TVET CERTIFICATE III in Crop Production

Module Title: Nursery Establishment

Code

CRPNE302

Competence: Establish a nursery

Competence

Credits: 5 **Learning hours:** 50

Sector: Agriculture and food processing

Sub-sector: Crop production

Module Note Issue date: November, 2020

Purpose statement

This module describes the skills, knowledge and attitude required to install the nursery. It is designed for learners who have successfully completed 9 years basic education or its equivalent and pursuing TVET Certificate III in crop production or any other related qualifications. At the end of this module, learners will be able to Prepare for nursery establishment operations, carry out plant propagation in nursery and maintain the established nursery. Qualified learners deemed competent may work in various places including Site/field, Office, Nursery and Vegetable garden performing a range of tasks related to crop growing he can work alone or with others under supervision.

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Learning Unit 1 Prepare for nursery establishment operations

LO 1.1 – Interpret instructions provided by supervisor

- Content/Topic 1. **Interpret instructions provided by supervisor**

In nursery establishment, the interpretation of the instruction provided by the supervisor is a crucial stage to achieve the targeted result. Therefore, it is important to read careful and understand the given instruction on:

- ✓ Materials, tools and equipment
- ✓ Desired site characteristics
- ✓ Plants species, area, quantity of planting materials
- ✓ Quantity of seedlings to be produced
- ✓ Layout/design
- ✓ Medium/Substrate
- ✓ Calendar/schedule of activities
- ✓ Maintenance practices
- ✓ Consultation of instructions
- ✓ Taking care of instruction
- ✓ Seeking for clarifications

LO 1.2 – Select tool, material and equipment considering nursery activities

- Content/Topic 1. **Materials used in nursery operations**

Planting materials used in nursery establishment are varied according to their importance and their use to help to the plant to strive and to adopt to the environmental conditions of the nursery site. Those materials include:

✓ **Fertilizer**: These may be organic and inorganic fertilizers. The used fertilizers should provide to the plantlets the essential nutrients to help to the seedling to grow and resist to adverse conditions.

✓ **Pesticides:** These are chemicals used to kill and to repel different harmful insects and other pests that can damage the seedlings in the nursery. Pesticides also may be chemicals that can prevent and treat diseases found in the seedling bed like fungal diseases.

✓ **Potting materials:** These are any kind of container that can hold substratum in which a seedling is grown after pricking out. Potting materials may be made from clay, plastic, and metal.

✓ **Planting materials:** These are seeds and cuttings that are used in plant propagation.

- Content/Topic 2. Small farm tools and equipment used in nursery activities

✓ **Land clearing tools and equipment**

These are tools and equipment for cutting grasses, shrubs and trees trunks for further facilitating the next land preparation activities like first tillage. A variety of this tool is selected according to background of the field and its usefulness in land clearing operation**:** Some of tools are for example: machete, slasher, axe, sow chain, sickle, hand hoe and knapsack sprayer in case of chemical land clearing.

In intensive legume production, mechanical land clearing by using tractor can also be used.

✓ **First tillage tools and equipment**

These are tools used to uproot tree stump, tree roots by digging the cleared land up to 35cm deep. In this operation, manual or mechanical methods can be used according to the farmer financial means and soil structure and texture. Tools that are mostly used in manual method are hand hoe, forked hoe, axe, pick and pick axe. In mechanical method, traction animal and its equipment and tractor are used.

✓ **Second tillage tools and equipment**

Like in the first tillage**,** manual or mechanical methods can be used according to the farmer financial means, structure, and texture of the soil. The purpose of this operation is to softening the soil for easy sowing of seed and its germination. In manual method, we can use hand hoe, forked hoe. In mechanical method, traction animals and tractor are used.

In some area with big clod after second tillage, rake for loosening and levelling the ground is used before sowing seed.

✓ **Nursery maintenance tools and equipment**

These are tools for weeding, hoeing and pests and diseases control in seedbed or seedling bed.

Example: hand hoe, and knapsack sprayer,…

✓ **Pricking out tools and equipment**

These tools and equipment may be used to uproot seedling and to transport them from the nursry site to the field where they will be planted. These tools are for example: trowel for uprooting seedlings, dibber for pricking out, bucket with water for seedling transportation.

✓ **construction tools and equipment**

Here we can give example of nails, ropes, pole timbers, beams and slabs, nursery covers, hammer, … used to build and to strengthen the nursery bed shelter.

- Content /Topic 3.**Selection criteria of tools and equipment used in nursery activities**

✓ **Activity to be done:** The tools and equipment used in the nursery activities are selected according to different utility in nursery establishment. The tools and equipment may be for land clearing, for tillage, for fertizers application, for pesticides application, transplanting seedlings, for sowing seeds in seedbed, for pricking out seedling and for maintenance activities.

✓ **Nursery type:** The tools are selected differently according to durability or lifespan of the nursery. Therefore, the tools selected for permanent nursery and for temporary nursery are different.

✓ **Soil**: The tools are selected according to structure and structure of the soil. They may also be selected according to the plant or trees occupy the land previously to land clearing.

✓ **Climatic conditions**: The tools are selected accordingly for rainy, dry and windy climate.

LO 1.3 – Identify the site according to specific nursery requirements and enterprise plan.

- Content/Topic 1. **Factors to consider when selecting a site**

While selecting the site for nursery establishment the following factors should be taken into consideration:

- **Ecological factors**

These are **biotic** and **abiotic** factors around a nursery bed site.

Abiotic factors:

- ✓ **Soil type:** Soil must be arable loosen well drained, rich in organic matter and should respond well to fertilizer and manure. Sandy loam and/or loamy soils preferably with high humus content and pH between 5.5 and 6.5
- ✓ **Climate:** In order to minimize different watering activities, nursery should be established in wet climate. But when it is established in dry climate, the provision of permanent source of water is necessary.
- ✓ **Access to water:** The site must be located near water source to facilitate daily watering. The total amount of water a tree receives will affects its cropping and fruit quality.
- ✓ **Topography:** The ground must be flat less than 3%of slop and accessible to sunlight.
- ✓ **Direction of sunrise:** The nursery bed should be oriented at East-West direction.
- ✓ **Wind*:*** The nursery must not be exposed to the strong wind otherwise wind-breaks will be installed.
- ✓ **Air:** Plants like other living beings, need air to carry out respiration process, therefore, ample air should be provided for a nursery bed for better living and growth of the seedlings.

Biotic factors are all living beings around the nursery site that can affect the growth of seedlings like harmful insects, wild ruminants, roots of the plant that can shoot, wild birds that can eat sown seeds, soil microorganisms including those that can be disease causal agent like bacterial (soil borne diseases causal agents).

- **Economic factors**

  - ✓ **Land**: The availability of the land, its topography, its location and its soils structure and texture should be considered.

Facilities such as power and roads: The site must be located near the road to facilitate the transportation of nursery equipment and seedlings.

  - ✓ **Access to market**: The grown seedlings should met the requirements of consumers/farmers.
  - ✓ **Labo**r to contribute in different nursery bed maintenance activities.
  - ✓ **Expertise services** like agricultural research institutions and other agricultural extension services.

- **Nursery type**

The nurseryman may consider the period that a nursery should occupy the land either permanent or temporary.

LO 1.4 – Assess occupational health and safety (OHS) hazards and risks for reporting to the supervisor.

- Content/Topic 1.**Types of hazards associated with nursery establishment**

In farming activities there are different types of hazards that are related to tools, equipment, chemicals and environment hazards around farming area.

Those hazards may be found or in area, where in nursery establishment activities are performed. Therefore, hazards associated with nursery establishment are:

1. **Biological hazards**

These are hazards relative to animals, plants and microbes around or in the land being prepared for nursery establishment.

Hazards related to animal: Are hazards from stinging animals like bees, ants, termites and snake**.**

Hazards related to plant: Are hazards from venomous plants, plant with needle leaves, and thorny plant.

Hazards related to microbes : are hazards from microorganisms than penetrate our skin and cause different diseases such as endo and ectoparasitic diseases. eg. worms, protozoa…

2. **Chemical hazards:** are hazards from pesticides applied on seeds, pesticide application and fertilizers application.
3. **Physical hazards :include**

Tools and equipment-associated hazards: accidents from sharpened tools like hand hoe, machete and noise or vibration from farming machines that can harm the farmer's ears.

Environmental hazards: Hazards from other farms like bad smell, noise and vibration that can cause different health problems. They may be from accident due unidentified holes, stones and residues from previous economic activities.

- Content /Topic 2. **Hazards risks**
  - ✓ **Risks associated with Biological hazards** in nursery establishment:

Health problem: like diseases, painful on harmed part or injured, loss of some of part of the body like leg and arm, etc.

- ✓ **Risks associated with Physical hazards** in nursery establishment are Fire problem, hearing problem, heart problems…
- ✓ **Risks associated with Chemical hazards** in nursery establishment are blindness, self-intoxication, Air pollution that main source of diseases, and Destroying beneficial insects, soil microorganisms and fishes.

LO 1.5- Select suitable personal protective equipment according to desired operation

- Content/Topic 1. **Categories of PPE used in nursery establishment**

PPE: is used to prevent exposure to infectious materials. In other words, it acts as barrier to stop the spread of germs. Infectious materials can be air born in the form of droplets, or happen through contact routes.

