



## Ethiopian TVET-System



# Crop Production Level – II

**Based on Version 3 March 2018 OS.**

**Training Module – Learning Guide 50-53**

**Unit of Competence: - Apply Plant Propagation Techniques**

**Module Title: Applying Plant Propagation Techniques**

**TTLM Code: AGR CRP2 M12 0919v1**

**October 2019**



## **Module Title: Applying Plant Propagation Techniques**

**TTLM Code: AGR CRP2 M12 0919v1**

This module includes the following Learning Guides

### **LG 50 . Prepare parent material for propagation**

LG Code: AGR CRP2 M12 LO1-LG-50

### **LG 51. Prepare propagation materials**

LG Code: AGR CRP2 M12LO2-LG-51

### **LG 52. Undertake propagation methods**

LG Code: AGR CRP2 M12LO3-LG-52

### **LG 53. Complete propagation activities**

LG Code: AGR CRP2 M12LO4-LG-53

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<b>Instruction Sheet</b>	<b>Learning Guide #51</b>
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Preparing parent plants and employing methods of taking propagation materials
- Identifying tools and equipment's for propagation
- Following hygiene practices for tools and equipment
- Choosing and using appropriate tools and employing safe work practices

This guide will also assist you to attain the learning outcome stated in the cover page.

Specifically, upon completion of this Learning Guide, you will be able to –

- Parent plant is prepared and the method of taking propagation material suitable to the species is employed in accordance with organizational procedures.
- Tools and equipment's are identified for propagation
- Tools and equipment which are free from contamination and hygiene practices are followed in accordance with Organizational guidelines.
- Tools appropriate to the task being undertaken are chosen and used in accordance with organization guidelines, and safe working practices are employed.

### **Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4”.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 and Self-check 4” in **page -3, 5, 6 and 7** respectively.



<b>Information Sheet-1</b>	<b>Preparing parent plants and employing methods of taking propagation materials</b>
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Vegetative plant propagation is propagating plants (plant reproduction) from plant parts other than seed. Plants grown by vegetative propagation are reproduced asexually, and have only one parent. The genetic characteristics of the new plant will be identical to those of the parent plant, although responses to different environments can make them different in some ways.

On other hands, Plants grown from seed are the product of sexual reproduction and contain a mixture of genes from two parents. Sexual plant reproduction may result in offspring with unpredictable characteristics.

Asexual propagation is the best way to maintain an individual plant that best represents a species. Clones are identical to their one parent and can be propagated only asexually.

The plant selected as mother plant should have the following characteristics.

- Plants of good quality and high yielder
- High adaptability to local climate and soil conditions.
- Grow strong/vigorous healthy plants, which have desirable characteristics
- Free from diseases
- compatibility, timing,
- Disease and insect resistance, drought, tolerance, and hardiness.

### **Employ method suitable to the species**

All asexual propagation methods may not be suitable for all fruit crops so to propagate crops successfully suitable propagation methods should be selected for each crop. Mango and Avocado should be propagated by grafting.



<b>Self-Check 1</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What is plant propagation? 4 pts
2. Discuss the difference between sexual and asexual propagation. 6 pts
3. Explain the advantages and disadvantages of sexual and asexual propagation. 8 pts
4. List the characteristics of good mother plant. 6 pts

**Note: Satisfactory rating – 20 points and above      Unsatisfactory - below 24 points**

You can ask your teacher for the copy of your answer

Name: \_\_\_\_\_

Date: \_\_\_\_\_



### Choosing appropriate tools

Tools and equipments used for applying plant propagation are:-

- ❖ **Grafting knives**-This has to be a sharp knife, which should be sterilized before use
- ❖ **Grafting wax**-After the graft is made, some covering must be used to keep it drying out. Either hand wax or brush wax may be used.
- ❖ **Hand wax** is most commonly used for home grafting. It is softened by the heat of the hand and can be easily applied.
- ❖ **Grafting tape**-This is a special tape with a cloth backing that decomposes before girding can occur. Electrical and masking tapes are also used.
- ❖ **Budding strips**-Budding strips are elastic bands and look like a wide rubber band that has been cut open.
- ❖ **Nails**-Veneer and bridge grafts require long, thin nails. Half-inch nails are long enough for most grafts, except for bridge grafting, which may require  $\frac{3}{4}$  inches nails. These help to hold the graft in place.
- ❖ **Chain saw**- The chain saw is used to do top working of big trees.
- ❖ **Temporary shade**-This is used to prevent newly grafted scions from rain water and wind. This could be shade nets, or rafters or loose thatch. This is also to protect the grafted seedlings from intensive sunshine.
- ❖ **Budding Knife** – A razor sharp knife used to make cuts on the seedlings and to cut off the bud-eye. The knife must always be sharp and in a good working condition to prevent tissue damage to the plant when cutting through it. If tissue damage occurs, the graft will most likely fail.
- ❖ **Budding Tape** – Clear polyethylene strips, used to maximize contact between the bud and the rootstock until the union and the healing is complete. It also prevents drying and excess water from getting in and rotting the bud.
- ❖ **Pruning Shears** – Bud-wood is cut using pruning shears. Pruning shears are also used where cuttings are used for propagation.
- ❖ **Sharpening Stone** – All blades become blunt with use and require periodic sharpening. A sharpening stone, or wet stone, and honing oil are required.



- ❖ **Sterilization Liquid** – Knives and shears must be periodically cleaned and sterilized properly with a solution of 10% bleach.

