NATIONAL OPEN UNIVERSITY OF NIGERIA

CRP 304

Principles of Horticultural Crop Production

Module 3

CRP 304 (Principles of Horticultural Crop Production) Module 3

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Unit 1 Method of Propagation of Horticultural Crops (Sexual and Specialised)

1.0 Introduction

In crop production, different parts of crop can be used to replicate the crop. These different parts could be seeds, leaves, stems, roots etc. The success of crop establishment depends on the cultural practices used for the production. In this unit, you will be studying methods of propagation of horticultural crops. Some crops have one method of propagation while others may have more than one method.

2.0 Objectives

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

- define propagation
- state the methods of propagation of horticultural crops
- explain the specialised structures used in propagation of horticultural crops
- explain cutting as vegetative propagation
- explain different types of layering
- explain different types of grafting.

3.0 Main Content

3.1 Propagation of Crop

Plant propagation is defined as the controlled process of creating new plants from a variety of sources such as seeds and other plant parts. The objectives of plant propagation are to:

i. Increase in number of plants
ii. Preserve the essential characteristics of plant

Propagation of crop involves the formation and development of new individuals using specialised part of the plant. These new individuals are used in the establishment of new plantings.

3.2 Methods of Propagation of Horticultural Crops

In general, two methods are employed in propagation of horticultural crop

1. The use of seed (sexual)
2. The use of vegetative part of plants (asexual).

3.2.1 Sexual Propagation (seed)

This is a method of increasing the number of plants through seeds formed from the union of gametes during pollination. Essentially, a seed consist of an embryo with nourishing and protecting tissue. The embryo is considered a minute plant. Principal parts of the embryo are plumule (which is the first growing point of the stem), the radical (the first growing point of the root) and the hypocotyls and epicotyls (together constitute the first, or original, stem of the plant). The nourishing tissues are endosperm and cotyledons. In well-developed mature seed, these tissues are packed with stored food such as starch, hemicelluloses, reserved proteins, or fats depending on the kind of plant. The protecting tissue is the seed coat. In general, the seed coat retards the rate of transpiration; in some kinds of plants, it retards the rate of respiration while the seeds are in storage and protects the delicate embryo from mechanical injury to some extent. When the seed is exposed to environmental condition favourable for its growth (soil, water, temperature, light etc), the seed germinates and produces a plant. Therefore, a seed may be defined as a minute plant with nourishing and protecting tissues that can be used to produce a similar plant. Sexual mode of propagation is the principal means by which biological variation is generated.

Advantages of sexual propagation

1. Easy and natural phenomenon – once the seed is given the right environmental condition it will germinate and produce the plants.
2. They are sources of genetic variability – They provide means of recombination of genetic material to produce improved varieties.
3. It helps in selecting different traits – The desirable traits can be retained while undesirable traits removed.

Disadvantages of sexual propagation

1. Not all plants produce viable seeds e.g. banana pineapple.
2. It is not possible to maintain a true – to - type genotype
3. sexual method of propagation takes longer period of time from seed to harvest. This is especially true with respect to tree crops.

3.2.2 Asexual Propagation (Vegetative Propagation)

Vegetative propagation is the method that uses any part of plant rather 'true' seed to produce new plants. Plants have a number of vegetative mechanisms. Some of these have been taken advantage of by horticultural and gardeners to multiply or clone plants rapidly. Plants produced using vegetative parts have no exchange of genetic material, therefore, the plants are identical to the parent. Vegetative propagation uses plant parts such as roots, stem and leaves. In some plants, seeds can be produced without fertilisation and the seeds contain only the genetic material of the parent plant. This is called apomixes. Apomixes is asexual reproduction but not vegetative propagation. Vegetative propagation is essential for the raising of many economic crops eg fruit crops, nut crops, many flowering and ornamental crops and certain Vegetables crops.

Advantages of Vegetative Propagation

1. Maintenance of true – to – type clones over a time. A clone is a group of plants with the same genetic makeup.
2. It maintains uniformity of plants genotype.

3. It is the only means of propagating certain plants e.g. banana and plantain which do not produce viable seeds.
4. Earliness of production is achieved.
5. It may be more economical to propagate asexually in some crops as in sweet potatoes.
6. Some seeds germinate with difficulty and as such vegetative propagation is best for them.
7. Seed borne diseases are avoided when plants are propagated asexually.

Disadvantages of Vegetative Propagation

1. Planting materials are usually bulky.
2. Storage of asexual material is cumbersome and usually short term.
3. It does not provide source of genetic variability for recombination of gene.
4. Mechanized propagation in most cases is not practicable.
5. Need specialised personnel to handle the procedures.
6. It is expensive than seed.
7. Systemic viral diseases can spread to all plants through plant materials and tools used.

The methods of vegetative propagation include the following;

a. Use of specialised vegetative structure eg. Root, corms, bulb, rhizomes etc.
b. Cutting
c. Layering
d. Grafting
e. Budding.

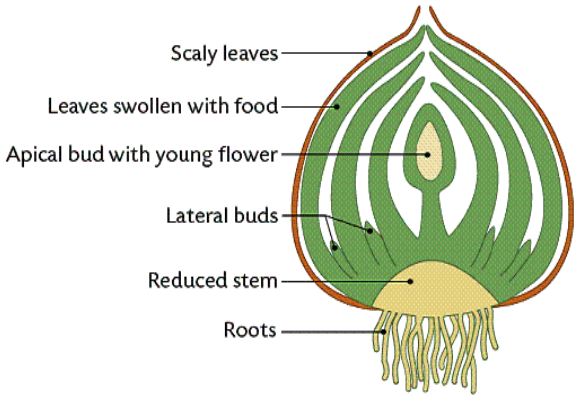
Self-Assessment Exercise

i. Define propagation and seed.
ii. State 2 advantage and 2 disadvantages of sexual propagation.
iii. List 5 specialised vegetative structures of vegetative propagation.

