COURSE GUIDE

CRP 304
PRINCIPLES OF HORTICULTURAL CROP

Course Team Mr J.A. Alfred (Course Developer/Writer)-NOUN
Dr. (Mrs) M.D. Katung (Course Editor)-ABU, Zaria
Prof. N.E. Mundi (Programme Leader)-NOUN
Dr.A.M.Petu Ibikunle (Course Coordinator)-NOUN

NATIONAL OPEN UNIVERSITY OF NIGERIA

National Open University of Nigeria
Headquarters
University Village
Plot 91, Cadastral Zone,
Nnamdi Azikiwe Express way
Jabi, Abuja

Lagos Office
14/16 Ahmadu Bello Way
Victoria Island, Lagos

e-mail: centralinfo@noun.edu.ng
website: www.nou.edu.ng

Published by
National Open University of Nigeria

Printed 2017

ISBN: 978-058-592-0

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INTRODUCTION

Principles of horticultural crop production: This is a two credit course for 300 Level students of Bachelor of Science (B Sc.) degree in Crop production programme. The course consists of 13 units in three modules which deal with introduction to horticulture, basic principles and practice of horticultural crop production and nursery practices. This course guide tells you briefly what the course is all about, and how you can work through these units. It suggests some general guidelines for the amount of time you are likely to spend studying each unit in order to complete it successfully. It also gives you some guidance on your tutor marked assignments.

WHAT YOU WILL LEARN IN THIS COURSE

The main aim of this course "Principles of Horticultural Crop Production" is to introduce the fundamental principles upon which horticultural crop production practices are based upon. By studying the principles of horticultural crop production you would be able to understand the interaction between the plant, the environment and how and why plants grow and develop. So that you would be able to manipulate the plants and their external conditions for better growth, development and crop yield.

COURSE AIMS

The aim of the cause is to acquaint you with the basic principles and practices of horticultural crop production.

This would be achieved through:

• Introducing you to the basic principles of crop production.

• Creating a better understanding of horticultural crops, their classification and their response to various conditions.

• Developing a clear understanding of the role of the surrounding condition of the plant in growth and development and distinguish the effect of these factors in order to have precise control of growth process.
• Introduce you to the various cultural practices upon which is laid successful horticultural crop production enterprise.
• Identification of competitive pests, weeds and diseases so that you can select appropriate method of control.
• Identifying the best practices of harvesting, processing and storage of field crop.

COURSE OBJECTIVES

In order to achieve the course aims, specific objectives are set in each unit. These are usually stated at the beginning of the unit. You should pay attention to the objectives of each unit before starting to go through them. You can always refer back to the unit's objectives to check your progress. You should also look at them after completing a unit. By so doing you can be sure that you have achieved what the unit expects you to acquire. By meeting these objectives, the aims of the course as a whole would have been achieved. These objectives include:

- state classification of horticultural crop based on usefulness, growth cycle, and response to some climatic conditions
- define and state the importance of horticultural crop production
- explain the distribution of vegetables and fruits with reference to climate and soil.
- state crops that are found in different climatic region of Nigeria.
- state and explain the requirement for sitting fruit orchards
- state and explain the requirement for sitting vegetables farm
- explain the practices of horticultural crop production
- differentiate the different practices for vegetables and fruits production
- discuss the similarity in production practices of vegetables and fruits.
- explain the post harvest operation of horticultural crops
- state and explain the methods of propagation of horticultural crops
- explain the specialised structures used in propagation of horticultural crops
- explain the different horticultural cropping system
- define and classified pests according to feeding pattern and economic threshold of destruction
- state the effects of pest and diseases on crop production
- analyse the symptoms of plant diseases and identify the kind of diseases that may be affecting a particular crop based on the symptoms
- prescribe the methods of controlling plant diseases.
- state the advantages and disadvantages of nursery
- explain the types of nursery
- explain the preparation of nursery

WORKING THROUGH THIS COURSE

To complete this course you are required to read the study units, read other recommended materials. You will be required to answer some questions based on

what you have read in the content to reaffirm the key points. At the end of each unit there are some tutor marked assignments (TMA) which you are expected to submit for marking. The TMA forms part of continuous assignments. At the end of the course is a final examination. The course should take you 12 to 13 weeks to complete. You will find listed the component of the course, what you have to do and how you should allocate your time to each unit in order to complete the course successfully on time.

COURSE MATERIALS

The main components of the course are:

1. Course Guide
2. Study Units
3. Textbooks
4. Assignment
5. Tutorials

STUDY UNITS

There are twelve (12) study units in this course as follows:

MODULE 1

Unit 1 Definition and History of Horticulture
Unit 2 Classification and Importance of Vegetables and Fruits in Nigeria
Unit 3 Scope and Distribution of Fruits and Vegetables Grown in Nigeria with Reference to Climate and Soil

MODULE 2

Unit 1 Requirement for Sitting Fruit Orchard and Vegetables Farm
Unit 2 Practices used in the Production of Horticultural Crops
Unit 3 Post Harvest Technology
Unit 4 Diseases and Pest of Vegetables
Unit 5 Horticultural Tools and Machineries

MODULE 3

Unit 1 Methods Propagation (Sexual and Special Organs)
Unit 2 Methods of Propagation (A Sexual)
Unit 3 Horticultural Cropping Systems

MODULE 4

Unit 1 Nursery Preparation and Production

TUTOR-MARKED ASSIGNMENTS (TMA)

There are tutor- marked assignments (TMA) and self- assessment in each unit. You would have to do the TMA as a revision of each unit. And there are four tutors -marked assignments you are required to do and submit as your assignment for the course. This would help you to have broad view and better understanding of the subject. Your tutorial facilitator would inform you about the particular TMA you are to submit for marking and recording. Make sure your assignment reaches your tutor before the deadline given in the presentation schedule and assignment file. If, for any reason, you cannot complete your work on schedule,

contact your tutor before the assignment is due to discuss the possibility of an extension. Extensions will not be granted after the due date unless there are exceptional circumstances. You will be able to complete your assignment questions from the contents contained in this course material. However, it is desirable to search other references/further readings, which will give you a broader view point and a deeper understanding of the subject.

FINAL EXAMINATION AND GRADING

The final examination for the course will be 2hours duration and consist of six theoretical questions and you are expected to answer four, questions. The total marks for the final examination is 70 marks. The examination will consist of questions, which reflect the tutor marked assignments that you might have previously encountered and other questions within the course covered areas. All areas of the course will be covered by the assignment. You are to use the time between finishing the last unit and sitting the examination to revise the entire course. You might find it useful to review your tutor- marked assignments before the examination. The final examination covers information from all parts of the course.

TEXTBOOKS AND REFERENCES

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

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

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

Doohan, D.J., Carchia., J. & Kleinhenz, M.D. (2000). *Cultural Practices in Vegetables Crop Weed Management Programs.* Ohioline: *Bulletin 888-00.* ohioline.ag.ohio-state.edu

Harper, F. (1983). *Principles of Arable Crop Production.* U.K: Blackwell Science Ltd.

Akobundu, I.O. (1987). *Weed Science in the Tropics. Principles and Practice*. John Wiley & Sons, Inc.

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

Wyant, (1996). *Agroforestry - An Ecological Perspective.* Agroforestry Today 8:1

ASSIGNMENT FILE

The assignment file will be given to you in due course. In this file, you will find all the details of the work you must submit to your tutor for marking. The marks you obtain for these assignments will count towards the final mark for the course. Altogether, there are 29 TMAs for this course.

PRESENTATION SCHEDULE

The presentation schedule included in this course guide provides you with important dates for completion of each tutor-marked assignment. You should therefore try to meet the deadlines.

ASSESSMENT

There are two aspects to the assessment of this course. First, there are tutor-marked assignments; and second, the written examination.

You are thus expected to apply knowledge, comprehension, information and problem solving gathered during the course. The TMAs must be submitted to your tutor for formal assessment, in accordance to the deadline given. The work submitted will count for 30% of your total course mark.

At the end of the course, you will need to sit for a final written examination. This examination will account for 70% of your total score.

COURSE MARKING SCHEME

The following table gives the course marking scheme

Assessment	**Marks**
Four TMA (comprising of 20 questions) carries 10marks	Total = 10% X 3 = 30% (the best 3, out of 4 TMAs are taken)
Final Examination	70% of overall course marks
Total	100% of Course Marks

HOW TO GET THE MOST FROM THIS COURSE

In distance learning, the study units replace the university lecturer. This is one of the huge advantages of distance learning mode; you can read and work through specially designed study materials at your own pace and at a

time and place that suit you best. Think of it as reading from the teacher, the study guide tells you what to read, when to read and the relevant texts to consult. You are provided exercises at appropriate points, just as a lecturer might give you an in-class exercise.

Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next to this is a set of learning objectives. These learning objectives are meant to guide your studies. The moment a unit is finished, you must go back and check whether you have achieved the objectives. If this is made a habit, then you will significantly improve your chances of passing the course. The main body of the units also guides you through the required readings from other sources. This will usually be either from a set book or from other sources.

Self-Assessment Exercises are provided throughout the unit, to aid personal studies. Working through these self-tests will help you to achieve the objectives of the unit and also prepare you for Tutor-Marked Assignments and examinations. You should attempt each self-test as you encounter them in the units.

The following are practical strategies for working through this course.

1. Read the course guide thoroughly

2. Organise a study schedule. Refer to the course overview for more details. Note the time you are expected to spend on each unit and how the assignment relates to the units. Important details, e.g. details of your tutorials and the date of the first day of the semester are available. You need to gather together all these information in one place such as a diary, a wall chart calendar or an organiser. Whatever method you choose, you should decide on and write in your own dates for working on each unit.

3. Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their course works. If you get into difficulties with your schedule, please let your tutor know before it is too late for help.

4. Turn to Unit 1 and read the introduction and the objectives for the unit.

5. Assemble the study materials. Information about what you need for a unit is given in the table of content at the beginning of each unit. You will

almost always need both the study unit you are working on and one of the materials recommended for further readings, on your desk at the same time.

6. Work through the unit, the content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit, you will be encouraged to read from your set books.
7. Keep in mind that you will learn a lot by doing all your assignments carefully. They have been designed to help you meet the objectives of the course and will help you pass the examination.

8. Review the objectives of each study unit to confirm that you have achieved them. If you are not certain about any of the objectives, review the study material and consult your tutor.

9. When you are confident that you have achieved a unit's objectives, you can start on the next unit. Proceed unit by unit through the course and try to pace your study so that you can keep yourself on schedule.

10. When you have submitted an assignment to your tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the Tutor-Marked Assignment form and also written on the assignment. Consult you tutor as soon as possible if you have any questions or problems.

11. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in this course guide).

FACILITATORS/TUTORS AND TUTORIALS

There are 8 hours of tutorial provided in support of this course. You will be notified of the dates, time and location together with the name and phone number of your tutor as soon as you are allocated a tutorial group.
Your tutor will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter and provide assistance to you during the course. You must mail your TMA to your tutor well before the due date. At least two working days are required for this purpose. They will be marked by your tutor and returned to you as soon as possible.

Do not hesitate to contact your tutor by telephone, e-mail or discussion board if you need help. The following might be circumstances in which you would find help necessary: contact your tutor if you:

- do not understand any part of the study units or the assigned readings
- have difficulty with the self test or exercise
- have questions or problems with an assignment, with your tutor's comments on an assignment or with the grading of an assignment.

SUMMARY

You should try your best to attend the tutorials. This is the only chance to have face to face contact with your tutor and ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain the maximum benefit from the course tutorials, prepare a question list before attending them. You will learn a lot from participating in discussion actively. GOODLUCK!

MODULE 1

Unit	1	Definition and History of Horticulture
Unit	2	Classification and Importance of Vegetables and Fruits in Nigeria
Unit	3	Scope and Distribution of Fruits and Vegetables Grown in Nigeria with Reference to Climate and Soil

MODULE 2

Unit	1	Requirement for Sitting Fruit Orchard and Vegetables Farm
Unit	2	Practices used in the Production of Horticultural Crops
Unit	3	Post Harvest Technology
Unit	4	Diseases and Pest of Vegetables
Unit	5	Horticultural Tools and Machineries

MODULE 3

Unit	1	Method of Propagation (Sexual and Specialised Organs)
Unit	2	Method of Propagation (Asexual)
Unit	3	Horticultural Cropping Systems

MODULE 4

Unit	1	Nursery Preparation and Production

MODULE 1

UNIT 1 DEFINITION AND HISTORY OF HORTICULTURE

CONTENTS

1.0 INTRODUCTION

Agriculture is generally regarded as cultivation of crops and rearing of animals for man and industrial uses. Agriculture has many branches which interplay in achieving agricultural aims and these branches include, agronomy, animal Science, crop science, horticulture, agric economics, agric extension, plant breeding, crop protection etc. one of these branches, horticulture, forms the basis of this course and we shall discuss it in details as we progress in the course.

2.0 OBJECTIVES

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

- define horticulture
- give examples of horticulture
- give a brief history of horticulture.

3.0 MAIN CONTENT

3.1 Definition of Horticulture

The word horticulture is derived from two latin words “Hortus” meaning garden and “Culture” meaning the cultivate. Horticulture is therefore concerned with the cultivation of garden plants such as fruits, Vegetables, flowers and ornamental plants. Horticulture may be defined as the science and art of growing fruits, vegetables, flowers, plantation crops and ornamental crops for man, industrial and aesthetic uses. When horticulture is considered from both the science and business perspectives, horticulture can be broadly defined as the science and art of cultivating, processing and marketing of fruits, vegetables, flowers and ornamental plants. Horticulture is a branch of agriculture. Horticulture is subdivided into five; namely pomology, olericulture, floriculture, arboriculture and landscaping.

a. Pomology: - The science and practice of fruit production.
b. Oleiriculture: - The science and practice of growing vegetables.
c. Floriculture: - The science and practice of production of flowers and ornamentals.
d. Arboriculture: - The science and practice of growing and caring for ornamental trees.
e. Landscaping: - The science and practice of using plants outdoor for aesthetic and functional purposes.

3.2 History of Horticulture

Horticulture is as old as mankind since man cannot survive without food. The concepts of garden culture can be traced as far as 3, 000 BC or beyond in Egypt. Historical evidence shows that by this time crops such as grapes, dates, olives and onions have been brought under cultivation by Egyptians and the technology such as land preparation, pruning, irrigation drying etc had also been used. The hanging garden of Babylon which was of flowers and fruits was hailed as one of the seven wonders of the ancient world. During the Middle Ages (500 – 1500 CA), horticultural plants were grown in protected areas surrounded by high walls or similar structures in temperate Europe. As society evolved, deliberate cultivation and domestication of edible plants replaced the less efficient food gathering habits of primitive societies. Agriculture, particularly horticulture, is therefore not a modern day invention but one that continues to be transformed as society advances technologically. The idea of intensive management of horticultural crops still holds today even though some of the vegetables like tomato are grown in the field like other filed crops. At present, the fields of horticultural crops are not only grown within the home gardens but also in large quantities as

commercial enterprises. Many researches have been conducted aimed at solving the problems of growing horticultural crops and a comparatively large volume of scientific information on behavior of horticultural plants and products have been made available.

4.0 CONCLUSION

Horticulture is a branch of agriculture which compliments crops science or agronomy in production of crops such as fruits, vegetables and nuts and it apply agronomic practices in its production, processing and marketing.

5.0 SUMMARY

In this unit, you have learnt that Horticulture is derived from two latin words "Hortus" meaning garden and "Culture" meaning cultivation Horticulture is defined as the science and art of cultivating, processing, marketing of fruits, nuts, vegetables and ornamental plants. You have also learnt that history of horticulture dates back to about 3, 000 BC onions, olives, grapes, etc. were brought under cultivation in Egypt and these ideas of cultivation of horticultural crop still holds today.

6.0 TUTOR -MARK ASSIGNMENT

i. Define horticulture
ii. Give a brief history of horticulture
iii. List 3 horticultural crops

7.0 REFERENCES/FURTHER READING

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

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

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

UNIT 2 CLASSIFICATION AND IMPORTANCE OF VEGETABLES AND FRUITS IN NIGERIA

1.0 INTRODUCTION

Horticulture is the science and art of production, processing and marketing of Vegetables, fruits nuts and ornamental plants. All crops or plant that constitutes horticultural crops are classified or grouped according to their uses, production or their type of product they produced. The unit you are about to study deals with the classification of horticultural groups.

2.0 OBJECTIVES

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

- classify horticultural crops based on their life cycle
- classify horticultural crops based on their climate requirement
- classify horticultural crops based on their growth habits
- state the importance of vegetables and fruits in Nigeria.

3.0 MAIN CONTENT

3.1 Classification of Horticultural Crops

From time to time, horticultural crops have been classified into various groups depending on their growth habits, cultivation requirements, climate needs and uses. Horticultural crops are popularly classified into 3 broad groups of fruits and nuts, vegetables and flowers or ornamentals.

3.1.1 Classification Base on Use of Horticultural Plants

A) Vegetables

i. Vegetables grown for the aerial edible parts (above the soil), include
   a) Cole crops – Vegetables that have curled leaves e.g. Cabbage, cauliflower
   b) Pulse crops – Vegetables that produce pods e.g. pea, bean or green bean.
   c) Solanaceous fruits – Vegetables that produce fruits and tuber e.g. tomato, pepper, garden eggs, potato
   d) Green of leafy Vegetables – Vegetables, that produce leafs e.g. Amaranth, bitter leaf, water leaf, spinach.
   e) Salad crops – Vegetables that produce their product in vine e.g. melon, cucumber, pumpkin.
   f) Corn vegetables e.g. popcorn, sweet corn.

ii. Vegetables or plants grown for the underground edible portion or parts.
   a) Root crops e.g. carrot, potatoes, Irish, Cassava.
   b) Tuber crops e.g. yam, cocoyam.
   c) Bulbs crops e.g. onion, garlic.

B) Fruits

i. Temperate fruits – fruits from cooler regions of the world
   a) Tree fruits e.g. apple, peach.
   b) Small fruits e.g. grapes vine, straw berry.
   c) Nut fruits e.g. peach, walnut.

ii. Tropical and subtropical fruits (Hot regions) of the world
   a) Tree fruits e.g. citrus, mango, guava, cashew
   b) Herbaceous perennial fruits e.g. banana, plantain, pineapple.
   c) Nut fruits e.g. cashewnut, datenut, aracanut.