<b>Self-Check 2</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List and discuss their function the tools and equipments uses for plant propagation. 10 pts
2. What is the function of budding knife during plant propagation? 6 pts

**Note: Satisfactory rating – 14 points and above      Unsatisfactory - below 16 points**

You can ask your teacher for the copy of your answer

Name: \_\_\_\_\_

Date: \_\_\_\_\_



<b>Information Sheet-3</b>	<b>Following hygiene practices for tools and equipment</b>
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Plant propagating tools and equipments should be free from of virus, insect, disease and other dangerous microorganisms. Infection grafting and budding union can cause difficulties with union.

For budding and cuttings, sterilization of pruning shears and budding knives ensures that the propagation material remains virus-free. Sterilization is accomplished by cleaning tools thoroughly with clean water and wiping the blades with a solution of 10% chlorine bleach

The solution should not be kept for more than five hours. A wetted cotton swab kept in a capsule is used to periodically treat propagation tools during nursery operations. Budding tools should be sterilized every time varieties are changed.

Because the bleach solution (Jik) is corrosive to most metals, sterilized tools must be rinsed in clean tap water, dried thoroughly and given a light coating of protective oil at the end of the day to prevent rust. A mixture consisting of 390ml clean tap water, 100ml clear vinegar, and 10ml oil provides long-term protection from rust.

<b>Self-Check 3</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Discuss hygiene practices of tools and equipments during plant propagation work? 6 pts
2. What is sterilization? 4 pts

**Note: Satisfactory rating – 8 points and above      Unsatisfactory - below 10 points**

You can ask your teacher for the copy of your answer

Name: \_\_\_\_\_

Date: \_\_\_\_\_





<b>Information Sheet-4</b>	<b>Choosing and using appropriate tools and employing safe work practices</b>
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Tools used for budding should always be clean and sharp. Waxing of the union helps to prevent infection and should be done quickly after grafting and budding.

Tools and equipments should appropriate and sharp.

- **Some of the equipments are** Grafting wax
- Sharp knives
- Tying and wrapping materials
- Nails
- Chain saw

<b>Self-Check 1</b>	<b>Written test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What is the impact of contamination of budding and grafting materials with dangerous micro organisms? 6 pts

**NOTE: Satisfactory rating – 6 points and above      Unsatisfactory - below 8 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_



<b>Instruction Sheet</b>	<b>Learning Guide #52</b>
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Selecting propagation materials
- Maintaining viability of materials by appropriate storage
- Disposing discarded materials
- Preparing stock
- Handling properly propagation materials and stock

This guide will also assist you to attain the learning outcome stated in the cover page.

Specifically, upon completion of this Learning Guide, you will be able to –

- Propagation materials are selected for propagation in accordance with organizational guidelines and supervisors instructions.
- Viability of materials is maintained by appropriate storage in accordance with the requirements of the species.
- Discarded material is disposed of in accordance with organizational waste disposal guidelines and/or procedures.
- Stock is prepared in accordance with species and organizational guidelines.
- Propagation materials and stock are handled in a way that prevents damage.

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4 and Sheet 5”.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 ,Self-check 4 and Self check 5” in page -11, 12, 13, 14 and 15 respectively.



<b>Information Sheet-1</b>	<b>Selecting propagation materials</b>
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### 1.1 Selecting propagation materials

Criteria for mother tree selection.

- Trees which had pure quality.
- High adaptability to local climate and soil condition.
- Grow strong (vigor growth).
- Pest and disease free.

#### Collecting Scion Wood

The success of any form of propagation depends on **the quality of the scion wood** to be grafted. Collect scion or bud wood **early in the day** while temperatures are cool and the plants are still fully turgid. The best vegetative buds usually come from the **current season's growth or dormant wood** that grew the previous year. Mature buds are most desirable; discard terminal and younger buds.

To keep buds from drying out, getting hot, or freezing (depending on the season), place the bud wood into plastic bags or wrap it in moist towels or burlap as you collect it. Place bud wood of only one variety in a labeled bag. Bud sticks that will not be used immediately should be bundled, labeled, and stored in moisture-retaining containers such as plastic bags or waxed cardboard boxes, which should be kept cool (32 to 45°F). The longer bud wood is stored, the less likely it is to "take."

Generally, bud wood stored for more than a few days should be discarded. In budding, the situation is somewhat different in that the "June bud" technique involves the use of previous season's terminal growth, whereas the dormant budding is made from non growing buds on the current season's growth.

The scions should be **wrapped in non perforated plastic** (a plastic bread wrapper is excellent) and placed in cold storage (30 to 40°F) or buried in moist sand or sawdust until ready for use. When making the graft, **remove an inch or two of the tip and basal portions of the scions** to eliminate wood that may have dried out. Another reason for discarding the tip and basal portions is that the tip portion is too small and the base too large for proper handling. Furthermore, neither portion will have properly matured buds.

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## 1.2 Select budding/grafting materials for propagation

Selected budding/grafting materials take from

- Actively growing portion at least one to two years of age
- Buds are collected from bud sticks which are small pieces of shoot of the same plant species, current season's shoot, and growing vigorously.
- Collect bud sticks that are in its vegetative stage not fruiting.
- The buds must be slender in shape and more pointed.
- Select the buds on the middle section of the bud stick because they are mature and ideal for budding.
- Grafting materials should be taken from middle part of branches
- Grafting and buds materials should be healthy

<b>Self-Check 1</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List the criteria to select mother plant for asexual plant propagation. 5 pts
2. How do we collect the scion? 5 pts

**NOTE: Satisfactory rating – 8 points and above      Unsatisfactory - below 10 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_



<b>Information Sheet-2</b>	<b>Maintaining viability of materials by appropriate storage</b>
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Bud stick should collect on the day where budding operation is to be done or Collected bud stick or grafting materials must be wrapped properly with waterproof paper to prevent desiccation.