3.2.2.1 Use of Specialised Vegetative Structure

Vegetative propagation can be achieved through the use of specialised vegetative structures other than seeds. These specialised structures include bulbs, corms, rhizomes, tubers, runners, off shoots.

a. Bulbs – These are shooting stems with thick fleshy leaves. Stem buds develop at the exile of leaf scale to form miniatures or small buds (bulblet) which are known as offsets when grown to full size e.g. onion.

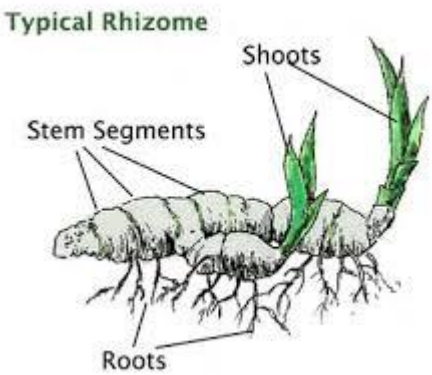


Onion bulb

b. Corms – These resemble bulbs but have no fleshy leaves. They are solid stems structure with node and internode e.g. cocoyam.

Cocoyam corm

c. Rhizomes- These are horizontal cylindrical stems growing underground with node and inter node and readily produce adventitious roots. They may be slender and elongated or thick and fleshy. Growth proceeds from the terminal bud or through lateral shoot. Propagation is by cutting the rhizomes into several pieces, each containing a vegetative bud e.g ginger.

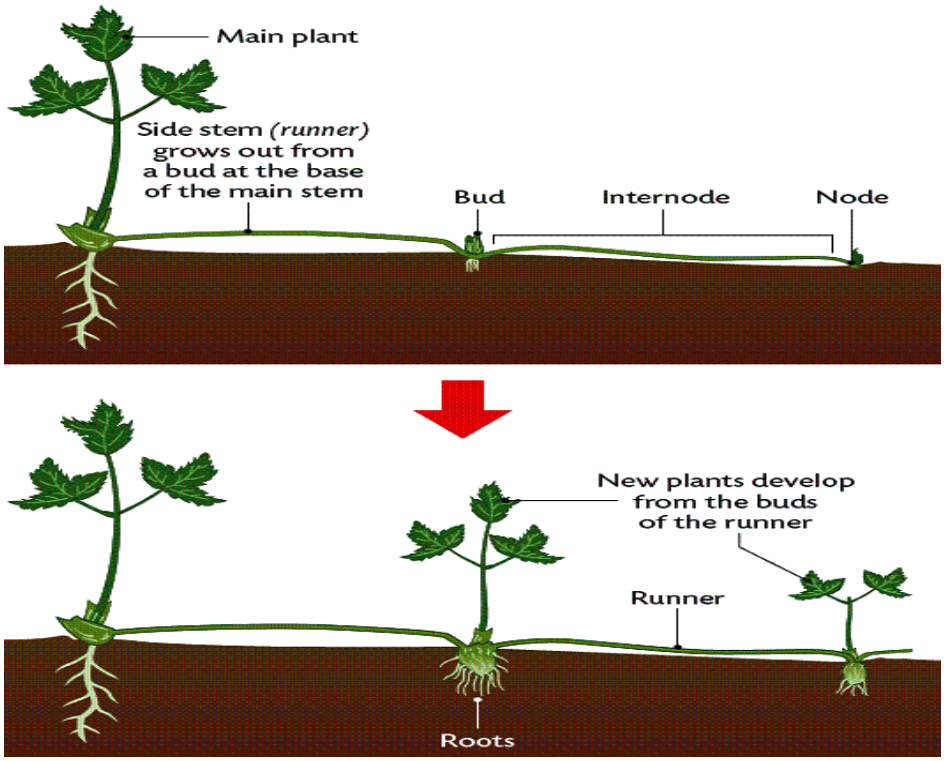


A Rhizome

d. Tubers – These are thick portions of underground stem e.g. Irish potatoes. Nodes and internodes are present and nodes are arranged spirally.

Tubers

e. Runners – Aerial stems develop from the leaf axil at the base or crown of plants. Runners grow horizontally along the ground and form new plants at one of the nodes along the ground eg. Strawberry.



f. Off Shorts – In many plants literal shoots develop from the stem which when rooted serve to reduplicate the plant. This has been referred in horticultural terminology as offsets, crown, division or slips e.g. banana, pineapple.

4.0 Conclusion

Plants or crops are usually reproduced through sexual or asexual means depending on the mode that is suitable for the crop to produce at maximum productivity. While some crops reproduce through one means others reproduce through both means. Those crops that reproduce through sexual means have the advantage of providing genetical variability for modification while those that reproduce through asexual means have the advantage of producing true-to-type plants

5.0 Summary

In this unit, you have learnt that plant propagation is defined as the control process of creating new plants from a variety of sources such as seeds and other plant parts. The methods used for plant propagation are sexual (seeds), asexual (vegetatively such as budding, grafting, layering, cutting) and use of specialised vegetative structures such as suckers, corms, bulbs, rhizomes, bulblets, tubers and runners.

6.0 Tutor-Mark Assignments (Tma)

1. Define propagation
2. List 4 vegetative propagation methods you know
3. Explain 5 specialised structures that are used for vegetative propagation

7.0 References/Further Reading

George A. (2004). *Horticulture- Principles and Practices*. 2nd edition. Eastern Economy Limited. Pp 3-720.

Lawrence, K. Opeke. (2005). *Tropical Commodity Tree Crops*. Spectrum Books Limited. Pp 1-70. 2nd Edition;

Edmond, J. B., Senn, T. L., Andrews, F. S. and Halfacre, R. G. (1975). *Fundamentals of Horticulture*. McGraw-Hill Book Company. Pp183-219, 1st edition.

