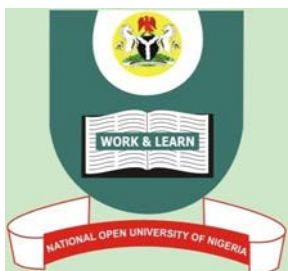


AEM 713: TREE CROPS PRODUCTION



NATIONAL OPEN UNIVERSITY OF NIGERIA

AEM 713: TREE CROPS PRODUCTION

COURSE GUIDE



NATIONAL OPEN UNIVERSITY OF NIGERIA

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Introduction

Tree crop is one semester course of two credit hours maximum. It will be available to all students to take towards the module of their Diploma in Agricultural Extension Management Course.

The course will consist of fifteen units, which involves basic knowledge in propagation, cultivation, nursery and field management and uses of major tree crops produced in Nigeria. The materials have been developed to suit students in Nigeria by adapting more practical examples from the local environment covering the whole country as much as possible.

The intention is for the students to know the major tree crops and how to produce them and be able to impart the knowledge to the farmers who are the ultimate target. The end product of this course is to make vitamins and proteins from various fruits available at affordable costs to Nigerian populace.

This course guide tells you briefly what the course is about. Detailed information on the TMAs is found in separate assignment file and the marking schemes.

What you will learn in this course

The over all aim of tree crops is to introduce the major tree crops cultivated in Nigeria, their centre of origin, general methods of propagation, sexual and asexual; for the asexual, various methods of propagations are treated, budding, grafting, cuttings and layering.

Individual tree crops are treated in great details. You will learn details of production of the crops that will enable you to extend the knowledge to the users of your technology. The technologies specific to different species are individually described. The uses, chemical composition and latest production technologies are treated for each of the crops taught in the course.

As much as possible, you will be treated to practical aspects leaving the details to the special practical classes to be mounted later.

Course aims

The aim of the course can be summarized as follows:

This course aims to give you an understanding of principles of tree crop production and technologies and how they are used in propagation with budding and grafting technologies with the aim of meeting the fruits requirements and needs of the nation.

Course Objectives

The unit objectives are always included at the beginning of each unit, you may read them before you start working through the unit. You should always look at the unit objectives after completing a unit. In this way you can be sure that you have done what was required of you by the unit.

On successful completion of the course, you should be able to:

- 1 Know the tree crops of economic, social and cultural importance to Nigeria.
- 2 Know how to prepare and manage a nursery.
- 3 Learn vegetative technique as methods of propagation in tree crops.
- 4 Know practical methods, materials and equipment generally used in tree crop production.
- 5 Be able to transplant seedling to permanent field site.
- 6 Know post-planting maintenance and service of a tree crop Orchard/plantation.

You will also learn on completion of this course how to propagate, manage, establish and produce the following tree crops:

- 7 Citrus
- 8 Mango
- 9 Guava
- 10 Pawpaw
- 11 Cashew
- 12 Banana/plantain
- 13 Grapevine
- 14 Agbono
- 15 Pineapple

Working through this course

In order to complete this course, you are expected to go through the study units. Each unit contains at least one self-assessment exercise and at a point in the course, you will be required to submit assignments for assessment purposes. At the end of the course, there will be a final examination. The course should take you about 45 weeks in total to complete.

Course materials

Major components of the course are:

- 1 Course guides
- 2 Study units

- 3 Assignments (TMA) file
- 4 References and other resources

Study units

- Unit 1 Introduction to the tree crops of economic, social and cultural importance in Nigeria.
- Unit 2 Preparation and management of nursery
- Unit 3 Vegetative technique as methods of propagation in tree crops
- Unit 4 Practical methods, materials and equipment generally used in tree crop production
- Unit 5 Permanent transplanting into the field
- Unit 6 Post-planting maintenance and services of a tree crop Orchard/plantation
- Unit 7 Citrus
- Unit 8 Mango
- Unit 9 Guava
- Unit 10 Pawpaw
- Unit 11 Cashew
- Unit 12 Banana/plantain
- Unit 13 Grapevine
- Unit 14 Agbono
- Unit 15 Pineapple

AEM 713: TREE CROPS PRODUCTION

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UNIT 1**INTRODUCTION TO THE CROPS OF ECONOMICS, SOCIAL AND CULTURAL IMPORTANCE IN NIGERIA.**

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1.0 INTRODUCTION

This unit will give you the general overview of what is meant by Tree crops. The unit will lead into the general objectives of the course. Definition of Tree crops and production areas in the country will be covered. General methods of propagation both the sexual and vegetative will be described. By the end of this unit you will be able to collect and prepare propagation materials. It will take you to preparation and management of nursery beds. You should be able to know the difference between budding and grafting.

2.0 OBJECTIVES

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

- * Distinguish between different types of economic crops in Nigeria
- * Know their origin
- * Understand different propagation types and methods

3.0 MAIN CONTENT

3.1 Definition of Tree Crops

You may wish to differentiate between Forest Trees and Tree Crops. Trees generally refer to woody plants. They could be Tropical Trees or Temperate plants. Tree crops in our context refer to trees cultivated for their food, cultural or economic values. These include oil palm, Rubber, Cocoa, Cashew, Mango, Oranges (Citrus), Plantain, Banana, Coconut, Guava, Pawpaw, Kolanut, Coffee and Parkia. These are other less prominent local fruit trees which are traditionally cultivated. Examples of such are **Irvingia** (Bush mango), Bread fruit and Pea trees, etc.

3.1.1 Types of Tree Crops

Broadly speaking, there are two types of Tree crops in Nigeria for our Purpose. Crops that are mainly cultivated for food and those that are produced for economic reasons. Tree crops in the former include plantains, bananas, pineapples, pawpaws, parkia, guavas and the likes. Crops such as oil palm, rubber, cocoa cashew, mangoes, citrus, kola, coffee are cultivated for their economic value as cash crops both for internal markets and export.

3.2.1 Importance of Tree Crops in Nigeria

Tree crops and their fruits are important in Nigeria for their nutritional, medicinal cultural or economic values to the nation. Fruit trees production is very important as they have the potentials for a large share contribution to national economic growth through the facilitation of better balanced nutrition for Nigerians, provision of raw materials for agro-based industries, creation of new employment opportunity as product market increases. Exportation of Tree crops produce contributes to generation of foreign exchange. The crops also play a major role in the cycling of plant nutrients, soil and water conservation and the maintenance of favourable macro- and micro-climatic conditions and the creation of shelter belts and wind breaks for desertification control efforts of the Federal Government of Nigeria. In recent times attention has been drawn to the medicinal potency of many of our fruits in Nigeria such as pawpaw, citrus, plantain, banana and pineapple.

3.1.3 Origin and Areas of Production

Most of the Fruit tree crops cultivated in Nigeria had their origin from the Tropical Africa, South America, Asia and Sub tropical regions of the world. Nigeria is one of the distribution centres for some of the crops, e.g oil palm.

Naturally, most of the fruit tree crops in Nigeria are grown in the southern parts of Nigeria, but some are adapted to the northern areas through improved cultural and agronomic practices and availability of modern irrigation systems.

Table 1: Summary Fruit Production in Nigeria (Martin 1979)

State	Citrus	Cocoa kola	Plantain	Banana	Pawpaw	Mango
Anambra/Enugu	xx	x	xx	xxx	x	x
Bauch/Gombe	x			x		xxx
Edo/Delta	x	xx	xxx	xx	x	x
Benue	xxx	xx	x		x	x
Borno/Yobe						
Cross River/Akwa Ibom	xx	xxx	xx	xx		x
Adamawa/Tarabo	xx		x	xx	xx	xxx
Imo	xxx	xx	xx	x		x
Kaduna	x				x	xx
Kano	x				x	xx
Kwara/Kogi	xxx	xx	x	xx	xx	xx
Lagos	xx	x	x	x	xx	x
Niger	xx	x		x	x	xx
Ogun	xxx	xxx	xxx	xx	xx	x
Ondo/Ekiti	xxx	xxx	xxx	xxx	xx	x
Oyo/Osun	xxx	xxx	xxx	xx	xx	x
Plateau/Nassarawa	xx			x	x	xx
Rivers/Bayesa	x	xxx	xx	xx	x	x
Sokoto/Kebbi	x			x	x	xxx

KEY:

- X: Scattered production
 XX: Grown generally
 XXX: Areas of heavy production

3.2.1 Vegetative Propagation

Tree crops are generally propagated by two main methods:-

When seedlings are produced through seeds it is known and called sexual propagation ie seedling production through seeds. However, in some instances (e.g) bananas) seeds are not normally produced by the plant and vegetative propagation is the only practical means of establishing seedlings for the orchard. Vegetative propagation is used, for instance in mango, rubber and citrus as a means of securing high-yielding, genetically – uniform field plantings. You will realize later that high yielding plants which are used to produce planting material are often far from being homozygous (uniforms) so that considerable segregation

occurs in seed material (e.g. oil-palm). This is why you find that many planters prefer to use vegetative materials for planting even though its production may be tedious. The two main methods of vegetative propagation as you will discover in 3.3.1 below are grafting and budding.

3.2.2 Sexual Propagation

In some crops where there is considerable uniformity, propagation is usually by sexual method (i.e seedlings are produced by direct seeding). These crops include guava, pawpaw, cocoa, kolanut and cashew to mention but a few. You will sow the seed in the Nursery directly and later transplant to the field at appropriate time depending on the crop and variety.

Exercise 1.1

SA1 What would you say is the major distinction between sexual and vegetative propagations of Tree crops? Give an example in each case.

TMA When a seedling is produced solely by sowing seed, the propagation is known as sexual e.g. pawpaw. Propagation through budding, grafting or layering is called vegetative propagation, e.g. mango or citrus.

3.2.3 Collection of Propagation Materials

For sexual propagation, you will need to collect your seed material from authentic sources. You must sow certified breeder's seeds so that you may obtain true to type fruit in future. Clean and healthy seed must be used.

You should first survey round to identify trees that have history of true to type fruits, high yielding and freedom from diseases and pests. Such trees would be marked before deciding on buds from which the scions would be taken. "Scions" are the materials taken from describe buds which would be used on the seedlings in the Nursery called "stocks". You will remove all the leaves on the chosen branches and leave them on the trees for about five days after which the branches would be cut and taken to the Nursery immediately for use. You will select scions to be used, carefully removing them devoid of wood with sharp and clean budding knife. You are now ready for budding or grafting proper.

Exercise 1.2

"Iroko" is a tree which grows naturally in the South west and South east of Nigeria. Quality timber is produced from it and it is very useful in the building construction and furniture making industries.

SA2 is "Iroko" therefore one of the leading economic Tree crops or fruit trees in Nigeria?

TMA2 “Iroko” is an economic forest tree but it is not qualified to be a Tree crop because it grows wildly in the forest and it is not cultivate in an orchard.

4.0 CONCLUSION

This unit has distinguished between forest trees and Trees produced in Nigeria. You must have identified the major tree crops cultivated in Nigeria. Their major areas of cultivation and their uses as food, cultural and economic resources. You should have learned major methods of producing seedlings for orchards or plantations by sexual or vegetative propagations. You have been taught how to collect and prepare materials for vegetative propagation, grafting and budding.

5.0 SUMMARY

You have learn in this unit that Nigeria is endowed with many different types of fruit trees/ tree crops and that these tree crops are cultivated throughout the length and breath of Nigeria.

You have discovered that the crops contribute to food, cultural and economic resources of the nation. This unit has introduced you to methods of propagating tree crops and the units that follow shall elaborate on the concept.

6.0 TUTOR MARKED ASSIGNMENT

- 6.1a. List 10 tree crops known to you to be cultivated in Nigeria. Give details of areas of their cultivation and levels of contribution to the food, cultural or economic resources of Nigeria.
- 6.1b. Distinguish between sexual and vegetative propagations in tree crops given example in each case.

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UNIT 2

PREPARATION AND MANAGEMENT OF NURSERY

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1.0 INTRODUCTION

The foundation of Tree crop production is actually the Nursery practices and management. Performance of the orchard or the plantation depends on the quality of nursery preparation, technique and management.

This unit will take you through nursery techniques and practices of the nursery husbandry in Tree crop cultivation. We shall see the purpose of this unit as highlighted in the unit objectives that follow.

2.0 OBJECTIVES

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

- select a satisfactory nursery site
- prepare a functional nursery
- manage nursery beds to the point of readiness for mastering the art and science of vegetative propagation methods.

3.0 Main Content

3.1 Nursery Site Selection

3.1.1 Factors to be considered in selecting a Nursery site.

- (a) You must take a number of factors into consideration as you select or choose the nursery site. You will want to minimize costs as you establish your nursery, therefore accessibility of the nursery to the permanent field site must be taken into consideration. It is of great advantage for the nursery sites to be situated very close to the planting site. This will reduce to barest minimum any damage to seedlings due to transportation. You should as much as possible transplant seedlings with ball of earth to avoid much risk of loss of seedlings during and seedling failure after transportation. Nearness of nursery to the permanent field site will enable you to coordinate

effectively uprooting seedlings from nursery with transportation of seedling and transplanting in the field.

- (b) **Accessibility to water source.** You should site your nursery where a reliable supply of good water is available. A lot of water is required on daily basis, especially during the dry season months by the seedlings and nursery workers alike. Water is needed also for preparation of chemicals for spraying as may be required from time to time. This water should be cheap and clean so that water borne diseases and pests would be eliminated from the nursery.

(c) **Location**

It is of an advantage to you if you select a level land as your nursery site. This will minimize the risk of soil erosion it will reduce cost of maintenance. Easy movement of nursery machinery and tools will be allowed and facilitate application of water by irrigation. If potting bags are to be used, even land will allow for stable arrangement of polythene bags and uniform growth of seedling will be ensure.

(d) **Type of soil**

Nursery soil should be rich, physically and chemically suitable. You must ensure that there is good drainage whether seedlings are raised directly on nursery soils or in containers – seed boxes, polythene bags, trays or pots – it is an advantage if the site is well drained. Absence of water pools and muddy spots in the nursery facilitates disease and pest control measures and general hygiene of the nursery.

- (e) **Availability of labour, proximity of market and accessibility to expertise services.** Operations in nursery are very labour intensive. It is an area where a dependable and regular supply of experience can be easily obtained.

The nearness of nursery sites to potential purchases is of importance to commercial nurseries which raise seedlings for sale to planters. Your nursery should be sited as close as possible to these planters.

You will certainly need services of agricultural or horticultural experts from ministries of Agriculture, Universities or Research Institutes. Nurseries should be located in area where the services of these experts can be obtained easily. You may wish to site your

nurseries where good roads and railway stations which are necessary for transportation supplies, seedling and workers are available.

Exercise 2.1

In this age when there is easy and abundant means of transportation of all sorts, why is it advisable to site nurseries in areas very close to the permanent field site?

It is of great importance if nursery sites are located on or very close to the planting site. Some of the advantages include the following:-

- reduction of the high cost of transportation of seedling (e.g. transportation of seedlings with ball of earth).
- less risk of loss of seedlings during transportation, and seedling failure after transplantation.
- better coordination of transplanting operation with uprooting of seedlings in the nursery
- increase percent “take” of the transplants

3.1.2 Preparation of Nursery Bed

You must have cleared the site of the trash, laid out the nursery site according to plan, planted the wind breaks and fenced the nursery. Erecting of permanent supports for shading materials, digging the nursery beds or laying polythene bags must have been completed.

Your nursery beds, in addition to providing an appropriate growing medium for seeds and seedlings, also help to conserve nursery soils from erosion.

Nursery seed beds are prepared to suit seasons of operation. You can prepare your seed beds to the size of your choice. The fact you must bear in mind is that you should be able to operate on the bed with your hands reaching the other end. The usual size is 1.5m in width, length as you may desire. There are two types of nursery beds.

(a) Raised beds

These are designed for wet or raining season. The distinguishing characteristic is that the bed is raised about 10-15cm above the level of the pathway, purposely to allow for good drainage and prevent water logged beds

(b) Sunken beds

The distinguishing feature is that the beds are sunken 10 – 15cm below the level of the pathway purposely to conserve moisture and retain water during dry season.

3.1.3 Application of Nematocide and Fertilizers

Three weeks before sowing the seeds, you must apply a nematocide, usually nemagon to destroy any nematodes in the nursery at the rate of 1gm per cm². This usually one match box of nemagon per cm². After this, you will now apply your fertilizers- superphosphate and nitrogen at the rates of 50kg and 100kg per hectare respectively.

You could broadcast your seed thinly but evenly on the bed, but it is better that you make shallow channels of 2cm in between rows and 1 cm deep.

3.1.4 Sowing of Seed

You must have selected good seed of known history. Seed with:

- good quality
- high yield ability
- good growth and uniformity
- freedom from diseases and pests (virus and bacterial infections)
- high viability

You can now sow your seed by drilling thinly about evenly in the channels, covering lightly with soil.

3.1.5 Mulching and Watering

The seed bed will now be covered with mulch to retain moisture. The sown seed needs sufficient moisture to enhance germination. You should supply water as required, more often during the dry season than the wet season. Too much water will make the seed to go rotten while insufficient water will dry up the seed and germination will be adversely affected.

Exercise 2.2

What are the two different types of seed bed? Give reasons to support the differences.

The two different types of nursery seed bed are Raised beds and Sunken beds. Raise beds are usually prepared during rainy season to encourage drainage and prevent water logging while the sunken beds are made during dry season to maximize watering effect and retain moisture in the bed.

3.2 Nursery Management

Many tree crop nurseries in Nigeria have collapsed because of poor management. You need to note some essential aspects of nursery management such as:-

- a). Routine hygiene – this will provide healthy environment to workers and aids to minimize pests and diseases. Cleanliness is established through regular weed control, removal of trash and other rubbish use of incinerator and proper handling of nursery materials and tools.
- b) Storage of nursery tools and equipment. You must clean nursery tools and equipment and store them securely each day after use. The tools shed must be properly organised and store items well labeled. You should keep a separate inventory for the nursery.
- c) Labour management. You will realize that nursery labor is specialized and this makes it very important to ensure that labourers, attendants and supervisors are carefully managed. You must provide adequate protection to workers by supply of uniforms (overalls) gloves, aprons, etc for nursery workers. This is paramount to the success of your nursery.
- d) First aid box
It is imperative that you provide a first aid box in the nursery. The nursery staff force must include somebody who has former training in first aid management, especially in treating fresh wounds, snake and scorpion bits and similar injuries.

3.2.2 Shade Management

It is usual that the amount of light received by the unit leaf surface will be too high in young plants which have recently germinated and have not yet developed a large leaf area. You will discover that lead growth or leaf expansion would improve with some degree of Shade. Shade is therefore recommended in the early stages for most of the tree crops such as mango, citrus, cocoa, oil palm, rubber and in any other crop nurseries. A few crops such as coconut may not like shade.

Under hot drying conditions some shade will reduce the loss of water and promote leaf expansion. Another reason for shading nursery plants and nursery materials occurs as a result of the operations involved in vegetative propagation. With cuttings for example you will discover that the material will be very sensitive to moisture stress before rooting has taken place.

It is therefore desirable to provide shade for young seedlings before they become very leafy, and for cuttings and other vegetatively propagated material. You will experience that after sometime, however, young plants will grow larger and inter and intra plant shading will occur so that it usually becomes necessary to remove the shade.

3.2.3 Germinating the Seed

The seeds of most tropical tree crops germinate readily when fresh, but they lose their viability on storage (e.g. cocoa, coffee, kola). With one important tree crop however, viz, the oil palm, seed germination is very low when the seeds are fresh. You will discover that oil palm seeds require a period of heat treatment to increase germ inability and you must give it.

4.0 CONCLUSION

In this unit you must have known what factors to consider in selecting site for a functional nursery and been able to set up a nursery. You have also learnt how to prepare nursery beds, sow seed and take care of germinating seed and take care of emerging seedlings. You have also known how to manage a nursery effectively. You are now ready to proceed to the most practical aspect of this course- the art and science of budding and grating techniques.

