

Crop Production III and IV

Wheat

Economic Importance

- (i) Generates income to the farmer.
- (ii) Wheat flour for bread, baby food, etc.
- (iii) Industrial alcohol.
- (iv) Wheat bran is a concentrate for livestock.
- (v) Wheat straw - fodder, thatching houses and beddings for livestock.
- (vi) Major source of carbohydrates, proteins, vitamins for humans and livestock.

Geographical Distribution and Environmental Factors

Rainfall

750 mm - 1000mm p.a and should come during tillering, flowering and filling of the grains.

At harvesting time it should be completely dry.

Altitude and Temperature

Grown at 1800m - 3000m above sea level. High altitude areas receiving a lot of rainfall and no humidity during the rainy season. Grown on flat and large extensive land for economic purposes:

Soil

- (i) Well drained.
- (ii) Good lime content.
- (iii) Silty loam or clay loams.
- (iv) Soil pH 5.0 - 6.0.
- (v) Should be fertile.

Main Growing Areas

Trans Nzoia, Uasin Gishu, Laikipia, Nakuru,

Nyeri, Nyandarua, Meru districts and Mau Narok.

Marketing

Handled by the National Cereals and Produce Board.

Barley

Economic Importance

- (i) Used in brewing industry.
- (ii) Used as livestock feed e.g. grains are rich in carbohydrates and proteins.
- (iii) Used as confectionery and health foods e.g. baby foods.

Geographical Distribution and Environmental Factors

Altitude and Temperature

Areas over 2000m above sea level where the temperature is around 18°C.

Rainfall

It requires a lot of rainfall during the growing period. Insufficient rainfall during this period leads to:

- (i) Premature ripening.
- (ii) Thin grains.
- (iii) Hard endosperm which is difficult to soak.
- (iv) High nitrogen content in the grain.

Soils

- (i) Should be fertile, well drained.
- (ii) Soils of good water holding capacity.
- (iii) Soil pH 7.0 - 8.0.

Growing Areas

Mau Narok, Molo, Timau and Londiani.

Marketing

Sold to the National Cereals and Produce Board and the brewing industries directly.

Sorghum**Economic Importance**

- (i) The dry grains are ground to make *ugali*, *uji* (rich in carbohydrates).
- (ii) For beer making.
- (iii) Can be used as livestock feeds.
- (iv) Starch extraction to be used in laundry.
- (v) Sorghum oil can be used as cooking oil.
- (vi) Inflorescence can be used as brooms.
- (vii) Sucrose can be extracted from it.
- (viii) Stems can be used for mulching, fire-wood or for thatching houses.

Geographical Distribution and Environmental Factors

Altitude: 900 - 1500m above sea level.

Temperature 30°C (requires high temperature).

Rainfall

420-600 mm per annum and should come during the growing period.

Soils

- (i) Should be well drained fertile soil.
- (ii) Well aerated.
- (iii) Soil pH 5.0 - 8.5.

Growing areas

Siaya District, Turkana District, Kitui District, Machakos, lower parts of Meru and lower parts of Kakamega.

Marketing

Most of the crop is consumed locally. Any excess may be sold to the National Cereals and Produce Board.

Pawpaws**Economic Importance**

- (i) Used as salads, jams and pawpaw juices.

- (ii) Papain used as mild laxative and meat tenderiser.
- (iii) Juice used in making alcohol.
- (iv) Latex is used for manufacture of paint.

Geographical Distribution and Ecological Requirements*Altitude*

From 0 - 2100 m above sea level. Can withstand light frost.

Temperature: 25°C

Rainfall

Average 1000 mm p.a. and should be well distributed throughout the growing period.

Soils

Should be deep, fertile, well drained and loamy. Soil pH 6-6.5.

Main Growing Areas

Along the Coast, Kakamega, Kirinyaga, etc.

Marketing

Fruits are sold in the local markets, supermarkets and processing industries.

Passion Fruits**Economic Importance**

- (i) Pulp used as salads, making jam and jellies.
- (ii) Flavouring confectionery e.g. cakes.
- (iii) Fruit residues used for cattle feeding.

Geographical Distribution and Ecological Requirements*Altitude*

1700m above sea level. Should not be exposed to strong winds.

Temperature

Can tolerate warm to cool conditions.

Rainfall

Range of 900-1000mm p.a. and should be well distributed throughout the year and a dry sunny period during flowering and pollination.

Soils

Free draining, friable loam soils are the best.

Main Growing Areas

Machakos around Mua Hills, Sotik, Kisii, Thika, Kakamega, Kitale and Taita Taveta.

Marketing

Sold in local markets, supermarkets and canning factories at Thika.

Pineapples**Economic Importance**

- (i) Used as pineapple juice, jam and salads.
- (ii) Used in making confectionery.
- (iii) Distillation of alcohol, citric acid and ascorbic acid.
- (iv) Livestock feeds from waste products.

Geographical Distribution and Ecological Requirements**Altitude**

From sea level to 2000m above sea level. Above 2000m, there is frost and the temperature is too low.

For canning the ideal altitude is 1350-1750m above sea level.

Temperature

Ideal temperature ranges from 20°C to 30°C.

Rainfall

Ideal amount is 1000-1500mm p. a. and well distributed throughout the growing period.

Soils

- (i) Recommended soils are the sandy loams. Well aerated and free draining.
- (ii) Soil pH 5.5-6.5.

Main Growing Areas

Central Province around Thika, Machakos, Ahero, Sondu and Kakamega.

Marketing

Sold locally, others are sold to canning factories e.g. at Thika.