Unit 2 Method of Asexual Propagation (Vegetative or Propagules)

1.0 Introduction

Plant species are naturally endowed with the ability to regenerate themselves through self- or cross-pollination of their flowers to produce seeds. When physiologically mature, seed germinate under optimum environments and generate new individual plants to perpetuate the parent plant. Similarly, plant species whose seeds are not adequately viable to produce new plants and/or sterile (e.g. plantains) and depend primarily on the induction of vegetative sections (leaf, stem, root, flower stalks) containing viable buds are particularly more vigorous in asexual propagation of these plant species. Seed propagation of crops is more ancient than asexual propagation, and evolved with the origin of agricultural crop production in pre-historic times. Historically, human use of seeds marks the transition from nomadic food gathering to sedentary civilizations based on agriculture, in different parts of the world. In recent times, technological advances have led to the development of micro-propagation, which involves the culturing of individual cells or groups of cells (tissues) under highly aseptic conditions to produce whole new disease- and insect-free plants. In this unit you shall be studying the types of propagation through propagules and the use of micro cells.

2.0 Objectives

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

- the distinction between sexual and asexual plant propagation
- the various methods of propagating different crop types
- the advantages and limitations of the propagation techniques
- the practical application of the techniques for self-sustenance.

3.0 Main Content

3.1 A Sexual Propagation Methods (Vegetative)

This method involves the induction of a vegetative section or part of a living plant to form roots and subsequently, developing it into a whole new plant. Plant multiplication does not involve the seed cycle (exchange of genetic materials) and therefore, it is the best way to maintain some species as clones; individuals identical to the parent.

3.2 Types of Propagating Materials (Propagules)

3.2.1 Seed

'Seed' is the generative part of the plant used for propagation. A seed is a small immature plant (embryo) protected by a seed coat or testa, which is formed from the outer layers of the ovule after fertilisation. The seed is the basic unit of propagating many tropical crops, including yam and fruits (pawpaw, passion fruit). Even in crop species whose primary mode

of propagation is by vegetative means (e.g. mango, avocado pear), seed sowing constitutes an important method of regenerating new plants. Seeds are sown in three different ways namely: by broadcasting, drilling/row-seeding, and pocket drilling/ sowing in holes. Advantages of sexual propagation are:

i. Ease of transportation of propagating materials,
ii. Less cost, skill and work to raise seedlings,
iii. Ease of vegetative propagation in mature plants, hybrid vigour and associated benefits of development of new varieties and
iv. Wider adaptation to varying environments.

The disadvantages of sexual propagation include:
i. Slow seedling growth,
ii. Non-prototype off springs,
iii. Problem of ensuring uniform produce quality since most seeds originate from cross-pollination (by wind, insects),
iv. Weaker seedlings and
v. Longer period to plant maturity than vegetatively-propagated crop species.

3.2.2 Budding/Bud Grafting

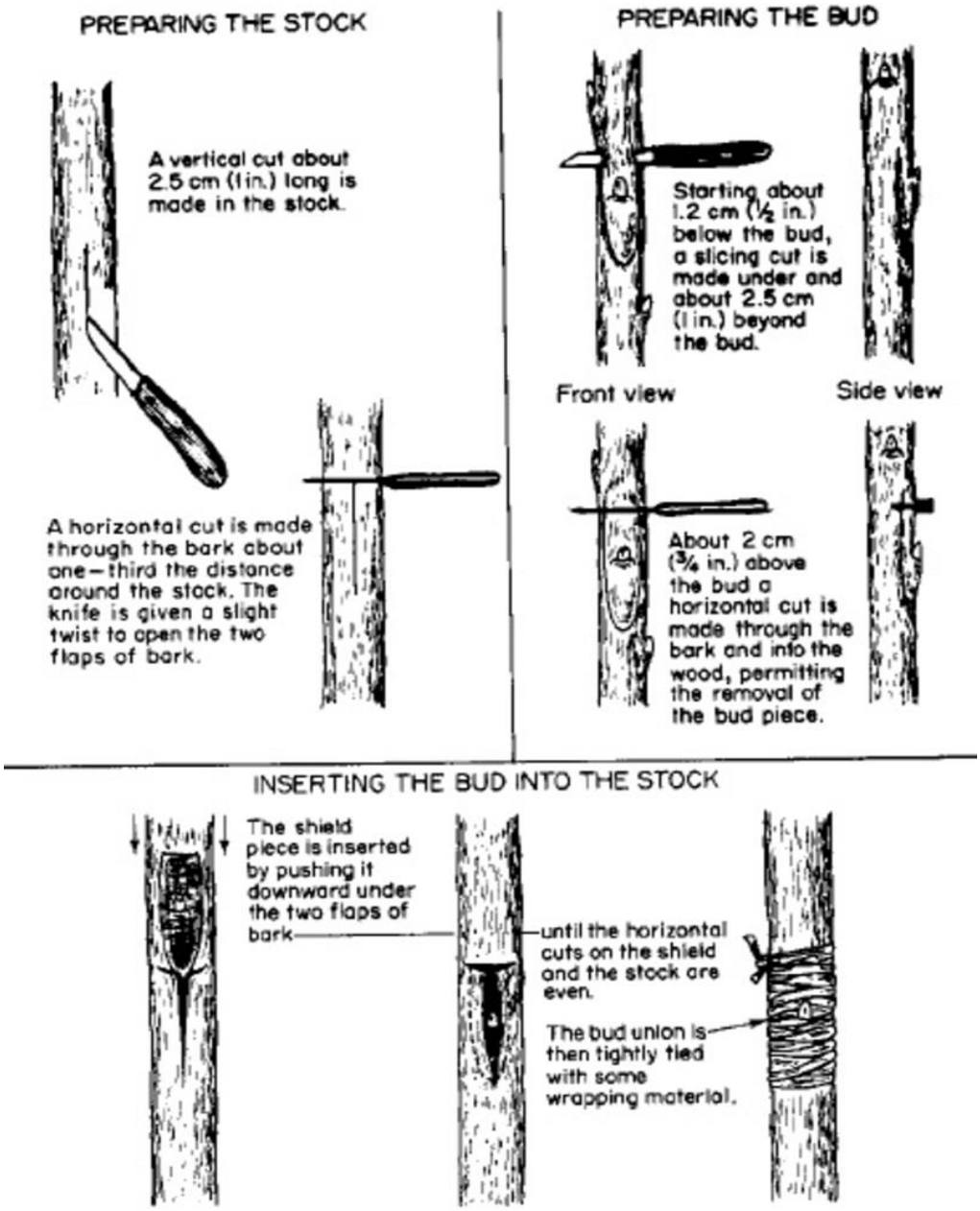
It is a process consisting of the engrafting of the bud (scion) of a plant into the stem (stock) of another plant of the same genus. Generally, it is very suitable for propagating deciduous fruit (*Citrus* spp.) and shade trees. Budding of improved materials on regenerated chupons is one of the new methods of rehabilitating cacao in Nigeria. In the most common T-budding pattern, the desired scion from a young, actively-growing shoot of a chosen crop variety is immediately slid into a T-shaped slit on the rootstock. The joined bud and rootstock are held by a winding of rubber band/ special tape/wrap which holds it until sealed, which prevents drying or contamination of grafted materials. Chip budding is used for budding species whose barks do not "slip" (when cut, the bark easily lifts in one uniform layer from the underlying wood) easily without tearing.