5.0 SUMMARY

What you have learnt in this unit was a very important aspect of tree crop propagation– selection of functional nursery site, preparation and establishment of nursery seed beds, fumigation and fertilizing the beds. You can now manage a nursery effectively and successfully and you are now ready to know how to produce seedlings for transplanting through different methods of vegetative propagation.

6.0 TUTOR MARKED ASSIGNMENT AND MARKING SCHEME

6.1 Answer the following questions by inserting in the provided box “True” or “False” .

1. Sitting a nursery far away from the permanent field site will prevent out crossing of the various varieties of crops.
2. Seedlings must not be transplanted into the field with a ball of earth to prevent nematode infection.
3. Nurseries should not be situated near water source to avoid water logging and possible flooding.
4. You must have learnt that shading leads to etiolation of young seedlings. In order to avoid etiolation. You should never provide shade to seedlings in the Nursery.
5. Raised beds are desirable in the nursery during the dry season to conserve moisture and retain water

6. Ideally sunken beds should be prepared during the rainy season to avoid accelerated soil erosion.
7. The best way of sowing seed for maximum effect in nursery bed is by broadcasting the seed
8. You should not apply mulch to the nursery bed in order to avoid possible termite attack on the seedlings
9. Nursery management is labour intensive as a result you only need to recruit volunteers from time to time as their need arises.
10. Modern technology and emphasis on direct seed sowing have actually taken the place of nursery practice.

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UNIT 3**VEGETATIVE TECHNIQUE AS METHODS OF PROPAGATION IN TREE CROPS****TABLE OF CONTENTS**

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1.0 INTRODUCTION

You must have learnt from the previous unit that tree crop propagation can be done by two methods – sexual and asexual (i.e vegetative propagation).

Sexual method is limited to a very small proportion while vegetative propagation is the technique most used to propagate majority of tropical tree crops. By the time you have finished this unit, you will be in a position to know, understand and be able to prepare seedlings for the permanent field site by budding, grafting, layering, cutting and other methods. This unit will also teach you various aspects of management and handling of different types of tree crop seedling in the nursery.

2.0 OBJECTIVES

By the end of this unit, you should:

- know the difference between budding and grafting
- know different techniques in budding
- be able to bud successfully
- know different techniques in grafting
- be able to graft seedlings successfully
- be able to manage nursery seedlings
- know how to prepare seedlings ready for transplanting to the permanently field position.

3.0 MAIN CONTENT

3.1 Budding and Grafting

3.1.1 You may wish to differentiate between budding and grafting. When a shoot or branch which contains more than one bud is cut from one plant and joined to another plant of same genus or species they are said to be grafted.

Budding is a form of grafting in which only one bud is involved instead of a shoot with several buds. There are many types of budding just as there are many types of grafting.

3.1.2 Essential in Budding and Grafting

When you are grafting or budding one essential requirement is the availability of root stocks. Root stocks are plants which will serve you as roots for the grafted or budded material. The root stocks could be seedlings or vegetatively propagated clones. The seedlings root stocks have an advantage of being cheap to produce. They are generally virus free and provide better anchorage because they have deeper rooting system.

The scion which is the material that contains the bud that will be budded or grafted on the seedling in the nursery must be disease – free and when removed must not contain the wood. Budding and grafting can only succeed if the scion and stock have contact only through the cambial tissues.

3.1.3 Budding

There are several types of budding, some of which are listed below. However for our practical purpose, you will be taken through only two or three which are commonly used in our Nigerian nurseries. They have been proven to be well adapted to our local situation in Nigeria:

- (a) Patch budding
- (b) Inverted “T” budding
- (c) Shield budding
- (d) “T” budding
- (e) Ring or annular budding
- (f) Chip-budding
- (g) Flute budding
- (h) Micro – budding

- **Patching budding**

You will make a patch cut or incision on the stock seedling in the nursery. You will then bring a scion (bud) of the same size from a desirable plant. The scion will now be inserted to the patch cut on the root stock. You will tie the bud union with a binding tape making sure that it is water light but the scion must not be covered with the tape. The budded seedling will be left in tact until the budding has taken. Budding is said to have taken when the bud remains green after 14 days followed by sprouting of the bud. (see fig. 1)

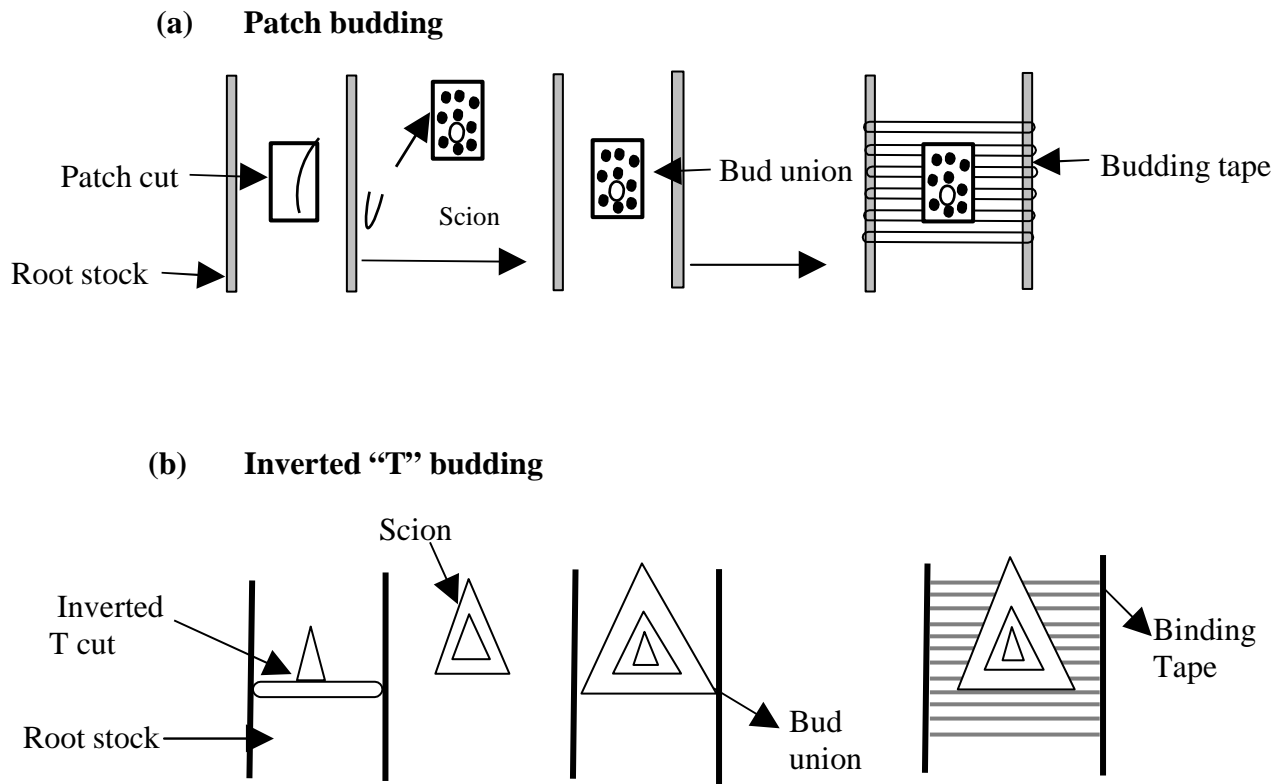


Fig. 1. Types of budding Adapted from Opekpe (1992)

3.1.4 Grafting

When plant parts are joined together they are said to be grafted. In strict terms, grafting is used in vegetative propagation when the graft-scion carries more than one bud. Apart from artificial grafting, natural grafting of branches and roots of trees respectively does occur in nature.

An essential requirement for grafting is the availability of root stocks; these are plants which serve as roots for the grafted or budded material. The root stocks could be seedlings or vegetatively propagated clones. The advantages of seedlings root stocks are that they are cheap to produce, generally virus free and deeper rooting this providing better anchorage. They are however, genetically variable, and to variability in growth and performance of grafted plants.

Sometimes interstocks are required. These are stocks which are inserted between root stocks and scions for special purposes. Inter-stocks are used to circumvent incompatibility or to take advantage of a specific characteristic of the inter-stock (disease resistance, stimulation of profuse flowering or favourable effects on the quality of produce).

3.1.4(a) Types of Grafts

There are many types of grafts. The more common ones are:

- Whip, tongue or saddle graft
- Side graft
- Cleft graft
- Approach graft
- Inarching
- Bridge graft
- Brace graft

We shall illustrate the side graft which is more relevantly simpler to adopt.

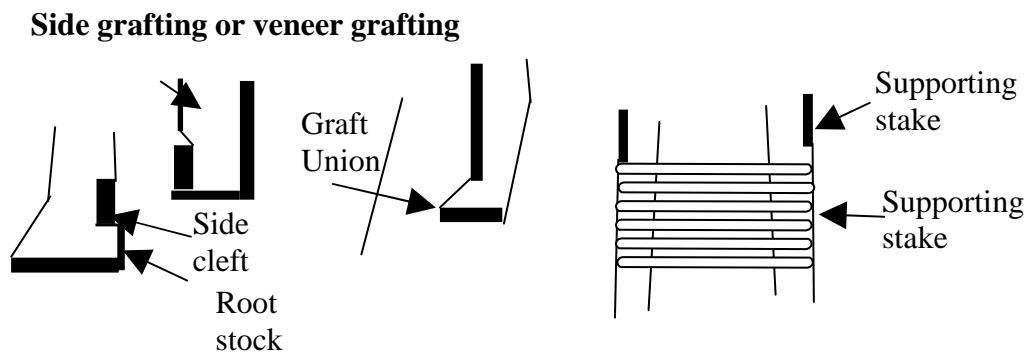


Fig. 2. Type of grafting Adapted from Opeke (1992)

Exercise 3.1

Distinguish between grafting and budding methods of vegetative propagation in Tree Crops.

When plant parts are joined together they are said to be grafted. The graft- scion carries more than one bud. When the graft-scion carries only one bud, the term budding is used.

3.1.5 Cautions to Observed in Vegetative Propagation

- Prepare root stocks for budding or grafting at least one week ahead.
- Use only healthy materials as root stocks and as scions
- Select bud-wood (scion) which is a suitable mature condition (usually about 6 to 15 months)
- Use sharp budding knives and make all cuts clearly and quickly
- Keeping the time interval between incision of the root stock and insertion of the scion to the barest minimum.
- Tie the bud firmly but not too tightly so as to avoid damage to the tender tissues.
- Do not bud or graft during dry or very wet weather, carry out budding or grafting operations in the morning and evenings only
- Use freshly cut bud-wood. Avoid storing bud-wood as much as possible
- After budding or grafting, protect the bud or graft union from rain and from direct rays of the sun
- Correct orientation of the scion on the stock must be ensured. The bud should not be placed upside down.

3.1.6 Post Grafting and Budding Cares

Budded material should be carefully looked after. In addition, the material should be inspected for success accordingly.

- A fortnight after budding, inspect budded material for indications of success. If the bud remains green, it indicates that the operation may succeed, but if the bud has turned brown and shriveled, it shows that the budding operation has failed. If the bud remains green after 10-14 days, the root stock is cut back at a point about 5cm above the bud union.
- 25 to 30 days after budding: the successful bud will at this time start spouting. At this stage, the stump of the root stock is cut back to about 1 cm above the bud union, paint is applied and the bud wrap is untied.

As the bud develops, the young shoot is supported with a stick, side shoots of the root stock are removed; mulch is applied and regular watering carries out when necessary; shade is provided, fertilizer applied; pest and disease control operations are regularly carried out, if required, until the budded material is transplanted into the field. These latter provisions of course also apply to grafted material.

3.1.7 “Incompatibility” and “Take” in Vegetative Propagation

Root stock and scion may be incompatible. The earlier stock – scion incompatibility is detected the better. There are not many reported cases of root stock – scion incompatibility in tree crops of West Africa; this does not mean that incompatibility does not occur. Where it exists it can be easily detected by the following symptoms:

- failure of formation of successful graft or bud union in a high percentage of cases (when experienced people carry out the grafting or budding operation).
- development of a large proportion of yellow foliage in the latter part of the growing season, followed by early defoliation. This may be accompanied by a decline in vegetative growth appearance of shoot die – back general unthriftiness of trees.
- premature death of trees which may live for only a few months or years in the nursery.
- marked differences in growth rates or vigour of scion and root stock.
- overgrowth at, above or below the graft bud union.
- Development of swelling and/or cancerous formation around the bud union.

When incompatibility is established, it may be circumvented by the use of compatible inter-stocks or growth substances.

3.2 Layering as a Technique of Vegetative Propagation

Layering is a useful means of preserving plant material or even of multiplying valuable trees on a small scale. It is a time consuming and laborious method, which may find application only in special cases. The principle is that existing shoots or branches of the tree are induced to form roots by covering part of the stem with soil (normal layering) or a moist rooting medium tied around the stem (air layering).

Vegetative propagation has been successfully applied to many tropical tree crops. Research is, however, needed in many areas including the use of growth substances as to overcome graft/bud scion incompatibility.

4.0 CONCLUSION

In this unit you have must have known, understood and been able to prepare tree crop seedling for the permanent field site by budding, grafting, layering etc. You have also known different types of budding and grafting from which you could choose those appropriate for your circumstances. You have now known how to detect “incompatibility” and “take” after budding and grafting operations. You can now manage your budded and grafted materials.

5.0 SUMMARY

This unit has defined budding and grafting for you. It has also differentiated the two methods of vegetative propagation, illustrating many approaches you can adopt and adapt to suit your local conditions.

Cautions to be taken before, during and after operations were described while another method of vegetative propagation – layering was described and illustrated. You have been shown how to take care of your seedlings after budding and grafting.

6.0 TUTOR MARKED ASSIGNMENT

6.1a Distinguish between budding and grafting

6.1b Write short notes on the following:-

- i. “Incompatibility”
- ii. “Take”
- iii. Layering

6.1.c The following terms are associate to budding or grafting. Classify them according in grafting or budding:-

- a) Inverted
- b) Patch
- c) Flute
- d) Side
- e) Cleft
- f) Approach

6.0 REFERENCES AND OTHER RESOURCES

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UNIT 4

**PRACTICAL METHODS, MATERIALS AND EQUIPMENT
GENERALLY USED IN TREE CROP PRODUCTION**

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1.0	Introduction
2.0	Objectives
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4.0	Exercise (SMA)
5.0	Conclusion
6.0	Summary
7.0	Tutor Marked Assignment (TMA) and Marking Scheme
	References and Other Resources

1.0 INTRODUCTION

The previous units have described in great details vegetative propagation and different methods of achieving it such as grafting, budding and layering success of vegetative propagation depends upon the quality and status of equipment and materials used to carry out the process. This unit will assist you in the selection of your tools and materials. Equipment and materials for tree crop production can be broadly divided into two categories, although the uses may overlaps. These are nursery equipment and materials, and field equipment and materials. Specialized tools and materials are needed for certain operations in the cultivation of individual crops.

2.0 OBJECTIVES

At the end of this unit, you should be able to identify and know all the equipment and materials normally used in the nursery and the field for general tree crops production and specific ones used in production of individual crops. The equipment and materials may look ordinary to you, but each serves different and specific purposes as you will discover.

3.1 Nursery Equipment

The nursery site must have been cleared of trees, trunks, wings and any trash by burning or packing away. You will need to apply correct methods of cultivation lay out. If you are planning a temporary nursery, you may not need to maintain a stock of tools and materials on the site. However, permanent nurseries require a permanent stock of the appropriate tools and materials. The followings are the major nursery equipment that you may need:-

1. **Cutlass or Machete:** This is used for cutting sticks, wood, weeds and bush undergrowth especially outside the nursery fence along the rows of the windbreak
2. **Spade hoe:** It is used for surface cultivation, preparation of bed and construction of drainage and irrigation channels.

3. **Local hand hoe:** This is used for surface cultivation weeding, earthling up of crops and clearing of irrigation and drainage channels and nursery paths.
4. **Spade:** The spade is used generally for digging, turning over of soils topsoil and subsoil clearing paths, drains, mixing soils, compost and construction of both sunken and raised beds during dry and rainy seasons respectively. The spade is an indispensable tool in a nursery.
5. **Shovel:** The shovel is similar in shape to the spade, but with a larger blade. Its main use is in loading soils into trucks or trolleys and in clearing nursery paths. It can be used as a substitute for the spade in a number of nursery operations.
6. **Rake:** This is used for gathering weeds after hoeing and leveling surfaces of nursery beds. It is also useful in spreading fertilizers, preparatory to mixing. It is an indispensable tool.
7. **Digging fork:** It is the main tool for loosening soils, burying weeds, preparing and turning compost, removing plant remains and for mixing particulate and bulky materials.
8. **Trovel:** This is like “running –m ate” to the horticulturist. It is a very useful tool in the nursery. It is used for transplanting seedling for mixing small quantities of fertilizers, soils and saw dust, for filling poly-bags with appropriate growing medium, for weeding, for loosening surface of soil and for application of fertilizers. The trovel is a very flexible tool.
9. **Wheel barrows:** You will discover that they are essential for movement of soils, fertilizers, seedlings and other movable materials and tools around the nursery.
10. **Watering cans:** You will use these for sprinkling water over the young seedlings. Different size jet nozzles should be stocked as very fine jets are needed for newly sown small seeds while medium size jets are used for growing seedlings.
11. **Knives:** You will need three different types of knives in your nursery;
 - (i) **Penknife** – This is used for general purposes of cutting ropes, sharpening of pencils etc. It must be very strong.
 - (ii) **Pruning knife** – Specifically for pruning operations. Must be very sharp and well kept.
 - (iii) **Budding knife** – For budding and grafting only.
12. **Secateurs** – This is a scissor like tool especially made for pruning small branches, leaves and for canopy maintenance.

- 13 **Head Pan and buckets** – You will need these for carrying materials and for measurements.
- 14 **Garden line or tape measure of 30m length** – You will use this for lining out operations and setting off right angles. It is an indispensable tool in the nursery
15. **Seed boxes:** These are needed for sowing small seeds that are later to be pricked out. These can be constructed locally on the nursery site.
16. **Budding tapes:** These are needed for budding and grafting operations. Budding tapes are being replaced with Raphia fibre on many occasions in different parts of West Africa.

Nursery operation is becoming specialized. Different types of equipment are being invested to meet the needs of specialized nurseries. The nursery man must constantly keep abreast of the equipment so as to be up to date in the selection of his equipment.

3.1.1 Nursery Materials

You will need many different types of materials in the nursery. Your need will depend on the specific crop being raised. However, the following materials are some of those often used in a nursery.

1. **Polythene bags-** They are used for various activities in the nursery depending on the size, thickness and texture. They are obtainable from manufacturers cane baskets used to be preferred to the polybags in those days that labour was cheap. Nowadays, the cane basket is too expensive and for economy, poly bags are in common use.
2. **Insecticides and Fungicides** – A good stock of different types of insecticides and fungicides must be maintained. As plants are crowded together in the nursery, each disease or pest outbreak must be promptly treated.
3. **Herbicides-** These are used for weed control particularly in controlling weeds along nursery paths and boundaries.
4. **Fertile topsoil-** This is one of your prerequisites for selecting a site for a nursery. Where nursery beds are used for sowing and raising of seedlings,

the topsoil of the nursery site should be fertile, or fertility has to be raised with the aid of admixtures as farmyard manure or compost.

5. **Sawdust-** Germinating seedling generally requires light and fertile soil. To lighten the texture of topsoil for good growth of seedlings, it is an advantage to maintain a regular supply of well-settled sawdust in the nursery.
6. **Manures and fertilizers-** Manures and fertilizers are not normally needed in the nursery provided fertile topsoil is available nevertheless, it is desirable to keep a small stock of complete fertilizer mixtures preferably those carrying traces of micronutrients.
7. **Plants-** It is a practice to keep a stock of various sizes of wood (planks) in the nursery. They are needed for many varied constructions such as seed boxes and seed trays.

The materials needed in nurseries will vary with the manure and intensity of operations. The list above is not exhaustive. The golden rule is to stock the nursery with whatever is needed well ahead of the time of use.

