferred into polythene sleeves with good potting soil. The potted plants are then allowed to develop in a shed until they are ready for planting in the field.

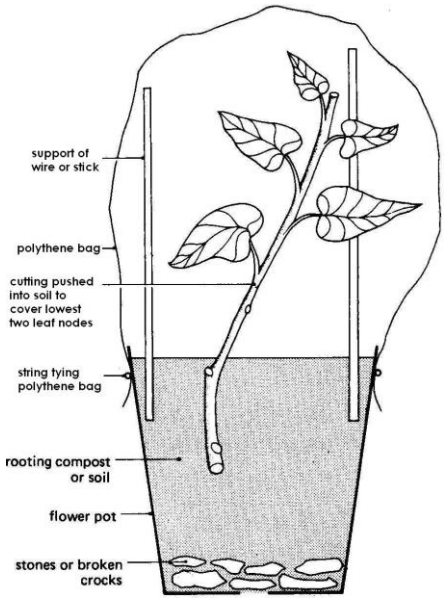


Figure DAGP/2/3.9 Potted stem cutting.

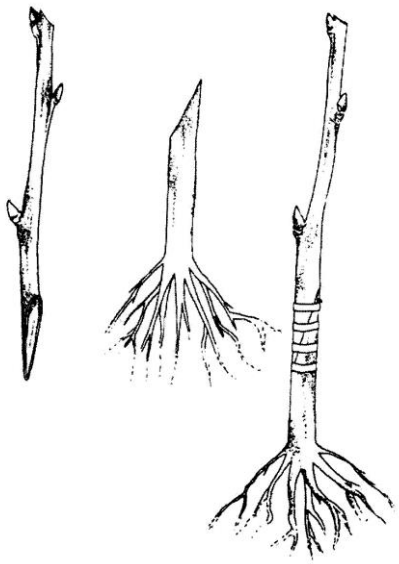
Grafting

Grafting is a technique of joining one part of a plant to another and allowing them to grow as one plant. The portion of the stem taken from a plant is known as the scion while the one onto which the scion is joined is known as the root stock.

In order to encourage the joining of the scion to the root stock it is important that their cambial surfaces come into contact with each other. It is therefore important that a large enough cambial surface is made available to facilitate union. This is done by slicing the surfaces at a narrow angle and joining them. There are several methods of grafting as discussed below:

Splice grafting

This is used when the stock and the scion are of similar diameter. A long, slanting cut is made in both scion and rootstock and these are tied together.



DAGP/2/3.10 Splice grafting. (Macdonald 1996)

Wedge or cleft grafting

When the scion has a smaller diameter than the root stock, wedge or cleft grafted is done. In this case scion is cut sharply at the lower end to form a 'V' shape or wedge. It is then inserted into the split made on the rootstock. The union area is then tied with polythene material as shown in the diagrams below:

Figure DAGP/2/3.11 Wedge or Cleft grafting

Tongue / whip Grafting

Tongue grafting is an improved form of splice grafting. It is designed to form a firmer joint that is less likely to slip during or after tying.