The selection of appropriate PPE is based upon the hazard assessment. One can follow the following assessment steps:

- Identify the potential hazard
- Determine the types of protective equipment available for the present hazards
- Evaluate the effectiveness of PPE
- Select the appropriate protective equipment

Depends on the identified hazard, the selected PPE should fulfill some of or the following conditions on which **SAFETY** stands for.

S	The equipment should protect the head/**Skull**
A	The equipment should protect the **Arms**
F	The equipment should protect the **Face**
E	The equipment should protect the **Ears/Eyes**
T	The equipment should protect the **Toes**
Y	The equipment should protect **Yourself**

Types of PPE are:

1. **Eyes and face protection equipment:** they include

- **Face shields**: Covers the face with a clear plastic screen. They protect the face from infectious droplets and contact with contaminated materials. Without a face shields, germs can gain access through the mucous membrane like those in the mouth, eyes and nose.
- **Goggles and glasses**: protect the eyes from infectious droplets and in the same cases, from contact with infectious agents.

2. **Hand protection equipment**

Gloves: Cover the hands and wrists protecting the skin from contact and droplets exposure. Gloves are most widely used type of PPE.

3. **Body protection equipment**

- **Gowns**: Protect clothing and skin from droplets and contact with infectious materials. Some are placed over clothing and tied in the back, adequately covering the arms and torso and parts of the legs. Other are more like a long drape or suit that covers most of the body.
- **Head covers**: protects the spread of germs through droplets or contact routes. It can also prevent some accident injury like up down fall mass over the head.
- **Shoes covers/ Rain boats:** Prevent accident on the toes and feet

4. **Respiratory protection equipment:**

A face cover fitted with a finer filter that removes small particles than masks. Respirator are classified in number and letter. We have respirator with 95, 99 and 100. It means the percentages of particles that are removed by the filters are 95%, 99% and 100% respectively.

They are also classified as N, R and P as the ability to resist to oil. N respirator is not oil resistant; R respirator is more resistant to oil while P respirator is oil proof.

5. **Hearing protection equipment:** To protect the farmer from noise during farming activities where noisy machines are used

- Content/Topic 2. **PPE Selection criteria**

During selecting PPE, one should consider the following criteria:

- **Potential hazards/Working** environment : one have to assess the environment by identifying all available hazards
- **Compatible/Available PPE to the hazard** : one match PPE to the hazards
- **Level of protection/Effectiveness of PPE to the hazards**: Ability of PPE to protect the exposed person to varieties of infections.

- **Fitiness/Size to properly fit the user**: Not too small or not too large compared to the size of the user.
- **Use or Task to perform**: PPE used by a farmer during tillage activities is different from those used during pests and diseases control.
- **Durability of PPE**: Has long life span
- **Awareness of limitation/Frequency to be used**: It should be reusable after properly cleaning.
- **Cost of PPE**: Even though the PPE should protect the user, it should not be expensive

LO 1.6 Identify environmental implications of nursery establishment for discussion with supervisor

- Content/Topic 1.**Definition of environmental impact**

Environmental impact is defined as any change to the environment, whether adverse or beneficial, resulting from a facility's activities, product, or services. In other words it is the effect that people's action have on environment.

- Content/Topic 2 **.Types Impacts of nursery activities on the environment**

There two impact that may be caused by nursery establishment activities on the environment

❖ **Negative impacts**

- **Water pollution(Air pollution):** caused by intensive use of pesticides and fertilizers to increase legume production
- **Excessive drainage:** underground water sources are destroyed
- **Soil erosion** caused by disturbed soil structure and land clearing by cutting forests and bushes.
- **Loss of wild diversity** caused by destruction of wild biodiversity's shelters and food.
- **Loss of genetic diversity** caused by the use of fertilizers and pesticides that can kill and push away some animal species.

- **Outbreak and new pest diseases:** nursery establishment has led to destruction of repellent plants and food of insects. Lack of food for those insects makes them severe pests for other plants. In this, case they transmit unexpected diseases.

  - **Positive impact**
- **Contribution to afforestation** as main sources of forestry and agroforestry seedlings used in forest establishment and forest rehabilitation.

Learning Unit 2 – Carry out plant propagation in nursery

LO 2.1 – Prepare the site for nursery establishment

- Content/Topic 1. **Site clearing methods**

Site clearing methods:

Physical clearing (manual and mechanical): By using simple farm tools like machete, slasher, axe, sow chain, sickle, and hand hoe. It consists of using workers equipped with the above simple farm tools.

The land can also be cleared by using machines like tractors equipped with specific tools to cut trees, tree stumps, bushes and grasses

Chemical clearing: The land is cleared by using specific herbicides to the grasses or herbs to be remove on the land. It consists on spraying dissolved herbicide on the grasses.

- Content/Topic 2. **Tillage type**

Tillage is the mechanical manipulation of soil with tools and implements for obtaining conditions ideal for seed germination, seedling establishment and growth of crops.

There are two types of tillage in land preparation:

- **Primary tillage**

It consist of initial/first plowing in order to remove tree stumps, tree roots by digging the cleared land up to 35cm deep.

In this operation, manual or mechanical methods can be used according to the farmer financial means and soil structure and texture. Tools that are mostly used in manual method

are hand hoe, forked hoe, axe, pick and pick axe. In mechanical method, traction animal and its equipment and tractor are used.

- **Secondary tillage**

Deeper plowing where large clods are broken to give the fine soil structure. The purpose of this operation is to softening the soil for easy sowing of seed and its germination. In manual method, we can use hand hoe and or forked hoe. In mechanical method, traction animals and tractor are used.

In some area with big clod after second tillage, rake for loosening and levelling the ground is used before sowing seed

- Content /Topic 3.**Leveling**

It is done by using rate to remove the remaining small clods, stones and some weeds and to limit water stagnation by giving the site or the bed the same level.

- Content /Topic 4. Criteria for designing layout

✓ **Size of bed:** It varies from locality to locality. Generally beds are 1-1.2m wide but sometimes, they are even kept up to 1.8m wide locally. This depends on seed beds, either stand out beds for polypots or beds for raising stumps or bare-rooted plants. Length of the beds is not important, though 10 – 12m must be convenient.

✓ **Watering:** the space between two parallel seedbeds should allow watering activity. The width of the seedbed should also allow equal and easy distribution of water during watering. Reason why during seedbed layout design, watering activity should be taken into consideration.

✓ **Accessibility**: Service alleys among seedbeds should be designed in such way that they allow easy access to all designed seedbed in the nursery site.

✓ **Dimension:** if possible, the beds should be oriented from east to west to provide better shade against the mid-day sun and not more than 50m length. Seedbeds and stand-out beds should be provided with frames on which shade can be placed; whether this is needed for beds for stumps or transplants depending on the species being raised. There should be 50-60cm wide between beds and the surrounding fence. This means that on terraced land, the terraces should be at least 2m wide.

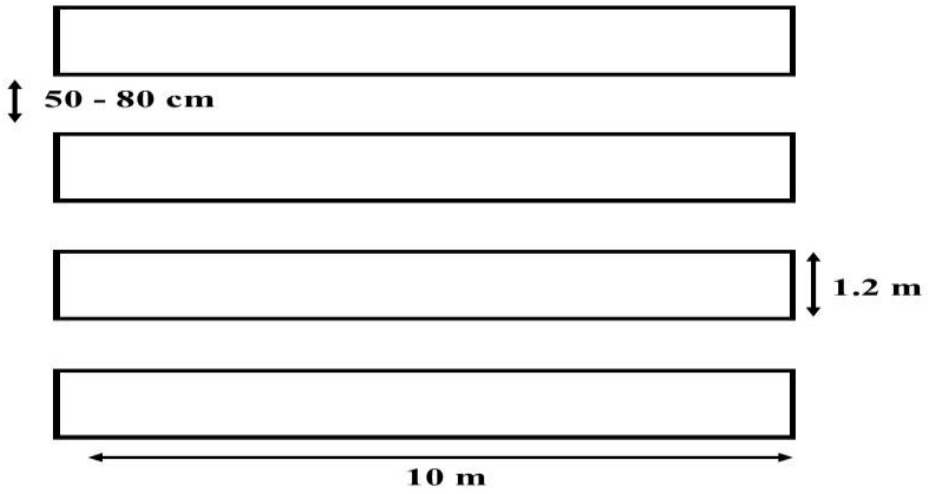


Figure 2: Seedbed layout

- Content/Topic 5. **Construction**

Selecting equipment

a. Pole timbers of 10-15cm of diameter

b. Sticks (Cross beams) of 5-7cm of diameter

c. Slabs for formwork (in the absence of slabs, pole timbers may be used for formwork)

 Pole size

a. Construction of a nursery starts with fixing 4 poles at each end to get a well-built nursery.

b. After fixing the 4 poles, we proceed with the establishment of cross beams.

c. Poles must be solid and have the following length:

Poles must be of 1.30m (30cm are in the ground) starting from the ground on the first end and1.25m (30cm are in the ground) on the second so that there is a small slope facilitating the rain water flow that can damage seedlings if stagnate on the roof.