C) Flowers and Ornamentals

i. Flowers e.g rose flower, marigold, sun flower

ii. Lawns e.g. carpet grass, bahama grass

iii. Hedges e.g. gambogi, croton yellow

iv. Trees e.g. Christmas tree, umbrella tree, neem tree

Other classifications of horticultural crops are given below base on certain important criteria.

3.1.2 Classification Based on Growth Habit

This is according to the growth nature of the crops and this include.

a) Herbs e.g. Ageratum
b) Shrubs e.g. Hibiscus

c) Trees e.g. Mango, citrus
d) Climbers e.g. Bougainvillea
e) Creepers e.g. Bignonia, gracillis

3.1.3 Classification Base on Life Circle of the Crop

a) Annual or seasonal crops – Those that complete their life cycle within a year e.g. marigold, Amaranth, tomato, Irish.
b) Biennial crops – Those that requires two years or at least two growing season to complete their life cycle e.g. Cassava, yam.
c) Perennial crops – Any plant that lives for more than two years to 35 years e.g. mango, citrus, grape vine, guava.

3.1.4 Classification Base on Climatic Requirement

This is based on the temperature need of the crop and this are grouped into

a) Temperate crops – These are horticultural crops found in cold regions of the world e.g. apple, almond etc.
b) Tropical crops – These are horticultural crops that do not tolerate severe cold but can tolerate warm temperature e.g. banana, papaya, pineapple.
c) Sub-Tropical crops – They need warmth and humidity and can tolerate mild winter e.g. fig, mango, cashew nut.

SELF- ASSESSMENT EXERCISE

i. Classify horticultural crops based on their edible aerial portion and give 2 examples each.
ii. Classify horticultural crops based on climatic requirements.

3.2 Importances of Vegetables and Fruits in Nigeria

The importance of vegetables and fruits in Nigerian economy cannot be overemphasised. Just as crops and animals play a vital role in the economy of Nigeria, so do vegetables and fruits play vital roles in individuals, community and the country at large. Vegetables and fruits provide the following;

1. Provision of Food – Vegetables and fruits are sources of food which provide carbohydrates, vitamins, minerals and water to humans and animals. Plant source of food are usually regarded as good and natural source of food for human and animals.
2. Provision of Income – Provision of income per unit area yield of horticultural crops is very high as compared to field crops. This high yield per unit area invariable leads to high returns per unit

area which means that the income of the farmer is significantly increased. This therefore, helps reduce poverty.

3. Source of Raw Material – Vegetables and fruits provide raw materials for industries such as fruit juice industries, pharmaceutical industries as well as oil mills. This helps to reduce importation of the raw materials and hence reduce cost of production.
4. Provision of Employment – Those that are involved in the production, processing and marketing of vegetables and fruits are usually self employed or employed by industries that use these products as raw materials. This reduces idleness and level of unemployment in the country.
5. Uses Waste and Undulating Lands – Fruits and Vegetables can be grown in land where the gradient is uneven or where the land is undulating. Mango, cashew, Vegetables can be grown on large scale on hilly area.
6. Source of Foreign Exchange – When Vegetables and fruits are exported to other countries this serves as foreign exchange for the country and this increases the country's economy.

3.3 Importance of Vegetables in Human Diet

1. Vegetables supply most of the nutrients that are deficient in other food materials. This includes supply of minerals, especially calcium and iron.
2. Vegetables are acid neutralisers e.g. Okra, Corchorus Spp neutralises the acid produced from the some fruits.
3. Vegetables prevent constipation and promote digestion as a result of fibres/roughages obtained from Okra, Cucumber, Amaranthus, Lettuce and Cabbage.
4. Vegetables are rich sources of vitamins A, B, and C which helps to lower susceptibility to infection. e.g.: Carrots, Sweet Corn, Amaranthus And Celosia provide Vitamin A; Bitter leaf, Water leaf, Solanum and Celosia provide Vitamin B; Tomatoes, Carrots, Lettuce, Cabbage and Amaranthus provide Vitamin C.
5. Some vegetables are rich sources of carbohydrate e.g. Potatoes, Sweet Corn, Carrot etc.
6. Green beans and peas are cheap sources of protein. Vernonia (Bitter leaf), Amaranthus and Telfeira provide some amount of protein in human diet.
7. Vegetables are generally needed to have balanced diets and overcome nutritional deficiencies.
8. Vegetables make our staple food more palatable and enhance their intake.

4.0 CONCLUSION

In this unit, you have learnt that horticultural crops are as important as other field crops and that their production should be encouraged at all level of production. This would help in reducing poverty and create employment for the unemployed.

5.0 SUMMARY

You have learnt that horticultural crops can be classified based on their uses, climatic requirement or growth habit. According to their uses, horticultural crops are classified as vegetables, fruits and flower and ornamentals. Based on climatic requirements, they are classified as temperate, tropical and subtropical while base on life cycle they are classified as animal, biennial and perennial.

You have also learnt that horticultural crops (vegetables and fruits) have the following importance;

- Provision of income
- Provision of food
- Provision of employment
- Provision of foreign exchange
- Provision of raw materials

6.0 TUTOR- MARK ASSIGNMENT

i. Explain briefly the importance of fruits and vegetables.
ii. Give the classification of horticultural crops based on their life cycle and cite examples.

7.0 REFERENCES/FURTHER READING

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

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

Edmond, J. B., Senn, T. L., Andrews, F. S. & Halfacre, R. G. (1975). *Fundamentals of*
Horticulture.(1st ed.). McGraw-Hill Book Company. Pp 183-219.

My Agriculture Information Bank (2012). Horticultural crops classification. www.agriinfo.in/horticultural crop classification

UNIT 3 SCOPE AND DISTRIBUTION OF VEGETABLES AND FRUITS GROWN IN NIGERIA WITH REFERENCE TO CLIMATE AND SOIL

1.0 INTRODUCTION

Horticultural crops are classified based on climatic requirements into temperate, tropical and sub tropical crop and this is based on temperature requirement of the crop. Some crops require low temperature and they are grown in temperature climate. Based on climate and soil, horticultural crops are dispersed and found in different part of the country. The unit you are about to study deals with the distribution of horticultural crops in Nigeria based on climate and soil.

2.0 OBJECTIVES

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

- give the scope of horticultural crops in Nigeria
- explain the distribution of vegetables and fruits with reference to climate and soil
- state crops that are found in different climatic regions of Nigeria.

3.0 MAIN CONTENT

3.1 Scope of Horticulture

Horticultural crops constitute a significant component of total agricultural production of any country. Environmental, soil and biotic

factors such as diseases, pest and to a lesser extend of demand of horticultural crops determines the level of production. In Nigeria, horticultural crops are grown all over the country. Horticultural crops are found in an area depends on the suitability of the climate, culture and demand of the commodity. Fruits and nuts are scattered in the country with their concentration in the southern part of the country.

3.2 Environmental, Soil and Biotic Factors affecting Horticultural Crop Production

The successful production of any crop depends on the suitability of the environment. Climatic (a biotic), edaphic (soil) and biotic factors determine the distribution of horticultural crops in Nigeria and the world in general.

3.2.1 Climatic factors

a) Rainfall – This is basically a natural means of water supply to plants. Water is very important because 70 – 80% of the fresh weight of herbaceous plant is water. For woody plants, water constitutes about 50% of their fresh weight. Water acts as a medium for uptake of nutrients and also for transportation of substances within the plant body. It is a primary raw material in the process of photosynthesis and it's also required for the maintenance of turgor pressure in plant stomata which controls its opening to permit exchange of gases between plants and the environment. Water is needed by the plants to replace the one lost by transpiration.

   The plant losses about 98% of the water absorb through transpiration. The water requirement of plants varies with species and age of the plant. Irrespective of the species, the water needs increases as the plant increases in size. Lack of moisture makes the air less humid, thereby increasing its drying power. The rate of plant processes such as transpiration, diffusion and evaporation are affected directly by lack of moisture. Excessive moisture exposes plants to diseases and causes lodging (falling of plants). Horticultural plants grown indoors are sometimes given a misty spray of water (irrigation) to increase the humidity of the plant environment, especially in winter when the heaters are turned on to warm the building.

b) Temperature – The response of plants to temperature varies among species. For every plant species there is an ultimate temperature range within which it can grow and reproduce. In general, most horticultural crops grow and produce between

15^{o}C. Horticultural crops can be classified according to their response to temperature as follows.

i. Hardy Plants – Plants that withstand low temperature but cannot grow under high temperature. These are basically temperate crops such as Carbage, Cole flower and apple.

ii. Tender or Tropical Crops – Plants that withstand high temperature but cannot tolerate low temperature. That is, they grow under warm to high temperature. E.g. Banana, Mango, Okra. Response of plants to temperature varies with the stage of growth of the plant. For example, the seedling of crops is more easily damage due to high temperature. Different parts of plant also response diffe**r**ently to temperature. For example the flowers are more susceptible to high temperature than the vegetative parts. Roots are more susceptible to low temperature than the aerial part. The response to temperature also depends on the duration and the degree of temperature extremes. High temperature especially night temperature has an adverse effect on plants because it increases respiration and hence, decreases food reserves. High temperature also prevents tuber initiation in crop such as potatoes and root formation e.g. in carrot.

There is also indirect effect of high temperature on plants. High temperature increases the activities of pest and disease organisms. It also has adverse effect on flowering and fruit formation e.g. in tomatoes, high temperature reduces the number of flowers and fruits formed. It has been shown that maximum fruit formation will require a night temperature of 21^{o}C. Low temperature is undesirable since it reduces germination, slows growth and result in fruit damage.

c. Light – Light for plant growth comes primarily from the sun. The role of light in the growth and development of horticultural plants depends on its quality, quantity and daily duration. When plants are grown indoors, artificial lightening is required. The most readily recognised role of light is in photosynthesis, but it also has other important functions such as seed germination in some horticultural species. The responses to light also vary among plants species. The light factors have three aspects. These are quality, intensity and duration.

i. Quantity – This refers to the wavelength of light. This aspect is affected by cloud cover. When there is continuous cloud cover, the quality of light reduces and this result in poor fruit colour. The visible light ranges

between about 390 – 735 nanometer wavelengths and most of the radiation reaching the earth from the sun falls within this range.

ii. Intensity – This refers to the quality of light or quanta. Some plants grow under full sunlight e.g. maize, and tomato and they are called the sun plants while some plants like asparagus and chrysanthemum do not do well under bright light and are called shade loving plants. Some other plants need shade at certain stages e.g. seedling of cocoa. Sunlight intensity at midday is about 10,000 foot candles of this quantity, many plants can effectively utilize only about 50% of the light for photosynthesis.

iii. Duration – This refers to the number of hours of light received on the basis of light requirement for flowering. Plants can be classified into three groups on the basis of light duration.

a) Longday Plants – These plants flower only under day length longer than 14 hours e.g. onion, peas, lettuce.

b) Short Day Plants – They flower at day length less than 10 hours e.g. citrus.

c) Day Neutral Plants – Many tropical crops are day neutral plants and they flower at day length of 12 hours e.g. tomato, maize.

d) Humidity – The water content of air is called humidity and is measured in units of relative humidity (RH) by using an instrument called a psychrometer. Humidity depends on vapour pressure (concentration of water vapour in the air) and temperature. Relative humidity decreases when temperature increases and water vapour remains constant. The amount of water needed by a plant for normal growth is directly related to the humidity or water content of the air. Relative humidity is a very important factor affecting the growth and development of horticultural plants as it is a products of rainfall and temperature. Some crops requires high humidity e.g. banana. Other plants require high humidity at one time and low humidity at another time e.g. mango requires high humidity for growth but for flowering, low humidity is necessary. Low humidity is required for drying crops like maize. High humidity has the disadvantage of encouraging attack by pests and diseases.

3.2.2 Soil

The soil is the primary medium for crop growth. The climate plays a significant role in determining the types of soils in which crop may be grown. This role comes from the fact that climate is a primary factor in the dynamic process of soil formation called weathering, which is the process by which parent materials (the rocks from which soils are

formed) are broken down into small particles. The type of soil formed affects the kind of vegetation it can support, which in turn further impacts on the process of soil formation by influencing the organic matter and nutrient content of the soil. Soil formation is a continuous process.

The role of soil in horticultural crop production is to provide physical support and a source of nutrients and moisture for growing plants. In terms of nutrition, soils may be described as fertile, marginal or infertile. Soil nutrients are depleted with years of use and need to be replenished periodically. The soil may not be rich in native nutrients, but for it to be useful for crop production, it should at least be capable of holding water and nutrients for some time. If this condition does not exist, the grower or farmer should make provision to supply supplementary nutrition to prevent deficiency problems. To be of any use for crop production, the soil should be able to permit root development for good anchorage while supplying adequate nutrition.

3.2.3 Biotic Factors

Biotic stand for living organisms that causes either diseases or damage crops. Climate influences plant diseases and insect pests. For a disease condition to occur there must be a susceptible host, pathogen and favourable environment called the disease triangle. Disease will not occur unless all three factors are present. However, disease can occur to varying degrees. Local weather conditions may favour the development of certain pathogens or expose plants to diseases by lowering their resistance. Many insects have a short life span therefore; changes in the climate can adversely affect their population and effectiveness at any stage of their life cycle. Certain insects proliferate (increase in population) in specific seasons and occur in low populations in others.
The soil surface contains organisms that are microscopic and largely pathogenic to plants. Other large bodied organisms that occur in the environment can help or harm plants. For example birds help in seed dispersal and bees and butterfly in flower pollination. On the other hand, rodents e.g. rats harm plants in the field in a variety of ways. Seeds may be eaten before they have a chance to germinate. Mature fruits may be eaten before harvest; plant stems and foliage may be eaten by herbivores such as deer, rabbits, monkeys etc.

SELF- ASSESSMENT EXERCISE

i. List the climatic factors that affect horticultural crop production
ii. Briefly explain light intensity as it affects horticultural crop production.
iii. List 3 biotic factors affecting horticultural crop production.

3.3 Distribution of Vegetable and Fruits Grown in Nigeria with Reference to Climate and Soil

In Nigeria, the rainfall is highest in the southern region, with a mean of about 3, 000mm per annum. As you move inland, the amount and duration of rainfall decrease. The northern part of the country records less than 400mm of rainfall per annum. The variation of temperature increases as you get inland, for example, in the southern part of the country, the mean maximum annual temperature is about 30^{o}C while the mean minimum annual temperature is 22 ^{o}C. In the northern parts of the country, the mean maximum annual temperature is 19 ^{o}C. Generally, temperatures are higher in the south throughout the year than in the north. The cooler period of the year which corresponds with dry season of the north is between the month of November and February. During this cool season, temperatures are lower in the north and this is the best season for vegetables production. With regards to humidity, the southern part has relatively high humidity throughout the year while in the northern part; relative humidity could go below 10% especially during the dry season.

From the above discussion we can understand that the country is divided into two distinct parts southern or forest zone where rainfall is about 1500 – 3000 mm, the temperatures are high. The zone favours the production of tropical fruits such as banana, pineapple and vegetables like cassava and yams. Temperatures tend to be too high for certain crops even though the high rainfall is suitable. Cloud cover limits the intensity and duration of sunlight which limit the growth of certain vegetables that require bright sunlight. The major disadvantages of the forest zone to horticultural crop production are high rain fall, high temperature and high relative humidity which encourage disease conditions. The savanna zone is more adaptable to horticultural plants such as citrus and many tropical crops but for many of temperate crops the temperature tends to be a limiting factor. These crops such as carrot, lettuce and cabbage can only be grown successfully during the cool, harmattan period. However, there is a general scarcity of water the during the dry or harmattan period as such the favourable condition established for vegetables during this season is not fully utilised except where irrigation facilities can be provided.

4.0 CONCLUSION

Horticultural crops are grown everywhere in Nigeria but the horticultural crop found in crop production depends on the climatic, soil and biotic factors which determine the growth and development of the crop. Before cultivation of any horticultural crop, the grower has to take

these factors into consideration so as to choose the crop that will grow best in his environment.

5.0 SUMMARY

In this unit, you have learnt that the success of horticultural crop production depends on climatic, soil and biotic factors. Environmental factors include rainfall, light, temperature humidity and wind while the biotic factors include all organisms that can cause disease or damage crops such as pathogen, pests, predators, bird etc. You have also learnt that the distribution of vegetables and fruits in Nigeria is characterised also by the above factors. While most tropical tree crops are found in the southern part of the country because of their high water requirement, most vegetables are found in the northern part of the country due to moderate rainfall in the area.

6.0 TUTOR- MARK ASSIGNMENT

1. Discuss the distribution of vegetables and fruits as affected by climate
2. Briefly explain biotic and soil factors of affecting horticultural crop production.

7.0 REFERENCES/FURTHER READING

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

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MODULE 2

UNIT 1 REQUIREMENT FOR SITTING FRUIT ORCHARDS AND VEGETABLES FARMS

CONTENTS

1.0 INTRODUCTION

The science and art of producing and marketing fruits and nuts is called pomology while the science and art of producing and marketing vegetables is called olericulture. Before any production, there are some certain requirements that you will meet to ensure successful production and marketing fruits and vegetables so as to reduce cost of production and increase profit. This unit deals with the requirement for setting fruit orchard and vegetables farm.

2.0 OBJECTIVES

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

- to explain the requirement for sitting fruit orchards
- to explain the requirement for sitting vegetables farm
- define orchard.

3.0 MAIN CONTENT

3.1 Requirement for Sitting Orchards and Vegetables Farms

Fruits and vegetables are of great importance in nutrition since they are sources of food. An orchard can be defined as a parcel of land devoted to the cultivation of fruits. Even though fruits and Vegetables may be different in their nature, life cycle and mode of production, what they require for a successful production of the enterprise are the same since they use the same resources (land, labour, environmental factors, market etc). The following are basic requirements for the sitting of fruits and Vegetables farms.

3.1.1 Environmental Factors

These include all the climate factors (rainfall, temperature, light, humidity) affecting crop production. The grower must have knowledge of the crop he want to produce and the climatic requirement of the crop so that he can produce maximally.

a) Rainfall – This is basically a natural means of water supply to plants. Water is very important because 70 – 80% of the fresh weight of herbaceous plant is water. For woody plants, water constitutes about 50% of their fresh weight. Water acts as a medium for uptake of nutrients and also for transportation of substances within the plant body. It is a primary raw material in the process of photosynthesis and it's also required for the maintenance of turgor pressure in plant stomata which controls its opening to permit exchange of gases between plants and the environment. Water is needed by the plants to replace the one lost by transpiration.