Exercise 4.1:

List five different nursery equipment and nursery materials commonly used in propagation of citrus and mangoes in your area.

Nursery equipment

Spade hoe
Local hand hoe
Spade
Shovel
Digging fork

Nursery materials

Manures and fertilizers
Saw dust
Herbicides
Insecticides and fungicides
Poly bags

3.1.2 Field Equipment

Various tools are needed for planting, maintenance and harvesting of tree crops in the field. While nursery tools are more or less common for most of the crops, field tools are more specialized. Specialized equipment will be treated under each crop. The more common ones are listed below for you.

1. **Clearing equipment-** The types of tool or machine used for bush clearing will vary with the size of plantation. You will need heavy machinery such as bulldozers and treedozer to clear bush for big plantations. For small farms, the bush clearing tools consist of machetes, axes, pickaxes, mattocks, sharpening stones and files.

2. **Digging equipment-** You will normally dig holes for transplanting seedlings of tree crops in Nigeria. The tools you require are the cutlass, shovel and hoe. With increasing shortage and high cost of labour, it is desirable for you to mechanize. This operation especially on large plantations. Tractor-operated post-hole diggers may be particularly useful.
3. **Lining up equipment-** The amount of surveying to be done will depend the nature of the land. Sloping lands will require contouring either for terracing or for contour planting when leveling equipment such as dump levels are needed. On fairly level lands, leveling may not be necessary in which case the lining tools will consist of machetes, ranging poles, garden lines, pegs, mallets and steel measuring tapes.
4. **Planting or transplanting equipment-** The equipment you will require for transplanting consists of a sharp knife for cutting of polythene bags, and shovels or spades for filling up holes with soil.
5. **Field maintenance equipment-** Because of increasing mechanization of the maintenance operations of the crops, requirements for various tools in the maintenance of tree crops in Nigeria are gradually changing.

However, you may find the following tools in dispensable: machetes, weeding hoes, extension ladders, pruning knives, lawn movers (either hand operated or tractor mounted), spraying pumps, recording materials, harvesting knives, processing, grading and packing tools.

Sometimes you may need soil augers to provide an opportunity to sample the soils in the plantation to allow chemical analysis soil laboratories can provide valuable advice on fertilization practices on the basis of correctly collected soil samples.

Researchers are concentrating on how best to mechanize maintenance, harvesting, processing and grading operations. You should keep abreast of any new developments in appropriate tools as will be recommended from time to time by researchers.

3.1.3 Field Materials

You will discover that the exact materials needed by you for field operations will vary with the individual tree crops. Nevertheless, it is advisable for planters or farm managers to keep a stock of the right types of fertilizers, plant protection chemicals, herbicides, growth regulators, substances and mulching materials mulching needs to be carried yearly until the young trees close their canopy. After the canopy has been closed, there may be accidents such as strong storms, there may be accident such a strong storms, fallen trees and pest damage that could cause a break in the canopy. Soil below such breaks must be mulched in addition to other steps that are taken to repair the damage.

As more people take interest in tree crops production, our researchers in relevant Research Institutes will come out with modern field materials for Fruit Tree Production throughout country.

Exercise 4.2 (SMA)

Field maintenance is a very important aspect of Tree Crops Husbandry. List what in your own opinion, are the indispensable field materials which can be locally sources or manufactured.

The exact materials needed for field operations will vary with the individual tree crops. However, the following are what could be regarded as indispensable or important field materials for Tree crops husbandry. Fertilizers such as NPK, CAN, Urea, Organic manures such as FYM, Poultry manure, compost, plant protection chemicals, herbicides, mulching materials, and growth substances or hormones.

4.0 CONCLUSION

This unit has taken you through various nursery equipment, nursery materials, field equipment and field materials, you have also learnt that most materials and equipment needed in the crop production can be sourced locally, simulated or manufactured. When necessary equipment and materials are available as and when needed, successful fruit tree production is guaranteed.

5.0 SUMMARY

In this unit, you have been introduced to some nursery equipment, nursery materials, field equipment and field materials which are used as routine in the nursery and field management of tree crops. The use of each equipment and materials was described and in some cases, where cheaper and locally fabricated substitutes are available, managers were advised to go for them. You are now ready for actual planting of seedlings permanently in the field.

6.0 TUTOR ASSIGNMENT (TMA)

Classify the following appropriately into Nursery equipment, Nursery materials, briefly giving the use of each of them: fertilizers, plant protection chemicals growth regulators, bush cleaning equipment, digging equipment, lining up equipment, planks. Sawdust, topsoil, herbicides, poly bags, ranging poles, budding tapes, seed boxes, secateurs, shovel, spade, cutlass.

7.0 REFERENCES AND OTHER RESOURCES

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UNIT 5**PERMANENT TRANS PLANTING INTO THE FIELD**

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1.0 INTRODUCTION

You have so far been taken through preparation of the nursery site, methods of vegetative propagation, nursery management, nursery and field equipment and materials. This unit will take you to the permanent field site for the seedlings. By the end of this unit you will be in a position to select your seedlings, prepare planting holes and space of the tree crop seedlings to their permanent positions in the field and be able to manage the seedlings post planting conditions.

2.0 OBJECTIVES

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

- select healthy and well propagated seedlings for trans planting
- select a suitable field site
- prepare the field
- mark out the field
- dig out planting holes at correct spacing

- transplant seedlings successfully

3.1 SELECTION OF THE FIELD SITE

The main factors that determine the suitability of a site for growing any tree crops are as follows:

- a). **Altitude** – Generally tree-crops. With a possible exception of crops such as **Coffea Arabica**, most other tree crops are cultivated from an altitude of up to 700m above sea level.
- b). **Topography**- Level sites are most suitable for growing tree crops, because they facilitate farm operations, movement of men and materials, and reduce the cost of anti-erosion such as terracing.
- c). **Drainage**- Soils that are well drained are the most suitable for most tree crops. However, crops such a Raphia palm, bred fruit and jack fruit prefer very wet but not water logged, sites.
- d). Strong winds are harmful to all tree crops. Most harmful is the harmattan wind which prevails over a considerable part of Nigeria during the dry season.
In selecting a site, the direction and duration of the prevailing winds must be considered.
- e). **Climatic factors**- Most tree crops in Nigeria do best under humid tropical conditions. Therefore, the major climatic factors that must be considered in selecting a site are the following:-
 - (i) **Temperature** – an annual average temperature of 25⁰C to 29⁰C is ideal for most tree crops in Nigeria.
 - (ii) **Rain fall** – When considering rainfall it must be noted that the tree crops of Nigeria are predominantly evergreen in a few cases semi-deciduous. Therefore they require a satisfactory supply of moisture all the year round. Most of these tree crops are adapted to an annual rainfall up to 1000mm and above.
Few, however, like cashew, mango, guava and date palm can do well in low rain fall areas (<1000mm). What is more important than the amount of rainfall is its distribution. The available rainfall should be distributed as evenly as possible over at least nine months of the year.

- (iii) **Sunshine-** Tree crops of Nigeria require much sunshine. Growth becomes poor in areas of frequent and dense cloud covers yield reductions of over 30 percent in cocoa have been attributed to cloudiness in some parts of Nigeria.
- f) **Soils-** Permanent crops, as tree crops, occupy the same site all through their life and their performance over the year is related to the characteristics of the soil in that spot. Therefore the soils should be deep, fertile, well drained, free from soil borne pathogens and supply sufficient water, air and nutrients.
- g) **Availability of labour-** You will recall that the culture of most tree crops in Nigeria is labour intensive. This has led to mechanization of most of the operations. It is not sure whether a number of operations can be economically mechanized. Therefore in selecting a site for any of the tree crops, the source of labour must be given serious consideration.
- h) **Accessibility-** Accessibility of the site is of great importance in sitting tree crop plantations. Accessibility by road, rail water or even air affects the supply of services- labour, agricultural chemicals machine, advisory services and marketing of farm produce. Accessibility is a procurable asset, but it must be taken into consideration in site selection
All these factors are important in selecting sites for tree crop cultivation. It is however, rarely possible to obtain an optimum combination of all the factors in a single location, and the prospective planter is expected to make a judicious choice of the best combination

3.1.1 Preparation of the Field

Most tree crops in Nigeria in the past were established by establishment into food crops in the farming system. With the increasing importance of cocoa and oil palm produce in the world market, the system of mono cropping was adopted for these crops in the country about 70-75 years ago, and this led to land preparation specifically for planting these tree crops. There are about three standard methods of land preparation for their purpose:

- **Clearing:** The area is under brushed. You will fell all the trees, small and big; you will either burn or carry away the trash from the site. You will clear the site of all vegetation. Experience has shown however, that soil deterioration on clear-felled land is very rapid. To reduce the fast rate of soil deterioration when clear – felling is adopted, it is advisable that you leave as much as possible the leaf litter and felled vegetation on the site. It is also advisable that you plant leguminous cover crops such as mucuna. When the crop to be planted requires shade trees it is important to establish these immediately upon clearing the land.

- **Selective thinning:** Selective thinning provides a means of establishing particularly those tree crops of Nigeria that require shading during early growth like cocoa. Kola, coffee, breadfruit. It is also a cheaper method than clear-felling.
- **Bush fallow traces or simple felling:** This as you will see is clearing of land under bush fallow for planting tree crops. It is the simplest type of land preparation, but it can be applied only if cleaning had been done during previous cropping cycles. It consists of cutting traces at the selected spacing through the fallow bush digging the planting holes along the traces, planting the crop. You will then cut the remaining bushes gradually as the crop develops its canopy in subsequently years.

3.1.2 Marking out the Field

After you have cleared the land, the next important operation you will perform in the preparation of the planting site is the marking out of the field. If your farm is small i.e less than 5 to 10ha, the making out operation consists of locating planting sites on the field. If your farm is large there are two aspects to the lining out operation:

- (i) **Blocking of the Plantation-** This is the process by which the plantation is divided into convenient, sizeable block; each block being 5 to 10 ha in size depending on the spacing of the crops. For closely spaced crops, the block size is nearer to 5 ha while large blocks are preferred for widely spaced tree crops.
The blocks are separated from one another by 4m wide farm roads. The shape of the block should normally be rectangular. It may be a rectangle of for equal sides, i.e. a square but experience has shown that rectangular blocks of length 1.5 times width, facilitate estate operations much more than square blocks.
- (ii) **Locating the planting sites-** After division of the plantation into blocks, the planting sites are to be located. Materials required for this purpose are ranging poles, measuring chains or tapes (30m) and pegs or stakes to mark the planting site.

A baseline is adopted at one side of the block in which the planting sites are to be marked. Along this baseline the various sites are marked at the appropriate distances required for the crop to be planted. If planting is done on the square a right angle is to be constructed on the base line in order to locate further sets of planting sites. This is done using the 3-4-5 principle. All planting sites, once located, are marked with wooden pegs pending the preparation of the planting holes. Preparation of the planting holes is done after laying out of the field. Common dimension for the planting holes are 60 x 60cm. During digging, topsoil is preserved at one side of the planting hole and subsoil at the other side. Once the

required depth of 60cm has been reached, the subsoil at the base of the hole is loosened.

Exercise 5.1

List the main factors that determine suitability of a site for cultivation any named major tree crops in Nigeria.

The main factors that determine the suitability of a site for growing citrus, mango, guava, pineapple, banana Irvingia (Agbono) in Nigeria are:

1. Altitude
2. Topography
3. Drainage
4. Aspect
5. Climate- Temperature - Rainfall – Isolation
6. Soils
7. Labour supply
8. Accessibility

3.2 Spacing

Adequate planting distances are essential for economic productivity of tree crops. Table 5.1 shows the method of propagation, average age of first bearing and usual spacing for some leading tree crops in Nigeria.

Table 5.1: Propagation age at first fruiting and spacing of tree crop

Tree Crops	Methods of Propagation	Age at First Seedlings	Fruiting (years) Budded plants	Spacing (m)
Cocoa	Seeds, budding/grafting	4	2.3	3.1 x 3.1
Kola	Budding/grafting	5	3	6.1 x 6.1
Mango	Seeds, budding/grafting	4	2	10 x 10
Citrus	Seeds, budding/grafting	4	3	10 x 10
Guava	Seeds, budding/layering	5	2	9 x 9
Cashew	Seeds	4		6 x 6
Oil palm	Seeds	4		10 x 10
Coconut	Seeds	5		8 x 8
A kee apple	Seeds	7		9 x 9
Rubber	Seeds, Layering, Grafting	5	4	5 x 5
Avocado pear	Seeds, Budding Nothing	7	5	8 x 8
Bread fruit	Rooting, Cuttings		5	11 x 11
Jack fruit	Root Cuttings		4	11 x 11

4.0 CONCLUSION

In this unit you have learnt how to select healthy and well propagated seedlings for transplanting into the permanent field site. You have also been instructed on how to select and prepare a suitable permanent field. You are now in a position to mark out the field for transplanting, dig out transplant holes at correct spacing and transplant seedlings successfully.

5.0 SUMMARY

This unit has described about ten different to consider when selecting a field site for transplanting tree crops and two main aspects viz: blocking of the plantation and locating the planting site while marking out the field. The unit has also taught you how to prepare the field and details of spacings to adopt and methods of planting and transplanting into the permanent field site for major tree crops cultivated in Nigeria. You are now looking forward to pest – planting maintenance operations of important tree crops in the country

6.0 TUTOR MARKED ASSIGNMENT (TMA) AND MARKING SCHEME

Nursery preparation operations are intensive, painstaking, technical and needs timely and precise practices, especially during vegetative propagation. The end result is successful planting and trans planting into the permanent field. What are the main factors you must consider to ensure a successful permanent field for Mango and Citrus in Nigeria?

7.0 REFERENCES AND OTHER RESOURCES

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Module 2

UNIT 1

**POST-PLANTING MAINTENANCE AND SERVICES OF A TREE
CROP ORCHARD/PLANTATION**

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1.0 INTRODUCTION

You will realize that the maintenance of free crop farms is an all – year – round activity. It embraces various operations at different periods of the year. If you give adequate field maintenance to your tree crops, you will discover that it helps to reduce the risks of weeds, disease and pest infestations. This unit will take you through the major items of post – planting maintenance which are among other things, weeding, mulching, shade management, pruning and removal of lateral suckers, replacement of dead stands, pest and disease control.

2.0 OBJECTIVES

By the end of this unit, you are expected to be in a position to have mastered post-planting maintenance operation of the major tree crops cultivated in Nigeria.

- weeding
- mulching
- shade management
- pruning
- disease and pest control
- establishment and management crops
- watering/irrigation
- replacement of dead tree

3.1 Gapping Up

Supplying of vacancies is usually done during the first two rainy seasons after planting of the new farm. This will give you a measure of uniformity among the tree. You should ensure that supplying operations or gasping up is done as soon the rains become established. You will realize that variation in climatic conditions makes the recommendation of a specific time difficult, but you should not that the essential point is adequate rainfall during and after the operation. You should carry out supplying operations well within rainy season to give the seedlings adequate rain for growth before the onset of dry season which may result in heavy losses. You will realize later that the earlier the vacancies are filled the better are the chances of these seedlings catching up to give a uniform tree crop plantation. If you could provide supplementary irrigation, the filling of vacancies becomes less dependent on climatic factors.

3.1.1 Weed Control

To control weed effectively, you must remove the unwanted plants and shrubs from the orchard. Weeding is a great problem when fields are badly established, especially where cover crops are not properly established and, generally, the weed is greatest during the first four to five years, before the plants have established a close canopy. You will experience that frequency of weeding, type of weeding and use of herbicides vary with the type of crop. You may follow the following guide lines:

1. You should keep the orchard weed free. You will have to supplement your three row weeding with at least four to six slashings of the foot paths in a year
2. You need to mulch the trees towards the end of the rains. You should grass mulch and avoid placing trash close to the base of the plants.
3. You may wish to plant plantain as a shade plant. You should avoid planting bananas.

3.1.2 Retention of Moisture (Mulching)

This is the provision of a surface layer of dead vegetable matter to keep soil around the plants moist and enrich it with organic matter you will need to apply this cultural method which yields great dividends when properly carried out. You will discover that application of mulch is important for the following reasons:

- mulch conserves moisture round the plant.
- it helps to cool the soil around the plant
- it supplied organic matter to the soil on decomposition
- mulch assist in controlling weeds around the plant and it acts as an anti-erosion measure.

If you add the advantages of mulching to those of other maintenance operations, growth of the crop is superior which results in more vigor, early canopy formation and early heavy yields.

You should provide the plant with much, 15cm thick and covering an area from 15 cm to 1m away from the base of plant to discourage termites which might first attach the mulching material and then move to the seedling. Vegetative much is preferred to synthetic much such as polythene sheets, because of high costs and also because the poly sheet does not add nutrients to the soil.

Exercise 6.1

Why must you provide mulch around the tree crop seedling which has its canopy to prevent excessive evaporation of moisture from its immediate environment?

The application of mulch is a cultural method which yields handsome dividends when properly carried out because it is beneficial to crop in at least five important ways:-

1. It conserves moisture round the plant especially in the early stages of the seedling.
2. Mulch helps to cool the soil round the plant
3. It adds organic matter to the soil
4. It suppresses weeds round the seedling and it acts as an anti – erosion measure in the orchard.

3.1.3 Shade Management

As you must have learnt in the first unit, many tree crops in Nigeria originated as part of the under storey of the tropical forest and require shade during their first few years after planting in the field. The ideal shade plant should satisfy the following conditions:-

- a) It should be easy to establish
- b) It should establish it to provide an evenly distributed shade within a short time of planting and throughout the year, especially during the dry season when shade is most needed.
- c) You should ensure that it completes as little as possible with the crops for soil nutrients and especially for moisture,
- d) It should be so temporary that it will be easy to remove when no longer needed, and the process of its removal should do as little damage as possible to the crop.
- e) It should not be an alternative host to insect pests and diseases of the crop.
- f) As much as possible, you should plant as shade, plants of some commercial or social value.

It might be of interest to you to know that so far the ideal shade plant has not been identified for many tree crops in Nigeria, but plantain and not bananas is nearest to an acceptable shade plant. As you have been earlier informed above, natural shade is used, land preparation is done by felling or by selective thinning.

In addition to permanent shade, nurse shade is recommended for a few tree crops in Nigeria. Cocoyams (*Colocasia esculentum*) have been successfully removed after two or three years so that you do not have a situation when it becomes an active competitor for nutrients and moisture with the orchard crop.

You may provide temporary shade in addition to various shade plants. This is generally necessary during the first dry seasons after planting into the field. You can provide temporary shade through the use of palm fronds. You must remove temporary shade at the end of the dry season i.e when the early rain must have become established.

3.1.4 Pruning

You need to carry out pruning essentially to remove unwanted growth and thus maintain regularly shaped trees carrying a well-balanced, firmly closed canopy. You carry out pruning sometimes to regenerate old trees. If your pruning is unskillful it may lead to unnecessary injuries to trees with consequent reduction in yield. You are advised to do light pruning, although the frequency of pruning depends on the rate of growth of trees and type of crops. You should remove unwanted vegetative parts (lateral suckers, chupons) These should be removed as close as possible to the stem from which they emerge preferably at an early age, to save the trees from wasting their energy on unwanted growth which may even affect their productive growth and development of the tree.

Canopy maintenance, the removal of unwanted growth from the canopy and light pruning can be carried out at any time of the year to minimize effect of mutual shading. Heavy pruning, (formation pruning) which is aimed at regulating the shape of the trees, you may wish to carry out when the early rains become established. You should use a light-weight sharp cutlass or pruning saw, which are the most suitable tools for most pruning operations. You should use a sharp knife or pair of secateurs for removing chupons, lateral suckers, young flushes and major branches. A heavy bow saw is recommended for removing branches and stems. Pruned surfaces should be painted with ordinary paints or any sealing compound to prevent disease infection. Lateral suckers are generally profuse and troublesome in crops such as citrus and coffee. In citrus their prevalence, especially around the bud union is indicative of incompatibility between root stock and scion.

