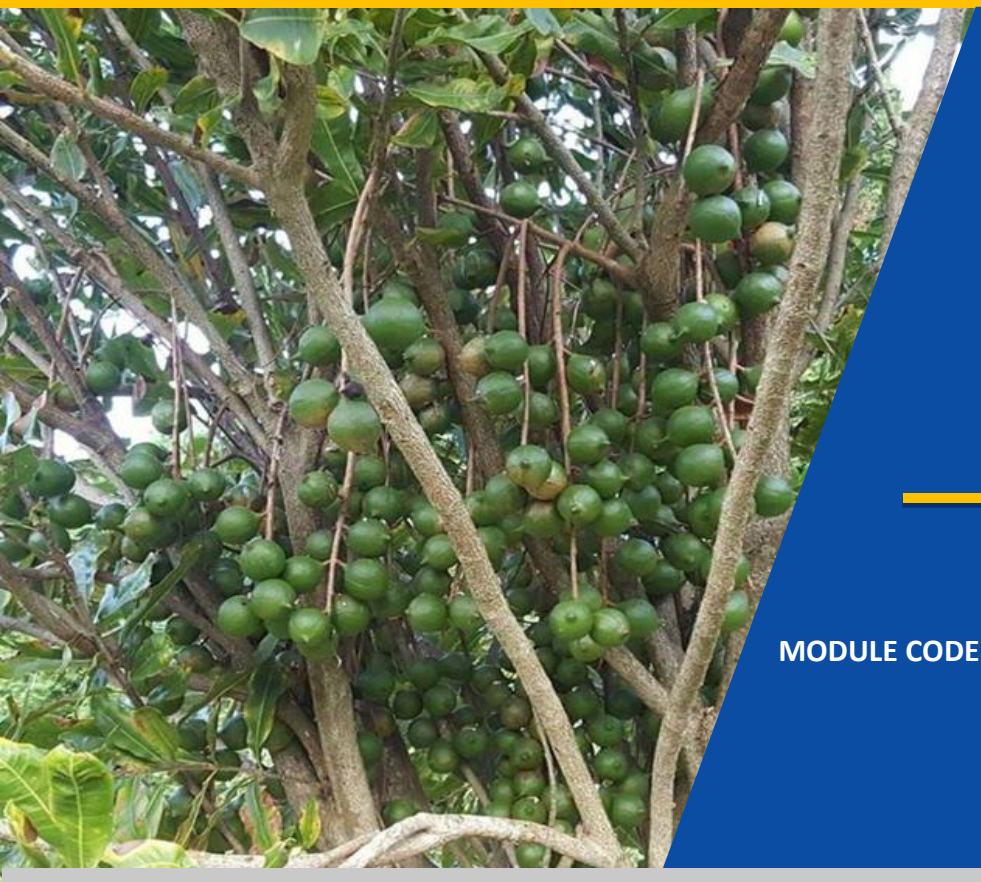
RQF LEVEL ….



TRADE: Crop production

MODULE CODE: CRPHVA502

TEACHER'S GUIDE

Module name:Growing high-value added crops

Table of content

Acronyms

Introduction

- The commonly accepted definition of a high-value crop is **one that generates more revenue per acre than a conventional grain crop**
- High value added crop is a crop that provides higher net returns per hectare to the farmer than higher yielding winter rice

High value crops generally refers to no staple agricultural crops such as vegetables, fruits, flowers, ornamentals, condiments, spices… In addition high value added crops after harvested undergo possessing to provide a final product, which is the process in which a high price is realized.

Value added in agriculture generally focus on production or manufacturing processes, marketing that increase the value of a primary commodity

Crops are the main need to feed our hunger. It is the source of income for farmers. Raw materials like starch, cellulose, and oil are extracted from the plants. Crops are the means of nutrition and are the source of survival. Crops provide better nutrition to humans. As they are transformed, they contribute access to new market.

No	Local/English name	Scientific name	Families
01	Macadamia	*Maccadamia integrifolia*	Proteaceae
02	Patchouli	*Pogostemon cablin*	Lamiaceae
03	Stevia	*Stevia Rebaudiana Bertoni*	Asteraceae
04	Geranium	*Pelargonium graveolens*	Geraniaceae

CRPHVA502: Grow high-value added crops

Learning Units

1. Prepare for planting activities
2. Establish high value added crop plantation
3. Maintain high value added crops
4. Deliver high value added crops

1. **Learning Unit:** Prepare for planting activities

Picture/s reflecting the Learning unit 1

STRUCTURE OF LEARNING UNIT

Learning outcomes:

1.1 Adequate selection of the site according to the crop requirements

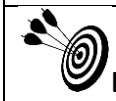
1.2 Proper selection of tools, materials and equipment according to the crop type

1.3 Adequate preparation of planting material referring to the crop

1.4 Appropriate rising of high value added crops seedlings in nursery depending on the crop type.

Learning outcome 1.1: Adequate selection of the site according to the crop requirements

 **Duration: 5 hrs**

 **Learning outcome 1. Objectives :**

By the end of the learning outcome, the trainees will be able to:

1. To identify the criteria of site selection.
2. To differentiate correctly the types of ecological requirement of high value added crop
3. To describe briefly the factor of ecological requirement

 **Resources**

Equipment	Tools	Materials
- Internet connection -DVD players of - Computer - Projector - PPE	- scientific papers - Soil auger - spade - Hoes - Pickaxe	-Planting materials - Books -container for currying sample

 **Advance preparation:**

- Group discussion on criteria for grow high value added crops
- Brainstorming on field accessibility criteria
- Oral presentation on ecological requirements

Indicative content 1.1: Site selection criteria for high value added crops

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

The criteria for site selection on high value added crops are:

a. Back ground of the field:

- Previous crop (respect of crop rotation plan) with advantages of crop rotation which are to control pest and disease, maintenance of soil fertility, soil erosion control, control of weeds, proper utilization of nutrients
- Identified pests and diseases
- Applied fertilizers and pesticides

b. Field accessibility:

- The site desired for industrial crops growing should be:
- near the road for facilitating the transport,
- Near the market (processing unit, city) to facilitate the commercialization
- Near the source of water to facilitate irrigation
- Near the workers

✓ Ecological requirements

- Edaphic: soil fertility, soil PH
- Climatic:
  - Temperature
  - Rainfall
  - Altitude

i. <u>Ecological requirement of Patchouli</u>

- Altitude: Patchouli grows successfully up to an altitude of 800-1100 m above sea level
- Rainfall: The crop can be grown successfully under a fairly heavy and evenly distributed rainfall ranging from 150 mm -300 mm per annum.
- Soil: Patchouli is hardly plant and adapts itself to a wide range of soil condition. However, deep soil rich in organic matter with loose friable texture is ideal for plant growth. The optimum pH of soil is 5.5 – 6.0.
- Temperature: A temperature ranges of 25- 30^{0c} and humidity range 70 – 75 % are suitable for its growth.

ii. <u>Ecological requirement of Macadamia</u>

- Soil*:* Most soil types are suitable for the production of macadamias, provided they are well drained and have no restrictive layers in the top 1 m of the soil. Poorly-drained clay soils are not suitable.
- **Temperature***:* The ideal temperature for macadamias is between 16 and 25 °C. Although the trees can survive when temperatures drop below 3 °C, they should not be regarded as frost resistant.
- **Altitude :** Height above sea level influences nut quality and production. Production declines dramatically above 600 m. Above 640 m growth is slower and trees take longer to produce.

Cultivars suitable in areas between 600 and 640 m above sea level are Mauka, Kau and Keaau.

Cultivars recommended nearer to the coast, 90 to 300 m above sea level, are Purvis, Makai and Keaau.

iii. <u>Ecological requirement of Geranium</u>

- **SOIL:** Geranium thrives in well drained soils. The soils which are either saline or alkaline with poor drainage are unsuitable for its cultivation.
- **Rainfall:** The crop flourishes in mild climate with low humidity, warm winter and mild summers having annual rainfall ranging 100 to 150 cm.
- **Altitude:** It is found growing successfully from an altitude of 1000 to 2100 m. VARIETIES Algerian and Reunion are the varieties suitable for heavy and less rainfall areas.
- **Temperature:** It thrives best in subtropical climates with a temperature ranging from 5-degree C to 23-degree C. However, temperatures below 3-degree C will kill the plant. It has been observed that it grows equally well at much lower altitudes and tolerates higher temperatures up to 43-degree C in the plains when grown under irrigated conditions.

iv. <u>Ecological requirement of Stevia</u>

Stevia is a short-day plant grown under tropical and sub-tropical conditions. Long day-length is helpful for higher leaf yield. Relative humidity of 65-80% is suitable for proper growth and development. Stevia grows well in sandy loam soil with pH range of 5.0-7.5, and requires a warm and sunny weather. Soils should be well drained but with reasonable water holding capacity.

Theoretical learning Activity

- Group discussion on site selection criteria of high value added crops
- Trainer ask trainees to Brainstorm about field accessibility criteria

Practical learning Activity

- ✓ Trainees in group of four (4) visit the school field and perform selection criteria for high value added crops

Points to Remember (Take home message)

Site selection criteria for high value added crops

- ✓ Back ground of the field
- ✓ Field accessibility criteria
  - Near the market
  - Near the workers
  - Near the road
  - Near the source of water
- ✓ Ecological requirements
  - Edaphic
  - Climatic
  - Temperature
  - Rainfall
  - Altitude

Learning outcome 1 Formative assessment

Written assessment

Q1: Give two (2) species of Macadamia

Answer:

- Macadamia tetrafolia
- Macadamia integrifolia

Q2: Describe **Macadamia** tree according to the following parameters:

a) Soil
b) Rainfall
c) Altitude
d) Temperature

Answer:

a) Soil : well drained and have no restrictive layers in the top 1 m of the soil,

, Poorly-drained clay soils are not suitable

b) Altitude: Production declines dramatically above 600 m. Above 640 m growth is slower and trees take longer to produce.
C) Temperature: The ideal temperature for macadamias is between 16 and 25 °C. Although the trees can survive when temperatures drop below 3 °C, they should not be regarded as frost resistant.

Q4: Identify the economic importance of high value added crop.

Answer:

- Medicine benefits
- Raw material for agro processing industrial
- Income generating for farmers
- Better nutrition to human being

Q5. Use ***true*** or ***false*** on the following statement.

a) Macadamia is one of the vegetable crop which is not bling income among the farmers. **(false)**
b) High value crops generally refers to no staple agricultural crops such as vegetables, fruits, flowers, ornamentals, condiments, spices**…(true)**
c) High value added crop is a crop that provides higher net returns per hectare to the farmer than higher yielding winter rice **(true)**

Duration: 4 hrs

Learning outcome 1. Objectives :

By the end of the learning outcome, the trainees will be able to:

1. identify of high value added crops (Macadamia, Geranium, Patchouli, Stevia).
2. describe briefly high value added crops
3. identify tools and equipment selection Criteria
4. explain correctly selection criteria of high value added crop species and varieties

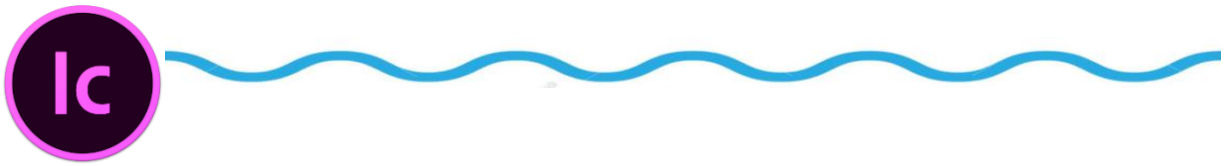
Resources

Equipment	Tools	Materials
Wheelbarrow - sprayers - Internet connection. - Related books - DVD players - Projector - Computer	- Hoe - Panga - Hammer - Rake - Spade -scientific papers	- Pesticides - Fertilizers - planting materials

Advance preparation:

- Group discussion on high value added crops
- Brainstorming on field selection criteria of high value added crop.

- Oral presentation on selection criteria of tools and equipment



Indicative content : 2.1 : Identification of high value added crops (Macadamia, Geranium, Patchouli, Stevia)

2.2. Description of high value added crops

- Description of Macadamia: **macadamia**, (genus *Macadamia*), genus of four species:

✓ Queen land nut (M.integrifolia)
✓ Rough shelled macadamia (tetraphylla)
✓ Gympie Nut (M. ternifolia) and
✓ Bulberin Nut (M.janseniil)

Family Proteaceae

The trees originated in the coastal rainforests and scrubs of what is now Queensland in northeastern Australia and are grown commercially in a number of subtropical areas. Commonly known as macadamia nuts, the seeds are often roasted and salted or are used by bakers and chocolatiers in confections and chocolates. They are a good source of calcium, phosphorus, iron, and vitamin B, and they contain 73 percent fat.

Physical description

Macadamia trees commonly grow to 18 meters (60 feet) high and 15 meters (49 feet) wide. They have shiny leathery leaves that are 20–30 cm (8–12 inches) long. Fragrant pink or white flowers are borne in clusters and are succeeded by bunches of up to 20 fruits. Not a true nut, the shiny round 25-mm (1-inch) seed is enclosed in a thick leathery husk that splits along one side during the ripening process.

- **Description of Geranium crop:**

Scientific name: Pelargonium graveolens

Usage: cosmetics, Perfumery

Geranium is one of aromatic and herbaceous bushy perennial annual plant commercially grown for its essential oil. It also being grown as ornamental purpose (cut flower for decoration). This plant is also known as poor man's rose. The oil extruded from the leaves, stems, flowers of the geranium plant has excellent health benefits and used in aromatic treatment. The commercial oil of geranium is extracted from Pelargonium graveolens of family of Geraniaceae. Geranium is a genus of 420 commonly known as the cranesbills.

The stem of geranium plant is cylindrical, woody at the base, pubescent, green when young and turns brown with age. The leaves of this plant are highly aromatic in nature. This plant is used as cosmetic and perfumery industries. The main ingredients of the oil are geraniol and citronellal and pure geranium oil is almost a perfume.

- **Description of Patchouli**: (**Pogostemon cablin**), Family**: Lamiaceae**; usage: the leaves are source of essential oil that is used as in perfumes, cosmetics, incenses, soap, detergent and deodorant. It is also used in aromatherapy. In traditional medicine, the oil is used to treat fungal skin infection… Patchouli is a shrubby perennial plant that grows up to 1 meter in height. The large fragrant leaves are roughly oval in shape and irregularly toothed and are borne oppositely along the branches stems. Both the stem and the leaves are densely hairy. There are 3 species of patchouli which are pogostemin cablin, pogostemon heyneanus and pogostemon hortensis

Description of Stevia crop

Scientific name: Stevia Rebaudiana Bertoni

Origin: Paragu ay in SouthAmerica

Usages: The leaves of stevia have a pleasantly sweet and refreshing taste that can linger in the mouth for hours. The leaves are used to prepare sauces but are best in herbal tea bags. Stevia is mainly used as a sweetener and flavor enhancer in the food and beverage industry. In medicine, stevia regulates blood pressure, fights cavities, induces pancreas to produce more insulin and act as bactericidal agent. Stevia is suitable for diabetic and obese persons.

Stevia is an erect ,tap root and perennial herbaceous species, they reach up to 90cm in height. Their leaves are simple and sessile oppositeSpecies: -stevia rebaudian, stevia phlebophylla

Theoretical learning Activity

- ✓ Ask trainees to discuss on description of Macadamia and Patchouli

Practical learning Activity

- ✓ Trainees in groups and perform the field visit
- ✓ Observe surrounding plantation
- ✓ Determine the type of high value added crops observed.

Points to Remember (Take home message)

Species and families of macadamia crops.