**The viability of materials can be maintained by**

- **Appropriate storage**
- **Shade regulation**
- **Showering**
- **Wrapping**
- **Deeping in the solution**

<b>Self-Check 2</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List maintenance of viability of propagating materials. 8 pts

**NOTE: Satisfactory rating – 6 points and above      Unsatisfactory - below 8 points.**

2. You can ask you teacher for the copy of the correct answers.

Name: \_\_\_\_\_

Date: \_\_\_\_\_



<b>Information Sheet-3</b>	<b>Disposing discarded materials</b>
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### Disposing-off

- ✿ **Dropped leaves** that are collected when we are performing propagation activity.
- ✿ **Other vegetation** such as clippings, woody debris and dead plants and shrubs that are collected during grafting process.

### Recycling

Currently there are several options for recycling some of the waste materials described above. Leaf and other vegetative debris can be made into compost for use at propagation nursery.

<b>Self-Check 3</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Discuss the waste materials management. 6 pts
2. What is recycling of waste materials 4 pts

**NOTE: Satisfactory rating – 8 points      Unsatisfactory - below 10 points.**

1. You can ask you teacher for the copy of the correct answers.

Name: \_\_\_\_\_

Date: \_\_\_\_\_



<b>Information Sheet-4</b>	<b>Preparing stock</b>
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Young, vigorous fruit trees up to 5 years old are best for top working. Older apple and pear trees of almost any age can be top worked but the operation is more severe and those over 10 years old must be worked at a higher point. Hibernial, Columbia, or Virginia crab, because of their 3 vigor and their strong, well-placed branches, are very good under stocks.

Young trees should have 1 to 2 feet of branch between the trunk and the graft. Otherwise the good crotch formation of the under stock will be lost by the trunk expanding past the union.

Trees up to 5 years old can be grafted at one time. On older trees about half—the upper and center part only—should be worked at one time. The remainder should be worked a year later until spring.

### Preparing the Rootstock for budding

Rootstock can be grown in the field where it will be budded, or dormant liners can be transplanted into the field and then allowed to grow under moderate fertility until they reach the desired 3/16- to 7/16-inch caliper. Since budding is generally done less than 4 inches above the soil surface, leaves and side branches must be removed from this portion of the rootstock to create a clean, smooth working area. To avoid quickly dulling the knife, remove any soil from the rootstock where the cut will be made just before actual budding takes place. The stem can be cleaned by brushing or rubbing it gently by hand or with a piece of soft cloth.

<b>Self-Check 4</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Discuss hygiene practices of tools and equipments during plant propagation work? 6 pts
2. What is sterilization? 4 pts

**NOTE: Satisfactory rating – 6 points and above      Unsatisfactory - below 8 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_



<b>Information Sheet-5</b>	Handling properly propagation materials and stock
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All grafts should be covered with a protective coating immediately after completing the graft.

Electrician's tape is an excellent material that will bind and protect graft unions. Choose a brand that is elastic and amply adhesive. A good tape for the purpose will stick well to itself. Do not stretch this tape too tightly or it may crack or weather. Better brands will last throughout the first summer, after which the tape is no longer needed. Asphalt water emulsion is now widely used as a protective coating on graft unions. It is of pasty consistency and can be applied with a brush. It is preferable, however, to smear it on thicker with a small paddle.

<b>Self-Check 5</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Discuss handling properly propagation materials and stock. 10 pts

**Note: NOTE: Satisfactory rating – 6 points and above Unsatisfactory - below 8 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_





<b>Instruction Sheet</b>	<b>Learning Guide #53</b>
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Selecting propagation methods
- Undertaking grafting and budding
- Undertaking layering practices
- Undertaking cutting practices
- Correcting and applying labels and identifications
- Completing accurate records
- Identifying, rectifying and/reporting out of specification process and equipment performance

This guide will also assist you to attain the learning outcome stated in the cover page.

Specifically, upon completion of this Learning Guide, you will be able to –

- Propagation method is selected in accordance with species and organizational guidelines.
- Grafting and budding are undertaken according to instructions.
- Layering practices are undertaken
- Cutting practices are undertaken
- Labels and identification are correct and applied in accordance with organizational guidelines.
- Records are completed accurately and at the required time in accordance with organizational guidelines.
- Out-of-specification process and equipment performance is identified, rectified and/or reported

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 5.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4 Sheet 5, Sheet 6 and Sheet 7”.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3, Self-check 4, Self check 5, Self check 6 and Self check 7” in **page -18, 27, 28,29,30,31 and 32** respectively.



5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2, Operation Sheet 3, Operation 4 and Operation 5 ” in page - 33,33,33,34 and 34 respectively.

<b>Information Sheet-1</b>	<b>Selecting propagation methods</b>
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The **major methods of asexual propagation** are as follows:

- ✿ **Grafting** (joining a piece of shoot and dormant buds from one plant to a different rootstock)
- ✿ **Budding** (joining a bud from one plant to a different rootstock)
- ✿ **Cuttings** (rooting a severed piece of the parent plant)
- ✿ **Layering** (rooting a part of the parent and then severing it)
- ✿ **Offsets** (removing new shoots that form at a plant’s base)
- ✿ **Separation** (dividing bulbs or corms)
- ✿ **Division** (dividing rooted crowns)

<b>Self-Check 1</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Discuss the major methods of asexual plant propagation. 8 pts

**NOTE: Satisfactory rating – 6 points and above      Unsatisfactory - below 6 points.**

**1. You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_



## Information Sheet-2

## Undertaking grafting and budding

Grafting is the art of connecting two pieces of living tissue in such they unit and grow as one plant. These two living tissues are rootstock and scion. Grafting is a process by which a piece of scion is attached to a root-stock in such a way that the combination of both scion and root- stock come in firm contact, so that the new secondary tissue resulting from cambial cell division in the scion and root stocks is closely knitted or it is a technique by which two plants are joined together and eventually grow together to become one.