   The plant losses about 98% of the water absorb through transpiration. The water requirement of plants varies with species and age of the plant. Irrespective of the species, the water needs increases as the plants increase in size. Lack of moisture makes the air less humid, thereby increasing its drying power. The rate of plant processes such as transpiration, diffusion and evaporation are affected directly by lack of moisture. Excessive moisture exposes plants to diseases and causes lodging (falling of plants). Horticultural plants grown indoors are sometimes given a misty spray of water (irrigation) to increase the humidity of the plant environment, especially in winter when the heaters are turned on to warm the building.

b) Temperature – The response of plants to temperature varies among species. For every plant species there is an ultimate

temperature range within which it will grow and reproduce. In general, most horticultural crops grow and produce between 15^{o}C. Horticultural crops can be classified according to their response to temperature as follows.

i. Hardy Plants – Plants that withstand low temperature but cannot grow under high temperature. These are basically temperate crops such as carbage, cole flower and apple.

ii. Tender or Tropical Crops – Plants that withstand high temperature but cannot tolerate low temperature. That is, they grow under warm to high temperature. E.g. Banana, Mango, Okra. Response of plants to temperature varies with the stage of growth of the plant. For example, the seedling of crops is more easily damage due to high temperature. Different parts of plant also response differently to temperature. For example the flowers are more susceptible to high temperature than the vegetative parts. Roots are more susceptible to low temperature than the aerial part. The response to temperature also depends on the duration and the degree of temperature extremes. High temperature especially night temperature has an adverse effect on plants because it increases respiration and hence, decreases food reserves. High temperature also prevents tuber initiation in crop such as potatoes and root formation e.g. in carrot.

There is also indirect effect of high temperature on plants. High temperature increases the activities of pest and disease organisms. It also has adverse effect on flowering and fruit formation e.g. in tomatoes, high temperature reduces the number of flowers and fruits formed. It has been shown that maximum fruit formation will require a night temperature of 21^{o}C. Low temperature is undesirable since it reduces germination, slows growth and result in fruit damage.

c. Light – Light for plant growth comes primarily from the sun. The role of light in the growth and development of horticultural plants depends on its quality, quantity and daily duration. When plants are grown indoors, artificial lightening is required. The most readily recognised role of light is in photosynthesis, but it also has other important functions such as seed germination in some horticultural species. The responses to light also vary among plants species. The light factors have three aspects. These are quality, intensity and duration.

i. Quantity – This refers to the wavelength of light. This aspect is affected by cloud cover. When there is continuous cloud cover, the quality of light reduces and this result in poor fruit colour. The visible light range

between about 390 – 735 nanometer wavelengths and most of the radiation reaching the earth from the sun falls within this range.

ii. Intensity – This refers to the quality of light or quanta. Some plants grow under full sunlight e.g. maize, and tomato and they are called the sun plants while some plants like asparagus and chrysanthemum do not do well under bright light and are called shade loving plants. Some other plants need shade at certain stages e.g. seedling of cocoa. Sunlight intensity at midday is about 10,000 foot candles of this quantity, many plants can effectively utilize only about 50% of the light for photosynthesis.

iii. Duration – This refers to the number of hours of light received on the basis of light requirement for flowering. Plants can be classified into three groups on the basis of light duration.

a) Longday Plants – These plants flower only under day length longer than 14 hours e.g. onion, peas, lettuce.

b) Short Day Plants – They flower at day length less than 10 hours e.g. citrus.

c) Day Neutral Plants – Many tropical crops are day neutral plants and they flower at day length of 12 hours e.g. tomato, maize.

d) Humidity – The water content of air is called humidity and is measured in units of relative humidity (RH) by using an instrument called a psychrometer. Humidity depends on vapour pressure (concentration of water vapour in the air) and temperature. Relative humidity decreases when temperature increases and water vapour remains constant. The amount of water needed by a plant for normal growth is directly related to the humidity or water content of the air. Relative humidity is a very important factor affecting the growth and development of horticultural plants as it is a products of rainfall and temperature. Some crops requires high humidity e.g. banana. Other plants require high humidity at one time and low humidity at another time e.g. mango requires high humidity for growth but for flowering, low humidity is necessary. Low humidity is required for drying crops like maize. High humidity has the disadvantage of encouraging attach by pests and diseases.

3.1.2 Land

Land is a gift of nature and found in it are the soil, water, minerals etc. To the Grower, soil is an important requirement without which production cannot take place. The soil should have a good texture and deep enough that it poses minimal resistance to root penetration and is easy to till. Sandy loam is ideal for fruit tree and vegetables production

since they retain moisture, nutrient and are easy to till and drain freely. Soil pH of 5.5-6.5 is best for fruits and vegetables.
Elevation (this is the degree of the slope of land) should encourage both air and water drainage to avoid erosion. Land with gentle slope is best for fruits and vegetables production.

3.1.3 Labour

This is the physical or mental energy required in any production. For a small garden, labour is not a problem. However, for a large operation, labour is needed for fruit harvest and also for various pruning operations. A commercial orchard should be located where seasonal labour is readily available and affordable for vegetables farm operations from weeding to processing require labour which should be readily available to avoid lost of yield or spoilage of the produce.

3.1.4 Inputs

These are materials that are required for a successful production apart from those mentioned above. These include the seed or seedling, fertilisers, herbicide, machines, insecticide etc are used for fruit and vegetables production. Inputs must be readily available at affordable cost for a meaningful fruit orchard and vegetables farm to be achieved. These inputs increase production when properly managed thereby, reducing cost of production while maximising profit of the grower.

3.1.5 Market

Home gardens are designed primarily for home consumption. However, plans should be made to handle surplus produce. The surplus can be preserved by processing it in a variety of ways and offering it to consumer for income. If larger scale farmer wish to serve the general public, then markets and marketing strategies should be carefully considered. Dry fruits can be stored for a long period of time. However, fresh produce is highly perishable and thus markets must be known before production.

3.1.6 Finance

Finance is a critical factor in any production as such it is required to buy inputs and pay for labour and also rent of land. Family labour sometimes is not enough when large production is involved and hired labour has to be engaged. In commercial enterprise, lived labour is the source of labour hence finance is needed to pay for it.

4.0 CONCLUSION

The success of any enterprise depends on not only the inputs required but the managerial ability of the operator. Good management of resources leads to maximization of profit while reducing production cost. A bad management even, with abundant resources at his disposal, leads to lost in the business.

5.0 SUMMARY

Fruits orchard and Vegetables farm have same requirement for sitting since they use the same resources and the requirement include;

- Climatic factors
- Land
- Labour
- Market
- Finance
- Management

6.0 TUTOR- MARK ASSIGNMENT

i. Explain the requirement for siting a fruit orchard.
ii. List the requirement for siting a Vegetables farm.

7.0 REFERENCES/FURTHER READING

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UNIT 2 PRACTICES USED IN THE PRODUCTION OF HORTICULTURAL CROPS

1. 0 INTRODUCTION

Horticultural crops are usually specialised crops because of the way they are produced and as such they require some specific production practices such as pruning, staking coupled with the conventional practices such as land preparation, watering fertiliser application e.t.c. This unit deals with the conventional and specialised practices carried out on horticultural crop production.

2. 0 OBJECTIVES

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

- explain the practices of horticultural crop production
- differentiate the various practices for vegetable and fruit production
- explain the similarity in production practices of vegetables and fruits
- state the advantages and disadvantages of different production practices.

3 . 0 MAIN CONTENT

3. 1 Practices Used in the Production of Horticultural Crops.

The practices used in the production of horticultural crops vary with the crops under cultivation. However, the conventional practices of production such as land preparation, weeding, fertiliser are practiced. Horticultural crops have specialised practices such prunning, staking, budding, grafting, and mulching which are carried out on some specific crops.

The general practices of horticultural crops production from establishment to post harvest processing include the following:-

3. 1.1 Land Preparation

Land preparation for sowing involves land clearing and tillage. Land clearing may be done manually (using machete, hoe), mechanically (using bulldozers!, stumper) or chemically (using non-selective herbicides in zero or no-tillage system). Bush burning (uncontrolled, controlled) helps to get rid of fallow or excess debris. Except in mechanical land clearing, farmers retain the heavier, bigger and more economically-useful trees such as palms, fruits, exportable timber,

nitrogen-fixing trees, some of which also help to preserve the soil environment.

a. Tillage involves the turning of the topsoil either manually (traditionally, minimum tillage) mechanically (conventional tillage), essentially targeted at creating a favourable environment for crop establishment. Primary tillage loosens the soil and mixes in fertiliser and/or plant material, resulting in soil with a rough Contenture. Secondary tillage produces finer soil and sometimes shapes the rows. It is done by using various combinations of equipment such as mouldboard plough, disc plough, harrow, dibble, hoe, shovel, rotary tillers, subsoiler, ridge- or bed –forming tillers, and rollers. No-till farming involves the growing of crops without tillage through the use of herbicides, genetically-modified (GMO) crops that tolerate packed soil and equipment that can plant seeds or fumigate the soil without really digging it up. Tillage uses hoofed animals, animal–drawn wooden plough, steel plough and tractorised ploughing.

b. Planting/Transplanting
Seeds of many crops can be planted by direct sowing in well-prepared field plots. Direct seed-sowing is achieved by broadcasting (especially for small seeds), drilling and planting in holes. In manual planting, seeds are sown using planting stick or cutlass. Mechanical planters are available and some of them perform combined operations such as seed sowing, fertiliser and pesticide application simultaneously. Vegetative parts are usually manually planted in holes dug in soil with a cutlass and at reasonable depth, or mechanically. For some crops, seeds require pre-nursery (e.g. oil palm) or nursery (e.g. tomato) where seeds and seedlings are hardened for subsequent field establishment. Growth chambers, nursery bags and seedbeds are also required for germinating some crops. Transplanting involves carefully moving seedlings (potted, unpotted ‘nursery transplants’) at appropriate times from the nursery to the field, during the rainy season or under copious irrigation. Field planting of crop propagules requires adequate spacing to obtain optimum yields.

3.1.2 Watering

In transplanted crops, copious watering is required immediately after transplanting for initial seedling establishment on the field. Irrigation, through controlled application of water over a crop field, is required for dry season planting and production of crops. Proper irrigation leads to increased yields from more plants and higher yields from healthier plants. Over irrigation should be avoided. Poor drainage usually which causes water logging resulting in poor crop establishment, growth and salting of farmland should be avoided. The type of irrigation to be adopted depends on the water source, method of water removal and

transportation of water. Techniques of watering include manual system using buckets (bucket irrigation), sub-irrigation (seepage irrigation), lateral move (side roll, wheel line) irrigation, centre-point irrigation, sprinkler (overhead) irrigation, drip/trickle irrigation, localised irrigation, surface irrigation and in ground irrigation.

3. 1. 3 Fertiliser Application

Fertilisers are chemical (inorganic) or organic materials containing plant nutrients, which are added to the soil to supplement its natural fertility or replenish lost fertility. There are many types of fertilisers, namely nitrogen fertilisers (primarily supply nitrogen; ammonium sulphate (AMS), calcium ammonium nitrate (CAN), urea), phosphorus fertilisers (primarily supply phosphorus; single superphosphate (SSP), triple superphosphate (TSP), basic slag, natural rock phosphate), potassium fertilisers (primarily supply potassium, potassium chloride (KCl), potassium sulphate, (K_2SO_4)potassium-magnesium phosphate, (K_2SO_4-$MgSO_4$), and mixed fertilisers (e.g. NPK 15-15-15, NPK 20-10-10, NPK 23-13-13, mono-ammonium phosphate (MAP), di-ammonium phosphate (DAP), potassium nitrate (KNO_3). Fertilisers may be applied by broadcasting, row placement by banding and ringing, or topdressing by either method. Micronutrients are also applied as foliar sprays to target crops. Organic fertilisation involves manuring (especially the ageing farm), green manuring (through ploughing of non woody fresh plants) and composting (use of compost consisting of crop residues, straw, manure, kitchen wastes, etc.). Also liming is done which involves the application of lime, steel slag or other materials to the soil to increase its pH level and subsequently, improve conditions for the growth of both crops and micro-organisms. Natural sources of lime are coral, marl, wood ash and steel slag. Artificial sources are lime, ($CaCO_3$) and CaO (unslaked lime). In a closed irrigation system, artificial fertilisers and pesticides are applied through “fertigation” (application of water and fertiliser at the same time).

3 .1 .4 Mulching

This involves the covering of the ground in a crop field with organic (dead, living) or inorganic materials (stones), especially to protect the soil from degradation and ensure sustainable agriculture. Organic mulch materials include crop residues, straw, leaf-litter, prunings’, weed free compost and black soil. Inorganic mulch materials such as paper, biodegradables, stones and plastic films are particularly desirable for physical weed control in high premium Vegetables and greenhouse crops.

3 .1. 5 Weeding or Weed Management

This involves all aspects of weed control, including prevention of spread and land use practices and modification in the crop's habitat that interfere with the ability of the weeds to adapt to the crop's environment. The three methods of weed management approaches are:

i. Preventive Approach- This involves preventing the incidence of weed infestation through plant quarantine, animal quarantine, fallow management, farm sanitation, rogging isolated stands, preventing weed seeding, re-seeding and propagule regrowth and weed contamination of crop prop gules. Other measures are choice of variety and field, planting rather than sowing, crop sequence, accurate sowing and planting, using certified weed-free plants, seeds, growth media and soil amendments.

ii. Eradication Approach- This involves the complete removal of a weed species from infested land. It is achievable in non agronomic situation but undesirable in agro-ecosystems. The reasons for this are that it is too costly, it disturbs natural ecosystem functioning and the activity of bioagents may lead to crop failure.

iii. Control Approach- This involves the suppression of weeds populations to a tolerable level that renders the cropping situation economically safe for agricultural production. It is the most important and environment-friendly approach to weed management in agro-ecosystems. The different methods of control approach are cultural, mechanical, chemical and biological control.

a. Cultural weed control involves any practice adopted by the farmer in his crop production effort not directly aimed at weed control. The practices help to minimise the number of weeds in the crop, suppress competition by surviving weeds and reduce weed seed production, thereby making the crop more competitive with weeds. The practices includes shifting cultivation, land preparation (stale seedbed), clean crop propagules, crop rotation, mixed cropping and mulching or soil cover with plant residues or plastic mulch. It is very efficient in controlling weeds in subsistence (peasant) agriculture.

b. Mechanical weed control involves any procedure governing direct physical removal or suppression of weeds on agricultural lands. These include hand weeding, hand hoeing, slashing, mowing, cultivation/tillage, flooding, burning (flaming) and smothering with non-living (in situ) mulch.

c. Chemical weed control involves the use of chemicals (herbicides) at toxic concentrations to kill or suppress (interrupt normal growth and development) of weed growth.

Herbicides may be inorganic (early types) or organic (most herbicides) compounds, which may be primarily selective (benzoic acids, carbamates) or non-selective (bipyridylium salts, glyphosate). They can also be applied pre-plant, pre-emergence, post-emergence or

postmaturity to the crop. Herbicides are of diverse formulations, including solutions, emulsifiable concentrates, wettable powders, flowables, granules, liquids, pellets suspensions, dust, paste, micro-encapsulation and micro-granules. A major limitation of chemical weed control is the insufficient specification of chemicals under the mixed farming systems of the humid tropics. The National Advisory Committee on Weed Control (NACWC) has published "Weed Control Recommendations for Nigeria", Series 3, under the sponsorship of the Department of Agriculture, Federal Ministry of Agriculture, Nigeria.
d. Biological weed control is the use of natural enemies (bioagents) of weeds in weed control. The organisms may be predators (fish, insects, snails), parasites (nematodes, plants) and pathogens (fungi, bacteria, viruses). Other methods are live mulching, preferential grasing, cover cropping of food and non-food species, allelopathy, crop manipulation and myco-herbicides (plant pathogens). However, biocontrol enhances shifts in weed species composition and possible allelopathic interaction.

iv. Integrated Weed Management- This is a weed management method that economically combines two or more weed management systems at low inputs to obtain a level of weed suppression superior to that ordinarily achieved with one weed management system. It ensures that weed interference is kept below threshold economic levels, thus preventing economic loss to the farmer. It is aimed at efficient and economic use of resources with minimum hazard to the environment and ultimately, sustained crop production.

3 .1.6 Pest and Disease Control

Pests and pathogens are among the most serious factors limiting economically-efficient crop production and utilization of natural resources in both tropical and temperate agriculture. Pests, which cause damage to crops, consist of both arthropods (winged and wingless insects, mites, millipedes) and non-arthropods (slugs, snails, nematodes/ eelworms, birds, mammals). Micro-organisms such as viruses, bacteria, fungi and mycoplasma cause crop diseases, such as anthracnose, leaf spots, mosaic virus disease, bacteria wilt, blast and stem and root rot. Approaches to pest and disease control are many and varied, but they are broadly based on the principles of prevention, control/curative and eradication in special situations. The methods include physical, cultural, biological, chemical and legislative measures. These include the use of resistant crop varieties (less effective than in disease control), cultural methods (crop rotation, burning, soil cultivations, soil drainage, crop sowing time, removal of alternative weed hosts and crop residues and plant quarantine), chemical methods (pesticides) and prophylactic measures for pest control.

In disease control, resistant cultivars of crops have been successfully bred for multiple resistances to diseases, crop rotation (most common), weed control, soil drainage, type of soil cultivation, low nitrogen fertilisation, choice of sowing date and destruction of inoculums sources. Legislative measures include seed certification schemes and preventing the movement of diseased plants within a country.
In pest control, a large number of pesticides is available for the control of soil-borne diseases by the use of sterilants, protectant fungicides, systemic fungicides and air-borne diseases by use of foliar protectant fungicides e.g. maneb; foliar eradicants; foliar systemic fungicides, benomyl. Generally, insecticides and fungicides are most commonly applied to crops during the post-planting period.