- ✓ Queen land nut (M.integrifolia)
- ✓ Rough shelled macadamia (tetraphylla)
- ✓ Gympie Nut (M. ternifolia) and
- ✓ Bulberin Nut (M.janseniil)

Family Proteaceae

Description of Geranium crop: Geranium is one of aromatic and herbaceous bushy perennial annual plant commercially grown for its essential oil. It also being grown as ornamental purpose (cut flower for decoration).

- ✓ family of Geraniaceae.
- ✓ Scientific name: Pelargonium graveolens

Description of Stevia crop

Scientific name: Stevia Rebaudiana Bertoni

Description of Patchouli:

(**Pogostemon cablin**), Family**: Lamiaceae**

Indicative content **2.3: Tools and equipment selection Criteria**

Tools and equipment selection Criteria

✓ **Activity to be done**: tools, materials and equipment are selected also according to the type task performed.

✓ **Working conditions of tools and equipment**: select tool or equipment which is in proper functioning for minimizing hazards and working well.

✓ **Availability and accessibility:** tools or equipment should be easy avail on the market and more accessible in the working area

✓ **Cost:** it is necessary to consider the various costs of maintenance or spare parts. It is better to opt for simple equipment with lower costs and a longer life span. Cost of purchasing or hiring tractors services are very high so peasant farmers cannot afford. This explains why hand hoes are still dominant in farming operations.

✓ **Tools and equipment efficiency**: tools or equipment can work according to level of automation (performance) or easy utilized for proving more productivity.

✓ **Durability:** selected tools or equipment should have long shelf-life and remain functional, without requiring excessive maintenance or repair, when faced with the challenges of normal operation over its designed lifetime.

✓ **Manoeuvrability:** the equipment should move (work) easily and freely. Its mobility is simple.

Theoretical learning Activity

- ✓ Ask trainees within groups to brainstorm about selection criteria of tool material and equipment.

Points to Remember (Take home message)

Tools and equipment selection Criteria

- ✓ Activity to be done
- ✓ Working conditions of tools and equipment
- ✓ Availability and accessibility
- ✓ Cost
- ✓ Tools and equipment efficiency
- ✓ Durability
- ✓ maneuverability

Indicative content: 2.4: Selection criteria of high value added crop species and varieties

Good species and varieties of high value added crop must fulfill the criteria below:

✓ Adaptability: ability to produce reasonable yields where most crops cannot and their capacity to provide high quality od carbohydrates make them the basis for food security at household level.
✓ Productivity: crop which give high yield with marginal soils fertility and low input agricultural systems.
✓ Market requirements: Farmer choose to produce a crop based on market demand
✓ Life cycle: crop must grow rapidly and take short period to mature

Theoretical learning Activity

- ✓ Ask trainees within groups to brainstorm about selection criteria high value added crop species

Points to Remember (Take home message)

✓ Adaptability: ability to produce reasonable yields where most crops cannot and their capacity to provide high quality od carbohydrates make them the basis for food security at household level.
✓ Productivity: crop which give high yield with marginal soils fertility and low input agricultural systems.
✓ Market requirements: Farmer choose to produce a crop based on market demand
✓ Life cycle: crop must grow rapidly and take short period to mature

Indicative content 2.5: Quality of good planting material:

Quality of good planting material: planting materials may be seed and or plant part (vegetative planting materials)

- **Quality of seed:**

✓ Purity: selected seed must be highly physically and genetically pure, that means there no stranger seeds and inert materials mixed in seeds

Germination Rate: seed must have a high germination percentage to ensure crop yield

✓ Absence of impurities: without any foreign materials

- Quality of vegetative planting materials

✓ Absence of pest and diseases, it is from a healthy plant that make it to resist pest and disease and other disaster present in the environment
✓ Vigor, Health, : must be have this quality which make it to thrive well in the presented environment
✓ Size: must be of good size
✓ Good variety: must be selected from a good variety of a known source

 **Theoretical learning Activity**

✓ Ask trainees to discuss on the quality of planting material

 Points to Remember (Take home message)

- ✓ Purity: selected seed must be highly physically and genetically pure, that means there no stranger seeds and inert materials mixed in seeds

Germination Rate: seed must have a high germination percentage to ensure crop yield

- ✓ Absence of impurities: without any foreign materials

- Quality of vegetative planting materials

- ✓ Absence of pest and diseases, it is from a healthy plant that make it to resist pest and disease and other disaster present in the environment
- ✓ Vigor, Health: must be have this quality which make it to thrive well in the presented environment
- ✓ Size: must be of good size
- ✓ Good variety: must be selected from a good variety of a known source

Learning outcome 2. Formative assessment

Written assessment

1. Emulate the quality of quality seed of high value added crop species

Answer:

- ✓ Purity:
- ✓ Germination Rate:
- ✓ Absence of impurities:

- Quality of vegetative planting materials

- ✓ Absence of pest and diseases:
- ✓ Vigor, Health
- ✓ Size:
- ✓ Good variety:

2. Describe the selection criteria of tool, material and equipment
   Answer:

✓ **Activity to be done**: tools, materials and equipment are selected also according to the type task performed.

✓ **Working conditions of tools and equipment**: select tool or equipment which is in proper functioning for minimizing hazards and working well.

✓ **Availability and accessibility:** tools or equipment should be easy avail on the market and more accessible in the working area

✓ **Cost:** it is necessary to consider the various costs of maintenance or spare parts. It is better to opt for simple equipment with lower costs and a longer life span. Cost of purchasing or hiring tractors services are very high so peasant farmers cannot afford. This explains why hand hoes are still dominant in farming operations.

✓ **Tools and equipment efficiency**: tools or equipment can work according to level of automation (performance) or easy utilized for proving more productivity.

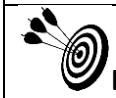
✓ **Durability:** selected tools or equipment should have long shelf-life and remain functional, without requiring excessive maintenance or repair, when faced with the challenges of normal operation over its designed lifetime.

✓ **Manoeuvrability:** the equipment should move (work) easily and freely. Its mobility is simple.

3. Answer by true or false on the following statement:
   a) Tetrafolia is one of macadamia species. **(true)**
   b) Germination rate is among of the quality of planting material **(true)**

Learning Outcome 1.3: Prepare planting material referring to the crop type

Duration: 3 hrs



Learning outcome 3. Objectives :

By the end of the learning outcome, the trainees will be able to:

1. Know High value added crop propagation ways.

2. Explain pre-treatments techniques

Resources

Equipment	**Tools**	**Materials**

- Internet connection -DVD players of - Computer - Projector - PPE	- scientific papers - Soil auger - spade - Hoes - Pickaxe	**- pesticide** **- fertilizers** -Planting materials - Books -container for currying sample - planting materials

Advance preparation:

- Group discussion on macadamia propagation ways
- Brainstorming on material pre-treatments techniques

Indicative content 1.3.1: High value added crop propagation ways

a. Geranium

Geranium is easily propagated by cuttings, since there is no seed setting in geranium, vegetative propagation is must. Terminal cuttings about 20 cm long and consisting of about 8 nodes are the best suited material for propagation, as they give 80% rooting even without any treatment. However, the middle portion and basal cuttings are reported to give poor rooting, which can be improved but treating them for 6 minutes with growth regulators like IBA or IAA at 200 ppm. Thus, a rooting of 80% and 6505 respectively can be obtained.

The cuttings are planted in raised beds 3 m long and 1 m wide. The soil should be well mixed with powdered FYM. The cuttings are planted closely at a spacing of 8-10 cm. Before planting, the cut ends of the cuttings are dipped in 0.1% Benlate solution. Before root initiation, temporary shade is provided and the beds are watered regularly. The nursery is sprayed with a 0.2% Urea solution at biweekly intervals and the cuttings are ready for transplanting. They can also be rooted in polythene bags, which help to avoid damage to the root-system while planting in the main field. This practice ensures a high percentage of success in the field.

Recently, its propagation through leaf petioles had also been reported to give a good rooting percentage (75%), which will help to multiply this plant in larger numbers than the traditional

method of propagation using 20 cm-long cuttings. The CIMAP, Lucknow, has developed a protocol for large –scale production of geranium cell clones and plants have been obtained under field conditions with improved oil-yield and quality.

b. Macadamia nut propagation

Macadamia nut is easily propagated using seed but the progeny takes 8-12 years to start bearing nuts and tend to produce low yields. Moreover, the nut quality is unpredictable because the crop is highly heterozygous. Grafting is necessary in order to obtain true-to-type clones and hasten reproductive maturity. The rootstock should be raised from seed of recommended variety and the scions be picked from a strong healthy mother-tree. Several methods including top wedge, side wedge, splice, veneer and bark grafting have been tried but top-wedge grafting is the most successful. Splice method is used on overgrown seedlings is used.

Macadamia Nut Propagation Nursery

Nursery location and site

Macadamia propagation nurseries are best located on ground that is flat or slightly sloping to allow for ease of water drainage. This facility should be near a reliable water source and sheltered from strong winds.

Nursery layout

The nursery constitutes of sand-beds, seedling transplanting room/shade, establishment shed, open area, shaded area (with shade net) for grafted seedlings, seedling hardening shed for grafted seedlings, and grafting room/shade.

nut seed germination

Macadamia Germination of macadamia seed-nuts under normal conditions occurs 3-4 weeks after seeding. The seed-nuts will continue to germinate for the next 3 months. Germination rates differ for different varieties whereby some finish germinating in a shorter time thus yielding a uniform sized seedlings. In Kenya, macadamia nut varieties KMB-3 (macadamia hybrid) and EMB-1 (M. integrifolia) have the best germination percentage of (50-60%).

Watering

Sand-beds should be watered regularly. A daily supply of water is necessary to ensure that seedlings do not dry up as water retention in sand is low.

Media for transplanting macadamia seedlings

To transplant macadamia nut seedlings, a mixture of sand, soil farm yard manure, compost and fertilizer is used. Soil media for transplanting should consist of 10 parts of top soil, 3 parts of manure, 3 parts of compost, 1-3 parts of sand at a ratio of 10:3:1-3 (v/v) and 300 g of compound fertilizer (17:17:17).

After mixing, sprinkle some water to moisten the mixture. Note: do not make the mixture too wet.

Transplanting Process

Seedlings with four to six hardened leaves are carefully lifted from the sand-bed avoiding damage of roots and placed in a bucket of water 10 cm deep. Fill potting bags (18cm x 15cm) with the transplanting soil mixture using a spade while holding the seedling at the center. The seedlings should be maintained under high shade, allowing only 40-50% sunlight for about two months before transferring to open area where they are maintained for 6-12 months before grafting.

The shade slows down leaf growth and allows for rapid root development. Macadamia nut seedlings should not be placed on the ground but raised at least 10cm above the ground reducing water logging or spread of water borne diseases such as fungal pathogens. The seedlings remain in the shade for 1-2 months where they are regularly watered. Nursery operators should ensure appropriate weed control and scout the plants for pests and diseases.

After 2 months the seedlings are transferred to an open area under direct sunlight on a bed of stone chips (5 to 6 cm thick) to facilitate drainage. This facility should be clean and free of weeds. The macadamia nut seedlings are maintained under direct sunshine to increase their photosynthetic efficiency. The following nursery operations are undertaken:

a. Watering – water the plants once every three days on cool days (normal conditions). During the hot/dry season, water once a day. Be careful not to use a high-pressure hosepipe to avoid washing off the soil.

b. Seedling management – for optimal management foliar feed is applied once a month. Apply pesticides only when pests and diseases are observed using the manufacturer recommendation.

c. Soil management – During the rainy-season apply a compound fertilizer (17:17:17) or CAN and top dress in subsequent seasons.

Fig. 16. Macadamia nuts rootstocks placed in an open area directly under the sun for rapid growth and hardening

Seedlings are ready for grafting after six months or when they have attained a pencil thickness (4-6mm) diameter.

Fig. 17. Macadamia nuts rootstocks ready for grafting at about 6 month

Grafting

For macadamia nut propagation, grafting is a process undertaken to reduce juvenility time, ensure true-to-type and take advantage of vigorous rootstocks. A grafted plant constitutes of a scion and rootstock

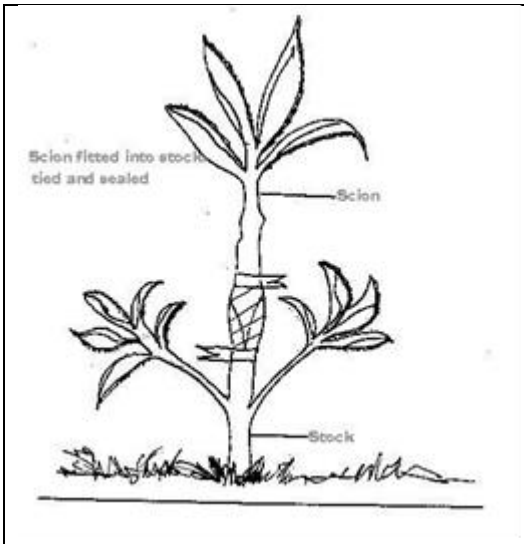


Fig. The anatomy of a grafted seedling

Grafting also:

a. Allows one to propagate superior high yielding clones

b. Reduces the time to bearing

c. Use of “clean” and healthy planting material

d. Allows one to change varieties of the already established trees using top-working

Grafting tools for macadamia nuts

A nursery operator requires several tools and equipment to enable macadamia nut propagation including a tree pruner/pruning saw, secateurs for harvesting scions, grafting knife, grafting tape, bees and candle wax for sealing the graft union.

Propagation

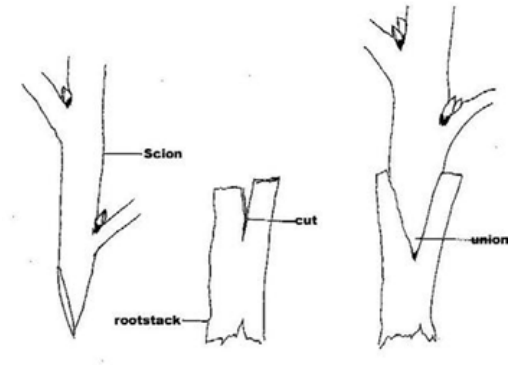
Macadamia nuts is easily propagated using seed but the progeny takes 8-12 years to start bearing nuts. Moreover, the nut quality is unpredictable because the crop is highly heterozygous. Grafting is necessary in order to obtain true-to-type clones and hasten reproductive maturity. The rootstock should be raised from seed of recommended variety and the scions be picked from a strong healthy mother tree. Several methods including top wedge,

side wedge, splice, veneer, bark grafting and top-working have been tried but top-wedge grafting is the most successful. Splice method is used on overgrown seedlings

TYPES OF GRAFTING IN MACADAMIA GROWING

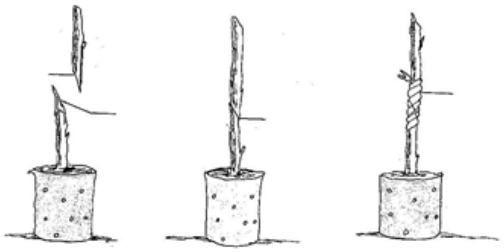
a. Top wedge (cleft) grafting

This grafting method is used for material in which the stock and the scion are of similar diameters about 4-6 mm diameter. A wedge-like slanting cut is made at the base of the scion with a sharp grafting knife. A vertical incision is made at the top of the rootstock. The two pieces are fitted together, wrapped firmly with a grafting tape and then sealed with grafting wax.