3.1.5 Establishment and Management of Cover Crops

Leguminous plants such as cowpeas, **centrosena pubescens** are commonly used as cover crops in tree crop cultivation in Nigeria, at least for the first few years before canopy establishment. The use of a cover crop is more popular with those three crops that are widely spaced. Guava, cashew and so on. As you must have known from previous sections above, the main advantages of leguminous cover crops in tree crop orchards are as follows:

- the cover crop serves as an anti-erosion measure
- it helps to suppress weed
- it adds nitrogen to the soil through its nodules
- adds organic matter to soil and help to cool the soil while the roots help to improve the physical structure of the soil

You should establish cover crops as early as possible after hand preparation. If you had clear – felled the land previously, it will be advisable to establish cover crops before planting the main crop. When sample felling and selective thinning as earlier discussed is practiced, the cover crop can be established after field planting.

You should know that the management of the cover crop is as important as its establishment. You should keep cover crops away from the crops by a space of at least 30-40cm around each plant. The cover crop is to cover the interspaces between the plants. If you use a cover crop, it is not necessary for you to use non-selective herbicides. Improperly managed cover crops can turn out to be the most dangerous used weed in the plantation.

3.1.6 Water Supply (Watering/Irrigation)

If you establish your orchards or plantation in area where there is adequate rain fall for a greater part of the year watering or irrigation of tree crops in the field may not be necessary. In many parts of Nigeria, the dry season may last up to three to six months. In such areas, as the Northern part of the country, success in the establishment of tree crops in the field will depend to a great extent on the supply of water to the seedlings during their first two dry seasons in the field. Adequate mulching and establishment of cover crops helps to economize on the application of water. You should carry out your watering during the cool hours of the day, preferably in the mornings or the evenings, and you should not allow water to collect around the seedlings in order to prevent water logging while could lead to diseases or even death of the seedlings.

3.1.7 Copping Patterns with Tree Crops

The normal practice with tree crops is sole cropping especially where land is abundantly available. However, land is gradually becoming limited in most free crop producing areas in Nigeria. Also, many tree crops are widely spaced, and in

the early years before these crops form their canopy, it has been shown that intercropping with compatible annual crops is an economic advantages.

When intercropping, you should leave a space of 1m to the tree crop seedling in the first year. You should gradually increase this distance in subsequent year until you stop intercropping when canopy closes in.

It is important that you adopt adequate fertilizer practices for the intercrop in addition to those for the tree crop.

By far the most common method you may adopt for tree crops is the “compound cropping system”. In this system, you can grow a few trees around the compound and they are supplied with their moisture requirements from house hold waste water compound crops also receive a large part of their nutrients from house hold wastes- ashes, food left over etc. generally compound crops will receive your intensive care and they are generally more productive than field grown crops. However, they are necessarily limited in number.

4.0 CONCLUSION

This unit has taken you through what is involved in Post – planting maintenance and services of a Tree crop Orchard plantation.

You have learnt that special attention must be paid to the following activities if a success must be made of maintenance of the field: gapping up; retention of moisture; known as mulching; weed control; shade management; pruning; establishment and management of cover crops; water supply and cropping patterns with Tree crops.

5.0 SUMMARY

At the end of this unit, you must have learnt maintenance of tree crop Orchards or plantation is an all – year round activity that embraces various operations at different periods of the year. You must have also learnt that adequate field maintenance helps to reduce the risks of weed disease and pest infestations. You have learnt that the major items of post-planting maintenance are weeding, mulching, shade management, pruning and removal of lateral suckers, replacement of dead seedlings and disease control.

6.0 TUTOR MARKED ASSIGNMENT (TMA)

List the major items of post-planting maintenance operation of four named fruit tree crops commonly grown in Nigeria and briefly discuss their importance to the cultivation of the crops

7.0 REFERENCES AND OTHER RESOURCES

Opeke, L.K (1992). Tropical Tree Crops. Spectrum Books Limited, Ibadan, Nigeria

UNIT 2

CITRUS

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1.0 INTRODUCTION

This unit will give you details specific to citrus production. You will be familiar with production details which apply to all members of the Genus Citrus

Table 7.1: Important Citrus species grown in Nigeria

Sweet orange	-	Citrus sinensis Sour
orange	-	Citrus aurantium
Lime	-	Citrus aurantifolium

Lemon	-	<i>Citrus limon</i>
King orange	-	<i>Citrus sinensis x Citrus reticulata</i>
Tangerine	-	<i>Citrus reticulata</i>
Grape fruit	-	<i>Citrus paradisi</i>
Shaddock (pomelo)	-	<i>Citrus grandis</i>
Tangelo	-	<i>Citrus paradise x Citrus reticulata</i> (an interspecific hybrid)

Citrus species are grown principally for the juices of their fruits and for local consumption. They are rich sources of vitamin C.

Citrus cultivation is on a small scale in Nigeria. The cultivation of citrus is yet to be organised and encouraged so as to maximized the use of the various products obtainable from the fruits.

2.0 OBJECTIVES

At the end of this unit you should be in a position to:

- be able to select site for citrus production
- know various varieties of citrus
- prepare nursery
- prepare seed bed
- provide rootstock
- prepare budding bed and carry out budding
- transplant to field, manage the field up to harvesting and storage

3.1 Site

You will prepare rich deep loamy site. Citrus will however survive and do rather well in soils to shallow and poorly aerated for other tree crops to survive. On the other hand you will find out that Citrus tress may be badly injured in soils a little more shallow and wet where mango for example would thrive. Any site selected should be level or only slightly sloping. It should also be protected from strong winds either naturally or by the establishment of wind breaks.

3.1.1 Varieties

You will discover that the group or Genus Citrus comprises species in which sweet orange, Grape fruit, Lemmon and Lime are included.

In the sweet orange, good varieties include Valecia, Washington Navel, King, Ibadan Sweet, Ogbomosho Sweet, Nigerian Green Sweet, Tangelo etc.

You will see that in the Grape fruit, there are varieties like pink freshed forster, the seedler March and Thompson.

3.1.2 Nursery Practices

In addition to what you have learnt in unit 2, “preparation and management of Nursery” above, on how to prepare nursery for tree crops, you will need to select an area with a good shelter from winds. In areas of heavy rainfall, a gently sloping ground must be preferred for free drainage. You must avoid water logging conditions. You should look for deep and well- drained soil.

3.1.3 Seed bed Preparation and Sowing

You will cultivate deeply and then apply fertilizers as a base dressing as follow:-

Super phosphate	60g/m ²
Sulphate of ammonia	30g/m ²
Potash	30g/m ²

You should make your seed bed to be about 1.2-2m wide and as long as practicably convenient for you. You will need to raise the bed to some 15cm above the surrounding ground level. You should be careful of using organic manure because it might introduce disease organisms.

You should sow your Citrus seeds in either seed boxes or in nursery beds as single seeds spaced at 3 x 6 cm. you should prick out the seedlings when they are 3 to 6 cm in height into care baskets or poly bags which you had filled with fertile top soil.

3.1.4 Root Stock Seed Planting

Plant the seeds of the desired rootstock. You will usually use rough lemon seed but could be others like sour orange etc in rows about 25cm apart on the bed and about 8cm within the row. You may drill the seeds and thin to about 8cm apart later.

You will need to mulch the seed bed with groundnut husk or some other suitable material. Apply plenty of water but avoid undue moisture other wiser fungus disease might attack the seedlings.

You will then trans plant to budding bed at about 4 months after sowing

3.1.5 The Budding Bed

Set seedlings in rows 45cm apart and 25cm within the row. Mulch heavily with dry grass leaving a small area around each seedling to reduce the danger of disease infection from the mulching materials.

Water the plants regularly. Each plant should get about a gallon of water per week.

Apply about 149 of sulphate of ammonia and 149 of muriate of potash per seedling every 8 weeks.

After 7-12 months on the budding bed, the seedlings are ready to be budded.

3.1.6 Budding

You will recall that we have dealt with budding in unit 3 “Vegetative technique as methods of propagation in Tree Crops” above. This section is to update you specifically for Citrus budding.

You may start budding at the beginning of the rains or at the end of the rains but not at the height of the rainy season. This is because disease organisms grow very easily during the rains.

You may bud your material during the dry season provided watering or irrigation facilities are available. In this case you can regulate the amount of water the budded trees receive.

Budding is carried out in the cool hours of the morning or in the evening at a height of 25 to 30 cm from ground level on the prepared seedling root stock. You should avoid budding during the hot hours of the day and during heavy rains.

You will look after your budded stocks in the normal way until they are old enough for transplanting into the field.

The Most Popular Methods of Budding used in Citrus are:-

1. Inverted “T” budding
2. “T” or Shield budding
3. “Side budding”, similar to side grafting in mango has just been discovered by us in IAR, Samaru. (It is yet to be published but it is about 75-80% successful, all other things being equal.

3.1.7 Transplanting

You may use two methods. The “bare-root system” or the “ball of earth” method. The “ball of earth” method is better because since a lot of soil is left on the roots, transplanting shock is greatly reduced. If the “bare root system” must be use

because of transport difficulty with the “ball of earth” method the roots must be dipped in a “slurry” mixture of soil, clay and water suitable consistency. The routine transplanting methods have already been discussed in unit 5 above.

3.1.8 Orchard Planting

You should plant your seedlings into the orchard at the beginning of the rainy season (May – June). You will dig your planting holes 1m x 1m x 75cm or as appropriate about one week before transplanting if possible.

You should half-fill the planting hole with top soil mixed with rotten compost or topsoil with high organic matter content. Put the seedling in position with one operator holding it upright and in position in the hole, and the other operator being responsible for arranging the roots properly (for seedlings planted with naked roots). After proper filling, the second operator should consolidate the soil around the seedling to ensure that air pockets are completely excluded from the zone.

You must allow adequate planting distances which are essential for economic productivity of Citrus.

You should use recommended spacing for Citrus which is 10m x 10m.

Orchard planting is a very delicate and extremely important operation. Those to do the planting should be selected on the bases of carefulness and be trained in correct ways of planting.

3.1.9 Fertilizer Application

You will be wise to apply Nitrogen, phosphorous, potassium and magnesium. Where the trace element has been found to be deficient (they are not normally deficient) by foliar analysis, for examples, the elements, manganese, molybdenum, Boron etc, should be supplied if necessary by spraying.

You should ensure that the recommended fertilizers by the Federal Ministry of Agriculture and Natural Resources for your zone are used.

Exercise 7.1 (SMA)

Citrus is a very important Genus in the family Rutaceae. It contains species that are most important sources of Vitamin C which was famous for curing or preventing scurvy in the exploration and navigational era. Classify this group.

Sweet orange	-	<i>Citrus sinensis</i> Sour
orange	-	<i>Citrus aurantium</i>
Lime	-	<i>Citrus aurantifolium</i>
Lemon	-	<i>Citrus limon</i>
King orange	-	<i>Citrus sinensis x Citrus reticulata</i>
Tangerine	-	<i>Citrus reticulata</i>
Grape fruit	-	<i>Citrus paradisi</i>
Shaddock (pomelo)	-	<i>Citrus grandis</i>

Tangelo - *Citrus paradise* x *Citrus reticulata* (an interspecific hybrid)

3.1.10 Pruning

You will do little pruning in Citrus because it is likely to reduce yields if severely done. You therefore limit to removal of dead wood, overly vigorous branches and suckers.

Sometimes it might be necessary for you to remove too much dense growth to open up the trees for sunshine and wind to dry the trees in area of heavy rainfall. This will reduce the infections by gummosis and foot rot fungi.

3.1.11 Water Requirement

Citrus trees deplete soil water simply throughout the year; long water deficits therefore impair tree growth and fruit setting. However, some short period of water deficit is required for flower initiation. Even though the drought may have lasted just enough to start flower induction, you will find that oranges will not blossom until the rains begin or you irrigate the orchard.

You know that citrus trees tend to drop their fruits excessively because of great daily water deficits especially parthenocarpic fruits (fruits which develop without fertilization) for example, Washington Navel Oranges.

Exercise 7.2 (SMA)

What do you understand by the term parthenocarpy? What is its significant importance in Citrus production an industry?

Parthenocarpy is the term used for a situation where fruit development takes place without fertilization. These fruits are said to be parthenocarpic. Examples of these in Citrus are Washington Navel, a sweet orange and marsh seedless, a grape fruit.

It is believed in the Citrus industry that when seeds are processed with fruits in the extraction of juice, the natural sweet taste of orange is tampered with. A situation where there are no seeds in the fruit is a welcome development. Having to remove seed mechanically or manually before fruit extraction attracts extra cost.

3.1.12 Harvesting and Storage

Citrus begins to bear fruits from 3 to 5 years after planting in the field depending on the species, variety and method of propagation. Vegetatively propagated materials comes into earlier than seedlings.

In Citrus, you will discover that the color of the fruit is green when fruits are not mature, in many cases (Nigerian Green Sweet is an exception). On maturity, the fruits begin to ripen during which period the Colour turns yellow.

You should harvest when mature fruits with considerable green will ripen if you store at 60°F without artificial treatment. (like ethylene). Only fruits that are ripe at harvest keep at low temperature like 45°F.

It is very important that you do not bruise the fruits while harvesting, otherwise moulds can gain entrance and cause foot rot and this is the greatest source of loss after harvest.

Citrus fruits are easily perishable after ripening. To ensure that fruits are not lost through over-ripening, fruits should be harvested immediately they are ripe and delivered to consumers, processors or retailers. In some cases, you may need to store your fruits for some time while awaiting markets or transportation to distant markets. Under such circumstances, you may need to harvest the fruits a short time before full ripening, the time interval between harvesting and full ripening depends on the length of time the fruits are to be stored or the length of time required for transportation.

When fruits are destined for distant markets, you should harvest when they are physiologically mature but before ripening, such fruits generally ripen a route to the market or they are treated with chemicals (ethylene, etc) to ensure uniform ripening.

3.1.13 Pests and Diseases

You will experience a number of insects attack on your Citrus. These include scale insects, aphids, mealy bugs, mites, fruit moths, beetles and others. You will need to use insecticides. However, in spraying Citrus with insecticides you should take caution. Certain persistent insecticides such as DDT could do more harm than good as they kill both pests, predators and parasites. Please consult a specialist before the application of chemical sprays to Citrus.

Citrus diseases may be caused by virus, bacteria, fungi, algae, nematodes and plant parasites. Citrus plants are also known to suffer from a number of deficiency diseases.

Major diseases of Citrus:

1. **Tristeza-** This is a virus disease of Citrus. It is not controllable but preventable by using correct root stock, e.g. Rough lemon.
2. **Anthracnose-** Major symptoms are leaf blight twig blight and staining. It can be controlled by spraying with copper fungicides, form sanitation and you could use resistant varieties, if any

3. **Scab-** It is caused by fungi. The main symptoms are whitish scabs on leaves twigs and fruits of Citrus. Major methods of control are farm sanitation; you may spray with fungicides such as Captan, Bordeaux mixture.
4. **Foot rot or brown rot-** This is simply known as Citrus gummosis. It is caused by phytophthora sp. It kills the bark on trunk and roots which eventually kills plants. Control is to treat plants with effective fungicides.

Minor Diseases:

1. Sooty mould
2. Algal leaf spots
3. Mistletoe
4. Mineral deficiencies

In most cases, you do not need to worry much with the minor disease. Adequate farm sanitation will keep them in check.

4.0 CONCLUSION

You must have learnt by the end of this unit that Citrus group comprises very important species that of economics and medicinal important as well being dietary nutritious. It grows across the nation and produced all the year round. It is in international trade and exportation could bring much required hard currency to the country.

Production of Citrus requires specific skills which can only come by training.

5.0 SUMMARY

You have learnt through this unit how to select a site and Citrus varieties for you Orchard. You have also known the nursery practices and how to prepare seed bed, root stock, budding bed and budding. You can now select bud wood for Citrus orchard, transplant and plant, fertilizers (types and rates). You have mastered weed control measures, pruning techniques, water requirements, harvesting, storage, pests and disease control.

6.0 TUTOR MARKED ASSIGNMENT (TMA)

What are the major and minor diseases of Citrus? Give control and preventive measures for each of them. List the major pests of Citrus and their controls.

7.0 REFERENCES AND OTHER RESOURCES

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UNIT 3

MANGO (*Mangifera Spp*)

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1.0 INTRODUCTION

This unit will take you through techniques and technologies required in production of mango and post-harvest activities.

Mango is one of the commonest and heavily consumed tropical fruits. Its production is seasonal in Nigeria, Limited to early rainy season, all over the country, although there are scattered mechanized orchard which have advantage of irrigation.

Mango is a good source of vitamin C. Mango fruits in their fresh forms are highly perishable after harvest particularly under hot tropical conditions. Post-harvest handling of mango will also be discussed in this unit.

2.0 OBJECTIVES

By the end of this unit, you will know how to:

- * select suitable site for mango orchard
- * propagate mango seedlings vegetatively
- * establish a viable mango nursery
- * prepare thriving field of mango
- * successfully maintain a mango orchard
- * know all about fruiting and harvesting mango fruits.
- * and know pests and disease of mango and their control measures

3.0 Site

You will best grow your mangos at elevations from sea level to 1,300m, but they do best below 700m and in climates with strongly marked seasons and dry weather for flowering and fruiting.

Mangoes will thrive on a wide variety of soils provided they are not too water logged, too alkaline or too rocky, but even shallow, impervious soils with adequate supply of water.

3.1 Variety

Mangoes belong to the family of Anacardiaceous and Genus *Mangifera* with over 60 species. In Nigeria, these are many varieties and cultivars in cultivation ranging from many species of local, fibrous small sized varieties such as “Binta

sugar to big sized improved and budded varieties”. Usually referred to as “Kerosine mangoes”. Some of the leading improved varieties that you are likely to come across are: Peter, Julie, Peach, Alfonso, Mambroulla, Indi Sincar, Kent, Admira – A, etc.

3.1.1 Propagation

You can propagate your mango varieties through seed and vegetatively. Propagation the seed is easiest and cheapest. However because of the problem of monoembryony which give rise to seedlings invariably different from maternal genotype, you will have to resort to various methods of vegetative propagation.

You can achieve vegetative propagation of mango by budding and grafting. You may wish to refer to unit 3, “vegetative technique as methods of propagation in Tree Crops”, above for greater details. You will recall that budded seedlings may come to bearing within 3 to 5 years, while normal seedlings may only reach this stage after 6-10 years.

3.1.2 Nursery Management

You may wish to refer to unit 2, “preparation and management of Nursery” above. All the details are relevant to Mango production.

In January you will maintain the graft in the nursery; spray against pests; irrigate as necessary etc.

In April, transplant established graft to the nursery bed. In May, start preparation for collection of Mango stones for rootstock production. In June continue collection of mango stones for nursery, start grafting in the nursery. In July start planting mango stones in nursery beds and established root stock collection block. In August, maintain root stock collection block, apply fertilizer, graft last year’s rootstock seedlings.

3.1.3 Field Preparation

You will start your field preparation by clear felling followed by burning the trash, lining out and preparing the planting holes. Your holes should be 60 x 60 x 60cm.

The spacing recommended for wing breaks as a protection against anticipated winds and storms.

3.1.4 Field Maintenance

Right from the time of transplanting you are advised to establish a cover crop to protect the soil, but this will have to be removed as the trees form their canopies.

You should water or irrigate your young seedlings during the first dry season after transplanting into the field. This is because the seedlings will not have formed a sufficiently deep root system.

You should remove any early flowers formed by the seedlings in the first few years after establishment in the field and support vegetative development by applying manure. You should use nitrogenous and potassium fertilizers a well.

It is advisable for you to intercrop your mango for the first 3 to 4 years after its establishment in the field. You can plant vegetables and leguminous crops in between the rows.

3.1.5 Harvesting

You will discover that mango is prolific in flowering but only one third or less of the flowers will set fruit. Flower shedding is very high in mango. Flowering starts during dry season, December to January while fruits mature from April to May.

Mango fruits are easily and rapidly perishable. Up to 40% of mango fruits are wasted in Nigeria, every year. Once the fruit matures, you should harvest for consumption or preservation.