3. 1. 7 Prunning

This is the practice of cutting or removing unwanted or diseased branch of shrubs, hedges, trees to maintain regular shape for the plant and/or prevent disease from spreading to other parts of the plant. Pruning is sometimes done with a view to regenerate old trees. Unskillful pruning may lead to unnecessary injuries to trees with consequent reduction in yield. Light pruning is recommended although; the frequency of pruning depends on the rate of growth of trees. Unwanted vegetative parts (lateral suckers, chupons, branches) should be removed as close as possible to the stem from which they emerge preferably at an early stage, to save the trees from wasting their phosynthates on unwanted growth. A light weight cutlass or pruning saw is the most suitable tool for most pruning operations. A sharp knife or secateur should be used for removing chupons, lateral suckers, young flushes and branches. A heavy bow saw is recommended for removing big branches and stems. Pruned surface should be painted with ordinary paints or any sealing compound.

3 .1. 8 Staking

This is the process of providing support for plant stems or vines. It is commonly practiced in tomato and yam production. In yam, staking enhances crop leaf exposure to full sunlight for optimum growth and yield. In tomato, staking prevents lodging and fruit rot by infection by soil pathogens.

3. 1 .9 Harvesting

This is the practice of removing crop produce e.g fruits, seeds, flowers etc when they are ripe for marketing or processing. Harvesting is one of the important operations that decide the quality as well as the storage life of produce and helps in preventing huge losses of fruits and Vegetables. The difficulty or ease of harvesting operation and how it is done depends on factors such as the, the part of economic importance, the growth habit (annual or perennial), the market needs or uses, the maturity pattern and others. Peppers are harvested differently from

apples. Potatoes are dug up while oranges are picked. The same crops may be harvested in two different ways for two different target markets e.g mangoes for near market are harvested when fully ripe while for distant market, they are harvested when they are ripe but still green. Some cultivars of crops are determinate in growth habit and therefore exhibit even maturity and ripening. In other cultivars and certain species, the product (indeterminate) matures at different times and hence requires multiple rounds of harvesting.

3.1.9 Methods of Harvesting

Different kinds of fruits and Vegetables require different methods for harvesting their produces. The methods of harvesting are;

a. Manual or hand harvesting

This is the use of hand to uproot, cut and pick or pluck crop produce. This is done when the produce can be reached with the hand and it is more economical and easy.

b. Mechanical harvesting

This is the use of machines and tools to harvest crop produce. This is done when crop produce cannot be reached with the hand and it is more economical for the crop. Usually, mechanical harvesting is done in commercial farms. Combine harvester machine is the common machine used for this purpose. Mechanized harvesting is generally indiscriminate (good and bad fruits are picked) and it is capital intensive. However, it saves time and large area can be covered within a short time. Mechanized harvesting is adapted to crops that mature uniformly.

3.1.10 Post – Harvest Cultural Practices

These are activities carried out after harvesting till disposal. Major activities include: Preservation, Processing; Storage and Marketing. Affiliated activities include: Transportation and Handling.

Processing:

This is the process of value addition of farm produce to the form that is most acceptable to the consumer. It can be partial or total. Most leafy vegetables are only partially processed for preservation. They can be trimmed, washed, sliced and then dehydrated for preservation. e.g.Amaranthus, Celosia. Some fruit vegetables can also be sliced and dried for preservation. e g. Pepper, Onion. Some leafy vegetables can be blanched in hot water. Fruits may be totally processed into paste or slurry in the factories for canning. Vegetable seeds can be threshed, winnowed and dried for preservation.

Storage:

Vegetables, in the fresh state are not usually stored for a long period. Storage/Preservation is usually done to keep vegetables for only a short period. Vegetables are usually highly perishable in nature, and so, do not store for a long time. Short-term storage can be done, using clay pots or padded materials. Storage should be done under cool, humid conditions.

Refridgeration can be used for some vegetables. Freeze – storage is usually not appropriate.

Marketing:

This is the movement of the vegetable from the farm gate to an accessible area for the consumers. The vegetables should still retain their good nature. The means of transportation to achieve the goal should be considered. The time of arrival at the market should also be considered. The quantity and the quality demanded by the consumers should be considered. Appropriate packaging material and method should be used.

4 .0 CONCLUSION

In this unit, you have learnt that crops have similar cultural practices used in their production. However, horticultural crops require some specialised cultural practices that make them special crop. All a farmer needs is to adopt and adhere strictly to the cultural practices that are peculiar to a specific crop to obtain maximum yield from the crop.

5 . 0 SUMMARY

You have learnt that cultural practices are all the preparations and cure given to plants before, during growth and harvesting of the plant. This starts from land preparation which includes clearing, tillage and planting/transplanting; watering; fertiliser application; mulching; weeding; pest and disease control to harvesting of the crop. These practices should be carried out carefully and at recommended number of times or at appropriate time to achieve a meaningful crop yield.

6. 0 TUTOR -MARKED ASSIGNMENT(TMA)

i-List five (5) practices that are carried out on horticultural crops

ii-Discuss five (5) conventional practices that are both carried out on horticultural crops

iii-Explain the two (2) methods of harvesting crops

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UNIT 3 POST HARVEST TECHNOLOGY AND HANDLING OF HORTICULTURAL CROPS

1 . 0 INTRODUCTION

Horticultural crops are cultivated for their produces which are harvested at the end of a production period. The produce harvested are either marketed for immediate and industrial utilization or stored for future used. What happens to harvested produce of any crop before they are taken by consumer is known as post harvest technology or operation. In this unit, you shall be studying post harvest technology and handling of horticultural crops to marketing of their produce.

2. 0 OBJECTIVES

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

explain the post harvest operation of horticultural crops

list the post harvest operation of horticultural crops
state the importance of post harvest operation
explain the storage of unprocessed horticultural produce
explain the methods of preservation of horticultural crops
list the processes of handling horticultural crops.

3 . 0 MAIN TEXT

3. 1 Post Harvest Technology

Postharvest technology involves all treatments or processes that occur from time of harvesting until the crop produce finally reaches the consumer. Efficient techniques for harvesting, transportation, handling, storage, processing, packaging, marketing are components of postharvest chain and all this activities are aimed at adding value to the produce and reduce losses. Harvesting is normally included as components of postharvest because the way produces are harvested have a large bearing on the postharvest life of the crop produce. Postharvest treatment largely determines quality, whether a crop is sold for fresh consumption or used as an ingredient in a processed food product. The most important goals of postharvest technology are keeping the product cool, to avoid moisture loss and slow down undesirable chemical changes, and avoid physical damage such as bruising and to delay spoilage.

3.2 Handling

This is the practice that is carried out on immediately harvested crop produce before they get to the consumer. Before horticultural crop produce reaches the table or consumer, it undergoes a number of postharvest handling processes which depend on the crop type and the form it will be presented. Handling includes the following.

i. Washing

This is the cleaning/washing of crop produce from soil and dirt particles before packaging or marketing it to consumers. Vegetables are generally not washed before packaging or marketing. They are usually managed such a way that they are clean while growing through close spacing or mulching in the field. However light shaking and sticking with hand is done to remove the particles that stick on the Vegetables. Fruits such as apples may be washed before packaging or marketing. Root Vegetables such as carrot are generally washed to remove the soil before marketing. Onions and other bulbs are not washed but are cured (dried) under the sun to increase their shelf life. Because horticultural products from above-ground plant part are not washed before packaging, the consumer should routinely wash the produce before use.

ii. Sorting and Grading

After harvesting, the produce are hand sorted or separated into different categories (ripe, unripe and discards). Sorting and grading are two postharvest operations designed to group products into quality classes for pricing and use. Hand harvesting allows only a certain quality of products to be picked, and hence sorting and grading may be done in

one operation in the field for certain crops. Some products are sorted and graded and are packed as they are picked and transported directly from the field to the intended market or consumers. During the process of sorting, defective and immature products are eliminated and so also diseased products. However, cracked or broken products and those with blemishes are removed but not always discarded. They are placed in a lower quality category or grade and sold at a lower price. The good product or premium quality grade are solid with higher price. Each crop has its own quality standards that are used for sorting and grading. Fruits are frequently graded on the basis of size.

3.3 Storing Unprocessed Produce

This is the act of preserving harvested products to extend their shelf life for future use. Horticultural crops are mostly perishable and they have to be stored properly to avoid postharvest losses. The storage conditions (especially temperature, humidity and light) and the kind of crop affect the duration of storage the crop can withstand before deteriorating. The general goals for storage are to slow the rate of respiration occurring in living tissues and to conserve moisture in the tissue to prevent dehydration. These goals are accomplished by providing the appropriate temperature (usually cold or cool), maintaining good levels of oxygen and carbon dioxide and controlling humidity. As a general rule, cool season crops are stored at low temperature ranging between 0-10^{o}C while warm season crops are stored at warmer temperature (10 -12^{o}C). Fruits and Vegetables should be stored at higher relative humidity to retain their succulence and general quality. Lettuce and spinach require 90-95% relative humidity while garlic and dry onion require 70-75% relative humidity. Light may cause produce such as potato tuber to be green and as such require darkness or aim light in the storage areas. There are generally two methods of storing unprocessed products. They are low temperature method and low moisture method.

3.3.1 Low Temperature Method

Temperature is known to affect the rate of respiration which may produce heat and cause rotting in products. Low temperature slows down all biological and enzymatic reactions of stored produce. Temperate or cool-season crops generally tolerate lower temperature than tropical crops, which are readily injured by cold. The mechanism for cooling is by refrigerating using the refrigerator. Refrigerated trucks and containers are used to transport fresh horticultural produce over long distances without spoilage. The temperature required for this type of storage range between 0 -10^{o}C.

3.3.2 Low-Moisture Method

Many crops including grape, date, apples may be preserved for long periods by drying. Solar dehydration (use of sun for drying) is a relatively inexpensive method for drying in areas where the sun shines for a long period. The products are spread in appropriate container and exposed to dry and warm air. For more rapid dehydration of large

quantities of produce, the forced hot air method, which involves air heated to 60-70^{o}C is used. The moisture content of produce to be stored using this method should be as low as 8-12% depending on the type of crop and its nature.

3.4 Fumigation

Storage of dry grains and fruits, such as grapes and citrus, require fumigation to rid the environment of rodents, insect pests, and decay-causing organisms. One of the widely used fumigants is methyl bromide, which are effects in storage houses. Sulfur dioxide is used to protect grapes from decay.

3.5 Preservation of Horticultural Produce

3.5.1 Freezing

One of the quickest and most commonly used methods of crop produce preservation is quick freezing, whereby a fresh produce is kept in a freezer. The main disadvantage of this method is the damage it causes to the physical or structural integrity of some products. For example, frozen tomato does not remain firm after thawing but assumes a soft Contexture; consequently, use of the product may be limited by freezing. For best results, freezing should be done rapidly. Slow freezing causes' larger ice crystals to form in the cells of the tissue and ruptures them. These large reservoirs of water in fractured cells give frozen produce a soft Contexture upon thawing. Rapid freezing results in tiny crystals that do not rupture cell. Quick freezing temperatures are around 29-40^{o}C. Stored produce may lose some colour, flavour, and nutrients. To protect against dehydration, produce to be frozen must be packaged (e.g. in plastic wrap). Failure to do so will lead to freezer burn, resulting from sublimation of water to ice, with adverse consequences such as deterioration of flavour, colour, and Contexture.

3.5.2 Canning

Canning is another method used in preservation after placing the produce in air-tight or hermetically sealed containers; they are sterilised in a pressure cooker. Instead of using water, brine (a salt solution) may be used to preserve vegetables such as onion, beet, and pepper. The intense heat used in sterilisation changes some quality traits such as colour, Contenture, and flavour, as well as nutritional value. Low acid produce (pH 4.5 to 7:0) such as Vegetables requires very high temperatures for sterilisation to kill the bacteria that cause food poisoning (Clostridium botulinum). Canned products can stay in good condition for several years. However, because heat treatment does not kill all bacteria, spoilage sets in after some time in storage. The salt in canning corrodes the can and reduces the shelf life. Also, humidity and high temperatures accelerate spoilage.

3.5.3 Fermentation

Fermentation involves bacteria that decompose carbohydrates anaerobic ally. Some of the producers of fermentation prevent the growth of bacteria. The produce differs according to the organism, conditions and

duration of the process. Fermentation may produce alcohol and lactic acid, products that affect the flavour of fermented foods. Alcohol may further ferment to produce vinegar. Certain fruit juices are deliberately fermented to produce alcoholic beverages (e.g. grape juice becomes wine). A special fermentation process involving the use of salt is called pickling. Vegetables that are pickled include cucumber, onion, cauliflower and tomato; pickled cabbage is called sauerkraut. Instead of using bacteria in packing, pickles may be produced by placing product directly in citric acid or vinegar.

3.5.4 Processing with Sugar

High concentration of sugar may be used to preserve certain fruits products. The sugar increases the osmotic pressure to a degree that prohibits microbial activity and thereby reduces spoilage opportunities. Different fruit products may be preserved in this way. When fruit juice is used, the products are called jelly. Jam involves concentrated fruit while marmalade is sugar processed citrus fruit and rind. When whole fruits are used, the product is called a preserve.

3.6 Marketing

Marketing in the simplest form entails the supply of satisfactory products by a producer to a consumer at a price acceptable to both. In more advanced market economies (and even in less advanced ones) where division of labour occurs, a host of service providers (called middlemen) operate between the producer and the consumer. The service provider include packaging, storage, transportation, financing, and distribution sometimes the fresh product changes in nature between the farm gate and the consumer's door, as is the case when middlemen add value to the product by processing it into other secondary products. In spite of the activities of middlemen some growers deal directly with consumers.

The characteristics of a horticultural enterprise are:

1. Horticultural products are highly perishable; they lose quality rapidly.
2. Many horticultural products are bulky to transport.
3. Prices for horticultural products are not stable.
4. Some storage may be required in a production enterprise.
5. It is important to identify a market before producing horticultural products.
6. Seasonality of the products.

4.0 CONCLUSION

From the explanations in this unit, you have learnt that for consumer to get value for their money and producer to get income they deserve, it is the duty of the farmer to present his product in a form the consumer will appreciate and buy and so he needs knowledge of post harvest technology. The farmer or any other processor involved in the marketing

chain carry out the task of one or many post harvest technology to add value to the crop before they are finally consumed by the consumer.

5.0 SUMMARY

You will note that postharvest technology involves all treatments or processes that occur from time of harvesting until the crop produce finally reaches the consumer. Post harvest technology start with the harvesting of the crop which determines the success of the post harvest technology practices and add value to the crop or product before it reaches the final consumer. The aim of post harvest technology is to present crop products at a form that the consumer will appreciate at all times. Post harvest technology involves handling after harvest, storage, processing, preservation and finally marketing of the produce or product.

6.0 TUTOR -MARKED ASSIGNMENT(TMA)

i-Explain the storage techniques of horticultural crops

ii-List the different forms of preservation of horticultural crops

iii-State the characteristics of horticultural crops

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UNIT 4 PESTS AND DISEASES OF VEGETABLES AND FRUITS

1.0 INTRODUCTION

It is estimated that world crop losses due to pests are of the order of about 35 per cent of potential yield, but in most tropical countries of Africa and Asia, the field and store losses are of a higher magnitude and may be as high as 50 per cent in some cases. Fao estimates showed, for example, that nearly 100 million metric tons of cereals grains are destroyed by pests each year. Diseases are estimated to caused about 10 per cent loss of the annual agricultural production in the U.S.A and about 20- 30 per cent in the developing countries. Therefore, it is now widely recognised that the reduction of losses due to pests and diseases is an important element in increasing the efficiency of crop production. Definition of pest and diseases, description of disease causing organisms, symptoms of plant diseases and control and preventive measures are extensively discussed in this unit.

2.0 OBJECTIVES

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

• define and classify pests according to feeding pattern and economic threshold of destruction
• state the effects of pest on crop production
• analyse and prescribe the best practices of pest control
• analyse the symptoms of plant diseases and identify the kind of diseases that may be affecting a particular crop based on the symptoms

• prescribe the methods of controlling plant diseases.

3.0 MAIN CONTENT

3.1 Definition and Classification of Pests

Pest is any animal or plant which harms or causes damage to man, his animals, crops, or possessions. On agricultural basis, a pest is that which causes a loss in yield or quality of the crops resulting in loss of profits by the farmer. When a loss in yield reaches certain proportions, then, the pest can be defined as an economic pest. Economic threshold is defined as the population density at which control measures should be started to prevent an increasing pest population from reaching the economic injury level.

3.1.1 Classification of Pests on the Basis of Economic Threshold

i. The Regular Pests

These are pests which perennially damage crops and whose population levels rarely fall below the economic threshold. Examples of these are Maruca testulalis on cowpea, Dysdercus spp. and red boll-worm on cotton, sorghum midge and Quelea birds in most parts of the grain producing Guinea and Sudan savanna of tropical Africa.

ii. The occasional pests

These are pests whose populations levels are normally below the economic threshold but occasionally rise above it. Examples of these include locusts that periodically ravage cereal crops and grasses in Sub-Saharan Africa, the stem borers and armyworms of cereals in western and eastern Africa, the variegated grasshopper, Zonocerus variegates, in West Africa, and many species of snails and lepidopterous larvae attacking deciduous forest trees, and arable and plantation crops.

iii. The potential pests

Those pest whose population levels are usually considered to be far below the economic threshold but which can become highly injurious under changed cultural conditions or as introduced pest. Examples of these include many species of grasshoppers and caterpillars in western and central Africa

3.2 Description of the Important Pests of Crops

The arthropods which comprise the insects, mites, millipedes and woodlice constitute the most dominant group, other organisms include: nematodes, rodents, birds and mollusks.

1. Insects

Insects belong to a group of organism known as arthropods. Insect pests are grouped into three basic classes according to feeding patterns, namely:

- Biting and chewing.
- Sucking.
- Boring insects.

i. Biting and Chewing Insects

These are insects which have biting mouth parts consisting of a pair of toothed horny jaws (mandibles) and a pair of accessory jaws. They tear and bite plant parts in their larval or adult stages. As a result, most of the leaves on the plant are eaten up. The grasshopper or locus, chewing beetle, the larvae of many butterflies and moths, the caterpillars are all examples of chewing insects.