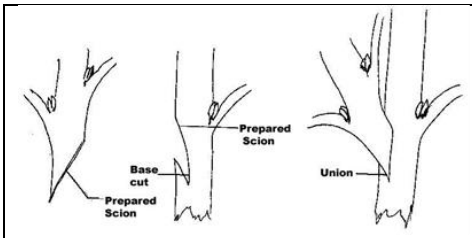
b. Splice grafting

The splice method of grafting is used for overgrown rootstocks. A simple slanting cut of the same length and angle is made on both the rootstock and the scion. They are aligned and the graft union is wrapped with the grafting tape and sealed with wax.



c. Side-wedge grafting

Side wedge grafting method is used in rootstocks with a larger diameter than the scion. A 3-cm deep cut is made on the scion at an angle of 20-30 degrees and a tapered cut is also made on the rootstock. The scion is inserted into the side of the rootstock, wrapped with grafting tape and waxed.



Care of grafted macadamia seedlings

After grafting, macadamia nut seedlings are placed in tunnels or individual polybags in tunnels where temperatures and humidity are controlled. Recommended temperatures are 25°C to 28°C and the relative humidity of 90%. Within the tunnels, seedlings are watered and sprayed with a fungicide and covered with a polysheet.

Remove all suckers from the rootstocks, watered and sprayed with the recommended insecticide and fungicide. Shoots will be observed 3 weeks after grafting after which the polysheet is gradually removed to harden the seedlings. After 2-3 months, seedlings are removed from tunnels to a shed net which allows 40 – 50% light intensity. Remove wax and grafting tape from the graft union one month after removal from the grafting tunnel.

Planting of Macadamia growing

Spacing

The recommended spacing is 7.5 x 7.5m or 10 x 10m depending on topography.

Transplanting

The planting holes should be 60 x 60 x 60 cm and should be dug during the dry spell or two months before planting. The topsoil and the subsoil should be kept separately. Fill the hole with the topsoil mixed with two debes of well-decomposed farm yard manure and a handful of compound fertilizer such as NPK 20 10 10 or DAP (150g). Carefully remove potting bag without disturbing the roots. Open the seedling containers carefully making sure that the soil covering the roots remains intact. Place the seedling in the centre of the hole and cover firmly with the topsoil. Ensure that the seedling is at the same soil level as that of the soil when the seedling was in the potting bag i.e. avoid burying the graft union. Make a basin around the seedling for holding water. If the soil pH is below 4.5, 120 g $CaCO_3$ and 60 g single superphosphate (SSP) should be mixed with soil at each planting hole. Transplanting is more successful when carried out during the long rains.

Care of transplanted seedling

Staking of the seedling should be done immediately after transplanting to prevent lodging. Staking should be done using straight stakes onto which the seedlings are tied. The seedlings

should be watered immediately after staking. The following cultural practices should be carried out:

Watering. The trees are sensitive to both waterlogging and water stress. Watering at least once or twice a week provides adequate moisture.

Mulching. This helps to maintain soil moisture, improve soil fertility and suppress weeds. The mulch should be placed 10-15 cm from the base of the tree. Commonly used mulches include coffee husks, sisal waste, grass and banana leaves. Polyethylene (clear of black), which can also be used as a mulch, is effective in water conservation in young orchards.

Weed control. Weed control minimizes competition for water and nutrients. An area 1.5 times the size of the tree canopy should be weeded. Hand weeding or chemical control using Roundup or glyphosphate are recommended.

Fertilizer.

Fertilizer NPK 20:20:10 should be applied in two split applications just before the short and long rains. The fertilizer should be applied under the tree canopy and away from the tree trunk. It should be gently incorporated into the soil to avoid runoff. Rates of fertilizer should be increased as the tree grows to a maximum of ten years

Training and Pruning.

The purpose of training is to develop strong and well-balanced low branching trees with only one trunk or leader (central leader system) and several sets of main branches forming wide angles with the trunk. The trees must be trained within three years of transplanting. Untrained trees produce several leaders and uneven branches spaced along the trunk. Such trees are prone to breakage by wind. Macadamia requires little pruning which involves removing broken, split or dead branches. The branches should be cut close to the laterals or the main trunk.

Intercropping. The objective of intercropping macadamia nut with other cash/food crops (common bean, cowpeas, vegetables e.g. tomato, watermelon, squash, pumpkin, green peas, chilies, eggplant and French beans; root and tuber crops (Irish potato and sweetpotato); nuts (ground nuts); staples (maize and cassava); and short duration perennials (e.g. papaya and passionfruit) to increase the gross margin per unit area.

Conservation agriculture. It is also recommended to cover the orchard floor with mucuna. This legume not only contributes to conservation of moisture, but also controls weeds and contributes to nitrogen fixing thus reducing the amount of inorganic nitrogen applied per acre by 200 kg.

c. Propagating of Stevia

Stevia can be propagated by seeds, division of suckers, vegetative cuttings and tissue culture. Propagation through seeds is easy and economically more viable. However, there are morphological and chemical variations among the individual plants of seed raised populations. Clonal propagation through cuttings and tissue culture provides uniform quality of produce, but the cost of planting material is high.

IHBT has developed improved cultivar "Him Stevia" with higher proportion of rebaudioside-A (7.34%) compared with stevioside (5.78 %) and total glycoside content of 14.49% on dry weight basis. Higher proportion of rebaudioside-A is a desirable component, which provides better quality of sweetness profile. Quality planting material can be procured from the Institute.

Nursery raising from seeds

Direct seeds sowing practice is not recommended due to very small size of seed. Nursery raising through seeds should be done in the month of January-March. However, under protected conditions, it can be done throughout the year. Germination of seeds take place in 7-10 days. Seeds can be sown in plastic trays, pots, wooden boxes or in raised nursery beds having a good mixture of sand, soil and organic manure. The bed width should be 1.0-1.5 m with suitable length. For the first five days after sowing, daily light irrigation should be given in the nursery beds, preferably during morning and evening hours and thereafter once a day in the next five days. Two month old seedlings at 5-7 leaves stage with10-15 cm height are suitable for transplanting.

Nursery raising from cuttings

Plants can be raised by vegetative means using stem cuttings of 10-15 cm height with 4-6 nodes. The cuttings should be taken from actively growing plants during mild weather avoiding extreme cold or hot months. Lower leaves of the cuttings are trimmed and the cuttings are planted in the bed keeping one node inside the soil. These cuttings should be raised under partial shade and high humidity for fast root development. Water should be sprinkled on daily basis till root formation occurs, which takes 10-15 days. The rooted cuttings are then transferred to sleeves filled with soil, sand and FYM mixture (1:1:1 ratio). These cutting raised plants need to be irrigated twice a week or as per the requirement.

d. Propagation patchouli

Patchouli is vegetative propagated. The nursery is raised in shade by planting 10-12 cm. long cuttings at 10 X 10 cm. spacing during the rainy season and the seed beds are kept continuously moist.

Theoretical learning Activity

- ✓ Trainees within groups discuss on high value added crop propagation methods

Practical learning Activity

- ✓ Trainees should appropriate tools which will use in propagation method.

Points to Remember (Take home message)

- ✓ Propagation ways of high value added crop
- ✓ Different type of grafting regarding on high value added crop
- ✓ Care of transplanted seedling

Indicative content 1.3.2: materials pre-treatments techniques:

- **Physical treatment**

Light treatment: automatically protects crops from pests and pathogens with daily light treatments.

Heat treatment: Heat treatment is a pesticide-free method to care for texture quality during storage. This method is conducted using hot air, hot water dips, or vapor heat, and is an alternative to cut down the need to use chemical products to assure the quality of fruits or vegetables.

Chemical treatment

Seed pelleting: Seed pelleting is the process of adding inert materials to seeds increasing their weight, size and shape. This improves plantability allowing for precise metering, spacing and depth of seed in the field.

Methodology

- ✓ Take the seeds in plastic tray.
- ✓ Add a small quantity of adhesive (10% maida solution) to the seeds.

- ✓ Shake gently, in such a way the adhesive spreads evenly on parts of each seed.
- ✓ Add filler material (Arappu leaf powder) evenly over the seeds and continue shaking until the uniform coating is ensured.
- ✓ Separate the seed dumps if any
- ✓ Remove the excess filler material by sieving
- ✓ Dry under shade to expel moisture

Benefits

- ✓ Small and irregular shape seeds can be handled easily
- ✓ Precision sowing of seeds is possible as size and weight of seeds are increased
- ✓ Increased physiological seed quality characters

There are various methods used for pelleting: Inoculant pelleting, Protective pelleting, herbicide pelleting nutrient pelleting hydrophilic/ hydrophobic coating and oxygen supplier coating

Seed priming: Seed priming is a pre-sowing treatment that causes a physiological change in the seed that permits it to germinate more rapidly. It also enhances crop activity by stimulating the resistance of plants against abiotic and biotic stresses

Overnight seeds are soaked with water or nutrient solution before sowing, known as seed priming, a significant low-cost technology to improve germination and seedling emergence. It may be recommended to increase the seed rate by 20–25% to have the desired plant population in rice fallows
What are 4 advantages of seed priming?
The priming of seeds allows the dormancy-breaking, acceleration and synchronization of germination as well as a better growth, an earlier flowering, a greater tolerance to abiotic stress and higher yields.

- **Soacking in insecticides**
- **Soacking in Fungicides**

Mechanical treatment:

- **Stratification**: Stratification is a process of pre-treating seeds in order to simulate natural conditions that seeds would experience in the soil over-winter. Pre-treating seeds helps the seed "break dormancy" and initiate the germination process.

Dry stratification is a seed pre-treatment in which the seed is subjected to cold temperatures of 32˚F or lower, for a period of a month or longer. This simple treatment of keeping the seeds in cold, dry storage helps increase germination rates by imitating a natural winter dormant period.

Materials for Cold Stratification:

- ✓ Seeds
- ✓ An all-purpose sand mixture and/or Peat Moss

- ✓ Paper towels
- ✓ Water
- ✓ Plastic Ziploc bags
- ✓ A sharpie or pen for labeling
- ✓ Mixing bowls.
- ✓ Refrigerator

Scarification: a scratching of the seed coat to aid germination, or otherwise treated to make the seed permeable to water and hasten germination**.**

Scarification is the process of intentionally damaging a seed to encourage germination. Although this sounds drastic, it's really just a case of weakening the outer seed shell a little, giving moisture a way into the embryo to set the natural sprouting process in motion

…or weakened by humans (scarification). In chemical scarification, seeds are dipped into strong sulfuric acid, organic solvents such as acetone or alcohol, or even boiling water. In mechanical scarification, they may be shaken with some abrasive material such as sand or be scratched with a knife.

- **Soaking in water**

Theoretical learning Activity

- ✓ Trainees within groups discuss on high value added crop pre-treatment methods

Practical learning Activity

- ✓ Trainees select tools and equipment based on pre-pre-treatment method.

Points to Remember (Take home message)

Types of pre-treatment methods used in grow high value added crops growing such as: **Physical treatment, Chemical treatment and Mechanical includes**

- Heat treatment
- Light treatment
- soaking in insecticides
- soaking in Fungicides
- Soaking in water

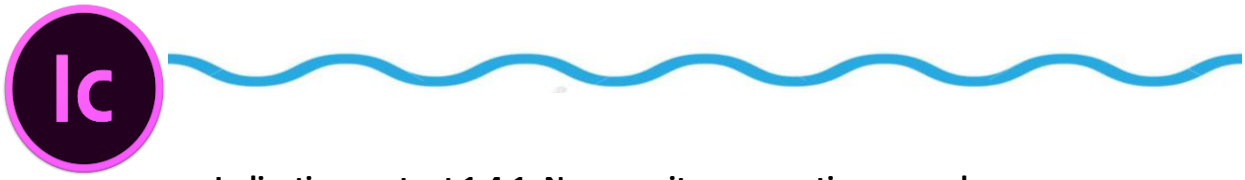
Learning outcome 3. Formative assessment

Written assessment

1. List out tools, material and equipment used in pre-treatment method
2. Discuss on important of pre-treatment of high value added crop planting material
3. Match with correct answer

Type of treatment	**Method**
1. Mechanical treatment 2. Physical treatment 3. Chemical treatment	- Heat treatment - Light treatment - soaking in insecticides - soaking in Fungicides - Soaking in water - Breaking of hard seed coat

Learning Outcome 1.4. Raise high value added crops seedlings in nursery depending on the crop typ



Indicative content 1.4.1: Nursery site preparation procedure

- **Land clearing**: Land clearing requires the removal of native cover – including trees, bushes and boulders – from the land surface. The land is subsequently broken to create a workable bed into which a crop can be seeded

- **First cultivation**: Cultivating breaks up the crusty soil surface allowing for a much easier penetration of air, nutrients and water deep into the soil where plant roots can gain access to them

- **Second plowing**: Secondary cultivation prepares a fine tilth as a bed for sowing small seeded crops such as carrots or beetroot. In the growing season, tertiary cultivation maintains weed control, preventing competition for resources (illustration no. 1) such as light, nutrients and water while discouraging pest and disease damage

Beds rising: an area in a garden that is higher than the ground around it and is usually surrounded by a frame made of wood or stone.
Raised beds are often more productive than beds in the ground because the soil is less compacted, has better drainage, and warms earlier in the spring, meaning that plants will start to grow earlier in the season

Pots filling and arrangement: Potting means pot culture for cultivation of plants in pot. High and deep pots are required for potting of plants. A hole is very essential at the bottom of pot for convenient of water removed. Rainy season is very suitable for pot plantation

Objectives of potting
1. Potting is done for increasing the beautification of social and government occasion.
2. To beautify the homestead.
3. Easy for handling here and there.
4. In terms of breeding program, individual plant is produced and maintained with special care.
5. Potting is done for experimental research.
6. To-protect plants from the adverse effect of sudden floods.
7. Potting is done for photo session.
8. To keep aromatic flowers in a specialized position.
9. Potting is done for the presentation of seedlings until the permanent place is ready for planting.
10. Potting is done for green house purpose.

Theoretical learning Activity

- ✓ Trainees within groups discuss nursery preparation site procedure

Practical learning Activity

✓ Trainees select tools and equipment based on nursery bed preparation.

Points to Remember (Take home message)

- Land clearing process
- Fist tillage operation
- Second tillage operation
- Planting tillage operation

Indicative content 1.4.1: Sowing/planting methods and techniques

✓ **Broadcasting**: Broadcast planting is the practice of dispersing seeds over the surface of the soil. The seeds are dispersed on the seedbeds either automatically or manually.

The advantage of broadcast seeding is that it permits large acreages to be sown in less time; the disadvantages are poor soil to seed contact, uneven planting depths (some seed too shallow for proper emergence of permanent root systems, and other seed too deep for germination), and, often, poor plant distribution.

✓ **Seed drilling**: Seed-drilling is the sowing of seeds in uniform rows to a standard soil depth (Bufton 1978). This is usually done with the aid of specialized machinery called a seed drill. Sowing at depth rather than sowing seeds by hand on the soil's surface may reduce seed removal by seed predators, such as birds.

The seed drill sows the seeds at the proper seeding rate and depth, ensuring that the seeds are covered by soil. This saves them from being eaten by birds and animals, or being dried up due to exposure to the sun.

✓ **Spots sowing**: For spot seeding, prepare the area by removing any weeds, then break up the surface with a hard rake or similar tool so the seeds will be in contact with soil. This is also a good time to add soil amendments, such as peat moss or a specially formulated starter fertilizer

Theoretical learning Activity

- ✓ Trainees within groups discuss on sow/ planting method

Practical learning Activity

- ✓ Trainees select tools and equipment based sowing/planting method.

Points to Remember (Take home message)

- Types of sowing/planting method
- Objectives of potting filling.

Indicative content 1.4.3: Maintenance practices of seedlings in nursery

1.4.3: Maintenance practices of seedlings in nursery

✓ **Watering:** Irrigation is the artificial application of water to the soil through various systems of tubes, pumps, and sprays. Irrigation is usually used in areas where rainfall is irregular or dry times or drought is expected. There are many types of irrigation systems, in which water is supplied to the entire field uniformly.