- Rootstock –is lower part of graft that will grow in to root system. It determines the vigor of the plant, resistance to root disease and pest.
- Scion-the upper part of the plant that will develop in to shoot. (It is either single or shoot with many buds. It determine the quality productivity and resistance pest and disease)

### 2.1 The purpose of grafting and budding

1. Perpetuating clones that are difficult to root from cutting.
2. Combining the benefit of stock and scion. some examples:
  - Disease resistance
  - Resistance to agro-climatic factor
  - Size and growth habits, e.g use of dwarf root stock(citrus on mandarins)
  - Fruiting characteristics-e.g sour orange rootstock causes of sweet orange to be smooth, thin-skinned and juicy, with excellent quality and storage characteristics.
3. Changing cultivars of established plants.
4. Repairing damaged tree

When the scion is grafted onto the rootstock, the **cambium** of the two must **touch**. The cambium is a layer of cells located between a **stem's xylem** and **phloem**. New xylem and phloem cells originate from cambial tissue.

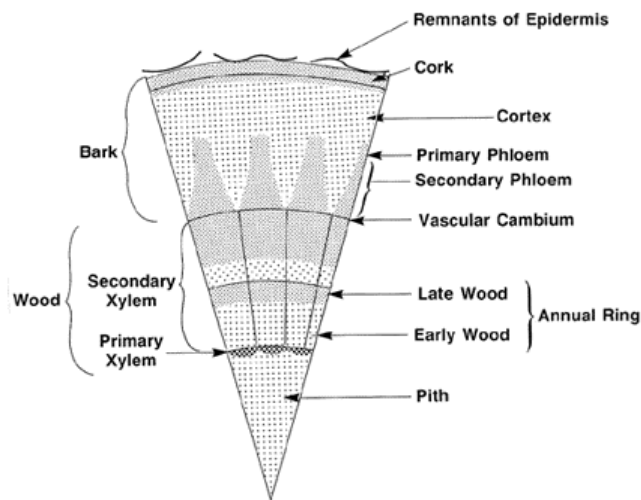


Figure 1.1 Cross section of a woody plant stem.

**Four conditions must be met for grafting to be successful:**

- The scion and rootstock must be **compatible**.
- Each must be at the proper **stage of development**.
- The cambial layers of the **scion** and **stock must meet**.
- The graft union must be **kept moist** until the wound heals.

Propagation	Propagation by		Typical examples
<b>Asexual (Vegetative)</b>	<b>Grafting</b>	Root grafting	Apple, pear
		Crown grafting	Persian walnut, camellia, grape
		Top grafting	Various fruit trees
	<b>Budding</b>	T-budding	Stone and pome fruit trees, rose
		Patch budding	Walnut, pecan
		Bench Grafting	
		Bridge and Inarch Grafts	

Table 1.1 Methods of grafting/budding plants, with typical examples

**Disadvantages of grafting**

1. Only closely related species grow together
2. Disease can transmit easily

## Techniques (Methods) of Grafting

### 1. Whip and tongue grafting (bench grafting)

- Is useful graft to use on young plants
- Often have high success rate because of cambial contact. Heal quickly and create strong union.
- It is better when scion and rootstock have the same diameter
- If the scion is smaller than the rootstock, scion should be placed one side making bark contact
- Scion should be dormant but rootstock can be either dormant or actively growing

#### Steps in whip grafting

- Along sloping cut 3-6cm long is made at the top of the stock and a matching cut at the base of the scion
- A second down ward cut is made in both the scion and the stock, starting 1/3 from the tip of the first cut
- The stock and the scion are joined with tongue interlocked and cambium layer matching
- The graft then tied in place with polyethylene tape

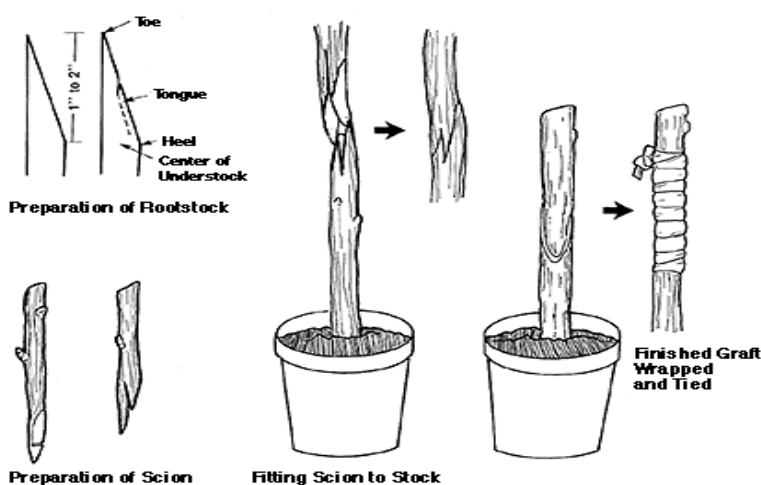


Fig.2 Whip and tongue grafting

### 2. Approach grafting



Approach grafting is technique used for difficult graft species because the scion is not cut from its root and the stock does not lose its leaves, therefore both the scion and rootstock continue photosynthesis and absorption process during the period of graft healing. It should be done when growth is active, as it will lead rapid healing.