 Seedling bed form work or coffring

Form work supports seedling bed and pots .Locally available materials namely stones burnt bricks, Bamboo, poles, slabs crowns etc.. can be used.

Those materials can be directly deposited well-straight on the ground or using small pickets to strengthen the formwork.

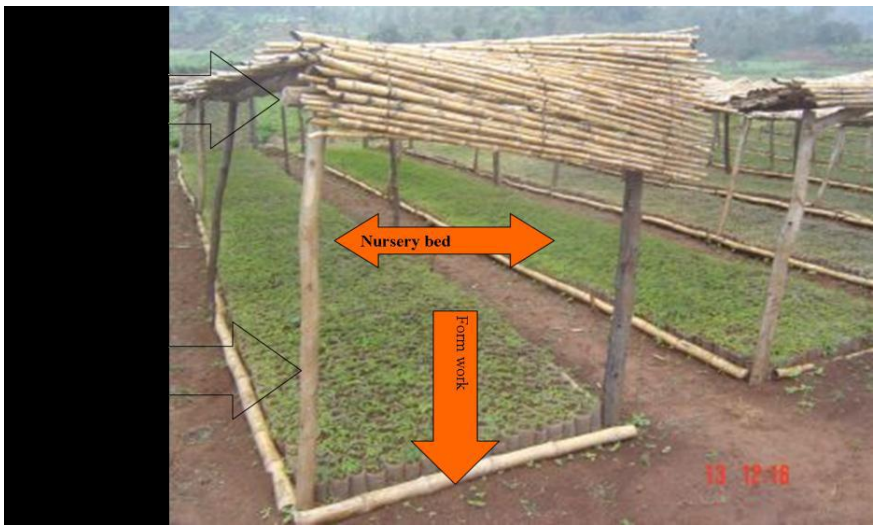


Figure 3: Nursery components with formwork

Source: http://www.kongo.l-h-l.org/Module_de_Formation

- **Roofing**

The individual shading method made in wood, under growth, reed of 1.4m wide is currently recommended as the best shading system.

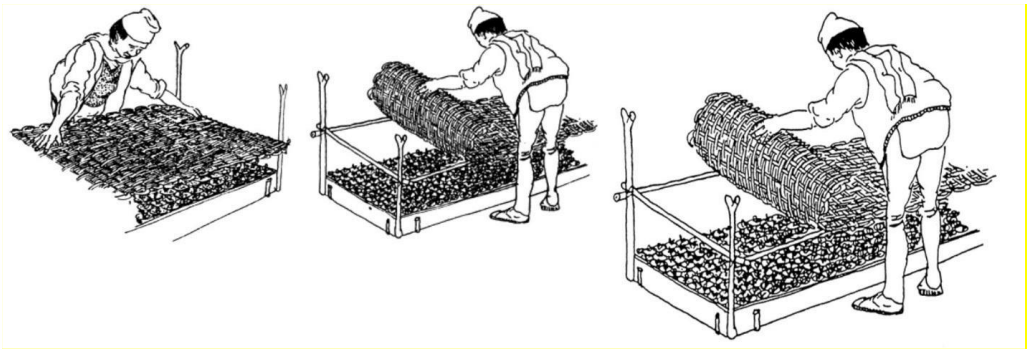


Figure 4: *Roofing. Source: http://www.fao.org/docrep)*

In tropical countries, seed beds should be aligned in a north-south direction and should be shaded to protect the sown seeds from direct sunlight and heavy rainfall. Black salon netting that allows 20-30 % light penetration should be erected above the seed beds at a height of 2 m

LO 2.2 – Carry out planting materials treatments following species requirements

- Content/Topic **2. Seed preparation**

✓ **Sorting of seeds:** Before seeds are put in the soil, they are sorted to remove all those are deformed, small or perforated.

✓ **Germination rate testing:**

The germination rate describes how many seeds of a particular plant species, variety or seed lot are likely to germinate over a given period. It is a measure of germination time course and is usually expressed as a percentage, e.g., an 85% .germination rate indicates that about 85 out of 100 seeds will probably germinate under proper conditions over the germination period given.

Germination test

✓ Obtain sample from the seed lot

✓ Count a known number from the sample

✓ Provide favorable conditions for germination or plant a known number of seeds and water them for some days.

✓ After few days count the number that has germinate

$$\text{Germination rate} = \frac{\text{number of germinated seed}}{\text{number of sown seeds}} X100$$

A high percentage of more than 80% indicate that the seeds are viable and suitable for planting while for a lower percentage, the seeds are of low viability and therefore not suitable for planting.

- Content/Topic 3. **Types of seeds pretreatments**

Pre-treatments of seed before sowing can be classified into the following categories: mechanical treatment, water treatment, dry heat treatment, chemical treatment, and electrical treatment.

- ✓ **Soaking in hot and cold water:** Seed dormancy can be overcome by covering the seed with boiling water, and then allowing it to soak for 24 hours as the water cools. This technique, which can be effective in enhancing imbibition and improving germination rates, is not useful for all plant species.
- ✓ **Fumigation:** Application of dry heat at 60°C to 80°C for 24 hours has been successful in increasing the imbibition and germination of seed. However, when exposed to temperatures of 90°C and higher for periods of three hours or more, the seeds can be seriously damaged
- ✓ **Seed priming:** Is a pre-sowing treatment which leads to a physiological state that enables seed to germinate more efficiently. The majority of seed treatments are based on seed imbibition allowing the seeds to go through the first reversible stage of germination but do not allow radical protrusion through the seed coat.
- ✓ **Seed coating:** Some time, seeds are coated with substances which protect them against fungal or insect attack. These substances can be hormones to activate the germination, to motivate the rooting, etc.
- ✓ **Pelleting:** is the process of adding inert materials to seeds increasing their weight, size and shape. ... If you're planting a crop that grows from small or irregularly shaped seeds, such as lettuce, carrots and onions, pelleting can help make planting significantly easier on you and your equipment.
- ✓ **Scarification:** Small numbers of seed can be effectively scarified by making a small scratch on each seed with sand paper, by cutting each seed with a knife. For large quantities of seed, mechanical scarification can be achieved by pounding the seeds with

sand. Both of these techniques are simple and inexpensive, and they have been found successful.

- ✓ **Stratification** n nature, seeds require certain conditions in order to germinate. Seed stratification is the process whereby seed dormancy is broken in order to promote this germination. In order for the stratification of seeds to be successful, it is necessary to mimic the exact conditions that they require when breaking dormancy in nature. Some seeds require a warm and moist treatment, while others require a cool and wet treatment. Even still, other seeds require a combination of both warm and cool treatments followed by a warm treatment, or a combination of warm and cool moist followed by a dry cycle and warm period to germinate. Therefore, knowing what seeds require to break dormancy is critical before beginning any seed stratification project.

Chemical treatment

Small samples of seed have been successfully scarified by immersion in absolute ethyl alcohol for 12 hours. For large seedlots, a concentrated (98 percent) sulfuric acid treatment is frequently recommended, if the soaking time in the acid is predetermined. Most commonly, soaking times vary from 15 to 30 minutes. The increase in germination due to treatment with sulfuric acid is generally attributed to a softening of the seed coat by oxidation, increasing the permeability of air and water through the seed coat. The seed must be meticulously rinsed several times in large quantities of water after soaking in the acid.

- ✓ **Light treatment**According to work done by Nelson et al. (1978), through the exposure of seed to various periods of radio-frequency (RF) dielectric heating by electromagnetic fields of 10 megahertz (MHz) and 39 MHz, germination rates were increased.
- ✓ **Vernalization:** is the artificial exposure of plants (or seeds) to low temperatures in order to stimulate flowering or to enhance seed production. By partially germinating the seed and then chilling it to 0° C (32° F) until spring, it is possible to cause winter wheat to produce a crop in the same year.

- Content/Topic 4. **Selection criteria of plants vegetative propagation parts**
  - ✓ **Vigor**: This is physical strength and good health.
  - ✓ **Health**: Without pests and diseases transmitted by the seed
  - ✓ **Size**: have required size and required nodes with lateral buds
  - ✓ **Variety characteristics**: fulfil the characteristics of required variety.

- Content/Topic 5.**Treatment of vegetative propagation materials**

✓ **Hormone treatments**

In some species root formation can be promoted by pretreatment with root setting hormones (RSH) before they are inserted in the rooting medium. There are three principal ways of application:

1. The chemical is mixed with talcum powder and the slightly moistured bases of the cuttings are dipped in the powder so that some powder will adhere.
2. The chemical is diluted in water to a concentration of ≈ 20–200 ppm (parts per million). The basal part of the cuttings are then soaked in the solution for about 24 hours.
3. The chemical is dissolved in 50% alcohol at a concentration of ≈ 500–10,000 ppm. The basal part of the cuttings are then dipped in the solution for 4–5 sec.

Root setting hormones can be made from a solution of the active chemical (e.g. indolebutyric acid (IBA) or naphthaleneacetic acid (NAA)) or it can be purchased from forestry or horticulture dealers under various commercial names such as IBA, Proportion, Seradix, Rootone, etc. For the specific use of these remedies reference is made to the individual instructions.