You should harvest mango fruits by hand and collect in bags. You should harvest your mango fruits once in a week or regular basis. However, you will discover that one of the problems that will require your attention in mango is irregularity of fruit ripening. This phenomenon has made the harvesting of mango a very expensive venture.

3.1.6 Post Harvest Handling

Mango is one of the most highly perishable fruits in the tropic. You will have to handle very carefully, after harvesting.

When you see the followings in the fruit: rotting, colour degradation and shrinkage, you should know that spoilage has set in.

Packaging and transportation:

1. You should place your fruits in suitable containers such as ventilated plastic crates, slatted wooden boxes or fibre – board boxes.
2. You should leave enough space between the roof top of the fruit and the top of the fruit and the top of container to avoid pressure bruising from over-head container.
3. Load and off load fruits carefully into and out of transport vehicles
4. Transport in clean, ventilated vehicle preferably during the cool period of the day

Storage:

You should store wholesome mango fruits in cool store/fruit shed. You could also use an evaporative cooler or cool chambers at temperature not below 8°C

Delayed Ripening of Mangoes

- Wrap in polythene bag of thickness not more than 0.05mm
- You could store in cool environment such as in evaporative cooler or thatched cool shed.
- Open package and remove the fruits after about one week and expose fruits for ripening

Processing of Mango Fruits

You can process mango fruits into fresh mango juice, jam or marmalade. It can be dried into mango chips that could be eaten or rehydrated and processed into juice, jam, as well as marmalade.

- Mango fruits may be canned as peeled fruits, slices or in the form of extracted juice.
- You can preserve your mango for up to 30 – 40 days by freezing immediately after harvesting. Nutrition or taste qualities remain the same.

Exercise 81 (SMA)

It is known all over the world that mango fruits are as perishable when mature and ripe as they are tasteful and nutritious. How would you harvest and handle ripe mango fruits with minimum damage and spoilage.

1. You must harvest at mature green stage early in the morning or late in the.
2. You should pluck fruits carefully, (preferably by hand or by a mango picker to avoid mechanical damage).
3. The fruit should be washed in potable clear water immediately after plucking to remove the gummy sap which could stain the fruit and thereby reduce its market appeal.
4. You should separate diseases or damaged fruits from the lot.
5. move fruits to a cool shed for packaging

3.1.7 Pests and Diseases

The mango tree is relatively free from pests. Mango hopper or jassid, **Idiocerus** spp, is the most serious pest of mango flowers. You may spray DDT for control. Fruit flies attack mangoes by laying eggs in mature fruits. Mango weevils, **Cryptorrhynchus** spp, damaged the seeds. Mangoes are also attacked by thrips, scale

insects and mealy bugs. You can control all of them by spraying with appropriate recommended insecticides.

You will discover that Anthracnose is the most serious, most common, widespread and dangerous disease of the mango fruit. It is caused by the attack of the fungus **Colletotrichum gloeosporoides**. The fungus attacks mango fruits at any stage of development, causing stunting and eventual drop of the attacked fruits. Fruit anthracnose can be controlled when you spray a fungicide to the affected fruits and as a routine as well. Powdery mildew, **Oidium mangiferae** also caused losses to flowers and young fruits.

You will find another important disease in mango scab, which may attack any part of the tree – leaves, twigs, flowers, fruits. It is caused by **Elsinoe mangiferae**, a fungus control can be achieved through farm hygiene and by spraying with appropriate recommended fungicides.

4.0 CONCLUSION

This unit has described in some detail production aspects specific to mango as opposed to general production practices of fruit tree crops. You have learnt that mangoes are produced in the tropics and consumed all over the world as fruits rich in Vitamin C. You must have been informed that mango is relatively free from pests then most other fruits trees and tree diseases are mainly fungi and are easily controlled by routine farm hygiene, and spraying of appropriate fungicides.

The unit has also informed you that mango fruits are delicate and very easily perishable. They should be handled carefully. The fruits are preservable by many methods which make mango available for use in ore form or the other throughout the year and every where in the world.

5.0 SUMMARY

You have learnt in this unit how to select your site for a mango orchard, the available varieties to choose from for your scions and root stocks. The unit has also illustrated vegetable propagation methods appropriate for mango and nursery management tips. You must have learnt how to prepare and maintain your mango field. Harvesting and post-harvest handling of the fruits are specific and skilful activities, which unless strictly adhered to may lead to great losses in quality and quantity of the fruits. Pests and diseases specific to mango have been described and you have been taught how to prevent or/and control them.

6.0 TUTOR MARKED ASSIGNMENT (TMA)

Mango fruits in their fresh forms are highly perishable after harvest particularly under hot tropical conditions. List the causes and signs of spoilage, signs of spoilage and recommendation for harvesting and handling mango fruits.

7.0 REFERENCES AND OTHER RESOURCES

- Olarewaju, J. D. (2002). Horticultural Crops Production in Nigeria. An overview paper presented at the National workshop on Horticulture Export, Abuja, Nigeria 23rd – 25th April.
- Opeke, L.K. (1992). Tropical Tree Crops. Spectrum Books Limited, Ibadan, Nigeria.
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UNIT 4**GUAVA (*Psidium guayaba*)**

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1.0 INTRODUCTION

Guava *Psidium guayaba* is becoming one of the most important fruits in Nigeria. It was not important in the past because it was erroneously believed that consumption of it was capable of causing appendicitis, (inflammation of the vermiform appendix) in human being. It contains very high concentration of vitamin C which makes it a leading economic fruit tree crop.

It grows quite well throughout Nigeria and produces prolifically in the drier parts of the country if supplemented with irrigation during the dry season.

2.0 OBJECTIVES

By the end of this unit you will be able to:

- select a suitable field site for a guava orchard

- know guava varieties
- be able to propagate guava seedlings vegetatively
- establish stooling
- plantain orchard and after care
- to apply fertilizers appropriately
- control weed
- harvest, pack and transport guava fruits and know guava pest and their controls.

3.1 Field Site

Your guava will survive on nearly every type of soil, but it grows best in a well-drained sandy soil. You should avoid planting guava on heavy soils because it will limit its growth especially in the dry.

3.1.1 Varieties

The following cultivars have been found to be promising for cultivation and further propagation:

- Jumbo white
- Ruby supreme
- Webber supreme
- Branca arredondede
- Supreme

3.1.2 Propagation

If you want to obtain guava trees which would produce uniform fruits of good quality as the mother trees, guava should not be propagated through seeds. Rather, you should use any of the vegetative propagation techniques which were described in unit 3 above, viz, grafting, rooting of hard wood cuttings and stooling.

3.1.3 Nursery Establishment

(a) Sowing of Seeds and Raising of Rootstock

Although seeds of guava will retain their viability to up to one or one and half year after extraction, you should plant guava seeds as soon as possible, after removal from fruits. You may sow the seeds in flats or trays containing light sandy loam soil and cover to a depth of 1cm. after the seedlings have formed their second leaves you can transplant them into the nursery you should use a space of 75cm between rows in the nursery and

30cm between plants in the row. You may commence your grafting when the seedlings are about pencil thick. Best time in the year throughout the

country is between May and September, because this is the most moist period in the year.

(b) Selection of Scion

If you choose to adopt the technique of veneer grafting, you should select your scion shoot from the current season's growth and it should be green and quadrangular in shape. The selected scion should be defoliated one week prior to removal from mother plants, as defoliation helps in activating the axillary buds. Immediately after you have detached the shoot from the mother tree, you should wrap the scion sticks in moist newspaper and pack in polythene buds. This way the scions can be kept in good condition for about one week, but you should graft these on rootstocks without much delay.

(c) Technique of Grafting:

Make a slightly slanting cut about 3.5cm long at the proximal end of the vigorous and healthy root stock seedlings (see fig 2 in unit 3 above) taking adequate care that both fit together completely without any gap in between. This will give you success in grafting. After joining the two, you should now wrap tightly with polythene tape. The scion bud should start to sprout in about 21 days. At this stage the upper part of the stock should be removed. About 45 to 50 days later, when the scion has sufficiently, you may cut off the stock just above the point of union. Your grafted plant that you have prepared is now ready for planting.

Rooting of hard wood cuttings

You should collect leafy hardwood cuttings from selected plants. Make for vertical incisions at the base of the cuttings from selected plants. Make four vertical incisions at the base of the cuttings. You should give a quick dip to cut ends in a solution of Indole butyric acid (IBA) 250 ppm (in 50% alcohol). You should plant the treated cuttings in a shade. Roots should begin to appear 25 days. You should transfer the rooted cuttings first to large pots or polythene bags filled with a well manured soil mixture. Your plant will be ready for transplanting in 15 days. These plants can be multiplied further by stooling technique described below.

Stooling

Establishing stooling plots by planting plants prepared by cuttings from the selected trees. In the succeeding year you should cut back the plants to a height of 30cm during the month of March.

Multiple shoots grow usually in the months from leading back. Make two rings 3-4 apart on new shoots near the base. Remove the bark and apply Indole Butyric Acid paste (500ppm) in lanolin. After about 10 days, you should cover the ringed portion with a mound of soil. The same stool will give you rooted shoots every year for several years to come. You should plant the rooted shoots immediately

after removal in polythene bags containing well manused soil. You can transplant these in a few weeks time.

3.1.5 Orchard planting and after - care

You will discover that guava grafts are slightly difficult to transplant and require more care in handling from nursery to the field. The usual practice is that you cut the tap root after the onset of rain to induce fibrous feeding roots. After about 45 – 50 days, the grafts should be removed from the nursery bed with a ball of earth. If the graft is too big, you should prune the branches to reduce lead area. In extreme cases, all the leaves should be removed before transplanting. You should take adequate care to reduce mortality of the grafts in the field during wet seasons. Incase of plants raised by stooling or cuttings, no such care is necessary because the plants have settled already in polythene bags.

You should dig the planting holes 50cm x 50cm at a spacing of 7m x 7m. You will fill the pits with about one bucket of compost, available, duly mixed with soil. You should place one plant in each pit. You must water the plants immediately after planting. You should continue watering during any dry spell. You should also mulch the ground around the base of the plant to retain moisture.

3.1.6 Fertilizer Application

You already know that fertilizer is applied in a ring about 30cm from the crop. This also stands for guava plants. You should give the young trees fertilizers in the following recommended proportion:

1 st year	-	50gm of NPK mixture (1.1.1) in one dose
2 nd year	-	300gm of NPK mixture (1.1.1) in three doses
3 rd year-	-	450gm of NPK mixture (1.1.1) in three doses
4 th year	-	600gm of NPK mixture (1.1.1) in three doses
5 th year	-	600gm of NPK mixture (1.1.1) in three doses

As we discussed in Citrus above, you can intercrop your guava trees with leguminous or vegetable crops up to 3 to 4 years.

Exercise 10.1 (SMA)

You will have observed from what has been discussed above that guava is somewhat different from other tree crops discussed so far. What has made propagating of guava unique from other tree crops such as Citrus, Mango etc



Recommended propagation methods adapted for Citrus and mango are mainly vegetative propagation i.e budding and grafting, using various methods as convenient. However, guava can be propagated by seed and vegetatively further more, all methods of vegetative propagation adapted for guava seedlings are different from those know and used for Citrus and mango. For guava, the following methods of vegetative propagation have been described above:- veneer grafting, Rooting of hared wood cuttings and stooling.

3.1.7 Weed Control

You will normally control weeds in a guava orchard by slashing manually or using mowers. You can also ring weed trees regularly when the seedlings are small, while total weeding could be done at 1-2 monthly interval depending upon the season. You can use contact herbicide such as paraquat, glyphosate as per recommendations only. You may use inter cropping with cover crop as a source of weed control as well, whatever method adopted you must keep clean your guava orchard all the time.

3.1.8 Harvesting, Packing and Transport

As a general rule, you should harvest guava when the fruits stat yellowing, except in some green varieties such as Jumbo white. If the fruits are meant for distant, market, you can harvest mature green fruits. Guava is usually hard-picked in baskets or wooden crates which are well ventilated. You will harvest fruits meant for the processing factories as per their standard requirements and specifications.

3.1.9 Pests and Diseases

Some common pests that you may likely experience on guava fields are:

- a. **Homeocerus Pallens** – an insect pest which attacks the fruits of the guava.
- b. **Pachnoda spp-** this also feeds on fruits
- c. **Argyoploce spp** – (false codling moth) attacks the leaves

Control: Spray the crop weekly with ambush at the rate of 4m in 10 litres of water. You must use clean potable water.

There are not many known major diseases in guava. However you may notice fungal disease of leaf and fruit spots. Spray with fungicide in noticed. The fruit – rot see in guava fruit is usually caused by fruit worms.

4.0 CONCLUSION

By the end of this unit you must have learnt that guava is one of the economic fruit tree crop in Nigeria mainly because of its high content of vitamin C. Yu must have also learnt that guava tree can be propagated sexually and asexually. Vegetative propagation in guava is done by unique grafting methods – side veneer

grafting, Rooting or hard wood cutting and stooling, stooling in guava – moulding of soil stooling in guava- rooted shoots. You must have known that guava has less pests and diseases than many other fruit tree crops produced in Nigeria.

5.0 Summary

For successful cultivation of guava:

- select a well drained sandy soil
- use any of the recommended varieties
- water plants immediately after planting in orchard and during dry spells
- mulch as recommended
- apply fertilizer as recommended
- weed as recommended
- harvest when fruits start yellowing

6.0 TUTOR MARKED ASSIGNMENT (TMA)

Guava tree grows throughout the year; this means that there should be some activities each month of the year.

Prepare a summarized calendar of operation for Guava.

7.0 REFERENCES AND OTHER RESOURCES

Olarewaju, J.D. Lecturer notes on Horticultural Production, ABU Zaria.
Guava NIHORT Press, Ibadan

UNIT 5

PAWPAW (PAPAYA) (*Carica Papaya*)

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1.0 INTRODUCTION

Pawpaw or papaya as it is also known belongs to a small, somewhat anomalous family with four Geneva, of which three are in tropical and subtropical America and one in Africa- *Carica papaya* belongs to this. Usually, as you will observe, pawpaw is a small tree with terminal clusters of leaves and later in all parts. The leaves are spirally arranged, stipulate. It is often disecious.

2.0 OBJECTIVES

At the end of this unit you should know;

- * Use of pawpaw
- * Origin and distribution
- * Chemical composition
- * Propagation; field establishment; harvesting pests and diseases of **Carica papaya**.

3.0 MAIN CONTENTS

3.1 Origin and Distributions

Carica papaya has never been found wild, but it is probable that it originated in Southern Mexico and Costa Rica. From there, it has now spread to all tropical and subtropical countries of the world.

3.1.1 Uses of Pawpaw

You should know that the ripe fresh fruits are what you eat at your breakfast and dessert, and in fruit salads. You could use pawpaw fruits for making soft drinks,

jam, ice cream flavouring, crystallized fruit and canned in syrup. Unripe fruits are cooked as a substitute for mango and for apple sauce.

You can use pawpaw, prepared from the dried latex of immature fruits, a proteolytic enzyme similar in action to pepsin, and used in meat-tenderizing preparations, manufacture of chewing gum and in cosmetics, as a drug for digestive ailments, in the tanning industry for bating hides, for degumming natural silk and to give shrink resistance to wool.

Young leaves are sometimes eaten as spinach. Sweet meat is made from the flowers. The leaves and young fruits are used to tenderize meat.

The seeds are used in some countries as a vermifuge, counter-irritant and abortifacient pawpaw fruits have been found to be medicinal – fibroid, tuberculosis, malaria.

3.1.2 Varieties

There are a number of named cultivars, but these are difficult to maintain in dioecious plants. The hermaphrodite “Solo”, introduced from Barbados is one of the best varieties, the fruits are pyriform, about 10 x 15 cm and weigh about 2kg.

3.1.3 Ecology

Pawpaw is a tropical plant and is grown in latitudes to 32°N and S, it is easily killed by frost. Near the equator, it produces good crops up to about 1,700. It requires full sun, but you should provide wind breaks. Low temperature results in fruits of poor flavour. You should prepare well-drained fertile soil with pH of 6-6.5; it thrives well in such soils. Pawpaw cannot stand water – logging, you should avoid it. If you grow pawpaw in dry regions, you should provide irrigation.

3.1.4 Fruits

Pawpaw is a fleshy berry, 7-30cm long, weighing up to 9kg, ovoid-oblong to nearly spherical from pistillate flowers; pyriform, cylindrical or grooved from hermaphrodite flowers; skin thin, smooth, green, turning yellowish or orange edible, with consistency of butter, and with mild and pleasant flavour; central cavity 5-angled.

3.1.5 Seeds

Many parietal, attached in 5 rows to interior wall of ovary; spherical, about 5mm in diameter, black or grayish, wrinkled, enclosed in gelatinous sarcotesta formed from the outer integument; embryo median, straight, with ovoid, flattened cotyledons surrounded by fleshy endosperm. About 20 dried seeds per gram.

If you want to germinate the seeds you must remove the gelatinous envelope before planting. You should also air-dry seeds so that they will retain viability for 2-3 years. Germination will take 2-3 weeks and it is epigeal.

3.1.6 Chemical Composition

The edible portion of fresh fruit contains approximately:

88%	-	water
10%	-	sugar
0.5%	-	protein
0.1%	-	fat
0.1%	-	acids
0.6%	-	ash
0.7%	-	fibre

Pawpaw is a rich source of vitamin A and has some vitamin C. The latex contains the enzymes papain and chymopapain, both of which have protein – digesting and milk clotting properties.

3.1.7 Propagation

You will normally propagate pawpaw by seed. You may plant the seed in wooden flats, which you will place in the sun while the cotyledons are still large and green. You will then transplant into containers or polythene bags 3-4 weeks after germination. At 8 - 10 weeks after sowing, when the seedlings are 15 – 20cm high, you will transplant them to the permanent orchard site.

On the alternate, you may sow your pawpaw seed into the nursery beds at 15cm depth at a spacing of 10 x 2.5cm. You will require 2,400 seedlings to plant one hectare. For papain production, seeds are usually planted at stake with 10-30 seeds per hill. On germination, you will thin to about 5 plants which you will allow to for 6 months the sex can be determined at flowering. Ultimately you will leave one female plant per hill and one male plant for every 25 – 100 female plants. When you plant hermaphrodite cultivars such as “Solo” you will remove the female plants so that fruits of uniform size and shape are produced.

You can propagate pawpaw vegetatively by cutting or grafting, but this is not economic and therefore not recommended for commercial production. It is largely an academic exercise.

3.1.8 Field Establishment

The usual spacing is 2-3m apart. It may be necessary for you to water the transplants and to shade with bracken or other material. Your after - cultivation should be limited to weed control only. You are allowed to intercrop your pawpaw with vegetables or leguminous crops before the canopies are established. Mulching the plants at the initial stages particularly is advantageous for retention of moisture. You will obtain good responses if you supply organic manure and nitrogenous fertilizer. NPK, 15:15:15 at the rate of 0.9kg per mature tree. Pawpaw trees come into bearing at 9-14 months. Although pawpaw tree may theoretically live for 25 years, yields decline with age. For practical purpose, the productive life of a pawpaw tree is not more than 3 years.

3.1.9 Harvesting

For fresh fruit, you may harvest your pawpaw when the first traces of yellow appear on the skin, after which they will ripen in 4-5 days. You should cut the fruits with a sharp knife. You will find that pawpaw yields per tree vary from 30 – 150 fruits per annum, giving up to 35tonnes of marketable fruit per hectare

3.1.10 Pests and Diseases

The most serious disease you may experience is a mosaic virus which stunts the plants. This causes yellow mottling and distortion of the leaves, blending down of petioles. It causes death of the tree. You will see that such diseased plants yield little or not at all. You will discover that in some areas of Nigeria it is now almost impossible to grow pawpaw on the account of the virus. This mosaic appears to be very virulent. It is caused by the vector.

Aphis spp and in Hawaii, a major pawpaw producing nation, the vectors are myzus spp. The vector of the bunchy – top virus is the leaf hopper, **Empoasca papaya**.