### **Steps in approach grafting**

1. Remove a piece of bark 2-6cm long from both rootstock and scion
2. The two parts pressed tightly together and covered with grafting tape
3. After the graft is healed, the root from the scion and the Shoot from the stock cut-off.

### **3. Cleft grafting (Top Working)**

#### **Cleft grafting is very old and widely used method**

Often used for matured plants which are to be changed to different cultivars. Adapted to either trunk of small tree or branch of large tree about 2.5 -10 cm in diameter. Carry out during dormant season or may achieve by holding irrigation water for a long period of time.

#### **Steps in cleft grafting**

1. The stock is prepared by splitting the stub of a cut branch to a depth of 5-8cm
2. The scion is prepared by cutting the base into along tapering wedge
3. The sc ion inserted
4. The entire union including the tip of the scion is covered with grafting wax.

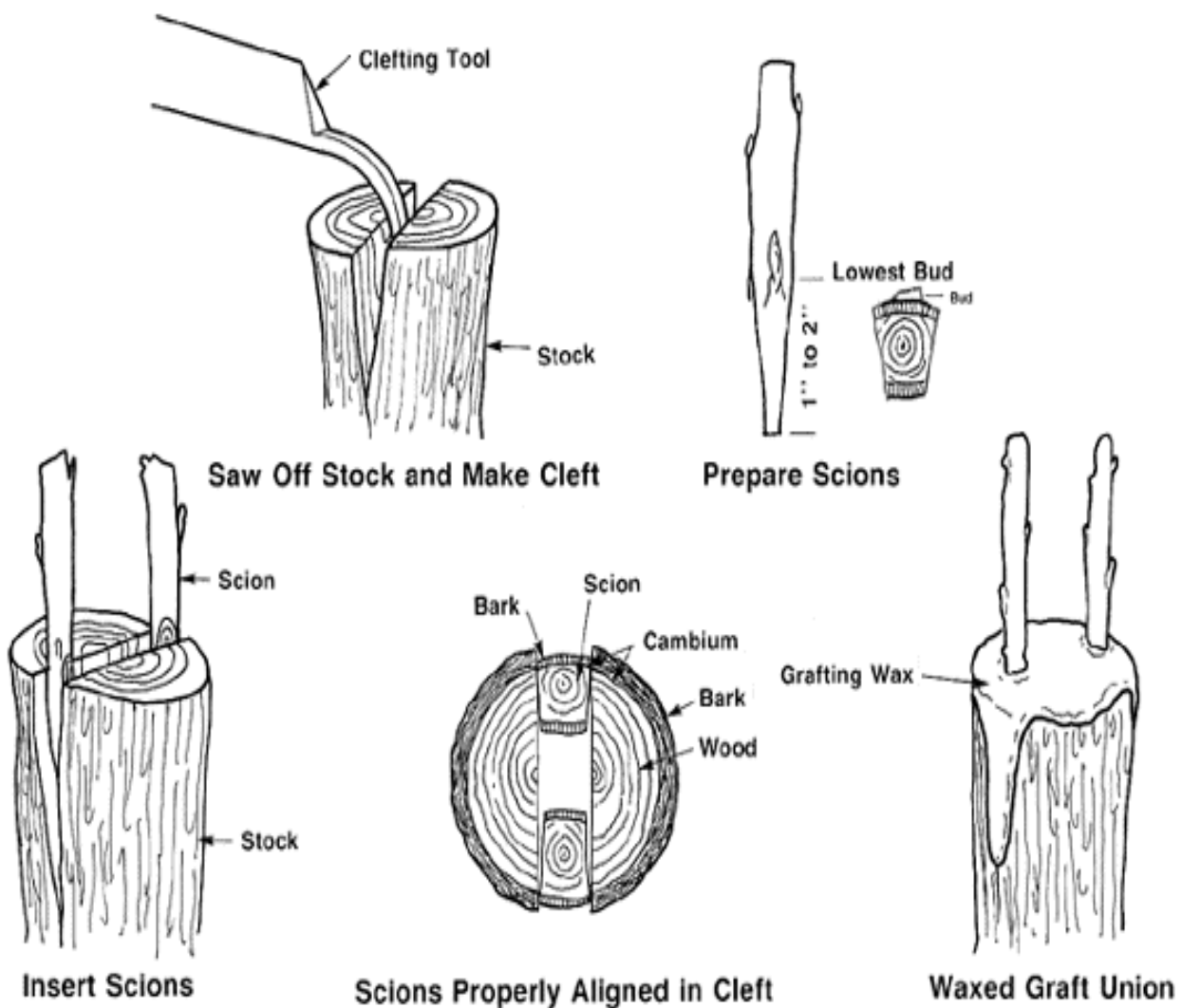


Fig.3 cleft grafting

#### 4. In-arch grafting

- It is similar to that of approach grafting differ in that the top of new root stock plant does not usually extended above the point of graft union as it does in approach grafting.
- A form of repair grafting used to repair tree with damaged roots. Spaced about 13-15cm from the base of the tree.
- Grafting done as active growth commences in early spring, when seedlings diameter at about 6-12mm wide.