Variegated grasshopper, Zonocerus variegates

Ii. Sucking Insects

These insects are made up of a long, powerful, piercing proboscis with which they suck the liquid cell contents from leaves, stems or fruits. Sucking of the liquid cell content has weakening effect on plants but the ability to transmit plant diseases such as viruses is the most serious effect which sucking insects have on crops.

The commonest types of sucking insects are those which have proboscis both at the immature and mature stages of growth. These insects feed on the stems and young fruits of many crops and may also introduce poisonous toxins into the crop tissues. Capsids and aphids are typical example of this group of insects that attack both young and old shoots and pods of cocoa. The cotton stainer is a troublesome sucking insect pest of cotton. It feeds on the young pods, and reduces the commercial value of cotton by staining the lint.

Other types of sucking insects include; scale insects, mealy bugs and aphid. Scale insects have shell that protects them during adverse weather condition and from predators. Fruit piecing moths are sucking insects which feed mainly on citrus fruits.

Citrus mealy bug

Iii. Boring Insects

These have mouth parts which are adapted to digging holes through plant and material. The cowpea weevil which infests cowpea is a good example of boring insect.

Bean or cowpea weevil

2. Nematodes

These are small organisms which are normally referred to as eelworms. Nematodes can cause a considerable damage to crops such as yams, cowpea and many Vegetables. A disease known as root-knot disease of cowpea, for example, causes the formation of irregular nodules on the roots and dwarfing of the mature plant.

3. Rodents

These are mammals with teeth which are well adapted to gnaw or grind hard substances. They include mice, squirrels, porcupines, rats and grass cutters. These animals may damage fruits and vegetables and are particularly very injurious to young seedlings of oil palm, rice, sugar cane, and the tubers of root crops such as cassava. The larger rodents such as squirrels and grass cutters can be trapped, and wire netting fences may be erected to protect crops from damage. Small rodents can

be prevented from destroying young seedling of palm trees by placing collars of small-mesh wire netting around the base of the trunk.

Rodent (rat)

4. Birds

Birds of various types may do considerable damage to grain crop farms by eating both developing and dry grains. Quelea quelea birds are by far the most populous and destructive birds in Africa. They invade crops like locust and cause heavy damage. Attacking the birds at their nesting and resting sites provides the most effective method of control. Toxic chemicals sprayed at dusk, has been found to be cheap and effective.

5. Mollusks

Garden snails and slugs may damage leaves of many kinds of Vegetables.

3.3 Effects of Pests on Crop Plants

A. Direct Effect of Insect Feeding

i. Leaves eaten, with subsequent reduction in assimilative tissue and hindrance of growth. Examples are grasshoppers, caterpillars, sawfly larvae, leaf-cutting ants, leaf beetle and some weevil.

ii. Leaves rolled and webbed, and eaten. Examples are larvae of skippers, and all Lepidoptera.

iii. Leaves mined with either tunnel or blotch mines, e.g. spinach leaf miner

iv. Buds eaten, destroying either the growing point of young flowers and fruit, e.g Budworms (caterpillars) of rose and Grape Flea Beetle

v. Flowers and young fruit eaten, as by pollen beetle, blister beetles.

vi. Fruits and seeds eaten or bored and destroyed, as by sorghum midge larvae, pea pod borers, maize weevil, coffee berry borer and various fruit flies.

vii. Fruits bored and caused to fall prematurely for example mango fruit fly, and coffee fruit fly.

viii. Stems of both woody and herbaceous plants bored, with subsequent death of the distal part of the stem, for example Earias spp in cotton stem.

ix. Stems of seedlings bored, producing a dead-heart, for example Athergona spp. larvae in cereal seedlings, and Chilo spp. larvae in cereals.

x. Stem of woody plants ring-barked, as done by Anthores spp. on coffee.

xi. Roots eaten, causing a loss of water and nutrient absorbing tissue, for example chafer grubs and some weevil larvae.

xii. Tubers and corms bored, leading to a reduction of stored food material, and impairing both storage properties and next season's growth; examples are Cylas spp. weevils in sweet potato tubers, yam beetles and potato tuber moth larvae.

b. Damage by insects with piercing and chewing mouthparts and mites

i. Loss of plant vigour due to removal of excessive amounts of sap, resulting in extreme cases in wilting, followed by stunting of growth; for example most aphid species, and whiteflies on a range of crop plants.

ii. Cause leaf-curling and deformation, as shown by aphids, thrips, mealybugs, white/black flies and jassids.

iii. Cause premature leaf-fall, as do many diaspidid scales.

iv. Cause leaf and fruit scarification by rupturing epidermal cells and removing sap; as by spider mites and many thrips.

v. Toxic saliva injected by feeding bugs causes premature fruit-fall in coconut and abortion of young cotton bolls etc.

vi. Provides physical entry points for pathogenic fungi and bacteria.

C. Indirect Effect of Insects on Crops

i. Insects can make the crop more difficult to cultivate/ harvest.

ii. They may distort the plant as do Earias spp. larvae on cotton.

iii. They may delay crop maturity, as do the bollworms in cotton, which makes the plant to develop a spreading habit thus making weeding and spraying difficult.

iv. Grain in cereal crops may become dwarfed or distorted.

v. Insect infestation results in contamination and loss of quality in the crop. The loss of quality may be in nutritional value or in marketability.

d. Transmission of Disease Organisms

i. Cassava mosaic, tobacco mosaic and banana bunchy top are typical examples of crop diseases that are transmitted by insect vector.

ii Mechanical or passive transmission takes place through lesions in the cuticle caused by feeding. The pathogen, usually a fungus or bacterium, may be carried on the proboscis of the bug or on the body of a tunneling insect.

SELF -ASSIGNMENT EXERCISE

i. Define pest
ii. State 5 direct effects of pest
iii. State 3 important pest of Vegetables crops

3.4 Insect Pest Control

The control of the various insect pests affecting crop plants is a major problem for crop production. Insect pests may be controlled by means of various cultural practices, the use of chemicals known as insecticides and, biological methods of insect control.

1. Cultural methods of insect control

i. Hand Picking: For example, fully grown adult grasshoppers and caterpillars of some insects may be partially controlled by hand picking.

ii. Crop Rotation: Since insects are generally selective in the choice of crops they attack a rotation of crops which can result in a reduction of insect number when new crops are planted.

iii. Tillage Practices: Ploughing and harrowing normally reduce the population of soil pest by exposing them to sunlight and desiccation, and to predators and parasites.

iv. Weed Control: some weeds act as host to insect pest, timely control of weeds would deprive them of their host.

v. Adjusting Time of Planting to Avoid Period when Insect's Population is at its Peak. For example sorghum midges can be effectively controlled by planting early so that flowering is complete before the adult midge population reaches damaging levels.

vi. Resistant Varieties: Pest may also be controlled by planting pests resistant varieties. New varieties, resistant to an increasing number of insect pests have been produced in recent years by the research institute.

vii. Timely Harvesting: Prompt harvesting is known to help protect maize and beans from damage by maize weevil and bean bruchid.
viii. Observance of a Closed Season: Some pest cannot survive in the absence of a specific host plant. Observing a closed season for the cultivation of this plant provides effective control. A good example is the pink bollworm (Pectinophora gossypiella), provided no cotton is grown during the closed season, this pest is deprived of a carry-over site for the next season, with the result that its population is kept below the level at which it causes serious economic loss.
ix. Trap Cropping: A trap crop is used to divert the pest from the main crop. The pest usually prefers it to the main crop for feeding or egg laying. The trap crops are grown in strips at appropriate intervals within the field. The pest population concentrates on the trap crop, while the main crop suffers little damage.

x. Optimum Plant Density: The biology of both pest and their natural enemies can be affected by plant density. For example, bean fly infestation in kidney bean is less severe in densely planted crops than in thinly planted ones. Similarly, populations of aphid (Aphid craccivora) are lower and the spread of rosette virus, of which this insect is a vector, is less rapid on more densely sown fields of groundnut.
xi. Crop Sanitation: Clearing crop fields after harvest and burning crop residues to destroy over wintering pest populations are important cultural practices.
xii. Cropping patterns: for example, intercropping controls the spread of pest.

2. Chemical Method of Insect Pest Control

The most effective method of controlling insect pest is by spraying or dusting crops with insecticides. The choice of insecticide will depend on the feeding habits of any particular insect. Biting and chewing insects are usually controlled by the use of stomach poisons. Example of stomach poisons are lead arsenate and Paris green while contact poisons are sprayed to kill the insect upon contact. Examples of contact poison include Gammexane, Lindane, nicotine sulphate, Gammalin 20, Didimac 25, etc. Insect pest of stored products are generally controlled by fumigants (insecticides which kill by poisonous vapours or fumes). Fumigants may either be gaseous, liquid, or powder forms. Examples are carbon disulphide, hydrogen cyanide (gas) sulphur and methyl bromide.

3. Biological Method of Pest Control

Biological control refers to the use of living organisms for the control of pests. The use of predators which feed on harmful insects and reduce their number to a minimum is recommended if there will be no adverse effect. Broadly speaking, biological control also includes the use of

pathogens such as bacteria, fungi, viruses, protozoan, and nematodes. Biological control using parasites and predators has been effectively utilised in the control of Kenya mealbug (Planococus kenyae) by Anagyrus spp.

3.5 Plant Diseases

Plant diseases can be defined in the broadest sense as conditions of the plant involving abnormalities of growth or structure. It is this departure from the normal healthy condition, resulting in the appearance of disease symptoms, which enables diseases to be recognised. The most important effect of plant diseases for the farmer is the reduction in crop yield or quality which usually occurs as a result as disease infestation.

3.5.1 Symptoms of Plant Diseases

Many diseases can be recognised immediately by the characteristic symptoms which they produce. Symptoms are usually described according to their appearance. Symptoms of plant diseases include the following:

i. Death of the Tissues or Necrosis: Various terms are used to describe the extent and shape of necrotic lesions, particularly on leaves, stripe for narrow, elongated lesions, scorch, scald, fire and blotch for indefinite areas which often become blanched and then brittle.

ii. An Abnormal Increase in the Tissues: This can result from both an increase in size (hypertrophy) and an increase in number (hyperplasia) of cells. The more common symptoms of this type are witches brooms, galls, canker and scab.

iii. A Failure to Attain Normal Size or Development (hypoplasia): An overall dwarfing or stunting of the plant is common in many diseases.

iv. Change in Colour: Yellowing or chlorosis is a common symptom of disease and is often associated with tissues surrounding a necrotic area.

v. Wilting: Caused by an interference with the normal movement of water within the plant resulting in the drying up of the plant.

vi. Unusual Development or Transformation of Organs: for example maize infected with Ustilago Maydis; The staminate inflorescences may bear pistillate flowers.

vii. Disintegration of Tissues: This is termed as rot. It may be accompanied by a release of cell fluids (wet rot), so much so that there is an exudate from partially disintegrated tissue. Alternatively, the cells may crumble to a powdery mass (dry rot).

viii. Excessive Gum Formation: This is particularly associated with diseases of trees and is known as gummosis or gumming.

3.5.2 Causes of Plant Diseases

Disease can be caused by various agents either acting singly or in combination with another, and the study of these agents is known as

etiology of the disease. The agents themselves fall into the following categories:

I - There are the bacteria, fungi and viruses which together probably account for the greatest number of diseases.

ii - Nematodes.

Iii - Some insects (excluding those that only serve as vectors for disease agents).

Iv - A few flowering plants such as broomrape (Orobanche), dodder (Cuscuta) and witch weed (Striga).

V - Heterogeneous group which includes mineral deficiencies and excesses.

Vi - Unfavourable environmental conditions.

Disease-inciting agents that are themselves living organisms are called pathogens. The term parasite and host describes a nutritional relationship between two organisms, but the growth of a parasite in its host usually result in changes which are detrimental to the plant and considered on its ability to induce disease. A parasite can also be a pathogen.

Parasites causing plant disease can be classified according to their dependence upon the host plant as:

- Obligate
- Facultative

i. Obligate Parasites

These organisms can only grow directly on the host plant and cannot generally grow saprophytically on non- living organic matter. Their survival in the absence of a suitable host depends upon dormant resting stages in the life cycle, such as spores. An obligate parasite depends critically upon the existence of the host. They cause only fairly mild symptoms such as growth malformation, stunting and discoloration. They would not kill the host.

ii. Facultative Parasites

These are usually well adapted to a saprophytic existence and can survive long periods in an active stage in the absence of a suitable host. The destruction of the host is of less consequence to the facultative parasites which therefore cause more immediate and drastic damage, such as necrosis and wilting.

1. Causal Agents of Crop Diseases

i. Fungi

The majority of plant diseases are caused by various parasitic fungi. Most parasitic fungi are facultative although some are specialised obligate parasites, such as powdery mildews (erysiphaceae) and rusts (uredinales). Fungal pathogens, although differ in form are characterised by the production of spores which enable them to spread between plants. Many parasitic fungi disperse their spores through water, in rain splashes or are carried in air. Some fungi attack crops at or below the

soil level while others are dispersed by insects or through seeds. The dispersal of spores is aided by the fact that most fungal spores are very small and are also produced in large number. When the spores of these fungi fall on a suitable host plant they grow into its tissue, absorb food and develop reproductive sporangia.

a. Some common diseases caused by the genus phytophthora include:

- Phytophthora palmivora which causes black pod disease of cocoa.
- Phytophthora infestans which causes potato and tomato blights.
- Phytophthora parasitica which causes stem rot of tomato.

Stem rot of tomato

c. Some common diseases caused by the genus Pythium include a number of soil inhibiting fungi which usually enter the host plant through wounds and subsequently cause rotting. Seedlings infected by Pythium spp. turn black and rapidly die; this is often referred to as damping off diseases.

Damping off disease causing dead of seedling

-Many crops are attacked at the seedling stage by Pythium debaryanum which rapidly causes death of the seedlings.

- Watery wounds rot of potato tubers is often caused by Pythium ultimum.

The genus Peronospora includes species which are widely referred to as downy mildew diseases. Examples are:

- Peronospora destructor; which infests crops such as onion.
- Sclerospora graminicola which attack guinea corn.

c. The genus Puccinia, include many different types of rust and smut diseases. They form rust coloured spore patches which develop on the epidermis of the infected host plant. These fungi infect graminaceous crops such as maize, guinea corn and rice, making the grains worthless for both food and planting materials.

ii. Bacteria

These microscopic organisms are generally capable of survival where other living organism cannot exist, such as water, the tissue of plants, dust particles and damp soils. Bacteria usually enter into the tissue of crops through wounds, stomata, flowers or fruits. The symptoms of bacterial infection are varied, but the most common ones are decay, accompanied by an unpleasant odour. Examples of bacterial diseases are: blight diseases of guinea corn and bacterial wilt of tomatoes, tobacco, garden eggs and peppers. Affected plants rapidly wilt, collapse and die. Citrus and mango fruits are liable to infection due to bacteria entering the wounds made by sucking insects or birds.

Bacterial wilt of tomatoes

iii. Viruses

Viruses are a group of extremely minute organisms which are visible only through a powerful electron microscope. They are very highly specialised obligate parasites and can only exist within living plant cells. Most often they cause obscure symptoms easily confused with mineral deficiencies of other environmental effects. Plants infected with diseases due to viruses show varying symptoms such as change in leaf colour, malformation such as swollen shoots, mosaic leaf patterns and distortion. Others are reduced leaf formation, leaf spot, rings and streak on leaves and stunted growth.

Most viruses spread between plants by means of living vector, usually insects or nematodes, which themselves become infected with the virus, after feeding on a diseased plant. Many viruses can be carried by insects, particularly sucking insects such as aphids, mealy bugs and leaf-hoppers. The knives used in budding and grafting may also transmit

viruses if used on infected plants. Viruses are rarely disseminated through seeds. Examples of common viruses which affect crops are:

- Cassava mosaic virus (CMV).
- Capsicum leaf curl virus (CLCV).
- Cocoa swollen shoot virus.
- Tristeza virus which affects citrus.

Capsicum or pepper leaf curl virus

Control measures against virus diseases are usually aimed at the vector, but use of resistant crop varieties and clean planting material are also important in the control against virus diseases.

3.5.3 Measures of Controlling Plant Diseases

Plant disease control is concerned with preventing or at least restricting the development of plant disease epidemics. Most control measures for plant diseases are designed to prevent rather than cure the disease. They aim to operate on the pathogen before it has established a parasitic relationship with the host.

3.5.4 Principles of Plant Disease Control

Two of these methods of plant disease control are mainly concerned with the pathogen:

- If the pathogen is not already present in an area then methods are devised to exclude it (exclusion);
- If the pathogen does get in then attempts are made to eradicate it (eradication).

The other two methods of plant disease control concern the host:

- By applying a chemical to the plant surface or by modifying the condition under which the plant is growing it is often possible to protect it from attack (protection).
- By breeding, it is sometimes possible to obtain varieties of the particular plant which resist attack by the pathogen (breeding for disease resistance)

Control measures can be classified into various categories; these include cultural practices, the destruction of insects by chemicals and the development of disease resistant varieties.