Advantages of bud grafting

1. Bud grafting is faster, easier and less messy than other forms of grafting discussed below.
2. Bud grafting allows the production of plants identical to a parent plant.
3. It may give increased productivity of crops through the hardness, superior rooting capacity, drought tolerance and insect or disease resistance of the rootstock.

Disadvantages of bud grafting

1. The method is labour-intensive,
2. Requires great skill of nursery operations (and therefore, expensive) and
3. Can only be efficient when performed at very specific times when weather conditions and crop physiological growth status are optimum.
4. The vascular cambium of the both the bud scion and rootstock must be aligned to stimulate tissue growth on the basal ends before rooting.



_Steps of T-budding and patch grafting

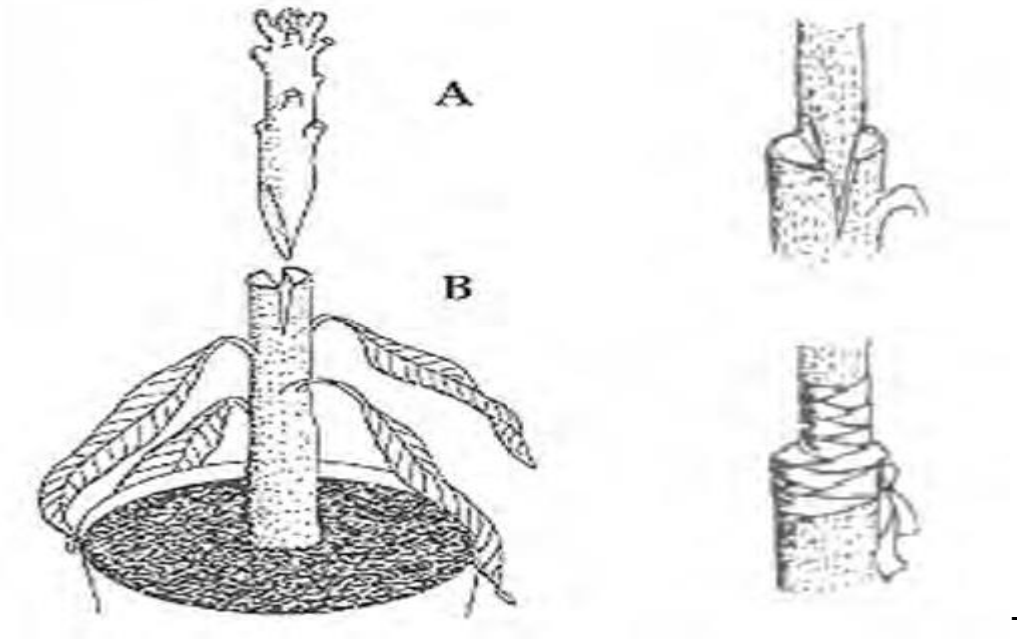
3.2.3 Grafting

This is similar to budding in theory, but different in the sense that grafting involves the joining of the upper part (scion wood, 0.63-1.27cm diameter and only with leaf buds) of one plant to the under stock (rootstock) of another plant of the same species (clones, varieties). Grafting is an old art and science of plant propagation in pears, citrus, mangoes, grapes and other fruit trees, traceable back to 4000 years to ancient China and Mesopotamia. Some plants graft naturally, where two branches are in close contact over several years (e.g. ivy).

Advantages of grafting

1. Grafting allows gardeners to produce plants identical to a parent plant,
2. Allows growers to control size and shape of a tree or shrub (e.g. apples)
3. Gives more vigorous and earlier-fruiting plants.

4. Two varieties can be grown on the same tree to facilitate pollination (e.g. in apples).
   Disadvantages of grafting
   1. Grafting is labour-intensive, expensive, inefficient in poor weather and plant growth conditions,
   2. Where cambiums of both scion wood and rootstock are not precisely aligned.
   3. Graft incompatibility, sucker production in grafted plants and death of rootstock due to rooting of the scion arising from planting the graft union below the ground. There is a need to protect the grafted area from dislodging the scion out of alignment, especially by bracing.
   4. There is a great risk of the top growth being very brittle thus, failing to harden off before cold weather.