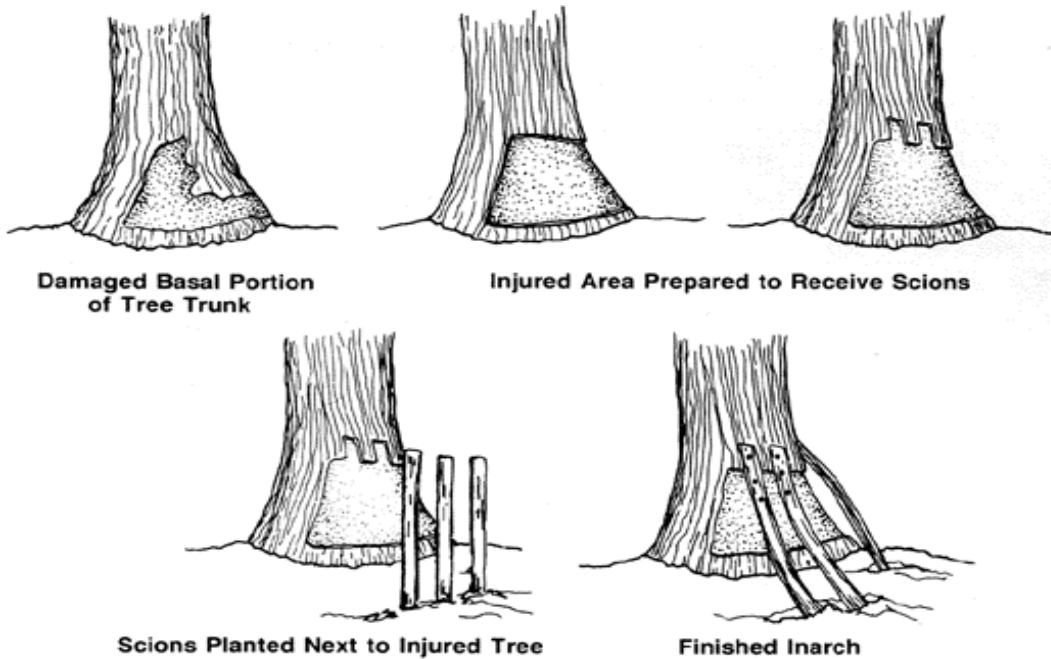


Fig.4 In-arch graft

## 2.2 Factors affecting healing of grafting union

Often grafting operation is not successful. The ability of plant to be grafted successfully termed as grafting compatibility.

### Symptoms of incompatibility include:

- Leaf yellowing and abscission
- Marked differences in the growth rate of stock and scion

The compatibility of graft/bud will be affected by:

1. The kind of plant :the scion and rootstock must be capable of uniting
2. Growth activities of stock plant: some grafting and budding depends on bark slipping which means the bark should be easily peel-off
3. Growth activity and quality of scion/bud wood materials the scion materials or bud wood is normally one year old or less. always current season growth for bud wood
4. Propagation method used: different method suited to different species. the best method should be selected
5. Cambial contact .the cambial regions of the scion must be placed in intimate contact with that of rootstock
5. Virus contamination, insect and disease infection of graft union can cause difficulties with union.





7. Equipment: proper tools and accessories should be used

### **Some Reasons Why a Graft Fails**

1. The scion and stock were incompatible; apple will not unite with plum, for example
2. The grafting was done at the wrong season.
3. The under stock was not healthy.
4. The scions were not vigorous.
5. The scions were dry or injured by cold temperatures.
6. The scions were not dormant.
7. The cambium of scion and stock were not meeting properly.
8. The scions were upside down.
9. The graft was improperly covered with grafting compound.
10. The scions were displaced by wind, birds or storms.
11. The graft was shaded too much after growth began.
12. New growth was damaged by aphids or other insects.
13. New growth was killed by fire blight.
14. The union girdled because the bindings or label were not released in time.

### **2.3 Budding**

**Budding** is a grafting technique in which a single bud from the desired scion is used rather than an entire scion containing many buds. Most budding is done just before or during the growing season.

Budding is another form of grafting where only the bud is used rather than a piece of scion with several buds. There are two types of budding: shield or T-budding and chip budding.



Budding is the adaptation of grafting where the scion consists of a single bud. Often fruit trees are budded rather than grafted.

Factors affecting the success of budding

1. Adverse growing conditions

- Lack of water
- Low temperature

2. Methods of budding used

3. The sharpness and cleanness of the knife blade

The budding process

- The bud is inserted high enough on the root stock so that there are several leaves below the bud ( e.g, about 30cm high for citrus)
- Three to four days after budding, the stock partially cut back to 9cm above the bud.
- Ten days to two weeks after budding, the stock is completely removed just above the bud.
- This forces the bud into active growth.

#### **2.4 Techniques of budding are:**

1. Shield or T-budding

2. Inverted T-budding

3. Chip budding

#### **Steps in T-budding**

a) A vertical cut about 3cm is made in the stock

b) A 2cm long horizontal cut is made at the top of the vertical cut

c) Remove the bud from the scion –beginning 1cm above the bud a slicing down ward cut is made to 2cm bellow the bud horizontal cut is made to remove the at the base.

d) The bud is inserted by pushing down ward

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- e) The bud union is tied with a water proof materials but the bud left Showing.
- f) After the bud healed, the top of the stock is cut off just above the bud

### **Inverted T-budding**

The steps in inverted T-bidding are almost the same with T-budding. The only differences in this case are the T-incision is made upside down. In the rainy location, water running down the stem of the root stock will interrupt the T-cut and disrupt the healing process. Inverted T-budding can avoid this problem. This method is widely used for citrus.

### **Steps in chip budding**

- a. A 45 degree angle down ward cut is made in scion just above the bud.
- b. A second cut is made going in ward until it meets the first cut and remove a chip of wood containing the bud.
- c. Identical cut is made on the stock the chip is inserted.
- d. The bud area is then wrapped with bud left exposed.