Mangoes**Economic Importance**

- (i) Used as dessert and juices to provide vitamin A, B and C.
- (ii) Used in making baby foods.
- (iii) Waste used as animal feeds.
- (iv) Wood used as fuel.
- (v) Bark used in leather tanning.

Geographical Distribution and Ecological Requirements

Altitude: 0-1500m above sea level.

Temperature: Mean 25°C.

Night and day temperature changes should be minimal (20°C-30°C.).

Rainfall: Ideal rainfall of 1000-1500 mm p.a. During blossoming, dry spell is required.

Soils

- (i) Can do well in sandy-loam soils.
- (ii) Should be free draining and friable.
- (iii) Fair water holding capacity.
- (iv) Soil pH 5.5-7.0.

Main growing areas: Coast and Eastern Provinces and Central Province (particularly Muranga and Kirinyaga).

Marketing

Sold locally in markets and supermarkets. The rest are exported.

Coconuts**Economic Importance**

- (i) Mature nuts provide copra and coir fibres.
- (ii) Copra produces oil which is used for cooking and soap making.
- (iii) Copra cake is used as livestock feed.
- (iv) Coir fibres are used in making mattresses, ropes, etc.
- (v) Immature nuts provide refreshing water.
- (vi) Inflorescence provides wine.
- (vii) Dry leaves used for thatching.

- (viii) Coconut shells used for making bowls and can be a source of fuel.
- (ix) Stem used as firewood.

Ecological Requirements

Altitude and Temperature

0-1100m above sea level. Require plenty of sunlight

Rainfall

Minimum 1250 mm p.a. and maximum 2500 mm p.a. and should be well distributed throughout the year.

Soils

Sandy loam or clay. Should be deep, well drained. The crop withstands saline soils. Soil pH 5.0-8.0.

Main Growing Areas

Coastal belt in Kilifi, Mombasa and Kwale Districts.

Cultivars: There are two types, tall and dwarf palms (Pemba).

- (iv) Dig holes of dimension 60 cm diameter, 60cm deep (spacing 8m x 8m).
- (v) Top soil should be separated from sub-soil.

Transplanting

- (i) Done at the beginning of rains.
- (ii) The best seedling is selected for planting.
- (iii) Filling in the planting holes: sand, topsoil and fertiliser then mulching at the top.

Field Maintenance

- (i) Intercropping with any annual crops or grass leys.
- (ii) Provision of shade to young seedlings.
- (iii) Mulching the young plants.
- (iv) Fertiliser application.
- (v) Control of weeds on young trees.

<i>Tall Palms</i>	<i>Dwarf Palms</i>
<ol style="list-style-type: none"> 1. When fully grown can reach a height of 30m. 2. Self pollinated. 3. Takes 5-10 years to first bearing. 4. Gives longer nuts. 5. Hardy and can survive under soils. 6. Has long economic life of 60-70 years. 	<ol style="list-style-type: none"> 1. Can reach a height of 8-10m. 2. Cross-pollinated. 3. Takes 3 years to first bearing. 4. Gives smaller nuts. 5. Needs fairly fertile soils. 6. Has short economic life of 30-35 years.

Selection and Preparation of Planting Materials

- (i) Seed nuts should be selected from high yielding, pest-free materials.
- (ii) Nuts which have fallen are selected then planted in the nursery.
- (iii) Site of the nursery should be near a source of water, on flat piece of land.

Seedbed Preparation

- (i) Digging of the land during the dry season.
- (ii) Removal of any tree stumps.
- (iii) Further digging of the soil until it is fine.

Pests and their Control

Rhinoceros beetle

Nature of damage

The adult feeds on the young terminal buds hence retards the growth of the plant.

Control

- (i) Removing any rotting material from the field.
- (ii) Physical method by pouring of sand in trunks.
- (iii) Biological method by use of wasp, etc.

Coreid Bugs / Coconut Bugs*Nature of damage*

They suck the developing nut causing wounds leading to low quality copra.

Control

Biological method by use of ants.

Diseases

Bole rot: Caused by fungus.

Symptoms

- (i) Rotting of the stem.
- (ii) Leaves turn yellow.

Control

- (i) Avoid damage during weeding.
- (ii) Do not damage roots during transplanting.

Harvesting

Coconuts start bearing fruits when they are 7-10 years old.

- (i) To obtain coconut water, immature nuts are harvested 7 months after the start of bearing period.
- (ii) To obtain copra, fallen nuts are collected when 9-12 months after the start of the bearing period.

Processing

- (i) De-husking and drying until the endocarp separates from the flesh.

*Pyrethrum***Economic Importance**

- (i) Flowers can be used to manufacture insecticides.
- (ii) By-product of pyrethrum extraction is pyrethrum marc which can be used as a livestock feed.
- (iii) The pyrethrum marc can also be used as organic manure.

Ecological Requirements*Altitude*

Between 2000-2500m above sea level. The higher the altitude, the lower the temperature and the higher the pyrethrin content.

Temperature

Ideal temperature is 15.5°C.

Rainfall

Minimum 1000mm p.a. It should be well distributed throughout the year and 1-2 months of dry spell to induce initiation of flowers. Irrigation can be done where rainfall is less than 1000 mm. p.a.

Areas where grown

Kisii Highlands, Nyandarua, Kiambu, Nyeri, Muranga and Embu districts (around Aberdares and Mount Kenya).

Clone and Cultivars Grown

- (i) Clone 4331: Does well in areas between 1800-3000m. Has wide adaptability.
- (ii) Clone 4729: Does well at low altitudes of 2100m.
- (iii) Clone L/64/197: Does well at all areas. Pyrethrin content 2%.
- (iv) MA/65/252: Does well at high altitudes; 2400m above sea level. Pyrethrin content: 2.40%.
- (v) Cultivar P4: Developed through crossing. Requires a lot of rainfall. Yield potential same as 4331. Grown at altitudes: 2100m above sea level.

Selection and Preparation of Planting Materials

Propagation materials are seeds and vegetative materials. For commercial purposes vegetative materials are preferred.

Vegetative materials should be selected from mother plants with the following characteristics:

- (i) Potentially high yields.
- (ii) High pyrethrin content.
- (iii) Resistance to diseases.
- (iv) Type which grows upwards.

Preparation of Planting Materials

- (i) Sub-divide the splits into three stems and a few roots.
- (ii) Discard old stems which have turned brown.
- (iii) Remove brown lower leaves.

- (iv) Discard roots with swellings.
- (v) Trim excessively long roots.

Nursery Practices

Site

Should be flat or gently sloping, sheltered from winds and having well drained fertile soil.

Dimension of the Nursery

1.5m wide, 15cm high and any convenient length, having paths of 60cm wide between the beds.

Spacing: of splits should be 23cm x 23 or 30cm x 30cm.

Field Maintenance

- (i) Apply phosphatic fertiliser at planting and nitrogenous fertiliser after one month.
- (ii) Control weeds by uprooting them and earthing up.
- (iii) Remove buds in case splits are used.

Seedbed Preparation

- (i) Prepare before the onset of the rains and eradicate all perennial weeds.
- (ii) Make ridges.

Planting in the Field

Transplanted at beginning of the rains. Use splits with three stems and reasonable roots. The roots are dipped in fungicides. Dimension of holes 10-15cm deep.

Spacing

60 cm x 30 cm small scale.
90 cm x 30 cm large scale.

Fertiliser Application

Apply phosphates during planting time and top-dress, in split application

Control of Weeds

Usually done manually.

Pruning or cutting back

Involves cutting off the old pyrethrum foliage. Done once a year by use of sickle or secateur, usually during the dry season after a heavy harvest.

Harvesting

- (i) Harvested when flowers are fully opened.
- (ii) Picked by twisting the heads.
- (iii) Flowers are put in well ventilated baskets to avoid fermentation.

Drying

There are two methods of drying, namely sun and artificial.

The flowers should be dried to 10-12 percent moisture content.

Pests and their Control

(i) Thrips

Nature of damage: They suck the sap leaves.

Control: Use of chemicals e.g. Rogor E.

(ii) Red Spider Mite

Nature of damage: Suck sap and introduce toxic, substances which make the leaves turn white or yellow.

Control: Spray Dimethoate.

(iii) Nematodes

Nature of damage: Cause galling in the roots thus blocking the conducting vessels. The plants wilt and die.

Control: Crop rotation, soil fumigation and biological control.

Diseases

(i) Bud Disease

Cause: Fungus

Symptoms:

- Brown or purple colour of the buds.
- Die-back of the flower stalk and turning upside down.

The disease is common under cloudy and rain conditions.

Control

- Cutting back old stems.
- Use of fungicides.
- Growing resistant varieties.

(ii) Root rot

Cause: Fungus

Symptoms

Attacked roots turn brown around the ground level and the whole plant dies.

Control

- (i) Avoid damaging roots.
- (ii) Control nematode attack.
- (iii) Reduce organic matter.
- (iv) Use fungicides.
- (v) Grow resistant varieties.

Sisal**Economic Importance**

- (i) Sisal fibres are used for making ropes, sacks, mats and twines.
- (ii) Sisal wastes can be used as livestock feed.
- (iii) Boles used as firewood.
- (iv) Poles used as firewood, roofing and fencing.
- (v) Sisal wastes are used as mulching materials.

Ecological Requirements

Altitude: Grown at low altitude areas 0 - 1800m with plenty of sunlight.

Temperature: 27 - 32°C is ideal.

Rainfall: Tolerant to dry areas (xerophytic). Optimum rainfall 1200 - 1800mm p.a. Sisal is mostly grown in areas receiving less than 750mm p.a.

Soils: Well drained soils preferably sandy loam.

Main growing areas: Coast Province, (Kilifi, Taita Taveta), Mogotio, Muranga, etc.

Cultivars and Types

- (i) *Agave sisalana*: This does well in all areas and is resistant to many diseases.
- (ii) Hybrid 11648: This does well in low altitudes but is susceptible to many diseases.

Propagation

Sisal can be propagated by use of seeds and vegetatively e.g suckers, rhizomes, bulbils.

Nursery Practices

Site: It should be well drained and have a fertile soil, be flat or gently sloping, be near a source of water and centre of plantation.

Management in the Nursery

This includes fertiliser application, watering, weed control and roguing.

Seedbed Preparation

Activities involved are:

- (i) Land clearing.
- (ii) Primary and secondary cultivation.
- (iii) Making rectangular blocks of 500m by 200m.

Transplanting

Done at the beginning of the rains. Holes should be 6.0-7.5cm deep and wide enough.

Spacing

Low rainfall areas: 4.0 m x 1m x 1m.

High rainfall areas 3.5 m x 1m x 0.75m.

Field Maintenance

- (i) Intercropping and cover cropping e.g. with pasture legumes.
- (ii) Fertiliser application: Apply phosphatic, nitrogenous, and potassic, calcium, sisal wastes, etc.
- (iii) Weeds are controlled by cultivation and use of herbicides.

Pests

- (i) *Sisal Weevil*

Nature of damage: The larva burrows and feeds on the tissues of the bole resulting in the weathering of leaves and eventual death of the the plant.

Control: Use of insecticides

- (ii) *Scales*

Nature of damage: Sucking the sap from the leaves and discolouring the sisal fibres.

Control: Use of insecticides e.g. malathion sprays.

Diseases

- (a) *Zebra Disease*

Cause: Fungus

Symptoms:

- Black stripe which runs parallel to the veins of the leaves.
- Black discolouration of the fibres.

Control: Grow resistant varieties and ensure good drainage of the soils.

(b) Bole Rot

Cause: Fungus

Symptoms: Rotting of the boles causing bad smell and eventually leaves turn yellow and whole plant dies.

Control: Provide adequate nutrients in the soil.

Harvesting

- (i) Done by cutting the leaves using knives with straight blades.
- (ii) Leaves should reach the factory in less than 24 hours. Factors to consider when harvesting sisal:
 - Time for first cutting (1½ - 4yrs).
 - Severity of the cutting.
 - Frequency of harvesting.

Processing of Sisal

Stage one: Decortication - separating the fleshy tissue from fibre.

Stage two: Drying of sisal fibres to a moisture content of about 10%.

Stage three: Brushing to remove wastes and separate fibres.

Stage four: Grading and baling - based on the length and colour of the fibres.

Each bale measures: 120cm x 60cm x 60cm and weighs 200kg.

Tobacco**Economic Importance**

- (i) Leaves contain nicotine and are processed into cigarettes, cigars, pipe tobacco and snuff.
- (ii) Nicotine can be used as an insecticide.
- (iii) When nicotine is oxidised, nicotinic acid is obtained which is a constituent of the vitamin B-complex.
- (iv) Seeds can be used in manufacturing oil.

Ecological Requirements**Altitude**

Grown from 0 - 1300m above sea level.

Above 1500m above sea level, leaves are thick and leathery.

Below 900m above sea level, leaves are very light.

Temperature range is 13°C - 27°C.

Rainfall

400mm of well distributed rainfall during the 3½ months after transplanting: Excess rainfall leads to high incidence of diseases.

Soils

Different types of tobacco require different types of soil.

- (i) Fire-cured tobacco require medium to heavy soils (clay) preferably a new land or virgin land.
- (ii) Flue-cured and air-cured tobacco require light, well drained soils with proper water holding capacity. Sandy loams are ideal.

Types and Cultivars

- (i) **Main Cultivars of Flue-Cured are:**
NC 95, Kutsaga 51, White gold, E. 2 and G. 28.
- (ii) **Fire-cured cultivar:** e.g. heavy western.
- (iii) **Air-cured cultivar:** e.g. Burley 21

Propagation

Can be propagated by means of seeds.

Seed Selection and Treatment

- (a) Selected from mother plants with the following characteristics:
 - (i) Healthy and vigorous in growth.
 - (ii) Having large number of big leaves.
 - (iii) Early maturing.
 - (iv) Adaptability to local conditions.
 - (v) Resistance to diseases.
- (b) Seeds are treated to prevent any disease by use of a solution of silver nitrate.

Nursery Practices

Site

Land should be flat or gently sloping, near a source of water and free from tobacco for about six years.

Nursery Preparation

Dimension of the beds:

- (i) 1.20m wide, 23 m long with paths of 30 - 60cm wide.
- (ii) Bed raised to 7.5 or 15cm by use of top soil to prevent waterlogging.
- (iii) Create a fine tilth since the seeds are small and sterilise the soil a week before planting.
- (iv) Apply phosphatic fertilisers by raking them in.
- (v) Sow the seeds by mixing them with water in a watering can or seeds can be mixed with soil then broadcasted to a depth of 5mm.

Maintenance of seedlings in the nursery includes: Mulching, watering twice per day, hardening off one week before transplanting and control of weeds manually.

Seedbed Preparation

This involves land clearing, primary secondary cultivation and ridging.

Transplanting

- (i) Seedlings are ready for transplanting after 6 to 8 weeks.
- (ii) Select healthy, disease - free seedlings of uniform height.
- (iii) Seedlings are transplanted at the onset of rains.
- (iv) Before transplanting water the nursery.
- (v) Lift the seedlings with balls of soil around them.
- (vi) Transplanting is done at the onset of rains.

Spacing

- (i) Flue-cured and air-cured 100cm x 60cm.
- (ii) Fire-cured 100cm x 100cm.
- (iii) Recommended spacing by B.A.T is 120cm x 60cm.

Field Maintenance

- (i) Gapping done within one week of transplanting.
- (ii) Fertiliser application.
- (iii) Weed control done manually, no herbicides.
- (iv) Priming: the removal of small, damaged or diseased leaves at the bottom of the plant. It is started when the plant is one and a half weeks after transplanting.
- (v) Topping: the removal of flowers from the top of the stem. Done to channel the nutrients to the leaves.
- (vi) De-suckering: the removal of suckers at the axils of the leaves to allow the leaves to get enough nutrients and sunlight.

Pests

Nematodes

Nature of damage: Form knots, galls on the roots thus blocking the translocation vessels, hence the plant becomes stunted and withers.

Control: Crop rotation, soil fumigation, growing resistant cultivars and sterilising the nursery beds.

Tobacco White Fly

Vector of tobacco leaf curl-virus disease.

Control: Closed season.

Diseases

(i) Anthracnose

Cause: Fungus

Symptoms: Water-soaked spots on the lower leaves of seedlings.

Control: Spray fungicides.

(ii) Damping off

Cause: Fungus.

Seedlings fall over and die.

Control:

- Spray fungicides.

- Seed dressing.

- Sterilise the nursery.

- Avoid too much shade and too much frequent watering.

Harvesting

- (i) Leaves are ready for harvesting 3 to 4 months after transplanting, when leaves change from green to yellowish green.
- (ii) Leaves are picked and attached to sticks then transported to the barns for processing.

Processing

Stages during processing are:

- (i) Yellowing of the leaves.
- (ii) Fixing of the colour.
- (iii) Drying of the leaves.
- (iv) Conditioning (allowed to absorb moisture).
- (v) Grading according to size, colour and texture.

Main Growing Areas

- (a) Flue-cured tobacco in Kitui and Muranga (Sagana).
- (b) Fire-cured tobacco in South Nyanza (Migori), Bungoma (Malakisi) and Meru Districts.

Cotton**Economic Importance**

- (i) Lint is used for making fabrics and surgical wool.
- (ii) Fuzz or linter used for stuffing pillows, mattresses and wicks for candles.
- (iii) Cotton seeds are processed to extract cooking oil.
- (iv) By-products of cotton seeds after oil extraction is used as livestock feed (cotton seed cake).
- (v) Stems can be used as firewood when dry.

Ecological Requirements**Altitude**

Grown at altitudes 0-1400 m above sea level.

Temperature

For optimum growth, 32-35°C. is suitable.

Rainfall

- (i) Should be well distributed throughout

the growing period, declining towards harvesting period.

- (ii) Can do well in areas receiving from 500mm to 1400 mm p.a. Irrigation can be carried out if rainfall is inadequate.

Soil

Requires well drained fertile soil of pH 5-6, preferably black cotton soil.

Main Growing Areas

Around Lake Victoria in Nyanza Province, Busia District, the coast, Machakos, Kitui, Kerio Valley and Meru District.

Cultivars

These include ALBAR 547, UKA 59/240 SATU and BPA.

Propagation Materials

Cotton is mainly propagated by means of seeds.

Treatment of Seeds

Treatment of seeds involves removal of the lint by machines or by use of sulphuric acid.

Seedbed Preparation

- (i) Done very early to allow organic matter to decompose.
- (ii) It should not be as fine as that of tobacco.
- (iii) The depth of the seedbed should be 10-15cm.
- (iv) Thorough control of weeds e.g. couch grass.
- (v) After primary and secondary cultivation, ridging is done.

Sowing

- (i) Done manually by use of hand.
- (ii) Planting time: Coast - February and March; Nyanza and Western - August and October.
- (iii) Dig holes and dibble the seeds then cover (2.5 - 5cm depth).
- (iv) Plant five seeds per hole then later thin to two seedlings.
- (v) Planting is done at the beginning of the rains.

Spacing

Generally spaced at 90cm x 30cm while at the coast it is spaced at 90cm x 45cm (two seeds per hole).

Field Maintenance

- (i) Gapping up: Done within two weeks after germination.
- (ii) Thinning: Done 2-3 weeks after sowing to leave only two seedlings per hole.
- (iii) Control of weeds: Done manually by ridging and use of herbicides.
- (iv) Fertiliser application: Apply phosphatic fertilisers during planting, nitrogenous fertilisers top dressed in two split applications at two months after sowing.

Pests*(i) American bollworm*

Damage: Larvae feed on young flowers (squares) and sometimes young bolls, leaving excreta where they have fed. They feed when half the body is inside the boll.

Control: Spray insecticides, field hygiene and closed season.

(ii) Cotton Stainers

Damage: Pierce the wall of bolls and suck the contents of the bolls thus introducing fungus which stains the lint.

Control: Spray insecticides and destroy of alternate hosts.

Diseases*(i) Bacterial Blight*

Cause: Bacteria

Symptoms:

- (i) Young seedlings - black spots on the cotyledons.
- (ii) Main stem - wounds develop.
- (iii) Branches - sunken or black wounds causing branches to break (black arm).

(iv) Bolls - black spots resulting in rotting of the lint.

(v) On pods - Black spots resulting in rotting of lints.

Control: Closed season, dressing the seeds, and growing resistant varieties.

(ii) Fusarium Wilt

Cause: Fungus

Symptoms: Browning or yellowing of leaves, stunted growth and peeling off of stems.

Control: Field hygiene, crop rotation and growing resistant varieties.

Harvesting of Cotton

- (i) Ready for harvesting 4-9 months after sowing.
- (ii) Picking is done manually when bolls are fully open.
- (iii) Discard dead or broken stems or leaves as they lower the quality.
- (iv) Grading of the lint is done into AR or BR and sorted out separately.

Coffee**Economic Importance**

- (i) Beans are used as beverage (contain stimulant called caffeine).
- (ii) Pulp and parchment can be used as manure and mulch when dry or fed to livestock when wet.
- (iii) Stems and husks are used as fuel e.g. husks are used in charcoal making.

Ecological Requirements

Altitude: 1400 - 1900m above sea level.

Lower altitude: less rain and problem of leaf rust, and stem borer.

High altitudes: Temperature is too low 20°C - 25°C.

- Fruit production is low.
- Physiological disease incidence is high e.g hot and cold disease.

Rainfall

750mm - 2500mm p.a. It should be well distributed throughout the year and 2-3

months of dry spell to stimulate production of flowers.

Soil

Well drained, well aerated and reasonable water holding capacity. Loamy soil of pH 5.3-6.0 is ideal.

Cultivars

Low altitudes - K7, Ruiru 11 and SL6.

Medium altitudes - SL 14, Ruiru 11 and SL 28.

High altitudes - SL 34, Ruiru 11 and Blue Mountain.

Areas where grown: Central, Eastern, Western and Rift Valley Provinces.

Propagation Materials

Seeds for commercial purposes and vegetatively for research purposes.