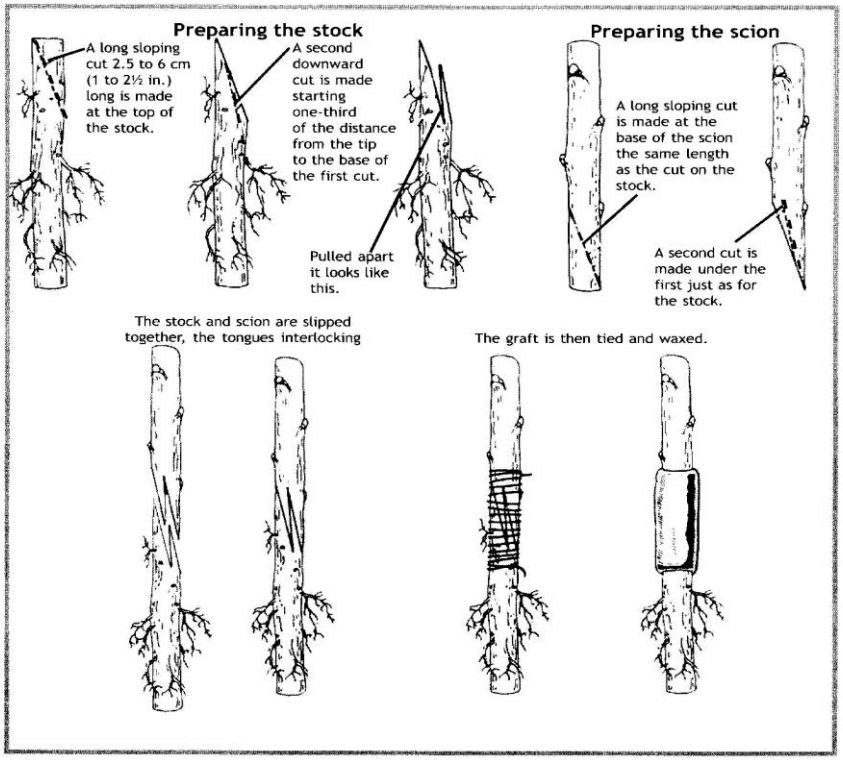


Figure DAGP/2/3.12 Procedure in Tongue grafting (Hartmann et al.1997).

Side Grafting

Side grafting is done when a small scion is to be grafted onto a rootstock, which may already be a mature tree. It is mainly used when a more productive scion is to be grafted onto an already existing fruit tree. This is known as 'top working'.

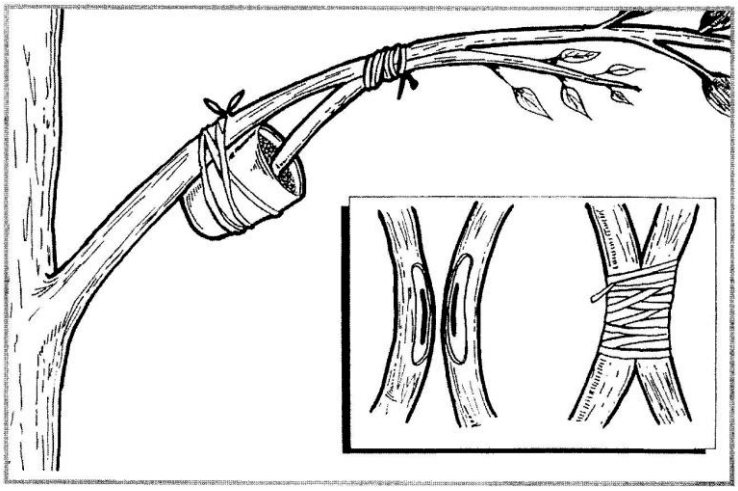


Figure DAGP/2/3.13 Side grafting

Budding

In some fruit trees such as citrus, it is possible to remove a bud with a little wood on and graft it to a rootstock. The bud is then allowed to develop into a new plant when the top of the rootstock is cut off.

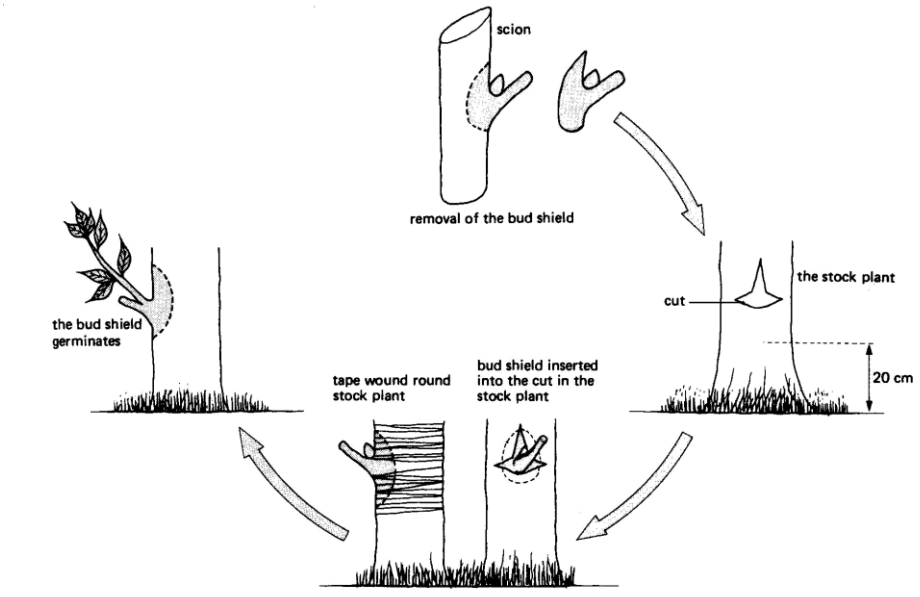


Figure DAGP/2/3.14 Budding

Layering

We have already discussed the use of stem cuttings in vegetative propagation of fruit trees. This involves the removal of plant parts before they have made roots. Layering involves methods of encouraging root formation on parts of the plant

still attached to the mother plant. When the roots are formed, the new plant can be cut from the mother plant.