<b>Self-Check 2</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What is grafting? 4 pts
2. Discuss the purpose of grafting and budding. 5 pts
3. Explain the techniques of grafting? 6 pts
4. Define budding? 4 pts
5. Why grafting and budding fail? 4 pts
6. Discuss different techniques of budding? 5 pts

**NOTE: Satisfactory rating – 25 points and above      Unsatisfactory - below 28 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_



<b>Information Sheet-3</b>	<b>Undertaking layering practices</b>
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### **Layering**

A propagation method by which adventitious roots are caused to form on a stem while it is still attached to the parent plant is known as layering. The rooted, or layered, stem is detached to become a new plant growing on its own roots. It is a simple and effective means of propagation that can be practiced in the field. Conditions necessary for layering are quite similar to those necessary for rooting cuttings. The wood should be young, so that it will form adventitious roots easily. Root formation during layering is stimulated by various stem treatment, which cause an interruption in the downward translocation of organic materials (carbohydrates, auxins, and other growth factors) from the leaves and shoot tips. These materials accumulate near the point of treatment, and rooting occurs at the point of interruption.

#### **Advantages of layering**

- Effective means of propagation of species which do not root readily on cuttings.
- The parent plant supplies the new individual with water, food, etc.
- Easy to perform and does not require elaborate facilities.

#### **Limitations of layering**

- The propagation method is usually limited to plants which form growing points readily and the method does not facilitate the production of a large number of individuals in a relatively short time.

<b>Self-Check 3</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Define layering. 4 pts
2. Discuss the advantages layering. 5 pts
3. What is the limitation of layering? 6 pts

**NOTE: Satisfactory rating – 10 points and above      Unsatisfactory - below 15 points.**

**You can ask you teacher for the copy of the correct answers.**

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Name: \_\_\_\_\_

Date: \_\_\_\_\_

<b>Information Sheet-4</b>	<b>Undertaking cutting practices</b>
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Plants can be multiplied from pieces of shoot, root, and leaf and even from a callus. Shoot and root pieces that can develop into entire plants called cuttings.

Advantages of cutting

- Rapid and accurate.
- Increases stock of true to type.
- The operation is simple.

Factors influencing rooting of cutting:

- The stage of development and the age of growth.
- Type and location of stem.
- Favorable environmental condition /the time of the year.

Suitable temperature (21-27°C for most plants), sufficient humidity, rich rooting media.

<b>Self-Check 4</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Define cutting. 5 pts
2. List the advantages of cutting. 5 pts

**NOTE: Satisfactory rating – 8 points and above      Unsatisfactory - below 8 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_



<b>Information Sheet-5</b>	<b>Correcting and applying labels and identifications</b>
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Plants which are grafted and budded should be labeled and given with identification number to identify them from other plants which are not operated easily. This labeling and giving identification number helps to perform management activities.

Self-Check 5	Written Test
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Discuss the advantages of labeling propagated plants. 10 pts

**NOTE: Satisfactory rating – 8 points and above      Unsatisfactory - below 8 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_



Information Sheet-6	Completing accurate records
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### Propagation Records

Although propagation may begin with a particular plant using techniques from associates or references, eventually personal experience with specific material will enable the propagator to develop individual and unique techniques. These detailed modifications in procedures separate the average propagator from the really skilled propagator. Development of “individual tricks of the trade” depends on accurate records. Experience gained each season must be used for propagation decisions in subsequent years. A journal may be the easiest way to record procedures that work. Record all procedures as the actual work is being accomplished, rather than at the end of the day or week. Details are easily lost over even a short time. Information essential for a propagation procedural journal includes the following:-

1. Date propagation began.
2. Name of plant (common and scientific).
3. Source and type of propagating material.
4. Propagation medium used.
5. Hormones or growth regulators used including full chemical name and the rates of application
6. Environmental treatments applied.
7. Pesticide treatments applied.
8. Temperature and light conditions.
9. Misting settings in detail.
10. Date propagation completed.
11. Percent success or failure and reasons therefore.
12. Percent survival and vigor of plants after transplanting.

Self-Check 6	Written Test
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. List the all essential information to be recorded at activity of plant propagation. 15 pts

**NOTE: Satisfactory rating – 13 points and above      Unsatisfactory - below 13 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_



Information Sheet-7	Identifying, rectifying and/reporting out of specification process and equipment performance
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Materials and equipments used for grafting and budding should perform their own function properly. The non-functional tools and equipments should identify and reported before.

### **Taking Care of Grafted and Budded Plants**

Any shoots which grow below the graft on the rootstock should be removed, because they compete with the shoots of the scion. Recently grafted trees need a lot of water distributed on a regular basis.

In the first year after grafting, avoid the application of any fertilizer, manure or compost, because the tree will begin to grow fast prematurely, which will not allow the graft to heal properly.

Budded plants should be kept under cool conditions until the graft has joined in order to keep the bud from growing prematurely.

As soon as the growing season starts, cut off the rootstock above the plant with a sloping cut. This will help the bud to begin growing.

Rub off the buds on the rootstock below the grafted bud as these other buds will only provide unnecessary competition with the grafted bud. This activity should be done on a regular basis until the rootstock buds stop appearing.