Pythium spp cause a collar – and foot-rot when pawpaws are grown under water logged conditions. Anthracnose **colletotrichum** spp cause spotting of ripe fruits. Mites are the most serious pests of pawpaws some birds also damage the fruits.

Exercise 10.1

Almost every part of pawpaw plant is useful one way or the other. List the major uses of pawpaw:

- The fresh fruits are eaten throughout the world for breakfast and in fruit salads.
- They are used for making soft drinks, jams, ice cream flavouring, crystallized.
- They are canned in syrup.
- Unripe fruits are cooked as a substitute for marrow and for apple source

- Papain is prepared from the dried latex of the immature fruits.
- Used in meat- tenderizing preparations
- Used in manufacture of chewing gum and in cosmetics
- Young leaves are sometimes eaten as spinach
- Seeds are used as a vermifuge, counter – irritant and abortifacient

3.1.11 Production

Much of the pawpaw crop in the tropics is consumed locally, as it is difficult to transport the fruits satisfactorily over long distances. Fresh fruits are exported by air and in cold storage by sea from Hawaii to the United States, but little fresh fruits reaches other temperature countries. Pawpaws are now being canned and this market will probably increase.

Tanzania has become the leading producer of pawpaw in the world, with maximum production of about 200,000 tons per annum smaller quantities are produced in Uganda. The production in Nigeria does not meet even domestic requirement in large cities. The Chief importer of papain is the United States. Market is very sensitive to over production.

Exercise 102

You can describe pawpaw fruit as a delicacy, loved by many people all over the world. What is the chemical composition of this fruit?.

The edible portion of fresh fruit contains approximately:

Water	-	88%
Sugar	-	10%
Protein	-	0.5%
Fat	-	0.1%
Acids	-	0.1%
Ash	-	0.6%
Fibre	-	0.7%

Pawpaw fruit is a rich source of vitamin A and has some vitamin C. The latex contains the enzymes papain and chymopapain, both of which have protein – digesting and milk clotting properties.

4.0 CONCLUSION

We have seen through this unit that pawpaw belongs to a small family, caricaceae with four genera. You have learnt that the pawpaw we know belongs to species **Carica** papaya which is cultivated throughout the tropies for its edible fruits. Pawpaw fruits are use for food; for making soft drinks and desserts. Unripe fruits are cooked as a substitute for marrow and for apple sauce. Papain is prepared from the latex of pawpaw. This papain is a proteolytic enzyme used in meat

tenderizing preparations etc. You have learnt that young leaves of pawpaw are used as spinach. Seeds of pawpaw are used as a vermifugu, counter – irritant and abortifacient.

You can propagate pawpaw by seeds, vegetatively by cuttings or by grafting.

5.0 SUMMARY

You have learnt through this unit that pawpaw can be cultivated in Nigeria. You must have also known that pawpaw has many uses and that it has been known even as domesticated crop. You now know that pawpaw is a short – lived, quick growing, soft – wooded tree, 2-10m in height the chemical composition of pawpaw. You are now in a position to propagate pawpaw from nursery to the orchard, through weed control, harvesting, storage of fruits, pests and diseases with their control measures. In Nigeria, pawpaw is produced mainly for domestic consumption but has a future in exportation.

6.0 TUTOR MARKED ASSIGNMENT (TMA)

Pawpaw is a very popular tropical fruit that is eaten as favourite all over the world. Describe the production of the tree crop under Family Genus Uses; Fruits; Chemical composition; propagation and major diseases and pests.

7.0 REFERENCES AND OTHER RESOURCES

Purseglove, J.W. (1968) Tropical Crops Dicotyledons I. Longmans, Green and Co. Ltd London and Harlow

Module 3**UNIT 1****CASHEW (*Anacardium Occidentale*)**

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1.0 INTRODUCTION

The cashew plant, *Anacardium occidentale*, is a native of central and south America with its main centre of variation in eastern Brazil. Cashew is now grown in many parts of the world where growth is not limited by cold. The annual world production of cashew nut, the main commercial product of the cashew plant is about 500,000 tones and more than 60% of this production

comes from south Asia and east Africa especially India and Tanzania. Small quantities of cashew nuts are produced in West Africa and in Nigeria. Production is limited to peasant farmers in the north central zone of the country.

As a crop plant that is very tolerant of poor soils, low soil moisture content and low rainfall, you will discover that cashew has proved to be a good cash crop in areas where other tree crops produce little or nothing.

2.0 OBJECTIVE

By the end of this unit, you will have understood the taxonomy, origin and distribution, ecology and structure of cashew as a tree crop. The unit will also teach you how to germinate the cashew nut seed, propagate, take care and produce cashew. You will have also known the uses, chemical composition, diseases and pest and their controls.

3.1 TEXONOMY

Cashew, *Anacardium occidentale* is a member of the family Anacardiaceae, the family to which mango belong. It belongs to genus *Anacardium* of about 8 spp of trees and shrubs of which *Anacardium occidentale* is widely cultivated throughout the tropics for its nuts.

The cashew tree is a medium size with a spread canopy often with branches that droop. The mature height is 10 – 11 metres.

3.1.1 Uses

You will see that seeds are the source of cashew nuts, produced by shelling the nested fruits. They are used in confectionery and dessert. They yield edible oil, but due to the high price of the kernels, this is not usually extracted. The shells or pericarp yield cashew-shell oil which you may use as a water proofing agent and as a preservative. If you distill and polymerize the cashew oil, you can use it in insulating varnishes and in the manufacture of type writer rolls oil and acid proof cement and tiles, brake linings inks etc. The cashew apple which is the fleshy swollen pedicel is juicy and astringent and it is edible. You may ferment the juice and make into wine. You may make the pulp also into preserves. You can get your indelible ink from the sap from the bark. You can also feed to the pulp of the apple to the livestock.

3.1.2 Origin and Distribution

The cashew is a native of tropical America from Mexico to Peru and Brazil and also of the West Indies. It was one of the first fruits trees from the new world to be widely distributed throughout the tropics by the early Portuguese and Spanish adventives. It was introduced into India from Brazil by the

Portuguese in the 16th century and it probably reached the East African coast and Malaysia about the same time. You should know that cashew has become naturalized in many tropical countries including Nigeria.

3.1.3 Ecology

The cashew is hardy and drought-resistance but it is damaged by frost. You may have noticed that it thrive under variety of climatic and soil conditions and can be grown from sea to 300 m, but it is best suited to the lower elevations. You need areas with rainfall ranging from 50 – 375 cm per annum. Your cashew will grow best on sandy soils with good drainage, but it often grown on hillsides too dry and stony for other crops.

3.1.4 Selection of a Site

Unlike the other tree crops we had considered in this course, you will grow cashew under a wide range of ecological conditions. Cashew is reasonably tolerant of low moisture content in the soil while its growth is not adversely affected by high soil moisture content. It will however not tolerate water logged conditions. You must keep the soil deep, freely drained and the land reasonably flat.

3.1.5 Germination of Cashew Seeds

Cashew seeds possess a very thick coat and because of this, the seed take a very considerable time to germinate. - You can obtain early germination, however, if you induce it by the following means:

- 1 You can crack the seed coat – this is a delicate operation which you must carry out with care to avoid damage of the embryo and cotyledons.
- 2 You may treat seeds with dilute sulphuric acid (H_2SO_4)
- 3 You can achieve quick germination by soaking in water for 24 to 36 hours before sowing in seed boxes.

With any of these treatments, you can germinate the seed in two to three weeks. On germination, you can plant the germinated seeds in filled polythene bags at the rate of one germinated seed per bag.

3.1.6 Chemical Composition

You will discover that the nuts contain:

Water	5%
Protein	20%
Fats	45%
Carbohydrate	26%

Fibre	1.5%
Minerals	25%

The shell which is the pericarp contain approximately 50% of cashew-shell oil, a visicant, composed of 90% anacardic acid and 10% cardol. The cashew apple which is what you take fresh contains:

Water	88%
Protein	0.2%
Fat	0.1%
Carbohydrate	11.6% and it is very rich in vitamin C.

3.1.7 Propagation and the Nursery

You will normally propagate cashew by seed. Research on vegetative propagation is in progress. You will arrange polythene in the nursery, mulch slightly and water regularly. You do not normally require shade, except in very dry area where light shade may be provided. You will as control measures against disease and pest, carry out routine spraying of insecticides and fungicides during the nursery period.

When you do not have polythene bags, you will plant germinated seeds in nursery beds at a spacing varying from 30 x 30 cm to 45 x 45 cm. You will mulch the nursery beds and water when necessary. You will also carry out disease and pest control measures. Where necessary, you may provide light shade. The nursery period for cashew ranges from four to six months at the end of which the seedlings are transplanted into the field when the rainfall is steady. You can also sow at stake.

3.1.8 Field Planting and Establishment

You do not need to provide shade to cashew plants in the field. You should clear- fill the land after the land preparation, you should divide the plantation into blocks of 4 ha units or whatever land size you have.

The recommended spacing for you to use are 9 x 9m, 10 x 10 m or 12 x 12m depending on the variety and the recommendation of your seed supplier. It is a normal practice for you to take advantage of dense populations in the early life of a cashew plantation. You may intercrop the plantation with leguminous or vegetable crops during the early years of the establishment of the plantation. Your planting holes should be 60 x 60 x 60 cm.

Your main post-planting maintenance operation is control of weeds. During the early years, it will be suffice for you to ring weed the crop. The establishment of your leguminous ground cover will help in weed control.

Another important operation you will need to carry out is the replacement of missing or dead stands and watering/ irrigation when and where necessary especially shortly after establishment. You will practice pruning of the lowest side branches at the end of the first year growth in the field. You may have to carry out the same operations in the second and third year of growth in the field. The objective of the pruning is to ensure that the main stem is free of any branches up to the height of about 1m above ground level. Branches at a height lower than this will interfere with your plantation operations.

3.1.9 Harvesting and Processing

Economic bearing of cashew plants under good management comes in the fourth year of field planting. The first crop is usually small, but this increases gradually up to the tenth year when the plants come into mature production. Flowering in cashew plants is usually very profuse but only about 10% of the flowers sets fruits.

You should slash the weed in the orchard very low to facilitate the fruits as the fruits are nearing maturity. Cashew fruit are not normally harvested by hand plucking. You will allow the fruits to drop from the trees and pick them up. After you have gathered the fruits, you will clearly remove the apple from the seed. You will gather the nuts and sun dry until they are fully dry. You may use the apple to prevent much wastage in the following ways:

- 1 You may suck it. You may find the taste slightly sharp but pleasant.
- 2 You may extract the juice and process into a soft drink or a potable alcoholic drink by fermentation, distillation and clarification.

Cashew operation is a specialized operation. It may be done by the farmers themselves or in an industrial plant. Both methods are based on the same principal, namely, roasting followed by cracking and picking.

Farmers Processing

There are two methods depending on the quantity of nuts to be processed. Small numbers of nuts for individual family use are dried and inserted in hot wood ash for up to 30 minutes, they are then cracked on a stone and the nuts gathered for use while the shell is returned to the fire as additional fuel.

When the peasant farmer processes larger for sale in the market, a native pot is used in roasting the nuts. The nuts are collected in a clay pot and placed on a wood fire. As the temperature increases and the nuts beg in to roast, the CNS oil in the shell of the nuts begins to exude and accumulate. The CNS oil facilitates the roasting of the nuts. After the nuts are fully roasted, you can remove them for cracking and picking.

Commercial processing

This is an industrial method based on the same principle as the peasant farmers' methods. You can get different cashew nuts processing machines in the market. The essentials in a cashew processing machine are that it contains a nut cleaning chamber, grading chamber, cashew seed grading system and a bagging unit.

Commercial cashew processing is specialized and as a labour is becoming more and more expensive, processing plants are being modified to meet the needs of the cashew industry.

3.1.10 Major Diseases and Pest

You will discover that cashew plants are relatively free of disease. The mature trees are very hardy but the young seedlings are generally susceptible to the following diseases:

- 1) **Seedling wilt** caused by *Fusarium* spp. It is encouraged by over watering. It can be controlled by reduced watering and spraying with fungicides.
- 2) **Leaf scas** – leaf scas occurs both in the nursery and in the field. A number of fungal species have been suspected as the casual agents control by spraying with copper fungicides.
- 3) **Immature fruit drop** – This is more of physiological than pathological problems. Apply balanced fertilizer rich in k.
- 4) **Fruit rot** caused by too much moisture. Avoid high rainfall areas for the cultivation of cashew.

Cashew plants are attacked by a number of pests. The major pests, their controls are:

1	Long horn beetle	-	kill adult and larvae
2	Fruit piercing moth	-	kill adult and larvae
3	Thrips	-	spray with roger
4	Flower beetles	-	spray with roger
5	Leaf rollers	-	spray with roger
6	Variegated locust	-	spray with gamalin 20
7	White flies	-	spray with roger, gamalin 20

Exercise 1.1

What are the major chemicals contained in cashew nut

Water	-	5 %
Protein	-	20 %

Fat	-	45 %
Carbohydrate	-	26 %
Fibre	-	1.5 %
Minerals	-	2.5 %

Exercise 12.2

Commonly but erroneously the cashew apple, which is what you take fresh is referred to as cashew fruit?

What are the different chemicals found in the apple as opposes to the nut analysed in 12.1?

The cashew apple contains:

Water	-	88 %
Protein	-	0.2 %
Fat	-	0.1 %
Carbohydrate	-	11.6 %
Vitamin C	-	very rich

4.0 CONCLUSION

By the end of this unit, you must have known that cashew, *Anarcadium occidentale* is a member of family *Anarcadeaceae*. It is widely cultivated throughout the tropics for its nut and apple which is the flesh that is usually eaten. The nuts yield an edible oil. The shells or pericarps yield cashew-shell oil (CNS oil). The cashew apple is a good raw material for the soft drinks industry. Cashew can be regarded as a new crop with very great potential. Cashew can be cultivated in Nigeria and it has great potential as a commercial tree crop of economic importance.

5.0 SUMMARY

At the end of this unit, you must have come to terms with the taxonomy, origin and distribution, ecology and structure of cashew plant. The unit must have imparted to you the technology of germinating the cashew nut seed, propagation and husbandry of cashew seedling. The unit has treated the uses, chemical composition of the nut and apple of cashew, diseases and pests, and their controls.

6.0 TUTOR MARKED ASSIGNMENT

12.1

- (a) Cashew seeds possess a very thick coat and because of this, the seed takes a very considerable time to germinate. How can you obtain early germination in cashew nut seed?
- (b) Compare and contrast cashew nut and cashew apple in terms of their chemical compositions.

7.0 REFERENCES AND OTHER RESOURCES

J. W. Pursealove (1968) Tropical Crops, Dicotyledons 1 Longmans Green and Co LTD London and Harlow.

Unit 2

BANANA/PLANTAIN

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1.0 INTRODUCTION

In the previous units, we have treated the core tree crops that are of socio-economic importance to Nigeria. They are referred to as tree crops with stems of chard wood. This unit will treat Musaceae crop, plantains and bananas. They are used inter changeably. They are referred to as pseudo tree crop because they are more or less “big shrubs” with soft and false stems. They do not have hard wood and they do not last more than two years before they die. They produce fruits only once in life time. However bananas are the most important fruits in Nigeria. They are eaten raw and fresh in every household as a sweet, dessert or even as a meal.

Plantains are often as cooked, boiled or roasted food. They can be eaten raw and fresh. Bananas and plantains are of high socio-economic importance crops in the tropical world we are treating it here as tree crops.

2.0 OBJECTIVES

By the time you have completed this unit, you will have known what bananas and plantains are called pseudo tree crops, their ubiquitous uses, while and special origin and distribution, their varied and special cultivors, the ecology of bananas and plantains, the unique and interesting husbandry of the musaceae family, harvesting and yields and their multi various diseases and pests with the control measures.

3.1 USES

To start with, you should know that *Musa cvs* provide the world’s edible bananas. *M.textilis* yields abaca’ manila hemp. The fe’i banana is eaten in Polynesia. Fibres are obtained from a number of *Musa spp* which are sometimes used locally. A few species are given as ornamental plants.

Bananas are the most important of the tropical fruits. If you compare with the world production of other fruits, the production of bananas is second only to grapes. Ripe bananas are sugary and easily digestible and are eaten raw as a

dessert fruits. Unripe fruits are cooked and provide a starchy food which is nutritionally similar to the potato, in this form you will call them plantains, but you may refer to them as bananas botanically. You may have read from Simmonds (1966) that about half of the bananas produced in the world eaten raw and ripe, about half are eaten as cooked vegetable. Bananas form one of the biggest single items in the international fruit trade.

You should know that the greatest hectorage of bananas is in Africa where bananas reach their greatest importance as a starchy food. Bananas chips are made from fully mature unripe fruits which are sliced and dried. Bananas flour is prepared from unripe fruits, and banana powder from ripe fruits. You may used them in confectionery trades. You give bananas to children suffering from coelic disease in which there is intolerance to carbohydrate. They are also recommended to people with various intestinal complaints.

The male buds are eaten as boiled vegetables in eastern Asia. The inner leaf sheath and the peduncle are also eaten. The clopped pseudo stems, peduncle and peeling can be fed to he livestock – cattle and pigs. Peasant people use the green leaves as plates, wrapping materials and umbrellas. You use the dried sheaths, leaves and petioles as trying material, for thatching and screens for the circular pads used in carrying head loads.

You can use bananas as a ground shade and nursery crop for cocoa and coffee.

The split pseud stems and leaves, you can use as mulch with perennial crops. You can use the sap which produces brown indelible stains on fabric and as marking bill. In Nigeria, perhaps the best use you put bananas/plantain to is in fried form called “Dodo” eaten with vegetable sauce.

3.1.1 Origin and Distribution

All edible bananas, except for the Fe'i bananas are derived from *M. acuminata* Colla (A genome) and *M. balbisana* Colla (B genome) in the section *Eumusa*. Edibility of mature fruites originated in diploid *M. acuminata* in the malesian area due to parthenocarpic pulp develop without the need of any stimulus by pollination. These characters would be fostered by human selection and vegetative propagation and transformed the bananas from jungle weeds into a productive crop.

Simmonds (1962) discuss the movement of bananas into and across Africa. Dispersal from northern India by way of Arabia and the horn of Africa is unlikely because of climatic conditions and other circumstances. He considers that bananas may have been taken from Indonesia to Madagascar about the 5th century A.D, with subsequent dispersal to Africa, spreading into the heart of the continent via the Zambezi valley and the great lakes and then across the Congo to west Africa.

Whatever maybe the truth of the place and date of their introduction into Africa by the Portuguese in the fifteenth century, and were taken to the Canary Island.

3.1.2 Cultivars

The cultivars, you will recall are referred to their genome groups as recommended above. They are clones which are propagated vegetatively and are variable only by somatic mutations. They are as yet incompletely known, but 200 – 300 clones are thought to exist, rather less than half of these are diploids. The remainder are almost entirely triploids, the hectorage of which is more than 100 times greater than the diploids. The triploids are hardier, more vigorous and easier to grow, their ovaries are twice as large and grow twice as fast as the diploids, they show gametic sterility which is of prime importance to human selectors

“**Gros Michel**” produces the best bananas in the world. Unfortunately, it is highly susceptible to Panama disease.

Cavendish Sub-group – four clones are recognized, all of which are of commercial and local importance.

Plantain sub-group provides an important source of food in India, Africa and tropical America. They originated in southern India where the variability occurs. They are introduced into tropical America, probably from West Africa. They are resistance to Panama disease and leaf spot, but very susceptible to borer attack.

3.1.3 Ecology

Bananas are plants of tropical humid lowlands and are mostly grown between 30° North and South of the equator, a mean monthly temperature of 27° C is optimal. If you grow bananas at very high temperatures, they will suffer from sun-scorch temperature of 21° C or less result in a check in growth, with reduced leaf production and delayed shooting of the branches. The time of shooting is 7 – 9 months in the tropical lowlands, but this may be extended to 18 months at 1000m or in the subtropics.