Nursery Establishment

Seeds are obtained from mother plants with the following characteristics: High yielding, disease resistant and high quality.

Treatment of Seeds

This involves selection of healthy cherries, pulping of cherries and floating test.

Nursery Site

Should be near a source of water, on flat gentle ground, sheltered topography, fertile and free draining soil and near the centre of coffee plantation.

Nursery Practices

In the nursery, remove weeds, dig the soil to fine tilth, raise the nursery to a height of 15cm and apply fertilisers.

Sowing: Use pre-germinated or ungerminated seeds.

Depth: 1-3 cm.

Spacing: 15 cm X 15 cm.

Mulching: Thin mulch is applied after planting to reduce strong sunlight and conserve moisture.

Watering: Twice a day

Weeds: Controlled manually by uprooting.

Hardening off: To acclimatise the seedlings to the environment, done by reducing the shade, reducing the frequency of watering.

N.B. Seedlings can also be raised in polythene bags.

Advantages of using polythene bags: Easy to transport, easy to control weeds and there is little interference of the roots when transplanting.

Seedbed Preparation

- (i) Done six months in advance.
- (ii) Clearing of trees by felling them and removal of tree stumps to get rid of *Armillaria mellea* fungus.
- (iii) Primary cultivation, secondary cultivation and terracing.
- (iv) Digging of holes, 60cm x 60cm, three months before planting. These are filled with fertilisers and top soil three weeks before transplanting.

Transplanting

Done at the beginning of the rains. Plant them at the centre of the hole to the same depth as in the nursery.

Spacing

2.7m x 2.7m or 2.7 m x 1.5m for Ruiru 11.

Field maintenance

- (i) Provision of shade.
- (ii) Mulching by use of organic mulch e.g coffee pulp, parchment or any grasses.
- (iii) Fertiliser application
 - Phosphatic fertilisers applied during planting.
 - Nitrogenous fertiliser applied as top dress.
- (iv) Weed control: Cultural, chemical and mechanical methods.
- (v) Pruning: There are two systems of pruning.
 - Single stem pruning - one stem
 - Multiple stem pruning - two or more stems.

Pests

- (a) *Leaf Miner*: There are two types:
 - (i) *Leucoptera meyricki* - found in unshaded conditions
 - (ii) *Leucoptera coffeina* - found in shaded conditions.

Damage: Pierces the epidermis of the leaf and feeds on it and forms communal mines characterised by brown blotches on the upper side of the leaf.
Control: Use of natural predators and spraying with pesticides.

(b) *Antestia Bug*

Damage: Suck the sap; as they suck they introduce nematospora fungus.

- (i) On flower buds - cause blackening and abortion.
- (ii) On young green berries - make them drop.
- (iii) On older berries - leave zebra stripes (posho beans).
- (iv) On terminal buds - fan branching.

Control: Open pruning and spraying insecticides.

Diseases

(a) *Coffee Berry Disease*

Cause: Fungus

Symptoms:

- (i) Flowers - dark brown blotches.
- (ii) Green berries - small, dark sunken patches.
- (iii) Ripe berries - dark sunken patches with black spots (brown bight).
- (iv) Leaves - brown spots occur on the margins:

Control: Pruning, growing resistant varieties e.g. K7 and blue mountain and use of fungicides e.g. captafol.

(b) *Coffee Leaf Rust*

Cause: fungus

Symptoms: Yellowish-orange, powdery spots on the underside of the leaf.

Control: Growing resistant varieties, spraying with fungicides e.g. copper sprays and open pruning.

Harvesting

- (i) Picking is done by hand. The uniformly red berries are picked.
- (ii) Avoid picking over-ripe and under-ripe berries.

- (iii) Picking is done every 10-14 days followed by proper sorting.

Processing

- (i) Inspection or sorting to determine under-ripe, uniformly deep red, over-ripe and yellow or diseased berries.
- (ii) Cherry hopper - supply cherry to the pulper.
- (iii) Pulper - the outer red skin is removed by squeezing each berry.
- (iv) Sieve - separate the pulped from the unpulped. The repasser to pulp the unpulped cherries.
- (v) Pre-washing channels:
 - Remove skin pits.
 - Floating objects.
 - Grading is done according to the density; heavy berries sink and lights float.
- (vi) Fermentation: To remove the mucilage from the parchment. Beans are turned every day for even fermentation and protected from sunlight.
- (vii) Drying: Done in wire trays and drying tables until the M.C. is 10-11% then stored for two weeks and sent to K.P.C.U. for further processing.

Tea

Economic Importance

Parts used:

- (i) Leaves; to obtain a beverage which contains caffeine which is a stimulant to the nervous system.
- (ii) Other components are polyphenols, tanning, protein and carbohydrates.

Ecological Requirements

Altitude

1500 - 2400m above sea level. Upper limit set by the incidence of frost and lower limit set by the scarcity of rainfall.

Rainfall

1200 - 2500mm. p.a.

Less than 1400mm. and should be even in distribution, misty and cloudy to reduce

evaporation and transpiration. More than 2000mm - excess leaching of nutrients.

Temperature

Depends on altitude.

Ranges from 13-28°C. With less than 13°C. the growth of shoots go dormant. More than 28°C makes growth stunted.

Soils

- Deep, well drained, fertile volcanic soil.
- pH 4.0 - 6.0.

Main areas where grown

Kericho, Nandi Hills, Limuru, Endebes in Kitale, Subukia, Kirinyaga, Meru, Kisii Highlands and higher areas of Nyeri, Muranga and Embu.