Certain precautions and tips when applying Root Setting Hormones are given below:

- Sometimes a fungicide can with preference be mixed with the RSH since it will save one work portion.
- RSH is best absorbed from a new cut surface. If the cuttings have been kept or stored for some length of time, a new fresh cut should be made.
- RSH will deteriorate with time. If a solution has been kept for a long time, its effectiveness should be checked before large scale use. Tomato leaves are sensitive to RSH and therefore good check plants. Treat some leaves with RSH and let them root together with some non-treated leaves.

- Concentration and length of time for absorption are critical. Some species will require only a brief treatment with low concentration whereas others may require a prolonged treatment with a more concentrated dilution.

✓ ***Disinfection***

Disinfection describes a process that eliminates many or all pathogenic microorganisms, except bacterial spores, on inanimate objects. In health-care settings, objects usually are disinfected by liquid chemicals or wet pasteurization. Each of the various factors that affect the efficacy of disinfection can nullify or limit the efficacy of the process. A few disinfectants will kill spores with prolonged exposure times (3–12 hours); these are called *chemical sterilants*. At similar concentrations but with shorter exposure periods (e.g., 20 minutes for 2% glutaraldehyde), these same disinfectants will kill all microorganisms except large numbers of bacterial spores; they are called *high-level disinfectants*. *Low-level disinfectants* can kill most vegetative bacteria, some fungi, and some viruses in a practical period of time (≤10 minutes). *Intermediate-level disinfectants* might be cidal for mycobacteria, vegetative bacteria, most viruses, and most fungi but do not necessarily kill bacterial spores. Germicides differ markedly, primarily in their antimicrobial spectrum and rapidity of action.

LO 2.3 – Prepare the substratum following requirements of species and media availability.

- Content/Topic 1. **Types of media**

✓ ***Soil***

The preparation of growing medium passes first through selecting the place where arable soil exists rich in organic matter and loose. (Under a tree or compost) if it is too clay, it is improved by the addition of sand and manure.

The proportions of the mixture vary from one soil type to another. The selection of the mixture depends on the soil texture.

Sandy soils: the growing medium mixture is1-0-1 that is to say one wheelbarrow of soil and one wheelbarrow of manure.

Loamy soils: the growing medium mixture is1-1-1 that is to say one wheelbarrow of soil, one wheelbarrow of sand and one wheelbarrow of manure.

Clay soils: the growing medium mixture is1-2-2 that is to say one wheelbarrow of soil, two wheelbarrow of sand and two wheelbarrow of manure.

✓ ***Soilless media:***

Liquid media: this is a solution with required nutrients for plant growth and development.

Solid media: Solid medium contains agar at a concentration of 1.5-2.0% or some other, mostly inert solidifying agent.Solid medium is useful for isolating bacteria or for determining the colony characteristics of the isolate.

- Content/Topic 2 **Media sterilization**

✓ **Steam sterilization:** Steam Sterilization Process. Steam sterilization is achieved by exposing the items to be sterilized with saturated steam under pressure. Steam enhances the ability of heat to kill microorganisms by reducing the time and temperature required to denature or coagulate proteins in the microorganisms.

✓ **Hot water sterilization:** Boiling water kills the germs in the water, and it also can kill germs on surfaces of items submerged in the boiling water. Using moist heat is an excellent method of sterilization, which is why boiling baby bottles for five minutes is a recommended practice to sterilize the them.

✓ **Solarization:** Soil solarization is an environmentally friendly method of using the sun's power to control pests such as bacteria, insects, and weeds in the soil. The process involves covering the ground with a tarp, usually a transparent polyethylene cover, to trap solar energy.

- Content /Topic 3. **Mycorrhization**

It literally means fungus-root, and describes the mutualistic association existing between a group of soil fungi and higher plants. The association is based on the plant component providing carbohydrates and other essential organic compounds to the fungi. In return, the fungal component, which colonizes both the root and the adjacent soil, helps the plant take up nutrients by extending the reach of its root system.

Species of Mycorrhiza

The following are the species which are currently used

- ✓ *Laccaria laccata*
- ✓ *Amanita muscaria*
- ✓ *Piloderma croceum*
- ✓ *Pisolithus tinctorius*
- ✓ *P. tinctorius*

Figure 7: Mycorrhiza (source: www.dragonfli.co.uk)

LO 2.4 Plant in nursery depending on species and enterprise plan

- Content/Topic 1.Methods of sowing

Direct: During direct sowing, Careful control of water, light and nutrients is required during germination and during the first weeks of seedling growth. Directly sowing the seeds in the container saves time, labor and money, because the extra step of preparing a seed bed and transplanting is eliminated.

This method simplifies tending and cost associated with transplanting.

Even if it takes a little longer to plant small seed directly in the containers or if they have to be moved and re-sown, this is easier and cheaper than pricking out. Direct sowing allows undisturbed seedling growth and thus reduces stress for the seedling. In a well-managed

nursery, seedlings can usually be directly sown. But by using this method, irregular seedling striking occurs and risk of having empty spaces in the nursery unless you do filling up. It should be easier to disseminate and has high adoption rate

When you are direct sowing, follow these good nursery practices:

Use only fresh and ripe seed

Pre-treat seed, if necessary, to speed up germination

Prepare containers and shade in advance

Mix small seed with sand or rice hulls, or use a bottle with a screen top (like a salt shaker, but larger), to make dispersing it easier.

Test seed for viability before sowing. If less than 70% germinate, plant more than one seed per bag. Throw away any extra seedlings in each pot. This is a small price to pay to avoid root deformities. This method is recommended for seedling difficult to transplant such as:

- ✓ *Maesopsis emini*
- ✓ *Avocado*
- ✓ *Podocarpus*
- ✓ *Pentadesma*
- ✓ *Calliandra*
- ✓ *Leucaena diversifolia and*
- ✓ *Leucaene trichandra.*

Indirect: It consists of raising seeds in seedbed and later prick out them in nursery bed.

Depending on the conditions in your nursery, including the tree species, number of plants produced, and labor availability, a combination of direct sowing and use of seed beds may be your best way of operating.

The use of seed beds is not recommended simply in order to ensure every container has a seedling.

Seed beds can be used:

 To select seedlings of uniform size and development for transplanting. Only plants of the same age should be compared when judging plant quality. When seed germination is highly erratic, seedlings should be transplanted in groups of the same age. Seedlings should be pricked out in groups of even ages so that later they will not be compared with plants of a different age class.

 When seed is old, or when the germination is low or unknown. Use a seed bed to test seed viability (as described above) before filling too many containers and wasting resources.

 If seed does not store well (that is, if it is 'recalcitrant').

 If containers are not available, or not filled in time to use. Seed beds can be used until the containers are ready.

This method permits to select only healthy seedlings. While pricking out and permits to achieve optimum plant population but high cost associated with tending and transplanting.

- Content/Topic 2**. Types of seedbed**

✓ **Sunken bed:** Sunken beds are deep pockets of improved soil, and have a long tradition in drylands. In southwest North America, Zuni Native Americans traditionally used very small rectangular beds bordered with clay berms for growing crops such as melons, herbs, chilis and onions. These gardens, near the main villages and surrounded with juniper stick fences, were watered by hand from larger containers using small dippers.

In drylands and during dry seasons, sinking the beds is better than raising them for several reasons:

 They are easier to water efficiently by flood irrigation.

 The berms give the moist soil and young seedlings and transplants some protection from drying winds and sun.

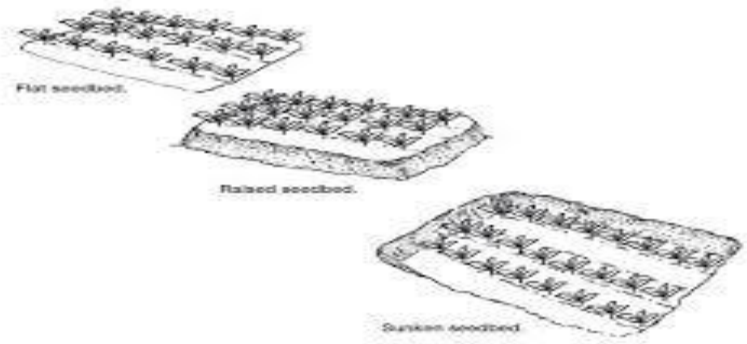
 Young plants can easily be protected by laying palm fronds or other material across the beds

 When wet season rains are intense, the garden is not eroded and water is not wasted, since it is captured by the beds.

steps of making sunken bed:

1. Prepare a compost
2. Prepare wooden forms to fit the bed
3. Mark out the ground with string
4. Remove all the weeds from the area and add to compost pile
5. Dig out the top soil and save this one side
6. Dig down a further 30cm into the subsoil , ensure that bottom is levelled

- ✓ **Raised bed:** Raised beds are most commonly used in humid regions where they can improve drainage in areas where the soil may be seasonally flooded or waterlogged. Like sunken beds they also function to increase the depth of improved soil. However, under hot, dry conditions raised beds are difficult to water deeply. Raised beds also expose a lot of surface area which heats up soil temperatures, and from which moisture evaporates, leading to salt buildup in the growing area.



✓ Flat or tray method

- Content /Topic 3 .**Types of sowing**

✓ **Broadcasting**

This is a method of planting where by seed are scattered in prepared garden by use of hand or machines and later with light soil.