Top cleft grafting method

Reasons for budding and grafting

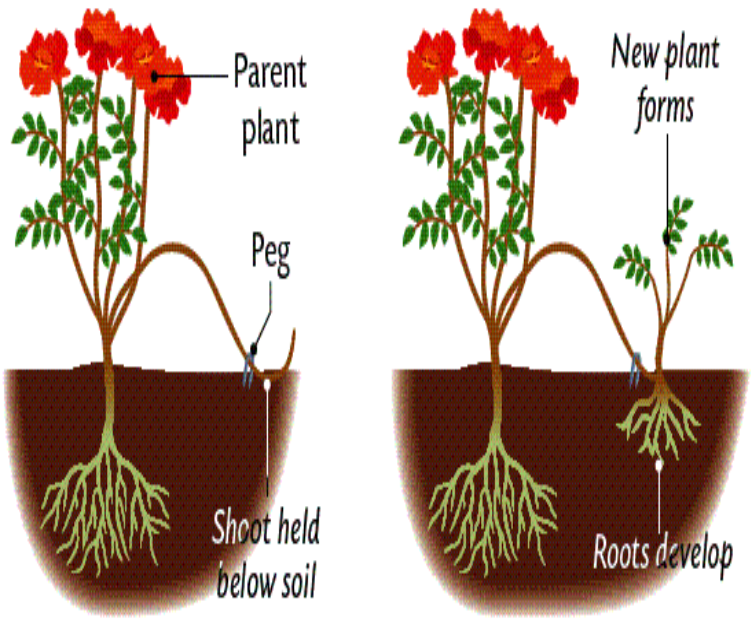
i. Opportunity to change varieties or cultivars for crop improvement;
ii. Optimising cross-pollination, especially in fruit trees that are not self-pollinating;
iii. Advantage of particular (desired) rootstocks, especially in respect of superior growth habits, disease and insect resistance, and drought tolerance;
iv. Benefit from interstocks, valuable in a situation of graft incompatibility;
v. To perpetuate clones by grafting onto seedling rootstocks when clones of plant species (e.g. conifers) cannot be economically reproduced from vegetative cuttings due to low rooting percentage of cuttings
vi. To produce certain plant forms e.g. weeping or cascading forms as in weeping hemlock (*Tsuga canadensi* Carr var. *pendula*);
vii. To repair damaged plants, arising from maintenance equipment, disease, rodents or winter storms, through in arching, approach grafting, or bridge grafting;
viii. To increase growth rate of seedlings, especially in seedling progeny of many trees requiring 8-12 years to fruit with natural development; and
ix. To facilitate virus indexing, through confirmation of presence or absence of the virus by grafting scions from the plant onto another plant that is highly susceptible and would quickly show symptoms of infection.

There are some rules, which must be taken consideration for any grafting method to be successful:

- Two incompatible plants cannot be grafted
- The cambium layers of the rootstock and the scion must touch
- The scion must be the right way up when you graft it
- You can grafting in any time of the year, but the best time for deciduous plants is, when the plant drops its leaves and is dormant
- Cool, cloudy day without wind prevents the graft from drying out, therefore this type of weather is the best for grafting
- The care activities are very important until the rootstock and scion are properly joined

3.2.4 Layering

This involves bending a branch/part of the stem of a growing plant and anchoring (with a rock or peg) and burying a portion of it, with a view to establishing a new root system at the point of contact between the bent part and the earth (i.e. on the shoots that are still attached to the parent plant). A light soil increases rooting success as will wounding or girdling of the buried portion. Treatment with a rooting hormone (e.g. Rootone, HormondinR, HormonexR) is most desirable, particularly one containing a fungicide. Plants with flexible branches are particularly suited to this method. As soon as the new plant is established, the connection with the parent plant is severed and the new plant becomes independent. Layering is a good propagation choice when only a few plants are needed. A heavy soil will reduce rooting success while covering the tip of the parent plant (bent shoot) kills it. Other types of layering are serpentine/compound layering, continuous/trench layering and mound/stool layering.



Layering of plants

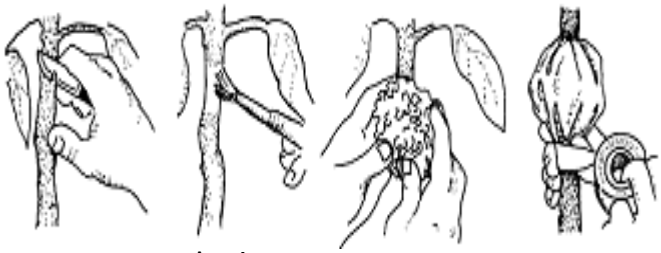
Types of Layering

Banking Up
This is the most common method to propagate pear, quince and apple rootstock (M type clones). This technique needs some preparative work. For about 2-3 years, we cut back the mother plant up to the surface level (or close to it), which will then result in a thicker root neck. This thick root neck will grow custard of stems. We then have to bank up the plant to 10-15 cm high (when the stems have an average 20-25 cm length). We can subsequently harvest the rooted stems at the end of the growing season.

Simple Layering
This technique is commonly used for hazel-nut propagation. During the dormant season, stems are bent down into a 20-25 cm deep trench and covered with soil. The top parts of the stems, which usually have 2-3 buds on them, remain above the surface.

Radial or Chinese Layering
In this case, the whole stem is bent down into a 10 cm deep trench and covered with soil. We then have to bank up the suckers to 2/3 of their height on regular bases. This occurs when the sucker grows 10cm above the surface leaving only the top 1/3 of the plant free. This method is used mostly to propagate Gooseberry, Currant and Hazel-nut.

Air Layering
This method is used on the tip of the branch, when stems are usually younger then one year old. A strip of bark is cut approximately 2 cm wide on the stem about 20 cm from the tip (just below a leaf stalk, or join). Once cut, a rooting hormone is applied and rooting material is placed under the strip. Finally, the cut is covered with a thin plastic bag, which is opened at both ends. Rooting material must be placed in the bag before it is sealed. This process must be completed during rainy conditions, when the air humidity is highest. Litchi, guava, macadamia and mango are propagated with this method.