A. Cultural Practices

I. Crop Rotation

Important pest and diseases such as cyst nematode and club root, attack specific crops. By the simple method of planting a given crop in a different plot each season, such pests or diseases are excluded from their preferred host for several seasons.

ii. Destruction of Infected Material

An important cultural practiced is the eradication of suspected sources of plant diseases. This includes the uprooting of weed hosts and alternate hosts and the removal, burning or burying of diseased plants, particularly those infected by bacterial or virus diseases. Diseased tree crops should be treated by pruning away diseased portions of individual plants, after which all cut surfaces, should be treated with white lead paint.

iii. Ploughing

This brings about physical improvement of the soil structure as a preparation for growing of crops. Ploughing improves drainage and tilt of the soil. The improved drainage and tilt may reduce damping-off diseases, expose soil pest to the birds.

iv. Soil Fertility

While the correct and balance of major nutrients in the soil are recognised as vitally important for maximum yield and quality, excessive nitrogen levels may encourage the increase of insects such as peach potato aphid, fungi e.g. grey mould. Adequate levels of potassium help control fungal diseases e.g. Fusarium wilt on carnation, and tomato mosaic virus. Club root disease of brassica is less damaging in soil pH greater than 6 and lime may be incorporated before planting these crops to achieve this aim. Dressing with suitable fertilisers may stimulate growth of the host plant so that it will recover from damage caused by disease.

v. General Farm Sanitation

Reasonable sanitary precaution on the farm helps to prevent the introduction of diseases from other fields. Some virus diseases are spread by contact. Therefore, clothing, machinery, and equipment that have been in use on such infested fields should be disinfected before being used on other fields.

vi. Seed Treatment

To avoid seed borne diseases being carried over from one season to the next, seed to be planted is often treated with a fungicide, e.g. Arasan.

vii. Avoidance

Sometimes, a pest or disease is most prevalent at a certain time of the year. The planting may be so timed that the crop grows during the time when the disease or pest incidence is least. For example the deliberate planting of early potato cultivars enables harvesting before the maturation of potato cyst nematode, so that damage to crop and the release of the nematode eggs is avoided.

b. Chemical Method of destruction of Insect Vectors

i. Use Chemicals (Insecticides)

The control of insect vectors which carry disease has been effective in reducing the spread of some diseases such as swollen shoot disease of cocoa and mosaic disease of cassava. Aphids and leaf-hoppers which transmit these diseases can be controlled by the use of insecticides e.g Aldrin dust.

ii. Fungal diseases are controlled by chemicals referred to as fungicides. These chemicals may be sprayed or dusted on to the seeds, young leaves, shoots or flower buds before the arrival of the fungal spores.

iii. Seed treatments are normally effective when the disease is transmitted via seed. Diseases such as smuts or rust may be controlled by soaking the seeds in fungicides before sowing. Certain chemicals (soil fumigants) are effective in controlling nematodes, soil-borne insects and soil borne diseases.

iv. Repellents; Repellents are chemicals which do not actually kill the pests, but they repel them from coming near the plants.

c. Biological Control

A more recent approach to the control of plant pests and diseases is biological control, which emphasises the control of diseases and pest through manipulation of natural and ecological factors.

i. Planting Disease-Resistant Varieties; the use of disease resistant varieties of some crops has proved to be very successful in the control of plant diseases.

ii. Biological control also refers to control of diseases by the use of other organisms to reduce inoculum density or the disease producing activities of the causative agents of diseases.

d. Physical Method

i. Treating seeds of cereals in hot water to kill the loose smut pathogen (Ustilago nuda), and floating of cereal seeds to separate healthy grains from those infected by ergot (Claviceps purpurea) are two examples of physical method of disease control.

ii. Grain smut of sorghum may be controlled by soaking seed in water for 4 hours to initiate germination of the fungal spores. The seed is then spread out to dry, first in the shade and later in the sun, causing the germinating of spores to be killed without harming the seed. Physical methods of this kind may be widely applicable in Africa for certain diseases, and represent one of the more feasible control options available to smallholders.

4.0 CONCLUSION

This unit concentrated on pest and diseases affecting crops. It explained the nature and characteristics of pest, effects of pests, the control and preventive measures. Diseases, symptoms of plant diseases, causative organisms, control and preventive measures were also treated. It stressed that the effective control of pests and diseases should be based on a sound knowledge and understanding of pests and diseases of a particular crop in a given locality.

5.0 SUMMARY

This unit discussed pest and diseases of crop plants. The characteristics of pests and how they destroy crop produce and how to tackle them were also treated. Diseases, definitions, symptoms and causes of plant diseases were highlighted. The different methods of disease prevention and control were enumerated and discussed.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1a. Define the term pests.

b. Categorise pests based on pattern of feeding.

c. Enumerate the direct effects of pests.

2a. State the principles of pest control.

b. Describe the cultural methods of pest control.

3a. Distinguish between localised and systemic symptoms of plant diseases.

b. Give the generalised symptoms of plant disease.

4a. Explain the chemical method of disease control.

b. Briefly describe the physical method of disease control.

c. List the cultural practices of diseases control.

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UNIT 5 HORTICULTURAL TOOLS AND MACHINERIES

1.0 INTRODUCTION

Contribution of horticultural and floricultural crops to the total agricultural production in the country is quite significant due to highly favourable and varied agro-ecological diversities. Major field operations for horticultural crops include nursery/seedling preparation, post hole digging for planting, ear thing, irrigation, plant protection, harvesting, handling, packaging transport. The cultivation of horticultural crops is predominantly dependent upon human labour, since commercial cultivation is only on a limited scale. Animal/power tiller or tractor-drawn mould board ploughs, disc ploughs, harrows, cultivators and rotavators, are available and used for land preparation.

2.0 OBJECTIVES

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

- list the different types of horticultural tools
- state the uses of the different types of horticultural tools
- explain the type of machineries used in horticultural fields

3.0 MAIN TEXT

3.1 Horticultural Tools and their Uses:

Some important tools used in horticultural farms include the following:

Pick Axe

The pick axe is made up of a long wooden handle with a double headed thick metal blade that is attached to the handle through a loop. The head of the pick axe is made up of two edges, one part of the end of the blade is pointed, while the other end is flat and sharp edged. They are mainly

used for breaking up of hard soil, and digging up of roots and tree stumps.

Axe

The axe is a simple hand tool, which consists of cutting edge and an eye for fixing of a

handle. It is multipurpose cutting tool used for felling and delimbing of trees, splitting of logs for firewood and dressing of logs for timber conversion. Small axes are also used for clearing of bushes.

Axe

Cutlass

The cutlass is one of the commonest used farm tools in Nigeria. They come in various shapes and sizes. It is a flat long metal blade with a short wooden or plastic handle with one edge sharp while the other is blunt. They perform many functions. It is used for the clearing of bushes around your homes, for the felling of big trees. It is used in harvesting crops like sugar cane, maize, cassava, yam and palm nut fruits. It is also used in the planting of melon during the planting season, cutlass can also be used for the transplanting of seedlings, weeding of crops, both in the digging of shallow holes and used in the trimming and pruning of flowers.

Cutlass

Hand Fork

When it is viewed, the hand fork, looks like the kitchen fork we eat with, just that it is a little bit bigger; it has a short wooden or metal handle with four prongs. It is used in mixing manure into the soil, for breaking the surface of the soil, so that air and water, can pass easily and it is also used for the removal of weeds on the seed bed.

Hand fork

Hand Trowel

It is boat shaped or it is either curved sloop metal blade that is attached to a short wooden or metal handle. When using it, you hold it with one hand. It helps in the transplanting of seedlings, for the application of fertiliser and also for the application of manure to the soil, it helps in loosening vegetable beds, it can also be used for light weeding, sampling or mixing up of soil and digging holes for the planting of seeds.

Hand trowel

Sickle

The sickle has a curved metal blade that is fitted into a short wooden handle. The inner part of the curved metal blade is very sharp while the other part, has a blunt edge.

To recognise a sickle when been viewed, it has a structure like that of a question mark (?). It used in the plucking of fruits. This can only be possible, when it is tied to a long handle, it can also be used to harvest cereals like rice, wheat barley because they possess thin stems. It can also be used in the harvest of grasses.

Hammer

It is made up of a thick heavy metal head that is fitted into a straight wooden or metal handle. At the end of the thick heavy metal there is a prong which is used for the removal of nails. The hammer can be used for driving nails into wooden structures whether in the farm or at home, it can also be used to straighten damaged or bent components of either farm implements or our home furniture. It can also be used in the removal of nails from wood.

Mallet

It is made up of a large head with a wooden handle that is similar to that of a hammer. The entire body is made up of wood. It is solely used for

the hitting of woods like pegs, so that they would not be damaged in the process, when they are been hit into the ground.

Hoe

Hoe comes in different types, which are used in Nigeria today. There is the West African hoe and the Indian hoe. They both have metal blades with wooden or metal blades. The West African hoe is made of short curve handle while the Indian hoe has a long handle. Hoes are used in tilling the soil, harvesting of crops like cassava, sweet potato and cocoyam, weeding between the rows of crops, digging of drains, making trenches and foundation of farm houses, and the making of ridges and mounds.

Hoe

Spade

The spade is made up of a long rectangular flat blade which is attached to a fairly long cylindrical handle that widens at the posterior end to form a triangular block with a D-shaped whole for hand when used. Spade is used for different proposes. It can be used for digging of holes and trenches around us, for leveling the ground, for making seedbeds, ridges, mounds and heaps, transplanting of seedlings like palm oil seedlings, turning the soil and the mixing of manures, light weeding in the farm and at home, mixing of cement and concrete for farm and home structures and the digging of foundations when constructing farm and home buildings

Spade

Watering Can

It is made up of galvanised iron which prevents it from rusting. Some are also made of very synthetic rubber. The water watering can is made up of a tank, a handle and a spout. This spout is long with a perforated metal sheet over its mouth which is referred to as the ROSE, but in case

of the rubber made watering can the mouth is covered by a rubber. It is used to apply water to crops like seedlings in a nursery and vegetables. Sometimes it is used in applying liquid fertilisers to crops as well as the watering of cement blocks used for the constructions of structures and buildings.

Watering cans

Garden Fork
It is used for turning manure during compost making and for spreading manure in the open field. It is also used for loosening the soil before transplanting.

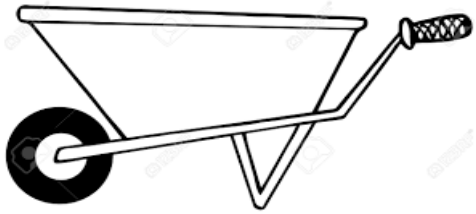
Digging mattock: It is used for digging and uprooting small stumps

Rake
A rake is used for levelling soil surface and breaking large soil crumbs into small ones. It is also used for removing stones and weeds from seedbeds and for covering vegetable seeds when they are broadcast.

Rake

Garden Line
It is used for lining up beds and for making straight line when planting.

Wheel Barrow
It is used for conveying materials (tools, seedlings, manure etc) to and fro the farm



Wheel barrow

Tape
A tape is used for taking short or detailed measurement on the field.

Ranging Pole
It is used for marking surveyed stations or intermediate stations. It is also useful in marking straight lines

Budding and Grafting Knife
The budding knife is an important hand tool of a gardener, which consists of a folding blade and a handle. The blade has two edges. One of the edges is sharpened all along its length; whereas the blunt or the other edge is sharpened on the tip and is slightly curved. It is use for budding and grafting in vegetables, nurseries and fruit gardens. The knife is also used for cutting of thin unwanted twigs, defoliation of leaves and general cutting works in nurseries and orchards.

Budding knife

Secateurs
The secateurs are made up of two metal blades of which one has a concave curve while the other has a convex curve that are joined together at a point. It has two short metal handles with a spring in between them when handling it; you handle with one hand, while the plant branch to be cut is held with the other free hand. To recognise the secateurs it looks like a pair of scissors. It is used for trimming flowers and the pruning of the branches of shrubs and trees. They are also used for pruning vines.

Secateurs

Chain Saw

It is also called power saw and is a light and portable machine. Cutting is done by an endless chain fitted with cutters, which runs around a flat piece called the bar. The chain saw is used to trim dead or diseased wood from trees, to remove inconveniently placed branches or fell trees.

Chain saw

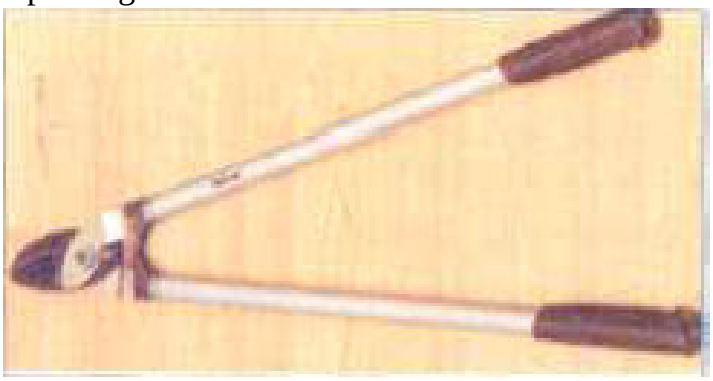
Shears

It is seen as a pair of an enlarged pair of scissors with two long blades, connected at a point by a bolt and a nut of which the blades are sharpened at one edge not the two sides in other not to injure someone. The handle of the shears may be made of wood, metal, plastic or rubber. It is usually handled with both hands. Shears are used to prune down trees or branches of shrubs, trimming of hedges and trimming of ornamental plants used in house decoration. It is also used for cutting of shrubs and removing of haphazard growth in gardens and lawns.

Shears

Lopping Shear

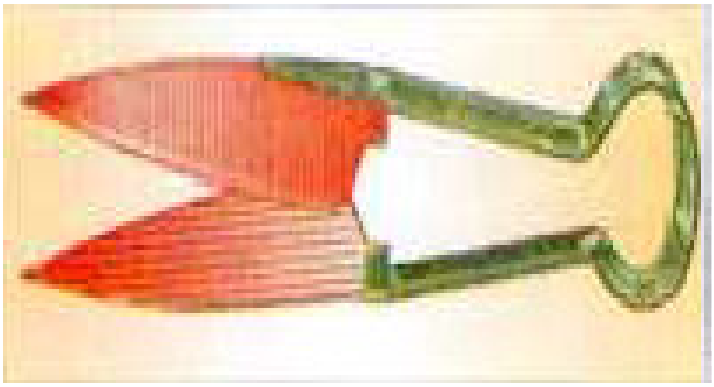
The lopping shear is used for pruning and cutting of branches and twigs of the orchard trees in standing position, which are beyond the reach, and capacity of pruning secateur.



Lopping shear

Grass Shear

The grass shear is simple hand tool used in maintenance of lawns The grass shear is used for trimming of the grass in the lawn. It is also used for side dressing of the lawn and cutting of the soft vegetative material. The shear with 'U' spring steel handle having sharp edges can also be used for shearing of sheep wool.



Grass shear

Crowbar

The crow bar is made either from the structural steel or from medium carbon steel. It is used for digging holes or pits for planting and fencing

Crowbar

3.2 Horticultural Machinery and Implement

The machines are elements that are used to direct the action of forces based energy work, for his part in the agricultural, motor mechanisms used in this work lighten the production and improve farming techniques. Most widely used horticultural machines include:

Tractor: Is a very useful agricultural machine, with wheels or designed to move easily on the ground and pulling power enabling successful agricultural work, even in flooded fields. It has two brake pedals and is preparing to pull sledges. There are two types of tractors: the track of stability and strength, and wheels, able to travel to by road, has a higher speed than the track.

tractor

Walking Tractor: Agricultural machine is a single axle and is operated by handles, have median motor power and strength led to horticultural and ornamental work, can work in strong fields, but is preferably used in construction of gardens.

Walking Tractor

Sprayer: It is a farm equipment designed to spray, is composed of a liquid tank, pressure pump, cap, mouth, tank and pressure valve, belts, hose, faucet and nozzle where the liquid to spray out, is insecticide, fungicide or herbicide. The hand sprayer is placed in the back of the sprayer and this has placed in the mouth and nose a special mask to prevent strong odours dismissed by the substance that expels the sprayer will harm.

Sprayer

Knapsack Sprayer

This is equipment that is used for spraying chemical on the farm.

Knapsack sprayer

Mower

Mower is a machine that is used for cutting lawn and grasses in the field, farm and homes.

Mower

Farm equipment is a group of devices designed to open furrows in the ground, shredding, spraying and fertilising the soil.

Plough

Agricultural equipment is designed to open furrows in the earth consists of a blade, fence, plough, bead, bed, wheel and handlebar, which serve to cut and level the land, hold parts of the plough, set shot and to serve as handle. There are various types of ploughs but the best known are:

- mould board plough, formed by the grating blade and mould board
- disc plough, disc concave formed by deep grooves to open
- shallow ploughing to remove the topsoil
- Subsoil plough to remove the soil depth.

Plough attached to tractor

4.0 CONCLUSION

For ease of farm operation in horticultural fields, there is need for the farmer to use farm tools and machineries. This help to make his work easier, faster and enable the farmer cover a larger area within a short

time. Commercial farmers used machineries in most of their farm operation while subsistence farmers used local farm tools.

5.0 SUMMARY

In this unit, you have learnt about farm tools that can be used in horticultural farms such as hoe, rake, spade, cutlass, hand trowel, watering can, budding and grafting knife etc and there uses on the farm. You also learnt about farm machineries that can be used in horticultural field for ease of farm operation. These machineries include:

i. Tractor
ii. Mower
iii. Sprayer
iv. Walking tractor

6.0 TUTOR -MARKED ASSIGNMENT (TMA)

1. List ten (10) farm tools and state there uses
2. Attempt the drawing of a knapsack sprayer

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MODULE 3

Unit 1 - Method of propagation (sexual and specialised organs)
Unit 2 - Method of propagation (asexual)
Unit 3 - Horticultural cropping systems

UNIT 1 - METHOD OF PROPAGATION OF HORTICULTURAL CROPS (SEXUAL AND SPECIALISED
Organs)

1.0 INTRODUCTION

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

2.0 OBJECTIVES

At the end of the lesson you should be able to

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

3.0 MAIN CONTENT

3.1 Propagation of Crop

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

i. Increase in number of plants

ii. Preserve the essential characteristics of plant

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

3.2 Methods of Propagation of Horticultural Crops

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

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

3.2.1 Sexual Propagation (seed)

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

Advantages of sexual propagation

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

Disadvantages of sexual propagation

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

3.2.2 Asexual Propagation (Vegetative Propagation)

Vegetative propagation is the method that uses any part of plant rather ‘true’ seed to produce new plants. Plants have a number of vegetative mechanisms. Some of these have been taken advantage of by horticultural and gardeners to multiply or clone plants rapidly. Plants produced using vegetative parts have no exchange of genetic material, therefore, the plants are identical to the parent. Vegetative propagation uses plant parts such as roots, stem and leaves. In some plants, seeds can be produced without fertilisation

and the seeds contain only the genetic material of the parent plant. This is called apomixes. Apomixes is asexual reproduction but not vegetative propagation. Vegetative propagation is essential for the raising of many economic crops eg fruit crops, nut crops, many flowering and ornamental crops and certain Vegetables crops.

Advantages of Vegetative Propagation

1. Maintenance of true – to – type clones over a time. A clone is a group of plants with the same genetic makeup.
2. It maintains uniformity of plants genotype.
3. It is the only means of propagating certain plants e.g. banana and plantain which do not produce viable seeds.
4. Earliness of production is achieved.
5. It may be more economical to propagate asexually in some crops as in sweet potatoes.
6. Some seeds germinate with difficulty and as such vegetative propagation is best for them.
7. Seed borne diseases are avoided when plants are propagated asexually.