✓ **Mulching:** Mulching is referred as spreading various covering materials on the surface of soil to minimize moisture losses and weed population and to enhance crop yield (Nalayini 2007; Kader et al. 2019).18 mai 2020

✓ **Fertilization:** Fertilization means you're applying something to the soil to make it better. Chemicals or even manure can be used for fertilization. That may not smell very nice, but your plants will grow better as a result.

✓ **Pricking out and Hardening off:** Pricking out' means separating out seedlings growing together and transferring them into their own plugs or pots of potting mix. Start pricking out as soon as the seedlings are big enough to handle. Fill plug trays or pots with good quality all-purpose potting mix.

Pricking out' your seedlings is a term that means transplanting them. The reason you have to do this is to help your plant move on from 'seed' stage to 'growing on' stage, where it will require a bigger pot or cell

✓ **Hardening off:** Hardening is the process of exposing transplants (seedlings) gradually to outdoor conditions. It enables your transplants to withstand the changes in environmental conditions they will face when planted outside in the garden. It encourages a change from soft, succulent growth to a firmer, harder growth.

✓ **Pest and diseases control in nursery:** Pest and disease management consists of a range of activities that support each other. Most management practices are long-term activities that aim at preventing pests and diseases from affecting a crop. Management focuses on keeping existing pest populations and diseases low.

Theoretical learning Activity

✓ Trainees within groups discuss maintenance practice procedure of grow high value added crop

Practical learning Activity.

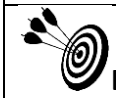
✓ Trainees select tools and equipment based on maintenance practice of grow high value added crops.

Points to Remember (Take home message)

- **Different types of crop maintenance operations.**
  - Watering
  - Mulching
  - Fertilization
  - Pricking out
  - Hardening off
  - Pest and diseases control in nursery

Learning Outcome 2.1: Prepare the land according to the type of soil and crop type

 **Duration: 3 hrs**

 **Learning outcome 3. Objectives :**

By the end of the learning outcome, the trainees will be able to:

1. Differentiate the methods/ways of land clearing
2. Know different types of tillage.
3. Explain the cultivation methods

 **Resources**

Equipment	Tools	Materials
• Internet connection • DVD players of • Computer • Projector • PPE	• scientific papers • Soil auger • spade • Hoes • Pickaxe • Spade • Trowel • pruning knife • Hand hoe • Panga	• pesticide • Fertilizers • Planting materials • Books • container for currying sample • planting materials • Soil amendment • Compost • Farm yard manure • Green manure • Lime • Dolomite • Gypsum

 **Advance preparation:**

- Trainees will prepare the tools material and equipment which will be used in land preparation activities

Indicative content 2.1: Methods/ways of land clearing

Picture/s reflecting the Learning unit 1

Methods/ways of land clearing

- **Land Clearing**: Is done to remove unwanted vegetation and objects from the field. This can be done manually or mechanically and using chemical spray clearing
- **Manual land clearing:** means the removal of trees, shrubs, and vines using chain saws or other cutting tools
- **Mechanical clearing**: means the clearing of vegetation using machinery which disturbs the soil surface or uproots woody vegetation
- **Chemical spray clearing**: it kills right down to the root, Glyphosate will eradicate almost all weeds, including deep-rooted perennials such as Lantana

Theoretical learning Activity

- ✓ Trainees within groups discuss methods/ways of land clearing

Points to Remember (Take home message)

- **Different types of ways/methods of land clearing.**
  - ✓ Land Clearing:
  - ✓ Manual land clearing:
  - ✓ Mechanical clearing:

- ✓ Chemical spray clearing:

Indicative content.2.2.2: Tillage types

- ✓ ***Primary tillage:*** loosens the soil and mixes in fertilizer or plant material, resulting in soil with a rough texture.
- ✓ ***Secondary tillage*** produces finer soil and sometimes shapes the rows, preparing the seed bed. It also provides weed control throughout the growing season during the maturation of the crop plants, unless such weed control is instead achieved with low-till or no-till methods involving herbicides.
- ✓ ***Zero or minimum*****:** refers to the arable land on which no tillage is applied between harvest and sowing. Zero tillage is a minimum tillage practice in which the crop is sown directly into soil not tilled since the harvest of the previous crop. Weed control is achieved by the use of herbicides and/or appropriate mulching and stubble is retained for erosion control.

Theoretical learning Activity

- ✓ Trainees types of tillage existed

Points to Remember (Take home message)

- **Different types of ways/methods of tillage.**
- ✓ First tillage
- ✓ Second tillage
- ✓ Zero (0) tillage

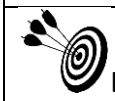
Indication content: Cultivation methods

1. **Flat cultivation:** high value added crop they may be grown on the land relatively low. This shape is used where soil moisture is adequate for crop growth and where there are no drainage problems.
2. **Ridges cultivation:** Ridges are hips of soil put across a garden to reduce surface run-off under heavy rainfall. Ridges are commonly used in the growing of Irish-potatoes and sweet potatoes. Root and tuber crops can be planted on performed beds of any length, 60-105cm wide by 18-30cm high with 3-5 defined planting rows per bed. These ridges have advantages of irrigation and drainage of water from bed surface and avoid negative effects of ponding and associated waterlogging. Ridges are oriented along the contours on slopping land, to maximize rain infiltration and minimize erosion.
3. **Mound cultivation**: The mounds are usually 16-20cm high and 20-25cm wide. Mounds are smaller than ridges.

Picture/s reflecting the Learning unit 2

Learning outcome 2.1: Proper preparation of land according to the type of soil and crop

Duration: 4 Hours



Learning outcome1. Objectives :

By the end of the learning outcome, the trainees will be able to:

1. To know the method of land preparation accordingly
2. To know different types of tillage
3. To differentiate cultivation methods
4. Identify type of soil amendments

Resources

Equipment	Tools	Materials
• Wheelbarrow • Knapsack sprayers	• Spade • Trowel • pruning knife • panga • Hoes	• Pesticides • Soil amendment • Farm yard manure • Compost manure • Green manure • Lime • Dolomite • Gypsum Rel

Advance preparation:

- Preparation of land clearing operations
- Prepare of field accordingly
- Field visiting

Learning Unit 3: Maintain high value added crops

Learning outcomes:
3.1 Proper identification of pest and disease according to crop type 3.2 Adequate selection of method and technique for crop maintenance depending on type of crop 3.3 Appropriate application of methods and techniques for crop maintenance depending on the crop type

Learning Outcome 3.1: Identify pest and disease according to crop type

Duration:5HRS

Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe pest and disease for macadamia, patchouli, geranium and stevia

2. Identify pest and disease symptoms in macadamia, patchouli, geranium and stevia plantation and the ways of control

3. Explain the right ways to get rid of pest and diseases for macadamia, patchouli, geranium and stevia

Resources

Equipment	Tools	Materials
Computer Projector Digital camera	**Hoe** **Pruning knife'** **Secator** **panga**	**Scientific paper** **Delivery note** **Sample** **Insect trap** **Book and pesticide**

Advance preparation:

.trainees within group discus on pests and diseases of high value added crop

.

.

Cont 3.1.1 : Description of Pest types for macadamia, geranium, stevia, patchouli

Macadamia, geranium, patchouli and stevia are attacked by the following pests

- ✓ Rodents
- ✓ Birds
- ✓ Animals
- ✓ Weeds
- ✓ Mites/termites

Insect and Mite Pests of Macadamia Nuts

Like most commercial crops, macadamia is subject to infestation by pests. About 60 insect and two mite species are known to attack macadamia trees and their fruit.. In South Africa, pentatomid and coreid stinkbugs are the most important pests in macadamia orchards. The macadamia nut borer (Cryptophlebia ombrodelta) lays its eggs on the husk and the larvae burrow through the nut shell to eat the kernel. Macadamia nut borer (MNB) will cause premature nut fall, particularly during the oil accumulation stage (around December to February in Northern NSW)

0. Tropical nut borer (TNB) are found in sticktight nuts, in nuts on the orchard floor, and in alternative hosts, e.g., carob, asoka fruit, and castor bean.
   Egg, larva, and pupa Adult TNB Damage to a kernel by TNB

   What kills them?—The beetles shown here eat the eggs and larvae of TNB.

   Chemical control can be achieved with endosulfan.

1. **Southern green stinkbug (SGS)**

Where do they occur?—SGS attacks maca- SGS causes pitting on damia nuts and various weed species. They cause pitting on kernels, resulting in rejection by nut processors. SGB attack nuts both on the tree and the ground

What kills them?—No parasites of their eggs are found here. Some parasitic wasps attack and kill the larvae. Chemical control of koa seedworm is not recommended.

3.Koa seedworm and litchi fruit moth. Where do they occur?—Koa seedworm moths lay their eggs on the husks of macadamia nuts. The larvae then bore into the husk or kernel, if the shell has not yet hardened.
What kills them?—No parasites of their eggs are found here. Some parasitic wasps attack and kill the larvae. Chemical control of koa seedworm is not recommended.

Some minor pests
Broad mites feed on macadamia flowers, leaves, and fruit; damage to flowers may be significant
Broad mite damage on husks
Flat mites rarely cause economic damage
Flat mite damage on husks
Redbanded thrips feed on husks and leaves. They may cause malformation of leaves
Thrips damage to leaves, Redbanded thrips damage to husks

Rats ***Rattus rattus***
Rattus norvegicus
Rattus fuscipes

Brown rat, Rattus norvegicus

Symptoms
Extensive loss and damage of developing nuts or nuts that have dropped from tree; nuts have holes approximately 1 cm in diameter gnawed through shell to gain access to kernels
Cause
Rodents
Comments
Encourage predatory birds such as owls by providing nesting boxes in the trees
Management
All food sources for rats should be removed from the orchard, this includes old nuts, nut waste and wild tobacco; remove any rat nests from trees; keep grass around trees mown short and, if possible, maintain a clear mown area around the orchard to deter rats from entering and to aid predators such as owls in detecting and hunting rats
Pests
Category : Insects
Macadamia nut borer ***Cryptophlebia ombrodelta***
Symptoms
Entry holes in husks of nuts, usually close to the panicle; holes usually have insect frass protruding from them and husks may have shallow, dimple-like depressions; infested nuts drop from tree prematurely; insect eggs are scale-like and are laid on the surfaces of green

husks; larvae are legless grubs which are pinkish in color when mature with dark green spots; adult insect is a red-brown moth
Cause
Insect
Comments
Larvae pupate in damaged nuts; entire lifecycle of the moth is completed in approximately 5 weeks
Management
Control of macadamia nut borer can be difficult as insecticides are ineffective once the larvae have entered the nuts; appropriate insecticides should be applied if gren fallen nuts exhibit damage or live, unparasitized eggs are present on the tre; old nuts should be removed from tree and the orchard ground at harvest
Tropical nut borer ***Hypothenemus obscurus***
Symptoms
Numerous round holes approximately 0.5 mm in diameter on husks; extensive tunnelling through husk and shell visible when nut is cut open; in late stage infestations the entire kernel may be consumed
Cause
Insect
Comments
Economic damage is usually incurred if the nuts remain on the ground for a period of three weeks or more before harvest
Management
Control of the tropical nut borer relies on the use of resistant macadamia varieties and cultural control methods including harvesting nuts at three week intervals immediately removing husks, avoiding varieties prone to sticktight and removing damaged nuts from the orchard;

COMMON PESTS OF PATCHOULI

Insect Pests. The crop is suspect to Root-knot Nematode attacks (Meloidogyne Incognita). Heavily infected plants are stunted in growth and wilt.

Common pests of stevia

Stevia Pests

Pest	How to control it
Aphids	Aphids are quite common when growing stevia. Fortunately, there are Remove aphids by hand by spraying water or knocking them into a bucket of soapy water. Control with natural or organic sprays like a

	soap-and-water mixture, neem oil, or essential oils. Employ natural predators like ladybugs, green lacewings, and birds
Whiteflies	Whiteflies may also populate stevia plants. Hence, also inform yourself on . A simple solution made from liquid dish soap and water will kill adult whiteflies without harming plants. Add 1 tablespoon of liquid dish soap to 1 gallon of water and mix well. Pour the solution into a plastic spray bottle and spray it on all infested plants, saturating the leaves' upper and undersides and the stems
Thrips	Thrips may also feed on stevia. Hence, also get some information on Greenhouse thrips is readily controlled with thorough application of contact sprays such as horticultural oil, natural pyrethrins (plus piperonyl butoxide), or insecticidal soaps to the underside of infested leaves. Repeat applications may be necessary.
Cutworms	Cutworms can also do great damage to stevia plants. Thus, also get some . Hand pick cutworms off of plants. Go out at night with a flashlight and gloves. Pick off the cutworms and drop into soapy water; repeating this every few nights. Surround stems with diatomaceous earth (D.E.), a natural powder made from ground up diatoms.
Slugs & snails	Slugs may also be present when growing stevia at home. Hence, also get some tips on Sage, rosemary, parsley, and thyme are all beautiful additions to your garden and also deter snails. Plant them in a border around your garden and between vulnerable plants to ward of slugs and snails. It also means you get a beautiful, additional herb garden to use in your cooking! Slugs & snails — Slugs may also be present when growing stevia at home. H rosemary, parsley, and thyme are all beautiful additions to Plant them in a border around your garden and between v and snails. It also means you get a beautiful, additional he Bugs — There are also many bugs feeding on stevia plants. You ca insecticidal soap from the garden center. Geranium pests Insects that frequently attack geraniums include aphids, cabbage loopers, and fall cankerworms. The four-lined plant bug, scale, and slugs can also cause damage. Properly identify the insect pest and control

with the recommended insecticide. Geraniums are one of the most popular annual plants grown by gardeners today.

Holes in geranium or pelargonium leaves

This is usually caused by caterpillars. There is a moth that can appear about August or September that will chew the leaves of the zonals which needs catching in the evenings or eradicating with a systemic insecticide. Geraniums are rarely affected by slugs and snails.

Whitefly on pelargoniums

Whitefly can be a problem with the **regal** and sometimes the **scented** pelargoniums, though they do not actually damage the plant. Garden Centres are loaded with insecticides to combat this pest, but it is a case of persevering during the warm weather, as they breed very rapidly. We spend a huge amount of money to keep this pest under control – and it still pops up again! Try using "Provado", it could help here!

Greenfly on geraniums

Greenfly are more of a problem than Whitefly, as these DO damage the plant as they can distort the leaves and spread quickly. Obtain a 'systemic spray' from the hardware shop (systemic just means the spray gets into the plant system and the fly eat the leaves and get the insecticide into them). Spray the whole plant, particularly under the leaves and the compost too. Best to isolate the plant if possible to stop them spreading or spray all plants so they are all protected.