Air layering

3.2.5 Cuttings

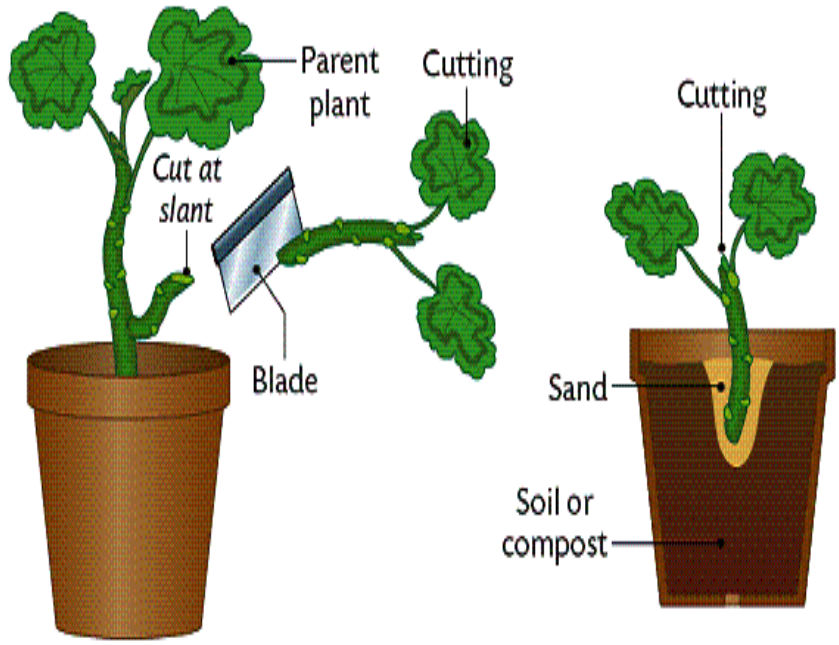
A cutting is a vegetative plant part which is severed from the parent plant in order to regenerate the parent plant (by regaining loss tissues), thereby forming a new plant. A cutting is therefore refers to as any cut portion of a plant which when place in a suitable environment can regenerate into an independent plant. Both woody and herbaceous plants are asexually propagated by cuttings of stems, leaves and roots. Cuttings regenerate new plants through change of mature cells into meristematic cells that are found at rapid growth sites like buds. As in layering, the use of rooting hormone such as auxins, cytokinins as a dip, preferably one containing a fungicide, helps to hasten rooting, increase number of roots, or gives uniform rooting, except on soft fleshy stems. Rooting medium may be coarse sand,

vermiculite, soil, water or a mixture of peat and perlite. A major advantage of cuttings is the practical regeneration of whole plants from actively-growing plant parts/organs. Cutting technique also, typically as with other asexual methods of plant propagation, produces several whole new plants, and which are genetically identical clones of the parent plant. Important disadvantages are that cuttings should be made as soon as possible after collection of plant material; not all species of plants can be propagated from cuttings (e.g. *Acacia* spp.); cuttings must be shielded from direct sunlight, especially if they are under glass or plastic; stock plants (plants used for asexual propagation) should be healthy and well-branched as should the tools and conditions for preparing cuttings to ensure healthy new clones; choice of correct rooting medium to achieve optimum rooting within the shortest possible time. There are many types of cuttings based on the vegetative part of the plant providing the cutting material. There are:

3.2.5.1 Stem Cuttings

This technique is the most commonly used method of propagating many woody ornamental plants and house plants e.g sweet potato, sugar-cane and cassava are food crops propagated from stem cuttings. Stem cuttings of many favourite shrubs are quite easy to root whereas those of a tree species are more difficult to root. A glasshouse is not necessary for successful propagation by stem cuttings but it is critical to maintain high humidity around the cutting. Facilities for rooting cuttings include flower pots, trays, small hoop frame and/or an intermittent mist system. Materials for making stem cuttings should be vigorous, new growth with no flower buds and free of diseases and insects. Cuttings should be 5.08-10.16 cm long, cut from older stems and have 2-3 leaves (2-3 nodes) attached. Dipping the base of the stem, including the node area, into a rooting powder stimulates rooting. The stem should however, be dry when dipped. Four main types of stem cuttings are identifiable based on the growth stage of the stock plant, which is very critical in the rooting of cuttings, namely:

i. Herbaceous Cuttings- Cuttings taken from non-woody plants, such as perennials and house plants e.g. Chrysanthemums, rose. Cuttings are 5.08-15.24 cm stem pieces, with a terminal bud.
ii. Softwood Cuttings- Cuttings taken from soft, succulent, new growth from non-woody stock plants, before the new growth starts to harden (mature). The cuttings are used to propagate flowering shrubs. They must be taken after rain or water is required to keep them cool in the morning. The larger diagonal cut gives more area to develop roots. Cuttings should be kept in water before rooting.
iii. Semi-Hardwood Cuttings- Cuttings prepared from partially mature (firm) wood of the current season's growth, just after a flush of growth. The method is used for propagating many broadleaf evergreen shrubs, some conifers, holly, rose and cacao (using the tips of shoots).
iv. Hardwood Cuttings- Cuttings taken from tissue that has become woody (firm) and the plant is mature and dormant with no signs of active growth. Several cuttings can be made from the same branch of some shrubs. Basal cuts should be just below a node, while the upper cut should be slightly above a bud. Cuttings should be kept moist until rooting. The system is most often used for deciduous shrubs and many evergreen species e.g. grape, fig and rose. The three types of hardwood cuttings are straight, mallet and heel cuttings.



3.2.5.2 Leaf Cuttings

Leaf cuttings are used almost exclusively for propagating a few indoor plants. Leaf cuttings do not include an auxiliary bud, and thus, can only be used for propagating plants that are capable of forming adventitious buds. The method involves the use of a healthy leaf blade or leaf without petiole in propagating new plants, following the same procedures as for stem cuttings, particularly treating leaf cuttings with growth hormones to stimulate rooting and quick bud development. There are several types of leaf cuttings, and for all of them, the old leaf is not part of the new plant and is thus, usually discarded. In most cases, the old leaf provides the energy food source for nurturing the newly-generated plant e.g. Bryophyllum pinnatum.

i. Whole Leaf with Petiole- This involves a whole leaf with about 3.81 cm of the petiole. The lower end of the petiole is dipped into a rooting medium (rooting medium may be coarse sand, vermiculite, soil water or a mixture of peat and perlite) after which one or more new plants form at the base of the petiole. The old petiole may be reused after the new plants have formed their own roots. African violets and pepperoni are propagated in this way.
ii. Whole Leaf without Petiole- This method is used for propagated plants with sessile (petiole-less) thick, fleshy leaves. The leaf is inserted vertically into the rooting medium after which one or more new plants will form from the auxiliary bud. The leaf may be removed after the plant forms its own roots.