Disadvantages of Vegetative Propagation

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

The methods of vegetative propagation include the following;

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

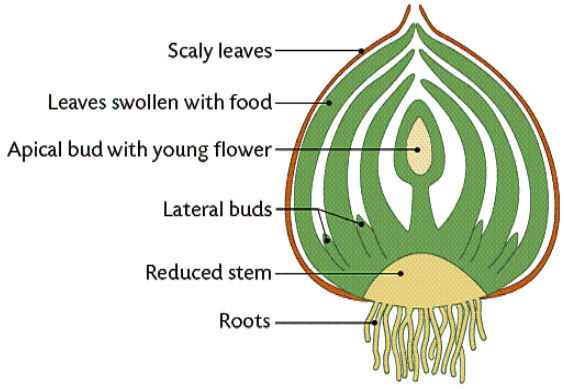
SELF- ASSESSMENT EXERCISE

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

3.2.2.1Use of Specialised Vegetative Structure

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

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

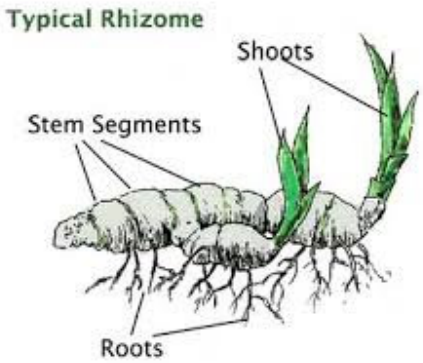


Onion bulb

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

Cocoyam corm

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

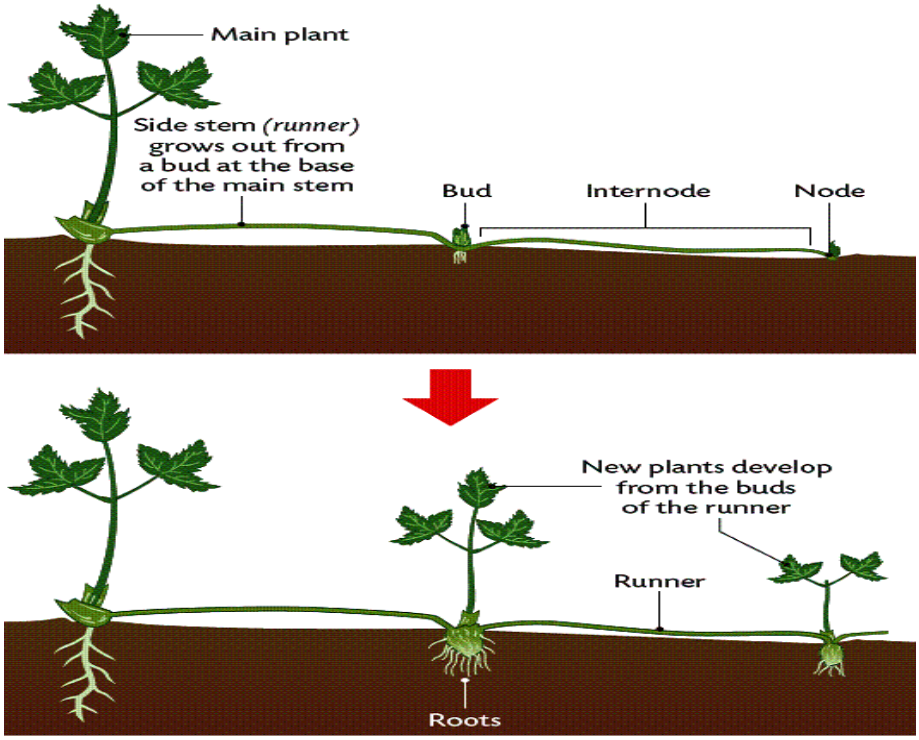


A Rhizome

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

Tubers

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



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

4.0 CONCLUSION

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

5.0 SUMMARY

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

6.0 TUTOR- MARK ASSIGNMENTS (TMA)

i-Define propagation

ii-List 4 vegetative propagation methods you know

iii-Explain 5 specialised structures that are used for vegetative propagation

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UNIT 2 METHOD OF ASEXUAL PROPAGATION (VEGETATIVE OR PROPAGULES)

1.0 INTRODUCTION

Plant species are naturally endowed with the ability to regenerate themselves through self- or cross-pollination of their flowers to produce seeds. When physiologically mature, seed germinate under optimum environments and generate new individual plants to

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

2.0 OBJECTIVES

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

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

3.0 MAIN CONTENT

3.1 Asexual Propagation Methods (Vegetative)

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

3.2 Types of Propagating Materials (Propagules)

3.2.1 Seed

'Seed' is the generative part of the plant used for propagation. A seed is a small immature plant (embryo) protected by a seed coat or testa, which is formed from the outer layers of the ovule after fertilisation. The seed is the basic unit of propagating many tropical crops, including yam and fruits (pawpaw, passion fruit). Even in crop species whose primary mode of propagation is by vegetative means (e.g. mango, avocado pear), seed sowing constitutes an important method of regenerating new plants. Seeds are sown in three different ways namely: by broadcasting, drilling/row-seeding, and pocket drilling/ sowing in holes.

Advantages of sexual propagation are:

i. Ease of transportation of propagating materials,
ii. Less cost, skill and work to raise seedlings,

iii. Ease of vegetative propagation in mature plants, hybrid vigour and associated benefits of development of new varieties and
iv. Wider adaptation to varying environments.

The disadvantages of sexual propagation include:

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

3.2.2 Budding/Bud Grafting

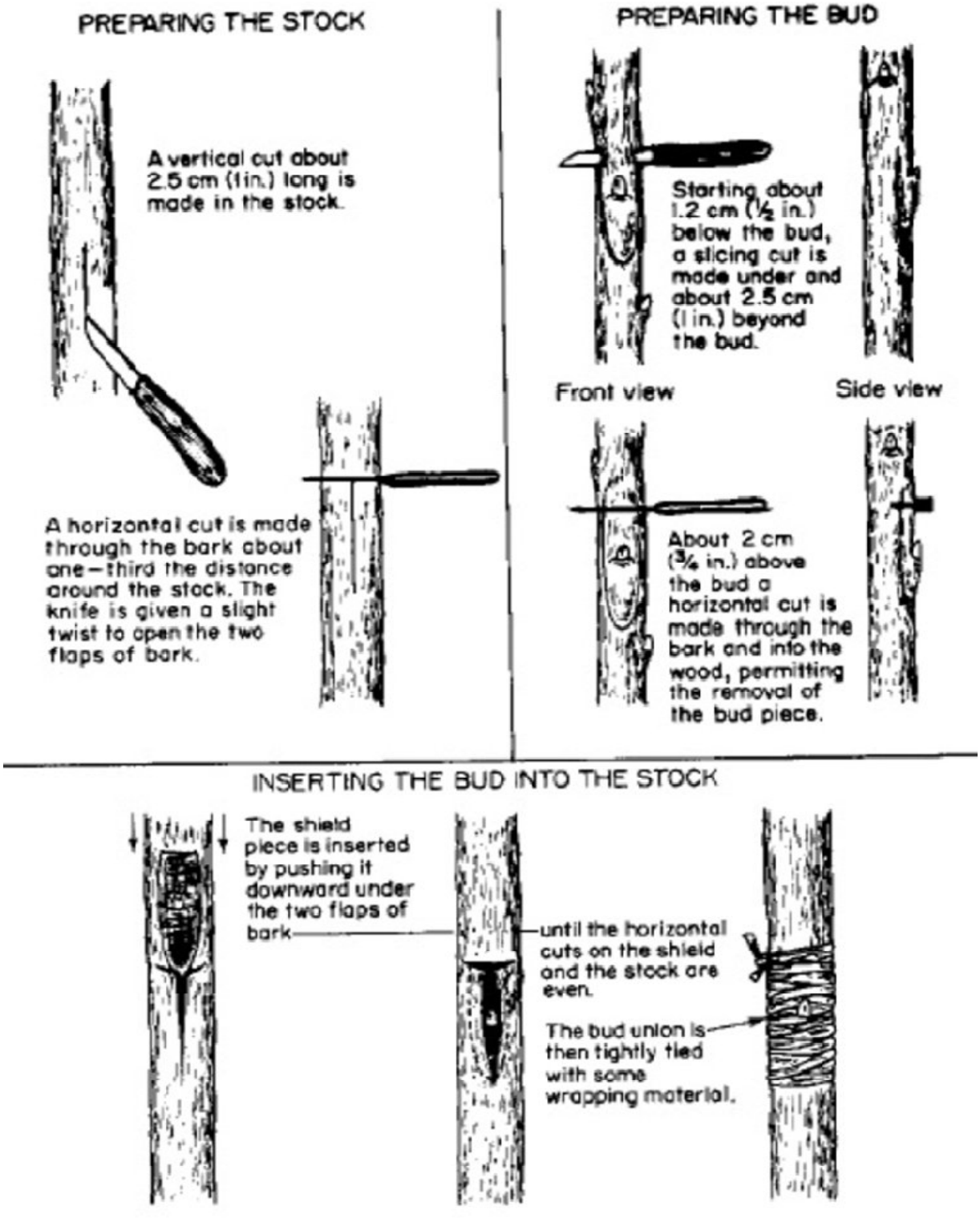
It is a process consisting of the engrafting of the bud (scion) of a plant into the stem (stock) of another plant of the same genus. Generally, it is very suitable for propagating deciduous fruit (*Citrus* spp.) and shade trees. Budding of improved materials on regenerated chupons is one of the new methods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

Advantages of bud grafting

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

Disadvantages of bud grafting

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



Steps of T-budding and patch grafting

3.2.3 Grafting

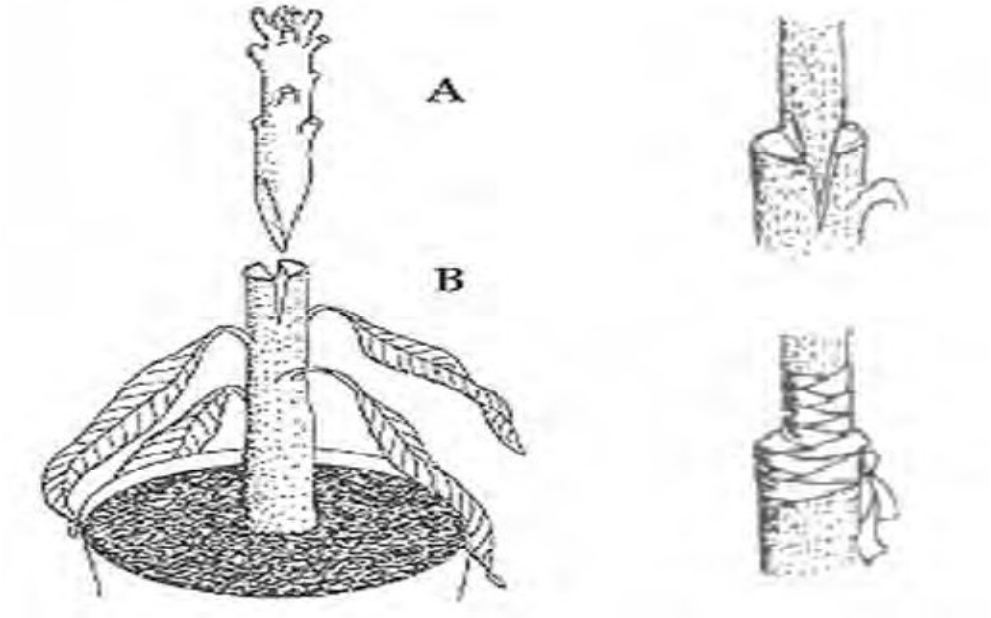
This is similar to budding in theory, but different in the sense that grafting involves the joining of the upper part (scion wood, 0.63-1.27cm diameter and only with leaf buds) of one plant to the under stock (rootstock) of another plant of the same species (clones, varieties). Grafting is an old art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

Advantages of grafting

1. Grafting allows gardeners to produce plants identical to a parent plant,
2. Allows growers to control size and shape of a tree or shrub (e.g. apples)
3. Gives more vigorous and earlier-fruiting plants.
4. Two varieties can be grown on the same tree to facilitate pollination (e.g. in apples).

Disadvantages of grafting

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



Top cleft grafting method

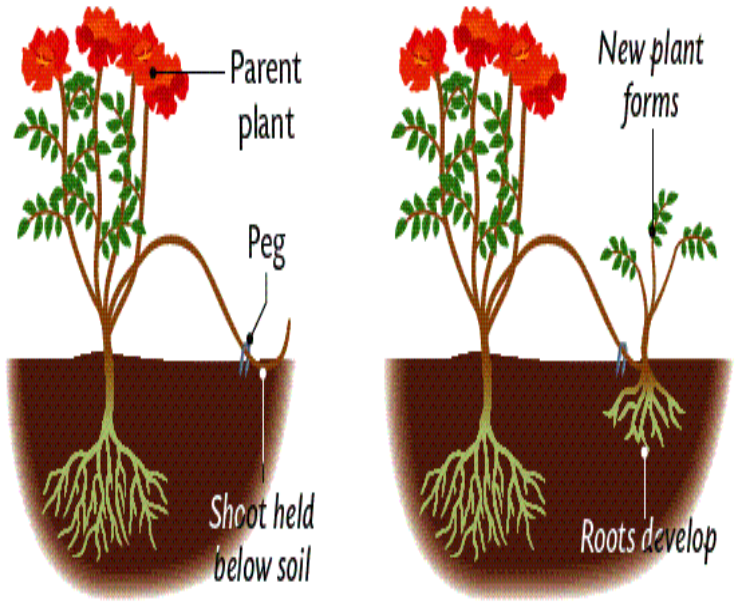
Reasons for budding and grafting

i. Opportunity to change varieties or cultivars for crop improvement;

ii. Optimising cross-pollination, especially in fruit trees that are not self-pollinating;
iii. Advantage of particular (desired) rootstocks, especially in respect of superior growth habits, disease and insect resistance, and drought tolerance;
iv. Benefit from interstocks, valuable in a situation of graft incompatibility;
v. To perpetuate clones by grafting onto seedling rootstocks when clones of plant species (e.g. conifers) cannot be economically reproduced from vegetative cuttings due to low rooting percentage of cuttings
vi. To produce certain plant forms e.g. weeping or cascading forms as in weeping hemlock (*Tsuga canadensi* Carr var. *pendula*);
vii. To repair damaged plants, arising from maintenance equipment, disease, rodents or winter storms, through in arching, approach grafting, or bridge grafting;
viii. To increase growth rate of seedlings, especially in seedling progeny of many trees requiring 8-12 years to fruit with natural development; and
ix. To facilitate virus indexing, through confirmation of presence or absence of the virus by grafting scions from the plant onto another plant that is highly susceptible and would quickly show symptoms of infection.
There are some rules, which must be taken consideration for any grafting method to be successful:
- Two incompatible plants cannot be grafted
- The cambium layers of the rootstock and the scion must touch
- The scion must be the right way up when you graft it
- You can grafting in any time of the year, but the best time for deciduous plants is, when the plant drops its leaves and is dormant
- Cool, cloudy day without wind prevents the graft from drying out, therefore this type of weather is the best for grafting
- The care activities are very important until the rootstock and scion are properly joined

3.2.4 Layering

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



Layering of plants

Types of Layering

Banking Up

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

Simple Layering

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

Radial or Chinese Layering

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

Air Layering

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

Air layering

3.2.5 Cuttings

A cutting is a vegetative plant part which is severed from the parent plant in order to regenerate the parent plant (by regaining loss tissues), thereby forming a new plant. A cutting is therefore refers to as any cut portion of a plant which when place in a suitable environment can regenerate into an independent plant. Both woody and herbaceous plants are asexually propagated by cuttings of stems, leaves and roots. Cuttings regenerate new plants through change of mature cells into meristematic cells that are found at rapid growth sites like buds. As in layering, the use of rooting hormone such as auxins, cytokinins as a dip, preferably one containing a fungicide, helps to hasten rooting, increase number of roots, or gives uniform rooting, except on soft fleshy stems. Rooting medium may be coarse sand, vermiculite, soil, water or a mixture of peat and perlite. A major advantage of cuttings is the practical regeneration of whole plants from actively-growing plant parts/organs. Cutting technique also, typically as with other asexual methods of plant propagation, produces several whole new plants, and which are genetically identical clones of the parent plant. Important disadvantages are that cuttings should be made as soon as possible after collection of plant material; not all species of plants can be propagated from cuttings (e.g. *Acacia* spp.); cuttings must be shielded from direct sunlight, especially if they are under glass or plastic; stock plants (plants used for asexual propagation) should be healthy and well-branched as should the tools and conditions for preparing cuttings to ensure healthy new clones; choice of correct rooting medium to achieve optimum rooting within the shortest possible time. There are many types of cuttings based on the vegetative part of the plant providing the cutting material. There are:

3.2.5.1 Stem Cuttings

This technique is the most commonly used method of propagating many woody ornamental plants and house plants e.g sweet potato, sugar-cane and cassava are food

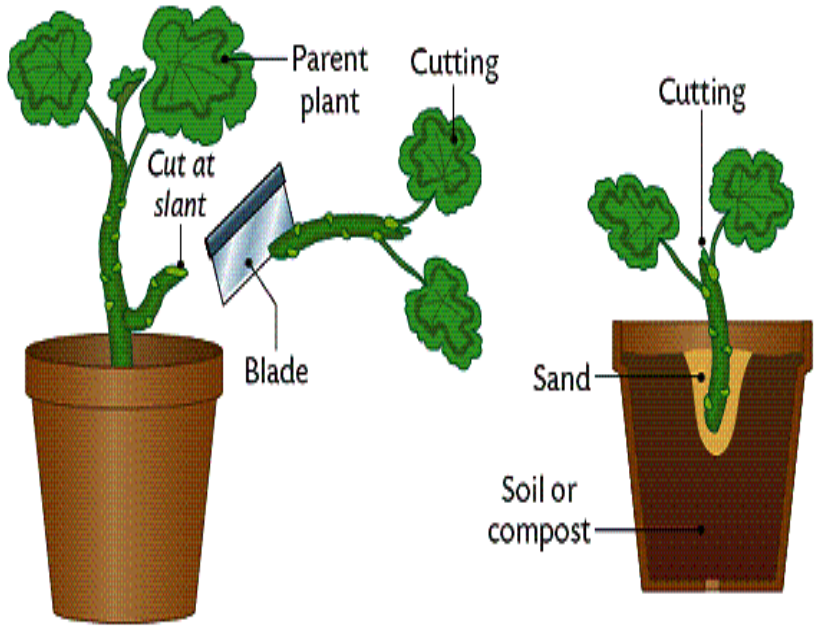
crops propagated from stem cuttings. Stem cuttings of many favourite shrubs are quite easy to root whereas those of a tree species are more difficult to root. A glasshouse is not necessary for successful propagation by stem cuttings but it is critical to maintain high humidity around the cutting. Facilities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

i. Herbaceous Cuttings- Cuttings taken from non-woody plants, such as perennials and house plants e.g. Chrysanthemums, rose. Cuttings are 5.08-15.24 cm stem pieces, with a terminal bud.

ii. Softwood Cuttings- Cuttings taken from soft, succulent, new growth from non-woody stock plants, before the new growth starts to harden (mature). The cuttings are used to propagate flowering shrubs. They must be taken after rain or water is required to keep them cool in the morning. The larger diagonal cut gives more area to develop roots. Cuttings should be kept in water before rooting.