Sciarid flies

These are small black flies which you will see on the surface of the compost, and their larvae can damage the roots. They can thrive in peat composts, but are not normally so active that they kill the plants. Once their life cycle moves on, they disappear, so are only a nuisance for about two months in the year. Drenching with a weak solution of Jeyes Fluid will usually put an end to them. Correct watering – keeping the soil moist but never wet – will help to keep them away

Macadamia tree infected with quick decline with healthy trees

Symptoms

Yellowing or browning of some leaves in the tree canopy; subtle change in color of tree canopy from dark to light green; entire tree turning brown; in final stages of disease, whole tree is brown and distinct from green trees around it; tree death may occur in a few months after initial symptoms have appeared

Cause

FungI

Comments

Management

Remove any dead or diseased trees from the orchard; avoid wounding tree trunks

Category : Oomycete

Phytophthora trunk and stem canker ***Phytophthora cinnamomi***

Symptoms

Nursery trees and young plantations trees are stunted and chlorotic and may be partially defoliated; if lesions girdle the stem then the tree will die; in mature trees, dark discoloration of wood is visible by removing the bark from the trunk of the tree; dark cankers may extend from trunk at soil line to the lower branches of the tree

Cause

Oomycete

Comments

Fungus survives in plant debris in soil; spread by water splash

Management

Plant only disease-free nursery stock; plant trees in well-draining soils on a slight mound to promote drainage and prevent water-logging; avoid wounds to the trunk of the tree which allow fungi to enter; incorporate organic matter into the soil around the tree; apply appropriate protective fungicides to tree trunks prior to wet season;

Category : Other

Rats ***Rattus rattus***

Rattus norvegicus

Rattus fuscipes

Brown rat, Rattus norvegicus

Symptoms
Extensive loss and damage of developing nuts or nuts that have dropped from tree; nuts have holes approximately 1 cm in diameter gnawed through shell to gain access to kernels
Cause
Rodents
Comments
Encourage predatory birds such as owls by providing nesting boxes in the trees
Management
All food sources for rats should be removed from the orchard, this includes old nuts, nut waste and wild tobacco; remove any rat nests from trees; keep grass around trees mown short and, if possible, maintain a clear mown area around the orchard to deter rats from entering and to aid predators such as owls in detecting and hunting rats
Pests
Category : Insects
Macadamia nut borer ***Cryptophlebia ombrodelta***
Symptoms
Entry holes in husks of nuts, usually close to the panicle; holes usually have insect frass protruding from them and husks may have shallow, dimple-like depressions; infested nuts drop from tree prematurely; insect eggs are scale-like and are laid on the surfaces of green

husks; larvae are legless grubs which are pinkish in color when mature with dark green spots; adult insect is a red-brown moth
Cause
Insect
Comments
Larvae pupate in damaged nuts; entire lifecycle of the moth is completed in approximately 5 weeks
Management
Control of macadamia nut borer can be difficult as insecticides are ineffective once the larvae have entered the nuts; appropriate insecticides should be applied if gren fallen nuts exhibit damage or live, unparasitized eggs are present on the tre; old nuts should be removed from tree and the orchard ground at harvest
Tropical nut borer ***Hypothenemus obscurus***
Symptoms
Numerous round holes approximately 0.5 mm in diameter on husks; extensive tunnelling through husk and shell visible when nut is cut open; in late stage infestations the entire kernel may be consumed
Cause
Insect
Comments
Economic damage is usually incurred if the nuts remain on the ground for a period of three weeks or more before harvest
Management
Control of the tropical nut borer relies on the use of resistant macadamia varieties and cultural control methods including harvesting nuts at three week intervals immediately removing husks, avoiding varieties prone to sticktight and removing damaged nuts from the orchard; applications of appropriate insecticides may be necessary

GERANIUM
. These plants are valued for their deep green leaves and clusters of bright flowers. They are usually low-maintenance plants, but they can become infested with caterpillars, whiteflies, aphids and mites.
DISEASES OF SEEDLING GERANIUMS:

The primary diseases encountered on seedling geraniums are Damping-Off, Pythium Root Rot, Rhizoctonia Root and Crown Rot, and Botrytis Leaf Blight, Crown Rot, and Flower Blight. Symptoms and management strategies for most of these diseases are similar to those for stock plants and cuttings and will be covered in the next section. The exception is Damping-Off, a problem that is unique to the germination stage of seed-propagated plants.

A.Damping-Off:

CausalAgents: Pythium, Rhizoctonia,and Botrytis.

Symptoms:--Pre-Emergence: recognized as many random "skips" or empty areas in the plug trays or flats since the fungi attack and kill the developing seedlings before they emerge from the propagation mix.

--Post-Emergence: seedlings topple over and often have a noticeable brown to black lesion at the soil line since the fungi attack and girdle the seedlings after they emerge from the mix; under wet, humid conditions, a gray or off-white, webby growth can be seen on the infected seedlings.

Disease management:
a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium;
b. use fresh seed;
c. maintain media (75-78°F or 24-25°C) and air (74-77°F or 22-24°C) temperatures to promote rapid and even germination;
d. avoid fungicides applied as soil drenches since seedling geraniums can be very sensitive.

FUNGAL DISEASES OF STOCK PLANTS AND CUTTINGS:

A. Pythium Root Rot or Blackleg:

Causal Agent: Pythium spp.

Symptoms: usually more serious on cuttings during propagation, but can occur on plants of any age; brown, water-soaked lesions develop at the base of cuttings or at wounds; they become coal-black and watery; plants collapse when girdled.

Disease Management:
a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium;
b. use disease-free cuttings;
c. avoid overwatering (disease is favored by high moisture and low oxygen levels);
d. rogue and remove symptomatic plants;
e. maintain good insect control, especially fungus gnats and shore flies;
f. fungicides: among those registered for use are metalaxyl, mefonoxam, fosetyl-Al, etridiazole, and etridiazole plus thiophanate methyl; also registered is the biocontrol agent Trichoderma harzianum T-22.

B. Thielaviopsis Root Rot or Black Root Rot:

Causal Agent: Thielaviopsis basicola.

Symptoms: black, fairly dry lesions develop on the stem at or below the soil line on both cuttings and young plants; rooting of cuttings may not occur or may be delayed; leaves yellow, drop prematurely, and plants eventually collapse.

Disease Management:
a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium (especially when geraniums follow poinsettias);
b. use disease-free cuttings;

c. avoid overwatering (disease is favored by high moisture and low oxygen levels);
d. rogue and remove symptomatic plants;
e. fungicides: among those registered for use are etridiazole plus thiophanate methyl, thiophanate methyl, and thiophanate methyl plus iprodione.

C. Botrytis Blight (Stem, Leaf, and Flower Blight):

Causal Agent: Botrytis cinerea.

Symptoms: (Symptoms can develop at any stage of production and on any plant part. Under conditions of high moisture and humidity, any infected plant tissues and debris can develop the diagnostic fuzzy, gray growth characteristic of this fungus.)
--Leaves: symptoms vary from discrete spots or lesions to large, dead areas, often with concentric rings; V-shaped lesions can also develop and can be confused with those associated with Bacterial Blight; lesions often occur when spent flower petals fall onto the leaves.
--Cuttings and Stems: symptoms appear at the base of cuttings as light- to dark-brown lesions, which can result in complete basal rot; stubs on stock plants can develop brown lesions after cuttings are taken.
--Flowers: usually first evident as premature fading and drying of flowers; flowers turn brown and drop prematurely; during periods of high moisture and relative humidity, senescing flowers are covered with a gray, fuzzy mass.

Disease Management:
a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium;
b. use disease-free cuttings;
c. avoid overhead irrigation and water early in the day;
d. regulate relative humidity by venting and heating (HF);
e. use adequate plant spacing to promote good air circulation;
f. rogue and remove symptomatic plants and plant parts; remove spent flowers and senescing leaves (do not carry infected plant material through the house);
g. fungicides: among those registered for use are iprodione, thiophanate methyl, thiophanate methyl plus iprodione, mancozeb, chlorothalonil, fenhexamid, azoxystrobin, fludiononil, copper sulphate pentahydrate, and the biocontrol agent Trichoderma harzianum T-22. For resistance management, avoid making more than two consecutive applications with the same fungicide or same class of fungicide.

D.Alternaria Leaf Spot:

Causal Agent: Alternaria alternata.

Symptoms: usually first evident on the lower leaf surface as small, raised, water-soaked areas; these spots quickly develop into brown, zonate, sunken spots; these can be confused with the spots associated with Bacterial Blight, but the Alternaria spots tend to be larger in size; additionally, under conditions of high humidity, dark-brown, fuzzy spore masses of the

fungus cover the Alternaria spots.

Disease Management:
a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium;
b. use disease-free cuttings;
c. avoid overhead irrigation;
d. rogue and remove symptomatic plants;
e. fungicides: among those registered for use are iprodione, thiophanate methyl plus iprodione, mancozeb, chlorothalonil, thiophanate methyl plus chlorothalonil, azoxystrobin, and fludiononil.

E. Leaf Rust:

Causal Agent: Puccinia pelargonii-zonalis.

Symptoms: small, yellow spots appear on the upper surface of the leaf and rust-colored pustules or circles develop in the spots on the underside of the leaf; pustules break open and release the rusty-colored spores for which this disease gets its name; when infection is severe, leaves yellow and drop prematurely; this disease is primarily a problem for zonal geraniums.

Disease Management:
a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium;
b. use disease-free cuttings;
c. avoid overhead irrigation and strong air currents;
d. rogue and remove symptomatic plants (BEFORE they sporulate, if possible);
e. fungicides: among those registered for use are triadimefon, mancozeb, thiophanate methyl plus mancozeb, chlorothalonil, oxycarboxin, azoxystrobin, and fenhexamid.

BACTERIAL DISEASES OF STOCK PLANTS AND CUTTINGS

A. Bacterial Blight (Bacterial Leaf Spot, Stem Rot or Wilt):

Causal Agent: Xanthomonas campestris pv. Pelargonii.

Symptoms:
Leaves: infected leaves typically develop two types of symptoms: small, discrete, water-soaked or brown spots and V- or pie-shaped, angular lesions; some leaves develop distinctly darkened veins and wilt at leaf margins.
Stems: when infection is systemic, the entire plant develops typical wilt symptoms, often first appearing in the lower leaves; leaves become flaccid and branches wilt and die back; stems can blacken and shrivel into a dry rot; infected cuttings fail to root and slowly rot from the base upward; stems become dull, black-brown and are drier than Pythium root rot; plants with systemic infection collapse and die; systemically-infected ivy geraniums do not wilt but

develop symptoms that can be confused with nutritional or insect problems.

Disease Management:
1. Sanitation:
a. start with a clean house and equipment and a sterile, well-drained medium;
b. isolate stock plants from propagation area;
c. use disease-free cuttings;
d. keep geraniums from different suppliers separate;
e. separate seedling geraniums from cutting types;
f. avoid growing perennial geraniums (Geranium spp.) near Pelargonium spp.;
g. avoid placing ivies in hanging baskets above seedling or cutting geraniums;
h. use drip irrigation if possible (especially on stock plants);
i. rogue and remove symptomatic plants as soon as possible.
2. Education:
a. discuss the contagious nature of bacterial diseases;
b. require frequent hand-washing;
c. avoid unnecessary handling of plant material;
d. minimize traffic flow in house.
3. Chemical Control: among the compounds registered for use is copper sulphate pentahydrate.

B. Southern Bacterial Wilt:

Causal Agent: Ralstonia solanacearum (formerly called Pseudonomas solanacearum).

Symptoms: initial symptoms appear as a general wilting of lower leaves followed by yellowing and necrosis; V-shaped chlorotic or dead areas similar to those associated with Bacterial Blight can develop on flaccid leaves; a brown discoloration of the vascular system is sometimes visible; roots of infected plants are often brown or black; plants eventually collapse and die; no discrete leaf spots are associated with this disease.

Disease Management:
1. Sanitation:
a. start with a clean house and equipment and a sterile, well-drained medium;
b. isolate stock plants from propagation area;
c. use disease-free cuttings;
d. keep geraniums from different suppliers separate;
e. separate seedling geraniums from cutting types;
f. avoid placing ivies in hanging baskets above seedling or cutting geraniums (?);
g. use drip irrigation if possible (especially on stock plants);
h. rogue and remove symptomatic plants as soon as possible.
2. Education:
a. discuss the contagious nature of bacterial diseases;
b. require frequent hand-washing;
c. avoid unnecessary handling of plant material;
d. minimize traffic flow in house.

3. Chemical Control: chemical control is not effective in preventing infection since this pathogen generally infects through natural openings or wounds in the roots.

STEVIA

Among diseases, leaf blight caused by Alternaria sp. and leaf spot caused by Septoria steviae are the most common and mainly occur during rainy season. These diseases reduce stevia leaf yield and quality. Sporadic occurrence of root rot (Sclerotium rolfsii) has also been observed during rainy season.

Stevia Pests

Pest	How to control it
Aphids	Aphids are quite common when growing stevia. Fortunately, there are R hand by spraying water or knocking them into a bucket of soapy water. C natural or organic sprays like a soap-and-water mixture, neem oil, or ess natural predators like ladybugs, green lacewings, and birds
Whiteflies	Whiteflies may also populate stevia plants. Hence, also inform yourself o solution made from liquid dish soap and water will kill adult whiteflies wi plants. Add 1 tablespoon of liquid dish soap to 1 gallon of water and mix solution into a plastic spray bottle and spray it on all infested plants, satu upper and undersides and the stems
Thrips	Thrips may also feed on stevia. Hence, also get some information on Greenhouse thrips is readily controlled with thorough application of cont horticultural oil, natural pyrethrins (plus piperonyl butoxide), or insecticid underside of infested leaves. Repeat applications may be necessary.
Cutworms	Cutworms can also do great damage to stevia plants. Thus, also get some cutworms off of plants. Go out at night with a flashlight and gloves. Pick and drop into soapy water; repeating this every few nights. Surround ste diatomaceous earth (D.E.), a natural powder made from ground up diato
Slugs & snails	Slugs may also be present when growing stevia at home. Hence, also get Sage, rosemary, parsley, and thyme are all beautiful additions to your ga deter snails. Plant them in a border around your garden and between vu ward of slugs and snails. It also means you get a beautiful, additional her your cooking!
Bugs	There are also many bugs feeding on stevia plants. You can get rid of the or insecticidal soap from the garden center.

Stevia Diseases

Disease	How to control it
Leaf spot	Leaf spot is a common problem on stevia plants. Hence, make sure to g on . Copper sprays can be used to control bacterial leaf spot, but they a when used alone on a continuous basis. Thus, combining these sprays v inducer, such as Regalia or Actigard, can provide good protection from
Rust	Rust may also be present when growing stevia. Thus, also get some tips of sulfur can prevent and treat rust fungus. Neem oil, a botanical fungic controls rust. Some organic gardeners swear by baking soda to control efficacy of baking soda spray might be enhanced by mixing it with light
Mold	• Mold may also do great damage to stevia plants. Fortunately, there are susceptible plants to improve airflow within the plant. • Maintain adequate spacing between plants and keep them far enough fences to ensure good air circulation and help reduce relative humidity • Locate plants in proper sunlight according to their needs. Maintain healthy plants by removing dead or diseased foliage. Disinfect pruners or shears after use on infected plants. (See Tool Care Because new growth tends to be more susceptible, be careful to not ov a rush of new foliage. Treat regularly with an organic fungicide that contains sulfur as the acti be used as a preventative measure as well as treatment for existing pov When shopping for plants, choose varieties with increased resistance t
Root rot	Root rot is another common issue when growing stevia. If you spot roo root parts and also slow down your watering schedule to get relief for y
Charcoal rot	Although rare, charcoal rot may also become an issue when growing st rot is present, you should just remove infested plants to avoid the spre your garden.
Blight	Blight may also become an issue when growing stevia at home. Hence, on .

	If you have had problems with bacterial blight, you may want to use a combinatior and mancozeb-containing fungicides for control. Apply fungicides two to three tim to 10 day intervals as leaves emerge, but before symptoms develop.
Mosaic virus	Mosaic virus may also infest stevia plants. Once plants are infested, there is no effe treatment and you should get rid of those infested plants as soon as possible to av further spread of mosaic virus in your garden.
Anthracnose	Anthracnose is a common fungal disease. You can get rid of it using fungicides from garden center.

PACHOULI

Diseases

Leaf Blight(Cercospora sp) Mostly when the plants are almost one year old brown spots are formed near the margin or at the apical region, which enlarge irregularly, coalesce, cover the entire lamina and create drying. It is, however, not of common occurrence and less serious as compared to root-knot. Control : The disease can be controlled with two sprays of Dithane Z-78 0.5%, at one-month interval. This, however, depends upon the severity of the disease.