Advantages:

- It is quicker than other method
- It is less tiresome
- It requires less labor
- It does not required skilled labor

Disadvantages*:*

- A high seed rate is used
- It is difficult to control plant population
- It is difficult to estimate yield
- It becomes difficult to carry out agronomic practices such as weeding and spraying
- High competition for nutrients
- Easy spread of pests and diseases

Figure 5: Sowing by broadcasting

Source: http://www.sunset.com/garden/garden-basics/sowing-seeds

- ✓ **Seed drilling or line sowing:** Seed drill also called line sowing this is when seed are sown in line at regular interval. It is the dropping of seeds into the soil.

Advantages*:*

- ✓ Seeds are placed at proper & uniform depths
- ✓ Along the rows, interculturing can be done
- ✓ Uniform row to row spacing is maintained
- ✓ Seed requirement is less than 'broad casting
- ✓ Sowing is done at proper moisture level
- ✓ A low seed rate is realised
- ✓ It is easy to estimate plant population
- ✓ It is easy to carry out agronomic practices
- ✓ Less competitions among seedlings

Disadvantages*:*

- ✓ Require implement for sowing
- ✓ Plant to plant (Intra row) spacing is not maintained
- ✓ Skilled person is required for sowing
- ✓ It is rather a tiresome method

- ✓ It requires a lot of labor

Figure 6: Linesowing (during and after sowing)

Source: http://www.yourgardeninginfo.com/how-to-plant-seeds

- Content /Topic 4. Container/ A nursery pots

A nursery pots or plant pot is a container in which flowers and other plants are cultivated and displayed. .

Types of pot

Containers are manufactured in a variety of shapes and sizes and are constructed from many different materials. These include plastic, paper, aluminum, fabrics, wood, and peat. There are often holes in the bottom, to allow excess water to flow out, sometimes to a saucer that is placed under the nursery pot.

- ❖ **Pot filling**

During filling, the soil should firmly pack in order that pots or bags not to be broken in the middle or have cracks.

The bags must be filled to the brim to avoid empty space during watering that can impede the water and air flow.

- ❖ **Arrangement techniques**

Pots or bags must be arranged on the line in the direction of the length and width of the seedling bed this facilitate pots or bags counting in the seedling bed.

Before putting in place those pots or bags, the seedlings bed must be properly leveled for homogenization of the pot height.

The nurseryman ensures that the water is distributed equally all over the pots.

Figure 10: pots arrangement on line (source: http://www.totallandcare.org)

- **Mixture proportion**

The proportions of the mixture vary from one soil type to another. The selection of the mixture depends on the soil texture:

Clayey soil: the growing medium mixture is 1-2-2 that is to say one wheelbarrow of soil, two wheelbarrow of sand and two wheelbarrow of manure.

Loamy soil: the growing medium mixture is 1-1-1 that is to say one wheelbarrow of soil, one wheelbarrow of sand and one wheelbarrow of manure.

Sandy soil: the growing medium mixture is 1-0-1 that is to say one wheelbarrow of soil and one wheelbarrow of manure.

- Content /Topic 5. **Post planting immediate care**

✓ **Mulching**

The objectives of mulching is to maintain adequate soil moisture for the overwintering process and keeping soil temperatures cool to prevent early germination.

In addition to modifying the physical soil environment, mulches can have an effect on the biological components in the soil system. Mulches can reduce the germination and emergence of undesirable plant species – better known as weeds.

Mulching Materials:

a) Seedless grasses like Eragrostis, Vetiver, Temeda,

b) Dried banana leaves

c) Crop residues of any kind

✓ **Shading**

Construct a shade to protect the seedlings from direct sunlight for two to three weeks after pricking-out. Use locally available materials such as grass, mats, or banana fibers for shade construction

Shading of the transplant beds may be beneficial when the weather is hot, and in any case immediately after transplanting. Any shade must be reduced slowly, because the shaded seedling would suffer if exposed suddenly to direct sunlight. During the rainy season shading should be used with care because of the danger of damping off.

✓ **Watering**

For homogeneous and fast emergence, moisture is an important factor. Daily watering ensures that constant moisture to seeds facilitate their emergence. Proper watering is critical to plant's health. Regular watering will also help to insure maximum flowering and proper growth.

LO 2.5 Keep record as required by the supervisor

- Content/Topic 1. **Importance of nursery records keeping**

Keeping records is the backbone of managing one's agribusiness. Efficient management a farming operation requires that records be maintained to enable the farmers to make informed decision affecting their profits.

There are 2 main types of records that a farmer must keep:

- Financial records
- Production records

Financial records concern the financial dealings of the farm. These records shows farmer income and expenditures. eg. Produce sales, operating expenses, equipment purchases, depreciation records,…

Production records includes things such as crop yields, plant population, quantity of inputs used and loss through death.

Importance of farm records

1. Farm records are used to evaluate the performance of any farm or farm entreprise 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 earned
5. Farm records enable the farmer to obtain loans from banks and their financial institution farm records tell a farmer where they are gaining progressively or loosing.

- Content /Topic 2. **Content of record keeping form**

The contents of record keeping form are:

- ✓ **Date**: this record should indicates date at which each seedling maintenance activities was carried out. It should also indicates sowing time. If there any abnormal cases, its case should be reported and its proper date.
- ✓ **Species:** This is the indication of planted species and its variety.
- ✓ **Nursery size:** It indicates dimensions (length and width) of the seedbed or seedling bed.
- ✓ **Nursery location:** It should contains local administrative entities in which nursery is and the distance from the main road.
- ✓ **Activity**: It indicates the activity carried out at N day (**N** varies from **1,2,3,4**,…..**n**)
- ✓ **Designation:** This is the purpose of a carried out activity for the achievement of a good nursery production.

Quantity: It indicates the quantity of sown seeds and quantity of seedling for seedling bed.

- Content /Topic 2. Methods of record keeping

They are 2 main methods of recording:

- ✓ **Written recording:** consists of using a pen to fulfill 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.

Learning Unit 3 – Maintain the established nursery

LO 3.1 Perform cultural practices

- Content/Topic 1. Cultural practices in nursery

  - ➢ **Pricking out**: This is the process of transferring young and tender seedlings from seedbeds into containers (pots). Pricking out should be carried out when the seedlings reach a height of 2 cm. This is usually about two weeks after sowing but depends on the species.

The pricking process:

• Water the seedbed and containers properly before commencing the operation

• Ensure adequate shade is available

• Take an empty container and fill with water to ¾ levels.

• Hold the leaves of the seedlings and insert a pencil thick stick (dibble) underneath the root system to loosen the soil.

Figure 11: Pricking out (Source: http://www.fao.org/docrep)

• Pull out the seedlings gently and immediately put them in the container with water. Note that if the roots of the seedlings are kept under sunshine they lose water and may die.

• Make a hole at the center of the pot using a stick.

• If the roots are too long clip off the tip.

• Do not hold the stem of the seedling because they are tender and feeble this may injure the seedlings.

• Hold the stick in the tilting position and insert it in the soil about one centimeter away from the seedling to the same depth as the hole.

• Push the soil towards the seedling to hold it tightly. This ensures that all the air pockets around the roots are closed.

• Using your fingers cover the hole you made.

• Water the containers properly once more after planting. Seedlings pricked out from same batch of the seedbed should be arranged in the same place.

- **Fencing**

Construct a fence around the nursery bed to protect it from livestock and wild animals browse or graze on seedlings. Fencing can offset this.

It can prevent stealing or intentional damaging of seedlings by human beings. Fencing and security are such options to overcome this.

- **Weedin**g

Weeds are a threat to healthy seedlings development. They compete with seedlings for nutrients, water and light hence they must be controlled. With your hands or a dibble gently pullout unwanted growth (rouging) this should be done whenever weeds are observed. Remove all the weeds around the beds with a hoe and don't leave any rubbish around unless you are sure that this can be converted to compost.

- **Watering**

The regular supply of clean water is essential to plant growth. Plants are made out of more than 90% water. When grown in containers, nursery plants have only a limited volume of substrate and do not have the ability of mature trees to search for water from below the soil surface.

The amount of water seedlings require depends on upon:

- ***Seedling age***. More water is required after germination when the seedling is young and at pricking out but this requirement reduces as the seedling grows in age. The amount of water should be reduced four weeks before the seedlings are planted out.

At that stage, the soil can be left to dry out completely and the plants to wilt for a day. The process should be repeated several times.

- ***Amount of sunlight.*** If the area is sunny, more water is needed and vice-versa. However, do not keep the area shady for too long to reduce water use.

- ***Soil type.*** A sandy soil loses water faster than a soil with high clay content hence need more frequent watering. However a clayish soil becomes hard and cracks if it dries out.

The substrate should be watered thoroughly so the water should be directed to the soil and not the leaves except to dust the soil lightly. A watering can or a hosepipe with a nozzle should be used to ensure uniform distribution water and one should water the whole bed and not just the plants in the center of the bed. Low water pressure is good but one should ensure that water gets to the bottom of the container to avoid a dry and hard bottom, which will affect the growth of the roots as they get to the bottom of the container.

Water should be clean to ensure seedling health so water from such sources as kitchen waste should not be used. Too much water can damage the plants just as much as not enough water because of water logging which makes the roots not breathe, the diagram below illustrates two ways of watering.