iii. Split-Vein- The veins on the lower surface of a leaf from the stock plant (e.g. *Begonia* and snake plant) are slit before the leaf cutting is laid on the medium. The rooting medium is used to hold down the margins of a curling leaf. A variation of this method involves inserting leaf wedges cut with at least one main vein into the medium with the main vein

partially covered. In both cases, new plants are formed from the base of the split vein and leaf wedge.

iv. Leaf-Bud Cuttings- These are used for many trailing vines and when space or cutting material is limited. Each node on a stem can be treated as a cutting. A leaf-bud cutting consists of a leafblade, petiole, and a short piece of stem with an attached axillary bud. The cuttings are placed in the rooting medium with the bud covered (1.27-2.54 cm) and the leaf exposed. Rubber plant, Camellia, Rhododendron and blackberry are propagated using this method.

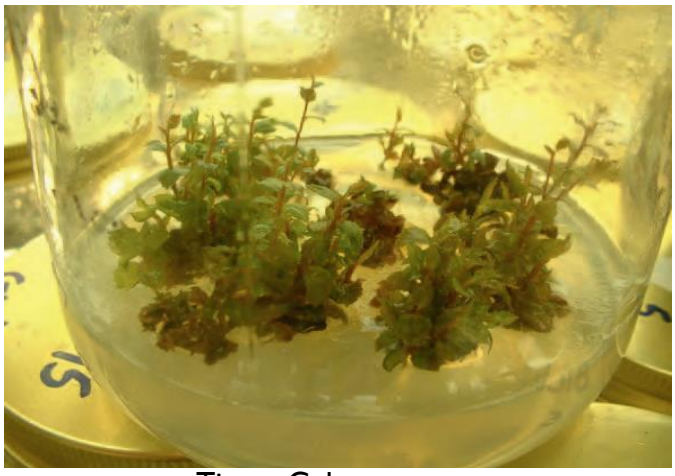
v. Flower Stalks- This follows the same technique as leaf cuttings. It involves plant propagation from a flower stalk, usually with large leaf ears devoid of flower buds. This method enhances chimera production in African violet.

3.2.6 Root Cuttings

This involves the propagation of plants from a section of a root. In some species, the root cuttings produce new shoots which subsequently form their own root system whereas in others, root cuttings develop root system before producing new shoots. Plants propagated from root cuttings include blackberry and rose. In most cases, root cuttings of woody plants are usually taken during the dormant (inactive growing period) season when roots have large carbohydrate levels. Root cuttings can also be taken from actively-growing plants i.e. throughout the growing season. In plants with large roots that are normally propagated outdoors in a hotbed, the root cuttings should be 5.08-15.24 cm in length, with a straight cut at the proximal end and slanted cut at the distal end of the root cutting. In plants with small roots, the root cuttings are 2.54-5.08 cm in length and are laid horizontally about 1.27 cm below the soil or sand in a flat. The flat is then placed under shade, which is removed after new shoots appear.

3.2.7 Micropropagation or Tissue Culture

Tissue culture is a method used for vegetative propagation based on the phenomenon that any part of a plant from a single cell to a whole apical meristem can grow into a whole plant. The explant, the piece of the plant taken, is grown in a sterile artificial medium that supplies all vitamins, mineral and organic nutrients. The medium and explant are enclosed in a sterile jar or tube and subjected to precisely control environmental conditions. In this method, individual or small group of plant cells (tiny pieces of bud leaf and stem) are manipulated in a way to enable them produce a new plant. Mass propagation of sugarcane, sweet potato tubers is achieved by in vitro culture of nodal segments in medium containing 9% sucrose under continuous darkness using Jar Fermentor Technique. Begonia and roses are also propagated by tissue culture using the meristem-tip.



Tissue Culture

The advantages of this method are:

i. speed and efficiency of plant propagation and
ii. Production of disease-free (aseptic) plants.

Disadvantages include:

i. Spontaneous natural mutations and
ii. Very exacting conditions for growing tissue culture materials, such as absolute sterile conditions, strict control of temperature, light, humidity and atmosphere with costly electronic sensors and computer equipment.

4.0 Conclusion

Plant or crops are usually reproduced through sexual or asexual means depending on the mode that is suitable for the crop to produce at maximum productivity. While some crops reproduce through one means others reproduce through both means. Those crops that reproduce through sexual means have the advantage of providing genetical variability for modification while those that reproduce through asexual means have the advantage of producing true-to-type plants.

5.0 Summary

In this unit, you have understood the concept of asexual propagation is a method that involves the induction of a vegetative section or part of a living plant to form roots and subsequently, developing it into a whole new plant. You have also learnt the different methods that can be used to achieve this and they include cutting, layering, grafting, budding and a modern method called micro propagation or tissue culture.

6.0 Tutor-Marked Assignment (Tma)

1. What is micro propagation?
2. Enumerate three advantages and two disadvantages of sexual propagation of plants using the seeds.
3. Define the following terms:

(a) Softwood cuttings (b) grafting (c) budding (d) divisions.

7.0 References/Further Reading

Ngeze, P.B. (1994). *Bananas and their Management.* Bukoba Tanzania: Kagera Writers & Publishers Cooperative Society Ltd. PP 85-93

Ngeze, P.B. &Gathumbi, M. (2004). *Learn How to Grow and Market Bananas.* Acacia Publishers/CTA. www.cta.int

Adams, C.R., Bamford, K.M. & Early, M.P. (1999). *Principles of Horticulture.*(3rd ed.)._ Butterworth-Heinemann, U.K. 213 p.

Simone, Van Ee (1999). Fruit Growing in the Tropics. The Netherlands: AGRODOK 5, CTA, 88 p.