Root rot disease of patchouli is caused by Fusarium solani

Theoretical learning Activity

1. **Trainees discuss on pests of high value added crops**
2. **Trainee brain on right ways to get rid of aphids in stevia plantation**

Practical learning Activity

Visit geranium plantation

Observe geranium showing symptoms tree in the plantation

Analyze the causal agents and determine the right ways of treatment

.

Points to Remember (Take home message)

• Description of Pest types for **macadamia, geranium, stevia, patchouli.** ✓ Insects ✓ Rodents ✓ Birds ✓ Animals ✓ Weeds ✓ Mites/termites
✓

• Indicative content 3.1.2 : Classes of Disease **of macadamia Geranium, Stevia,Patchouli**based on causal agents

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

- ✓ Fungal disease
- ✓ Bacteria disease
- ✓ Viruses disease
- ✓ Physiological disease

Theoretical learning Activity

- ✓ Trainees within group brainstorm on the 4 causal agents of diseases

Practical learning Activity

Points to Remember (Take home message)

Classless of diseases of high value added crops: Fungal disease

- ✓ Bacteria disease
- ✓ Viruses disease
- ✓ Physiological disease

Indicative content 3.1.3 Symptoms of disease based on causal agent

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Diseases
Category : Fungal

Anthracnose Colletotrichum gloeosporioides

Symptoms

Black lesions on leaves and fruit; soft black lesions on husks of nuts followed by decay of nuts on the ground; senescent mature nuts may remain attached to the tree; shells of infected husks may turn brown-gray in color but the kernel inside remains unaffected

Cause

Fungus

Comments

Disease emergence favors high humidity; fungus survives on plant debris; spores are spread by splashing water
Management
Avoid stressing trees by providing them with adequate irrigation and fertilization; prune out dead or dying limbs from tree canopy to reduce levels of disease inoculum; control insect pests to prevent stress to trees
Husk spot ***Pseudocercospora macadamiae***

Symptoms

Initial symptoms of the disease are chlorotic to yellow flecks on the husks which enlarge and develop tan brown centers; lesions coalesce and develop diffuse bright yellow halos; lesions

may be covered in powdery gray spore masses during periods of wet weather; lesions mature into tough, woody spots; circular tan spots may develop inside the husk but shells and kernels remain unaffected

Cause
Fungus

Comments
Yield losses may result in susceptible varieties due to nuts dropping from tree prematurely; spores are spread by water splash from infected husks; diseased husks may produce spores for up to 2 years following infection
Management
If variety of macadamia being grown is susceptible to the disease then an appropriate protective fungicide should be applied to the fruits when they are approximately the size of a match head; remove and old and diseased husks from the tree to reduce inoculum levels

Raceme blight ***Botrytis cinerea***
Symptoms
Small brown spots on flower petals which spread to racemes (flower stalks); infection may affect small flower buds, florets and rachis; racemes turning black and dying; entire raceme may become blighted within a few days; necrotic flowers remain on tree and become covered in fuzzy gray fungal growth

Cause
Fungus

Comments
Disease emergence favors wet weather and cool temperatures

Management
Fungicide application is not usually warranted unless infection occurs during wet weather which can cause severe infections

Slow and quick tree decline ***Xylaria arbuscula***

Macadamia tree infected with quick decline with healthy trees

Symptoms

Yellowing or browning of some leaves in the tree canopy; subtle change in color of tree canopy from dark to light green; entire tree turning brown; in final stages of disease, whole tree is brown and distinct from green trees around it; tree death may occur in a few months after initial symptoms have appeared

Cause

Fungl

Comments

Management

Remove any dead or diseased trees from the orchard; avoid wounding tree trunks

Category : Oomycete

Phytophthora trunk and stem canker ***Phytophthora cinnamomi***

Symptoms

Nursery trees and young plantations trees are stunted and chlorotic and may be partially defoliated; if lesions girdle the stem then the tree will die; in mature trees, dark discoloration of wood is visible by removing the bark from the trunk of the tree; dark cankers may extend from trunk at soil line to the lower branches of the tree

Cause

Oomycete
Comments
Fungus survives in plant debris in soil; spread by water splash
Management
Plant only disease-free nursery stock; plant trees in well-draining soils on a slight mound to promote drainage and prevent water-logging; avoid wounds to the trunk of the tree which allow fungi to enter; incorporate organic matter into the soil around the tree; apply appropriate protective fungicides to tree trunks prior to wet season;

GERANIUM

. These plants are valued for their deep green leaves and clusters of bright flowers. They are usually low-maintenance plants, but they can become infested with caterpillars, whiteflies, aphids and mites.

DISEASES OF SEEDLING GERANIUMS:

The primary diseases encountered on seedling geraniums are Damping-Off, Pythium Root Rot, Rhizoctonia Root and Crown Rot, and Botrytis Leaf Blight, Crown Rot, and Flower Blight. Symptoms and management strategies for most of these diseases are similar to those for stock plants and cuttings and will be covered in the next section. The exception is Damping-Off, a problem that is unique to the germination stage of seed-propagated plants.

A.Damping-Off:

CausalAgents: Pythium, Rhizoctonia,and Botrytis.

Symptoms:--Pre-Emergence: recognized as many random "skips" or empty areas in the plug trays or flats since the fungi attack and kill the developing seedlings before they emerge from the propagation mix.
--Post-Emergence: seedlings topple over and often have a noticeable brown to black lesion at the soil line since the fungi attack and girdle the seedlings after they emerge from the mix; under wet, humid conditions, a gray or off-white, webby growth can be seen on the infected seedlings.

Disease management

a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium;
b. use fresh seed;
c. maintain media (75-78°F or 24-25°C) and air (74-77°F or 22-24°C) temperatures to promote rapid and even germination;
d. avoid fungicides applied as soil drenches since seedling geraniums can be very sensitive.

FUNGAL DISEASES OF STOCK PLANTS AND CUTTINGS:

A. Pythium Root Rot or Blackleg

Causal Agent: *Pythium* spp.

Symptoms: Usually more serious on cuttings during propagation, but can occur on plants of any age; brown, water-soaked lesions develop at the base of cuttings or at wounds; they become coal-black and watery; plants collapse when girdled.

Disease Management:

a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium;
b. use disease-free cuttings;
c. avoid overwatering (disease is favored by high moisture and low oxygen levels);
d. rogue and remove symptomatic plants;
e. maintain good insect control, especially fungus gnats and shore flies
f. fungicides: among those registered for use are metalaxyl, mefonoxam, fosetyl-Al, etridiazole, and etridiazole plus thiophanate methyl; also registered is the biocontrol agent Trichoderma harzianum T-22.

B. Thielaviopsis Root Rot or Black Root Rot:

Causal Agent: *Thielaviopsis basicola.*

Symptoms: black, fairly dry lesions develop on the stem at or below the soil line on both cuttings and young plants; rooting of cuttings may not occur or may be delayed; leaves yellow, drop prematurely, and plants eventually collapse.

Disease Management

a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium (especially when geraniums follow poinsettias);
b. use disease-free cuttings;
c. avoid overwatering (disease is favored by high moisture and low oxygen levels);
d. rogue and remove symptomatic plants;
e. fungicides: among those registered for use are etridiazole plus thiophanate methyl, thiophanate methyl, and thiophanate methyl plus iprodione.

C. Botrytis Blight (Stem, Leaf, and Flower Blight)

Causal Agent: Botrytis cinerea.

Symptoms: (Symptoms can develop at any stage of production and on any plant part. Under conditions of high moisture and humidity, any infected plant tissues and debris can develop the diagnostic fuzzy, gray growth characteristic of this fungus.)
--Leaves: symptoms vary from discrete spots or lesions to large, dead areas, often with concentric rings; V-shaped lesions can also develop and can be confused with those associated with Bacterial Blight; lesions often occur when spent flower petals fall onto the leaves.
--Cuttings and Stems: symptoms appear at the base of cuttings as light- to dark-brown

lesions, which can result in complete basal rot; stubs on stock plants can develop brown lesions after cuttings are taken.

-Flowers: usually first evident as premature fading and drying of flowers; flowers turn brown and drop prematurely; during periods of high moisture and relative humidity, senescing flowers are covered with a gray, fuzzy mass.

Disease Management:

a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium;
b. use disease-free cuttings;
c. avoid overhead irrigation and water early in the day;
d. regulate relative humidity by venting and heating (HF);
e. use adequate plant spacing to promote good air circulation;
f. rogue and remove symptomatic plants and plant parts; remove spent flowers and senescing leaves (do not carry infected plant material through the house);
g. fungicides: among those registered for use are iprodione, thiophanate methyl, thiophanate methyl plus iprodione, mancozeb, chlorothalonil, fenhexamid, azoxystrobin, fludiononil, copper sulphate pentahydrate, and the biocontrol agent Trichoderma harzianum T-22.
For resistance management, avoid making more than two consecutive applications with the same fungicide or same class of fungicide.

D.Alternaria Leaf Spot:

Causal Agent: Alternaria alternata.

Symptoms: usually first evident on the lower leaf surface as small, raised, water-soaked areas; these spots quickly develop into brown, zonate, sunken spots; these can be confused with the spots associated with Bacterial Blight, but the Alternaria spots tend to be larger in size; additionally, under conditions of high humidity, dark-brown, fuzzy spore masses of the fungus cover the Alternaria spots.

Disease Management:

a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium;
b. use disease-free cuttings;
c. avoid overhead irrigation;
d. rogue and remove symptomatic plants;
e. fungicides: among those registered for use are iprodione, thiophanate methyl plus iprodione, mancozeb, chlorothalonil, thiophanate methyl plus chlorothalonil, azoxystrobin, and fludiononil.

E. Leaf Rust:

Causal Agent: *Puccinia pelargonii-zonalis*.

Symptoms:
small, yellow spots appear on the upper surface of the leaf and rust-colored pustules or circles develop in the spots on the underside of the leaf; pustules break open and release the rusty-colored spores for which this disease gets its name; when infection is severe, leaves yellow and drop prematurely; this disease is primarily a problem for zonal geraniums.

Disease Management:
a. practice good sanitation by using a clean house and equipment and a sterile, well-drained medium;
b. use disease-free cuttings;
c. avoid overhead irrigation and strong air currents;
d. rogue and remove symptomatic plants (BEFORE they sporulate, if possible);
e. fungicides: among those registered for use are triadimefon, mancozeb, thiophanate methyl plus mancozeb, chlorothalonil, oxycarboxin, azoxystrobin, and fenhexamid.

BACTERIAL DISEASES OF STOCK PLANTS AND CUTTINGS

A. ***Bacterial Blight*** *(Bacterial Leaf Spot, Stem Rot or Wilt):*

Causal Agent: Xanthomonas campestris pv. Pelargonii.

Symptoms:
Leaves: infected leaves typically develop two types of symptoms: small, discrete, water-soaked or brown spots and V- or pie-shaped, angular lesions; some leaves develop distinctly darkened veins and wilt at leaf margins.
Stems: when infection is systemic, the entire plant develops typical wilt symptoms, often first appearing in the lower leaves; leaves become flaccid and branches wilt and die back; stems can blacken and shrivel into a dry rot; infected cuttings fail to root and slowly rot from the base upward; stems become dull, black-brown and are drier than Pythium root rot; plants with systemic infection collapse and die; systemically-infected ivy geraniums do not wilt but develop symptoms that can be confused with nutritional or insect problems.

Disease Management:
1. Sanitation:
a. start with a clean house and equipment and a sterile, well-drained medium;
b. isolate stock plants from propagation area;
c. use disease-free cuttings;
d. keep geraniums from different suppliers separate;
e. separate seedling geraniums from cutting types;
f. avoid growing perennial geraniums (Geranium spp.) near Pelargonium spp.;
g. avoid placing ivies in hanging baskets above seedling or cutting geraniums;
h. use drip irrigation if possible (especially on stock plants);
i. rogue and remove symptomatic plants as soon as possible.
2. Education:
a. discuss the contagious nature of bacterial diseases;

b. require frequent hand-washing;
c. avoid unnecessary handling of plant material;
d. minimize traffic flow in house.
3. Chemical Control: among the compounds registered for use is copper sulphate pentahydrate.

B. Southern Bacterial Wilt:

Causal Agent: Ralstonia solanacearum (formerly called Pseudonomas solanacearum).

Symptoms: initial symptoms appear as a general wilting of lower leaves followed by yellowing and necrosis; V-shaped chlorotic or dead areas similar to those associated with Bacterial Blight can develop on flaccid leaves; a brown discoloration of the vascular system is sometimes visible; roots of infected plants are often brown or black; plants eventually collapse and die; no discrete leaf spots are associated with this disease.

Disease Management:
1. Sanitation:
a. start with a clean house and equipment and a sterile, well-drained medium;
b. isolate stock plants from propagation area;
c. use disease-free cuttings;
d. keep geraniums from different suppliers separate;
e. separate seedling geraniums from cutting types;
f. avoid placing ivies in hanging baskets above seedling or cutting geraniums
g. use drip irrigation if possible (especially on stock plants);
h. rogue and remove symptomatic plants as soon as possible.
2. Education:
a. discuss the contagious nature of bacterial diseases;
b. require frequent hand-washing;
c. avoid unnecessary handling of plant material;
d. minimize traffic flow in house.
3. Chemical Control: chemical control is not effective in preventing infection since this pathogen generally infects through natural openings or wounds in the roots.

STEVIA

Among diseases, leaf blight caused by Alternaria sp. and leaf spot caused by Septoria steviae are the most common and mainly occur during rainy season. These diseases reduce stevia leaf yield and quality. Sporadic occurrence of root rot (Sclerotium rolfsii) has also been observed during rainy season.

Stevia Diseases

Disease	How to control it
Leaf spot	Leaf spot is a common problem on stevia plants. Hence, make sure to get some information on . Copper sprays can be used to control bacterial leaf spot, but they as effective when used alone on a continuous basis. Thus, combining these sprays plant resistance inducer, such as Regalia or Actigard, can provide good protection f the disease.
Rust	Rust may also be present when growing stevia. Thus, also get some tips on . A wee dusting of sulfur can prevent and treat rust fungus. Neem oil, a botanical fungicide pesticide, also controls rust. Some organic gardeners swear by baking soda to cont garden fungus. The efficacy of baking soda spray might be enhanced by mixing it w light horticultural oil
Mold	• Mold may also do great damage to stevia plants. Fortunately, there are Thin out e susceptible plants to improve airflow within the plant. • Maintain adequate spacing between plants and keep them far enough away from v and fences to ensure good air circulation and help reduce relative humidity. • Locate plants in proper sunlight according to their needs. • Maintain healthy plants by removing dead or diseased foliage. • Disinfect pruners or shears after use on infected plants. (See Tool Care & Maintena • Because new growth tends to be more susceptible, be careful to not over-fertilize cause a rush of new foliage. • Treat regularly with an organic fungicide that contains sulfur as the active ingredie can be used as a preventative measure as well as treatment for existing powdery m • When shopping for plants, choose varieties with increased resistance to powdery m
Root rot	Root rot is another common issue when growing stevia. If you spot root rot, remov infested root parts and also slow down your watering schedule to get relief for you plants.
Charcoal rot	Although rare, charcoal rot may also become an issue when growing stevia. Once charcoal rot is present, you should just remove infested plants to avoid the spread disease in your garden.
Blight	Blight may also become an issue when growing stevia at home. Hence, also inform yourself on .

	If you have had problems with bacterial blight, you may want to use a combinatior copper and mancozeb-containing fungicides for control. Apply fungicides two to th times at seven to 10 day intervals as leaves emerge, but before symptoms develop
Mosaic virus	Mosaic virus may also infest stevia plants. Once plants are infested, there is no effe treatment and you should get rid of those infested plants as soon as possible to av further spread of mosaic virus in your garden.
Anthracnose	Anthracnose is a common fungal disease. You can get rid of it using fungicides from garden center.