- **Mulching**

The objectives of mulching is to maintain adequate soil moisture for the overwintering process and keeping soil temperatures cool to prevent early germination.

In addition to modifying the physical soil environment, mulches can have an effect on the biological components in the soil system. Mulches can reduce the germination and emergence of undesirable plant species – better known as weeds.

- **Shading**

Construct a shade to protect the seedlings from direct sunlight for two to three weeks after pricking-out. Use locally available materials such as grass, mats, or banana fibers for shade construction

Shading of the transplant beds may be beneficial when the weather is hot, and in any case immediately after transplanting. Any shade must be reduced slowly, because the shaded

seedling would suffer if exposed suddenly to direct sunlight. During the rainy season shading should be used with care because of the danger of damping off.

- **Hardening off**

Hardening up is to expose the seedlings to harsh conditions to make them strong so that they will be able to survive under harsh climate in the field after planting out. It is also a gradual preparation of seedlings for field conditions.

Hardening up process:

- ✓ When the seedlings grow and reach the planting size, the shade should be removed to exposure to more sunshine
- ✓ Reduction in watering intensity (quantity) and frequency-water twice a week and later once a week
- ✓ Before planting out, root pruning should be carried out frequently or re-arrangement of pots to allow more adoption to stress.
- ✓ Good preparation for out planting results in good field survival, therefore hardening off should be done 2 – 3 weeks before out planting time.

- **Trimming of roots / pruning of roots**

Root cutting or roots-pruning is the cutting of roots to control root system development beyond the container. Why root prune? When seedlings have reached to a certain size and their roots become longer than the depth of the pots. If the roots are left without pruning, they penetrate into the ground and develop the root systems there. Once the root system develops under the ground, it is hard to move the pots, and if the roots are cut when the seedling is old, the seedlings will be weakened; hence periodical root pruning is required before the root system reaches into the ground. The period and interval of pruning depends on different species and other conditions. Root pruning should be done regularly preferably every 2 –3 weeks. Prune when seedlings are the height of the span of your palm and when their roots have started to penetrate into the under surface

Procedure:

- ➢ Water the seedlings properly before root pruning.

- Using a sharp knife or wire or scissors to cut the long roots underneath the container. You can also uplift the containers (wrenching) to cut overgrown roots.

- ✓ **Routine hygiene**: this include planting or sowing pattern, weeding, watering, pests and diseases control, and field inspection.
- ✓ **Fertilizers application:** Fertilizers or manure is applied when the seedlings show sign of weakness. The most common fertilizers are NPK and DAP. It is important to note that manure from livestock can also be used. However weakness of the seedlings can be caused not only by insufficiency of the nutrient but also by pests and disease.

LO 3.2 – Perform grafting activities

- Content/Topic 1. **Grafting**

Grafting is a horticultural technique whereby tissues from one plant (scion) is inserted into those of another (root-stock) so that the two sets of vascular tissues may join together

- ✓ **Characteristics grafted species**

In theory, any two plants that are closely related botanically and that have a continuous cambium can be grafted. Grafts between species are often successful, between genera occasionally so, between families nearly always failures. Within the genus the closeness of botanical relationship is not an infallible guide as to probable success, but in the absence of recorded experience it is the best available. The ability of two plants to continue to grow or be compatible when joined together by the asexual practice of grafting is mediated by many complex physiological and environmental factors. In practices only the dicotyledonous group of plants render themselves to graft readily. Monocotyledonous plants which do not undergo secondary thickening. Example maize sugarcane, etc, are not readily graftable.

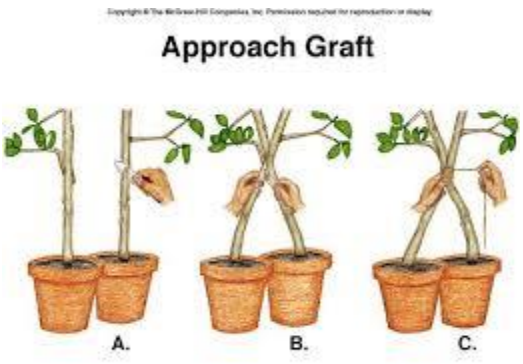
Examples of graftable crops

Avocado, Citrus species, Mango, apples, passion fruit,etc.

Grafting methods

1. **Approach grafting**

Approach grafting or inarching is used to join together plants that are otherwise difficult to join. The plants are grown close together, and then joined so that each plant has roots below and growth above the point of union. Both scion and stock retain their respective parents that may or may not be removed after joining. Also used in pleaching. The graft can be successfully accomplished any time of year.



2. **T-Budding**

T budding or shield **budding** is a special grafting technique in which the scion piece is reduced to a single **bud**. As with other techniques of asexual propagation, the resulting plants are clones (genetically identical plants reproduced from one individual entirely by vegetative means).

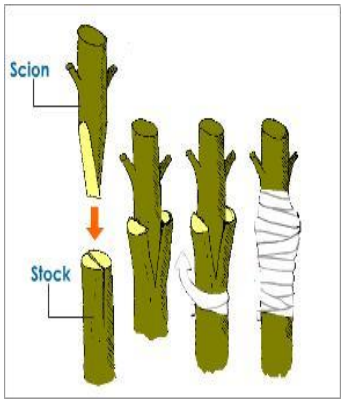
Bud grafting uses a bud instead of a twig. Grafting roses is the most common example of bud grafting. In this method a bud is removed from the parent plant, and the base of the bud is inserted beneath the bark of the stem of the stalk plant from which the rest of the shoot has been cut. Any extra bud that starts growing out from the stem of the stalk plant is

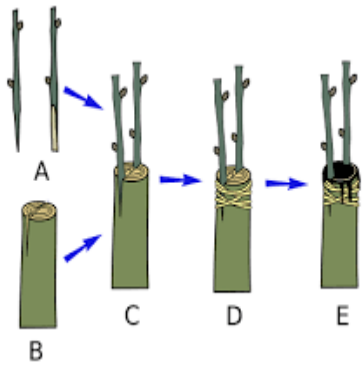
removed because that would bear the flower of the unwanted original kind. Examples: roses and peaches.

3. Cleft grafting

Cleft grafting is a **grafting** technique which allows the union of a rootstock limb that is much larger in size than the scion piece.

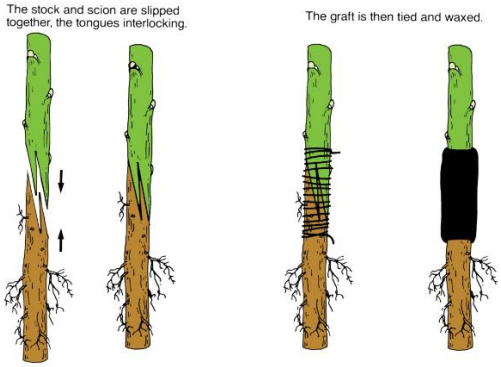
In cleft grafting a small cut is made in the stalk and then the pointed end of the scion is inserted in the stalk. The most common form of grafting is cleft grafting. This is best done in the spring and is useful for joining a thin scion about 1 cm (0.39 in) diameter to a thicker branch or stock. It is best if the latter is 2–7 cm (0.79–2.76 in) in diameter and has 3–5 buds. The branch or stock should be split carefully down the middle to form a cleft about 3 cm (1.2 in) deep. If it is a branch that is not vertical then the cleft should be cut horizontally. The end of the scion should be cut cleanly to a long shallow wedge, preferably with a single cut for each wedge surface, and not whittled. A third cut may be made across the end of the wedge to make it straight across.





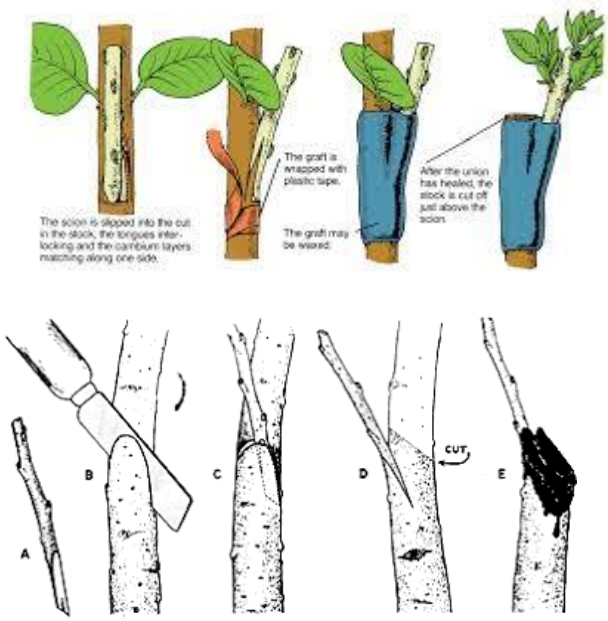
4. **Whip grafting** (also called splice or **tongue grafting**)

Is one of the oldest methods of asexual plant propagation known. It is the predominant propagation method used on apples and is widely used on pear. Although most grapes are grown from cuttings in this country, **whip grafting** is the standard when they are propagated.