Iii. Semi-Hardwood Cuttings- Cuttings prepared from partially mature (firm) wood of the current season's growth, just after a flush of growth. The method is used for propagating many broadleaf evergreen shrubs, some conifers, holly, rose and cacao (using the tips of shoots).

iii. Hardwood Cuttings- Cuttings taken from tissue that has become woody (firm) and the plant is mature and dormant with no signs of active growth. Several cuttings can be made from the same branch of some shrubs. Basal cuts should be just below a node, while the upper cut should be slightly above a bud. Cuttings should be kept moist until rooting. The system is most often used for deciduous shrubs and many evergreen species e.g. grape, fig and rose. The three types of hardwood cuttings are straight, mallet and heel cuttings.



3.2.5.2 Leaf Cuttings

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

i. Whole Leaf with Petiole- This involves a whole leaf with about 3.81 cm of the petiole. The lower end of the petiole is dipped into a rooting medium (rooting medium may be coarse sand, vermiculite, soil water or a mixture of peat and perlite) after which one or more new plants form at the base of the petiole. The old petiole may be reused after the new plants have formed their own roots. African violets and pepperoni are propagated in this way.

ii. Whole Leaf without Petiole- This method is used for propagated plants with sessile (petiole-less) thick, fleshy leaves. The leaf is inserted vertically into the rooting medium after which one or more new plants will form from the auxiliary bud. The leaf may be removed after the plant forms its own roots.

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

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

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

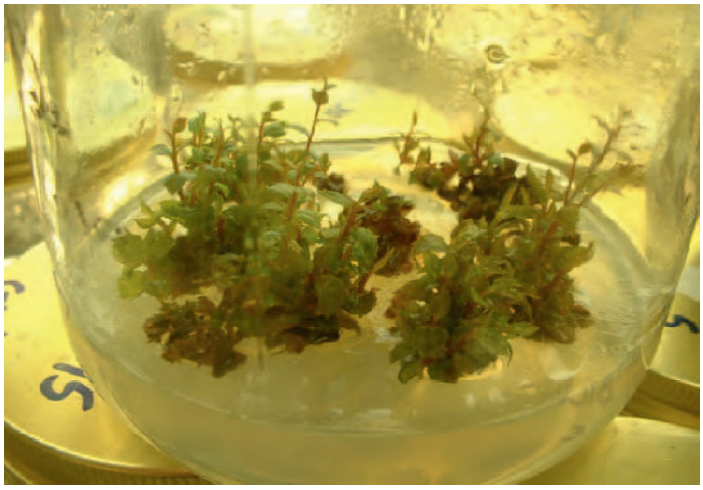
3.2.6 Root Cuttings

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

3.2.7 Micropropagation or Tissue Culture

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

Fermentor Technique. Begonia and roses are also propagated by tissue culture using the meristem-tip.



Tissue Culture

The advantages of this method are:

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

Disadvantages include:

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

4.0 CONCLUSION

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

5.0 SUMMARY

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

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1. What is micro propagation?

2. Enumerate three advantages and two disadvantages of sexual propagation of plants using the seeds.

3. Define the following terms:
(a) Softwood cuttings (b) grafting (c) budding (d) divisions.

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UNIT 3 HORTICULTURAL CROPPING SYSTEMS

1.0 Introduction
2.0 Objectives
3.0 Main Content

1.0 INTRODUCTION

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

2.0 OBJECTIVES

At the end of the unit you should be able to

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

3.0 MAIN CONTENT

3.1 Horticultural Cropping System

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

3.1.1 Continuous Cropping

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

3.1.2 Crop Rotation

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

i. Deep rooted crop should be followed by shallow rooted crop.

ii. Crop likely to be affected by the same insect pest and diseases should not follow each other.
iii. Nitrogen taking crops should be followed by nitrogen fixing crops.
iv. A short period of fallow must be introduced into the rotation.

3.1.3 Sequential cropping

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

i. Double Sequential Cropping: It is the practice of growing two crops in sequence in a year.

ii. Triple Sequential Cropping: It is the practice of growing three crops in sequence in a year.

iii. Quadruple Sequential Cropping: It is the practice of growing four crops in sequence in a year.

iv. Ratoon Cropping: It is the practice of cultivating crop regrowth after the first harvest for subsequent production

3.1.4 Sole Cropping

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

3.1.5 Intercropping

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

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

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

i. Row Intercropping- Row intercropping involves growing of two or more crops at the same time with at least one crop planted in rows and alternated with other crop.
ii. Mixed Intercropping:- This is the growing of two or more crops simultaneously with no distinct row arrangement.

iii. Strip Cropping:-This is the growing of two or more crops together in strips wide enough to permit separate crop production. The strips are alternate, running perpendicular to the slope of the or to the direction of prevailing winds for the purpose of reducing erosion.

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

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

3.1.7 Alley Cropping

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

4.0 CONCLUSION

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

5.0 SUMMARY

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

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

6.0 TUTOR- MARKED ASSIGNMENT

List five(5) cropping systems used for horticultural crops

i- Briefly explain the types of inter cropping you know

ii- Differentiate between sole cropping and inter cropping

7.0 REFERENCES/FURTHER READING

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MODULE 4 - NURSERY PLANT PRODUCTION

1.0 INTRODUCTION

In horticultural crop production some crops are planted directly while some are not planted directly. Those that are not planted directly have to be placed under intensive care for a period of time before they are taken to the field. This unit explains the procedures of nursery practices and why it is necessary for some crops to be raised in nursery before they are taken to the field.

2.0 OBJECTIVES

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

- define nursery
- state the advantages and disadvantages of nursery
- explain the factors that determine the choice of location for field nursery.
- explain the types of nursery
- explain the preparation of nursery.

3.0 MAIN CONTENT

3.1 Nursery

Nursery refers to very special prepared seed beds where young seedlings can be raised in a more protected environment before they are transplanted in the field or nursery can be defined as a place where young crop plants are raised under intensive management for later transplanting to the field. Although many of the important tree crops and Vegetables can be sown directly in the field, experience has shown that raising seedlings in the nursery has a number of advantages. Some of these advantages are;

i. Economy of seeds – fewer seed are required for raising seedling in the nursery than for sowing directly in the field.
ii. Seedlings receive more intensive care (protection against animals, diseases and pest; regular maintenance practices, watering, irrigation, manuring, etc) in the nursery.
iii. Raising seedlings in the nursery affords the planter an opportunity for selecting well grown, vigorous and disease free- seedlings.

iv. Where vegetative propagules (vegetative parts) are used, it is often essential to cultivate them in special nurseries until they have stock roots before planting out as in ornamental plants.

v. Shade management – most nursed plants because of their tender nature need to be protected against scorching sun for quite a period of time and they are transplanted when they are hardened.

vi. Cultural practice such as mulching, chemical spraying and others are easily carried out in a nursery.

They rising of seedlings in the nursery has some disadvantages and this include

i. High cost as a result of nursery practices is introduced into the total cost of crop after production.

ii. Nursery labour is specialised and therefore expensive.

iii. It is more expensive to transplant seedlings than to plant seeds at stake.

Despite these disadvantages, most tree crops, some Vegetables and ornamental should be established in a nursery, particularly when either the varietal or genetic nature of the materials can be guaranteed only for nursery grown / selected materials, or when special techniques (e.g budding) demand nursery technique.

3.2 Factors that Determine the Choice of Location of Field Nursery

The following factors determine the location of a field nursery.

i. Choice of Soil: - Since nursery practice aims to provide a high standard of husbandry to the young developing plants, it is usual to select a good soil both for the location of the nursery and the filing of containers it is desirable to choose a free draining fertile soil and if necessary fertilisers may be used to maintain good nutrient balance. In choosing such a soil, two factors have to be considered.

a) The ease of lifting plants
b) Water retention.

The recommended soil based on the above factors is sandy loam soil.

ii. Choice of Site: - The site for a nursery should be as level as possible. Slopy site should be avoided. Nursery should be sited away from strong wind. The problems of strong winds can be controlled by planting wind break using 2 or 3 lines of tall trees.

iii. Near to Source of Water: - Since frequent watering is required, nearness to water source is important. A nursery should have permanent and a continuous source of water. Water may be provided by a bore-hole or a small reservoir or a well. A nursery should not depend on any external water supply.

iv. Proximity to Planting Sites: - To reduce transportation problem, cost and handling problems, nursery should be sited near the final field.

v. Accessibility: The nursery should be easily accessible to the field, to the road or market.

i. Slope or Land Gradient. Level land is ideal for establishment and maintenance of a nursery. It reduces the risk of soil erosion. It also enhances application of irrigation water. However, appropriate conservation methods should be undertaken if a nursery is sited on a sloppy land.

3.3 Types of Nursery

There are many types of nursery or seed beds but basically we can classify nursery into 2;

i. Ground nursery
ii. Portable nursery.

3.3.1 Ground Nursery and their Preparation.

Ground nursery is used for raising Vegetables like tomatoes, pepper, cabbage and others. There are various stages in the preparation of ground nursery. Here we are going to discuss bed preparation for a tomato nursery.

a) Bed Preparation: - A bed 90 – 120 cm wide and as long as possible should be made. The bed may be raise up to 15 cm high or sunken by the same dimension as the case may be. The soil is compacted and raked to make a level surface. If there are any clods these should be broken into a fine till.

b) Application of Chemical: - This should be applied 2 weeks before the seeds are sown and should be done uniformly. Chemical to be applied include nematocide, arcaricide for control of mites and ticks. Examples of nematocide are nemagon, and examples of arcaricide are parathion and Malathion. During the application of the chemicals, the soil should be moist (not to wet or too dry) and the chemical can be applied either single or mixed at the rate of 8.5 g/m^2 and should be in corporate into the soil at depth of 15-20 cm. During application, all precautions should be adhered to.

c) Fertiliser Application: - The compound fertiliser (N.P.K. of grade 20:10:10 or 15:15:15) may be applied uniformly at the rate of 30 g/m^2 and properly raked.

d) Sowing: - After fertiliser application, the seeds beds should be consolidated again and level led. With a blunt stick you draw your spacing and the spacing should be 10-15 cm apart and a depth of 6 mm. The seeds are then sown lightly and thinly in the drill or furrow and covered with soil lightly.

e) Mulching: - After sowing, the seed bed is mulched with dry grass. This is to protect the seed from being washed away by heavy rain. The mulch also helps to conserved soil moisture needed for seed germination. The mulching should be removed as soon as the seed germinate.

f) Watering: - Watering should be done at interval of 2 – 4 days depending on how dry the climatic condition is. The seed bed should be watered with a fine spray from a watering can.

g) Thinning: - As soon as the first two leaves start to develop, it is necessary to thin the seedlings in order to promote steady growth. Seedling must be allowed a spacing of 5 cm apart. When the seedlings grow to the required height of 8-10 cm or 4-5 weeks, they are transplanted in the field.

Ground nursery

3.3.2 Portable Nursery

Portable nursery is a movable nursery and can be categorized into 3;

- Box or tray nursery
- Pot nursery
- Polythene bag nursery

Polythene bag nursery

Box tray nursery

In a portable nursery (box or tray, pot and polythene bag portable nursery), the soil should be sandy loam well manure and preferably sterilised when using boxes, it should be of convenient size about 45 by 30 cm and the depth of the soil should be about 10 cm.

The bottom of the container should be perforated to drain out excess water. Draining hole should be about 5 mm in diameter and spaced 15 cm apart.

3.3.3 Preparation of Portable Nursery

a. Cover the drainage hole with small stones or gravels to prevent soil particles from blocking the drainage hole.
b. Place a thin layer of dry grass to serve as an aid to good drainage.
c. Fill the box within 1 cm of the top with a mixture of sandy loam soil and farm yard manure in the ratio of 3:1 by volume.
d. The surface of the soil is then level led and firmed. It is important to have a good level surface to avoid light seeds being washed to one side during watering.
e. Make grooves or drills not more than 1cm deep and 10 cm apart with a blunt stick. Sow the seeds in these grooves not too close together.
f. Scatter fine soil over the seed and lightly firm it.
g. Water the soil lightly by sprinkling. The seed box should be watered enough so that the soil appears moist but not too wet to avoid over watering.
h. Placed boxes on a firm support off the ground to protect them from pest e.g. insect, sheep and other animals.
i. After the seeds have started to grow, it may be necessary to thin out the seedlings to ensure healthy steady growth.

SELF -ASSESSMENT EXERCISE

- Define nursery
- State the different types of nursery
- State 3 reasons for establishing a nursery.

3.4 Transplanting

Transplanting is the planting or movement of seedlings from the nursery to the main field. This is usually done when the seedlings have reached a certain period in the nursery and they can with stand the environmental conditions in the field. For tree crops usually the field is cleared and holes dug at a spacing of 3x3 m for trees such as pawpaw guava. 8x10 m for mango and manure placed at the bottom of the hole about 3-5cm before transplanting is done while for Vegetables, beds are raised about 15-20cm before transplanting.

Beds meant for transplanting Vegetable crops should be raised during the rainy season to encourage good drainage and better aeration of the soil. During the dry season or areas with light rainfall, beds should be sunken to conserve water. The success of transplanting is reflected by.

a. The fact that seedlings have recovered very rapidly.
b. The degree of establishment.

The success indicated by the fact that seedlings have recovered very rapidly and also the degree of establishment depends on 4 factors;

i. The Plant Type or Species: - Some species establish easily e.g. sweet potato while others do not take up easily and should not be transplanted e.g. okra and carrot.

ii. The Age of the Seedlings: - The larger the seedling, the more difficult it is to recover. When the seedling is large, many roots are damaged and this could lead to high transpiration in relation to water absorption. This results in wilting and lack of recovery. The optimum time for transplanting Vegetable crops are; Amaranth 2-3weeks, tomato 3-4weeks, onions -5-6weeks pepper 4-5weeks.

iii. The Weather at Transplanting: - Favorable weather for transplanting is that which favours less transpiration (morning and evening period when the sun is not hot). The weather should be cool and humid and not sunny.

iv. Methods of Transplanting: - The procedure followed during transplanting determines the success or failure of the whole operation. It is essential that before uprooting seedlings, the nursery bed should be wet.

For quick recovery and good establishment the following points should be considered.

1. Healthy looking seedlings should be selected for transplanting. Discard wilted and over grown seedlings.
2. Transplant seedlings in the evening or during cloudy weather.
3. Uproot the plants carefully and use the hand trowel to lift the seedling with soil on the root.
4. Do not let seedling wilt. Keep them in the shade or in bucket of water after uprooting.
5. Make transplanting hole large enough and deep enough to receive the roots without damaging or bending them.
6. After setting, apply 100ml of a starter dose of fertiliser around each plant. This is preferred by dissolving about 10 g of N.P.K. (15 – 15 – 15) in a litre of water.
7. Firm the soil around the root to be sure there are no air pockets.
8. Water the seedlings very frequently to ensure good establishment. Water before 7:00 am and after 4:00pm.
9. Dust plant and the ground around them with a contact insecticide e.g Aldrin dust to prevent cutworms and cricket from cutting off the seedlings.

3:5 Nursery Tools and their Uses

Some important tools used in nursery are as follows:

1. Cutlass or Machete: Cutlass is used for clearing the nursery site. It may also be used for transplanting seedlings and digging holes.

2. Hoe: It is mainly used for making heaps, ridges and nursery beds. It is also very effective for turning up the soil, loosening the soil surface and to destroy weeds.

3. Hand Trowel: It is used for transplanting seedlings from the nursery to the field and for spreading manure and also for digging shallow holes on the beds.

4. Garden Fork: It is used for turning manure during compost making and for spreading manure in the open field. It is also used for loosening the soil before transplanting.

5. Digging Mattock: It is used for digging and uprooting small stumps

6. Rake: A rake is used for leveling soil surface and breaking large soil crumbs into small ones. It is also used for removing stones and weeds from seedbeds and for covering vegetable seeds when they are broadcast.

7. Garden Line: It is used for lining up beds and for making straight line when planting.

8. Watering Can: It is used for sprinkling water over young seedlings and for irrigation during dry season farming.

9. Tape: A tape is used for taking short or detailed measurement on the field.

10. Ranging Pole: It is used for marking surveyed stations or intermediate stations. It is also useful in marking straight lines

4.0 CONCLUSION

The success of crop production depends on the quality of seeds and seedlings used and the cultural practices employed in the production. Raising of seedlings in the nursery should be done in a careful manner and all necessary requirement should be met so as to produce healthy seedlings.

5.0 SUMMARY

In this unit, you have learnt that a nursery is a place where young crop plants are raise under intensive management for later transplanting to the field. The reasons for nursery practices are economy of seeds, protection of seedlings against pest and diseases, shade management etc. however, it has the disadvantages of high cost of establishment, high cost of labour and transplanting them direct seeding.

6.0 TUTOR -MARK ASSIGNMENTS (TMA)

i. Define transplanting

ii. List the points to be considered for quick seedling recovery and establishment.

iii. State the different types of portable nursery

iv. State 2 advantages and 2 disadvantages of a nursery.

7.0 REFERENCES/FURTHER READING

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