PACHOULI

Diseases

Leaf Blight (Cercospora sp) Mostly when the plants are almost one year old brown spots are formed near the margin or at the apical region, which enlarge irregularly, coalesce, cover the entire lamina and create drying. It is, however, not of common occurrence and less serious as compared to root-knot. Control : The disease can be controlled with two sprays of Dithane Z-78 0.5%, at one-month interval. This, however, depends upon the severity of the disease.

Root rot disease of patchouli is caused by Fusarium solani

- ✓

Theoretical learning Activity

- ✓ Trainees within group discuss on the signs of any two fungal diseases of macadamia

Individual trainee give any two bacterial diseases of stevia

Practical learning Activity

- ✓ Trainees visits macadamia plantation and determine the causal agent of macadamia diseases

Points to Remember (Take home message)

Diseass management in high value added crop plantation:

Sanitation:
a. start with a clean house and equipment and a sterile, well-drained medium;
b. isolate stock plants from propagation area;
c. use disease-free cuttings;
d. keep geraniums from different suppliers separate;
e. separate seedling geraniums from cutting types;
f. avoid placing ivies in hanging baskets above seedling or cutting geraniums
g. use drip irrigation if possible (especially on stock plants);
h. rogue and remove symptomatic plants as soon as possible.
2. Education:
a. discuss the contagious nature of bacterial diseases;
b. require frequent hand-washing;
c. avoid unnecessary handling of plant material;
d. minimize traffic flow in house.
3. Chemical Control: chemical control is not effective in preventing infection since this pathogen generally infects through natural openings or wounds in the roots.

Learning outcome3.1 : formative assessment

Written assessment

1. answer by true or false
   a) Leaf spot is among diseases affecting geranium**?(false**)
   b) Slow and quick tree decline ***Xylaria arbuscula*** is a fungal macadamia disease(**true**)
2. Give any two bacterial diseases of high value added crop:
   Answer:
   - ✓ .Phythium Root Rot or Blackleg.
   - ✓ .Husk spot Pseudocercospora macadamiae
3. Identify the symptoms of ***Bacterial Blight***

   Answer:.

   Leaves:
   - ✓ **infected leaves** typically develop two types of symptoms: small, discrete, water-soaked or brown spots and V- or pie-shaped, angular lesions;
     some leaves develop distinctly darkened veins and wilt at leaf margins.
     Stems: when infection is systemic, the entire plant develops typical wilt symptoms, often first appearing in the lower leaves; leaves become flaccid and branches wilt and die back; stems can blacken and shrivel into a dry rot; infected cuttings fail to root and slowly rot from the base upward; stems become dull, black-brown and are drier than Pythium root rot; plants with systemic infection collapse and die; systemically-infected ivy geraniums do not wilt but develop symptoms that can be confused with nutritional or insect problems.

Practical assessment

1. **References:** Katinka W. and Lumpkin T. A, 2005. High value agricultural products in Asia and the Pacific for small-holder farmers: Trends, opportunities and research priorities. Workshop “How Can the
   Poor Benefit from the Growing Markets for High Value Agricultural Products” CIAT, Cali, Colombia

2. Dueñas M. C. and Maekawa T., 2010 Raising Farmer Incomes through High-Value Crops. Agriculture and Food Security, ADB-Knowledge Showcases, India

3. MINAGRI, 2017, National Agriculture Policy, Rwanda

Learning Outcome 3.2: Selection of method and technique for crop maintenance depending on type of crop

 **Duration:3HRS**

 **Learning outcome 2 objectives:**

By the end of the learning outcome, the trainees will be able to:

1. Describe correctly **high value added crops** maintenance practices
2. Differentiate correctly Pests and disease control techniques

 **Resources**

Equipment	Tools	Materials
Computer internet Computer Projector Video	Hoe Cutter Pruning saws	Book Flipchart s Sample delivery note - Watering can

Advance preparation:

.Tools and equipment selection based on of crop maintenance techniques

Cont 3.2.1 : Description of high value added cropsmaintenance practices

- **Gapping**: is done to fill the gaps by sowing of seeds or transplanting of seedlings in gap where early sown seed had not germinated. It is a simultaneous process. Normally, these are practiced a week after sowing to a maximum of 15 days. In dry land agriculture, gap filling is done first. Its practiced to maintain optimum plant population.
- **Mulching**: Mulching is one of the simplest and most beneficial practices you can use in the garden. Mulch is simply a protective layer of a material that is spread on top of the soil. Mulches conserve the soil moisture, enhance the nutrients status of soil, control the erosion losses, suppress the weeds in crop plants, and remove the residual effects of pesticides, fertilizers, and heavy metals. Mulches improve the aesthetic value of landscapes and economic value of crops.

- **Weeding and hoeing**

Weeding with a hoe includes agitating the surface of the soil or cutting foliage from roots, and clearing the soil of old roots and crop residues. Hoes for digging and moving soil are used to harvest root crops such as potatoes. It is an effective pre-harvesting method of crop protection and crop production management. Weeds act as competitors of the crop for various resources required for growth like nutrients, light, water, etc.

-Thinning of ornamental crops :

Thinning is a partial tree harvest in an immature stand to maintain or accelerate diameter growth of the remaining trees and, if done properly, can bring substantially higher revenues when trees are harvested at 25 to 40 or more years of age.

Thinning ensures growing plants have adequate space.

Some vegetables can be grown in small areas if they get enough other resources such as plentiful water and nutrients however there's always a limit. For example, root vegetable harvests will suffer tremendously without optimum space.

-Supporting of climbing ornamental crops : is a means of providing supports to ensure clean and unblemished fruits by keeping fruits off the ground, thereby increasing marketable yield

The most important reason for staking crops is to increase yield. Studies carry out in different locations shows that grow crops vertically increase yield three times than when they are allow to run on the ground.

-Watering/Irrigation

Irrigation is the artificial application of water to the soil through various systems of tubes, pumps, and sprays. Irrigation is usually used in areas where rainfall is irregular or dry times or drought is expected. There are many types of irrigation systems, in which water is supplied to the entire field uniformly. Irrigation helps to grow crops, maintain landscapes, and vegetate disturbed soils in dry areas and during times of below-average rainfall. In addition to these uses, irrigation is also employed to protect crops from frost, suppress weed growth in grain fields, and prevent soil consolidation.

-Fertilization

Fertilizers are additional substances supplied to the crops to increase their productivity. These are used by the farmers daily to increase the crop yield. These fertilisers contain essential nutrients required by the plants, including nitrogen, potassium, and phosphorus

Pruning of ornamental: pruning, in horticulture, the removal or reduction of parts of a plant, tree, or vine that are not requisite to growth or production, are no longer visually pleasing, or are injurious to the health or development of the plant. The Benefits of Pruning in Agriculture. Promote plant health – It removes dead and dying branches, allowing room for new growth and protecting property from damage. Also, it deters pest and animal infestation and also promotes the plant's natural shape and healthy growth.

Training: Training, the orienting of the plant in space, is achieved by techniques that direct the shape, size, and direction of plant growth. It may be accomplished by use of supports to which plants can be bent, twisted, or fastened.

Earthling up: Earthling up refers to the act of heaping soil around the root zone of the potato plant. It is one of the primary production practices that must be done to increase the potato yield.9 mars 2020 Soil stirring and earthling up are essential to break the soil hardpan formed by rain or irrigation, and it also helps in checking weed growth, conserving soil moisture, mixing applied manure thoroughly with the soil, enlargement of daughter rhizomes, and provides adequate aeration for root expansion

Pests and disease control techniques:

Pest and disease management consists of a range of activities that support each other. Most management practices are long-term activities that aim at preventing pests and diseases from affecting a crop. Management focuses on keeping existing pest populations and diseases low.

The following are different pest and disease control techniques

.**Physical control techniques**: Physical control refers to mechanical or hand controls where the pest is actually attacked and destroyed. Physical controls are used mostly in weed control. Tillage, fire, removal by hand, grazing and mowing is all used to destroy weeds and prevent reproduction.

.**Cultural control techniques**: Cultural control methods include properly selecting and rotating crops, sanitizing and solarizing the soil, choosing the best planting and harvest times, using resistant varieties and certified plants, taking advantage of allelopathy, and intercrop- ping.
.**Biological control techniques**: Biological control can be defined as the deliberate use of natural enemies - predators, parasites, pathogens, and competitors to suppress and maintain populations of a target pest species (insects, mites, weeds, plant pathogens, and other pest organisms)
.**Chemical control techniques** : Chemical control is the use of pesticides. In IPM, pesticides are used only when needed and in combination with other approaches for more effective, long-term control. Pesticides are selected and applied in a way that minimizes their possible harm to people, no target organisms, and the environment.

 **Theoretical learning Activity**

1. Trainees within group discuss on any 2 high value added crop maintenance techniques
2. Individual trainee brainstorm on Pests and disease control techniques

 **Practical learning Activity**

Trainee select tools and equipment he should use during fertilization of macadmia

 Points to Remember (Take home message)

high value added cropsmaintenance practices:

- ✓ Gapping
- ✓ Mulching
- ✓ Weeding and hoeing
- ✓ Thinning of ornamental crops
- ✓ Supporting of climbing ornemental crops
- ✓ Watering/Irrigation
- ✓ Fertilization
- ✓ Pruning of ornamental

- ✓ Training
- ✓ Earthing up
- ✓ Pests and disease control techniques
  - Physical control techniques
  - Cultural control techniques
  - Biological control techniques
  - Chemical control techniques

Learning outcome4.3 : formative assessment

Q1. Explain any four high value added crop maintenance techniques

2. Differentiate biological pests and diseases control technique in high value added crop plantation from chemical control

3. Crop maintenance aim at keeping high value added crop healthy in order to increase crop yield explain why mulching must be carried out for high value added crops

Q3. Differentiate pests and diseases biological control techniques from chemical control techniques

Practical assessment

References:

1 . Dueñas M. C. and Maekawa T., 2010 Raising Farmer Incomes through High-Value Crops. Agriculture and Food Security, ADB-Knowledge Showcases, India

2.MINAGRI, 2017, National Agriculture Policy, Rwanda

3.Kurt, M.; Van Thiet Ng. & Jansen D.M. 2004 Manual for Arabica cultivation, coffee. Hand book, Tan Lam Agricultural Product Joint Stock Company & PPP Project: Improvement of coffee quality and sustainability of coffee production, in Vietnam, Cam Lo, Quang tri, Vietnam

Learning Unit 4: Deliver high value added crop products

Learning outcomes:

1. Identify maturity signs according to type of crop
2. Apply harvesting methods and techniques according to the type
3. Handle produce according to type of crop and market requirements
4. Perform records keeping and Reporting referring on performed activities

Learning Outcome 4.1: Identify maturity signs according to type of crop

 **Duration:4HRS**

Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. . Identify the maturity signs of a crop
2. Differentiate physiological maturity from utility maturity
3. Explain the different maturity indices determination methods

Resources

Equipment	Tools	Materials
balance o Fruit crops field o Internet connection o Related books o Reports o Scientific paper	• Panga	Sacs o Basket Wheelbarrow o Buckets o balance o Fruit crops field

Advance preparation:

Photo showing signs of a mature high value added crop

Content 4.1.1 : Types of maturity

Maturity is the stage of fully development of tissue of fruit and vegetables only after which it will ripen normally. During the process of maturation the fruit receives a regular supply of food material from the plant.

There are two types of maturity:

✓ **Utility maturity**: is defined as the time when the plant is harvested for a given purpose before attaining or showing a physiological maturity stage. The harvested products may be used as fodder for animal or for soil improvement in case of vegetables.

✓ **Physiological maturity**: is defined as the time when dry matter accumulation in the kernel or seeds ceases, in other words the grain stop "filling".

Type of crop	**Maturity time**	**Maturity signs**
patchouli	Harvesting in Patchouli Farming:- The first crop is ready for harvesting 4 to 6 months after transplanting and subsequent cuttings can be taken after every 3-4 months. The ideal time for harvesting the Patchouli leaves is when the leaves turn to pale green or slightly brown.	It has to be harvested when the foliage becomes pale green to light brownish and when the stand emits characteristic patchouli odour, which could be easily smelt by a passer-by, especially in the morning hours.
macadamia	10 to 15 years It can take 10 to 15 years before a macadamia tree reaches maturity and maximum yield. Mature trees grow to heights of between 12 and 15 metres and have shiny dark green leaves.	.they reach about 1 inch in diameter. .Green husks begin to turn brown, shrink, and split. .Split husks show brown edges. .Brown shells are visible inside split husks. .Husks feel dry to the touch, not tacky. ."Self-harvesting" fruit begins to fall to the ground.

geranium	between 18-20 weeks Geranium seeds take between 18-20 weeks to mature and produce flowers. This is influenced by the time of year the seeds are sown, as well as light levels and temperature.	Geranium is harvested about 4 months after transplanting, when there is sparse flowering, leaves start turning light green and exhibit a change from lemon-like odour to that of rose.
stevia	about 40 days Stevia is ready to harvest about 40 days after transplanting. It is best just before flowers form. Stevia leaves are sweeter than the stem so usually only the leaves are used. They may be used fresh to flavor drinks or used as a garnish.	harvest the entire plant **once flower buds have appeared but before they've opened**. Ideally, harvest in the morning when the plant is at its highest sugar content. Also, be sure to harvest before many flowers (four to five buds) have opened.

Theoretical learning Activity

1. trainees within group of 4 discuss on maturity and differentiate the two types of maturity
2. trainees in classroom brainstorm on the maturity time of macadamia, stevia, patchouli and geranium

Practical learning Activity

- Visit a field of geranium located on your surrounding
- Observe geranium growth stage
- Determine the right time of geranium harvesting

.

Points to Remember (Take home message)

✓ Types of maturity which:
- are utility maturity
- physiological maturity

✓ Time and maturity signs of macadamia, stevia, geranium and patchouli crops

Indicative content : **4.1.2: Methods of maturity indices determination**

✓ **Visual methods**: By using our naked eyes, one can differentiate a mature vegetables species from a young one.

✓ **Physical methods**: By using signs of physical change, by measuring the relative humidity of the seeds and reduction of weight and dryness of the seed and its hardness by using our teeth.

✓ **Chemical methods**: By testing the accumulation of dry matter in laboratory or using relative reagents to test the accumulation of starch in the seed.

✓ **Physiological method**: By observing and using a physiological signs shown by a physiological mature vegetables.