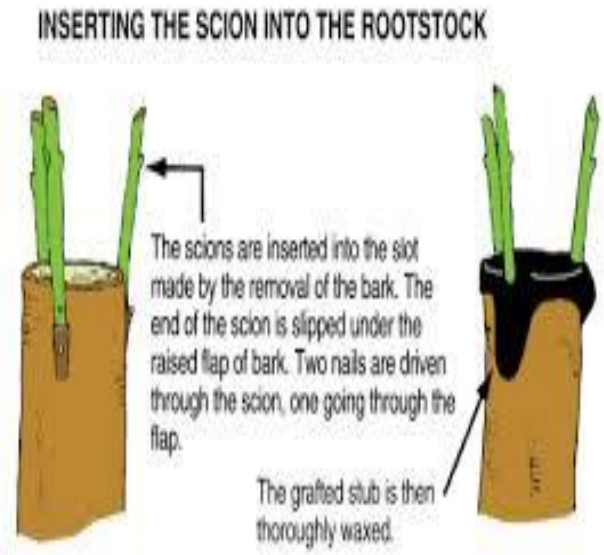
5. **Side grafting**

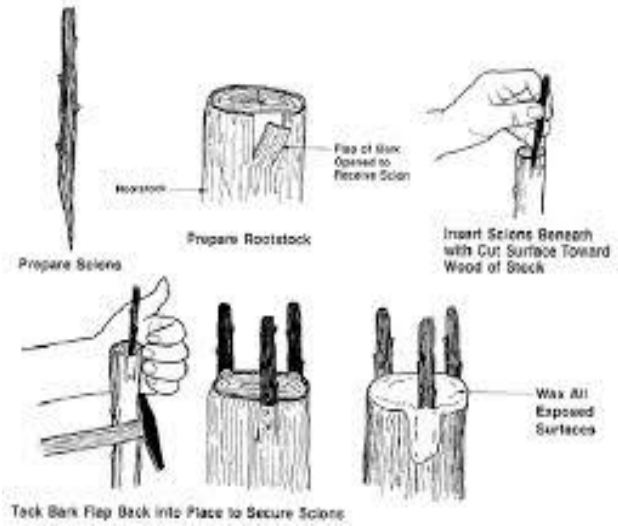
A plant grafting in which the scion is inserted into the side of the stock and the aerial head of the stock permitted to grow until union is established between stock and scion.



6. **Bark grafting**

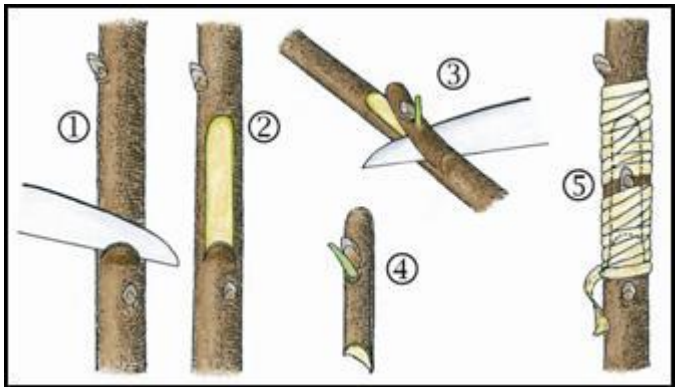
Grafting consists of inserting a SCION (a section of a shoot of a desired variety) to the rootstock of another variety. Generally speaking, apples to apples, pears to pears, etc. Some exceptions are listed on the back of this sheet.





7. **Chip budding**

Chip budding is a grafting technique. A chip of wood containing a bud is cut out of scion with desirable properties. A similarly shaped chip is cut out of the rootstock, and the scion bud is placed in the cut, in such a way that the cambium layers match. The new bud is usually fixed in place using grafting tape.



Procedure of grafting

Choose the scion and rootstock

- Make a slanting cut with sharp knife at the base of scion and at the top of the stock
- Fit or bind the two parts together
- Wrapping with grafting tape

- Content/Topic 2. **Conditions of success of grafting**

The success or failure of any grafting operation is based upon the compatibility of each plant part, closeness of fit, and cambial contact. The union is initially held in place by pressure exerted by the stock, by grafting tape, or by rubber budding strips applied over the point of union.

- Content /Topic 3. **Conditions related to the plant:**

✓ **Compatibility**

1. The stock and scion must be sufficiently closely related taxonomically (i.e. genetically) to form a functional graft union.

2. The opposite of compatibility is incompatibility, which is the failure to form a functional graft union. Incompatibility may develop either rapidly or slowly. The latter is called delayed incompatibility.

3. The degree of *"relatedness"* necessary for compatibility (i.e. the Limits of compatibility) varies with different taxa (species, genera, families).

- ✓ **Diamerter of part** : Diameter of the root stock and the scion should be proportionally equal
- ✓ **Physiological state**

✓ **Alignement of tissues/Cambial "contact" (alignment)**

1. The secondary meristem known as the **vascular cambium** (vc) lies between the outer wood (secondary xylem) and the inner "bark" (secondary phloem) of woody plants.

- Cell division of the vc and subsequent differentiation results in deposition of new xylem and phloem during the normal course of (ungrafted) plant development. So, it is not surprising that vc formation across a graft union is essential for the production of new interconnecting xylem and phloem.

2. For a new vc to form across a graft union it is essential that the vc of the scion and that of the stock be fairly **closely aligned** (so called cambial "contact"), although not necessarily in direct contact at all points.

✓ **Pressure**

1. Sufficient pressure between stock and scion is required to prevent them from moving independently of each other for three reasons:

a. Movement against each other at the point of contact would prevent the intermingling of callus cells from stock and scion. This is necessary for a continuous bridge of callus to form, across which a new vascular cambium and then xylem and phloem can form.

b. If stock and scion are not held together tightly the entire graft may fall apart before callus or vascular tissue (especially wood) formation can occur.

c. Pressure is necessary to orient the plane of cell division give rise to spatialy-organized tissues (vascular cambium, xylem, phloem) rather than jumbled masses of cells.

- Content/Topic 4. **Conditions related to environment**

Graft failure can be caused by factors such as: Poor formation of the **graft** union due to **problems** with anatomical mismatching (when the rootstock and scion tissue is not lined up properly), poor **grafting** technique, adverse **weather conditions** and poor hygiene. Mechanical damage to the **graft** union. **Graft** incompatibility.

- **Humidity (water):** High relative humidity after grafting can lead to rotting of the scion. The same as low relative humidity can lead to desiccation of the scion.
- **Direct sunlight:** Direct sunlight can harm scion due to evotranspiration and leads to its desiccation.
- **Temperature:** Grafting was done at the wrong time of the day where the temperature is too high. eg when grafting is done at midi time. Scions may dried out or injured by cold so it is better that operator carries out grafting at proper time of the day where the temperature is not too high or too cold.

- **Conditions related to the operator:** These are conditions related to the farmer who needs to carry out grafting, hygiene and experience she/he has during and after grafting operation.
  - **Skills/ experience:** The experience of the farmer also can lead to failure especial when he/she is not frequently habitual for this practice because scion and rootstock may not be joined properly. The operator may also dispose scions at upside down position.
  - **Materials used:** Contaminated materials and tools used can be one of factors that leads to failure in grafting practices. On one hand, materials like scion and roots on can be injured or contaminated before, during and after grafting and leads to grafting failure. On the other hand, tools like rope or string used may be dirtied and cause contamination of the junction part.
  - **Species to be grafted:** Some species are difficult to graft. Therefore, they require experienced operator and repetitive grafting time in order to succeed grafting.

- Content /Topic 5. **Plant material preparation**

✓ **Collection of scion**

Scion should be collected when the tree is still dormant, usually February or early March. The best scion wood may come where pruning was done the previous spring; causing good vigorous growth last summer. If water sprout wood is very long, the best scions will come from the middle and out toward the terminal bud.

When collecting scion, use clean, sharp pruners to cut selected scion. Then wrap the sections of cut scions in paper towels, moss or sawdust. Store scions in a cool place, such the refrigerator, until spring when they can be grafted on the rootstock.

✓ **Preparation of scion**

Scion should be collected off plants that are true-to-type and diseases free. Cut from tree when they are dormantin winter. Sterilize secateurs with Methylated spirits mixed (75-80% Metho &25-20% water) between cutting each tree.

✓ **Preparation of rootstock**

In this situation, longer rootstock stems are required to allow for deeper planting while avoiding contact between scion stem and soil. Under these circumistances grower may graft onto roots stock 3-5 nodes above the cotyledons.

✓ **Grafting union**

The union in a graft is a lumpy raised scar that should be just above the surface of the soil or just under the canopy. It is caused when the scion and the rootstock are united. The scion is the variety of the species that produces and performs the best. When grafting takes place, the scion and rootstock grow their cambium together. The cambium is a living layer of cells just under the bark.

✓ **Postgrafting care**

In Postgrafting care, the following activities have to be done:

- Recheck wax in 3 to 5 days and maintain seal on the graft.
- Try to keep humidity high. Humidity, but not wet.
- Control temperature with high shade or other methods
- Suppress rootstock growth
- Prevent girdling

For grafted tree, take care on:

- Plant your grafted fruit in an area that has direct sunlight and well- drained soil
- Check on your graft's seal weekly and repair when necessary
- Prune off any new rootstock growth immediately
- Continue to provide the tree with 5 gallons of water once a week
- Remove the graft tape or wax once you notice new growth which generally occurs a few months after grafting

LO 3.3 – Control of pests and diseases

- Content/Topic 1. **Means of control**

Seedlings are delicate and susceptible to attack by various pests and diseases as well as weather conditions. Such damages can seriously weaken or kill the seedlings. It is important that the damages be dealt with immediately. Damage and disasters in the nursery may be categorized as below.

- **Control of diseases in nursery**

Fungal Diseases

1 .Damping Off: This is a fungal disease caused by *Pythium spp*., *Rhizoctonia salani* and other various fungus. The severity of the attack usually increases with increase in soil moisture. Dumping off can occur before germination, after germination and at pricking out. The fungi attacks the seedlings at soil level and causes rotting of the part attacked consequently killing the seedling. Susceptible species include *Eucalyptus*, *Casuarina, Kei apples* etc.

Conditions favorable to spreading of the disease are:

- High sowing intensity
- Over watering
- Using soil with under-composed material
- Damaging the bark of tender seedlings

Control measures: Use of optimum sowing density, Use of appropriate quantity of water or not damaging the bark of seedlings. Use of specific fungicide like Dithan M45, Lidomil, ENA-MANCOZEB 80

2. Wilting: This is a dying bark of the main shoot of a seedling. It is mainly caused by overcrowding. Separating the seedlings or immediate planting out can help control it.

3. Powdery mildew: First small white powdery patches are formed on the leaf surface and later the whole surface of the leaf is covered with white powdery *Mycelial* colonies.

Damaged leaves gradually defoliate. This affects the growth of young seedlings. Control-fallen diseases leaves should be buried in soil or burned and the young seedlings sprayed with Benlate.

- **Control of pests in nursery**

Common nursery pests are aphids, leafminers, scale, spider mite, and weevil. These pests are controlled by using available local insecticides like Cyermethrin, Rocket,etc.

- Content/Topic 2. **Cultural methods**

- **Weeding**: It consists of uprooting all undesirable weeds that are grown in nursery bed to prevent nutrients and light competition in the nursery bed or seedling bed. This activity also reduces high humidity in the seedling bed and destroy some weeds that may be hosts of some pests and diseases.
- **Pruning**: It consists of cutting branches of seedlings that can touch the soil level and be shelter of pests and diseases. This pruning also allows to the sunlight to reach to seedbed and reduces the humidity of the soil.
- **Watering**: Even though, frequent watering in seedling bed can cause fungal diseases to develop, pests like aphids also profit drought to attack plant. Therefore, watering regularly may reduce the severity of that pest.
- **Thinning:** Is considered as the reduction of plant population in the field by uprooting plants with poor growth and development. In nursery bed, this will reduce intraspecific competition into nutrients and light, and minimize high humidity that may be source of fungal diseases development.
- **Hand picking and destruction:** This is the practice of searching and killing pests that are found in nursery bed/ seedlings bed by using our hands.

- Content /Topic 3. **Chemical methods**

- **Dosage**

This is the amount of chemical to spray in gm/ml in a given volume of water and per unit of area.

Generally, pesticides application in the field is calculated and applied based on area (gm/ml active/ ha). Concentration of the chemical not taken into account. However, the

concentration of chemical playing major role for determining efficacy. The concentration may vary based on the volume.

When applying pesticides, water acts as a means of delivering the product to the plant. After spraying / treatment, the water evaporates and pesticides or the preparation remains on the surface of the leaves with high concentration.

- **Spraying activity**

This is the activity of applying pesticides on the seedling to control nursery pests and diseases.

Before spraying pesticide, follow label direction carefully, avoid splashing, spelling, leaks, spray drift, and contamination of clothing. Never eat, smokes, drink, or chew while spraying pesticides.

When spraying pesticides in doors, make sure the area is ventilated. When applying pesticides as spray or dust outside, avoid windy conditions and close the doors and windows to your home.

After using pesticides, wash your hands before smoking or eating. Apply pesticides during the cooler part of the day, such as early morning or evening. Treatment made in early morning allow foliage to dry before temperature reach 85-90^{0}F. Take special precaution when using pesticides containing oil. Treat when conditions allow the plant to dry.

- Content /Topic 3. Mechanical/Physical methods

Using traps: Traps are all structures that may be used to catch pests and other animals that can damage seedlings in the nursery. In additional to traps, there is fences that can hinder and repel animals (grazing animals) and insects to enter freely in the nursery and damage seedlings.

Traps may be trap crops which are plant stands grown to attract insects or other organisms like nematodes to protect targeted crops from pests attack.

Protection may be achieved either by preventing the pests from reaching the crop or by concentrating them in a certain part of the field where they can economically be destroyed.

Apart from trap crop, other structure with characteristic colors and or with hormone that attract pests can be used. On these, there are sticky substances that can capture the oncoming insects (pests).

LO 3.4 –Deliver seedlings considering standards and costumers requirements

- Content/Topic 1**. Seedlings quality**

1. Seedlings stage: the stage of delivering seedling depends on the plant species, lengths of seedlings and age of seedlings.

2. Plant species: delivering stage is based on plant types basically vegetables, fruits, agro-forestry and forestry species.

3. Height of seedlings: this also is based on plant species like example vegetables may be delivered if presenting 15cm to 20cm length while agro-forestry species may be delivered if presenting 40cm to 50cm length.

4. Age of seedlings: generally for vegetables crops, delivery period is from 1to 2months, for agro-forestry species, this period vary from 3to 4months, for non grafted fruits seedlings, this delivering stage can vary from 6 to 7months while for grafted fruits seedlings, delivering stage take 9 to 12months.

Age

5. **Health:** The seedlings should be free of pests and diseases and without nutrients deficiency.

6. **Vigor**: The seedlings to deliver should have a strong stem, strong and green leaves.

- Content/Topic 2**. Types of seedlings**

✓ **Bare roots seedlings**

Is when a plant and its roots are removed from the soil and sold this way. This limit the harvesting season to a few weeks in spring time.

- ✓ **Balled & Burlapped seedlings**

Balled refers to the root ball (that is soil plus roots) which has been dug up, while Burlapped refers to the wrapping material traditionally used for transporting tree and shrubs deliveries.

- ✓ **Container seedlings**

Container seedlings are our smallest sellable plants generally used for reforestation and riparian buffer plantings. These plants are best for high volume planting.

- Content /Topic 3. **Handling practices**

- **Seedling lifting**

The general rule of thumb is that when a seedling has 3 to 4 true leaves, it's large enough to plant out in the garden (after it has been hardened off). When you plant a seed, the first leave to emerge are the cotyledons. These leaves will look differently from leaves that will grow later.

- **Watering**

Watering the seedlings is necessary. As the seedlings grow use a mister or a small watering can to keep the soil moist but soggy. Lets the soil dry slightly between waterings, Set up a fan to ensure good air movement and prevent diseases.

- **Temperature control**

In seedling bed, temperature is either controlled by putting seedling under the shade or by controlling direct sunlight. Acclimate seedlings to direct sunlight. It is best to do this over a three-day period by placing them in direct sunlight during the morning only of the first day, then increasing their time outside by few hours each day until they are vigorous enough to be transplanted.

- **Stripping and trimming**

Stripping is a practice of reducing a number of leaves or reducing their surface on seedling by using our thumbnails in order to reduce evapotranspiration of seedlings and further their desiccation.

- **Storing in shade**

Shading the seedlings reduces the temperature of the soil and the amount of water lost by seedlings. However if seedlings are left under shade all the time they grow too tall, too weak

and yellow. It is important, therefore, only to shade seedlings when shade is needed. Shade are also used to protect against frost, rain and sun.

- **Wrapping seedlings with root ball**

Seedlings with root ball should be wrapped to keep the root ball secure until you have a new home ready for your transplanting, wrap the root ball in what is referred to a burlap diaper.

wrapping holds the soil in place and protect roots after the plant has been unearthed.

- Content /Topic 3. **Precautions**

  - **Physical damage**

Preventing physical damage to seedlings should be an obvious concern, but it is often overlooked. A seedling can be damaged by physical pressure caused by crushing, dropping, or excessive vibration in much the same way as people are bruised when hit by an object. The seedling often can repair the damage in the same way that humans recover from injury—but only at a loss in ability to survive and grow. In the extreme case of complete girdling or removing part of the seedling, recovery is not possible. Handle seedlings carefully.

Additionally, you must keep out-of- soil seedlings moist, either by restricting water loss with a water vapor barrier or by adding water to the roots at regular intervals.

  - **Avoid cramming seedlings**

Watering the seedlings and confining soil around the roots is important to avoid cramming seedling (wilting of seedlings) after uprooting and lifting of seedlings.

  - **Deep seedlings in water**

This practice conserves water by preventing evaporation and holds down fungal diseases from rain that can splash onto bottom of leaves.

  - **Transport in aerated container**

By maximizing plant propagation aeration, young plant roots have more access to oxygen and breathe more freely. Transplants will develop sturdier, hardier and more quickly while avoiding common propagation problems like damping off and insects that occur when a plant is weakened by warm and waterlogged conditions.

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