Clones

1. TRI 618 (Tea Research Institute)
2. BB 35 (Broke Bond).

Propagation Materials

- (i) Seeds and vegetative materials, e.g. stem cuttings.
- (ii) Obtained from mother plants which are six months old, and planted in the nursery for 6-10 months before transplanting.

Seedbed Preparation

- (i) Ring-barking of trees six months in advance
- (ii) Done during the dry season to kill perennial weeds by primary and secondary cultivation.
- (iii) Construction of terraces if on slopy areas.
- (iv) Establishment of windbreaks.
- (v) Marking of holes by pegging at a spacing of 1.5m x 0.75m or 120cm x 75cm.
- (vi) Depth of holes - seedling stumps 60 cm and sleeved plants 40 - 45 cm.
- (vii) Transplanting is done at the onset of the rains.

Field Maintenance

- (i) *Pruning* - This is the process of training young tea plants after transplanting until they are ready for first har-

vesting or plucking. Done in two ways: pegging and formative pruning.

- (ii) *Gapping up*: Done as soon as possible to maintain a uniform growth.
- (iii) *Mulching*: Done to young tea of about one year old.
- (iv) *Weed control*: Done manually by cultivation and use of herbicides.
- (v) *Fertiliser application*: Phosphatic and nitrogenous fertilisers.

Pests

- (i) *Yellow Tea Mites*
These are found on the lower epidermis of the leaf.
Damage: They cause corky patches and curling of leaves inwards as a result of sucking.
Control: Spray insecticides.
- (ii) *Systates Weevil*
Damage: Eats the leaves and bark of young tea causing round holes at the edges of the tea leaves and ring-barking of the stem.
Control: Avoid mulching close to the plant and spraying insecticides.

Diseases

Armillaria root rot

Cause: Fungus

Symptoms: Slow die-back, bark of stem at the ground level shows vertical cracks.

Control: Destruction of affected plants and proper removal of tree stumps during seedbed preparation.

Harvesting

The process of harvesting tea is known as plucking. It involves the plucking of two or three leaves and a bud as they appear above the plucking table. A bamboo stick is used for guidance when plucking. Tea leaves are put in weave baskets and delivered to the factory to avoid fermentation.

Processing of Tea

- (i) *Withering*: Moisture is driven out by cool or warm air current.

- (ii) Cut, tear and crush (C.T.C.) to release juices and enzymes necessary for fermentation.
- (iii) Fermentation or souring. This takes about 3-4 hours.
- (iv) Drying to stop fermentation and further removal of moisture.
- (v) Cooling and sorting into different grades e.g. BB, PF1, D1, D2, etc.
- (vi) Packing.

Sugar cane

Economic Importance

- (i) Sweetening beverages, sweets, cakes and biscuits.
- (ii) Used to introduce lactic acid.
- (iii) Molasses used in distillation industries.
- (iv) Can also be used to improve the palatability of livestock feeds e.g. molasses in silage.
- (v) Bagasse used as source of fuel, making paper and as a mulch.
- (vi) Filter mud used as organic manures.

Ecological Requirements

Altitude: 0 - 1500m above sea level.

Temperature: 18°C - 32°C.

Rainfall: Minimum rainfall of 1500mm p.a.

The effectiveness of rainfall depends on: soil type and amount of organic matter.

Soils

Heavy soils such as black cotton soil which is free draining are suitable. Ditches may be necessary to prevent waterlogging. Soil pH 4.8 - 8.5.

Main growing areas:

- (a) Nyanza sugar belt i.e. Miwani, Chemelil, etc.
- (b) South Nyanza - Awendo.
- (c) Western Province - Mumias and Bungoma.
- (d) Coast Province - Ramisi, Gazi and Shimba Hills.

Cultivars

Co 421, Co 331, N.Co, Co. 775, B 41227, N50/211.

Propagation Materials

- (i) Seeds (for research purposes).
- (ii) Stem cuttings (for commercial production). Seeds are not normally used because of low viability, takes long to form good canes, do not breed true to type and not easy to collect.

Preparation of Setts in the Nursery

- (i) Canes of 3 - 5 nodes are used.
- (ii) Canes treated with hot water to control ratoon stunting disease.
- (iii) Dipped in mercurial solution to control fungal disease.
- (iv) To control termites, spray setts with Dieldrin.

Seedbed Preparation

- (i) Ripping before ploughing.
- (ii) Deep ploughing.
- (iii) Land under crop previously requires 3 - 4 harrowings.
- (iv) Make furrows 15-20 cm deep at a spacing of 1.5m between the rows.

Planting

- (i) Done at the beginning of the rains.
- (ii) Place setts end to end in the furrows and cover to a 5cm depth.

Field Maintenance

- (i) Gapping up done after the first month.
- (ii) Fertiliser application: Apply phosphatic during planting time and top dress later with nitrogenous fertilisers.
- (iii) Weeds and their control: Critical when they are still young. Mulch helps to reduce weed competition, weeding manually is carried out by uprooting by hand and use of herbicides.

Pests

- (i) *White scales*

Damage: Suck sap from the leaf sheaths causing wilting.

Control: Stripping the leaves and planting clean materials.

(ii) *Termites*

Damage: Attack the setts when planted in the ground.

Control: Dipping the setts in insecticides.

Diseases

(i) *Ratoon Stunting Disease*

Cause: Bacteria.

Symptoms: Decline in vigour of the plant due to the blockage of the vascular bundles.

Control: Heat treatment before planting and planting disease-free materials.

(ii) *Smut*

Cause: Fungus

Symptoms: Development of a long whip-like structure at the tip of the plant instead of inflorescence. Black spores enclosed in silvery sheath.

Control: Rogueing, planting disease-free material, disinfecting the setts before planting and planting resistant materials.