✓ **Computation method**: By counting the period from sowing to a given date and compare it with the life cycle of the vegetables specie

 **Theoretical learning Activity**

- ✓ Trainees within group of four discuss on maturity indices determination

 **Practical learning Activity**

Trainee during field visit observes and determine any two signs reflecting crop maturity

 Points to Remember (Take home message)

Methods of maturity indices determination:

- Time (computation)
- Measurement
- Visual indices and quantitative
- Colour
- Size and shape
- Firmness of flesh
- Tenderness

- Chemical
- characteristics

Learning outcome4 : formative assessment

Written assessment

Q1. Explain the two type of maturity

Answer: there are two type of crop maturity which are uturity maturity and physiological maturity

Q2. Describe macadamia maturity

Answer: It can take 10 to 15 years before a macadamia tree reaches maturity and maximum yield. Mature trees grow to heights of between 12 and 15 metres and have shiny dark green leaves

Q3. Answer by true to the following statement

a. physical maturity indices determination involve taking produce sample in the laboratory for maturity testing**(false)**
b. visual maturity indices determination , the crop reflect signs of maturity which are identified with naked eye**(yes)**

Practical assessment

4. **References:** Katinka W. and Lumpkin T. A, 2005. High value agricultural products in Asia and the Pacific for small-holder farmers: Trends, opportunities and research priorities. Workshop "How Can the
   Poor Benefit from the Growing Markets for High Value Agricultural Products" CIAT, Cali, Colombia

5. Dueñas M. C. and Maekawa T., 2010 Raising Farmer Incomes through High-Value Crops. Agriculture and Food Security, ADB-Knowledge Showcases, India

6. MINAGRI, 2017, National Agriculture Policy, Rwanda

Learning Outcome 4.2: Apply harvesting methods and techniques according to the type

 **Duration:3HRS**

 **Learning outcome 2 objectives:**

By the end of the learning outcome, the trainees will be able to:

1. Describe correctly the two techniques of harvesting
2. Differentiate correctly the two methods of harvesting
3. Explain briefly the techniques of harvesting

 **Resources**

Equipment	Tools	Materials
✓ Internet connection ✓ Related books ✓ Reports ✓ Scientific paper	✓ Knives ✓ Hoe	✓ Macadamia, Geranium, ✓ Stevia and Patchouli field

		✓ Bags ✓ Wheelbarrow ✓ Ropes

Advance preparation:

.Harvesting tools and equipment selection based on harvesting method and technique

Content 4. 2. 1 : Harvesting techniques on Macadamia, Geranium, Stevia and Patchouli crops

There are two techniques of harvesting generally which are selective and non-selective techniques

- ✓ **Selective harvesting**: according to dictionary, selective harvesting is the practice of removing individual plants a small group of plants leaving, other plants standing to anchor the soil. In forestry, selective harvesting is a forestry practice of cutting some of the trees in area of land, while allowing others to grow. During selective harvesting, the farmer can harvest the best vegetables plant that shows good performance in production and good health that may be used for the next vegetables production. This practice can also be performed in agricultural research institutions when a new plant variety is being tested.
- ✓ **Non-selective harvesting**: This is the harvesting the all plant in the field without considering any trait. The best performance plants and the worst one are harvested mixed together.

Harvesting methods for Macadamia, Geranium, Stevia and Patchouli

Generally there are two harvesting methods such as, Manual harvesting and Mechanical harvesting

✓ **Manual harvesting**: The mature high value added plants are harvested by using manpower hands. It consists of uprooting mature plant, cutting mature plant above the soil and or picking dry pods while other parts of the plant are omitted in the field.

Mechanical harvesting: The mature plants are harvested by using specific harvesting machine or tractor

Theoretical learning Activity

1. Trainees within group discuss on high value harvesting techniques
2. Individual trainee brainstorm on harvesting methods of high value added crop

Practical learning Activity

Trainee harvesting tools and equipment based on harvesting methods and techniques

Points to Remember (Take home message)

Harvesting techniques aim at selecting suitable **harvesting technique** so as to avoid yield wastage during harvesting. Such techniques are:

- ✓ Selective harvesting
- ✓ Non-selective harvesting

Harvesting methods:

- ✓ Manual harvesting
- ✓ Mechanical harvesting

Content 4. 2. 2: Execution of harvesting of Macadamia, Geranium, Stevia and Patchouli

Harvesting technique of macadamia

Collect the nuts: Nuts usually fall to the ground when they are ready to eat and it's best to collect them up as soon as possible. If they haven't fallen by the end of Spring, you can pick the nuts from the tree. Remove the husks: Do this immediately. Husks can be mulched and used in the garden or composted

Harvesting techniques of geranium

They are harvested with a sharp sickle and taken up for distillation immediately. The use of sharp sickle is important since it minimizes damage to the crop while harvesting. Harvesting is done manually in sunny weather in the morning hours.

Harvesting techniques of stevia

Harvesting stevia is simple: pick leaves off of the plant as you need them, leaving the rest of the plant to continue growing. Picked leaves can then be prepared a number of ways as an alternative to artificial sweeteners, honey, or syrup: Use fresh leaves.

Harvesting technique s of patchouli

Basically **harvest the large leaves and spread them on a screen**. Be sure the leaves are well ventilated and not in direct sunlight. The leaves usually take 1-2 weeks to dry in these conditions. Once they are dry you can store them in a dry dark location or use in potpourri c recipes

Theoretical learning Activity

1. Trainees within group of 4 describe macadamia, geranium, stevia and patchouli harvesting techniques execution

Practical learning Activity

Trainee execute geranium harvesting technique

Points to Remember (Take home message)

Parts to harvest on macadamia and when to harvest:

Nuts usually fall to the ground when they are ready to eat and it's best to collect them up as soon as possible. If they haven't fallen by the end of Spring, you can pick the nuts from the tree.

Harvesting techniques of geranium

They are harvested with a sharp sickle and taken up for distillation immediately. The use of sharp sickle is important since it minimizes damage to the crop while harvesting. Harvesting is done manually in sunny weather in the morning hours.

Harvesting techniques of stevia

Harvesting stevia is simple: pick leaves off of the plant as you need them, leaving the rest of the plant to continue growing. Picked leaves can then be prepared a number of ways as an alternative to artificial sweeteners, honey, or syrup: Use fresh leaves.

Harvesting technique s of patchouli

Basically **harvest the large leaves and spread them on a screen**. Be sure the leaves are well ventilated and not in direct sunlight. The leaves usually take 1-2 weeks to dry in these conditions. Once they are dry you can store them in a dry dark location or use in potpourri c recipes

Learning outcome 4.2 : formative assessment

Q1. Give the two methods of harvesting high value added crops

Answer: there are two harvesting techniques which are

Selective harvesting technique

Non-selective harvesting

Q2. Describe stevia harvesting execution

Answer: Harvesting stevia is simple: pick leaves off of the plant as you need them, leaving the rest of the plant to continue growing. Picked leaves can then be prepared a number of ways as an alternative to artificial sweeteners, honey, or syrup: Use fresh leaves.

Q3. High value added crop harvesting techniques involve selective and non-selective techniques, explain why selective harvesting is more adopted over non-selective harvesting

Answer: in non- selective harvesting, diseased, dead, mature and immature plant parts are harvested in mixture resulting in yield and quality deterioration. It Is good to implement selective harvesting to avoid this damage

Q4. Answer by true or false

a) Non-selective harvesting is when a farmer harvest the best performer crop leaving the wrong performer to ensure produce quality **(false)**
b) Manual harvesting is when a farmer use specific machine or tractor to harvest mature crop **(false)**
c) Manual and mechanical harvesting are the two techniques of high value added crops harvesting **(false**)

References:

1. Kurt, M.; Van Thiet Ng. & Jansen D.M. 2004 Manual for Arabica cultivation, coffee. Hand book, Tan Lam Agricultural Product Joint Stock Company & PPP Project: Improvement of coffee quality and sustainability of coffee production, in Vietnam, Cam Lo, Quang tri, Vietnam

2. Wandahwa, P. & Van Ranst, E. 1996 Qualitative land suitability assessment for pyrethrum cultivation in west Kenya based upon computer-captured expert knowledge and GIS in Agriculture Ecosystems & environment 56 (1996) 187.

Learning Outcome 4.3: handle produce according to type of crop and market requirements

Duration:5HRS

Learning outcome 2 objectives:

By the end of the learning outcome, the trainees will be able to:

1) Describe the techniques of macadamia, stevia, patchouli and patchouli product handling
2) Clarify correctly the characteristic of a good package
3) Explain the characteristic of a good label

Resources

Equipment	Tools	Materials
✓ PPE ✓ Internet connection ✓ Related books ✓ Reports ✓ Scientific paper	✓ Winnower ✓ Stick	✓ Macadamia, Geranium, Stevia and patchouli crops field ✓ Bags ✓ Sheeting ✓ Hygrometer ✓ Sorting screen/sieve ✓ Pesticides ✓ Fumigants ✓ Internet connection ✓ Related books ✓ Reports ✓ Scientific paper ✓ Labels

Advance preparation:

Cleaning of storage and handling materials

Content 4. 3. 1 : Techniques of macadamia, Geranium, Stevia and patchouli products handling

Sorting: It is a practice of separating remains residues (with bad shape or broken) with crop products.

grading : Grading is done by using a grading machine that allows the products of the same size to heap together

Washing: it is necessary to wash them with water in order to remove the soil particles found from their outer layer.

drying : t consists of putting harvested products on the sunshine and allow them to dry

.Waxing: Fruit waxing is the process of covering fruits with artificial waxing material. Natural wax is removed first, usually by washing, followed by a coating of a Produce that is often waxed

A protective edible coat on fruit and vegetable which protect them from transpiration losses and reduce the rate of respiration is called 'waxing'

Theoretical learning Activity

1. Trainees within group of four describe high value added product handling techniques
2. Individual trainee brainstorm on product handling techniques

Practical learning Activity

Trainee select tools and equipment depending on product handling technique

Points to Remember (Take home message)

high value added crop product handling technique aim at maintaining quality of yield after harvesting resulting in yield quality including Washing, drying, Waxing, De-husking, Packaging

Content 4. 3. 2: Characteristic of good packages

A good package should fulfil the following characteristics ✓ Aesthetic ✓ Status ✓ Dependability ✓ Adaptability ✓ Security ✓ Not being too heavy

Theoretical learning Activity

1 .Trainees in classroom brainstorm on the characteristics of good package

Points to Remember (Take home message)

Characteristics of a good package which are

- ✓ Aesthetic
- ✓ Status
- ✓ Dependability
- ✓ Adaptability
- ✓ Security
- ✓ Not being too heavy

Content 4. 3. 3: Characteristic of label

A good label should be :

✓ Readable: Written with large characters that allow easy to read
✓ Visible: the label should large enough for easy to identify/to see by the consumers.
✓ Understandable: The words and the pictures should explain and give more information to consumers.
✓ Presentable: Colours and pictures used to demonstrate the product should attract the consumer

Theoretical learning Activity

1. Trainees in classroom brainstorm on the characteristic of label

Points to Remember (Take home message)

Characteristics of a good label

- ✓ Readable
- ✓ Visible
- ✓ Understandable
- ✓ Presentable

Learning outcome 4.3: formative assessment

Q1. Enumerate the 5 Techniques of macadamia, Geranium, Stevia and patchouli products handling

Answer: the 5 product handling techniques are

- ✓ Sorting
- ✓ Grading
- ✓ Washing
- ✓ Drying
- ✓ Waxing
- ✓ De-husking

Q3. Explain different characteristics of label

Answer: ✓ Readable: Written with large characters that allow easy to read

✓ Visible: the label should large enough for easy to identify/to see by the consumers.

✓ Understandable: The words and the pictures should explain and give more information to consumers.

✓ Presentable: Colours and pictures used to demonstrate the product should attract the consumer

3. Give the characteristic of a good packaging

References:

1. MINAGRI, 2017, National Agriculture Policy, Rwanda
2. Kurt, M.; Van Thiet Ng. & Jansen D.M. 2004 Manual for Arabica cultivation, coffee. Hand book, Tan Lam Agricultural Product Joint Stock Company & PPP Project: Improvement of coffee quality and sustainability of coffee production, in Vietnam, Cam Lo, Quang tri, Vietnam
3. Wandahwa, P. & Van Ranst, E. 1996 Qualitative land suitability assessment for pyrethrum cultivation in west Kenya based upon computer-captured expert knowledge and GIS in Agriculture Ecosystems & environment 56 (1996) 187.

Learning Outcome 4.4:

Duration:3HRS
Learning outcome 4 objectives: By the end of the learning outcome, the trainees will be able to: 1. Identify clearly record form content 2. Explain correctly methods of record keeping 3. Identify clearly report components 4. Clarify correctly importance of record keeping
Resources

Equipment	Tools	Materials
Projector Field notebook		Flip chart Records keeping forms Pens
 **Advance preparation: pen, notebook and computer are prepared**		

Content 4. 4. 1 : Content of record keeping form

Farm Recording involves farmers or members of the farm family keeping daily records. of:
- income and expenditure in cash and kind
- related records of physical activities and events covering land use, use of other.

Importance of farm records

1. Farm records are used to evaluate the performance of any farm or farm enterprise within a given period of time
2. Records are an aid to managerial control
3. farm record provide figure for farm planning and budgeting
4. Farm records tells a farmer how is being earning
5. farm records enable the farmer to obtain loans from banks and their financial institution 6. farm records tell a farmer where they are gaining progressively or loosing

Content of record keeping form which include Crop species

- ✓ Date
- ✓ Activity
- ✓ Site location
- ✓ Quantity and type of pesticide
- ✓ Quantity and type of fertilizer
- ✓ Unit/Designation
- ✓ Field size
- ✓ purpose of growing

Theoretical learning Activity

1. Trainees within group of four discuss on the importance of record keeping
2. Individual trainee brainstorm on record form content

Points to Remember (Take home message)

Record keeping aim at recording financial and product factor to ensure your business is running appropriately.

Importance record keeping:
1. Farm records are used to evaluate the performance of any farm or farm enterprise within a given period of time
2. Records are an aid to managerial control
3. farm record provide figure for farm planning and budgeting
4. Farm records tells a farmer how is being earning
5. farm records enable the farmer to obtain loans from banks and their financial institution 6. farm records tell a farmer where they are gaining progressively or loosing

Content of record form:

- ✓ Date
- ✓ Activity
- ✓ Site location
- ✓ Quantity and type of pesticide
- ✓ Quantity and type of fertilizer
- ✓ Unit/Designation
- ✓ Field size
- ✓ purpose of growing

Content 4. 4. 2: Methods of recording

They are 2 main methods of recording:

✓ **Written recording**: consists of using a pen to fulfil a record form. It is also known as hard copy recording.

✓ **Soft recording on computer**: consists of fulfilling a record form found in a computer by using keyboard or other part of a computer that can permit to enter data within it.

Theoretical learning Activity

Trainee brainstorm on method of record keeping

Points to Remember (Take home message)

Characteristics of a good package which are

- ✓ Aesthetic
- ✓ Status
- ✓ Dependability
- ✓ Adaptability
- ✓ Security
- ✓ Not being too heavy

Content 4. 3. 3: Characteristic of label

A good label should be :

✓ Readable: Written with large characters that allow easy to read
✓ Visible: the label should large enough for easy to identify/to see by the consumers.
✓ Understandable: The words and the pictures should explain and give more information to consumers.
✓ Presentable: Colours and pictures used to demonstrate the product should attract the consumer

Theoretical learning Activity

2. Trainees in classroom brainstorm on the characteristic of label

Points to Remember (Take home message)

Characteristics of a good label

- ✓ Readable
- ✓ Visible
- ✓ Understandable
- ✓ Presentable

Learning outcome 4.3: formative assessment

Q1. Enumerate the 5 Techniques of macadamia, Geranium, Stevia and patchouli products handling

Answer: the 5 product handling techniques are

- ✓ Sorting
- ✓ Grading
- ✓ Washing
- ✓ Drying
- ✓ Waxing
- ✓ De-husking

Q3. Explain different characteristics of label

Answer: ✓ Readable: Written with large characters that allow easy to read

✓ Visible: the label should large enough for easy to identify/to see by the consumers.

✓ Understandable: The words and the pictures should explain and give more information to consumers.

✓ Presentable: Colours and pictures used to demonstrate the product should attract the consumer

3. Give the characteristic of a good packaging

References:

4. MINAGRI, 2017, National Agriculture Policy, Rwanda
5. Kurt, M.; Van Thiet Ng. & Jansen D.M. 2004 Manual for Arabica cultivation, coffee. Hand book, Tan Lam Agricultural Product Joint Stock Company & PPP Project: Improvement of coffee quality and sustainability of coffee production, in Vietnam, Cam Lo, Quang tri, Vietnam
6. Wandahwa, P. & Van Ranst, E. 1996 Qualitative land suitability assessment for pyrethrum cultivation in west Kenya based upon computer-captured expert knowledge and GIS in Agriculture Ecosystems & environment 56 (1996) 187.