Bananas require a high light intensity. Because the crop makes high demand on water, you need to supply an approximately 25mm per week is minimal for satisfactory growth. An average annual rainfall of 2000 – 2500 mm which is well distributed is considered the most satisfactory, but they are often grown with less and also in areas with a fairly pronounced dry rainy season. You can grow your bananas with irrigation

You may need to provide wind breaks as severe winds cause serious damage by breaking and uprooting the pseudo stems and are a major source of crop

loss. Velocities above 60 kph cause considerable losses above 80 kph results in total destruction.

You can grow bananas on a wide range of soils provided there is a good drainage and adequate fertility and moisture. Good bananas are usually indicative of good soils. The best soils are usually deep well drained retentive loams with a high humus content, often of volcanic or alluvial origin. You should avoid very acid soils. There is no evidence of photo periodicity. Flowering and bunch size depends upon previous growth, consequently you should apply fertilizer early.

3.1.4 Germination

You may experience germination of viable seeds you remove them as soon as possible from ripe fruits. In breeding work, you could obtain optimum germination if you extract seeds from mature ripe fruits, wash and sow at once.

You may store them for a few months if you wash them very carefully and sun dry immediately. For a longer period, you should store the seeds over dry calcium chloride.

Experience shows that germination of seeds from “Gros Mitchel” pollinated by AA diploids is variable and is affected by seasonal factors. Only about 20% of the seeds germinate, and of these, half produce useless heptaphoids.

3.1.5 Chemical Composition

You will discover that the edible pulp of the ripe bananas, which constitutes about two thirds of the fruits, contain approximately:

Water	-	70 %
Carbohydrate	-	27.1 %
Protein	-	1.2 %
Fat	-	0.3 %
Fibre	-	0.5 %
Ash	-	0.9 %

The calorific value is about 100 calories per 100g. They are nutritionally similar to the potato which contain rather more water. You may have known that carbohydrate is stored in starch, but this is largely converted to the sugar, glucose and fructose on ripening. An unripe firm green banana you harvest for export contain up to 2.0 % soluble sugars and 21.5 % starch. Bananas have a good content of vitamin A, fair in vitamin C but poor in vitamin B. You will find that all parts of the plant are conspicuously rich in potash

3.1.6 Propagation

You should know that except in breeding work, all bananas are propagated vegetatively. The type of planting material s you should use areas follows:

- 1) **Peepers:** very young suckers appearing above ground with scale leavers only.
- 2) **Sword suckes:** formed from buds or eyes low on corm and bear narrow sword leaves, planted out intact when not more thn75 cm high and corms about 15 cm in diamrter
- 3) **Maiden suckers:** these are taller suckers which have broad leaves, but have not yet shot a bunch, and are 5 – 8 months old with corms about 25 cm in diameter. After you have lifted them, you may cut them to about 10 – 15 cm above the comb, the central meristem destroyed and the root trimmed. You should plant usually on their sides with bud or eye which will form the new plant about 25 – 30 cm below soil level. You may also cut them into pieces each bearing a bud and the pieces or “bits” used for planting.
- 4) **Bits and large corm:** these are obtained from comb known as “bull head” in Jamaica which have bunch . You will dig these up after removing all the aerial parts and you cut into two or more pieces, each containing one or more eye and weigh over 2.5 kg. You will plant the eyes down and cover with 25 – 30 cm of soil.
- 5) **Water suckers:** these are suckers of superficial origin bearing broad leaves.

3.1.7 Field Establishment

The first crop after planting is known as the plant crop; subsequent crops are known as rations.

If you are using new forest areas for planting, you will usually under brush, drain, line out and plant. You will fell the larger trees and lop the lower branches later. You may sometimes interplant your bananas with other crops such as coconuts. When used as a nurse-crop for cocoa or other crop, you will usually plant your bananas the season before the cocoa and gradually thin out until they are removed totally after 4 – 6 years.

The total spacing is 5m between plants. You will plant bananas usually in holes dug by hand. You should make holes in heavy soil deep. You should add FYM or compost to the hole at planting. The hole should be about 45 x 45 cm on the average. Your planting material should be as fresh as possible. You should plant with the eyes of the suckers about 25 – 30 cm below the soil surface.

Bananas require considerable amounts of mineral nutrients to maintain yields and these can be supplied by growing them on very fertile soil or applying fertilizers regularly. They have high demand for nitrogen and potash. You should apply fertilizers and manures according to the recommendations in your area.

3.1.8 Harvesting and Yields

The time from planting to harvesting for the plant crop is 9 – 18 months, depending on the cultivar, local climatic and cultural conditions, etc. The time from shooting to harvesting varies from 2 – 4 months. The stage of maturity at which the bunch is harvested depends whether it is used locally, when you will cut full-green, or for shipping when you cut three quarters full (80 days from shooting) or high three quarters (90 days from shooting) You can judge this by the angularity of the fingers.

Under poor management, yields are usually high for the plant crop and decline somewhat for the first and second rations. Under intensive management with adequate fertilization, correct climatic conditions, you can obtain up to an average of 50 tones per hectare. The average life of a banana field varies greatly for 3 – 20 years.

3.1.9 Diseases and Pests

- 1 One of the most catastrophic plant diseases panama disease – also known as banana wilt and vascular wilt, caused by *Fusarium Oxysporum*.
- 2 Leaf spot also known as sigatolla disease is a fungal disease and destroys the foliage system.
- 3 Black leaf streak is another important disease.
- 4 Bacterial wilt
- 5 Fruit rots
- 6 Bunchy top virus
- 7 Mosaic
- 8 Heart rot

Major pests of banana are:

- A Banana borer
- B Banana rust thrips
- C Burrowing nematode

Excecise 12.1

List the major diseases and pests of banana?

Black leaf streak, banana wilt, leaf spot, bacterial wilt, fruit rots, bunchy top virus, mosaic disease, heart rot, banana borer, banana rust thrips, and burrowing

Exercise 12.2

Banana is consumed all over the world because it is not only refreshing, but it is nutritious as well. What are the main foods nutrients of banana and in what quantities are they available to the body?

Water	-	70 %
Carbohydrate	-	27.1 %
Protein	-	1.2 %
Fat	-	0.3 %
Fibre	-	0.5 %
Ash	-	0.9 %

Rich in vitamin A and fair in vitamin C

4.0 CONCLUSION

By the end of this unit, you must have known that banana is one of the most important fruits consumed all over the world for its valuable food contents. You have also learnt that the fruit is highly nutritious as revealed by the chemical composition. You have learnt that bananas can be grown in Nigeria all the year round with supply of irrigation. It is one of the economically important tree crops in Nigeria.

5.0 SUMMARY

At the end of this unit, you have known more about the bananas and plantains than the fruits you have picked up on it. You must have seen that it is an international crop that grows well in the tropical and sub-tropical areas of the world. You must have known the world-wide uses of the bananas, origin and distribution, their varied and special cultivars, ecology, unique germination and propagation, production, harvesting and yields, their many diseases and pests.

6.0 TUTOR MARKED ASSIGNMENT (TMA)

Describe the cultivation and production of banana/plantain as a fruit crop of value in Nigeria under the following parameters:

Propagation,
Chemical composition,
Diseases and pests.

7.0 REFERENCE AND OTHER RESOURCES

J. W. Pursglove (1972) *Monocotyledons 2* Longman Group
Limited London

Unit 3

GRAPE VINE

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1.0 INTRODUCTION

The grape vine was introduced to Nigeria by Hay Pilgrims from the Middle East and Christian Missionaries from Europe. Hitherto, the growing of grape vine was confined to a few stands around the backyard and some vegetable garden with little or no success due to lack of know-how of its cultivation. Successful cultivation of grape vine requires high capital investment and intensive maintenance. A well managed vineyard will produce good yield and consequently give enviable profits. Ripe fruits are eaten fresh as dessert and fruit juice, raisins and wine are also made from it.

2.0 OBJECTIVES

This unit is purposed to introduce a relatively new tree crop to our system. By the end of this unit, you will have been introduced to a new valuable crop – grape vine. You will have known the climate and soil suitable to its production, the variety and propagation methods, how to prepare land and planting, staking, training and pruning techniques, manuring, irrigation and weed control measures. You will have learnt how to harvest grapes and you will have also known the pests and diseases of the crop with their control measures.

3.1 CLIMATE AND SOIL

Grapes are basically grown in the temperate and sub-tropical regions. The vines shed leaves to rest in winter, put forth new shoots in spring and mature in summer. In the tropics, however, the vines are evergreen and yield poorly unless special techniques of pruning are employed. Humid tropical conditions are ideal for pests and diseases and therefore unsuitable for grape cultivation. Rains during flowering and ripening result in poor fruit set and berry splitting respectively. The grapevine can withstand temperature up to 35 ° C during the dry season provided they profusely irrigated. You can grow grapes on a variety of soils with free drainage. The root system of the grape vine does not go beyond on meter depth therefore silty and loam soils are ideal. You will need to fortify acidic soils with calcium.

3.1.1 Variety an Uses

Variety	Uses
1 Anab-e –shahi	Table and dessert
2 Black Hambury	Juice grapes
3 Thompson seedless	Raisins and desserts
4 Muscat of Alexandria	Wine
5 Blue grapes	Wine

3.1.2 Propagation

If your cultivation is on a large scale, you will propagate your grape by cuttings. You will resort to seed propagation to breeding work mainly. You can also practice grafting and budding on rootstock to obtain resistance to phylloxerapest or nematods, or to increase the vigour of weak growing varieties in grape cultivation. If how ever, the need for propagation through the seed or rootstock has not arisen, cutting, should be preferably be used.

You should select mature wood for the previous season's growth at grape pruning. Each cutting should be at least 8mm thick (about pencil thickness) make the basal

cut just below a bud. However, mallet cutting (cutting he bear a small portion or heel, of the previous growth) root more easily. The cutting should also be at least three buds long. You should protect the cutting from drying out by putting them in moist sacks or in wet soil, sand or saw dust. You should plant before any root or shoot growth occurs in the cuttings.

You should plant your cutting in nursery soils well prepared, well fertilized and free of weeds. You may used polythene bags however, to raise seedling for transplanting. You should prepare soil mixture, two parts top soil and one part sand in ratio 2:1. to every kerosene tin-full of these mixture, add a handful of super phosphate fertilizer. Fill the polythene bags with the soil mixture and then water. You can plant one cutting per bag with one or two buds above soil surface and firm the soil around them. You should water the cuttings as often as necessary until good sprouts and sufficient roots are established or transplanting.

3.1.3 Preparation of Land and Planting

Grapevines are planted in pits, however, it is preferable to plough and harrow the land at the beginning of the raining season. You should plant the vines at equal distances in the square system with the following spacing:

Anab-e –shahi	5 x 5 m
Thompson seedless	2.5 x 2.5m
Black Hambury	3.5 x 3.5 m
Blue grapes	3.5 x 3.5 m

Dig rectangular pits of size 72 cm deep by 50 cm width at specified distances. At digging, you should put the half top soil on one side and the other half of the dug soil on the opposite. Add to the top half of the soil an equal amount of well decomposed organic matter, preferably animal manure and mix them well. Then to this, add 5 kg of single phosphate and mix thoroughly. You will plant vigorous and healthy rooted cuttings of the age 6 – 12 months. You should plant the rooted cuttings anytime from the month of January to June. You should put he plant deep in the centre of the pit with half of the plant exposed. The soil should be rammed and compacted with foot and watered profusely.

3.1.4 Staking

You should support the vine with any stick of two meters height. Paint the stick with tar or old engine oil to prevent termite attack. It will take about one month for transplanted young plant to establish. As the vine grows, you should leave only one single shoot to grow. You should tie the shoot to the stick at every half meter distance with the strip of polythene firm of 1 cm width you should nip all side branches that appear from time to time allowing one main shoot to climb up to 2m in height.

3.1.5 Training and Pruning

The followings are the terms used in training and pruning of grape vine. You need to understand them before we embark on discussion on training and pruning.

- 1 **Trunk or main stem** – This is one single stem raised up to 2m height.
- 2 **Arms or secondary stems** – These are two horizontal arms (right and left of the vine along the bower) branching at 2 m height.
- 3 **Tertiary** – Shoots produced up to 1 m initially and at one time, allowed to extend only up to 2m length. A vine will have 20 tertiaries with 10 each.
- 4 **Cane** – Shoot which are of pencil thick and attain brown colour as they ripen). This care ripening occur 100days from pruning the vine.
- 5 **Spur** – A cane that has been cut back to one bud to produce next year fruiting cane.

TRAINING

You will train the vine to assume many shapes and forms. Usually these form are in relation to the different types of support and determines the disposition of trunk, arms and canes. Many modification of grape vine training have been adopted the world over. In Nigeria, the over head horizontal bower system (A bour system) appears most suitable for high yield.

3.1.6 Pruning

Pruning is another important operation performed when a vine attains one year age. It is perform twice a year, one in September, for security of fruit, and again in march, after harvest of the fruits. In March you should cut back the cane to produce the spur. You should remove all tendrils once in every three days. You will find these tendrils which are hair-like structures and coil-like springs opposite each leaf. After pruning, you should bury all leaves into the soil. You should leave the vine leafless for three weeks. You will apply manure to the vine as stated under manuring below three to five days before pruning.

In September, after the rain, you should do the pruning, you should cut back the canes or ripened shoot alone, leaving three to twelve buds depending on the variety grown

Anab-e –shahi	-	5 -7 buds
Thompson seedless	-	10 -12 buds
Blue grapes and other	-	
Black Hambury	-	3 – 5 buds

If you make any mistake in cutting or pruning, this leads to loss of crops. You should bury all leaves and other green shoots that were removed in the vine yard as this too is good manure.

3.1.7 Manuring

You should know from the onset that the grape vine are voracious feeder and needs large quantities of manures and fertilizers. The initial requirement of manure and fertilizer has been described above at planting. You should give a compound fertilizer (15: 15: 15) at the rate of 50 g per plant as broadcast one meter distance round the vine at fortnightly interval, beginning at one month up to five months after planting. Rake gently with a hoe every week. As the vine grow, you need to apply manure 100kg/plant all over 2m distance round the plant and hoe the manure as to penetrate 5cm depth of soil. You should do the application of manure once during each pruning that is twice a year. This you should follow up with 15:15: 15 at 2.5 kg/plant in six doses at fortnightly interval.

Apply muriate of potash at 2kg/ plant one year after transplanting and during September pruning only.

3.1.8 Field Management

Irrigation

Usually, young vines need watering on alternative days at 75 l and old vines 350l at every three day-interval. You should apply water in a basin of 2m diameter around each plant. You do not require irrigation during the wet season except if there is a break in rainfall for over two weeks.

Weeding

You should give special attention to keep the vine yard free from weeds by occasional shallow cultivation. Young grapes vines are very sensitive to herbicides. You should not use and herbicide for the first 3 – 4 years.

3.1.9 Harvesting

The fruits do not ripen or improve much after harvesting, therefore you should pluck fruits only when fully ripe. You should expect grape bunches to ripen 125 to 150 days after manuring. Ripeness in grapes is judged by the a combination of indications like the waxy bloom of the fruits, characteristic colour development, slight thickening of juice, easy detachment of berries, browning of cluster stems, freedom of seeds from pulp and sweetness of berries

Grapes start bearing fruits from second year of planting and the yield increases with age. If the vines give a heavy yield one year, the succeeding year will be

less due to exhaustion. Yield varies from 10 – 25 t/ha depending upon variety, method of training, and pruning, irrigation and manuring. Under tropical conditions, your vine may continue to produce fruits for 25 years with good management. If you head or prune severely to ground level, you can revive an old grape vine.

3.1.10 Pest and disease and Control Measures

Fruits in grape vine are produced during the dry season and therefore you will not experience many disease problems. However, some of the important diseases and pests you may experience include the following:

- 1 Powdery mildew – affects the berries and the leaves. It is controlled by spraying sulphur 30g in 18l of water at weekly interval.
- 2 Downy mildew – affects twigs, buds, flowers and fruit as while growth on the lower surface of the leaves which later turn brown. You can control it by pruning and burning affected parts.
- 3 Anthracnose as dark brown oval spot on leaves, twigs and fruits, especially in the raining season. Prune affected part. You will also spray difilition or dithane M 45 at 0.1% in water at weekly interval.
- 4 Termites – affects roots and stems and kill plants, once one is control by applying diedrex or aldrex T or gamlin at the rate of one table spoon in a litre water per plant at 4 weekly interval.
- 5 Birds – destroy fruits seriously just as they ripen. You can cover fruits with cloth bags, plastic netting or chicken mech wire, you can use bird scarers during the day.

Exercise 13.1

In order to understand better training and pruning in grapevine, what are the important terms to know first?

- 1 Trunk main stem – single stem raised up to 2m height.
- 2 Arms or secondary stems – 2 horizontal arms right and left branching at 2 m height.
- 3 Tertiary – shoots produced up to 1 m, allowed to extend up to 2m. A vine will have 20 with 10 on each side.
- 4 Cane-shoot – pencil thick, it ripens in 100 days pruning the vine.
- 5 Spur-cane – that has been cut back to one bud to produce next year fruiting cane.

Exercise 13.2

List the important varieties of grapevine with their uses.

- 1 Anab-e –shahi Table and dessert

2	Black Hambury	Juice grapes
3	Thompson seedless	Raisins and desserts
4	Muscat of Alexandria	Wine
5	Blue grapes	Wine

4.0 CONCLUSION

In this unit, you have learnt that grapevine cultivation belongs mainly to the temperate and sub-temperate regions of the world. However, with good management it can be cultivated in tropical regions which have distinct rainy and dry seasons in the year with dry and cool spell. It can be produced successfully in the northern parts of Nigeria. It requires good management and intensive husbandry. The fruit are used for dessert, eaten fresh or used in the wine factories.

5.0 SUMMARY

By the end of this unit, you must have learnt much about the delicate, special and intensive husbandry of grapevine. You must have learnt to:

- Choose climate and soil to produce grape.
- Choose varieties and their uses.
- Propagate the grapevine
- Prepare land for planting
- Stake the vine, train and pair the cane
- Manure, irrigate, weed and control pests and diseases

6.0 TUTOR MARKED ASSIGNMENT (TMA)

Grape vine cultivation which essentially belongs to the temperate and sub-temperate regions of the world has been adapted in Nigeria in the northern states with distinct raining season and dry spell with harmattan period. It has now become a socio-economic crop which has grown from backyard to the orchard stage.

Describe in detail the production of grape vine in Nigeria under the following topics:

- Climate and soil
- Variety and uses
- Propagation
- Preparation and planting

- Staking

- Training and pruning
- Manuring
- Irrigation
- Weeding
- Pests and diseases with their control
- Harvesting and yields.

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Unit 4

AGBONO (*IRVINGEA spp*)

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1.0 INTRODUCTION

We have treated well known exotic fruit tree crops which have been adapted to our situations and systems in Nigeria in the last 14 units. There are many tree species in the tropics which are potentially useful but which still remain unknown to the international market and scientist and are therefore not exploited. In Nigeria, there are some trees that belong to this category such as Irvingia (Akpon, Ogbono, Akee-apple (Isin), Chrysophyllum albidum (white star-apple), Gmelina arborea, Dacryodes edulis (African pear), Butyrospermum parkii, (The shea butter tree), Tetra-pleura tetraptera (The Aidan Tree) etc. This unit will describe briefly what is known so far on cultivation of Agbono (Irvingia spp).

2.0 OBJECTIVES

In this unit you will learn concerning Irvingia on the following

- Seed extraction
- Seed germination
- Budding
- Field establishment
- Uses
- Pests and diseases

3.0 SEED EXTRACTION

You will select the ripened fruits, preferably those that have fallen by themselves. You should not use fruits that have been plucked from the tree. You will then remove the pulp carefully and completely and wash the nuts thoroughly using sand and water. You will allow the nut to dry in the shade for one or two days if it is during the dry season or three to four days during the wet season.