Self-Check 7	Written Test
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Discuss the identification, rectification and reporting performance of propagation equipments. 10 pts
2. What are the cares to be given for propagated plants? 10 pts

**NOTE: Satisfactory rating – 18 points and above      Unsatisfactory - below 18 points.**

**You can ask you teacher for the copy of the correct answers.**





Operation Sheet 1	Undertake whip and tongue grafting
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### Procedures of whip and tongue grafting

**Step 1-** Along sloping cut 3-6cm long is made at the top of the and a matching cut at the base of the scion

**Step 2-** A second down ward cut is made in both the scion and the stock, starting 1/3 from the tip of the first cut

**Step 3-** The stock and the scion are joined with tongue interlocked and cambium layer matching

**Step 4-** The graft then tied in place with polyethylene tape.

Operation Sheet 2	Perform approach grafting
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### Procedures to perform approach grafting

**Step 1-** Remove a piece of bark 2-6cm long from both rootstock and scion

**Step 2.** The two parts pressed tightly together and covered with grafting tape

**Step 3.** After the graft is healed, the root from the scion and the Shoot from the stock cut-off.

Operation Sheet 3	Undertake cleft grafting
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### Procedures to undertake cleft grafting

**Step 1-** The stock is prepared by splitting the stub of a cut branch to a depth of 5-8cm

**Step 2.** The scion is prepared by cutting the base into along tapering wedge

**Step 3.** The scion inserted

**Step 4.** The entire union including the tip of the scion is covered with grafting wax.



Operation Sheet 4	Perform T-budding
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### Procedures of T-budding

**Step1.** A vertical cut about 3cm is made in the stock

**Step2.** A 2cm long horizontal cut is made at the top of the vertical cut

**Step3.** Remove the bud from the scion –beginning 1cm above the bud a slicing down ward cut is made to 2cm bellow the bud horizontal cut is made to remove the at the base.

**Step4.** The bud is inserted by pushing down ward

**Step5.** The bud union is tied with a water proof materials but the bud left showing.

**Step6.** After the bud healed, the top of the stock is cut off just above the bud

Operation Sheet 5	Undertake chip budding
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### Procedures to undertake chip budding

**Step 1-** A 45 degree angle down ward cut is made in scion just above the bud.

**Step2.** A second cut is made going in ward until it meets the first cut and remove a chip of wood containing the bud.

**Step3.** Identical cut is made on the stock the chip is inserted.

**Step4.** The bud area is then wrapped with bud left exposed.



<b>Instruction Sheet</b>	<b>Learning Guide #54</b>
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Cleaning equipments
- Disposing or storing unused propagation materials
- Collecting, treating, disposing and recycling waste generated by propagating
- Recording workplace information

This guide will also assist you to attain the learning outcome stated in the cover page.

Specifically, upon completion of this Learning Guide, you will be able to –

- Equipments are cleaned as required.
- Unused propagation material is disposed of/stored according to company procedures.
- Waste generated by both the propagation and cleaning procedures is collected, treated, disposed of or recycled according to company procedures.
- Workplace information is recorded in the appropriate format.

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described
3. Read the information written in the information “Sheet
4. Accomplish each “Self-check respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to the next



Information Sheet-1	Cleaning equipments
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After the end of each working day/season we have to dis-infect and after dis-infecting, since the dis-infecting chemical has a corrosive nature should be rinsed every working tools and equipment with clean water, then drying with a cotton cloth, after this we should lubricate with oily lubricant (grease), wrapped with polythene sheet/bag (plastic sheet/bag) and keep appropriately in the right storage place.

Self-Check 1	Written Test
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Discuss the importance of cleaning equipments during plant propagation activity. 8 pts

**NOTE: Satisfactory rating – 6 points and above      Unsatisfactory – below 6 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_



Information Sheet-2	Disposing or storing unused propagation materials
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After the end of each working day/season we have to dis-infect and after dis-infecting, since the dis-infecting chemical has a corrosive nature should be rinsed every working tools and equipment with clean water, then drying with a cotton cloth, after this we should lubricate with oily lubricant (grease), wrapped with polythen sheet/bag (plastic sheet/bag) and keep appropriately in the right storage place.

Self-Check 2	Written Test
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What is the importance of disposing or storing of waste materials during plant propagation activity? Discuss on it. 10 pts

**NOTE: Satisfactory rating – 8 points and above      Unsatisfactory – below 8 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_



Information Sheet-3	Collecting, treating, disposing and recycling waste generated by propagating
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### Disposing-off

- ✓ **Dropped leaves.**
- ✓ Clippings,
- ✓ Woody debris and dead plants and
- ✓ Shrubs that are collected during grafting process.

### Recycling

Currently there are several options for recycling some of the waste materials described above. Leaf and other vegetative debris can be made into compost for use at propagation nursery.

### Storing

We have to store all grafting materials after dis-infecting with chemicals and rinsing with clean water, dried and lubricated with lubricant oil (grease) to avoid corrosive.

<b>Self-Check 3</b>	<b>Written Test</b>
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What is a waste material? 5
2. Discuss the method of waste material management? 7 pts

**NOTE: Satisfactory rating – 10 points and above      Unsatisfactory - below 12 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_



Information Sheet-4	Recording workplace information
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- ✪ Source and identity of rootstock
- ✪ Source and identity of scion

Self-Check 4	Written Test
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Directions: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. Discuss the importance of recording workplace information. 10 pts

**NOTE: Satisfactory rating – 8 points and above      Unsatisfactory - below 8 points.**

**You can ask you teacher for the copy of the correct answers.**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

LAP Test	Practical Demonstration
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Name: \_\_\_\_\_ Date: \_\_\_\_\_

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within 10 hour.

**Task 1. Undertake whip and tongue grafting**

**Task 2. Perform approach grafting**

**Task 3. Undertake cleft grafting**

**Task4. Perform T-budding**

**Task 5. Undertake chip budding**



## List of Reference Materials

- 1- **BOOKS**
- 2- **WEB ADDRESSES (PUTTING LINKS)**