Harvesting

(a) *Western Kenya*

- Harvest after 20 months for plant crop.
- Harvest after 16 months for ratoon crop.

(b) *Coast*

- Harvest after 14 months for plant crop.
- Harvest after 12 months for ratoon crop.

(i) Sugar cane is cut when mature as judged by the uniformity, distribution of sucrose from base to top. Cut near the ground level and cut the top to stop enzyme reversion.

(ii) Strip off all dry leaves or burn.

(iii) Transport to the mills within 48 hours.

Processing

1. Crushing to extract juice from the cane.
2. Clarification - purification of the juice.
3. Concentration and crystallisation - thickening of the juice upto its crystallisation.
4. Centrifuging - separating the sugar crystals from the syrup.
5. Packing of sugar - filling, weighing 100kg and closing of bags. Mostly automatic in modern factories.

Oranges

Economic Importance

- (i) Used as desserts when fresh and for making squash and marmalade.
- (ii) Extraction of citric acid for industrial purposes.
- (iii) Peels, leaves and seeds used for making cosmetics and medicinal infusions.
- (iv) The juices can be used to flavour cakes, etc.
- (v) Pulp can be used as livestock feeds.

Ecological Requirements

Altitude: 0-1800m above sea level.

Temperature: Ideal temperature 21°C-31°C.

Rainfall: It is critical during flowering and ripening stage. It should be well distributed throughout the year. Where rainfall is inadequate, irrigation can be done.

Soils: Ideal soil is sandy-loam.

Soil pH 5.0 - 6.0

Cultivars

These include Washington Navel, Valencia and Hamlin.

Growing Areas

Thika, Kitale, Naivasha, Coast and Machakos.

Propagation Materials

- (i) Seeds.
- (ii) Vegetatively by use of budlings (commonly used).

Selection of Rootstock (Rough Lemon)

These should be vigorous in growth, resistant to drought and diseases, high degree of compatibility and wide adaptability.

Nursery Practices

- (i) Seeds are planted in the nursery at 1.5m wide and any convenient length.
- (ii) Shade is provided.
- (iii) Seeds are sown 10cm between rows and 2cm apart.
- (iv) After six months they are transplanted into seedling beds or polythene bags.
- (v) Spacing at seedling beds is 90cmx30cm.
- (vi) After six months, they (when pencil thick) are ready for budding.

Maintenance in the Nursery

Practices carried out: control of weeds, provision of shelter belts, pruning, fertiliser application and control of pests and diseases.

Seedbed Preparation

Practices involved are: land clearing, primary and secondary cultivation, and planting in gently-sloping land.

Planting

- (i) Spacing: 8m x 8m or 9m x 9m.
- (ii) Holes 60cm diameter and 60cm deep.

Field Maintenance

- (i) Control weeds by cultivating, mulching, and slashing.
- (ii) Cover cropping and inter-cropping e.g. with beans.
- (iii) Provision of shelter belts.
- (iv) Pruning.
- (v) Fertiliser application.

Pests

- (i) *Aphids*
Damage: Suck sap from the leaves causing growth distortion. They transmit tristeza disease.
Control: Spray insecticides e.g. Dimethoate.
- (ii) *Orange Dog*
Damage: Feed on the leaves.

Control: Hand picking and spraying with insecticides.

Diseases

- (i) *Tristeza disease.*
Cause: Virus transmitted by aphids and root stock.
Symptoms: Stem pitting (honey comb appearance).
Control: Control aphids, use resistant root stock and rogueing.
- (ii) *Greening Disease*
Cause: Virus.
Transmitted by citrus psyllids.
Symptoms: The tree turns yellow from one branch to the other while others are green. Eventually the whole plant becomes yellow.
Control: Control of vector, use clean planting materials and use resistant root stock.

Harvesting

- (i) Seedlings mature in 5-7 years while budlings mature in 2-3 years.
- (ii) Pick fruits before they fall by twisting and pulling the stalk.

Fruits are graded into three categories:

- Grade I: Over 8 cm in diameter (Exported).
Grade II: Between 8-6.5 cm in diameter (super market).
Grade III: Less than 6.5 cm in diameter (eaten locally).

WORK TO DO

1. Describe the crops: wheat, pineapples and passion fruits under the following sub-headings:
 - (a) Economic importance.
 - (b) Ecological requirements and where grown.
 - (c) Marketing.
2.
 - (a) Name one commercial product obtained from pawpaw.
 - (b) What is the main use of the product named above?
3. Discuss the growing of oranges under the following sub-headings:
 - (a) Establishment of the nursery.

- (b) Management of seedlings in the nursery.
- (c) Pest and disease control.
4. Discuss the growing of coffee under the following sub-headings:
 - (a) Nursery establishment.
 - (b) Transplanting of seedlings.
 - (c) Pruning.
 - (d) Processing.
5. Describe the growing of cotton under the following sub-headings:
 - (a) Seedbed preparation.
 - (b) Planting.
 - (c) Harvesting.
 - (d) Grading of lint.
6. Write short notes on either coconut or pyrethrum on:
 - (a) Uses.
 - (b) Pest and disease control.
 - (c) Harvesting.
7. Describe the preparation of vegetative planting materials in either tea or sugar-cane.
8.
 - (a) State the economic importance of sisal.
 - (b) Describe the processing of sisal.
9.
 - (a) State varieties of flue-cured and fire-cured tobacco.
 - (b) Describe the difference between priming and desuckering in tobacco production.
10. Describe one major disease of coffee under:
 - (a) Casual agent.
 - (b) Symptoms of attack.
 - (c) Control measure.