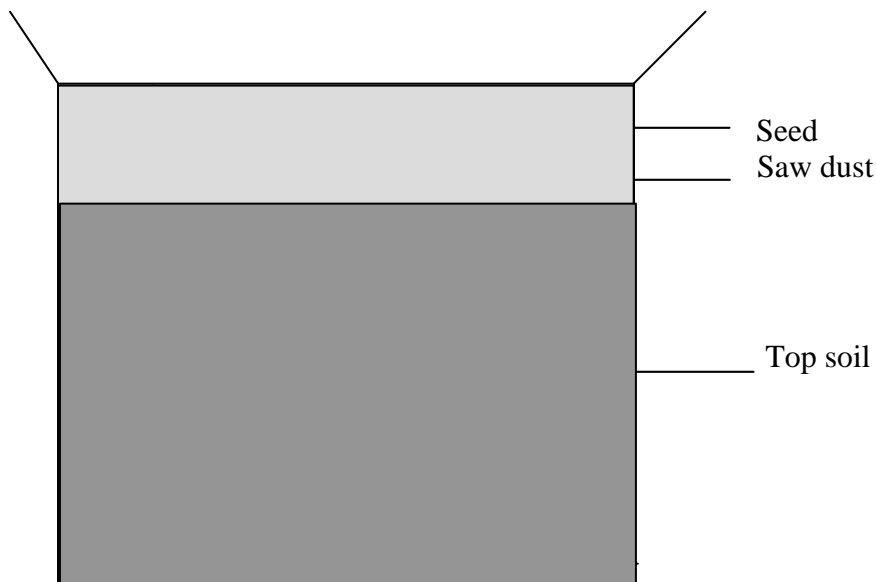
If you allow the seed to have prolong drying for more than seven days, the seed viability will decrease significantly. It must be emphasize

that drying should be done in airy open space and not directly
in the sun.

3.1.1 Seed Germination

Seed germination should be done in a polythene bag which is thick, complete and strong, basket or perforated tray.

Figure 1



You should fill the container with rich top soil to a height of about 17 cm. Then you will put uncontaminated saw dust on top of the top soil to fill the next 10 cm. You will now plant your seed in the centre of the polythene bag, making sure that it is well covered by the saw dust (see figure 1 above)

You will ensure that seeds are planted within two or three days after extraction. If you have been experiencing the problem of damping-off disease in the environment, then you should treat your seed with benlate by dusting the seeds completely or any other suitable recommended fungicide. After planting, you should water daily and keep in shady environment. For a polythene bad of about 15 cm diameter, you may plant 3 – 4 seeds.

Germination should start about 3 weeks after planting and it may continue for several weeks, there after. At about 12 months after germinatio, your seedlings are ready to be transplanted to the field or to be budded.

3.1.3 Budding

Where you intend to carry out budding, you should obtain bud wood from mature flowering trees, preferably during the month of June during raining season. You will need root stock of about 0.5 cm diameter or pencil size at about 15 cm from the soil surface. You will carry out your budding while the seedlings are still in the polythene bag in the nursery. You should transplant your budded seedlings to the field 9 – 12 months after budding.

3.1.4 Field Establishment

Your seedling will be ready to be transplanted to the permanent field site about 9 to 12 months after germination or 9 to 12 months after budding.

You will transplant the seedling into the pre-dug holes of 1m x 1m x 1m at least two weeks before transplanting. The holes would have been filled with top soil first, then manure and 15: 15: 15 compound fertilizer, thoroughly mixed. Your field spacing should be 7m x 7m. Your transplanting should be done in the month of June, during the raining season and you should transplant with the ball of earth around the roots well intact.

3.1.5 Field Management/Maintenance

You should establish a cover crop to protect the soil, but this will have to be faced out as the trees form their canopies. If you so choose, you may inter crop your trees between rows with other crops such as cassava for the first few years.

You should water or irrigate your seedling during the first dry season after transplanting into the field, because the seedling may not have developed a sufficiently deep root system. The first formed flowers by the seedlings in the first few years should be removed to allow for very strong vegetative development to be supported by applying manure. You should use nitrogenous and potassium fertilizers as well. You should weed your seedlings regularly to allow a maximum yield from your inter-crop and later your trees.

3.1.6 Harvesting

You should harvest your Irvingia when the fruit are mature. The stage M of harvesting depends upon the purpose for which the fruits will be used. If you are transplanting the fruits to outside market from source of production, you will harvest when mature and green.

For fresh market, you allow the fruits to be fully ripe and fall from the tree, and you will go round to pick once or twice daily. If your fruits will be used as stones for germination, you should use fruits that are fully ripe and have fallen from the tree on their own. For any purpose at all, you should avoid harvesting damaged and bruised fruits to avoid diseases.

3.1.7 Uses

Irvingia fruits are delicacies because they are not commonly available. They are eaten as fresh fruits in the south western and eastern zone of Nigeria. They are particularly value as fruits and desserts in Ibadan land. The fresh fruits are getting

popularized in the northern zones of Nigeria by the southerners living in the north. The fruits are shipped from the south.

Delayed ripening is being encouraged and further work is continuing by researchers to ensure availability of Irvingia fruits all round the year. The most popular use of Irvingia all over the country is the draw soup ingredients known as **Ogbono soup**. It goes solely or a mixture with “egusi” and/or other vegetables to eat pounded yam, eba, apu. Amala and semovita. Irvingia has a potential as a future juice drink.

3.1.8 Chemical Composition

Irvingia is a fruit tree for the future. Little work has been done by food nutritionists in the area of chemical nutrition. You may wish to know that the chemical composition would be similar to that of mango. The fruit is rich in vitamin C and same level of proteins. The seed is rich in protein, carbohydrate and traces of vitamins. Irvingia is said to be of medicinal value.

3.1.9 Pests and Diseases

There are not many known pests and diseases of Irvingia. Tree is generally free from pest attacks and disease infections. However, in some areas you may experience some fungal diseases such as damping off. This is effectively controlled by dusting seeds with benlate or any other suitable fungicide before planting.

Exercise 15.1 SMA

Irvingia is not a well known tree crop popularly grown in Nigeria. How do you obtain seeds and extract same for propagation?

- You will select ripened fruits, preferably those that have fallen by themselves.
- You should not use fruits that have been plucked from the trees.
- You will remove the pulp carefully and completely and wash the nut thoroughly using sand and water.
- You should let the nut dry in the shade for one or two days.
- Prolonged drying for more than a week will result in decreased seed viability.
- You should avoid drying in the sun.

4.0 Conclusion

At the end of this unit, you will have known that Agbono, Ogbono, Oro, Irvingia, gabonensis, excelsa or *Irvingia gabonensis*, gabonensis is one of the tree species in Nigeria that are potentially useful but which still remain unknown to the

international market and are not fully exploited. You will have known that, the fruit is used throughout the country as fresh fruit, dessert or as very important and nutritious soup ingredient that is used either on its own in mixture with other vegetables and fish to eat all traditionally carbohydrate pot preparation, examples pounded yam, amala, eba, apu and semovita. You must have been convinced that it is a tree crop of tremendous potential.

5.0 Summary

What you have learnt in this unit concerns the potentiality of one of the indigenous tree crop of great value, *Irvingia* spp. You must have learnt how to extract the seed from the fruit that had not been plucked from the tree, how to germinate the seed, vegetative propagation by budding, established the trees in the field and manage them to fruition. You have also known that the trees do not have many pests and diseases and that the fruits are used throughout the length and breadth of Nigeria as fresh fruit and ogbono soup.

6.0 Tutor Marked Assignment 15.1

Irvingia is an indigenous fruit tree cultivated mainly in the south east and south west of Nigeria. It is not yet fully exploited for international market, but it has a great potential.

Trace the cultivation of the potential from seed extraction to the harvesting.

7.0 References and other Resources

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UNIT 5**PINE APPLE (*Ananas comusus*)**

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1.0 INTRODUCTION

Pineapple (*Ananas comusus*) belongs to the Bromeliaceous family and has its probable origin in South America. With the development of world trade, the cultivation and utilization of pineapple spread rapidly to other parts of the world. Today pineapple is cultivated in all hot, wet, inter tropical regions, mainly close to the equator. Four horticultural varieties represent the bulk of this fruit used in industrial production. These are cayenne, Singapore, Queen and Red Spanish. Australia and South Africa are the commercial producers of Queen; Malaysia Peninsula grows Singapore, Red Spanish is grown in the Caribbean while

Cayenne is grown in Hawaii, Taiwan, the Philippines and in many other production centers of the world.

Pineapple cultivation is most common in the Southern parts of Nigeria, where the crop is simply grown as a compound crop (front or back yard) or intercropped with yams, Cassava or Cocoa. No special attention is given or planting pattern used, and harvesting is done as and when the fruits are ripe. Since the plant is rain fed, it grows naturally in area with 1000mm and above of rainfall, but cannot thrive in swampy or water logged areas.

In some areas where the soil and climatic conditions are very conducive to the crop, fairly bigger farms of 0.2-0.5 scattered holdings can be seen. Harvested fruits are sold to middle-men who cart them to large urban cities and the Northern part of the country for large profits.

2.0 OBJECTIVES

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

- * know the uses of pineapple
- * know the origin and distribution of the crop
- * identify cultivars of the crop
- * know the ecology
- * be familiar with its chemical composition
- * be able to propagate the pineapple
- * be able to establish and produce the crop
- * know the major pests and disease with their controls

3.1 Uses

Pineapples are eaten as dessert fruits throughout the tropics and subtropics, for which they are best harvested fully ripe in order that the full flavour may be developed.

For shipping half-ripe fruit may be transported at 7-10°C. Most of the commercial crop of pineapples is canned in the producer countries. The central cylinder of the fruit after the removal of the shell and central core is sliced, or is cut into chunks, or diced.

You could obtain crushed pineapple from small pieces of flesh. You can obtain canned juice from the fruit.

You could also can pineapple fruit mixed with other fruits in fruit salad.

You may obtain sugar-syrup from the mill juice which was formerly a waste product.

You can also manufacture alcohol and citric acid from it.

Fresh pineapple flesh and juice contain a protein – digesting enzyme, bromelain, which you can use for making in a similar manner to papain, obtained from papaya, **carica papaya**. You can also make wine from pineapple

The leaves yield 2-3% of a strong white silky fibre, 38-90cm in length, which is used for making a fine fabric.

A number of local medicinal uses have been recorded; in South eastern Asia the young immature fruits are used as an abortifacient.

In Nigerian, you can make a delicacy drink known as “soborodo” mixed with Roselle, *Hibiscus sabdanffa*.

3.1.1 Origin and Distribution

The modern pineapple is a cultigen which was domesticated in South America. It has since become semi – naturalized in some areas.

The centre of origin is probably in Paraguay. Pineapples are now widely grown throughout the tropics and subtropics. The development as an important economic crop in Malaysia, Hawaii and in all hot, wet inter tropical regions, mainly close to the equator, has occurred during the present time.

3.1.2 Cultivars

A large number of cultivars have been recorded, but the number grown in commercial production is mainly limited to the following:

“Cayenne” is the most widely grown cultivars for commercial production and canning, and is the basis of the exports of Hawaii, the Philippines, Kenya, Mexico and Taiwan; you should know also that it is also of increasing importance in Australia, South Africa Guinea and Puerto Rico.

You should know that in addition to cayenne, three other horticultural varieties represent the bulk of pineapple used in industrial production. These are Singapore, Queen and Red Spanish. Queen is an old variety, and is grown mainly in Australia and South Africa, where it is favoured for the fresh fruit trade. The plants, fruits and shoots are smaller than cayenne, and the margins of the leaves have small, closely spaced spines. Fruits ripen early, 0.9 – 1.3kg in weight, of good shape, on short peduncle

You should know that Red Spanish is extremely cultivated in the West Indies Cuba Puerto Rico and Mexico, and is used mainly in the fresh fruit trade. The plant and fruit size is intermediate between cayenne and Queen. The leaves are long, about 1.2m and spiny.

Singapore is the variety grown in Malaysia for the canning industry. Leaves about 50, about 100cm long, margins smooth except for few spines near tip.

3.1.3 Ecology

Ananas comosus must have originated in the same region and not commercial pineapples are now grown at low elevations 25° N and S. You should know the pineapples cannot tolerate frost. In Hawaii, 19° – 22° N, cayenne is grown from sea to 600m, with maximum and minimum temperatures of 32° C and 10°C respectively. At the higher elevations in Hawaii you must know that cayenne plants and fruits are smaller, and the flesh poorer in colour with poor flavour and high acidity. The same effects are produced in winter in Australia. In Kenya on the Equator, where a canning factory has recently been started production is limited to altitudes of 1400 – 1800m where cayenne has a sugar – acid ratio of 16:1, which is considered the best for canning.

Pineapple, you should know are tolerant to drought due to the special storage cells. You can grow them with a wide range of rain fall from 635 – 2500mm per annum, but the optimum for commercial production is 1000 - 1,500mm. Much of the commercial production is not far from the sea in areas with a high atmospheric humidity. Dew and other moisture collects in the clapping leaf bases where it can be absorbed by the trichomes.

You should know that the crop can be grown on a wide range of soils, but it will not tolerate water logging. Sandy loams with a pH of 5 – 6.5 preferred.

Exercise 15.1

List the varieties of modern pineapple and briefly describe their origin and distribution.

Cayenne, Queen, Red Spanish, Singapore.

Cayenne is the most widely grown variety for commercial production and canning and is the basis of export of Hawaii, the Philippines, Kenya, Mexico and Tawa.

It originated in the interior region of Venezuela long ago. It was introduced into England about 1835. It was taken to Hawaii where it is now widely cultivated.

Queen is an old variety and is grown mainly in Australia and South Africa where it is favoured for the fresh fruit trade.

Queen is said to be probably originated from Spain where it was taken to England and presented to King Charles in 1661. It has since spread to Malaysia and Hawaii where it is widely grown.

Red Spanish is extensively cultivated in the West Indies Cuba, Puerto Rico and Mexico. Singapore is grown in Malaysia for the canning industry.

3.1.4 Germination

When you produce the seeds by artificial cross – pollination, you will harvest them 5-6 months after this operation. The seeds are held in the carpel about 1.7cm below the surface of the fruit lets and are obtained by cutting the fruits into longitudinal sections and removing the flesh round the core to the carpel cavities. You will then wash and dry them. You will observe that germination is slow and irregular unless you first treat the seeds with concentrated sulphoric acid for about one minute. You should sow on sterilized sand and keep at a temperature of about 32°C. The seed should germinate in about 10 days and after 30-40 days the seedlings should be transplanted into flats of composted soil. They are transplanted to the field at 15 – 18 months, after which they would take 16-30 months to produce mature fruits.

3.1.5 Chemical Composition

You will find out that the edible portion, which constitutes about 60% of the fresh fruit,, contains approximately:

Water	-	85%
Protein	-	0.4%
Sugar	-	14%
Fat	-	0.1%
Fibre	-	0.5%

Canned pineapple is syrup contains about:

Water	76%
Protein	0.4%
Sugar	22.6%
Acids (citric)	0.6%
Fibre	0.4%

You will know that the fruit is a good source of vitamins A and B. The mill juice, from which sugar syrup and sometimes citric acid are obtained, contains, on dry weight basis 75 – 85% sugar and 7-9% citric acid. Pineapples contain the protease, brome lain, a protein – digesting enzyme.

3.1.6 Propagation

You should know that except in breeding work and research purposes, for ever practical purpose, pineapples are always propagated vegetatively. You may use the following material

1. **Suckers** – which arise from buds below ground level. They are sparsely produced.

2. **Shoots** – which are leafy branches arising from buds in the leaf branches arising from buds in the leaf axils. Each plant produces up to 3 shoots. They reach a length of 35 – 40cm when mature, but are suitable for planting when 30 – 35cm long. If you leave them on the plant, they will produce the ratoon crop.
3. **Slips** – which are borne on the peduncle just below or on the base of the fruit. The size of the plant and 0 – 10 are produced.
4. **Harps** – are shoots produced at the base of the peduncle. They are intermediate in size between shoots and slips.
5. **Crown** – from the top of the fruits. Normally only one crown is produced except in Singapore Spanish. At maturity the crowns come dormant.
6. **Butts or Stumps** – Consist of the entire plants after the fruits have been harvested and from which the base of the stem, roots, leaves and peduncle have been removed.

These are used for propagation in Australia and South Africa.

You should know that all the above forms of planting material have considerable resistance to desiccation and may be stored for several weeks before planting.

3.1.7 Field Establishment and Management

You should know that the normal crop cycle is four years from the time the crop is planted until the same land is planted with a new crop. This includes one plant or first crop, one ratoon – crop, and 6-9 months to prepare the land for the new crops. A second ratoon crop is sometimes taken and this will require a further year.

Planting and after-care: You will clear new land. In replanting, you may knock down the old plants, crushed and chopped, and incorporate in the top soil. You can do this mechanically. You will plough the fields to a depth of about 25 – 30cm and you allow the trash to rot down. You should produce a fine before planting. You may even fumigate the soil to destroy nematodes and other destructive organisms.

You will usually plant your material, usually shooting shoots, slips or crown at a density of 40,000 to 45,000 plants per hectare. You will normally plant your pineapples in beds, each with two rows 60cm apart, and 15cm from the edge, with plants 25 – 35cm apart in the rows and staggered so that the plants on each row alternate. The distance between beds is 75 – 90cm.

It is necessary for you to weed particularly during early growth, and this you will do by hand, mechanically or by selective herbicides or a combination of these.

Manuring: You need to apply heavy fertilizer calcium ammonium nitrate should be applied at the rate of 112kg/ha prior to or 3 months after planting, with further applications at intervals of 3 – 6 months with a total of up to 450 – 670kg during the cropping period. Potassium sulphate at 225 – 450 kg/ha and ammonium phosphate at 170 – 280kg/ha should also be applied.

Iron deficiency results in sclerosis of the leaves, followed by a reddish colour on the young fruits, Zinc deficiency by a mottled yellowing of the leaves with some epidermal sclerosis, you can correct them by sprays of ferrous sulphate and zinc sulphate respectively. Excess calcium and manganese result in stunted plants.

3.1.8 Harvesting

You can induce pineapples to flower and fruit before the normal time by the use of ethylene, acetylene or some growth hormones. The growth hormones you will normally use is NAA or its sodium salts. You can use hormones to bring ratoon plants into fruiting uniformly and at a predetermined date, and to force late flowering, first crop plants to flower and fruit with the rest of crop.

You will pick the fruits by hand as it is necessary you select only fully ripe fruits. The yield of fruit per hectare is 38 – 75 tons for the plant crop, but the ratoon crop may give you only half of this quality.

3.1.9 Pests and Diseases

1. Butterfly larval cause serious damage to fruits.
2. Root-knot nematodes cause some damages. They are controlled by fumigation.
3. Rats damage crowns and fruits.
4. Mealy bug wilt is the most widely distributed and most serious disease of pineapples. Control by destroying the mealy bugs
5. Heart and root rots occur
6. Yellow spot virus produces yellow spots on the upper surface of the leaf.

Exercise 15.2 (SMA)

“Except in breeding work, pineapples are not normally propagated by seed”. Justify this statement by starting how you will normally supply seedlings to plant a 10 ha field made available to you by your uncle for the purpose of cultivating pineapples.

The following material will be used to provide adequate planting materials:

- Suckers
- Slips

- Hapas
- Crowns
- Shoots
- Butts.

4.0 CONCLUSION

This unit has discussed pineapple and shown the universality of its use as fresh, canned, sliced, syrpped fruit all over the world. You have been informed of the centre of origin, distribution and present areas of cultivation. The unit has also demonstrated that the crop can be produced on varied type of soils. You have learnt that the fruit which is a universal delicacy can be shipped virtually to any part of the universe for use.

5.0 SUMMARY

By the end of this unit you must have know the uses of pineapples; Centres of origin and distribution; Various cultivar or varieties – Cayenne, Singapore, Red Spanish, Queen; ecology; special germination of the seeds; chemical composition of the fresh fruits; chemical composition of the canned fruits; propagation technique and materials; husbandry – field establishment and management; harvesting and pests and diseases.

6.0 TUTOR MARKED ASSIGNMENT

Classify pineapple. Give the general uses of the fruit and what are the chemical compositions of the fresh pineapple fruits and the canned products? How many varieties of pineapples in cultivation do you know? List them.