Layering occurs naturally in most crops that have creeping stems (runners). Such crop roots are developed at the nodes and new plants are formed in that way. Layering can however be done artificially and this is of two types:

Serpentine layering (Also known as "Abobiada")

Here parts of a growing stem are forced into the ground and pegged there. The part of the stem buried in the soil must have a bud. The buried part must be kept moist.

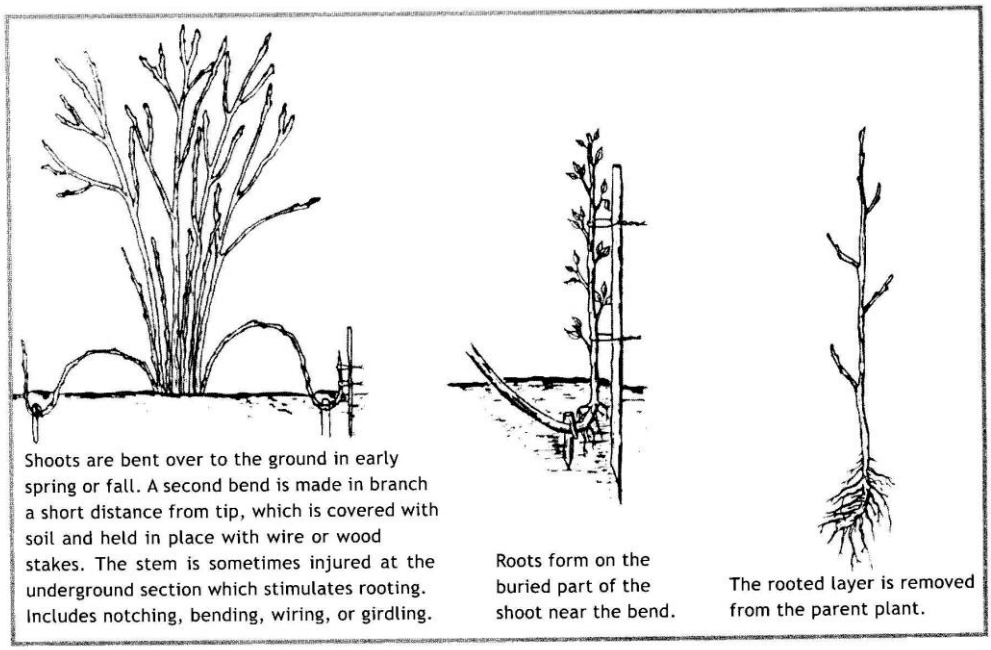


Figure DAGP/2/3.15 Serpentine layering (Simple Layering Hartmann et al. (1997)

To encourage root formation a slice is made close to the bud area at the node. This is known as a tongue. After the roots have developed, the new plant can be disconnected and planted in pots or in the garden directly.

Air Layering

Serpentine layering is only possible where the stem is able to bend and touch the ground without breaking. Where this is not possible a technique known as air layering is used. This technique is only successful in some plants.

The tongue is cut in the stem near the bud and supported to remain open with moist material such as polythene. The polythene is filled with loam soil mixed with some fibrous material and tied at both ends.

The set up is left for several weeks. If the roots develop then they will be seen through the transparent polythene and the polythene bag is the cut out land the new plant disconnected from the mother plant and planted in a pot for further developed before it is planted in the garden.

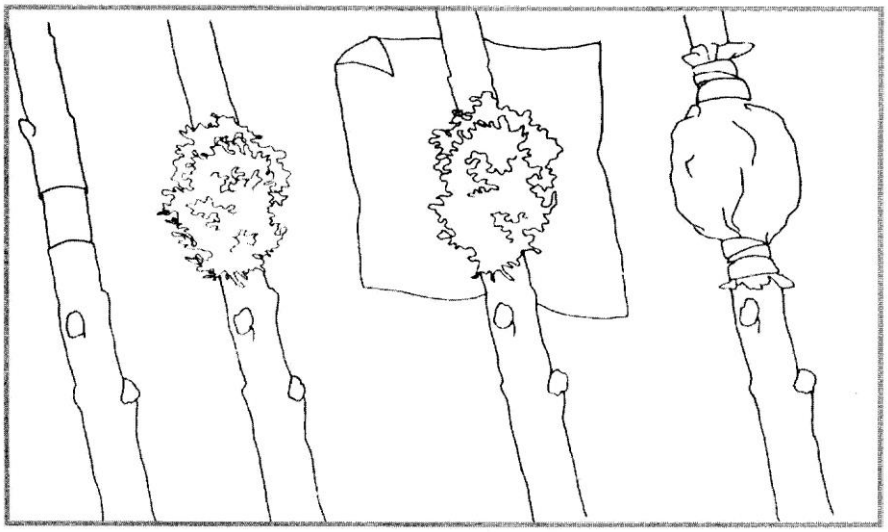


Figure DAGP/2/3.16 Air Layering or marcotting. (Macdonald 1986)

ACTIVITY DAGP/2/3-4

Using soft wood or clay, make out models of the different methods of grafting.

Note that you could set this as your own class exercise and help your pupils to make these models.

(ii) ESTABLISHMENT AND MAINTENANCE OF AN ORCHARD

Establishing an orchard

An orchard is a garden of fruit trees. It is important that as you establish your vegetable gardens, you also allocate some area for the growing of fruit trees.

Choosing a good site for an orchard

When choosing a good site for an orchard the following considerations should be made:

1. Most fruit are perennial and they take a long time to produce, it therefore not possible to include them in a normal rotation.

2. Fruit trees have deep roots and will require deep soils. The soils should be at least 1.8m deep with not murrum layer.

3. Some fruit trees require protection from strong winds. The selected area should therefore be sheltered from strong winds.

4. Fruits can easily be stolen if the orchard is located too far away from the living quarters or if the orchard is not fenced.

After the site for the orchard has been selected, the vegetation should be cleared. Planting holes should then be dug according to the recommended spacing of the fruit tree to be grown. The holes should be at least 60cm wide and 60 cm deep.

It is best to make the planting holes three weeks in advance of planting. The holes are filled with topsoils mixed with organic matter. A stake is placed in the middle of the filled hole to indicate where the plant would be placed.

At planting the hole is re-opened only sufficiently to allow the placement of the fruit tree seedling, which should be in a polythene sleeve or a soil block where the seedlings are raised in a polythene sleeve. The polythene is cut and removed before the seedling is planted.

After the seedling is planted, make sure that you compress the soil round the seedling to make it firm. This prevents sinking of the seedling, which leads to the damaging of roots. Water the seedlings immediately after transplanting and mulch. You may also need to provide some shed on each seedling until the seedlings establish.

Since the spacing between the fruit trees is likely to be large, the area between the rows can be used to grow quick maturing cover crops such as beans, peas, vegetables, etc. This allows for maximum utilization of land at the time when the tree plants are still young. One should however chose carefully the crops that are grown together with the fruit trees to avoid competition between the fruit trees and the crop for soil nutrients and growing space. Low growing leguminous crops and vegetables are often best. This is what is referred as multiple cropping. Multiple cropping is planned growing of compatible crops on the same piece of land.

When the trees become larger, they occupy more space and gradually reduce the possibility of growing crops within their rows. This is when you have an established orchard.

Maintaining an orchard

Freshly planted fruit trees need to be protected from stray animals, passer-bys, strong sunlight and excessive rainfall. It is best to build a strong fence round the orchard. If this is not possible protective fences should be built round each tree and a temporary shed provided.

Older orchards have to be maintained if high yields are to be realized. Some of the practices involved in the maintenance of orchards are discussed below:

Weeding

In the early stages of growth, fruit trees can easily be out, competed by weeds. If you have established a multiple cropping system, however, your fruit trees will remain weed free most of the time because as you weed the crops grown between the rows of the fruit trees you are also carrying out weeding of the orchard.

After the trees are well established, the tree canopy will to some extent suppress the growth of weeds. However, it may be necessary to weed the area around each tree. The inter-row space need not be dug up but the grass must be kept low by

slashing from time to time. Slashing, rather than digging between the rows also helps to conserve soil in sloppy areas. Deep digging between the tree rows should be avoided as the roots of the trees could be damaged in the process.

Some fruits which are not borne on trees e.g. pineapples, water melons etc. require a weed free soil. To reduce the frequency of weeding, mulching can be useful in this case.

Pruning

Pruning refers to the removal of excess branches, buds, leaves or suckers. Pruning helps to control the shape of the plant and allows for better utilization of plant nutrients.

Pruning also has other advantages which you can read about in Unit 2 topic 4 of Module 1. The guidelines for pruning are also covered in the Practical Guide..

Pests and disease management in orchards

Pests and diseases can be controlled in a number of ways such as:-

Use of resistant varieties

A resistant variety is that which is not easily attacked by a pest or a disease because it is not preferred as food or for habitation. In fruits, the emphasis has been on the development of resistance against viral diseases. Viral diseases are important because they have no cure, they can only be prevented in crops. Hence starting off with a fruit variety which is resistant to major viral diseases saves you a lot of problems later on. Resistance against pests and other diseases are also being developed or identified e.g. Rough lemon or the yellow passion fruits are used as root stocks into which oranges and passion fruits are used as root stocks onto which oranges and passion fruits are grafted respectively because rough lemon and yellow passion fruits are resistant to soil borne diseases.

Clean culture

This includes practices like:
- destruction of infected plant material
- keeping the weed population down.
- using uninfected planting materials.
- proper pruning to keep the plant open and well aerated.

Chemical control

Chemical pest and disease control in orchards should start with the control of soil borne pests and diseases. The potting mixture must be well sterilized using steam so that the seedlings are free from fungal, nematode or pest attack. In the field it is necessary to treat the soil and kill pests and disease causing organisms. They are said to have a fumigant action. Examples include Furadan, Mocap, Termic, Prumicid.

Control of foliar pests and diseases of fruit trees can be difficult because trees are often tall and are difficult to reach with the normal sprayers. For more effective spraying therefore motorized sprayers are used.

Harvesting, Processing and Storage

At the beginning of the unit we emphasized that fruits are often eaten raw. It is therefore very important that high standards of hygiene are observed during their harvesting, processing and storage or marketing. Harvesting fruits should be regular because the fruits rarely ripen at the same time.

Fruits that have been sprayed with pesticides should not be harvested before the pre-harvest period of the chemical has expired. Notice that this pre-harvest period is often specified on the containers for pesticide, and it excludes the period for storage.

Only undamaged fruits should be stored. The store must be kept well aerated and clean. It should also be moist to avoid the fruits getting dehydrated during storage.

Packing and transporting fruits should be done with a lot of care. Fruits are best transported in specially designed crates with smooth inner linings and a provision for aeration.

ACTIVITY DAGP/2/3-5

1. Can you think of any more reasons why the growing of fruits is not quite popular among the Ugandan farmers? Include these seasons here.
   ……..
   ……
   ……

2. Can you give examples of crops that are propagated through stem cuttings?

   ……..
   ……..
   ……..

3. Can you think of some advantages of using seeds in propagation of plants?

   ……..
   ……..
   ……..

4. Can you think of the advantages of multiple cropping?

   …….
   …….
   …….
   …….

(b) GROWING OF SELECTED FRUITS

(i) Growing of Pineapples

The pineapple is a perennial crop with a short stem and with spiny edged leaves arranged in a rosette (Figure DAGP/2/3.20) The flowers of pineapples are pink in colour. The flowers may develop into fruit without pollination or cross-pollination between various pineapples varieties.

Varieties

There are several varieties of pineapples grown in Uganda but the most common ones are:

Smooth cayane**:** The most widely grown, with a yellow flesh and plenty of juice.

Red Spanish**:** This has a reddish flesh. It is good for dry processing.

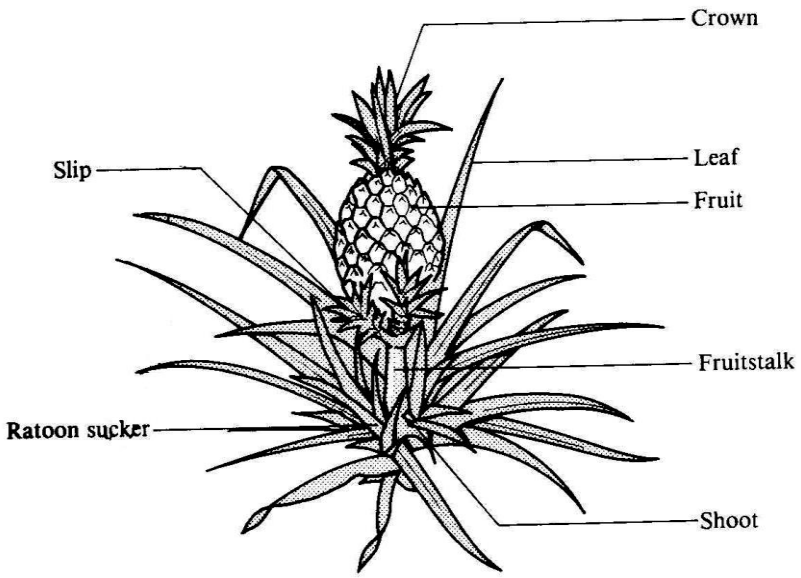


Figure DAGP/2/3.17 A pineapple plant

The fruit is rich in Vitamin B and C. It can be eaten as a fresh fruit, canned or made into juice. Jam and sugar syrup can also be obtained from the juice. If the juice is fermented, wine / alcohol is obtained. The fruit residues after milling juice can be fed to cattle.

Growth requirements

Pineapples grow well up to altitudes of about 2000 m. They are quite drought-resistant and grow in a wide range of soils. Free draining sandy loams are the best soils. Optimum rainfall is 1000 – 1500mm and average annual temperature should be 20^0C – 32^0C.

Land preparation and planting

The land to be used should be deeply cultivated since the crop has shallow weak roots. The crowns, slip or suckers are used as planting materials. A double row spacing of 150 cm between centres of double rows and 0.5 cm apart within rows are used. The slips are the preferred planting materials since they take a shorter time to fruiting.

Figure DAGP/2/3.18 Double row spacing

Weed control

Weeds are controlled through a combination of mulch, herbicides and hand cultivation. Mulching with black polythene has been proven to raise yields by up to 50%. This is done by conserving moisture, suppressing weeds and raising soil temperature.

Fertilizer application

The crop responds well to heavy nitrogen fertilizer application (100 kg / ha). Phosphate fertilizers are sometimes necessary at about 4 months after planting.

Table DAGP/2/3.7 Pest and disease control

Pest	Damage	Control
Nematodes	Feed on roots	- Soil fumigation using Nematicides - Crop rotaltion
Mealy bugs	Attack roots, leaf bases and fruits	- Dip planting material in Aldrin or Dieldrin. - Spray with Parathion

ACTIVITY DAGP/2/3-6

1a) Visit farmers that grow pineapples in your area. Compare their crop management practices and those you have read about in their topics.

b) Think of ways you can advise the farmers to improve on their husbandry practices.

2. If there are any farmers that grow pineapples for commercial purposes, ask the problems they face when marketing the crop.

(ii) Citrus Growing

1. Introduction

In Uganda, citrus is rarely grown on a commercial scale. The citrus schemes, which were established in Kiige in Kamuli District, Ongom in Lira District and Odina in Soroti District in the 1960s, have all been neglected and currently, there is no commercial production from these schemes. Most of the citrus is produced from scattered trees in smallholdings or around homesteads. The quality of the fruits is also generally poor and cannot meet the quality standards of international markets. Most of the fruits are therefore consumed locally. Attempts to revitalize citrus production were made in 1991-1993 under the UNDP/FAO Supported Development of Horticulture Industry Project. Large numbers of citrus seedlings were propagated in government nurseries established in various places with the country under this project. Private nurseries have also been established partly as a result of this project.

Varieties

1. The sweet orange *(Citrus Sinensis)*

   Is the most widely grown of the citrus fruits. It grows at all altitudes below 2500m and where the dry season is not too severe. When raised from seedlings the trees take up to 3 years to yield. However, if the trees are raised from grafted or budded material they can take from 1 – 1 ½ years to flower.
   The fruits are of good flavour and are borne in abundance. They have seeds and their skins rarely change from green to yellow. The common varieties of sweet orange in Uganda are Washington Navel, Golden Buckeye, Pineapple, Valencia Late, Mediterranean Sweet, Du Roi.

2. Tangerines *(Citrus nobilis)*

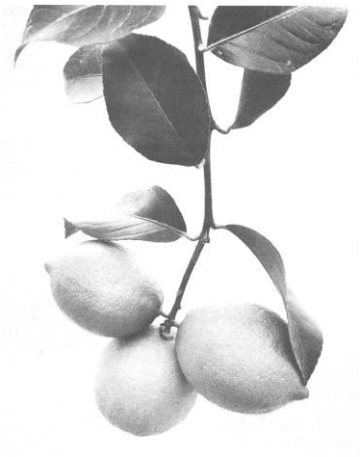
   These also grow and fruit well in Uganda. They have a bright yellow colour on ripening. However, this bright colour is often developed only after the fruits have been stored for sometime. The common varieties are: Emperor, Beauty of Ghen Retreat, Jacob's Improved Throny, Daney.

3. Sour Orange *(Citrus aurantium)*

Is not commonly cultivated but has a good potential because it makes good marmalade. The fruits remain green even when ripe.

4. Lemons *(Citrus lemonia)*

Lemons are rarely grown on large scale in Uganda. The common varieties are Lisbon, Villafrance, Eureka



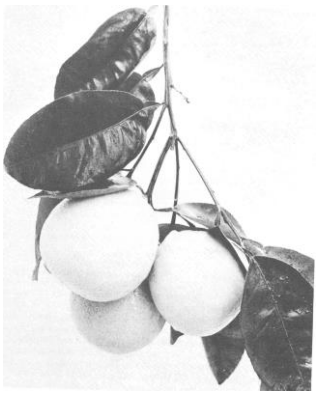
DAGP/2/3-19 Lemon "Eureka." Samson J.A. PP 85

5. Limes – Sweet lime *(Citrus limetta)* and Sour lime *(Citrus aurantiifolia)*

Like the lemons, limes are rarely grown on any large scale in Uganda.

6. Grape fruit *(Citrus paradis)*

These are grown in several districts of Uganda. Their fruits are of good quality if allowed to ripen when still on the tree. If they are harvested prematurely however, they have an excessively bitter flavor. Common varieties are; Marsh's seedless, Royal, Red blush and Star Ruby.



DAGP/2/3-20 Lemon "Eureka." Samson J.A. PP 83

Ecology

- Rainfall

Citrus requires regular supply of soil moisture. Where rainfall is unreliable, citrus will need irrigation of the quality of the fruit is to be maintained. Availability of

moisture also encourages flowering and fruit setting. With judicious irrigation, flowering can be encouraged throughout the year.

- Soils

Citrus does well in deep, light and medium textured soils. It is important that the soil is well drained because the rough lemon, which is almost universally used as a rootstock, is very sensitive to low concentration of oxygen in the soil. It is also sensitive to Saline soils (i.e. soils with high pH). Soil pH of 5.5 – 7.0 is ideal.

- Temperature

Citrus does well in a wide range of temperatures. Temperature and humidity affect the colour of the fruits on ripening. High temperatures when coupled with high humidity discourage the development of the fruit colour to yellow and the fruits remain green even when ripe.

- Wind

Citrus plants must be sheltered from strong winds. The winds cause the branches to rub against each other causing injuries. Strong winds may cause breakage of branches and shedding of flowers.

Propagation

Citrus can be propagated from seed. In fact most of the citrus trees grown round the homesteads in Uganda are propagated from seed. However, the modern ways of growing citrus require that buddings are used instead of seeds. Propagation from budding has the following advantages:

- It is possible to grow seedless citrus varieties. Moreover, seedless varieties are more popular than seeded varieties.

- Budding is a type of vegetative propagation, which ensures that the offspring is exactly identical to the parent tree. It is therefore easy to select and maintain high yielding trees.

- Varieties, which would not have been possible to grow in particular soils, can be grafted onto a rootstock, which is not affected by the soil conditions.

- Buddings are often less thorny than the seedlings.

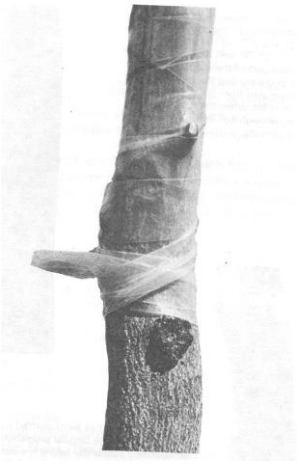
- The size and height of the tree can be limited if buddings are used. This makes spraying and harvesting easier.

- Buddings come into bearing more quickly than seedlings.

Propagation by budding has already been discussed in the previous topic. You could refer to the unit to familiarize yourself with the procedures of bud grafting.

One-year-old rough lemon is almost used exclusively in Uganda as rootstock. This rootstock is grown from seeds in a nursery until they are at least one year old before suitable buds are grafted onto them.

DAGP/2/3-21Rough lemon Root stocks (Samson pg. 88)



DAGP/2/3-22 Bud inserted and firmly bound with with transparent polythene to encourage grafting (Acland J.D. Pg 46.)

DAGP/2/3-23 *Bud shooting on a rootstock (Samson Pg 99)*

Grafted seedlings have to remain in the nursery for another 12-18 months before they are transplanted into the field.

Field Establishment

Planting holes which are 60x60cm wide and 60cms deep are dug in the field well before the time of transplanting. These holes are filled with a mixture of topsoil, manure and super phosphate fertilizer to encourage root development.

Spacing

Spacing varies depending on the maximum size the tree attains at maturity. Lemon trees are often larger than orange trees. On the average, however, a spacing of 6m x 4m is sufficient.

Planting

At transplanting, the buddings, which are often in pots or polythene sleeves have the sleeves cut off. Roots should be pruned where necessary before planting. If this is done, then the leaves should be removed to avoid excessive water loss after

planting. The planting holes are reopened to accommodate the budding. The soil is firmed around the budding and plenty of water is applied. Care must be taken not to heap soil round the plant up to the area of the bud union as this may encourage attack of the union by *Pytophthora* fungi.

Mulch should be applied round each tree to prevent excessive water loss.

Field Maintenance

Citrus requires adequate amounts of moisture in order to yield highly. Irrigation is therefore necessary during dry spells.

During the first 2 years of growth, it is advisable to remove flowers and immature fruits. This reduces on stress put on the growing tree and allows for normal growth of trees to mature size and the formation of a strong framework of branches.

Citrus can be intercropped with annual crops during the first few years. This allows for better utilization of land.

Citrus trees are rarely pruned. However, light pruning is necessary to keep the centre of the tree free from overcrowded branches. The tips of the lower branches should also be pruned to prevent the branches from touching the ground.

Fertilizers and Manures

Good quality organic manures should be supplied regularly round each tree. This improves yields. Fertilizers may also be applied around each tree. Both Calcium Ammonium Nitrate (CAN) at the rate of 1 - 1.5 kg / tree and Single Super Phosphate (SSP) at the rate of 200g/tree have given good results. These fertilizers are applied once every 6 months.

Weed control

Weed control is done by hand cultivation, disc harrowing, mulching or use of herbicides. In areas of steep slopes, weed control, may be done by slashing in between the trees. Why?

Harvesting

Citrus trees often start yielding after 3-5 years. Maximum yield is however often achieved at 10 years after planting and may bear for many years after. In Uganda, the life of citrus trees is often limited to 20-30 years because of poor nutrition and disease attacks.

The fruits should be removed carefully to avoid bruises that may lead to rotting, discolouration and loss of quality.

After harvesting fruits should be stored in well-aerated cool stores. The fruits should also be sorted out into grades according to size, colour, skin texture, etc.

Yields

Average yields in 13-26 t/ha depending on the level of management of the trees. In other parts of the world citrus can yield as high as 63 t/ha.

Pests and Diseases

Pests

Pests	**Damage**	**Control**
Mediterranean fruit fly *(Ceratitis capitata)*	Bores into the fruits and cause premature fruit dropping	- Spray with Fenthion, Malathion, or Endosulfan. - Collect dropped fruits and dispose them in drum of water with a film of oil on top.
False codling moth *(Cryptoptebia leucotrea)*	Bores into the fruits and cause premature fruit dropping	- Spray as in Mediterranean fruit fly above. - Good field hygiene.
The Citrus mite *(Phyllocoptruta oleivora and Aceria Sheldoni)*	- Discolouration of the fruit surface although the flesh is not damaged. - Severe bending and twisting of twigs and severe disfiguration of the fruit.	- Spray with Chlorobenzilate
Aphids *(Toxoptera sp.)*	Suck the leaves and growing points and cause distortion of growth	Spray as with Scales. However, damage is only serious in dry weather.
Scales *(Aonidella laurantii, Coccus vividis & Lepidosaptes backii).*	Found on twigs, trunk and leaves causing dieback of branches, premature leaf fall	- Spray as with Malathion, Chazinon dimiethoate. - Painting the trunks with oil or tar.
Diseases Virus	- Die back - Stunting - Pitting of wood	Resistant varieties

LEARNING OUTCOMES

At the completion of this unit you should be able to:

- Appreciate the importance of horticultural crops and the general principles of growing and caring for them.
- Start vegetable and fruit tree gardens and manage them satisfactorily.
- Demonstrate confidently the various skills in vegetable and fruit tree production.

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