Akita, M. & Takayama, S. (1988). *Mass Propagation of Potato Tubers using Jar*

Fermentor. Techniques. http://www.actahort.org/Asexual Propagation. http://plantanswers.tamu.edu/misc/asexualpropagation.html

A sexual Propagation. http://glossary. gardenweb.com/ glossary/ asexual_propagation.html

Methods of Plant Propagation. http://mastergardenproducts. com/gardenerscorner/new_page_4.htm

Cassells , A.C. & Graham , P.B. (2006). *Dictionary of Plant Tissue Culture* . Haworth Press.

Unit 3 Horticultural Cropping Systems

1.0 Introduction

In horticultural crop production, general agronomic practices are applied and in addition some specialised practice such as prunning, staking, mulching are carried out on some specific crops. These additional agronomic practices are usually done in a carful manner not to harm the crop. Apart from agronomic practices, there are cropping systems that are employed or used on horticultural crops as well as field crops. In this unit, you shall be studying horticultural cropping systems.

2.0 Objectives

At the end of the unit, you should be able to

- define cropping system.
- list the different horticultural cropping systems
- explain the different horticultural cropping system.

3.0 Main Content

3.1 Horticultural Cropping System

Cropping system is pattern or sequence in which the crops are cultivated on a piece of land over a fixed period and their interaction with farm resources and other enterprises. In horticultural crop production the following cropping systems are used.

3.1.1 Continuous Cropping

This is the growing of the same crop for two or more years on the same piece of land. Continuous cropping is typically practiced when there are economic incentives for growing that single crop or there is a limited market for the alternative crop. Continuous cropping also allows greater specialization in terms of management equipment and marketing. However, it can lead to exhaustion of nutrients which are constantly replenished through organic means.

3.1.2 Crop Rotation

This is a planned sequence of different crops grown on the same land over years. The rotation is planned in such a way as to restore nutrients removed of over years and diversity of crop species. The principles used in crop rotation include.

i. Deep rooted crop should be followed by shallow rooted crop.
ii. Crop likely to be affected by the same insect pest and diseases should not follow each other.
iii. Nitrogen taking crops should be followed by nitrogen fixing crops.

iv. A short period of fallow must be introduced into the rotation.

3.1.3 Sequential cropping

This is the growing of crops continuously on the same land throughout the year. In sequential cropping, when one crop is harvested another crop is grown immediately either under rain fed or through irrigation. The land is put on cultivation all year round with same or different types of crop. This type of cropping system requires continuous replenishing of removed nutrients through application of fertilisers. This is usually done on crops that are in high demand throughout the year e.g. Vegetables. Sequential cropping consists of the following;

i. Double Sequential Cropping: It is the practice of growing two crops in sequence in a year.
ii. Triple Sequential Cropping: It is the practice of growing three crops in sequence in a year.
iii. Quadruple Sequential Cropping: It is the practice of growing four crops in sequence in a year.
iv. Ratoon Cropping: It is the practice of cultivating crop regrowth after the first harvest for subsequent production

3.1.4 Sole Cropping

This is the growing of one crop on a piece of land within farming or cropping season. This system of cropping is common among large commercial farms particularly, in developed countries. Sole cropping is usually practiced on crops that are in high demand and have high net return to the farmer. In Nigeria, the farm size for horticultural crops especially Vegetables is small compared with other crops. Monoculture and mono cropping are examples of sole cropping.

3.1.5 Intercropping

This is the growing of two or more crops on the same piece of land either on row arrangement or alternate arrangement. In intercropping, there is competition during all or part of the crop growth and as such, intercropping should be in such a manner that the competition would be minimised. To accomplish these, the following must be considered.

1. Spatial crop arrangement: - Planting pattern on the field.
2. Plant density- number of plants per area.
3. Maturity dates.
4. Plant architecture – canopy cover of the plant.

There are four types of intercropping that can be practiced based on spatial arrangement.

i. Row Intercropping- Row intercropping involves growing of two or more crops at the same time with at least one crop planted in rows and alternated with other crop.
ii. Mixed Intercropping:- This is the growing of two or more crops simultaneously with no distinct row arrangement.
iii. Strip Cropping:-This is the growing of two or more crops together in strips wide enough to permit separate crop production. The strips are alternate, running

perpendicular to the slope of the or to the direction of prevailing winds for the purpose of reducing erosion.

iv. Relay Intercropping:-This is planting of two or more succeeding crops when the standing crop is at its reproductive stage but before harvesting.

3.1.6 Agro-Forestry

It is the practice of integrating the raising of trees into horticultural fruit tree plantation and arable farming by mixed cropping. It can simply be referred to as growing crops under tree canopy. Agro-forestry sustains green cover on the land throughout the year and also involves the integration of appropriate fertiliser trees into crop production. The system bolsters nutrient supply through N-fixation and nutrient recycling, and increases direct production of food crops, fodder, food, fibre and income from products produced by the tree.

3.1.7 Alley Cropping

It is the practice of growing two or more crops in alleys of hedgerows of young tree crops or multipurpose trees and shrubs, preferably N-fixing leguminous species. It is a modified form of agro-forestry.

4.0 Conclusion

Cropping systems are usually a guide for the farmer on how he can plant his crop so as they efficiently utilize the environmental factors to his advantages while sustaining the ecosystem. It is imperative for farmers to choose and adopt cropping systems that would be of tremendous benefit to all stake holders in agriculture.

5.0 Summary

In this unit, you have learnt that cropping system is a pattern of cultivating crop on a piece of land over a fixed period and their interaction with farm resources. The cropping systems that are used for horticultural crops include the following;

- Sole cropping
- Inter cropping
- Sequential cropping
- Continuous cropping
- Strip cropping

6.0 Tutor- Marked Assignment

List five (5) cropping systems used for horticultural crops

1. Briefly explain the types of inter cropping you know
2. Differentiate between sole cropping and inter cropping

7.0 References/Further Reading

My Agricultural Information Bank (2012). Cropping Systems in Horticultural Crops. www.agriinfo.in/cropping

Wyant, (1996). Agroforestry - An Ecological Perspective. Agroforestry Today 8: