COURSE GUIDE

CRP 505
VEGETABLE AND FRUIT CROP PRODUCTION

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Printed 2021

ISBN: 978-978-058-283-8

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INTRODUCTION

Vegetable and Fruit Crop Production is one-semester course of two credit hours maximum. It will be available to all students offering crop production in their final year of B. Agriculture degree. The course will consist of eight units, which involve a good knowledge of botany and the natural sciences. Your previous courses in crop production will greatly aid your understanding of this course.

The major fruits produced in Nigeria include mango, pineapple, plantain/banana, citrus, guava, pawpaw, while vegetables include onion, tomato, okra, pepper, amaranthus, carrot, melon, *Corchorus olitorus* (ewedu), *Hibiscus sabdariffa* (sobo), *Adansonia digtata* (baobab leaves), etc. In Nigeria, enormous quantities of fruits and vegetables are produced and staggering figures are sometimes given as estimated annual production. Fruits and vegetables play a very important role in nutrition and health especially as they contain substances that regulate or stimulate digestion, act as laxatives or diuretics, pectins and phenolic compounds which play a part in regulating the pH of the intestines. Fruits and vegetables also contribute to the income of both rural and urban dwellers. The industrial potential of many fruits and vegetables available in Nigeria is enormous.

The distinction between vegetables and fruit is difficult to uphold. In general, those plants or plant parts that are usually consumed with the main course of a meal are popularly regarded as vegetables, while those mainly used as desserts are considered fruits. This distinction is applied in this article. Thus, cucumber and tomato though are fruits botanically, since they are the portion of the plant containing seeds, are commonly regarded as vegetables. It is rather very difficult to separate fruits from vegetables but on the strength of our understanding of botany and utilization, we will make attempts to distinguish between fruits and vegetables.

PREREQUISITES

Your background knowledge of botany, natural sciences, and general agriculture is required.

WHAT YOU WILL LEARN IN THIS COURSE

The overall aim of this course of study is to understand the origin and distribution of most fruits and vegetables, their nutritional and economic importance. While today we grow most crops in many more places than from whence they originated, modern agriculture tends to favor large-scale production though there are pockets of household orchards and

gardens including fruits and vegetables. The development of their industrial uses will stimulate large scale production of the crops and enhanced diversification of entrepreneurs to establish processing plants in the rural areas which will improve the quality of life of the rural population and reduce the rate of rural-urban migration Fruits and vegetable production in Nigeria is a serious business because it provides a means of livelihood for some people and also plays an important role in the improvement of the health of Nigerians.

COURSE AIMS

The course aims to provide you with an understanding of the origin, distribution and adaptation of our fruits and vegetables to their environments. The course will highlight the importance of these fruits and vegetables and their production techniques. Handling, processing, packaging and storage are essentials in our study of fruits and vegetables.

COURSE OBJECTIVES

To achieve the aims set out for this course, each unit has a set of objectives which are included at the beginning of the unit. You should read these objectives before you study the unit. You may wish to refer to them during your study to check on your progress. You should always look at the unit objectives after the completion of each unit. By doing so, you would have followed the instructions in the unit. Below are the comprehensive objectives of the course as a whole. By meeting these objectives, you should have achieved the aims of the course as a whole. In addition to the aims above, this course sets to achieve some objectives. Thus, after going through the course, you should be able to:

- Know the history, origin and distribution of fruits and vegetables
- Know the major fruits and vegetables produced in Nigeria
- Understand the systems of production of fruits and vegetables
- Understand the processes of handling, processing, marketing and utilization of fruits and vegetables
- Know the requirements for sitting fruit tree orchards and vegetable farms
- Identify horticultural machines and equipment
- Understand the principles of planting and maintaining ornamental trees, shrubs, and perennials
- Understand the principles of nurseries, homes and gardens.

WORKING THROUGH THE COURSE

To complete this course, you are required to read each study unit, read relevant textbooks and references which may be provided by the National Open University of Nigeria. Each unit contains self-assessment exercises and at certain points, in the course you would be required to submit an assignment for assessment purposes. At the end of the course there is a final examination.

This course should take you a total of eighteen (18) weeks to complete. From the listed components of the course, you should be able to allocate your time to each unit to complete the course on time.

In addition to spending quality time reading, I would advise that you avail yourself of the opportunity of attending the tutorial sessions with your facilitators. This will allow you to compare notes with your colleagues and seek explanations where necessary.

THE COURSE MATERIALS

The main components of the course are:

1. Course guides
2. Study units
3. References/further reading
4. Assignments (TMA)

STUDY UNITS

The study units in this course are as follows:

Module 1

Unit 1	History and Definition of Fruits and Vegetables
Unit 2	Classification and Economic Importance of Fruits and Vegetables in Nigeria

Module 2

Unit 1	Varieties and Adaptation of Exotic Fruits and Vegetables to the Nigerian Environment
Unit 2	Types and Systems of Production: Production Practices, handling, processing, Packaging, Storage, Marketing and Utilization of Tropical Fruits and Vegetables

Module 3

Unit 1 Horticultural Machines and Equipment
Unit 2 Methods of Plant Propagation, Nursery Systems, Diseases and Pests of Fruits and Vegetables

Module 4

Unit 1 Requirements for Sitting Fruit Tree Orchards and Vegetable Farms
Unit 2 Principles of Producing, Planting and Maintaining Ornamental Trees, Shrubs, Perennials and Fruits in the Nursery, Homes and Parks

ASSESSMENT

You will be assessed in two ways in this course – the Tutor-Marked Assignments (TMA) and a written examination. You are expected to do the assignments and submit them to your tutorial facilitator for formal assessment following the stated deadlines in the presentation schedule and the assignment file. Your tutor-marked assignments will account for 30% of the total course mark.

TUTOR-MARKED ASSIGNMENT

CRP 505 involves a lot of reading and study hours. There are tutor-marked assignments at the end of every unit which you are expected to do. You are also expected to go through the study units very carefully so that you can attempt the self-assessment exercises. You will be assessed on the different aspects of the course but only three of them will be selected for continuous assessment. Send the completed assignments (when due) together with the tutor-marked assignment form to your tutorial facilitator. Make sure you send in your assignment before the stated deadline.

FINAL EXAMINATION AND GRADING

The modalities for the final examination for CRP 505 will be determined by NOUN. The pattern of the questions will not be too different from those you have responded to in the tutor-marked exercises. However, as the university has commenced online examinations, you may have to adjust to whatever format is made available to you at any point in time. Nonetheless, you can be assured of the content validity of the examinations. You will only be examined strictly on the content of the course, no matter the form the examination takes. It is thus advisable

that you revise the different kinds of sections of the course properly before the examination date.

HOW TO GET THE BEST FROM THE COURSE

The study units in this course have been written in such a way that you can easily go through them without the lecturer being physically around and this is what happens in distance learning. Each study unit is for one week depending on the volume of the unit. The study units will introduce you to the topic for that week; give you the objective(s) for the unit and what you are expected to be able to do at the end of the unit. Follow these religiously and do the exercises that follow. In addition to the above, unlike other courses where you just read and jot notes, CRP 505 has a lot of basic principles and theories to learn. You, therefore, need a lot of concentration while going through the course.

TUTORS AND TUTORIALS

This course has tutorial hours. The dates, times, and location of these tutorials will be communicated to you as well as the name and phone number of your tutorial facilitator. You will also be notified of your tutorial group. As you relate with your tutorial facilitator, he/she will mark and correct your assignments and also keep a close watch on your performance in the tutor-marked assignments and attendance at tutorials. Feel free to contact your tutorial facilitator by phone or e-mail if you have any problem with the contents of any of the study units.

COURSE MARKING SCHEME

The following is the layout of the actual marking scheme for this course.

1. Assessments and TMAs will account for 30% of the overall course marks.
2. The final examination will take 70% of the overall course marks.

MAIN COURSE

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MODULE 1

UNIT 1 HISTORY AND DEFINITION OF FRUITS AND VEGETABLES

CONTENTS

1.0 INTRODUCTION

Most plants are poisonous. Humans have cultivated those few that were edible and nutritious or good tasting, and have selectively bred them over thousands of years for a variety of traits including size, flavour, colour, and yield. These plants have also been moved around the world by early explorers, traders, and missionaries. The geographic region from which our food crops originated is not always obvious from their present-day distribution. While today we grow most crops in many more places than from whence they originated, there is the need to establish their origin because of the genetic diversity and to help make our modern crops more hardy while also possibly allowing for new and interesting types.

2.0 OBJECTIVES

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

- trace the history and origin of some fruits and vegetables
- define fruits and vegetables.

3.0 MAIN CONTEXT

Did you know that papaya and pineapple fruits are associated with Hawaii, Cuba? Oranges grow very well in Florida and California, but they started growing there with the help of the Spanish missionaries that took them there. Where did they come from? Did you know that one of the likely reasons why North American Indians never developed agriculture on a large scale was the belief that there was just nothing edible on earth? This notion only began to change when they started trading with their more agriculturally prosperous neighbors in Central and South America.

Scientific evidence shows that the vegetables and fruits of today did not suddenly appear on earth, but have evolved over a very long period due to natural selection, human selection, and more recently plant breeding and other forms of genetic improvement including mutation.

3.1 History and Origin of Fruits and Vegetables

The Russian botanist Nikolai Vavilov described Centers of Origin as locations where the original center for the domestication of certain crop plants might have likely occurred. The geographic region from which our food crops originated is not always obvious from their present-day distribution. Ethnobotany, which is the scientific study of the relationships that exist between people and plants, has established that ancient humans were not farmers but gatherers of all kinds of plants from the wild to supplement food obtained from hunting and fishing. The need to settle in one place rather their nomadic life made humans to think about the domestication of crops. Domestication describes a selection process conducted by humans to produce plants that have more desirable traits from their wild parents. The difference between crops and native plants occurred because large populations of wild plants that were first selected for domestication were genetically very diverse. Saving seeds from wild plants selected for desirable traits obtained through natural hybridization and genetic recombination resulted in crops possessing traits that were desirable to humans but different from the average plant in a wild population. Later, interaction among people of other nations for purposes of trade, colonization and missionary works made it possible for wide distribution of plants including fruits and vegetables to other locations aside from their places of origin. When these people move from place to place, they travel with their food and upon arrival, they plant these earlier domesticated plants in their new locations for their survival. Later these foreign plants have to undergo another ‘domestication’. Then over the years, the centre of origin may not be properly traced.

There are three approaches to consider in our search for the origins of crops including fruits and vegetables.

1) Botanical evidence- this is obtained from a crop through observations to see whether it has wild relatives and semblances.
2) From archaeological evidence-carbon dating technique is employed by historians and archeologists to establish the likely origin of plants.
3) Linguistic evidence crops of a particular location have local names given by the natives. Where the original name is lost, the new host community will give their name to the crop. This is not strong evidence of the origin of a crop as crops tend to have different names as they get introduced to new locations. Some are named after the person that first introduced them to the community.

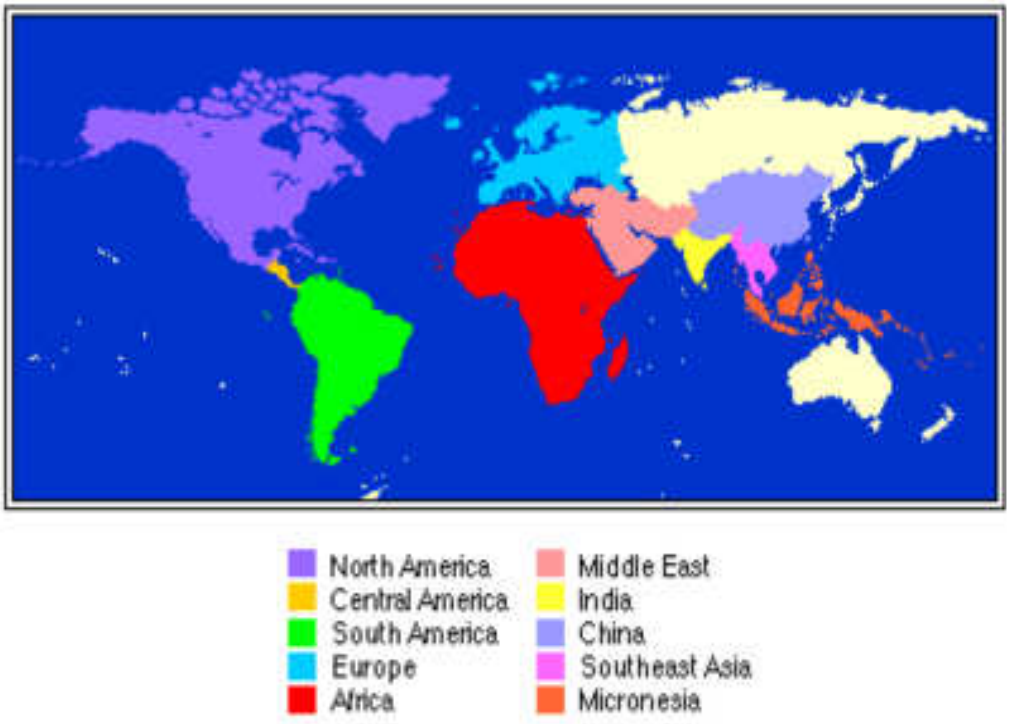
Below is the list of some selected fruits and vegetables and their origins.

Table 1: List of some selected fruits and vegetables and their origins

SOURCE	**FRUITS**	**VEGETABLES**
North America	Blackberry Blueberry Grape Strawberry	Pumpkin
Central America	Papaya Cherimorge	Corn
South America	Avocado Pineapple Strawberry	Green beans Lima beans Peppers Potato Pumpkin Sweet potato Tomato
Europe (Western)	Currant Gooseberry	Carrot Cabbage Turnip
Europe (Eastern)	Apple Pear	Endive lettuce horseradish
Africa	Date Watermelon	Okra
Middle East	Cherry Grape Olive	Beet Lettuce Onion Spinach

India	Lemon Lime Mango Musk melon	Cucumber Egg plant Onion Spinach
China	Apricot	Chinese cabbage Onion Cucumber
South East Asia	Banana Orange Tangerine	

The Origin of Cultivated Fruits and Vegetables



3.2 Definition of Fruits and Vegetables

Vegetable

A popular distinction between vegetables and fruits is difficult to uphold. In general, those plants or plant parts that are usually consumed with the main course of a meal are popularly regarded as vegetables, while those mainly used as desserts are considered with fruits. Thus, cucumber and tomato are fruits botanically, since they are the portion of the plant containing seeds, but are commonly regarded as vegetables.

Precisely **vegetables** are edible plant parts including stems and stalks, roots, tubers, bulbs, leaves, flowers, and fruits; usually includes seaweed and sweet corn; may or may not include pulses or mushrooms; generally consumed raw or cooked with the main dish, in a mixed dish, as an appetizer or in a salad.

More specifically, a **vegetable** may be defined as "any plant, part of which is used for food", a secondary meaning then being "the edible part of such a plant". A more precise definition is "any plant part consumed for food that is not a fruit or seed, but including mature fruits that are eaten as part of the main meal".

Vegetables are parts of plants that are consumed by humans or other animals as food. The original meaning is still commonly used and is applied to plants collectively to refer to all edible plant matter, including the flowers, fruits, stems, leaves, roots, and seeds. An alternate definition of the term is applied somewhat arbitrarily, often by culinary and cultural tradition. It may exclude foods derived from some plants that are fruits, flowers, nuts, and cereal grains, but include savoury fruits such as tomatoes and courgettes, flowers such as broccoli, and seeds such as pulses.

Originally, vegetables were collected from the wild by hunter-gatherers and entered cultivation in several parts of the world, probably during the period 10,000 BC to 7,000 BC, when a new agricultural way of life developed. At first, plants that grew locally would have been cultivated, but as time went on, trade brought exotic crops from elsewhere to add to domestic types. Nowadays, most vegetables are grown all over the world as climate permits, and crops may be cultivated in protected environments in less suitable locations. China is the largest producer of vegetables, and global trade in agricultural products allows consumers to purchase vegetables grown in faraway countries. The scale of production varies from subsistence farmers supplying the needs of their family for food to agribusinesses with vast acreages of single-product crops. Depending on the type of vegetable concerned, harvesting the crop is followed by grading, storing, processing, and marketing.

Vegetables can be eaten either raw or cooked and play an important role in human nutrition, being mostly low in fat and carbohydrates, but high in vitamins, minerals, and dietary fiber. Many nutritionists encourage people to consume plenty of fruit and vegetables, five or more portions a day often being recommended.

Fruits

Fruits are produced only by flowering plants (angiosperms). Following pollination of the flower, the fertilized ovules develop into seeds while the surrounding ovary wall forms the fruit tissue or pericarp. The botanical definition of a fruit is an organ that contains seeds, protecting these as they develop and often aiding in their dispersal. This may be at odds with everyday usage of the word "fruit." Botanically, pineapples, oranges, and apples are fruits, but so too are "vegetables" like tomatoes and cucumbers. The pods that contain peas and beans are fruits, as are the dry, inedible structures that bear the seeds of many wild plants.

Precisely **fruits** are edible parts of plants that contain the seeds and pulpy surrounding tissue; have a sweet or tart taste; generally consumed as breakfast beverages, breakfast and lunch side-dishes, snacks, or desserts.

Most definitions of fruit and vegetable are not botanically based. These definitions are rather arbitrary by nature and commonly based on usage rather than plant morphology. Mushrooms are fungi and not plants but are generally considered to be vegetables.

“vegetable” is not a botanical term, some vegetables botanically speaking are also fruits. In a botanical sense, a fruit describes a ripened ovary containing seeds together with adjacent parts that are eaten at maturity. For example, tomato, pepper, and bean botanically speaking meet the definition of fruit, but because of the way they are traditionally used and produced, they are considered to be vegetables. Therefore, since there are essentially two classification systems here, some commodities may be classified as a vegetable-based on their usage while at the same time they are botanically fruits.

Below are four definitions of fruits

Definition: 1
Any product of plant growth is useful to humans or animals.
Definition: 2
The developed ovary of a seed plant with its contents and accessory parts, as the pea pod, nut, tomato, or pineapple.
Definition: 3
The edible part of a plant developed from a flower, with any accessory tissues, as the peach, mulberry, or banana.
Definition: 4
The spores and accessory organs of ferns, mosses, fungi, algae, or lichen.

SELF-ASSESSMENT EXERCISE

Most vegetables are green in colour, but mushrooms though fungi are considered vegetables. Advance reasons.

4.0 CONCLUSION

Vegetables are increasingly being recognised as essential for food and nutrition security. It is usually important to briefly discuss the history and origin of some fruits and vegetables that we consume today in other to understand and appreciate the works of early explorers. Scientific evidence shows that the vegetables of today did not suddenly appear on earth, but have evolved over a very long period.

5.0 SUMMARY

The popular distinction between vegetables and fruit is difficult to uphold. In general, those plants or plant parts that are usually consumed with the main course of a meal are popularly regarded as vegetables, while those mainly used as desserts are considered fruits. This distinction is applied in this unit. Thus, cucumber and tomato botanically are fruits, since they are the portion of the plant containing seeds, are commonly regarded as vegetables based on their culinary importance.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1) Which regions of the world can you say the under-listed fruits and vegetables originated from:
   Tomato, Cucumber, Pepper, Spinach and Okra.
2) Why do you think that domestication is important in agriculture?
3) Is cucumber a fruit or a vegetable?

7.0 REFERENCES/FURTHER READING

Alagba, R; Ofor, M; Okoli, Nneka; Ibeawuchi, Izuchukwu Innocent; Obiefuna, J.C. (2015). Fruit and Vegetable Crop Production in Nigeria: The Gains, Challenges and The Way Forward. https://www.researchgate.net/publication/332876077_Fruit_and_Vegetable_Crop. Downloaded 8/7/2020

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UNIT 2 CLASSIFICATION AND ECONOMIC IMPORTANCE OF FRUITS AND VEGETABLES IN NIGERIA

CONTENTS

1.0 INTRODUCTION

Vegetables are increasingly recognised as essential for food and nutrition security. Vegetable production provides a promising economic opportunity for reducing rural poverty and unemployment in developing countries and is a key component of farm diversification strategies. In Nigeria, enormous quantities of fruits and vegetables are produced and staggering figures are sometimes given as estimated annual production. Fruits and vegetables play a very important role in nutrition and health especially as they contain substances that regulate or stimulate digestion, act as laxatives or diuretics. The development of industrial uses of fruits and vegetables will stimulate large-scale production of the crops and enhanced diversification of rural entrepreneurial skills. Many nations of the world depend on fruits and vegetables for their foreign exchange earnings, thus making them important in international trade and politics.

2.0 OBJECTIVES

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

- explain the bases of classification of fruits and vegetables
- explain the importance of fruits and vegetables to man and the economy.

3.0 MAIN CONTEXT

The major fruits produced in Nigeria include mango, pineapple, plantain/banana, citrus, guava, pawpaw, while vegetables include onion,

tomato, okra, pepper, amaranthus, carrot, melon, *Corchorus olitorus* (ewedu), *Hibiscus sabdariffa* (sobo), *Adansonia digtata* (baobab leaves) etc.

Broadly, the botanical term *fruit* refers to the mature ovary of a plant, including its seeds, covering and any closely connected tissue, without any consideration of whether these are edible. As related to food, the botanical term *fruit* refers to the edible part of a plant that consists of the seeds and surrounding tissues. This includes fleshy fruits (such as cucumber, blueberries, pumpkin, watermelon, tomato) and dry fruits, where the ripened ovary wall becomes papery, leathery, or woody as with cereal grains, pulses (mature beans and peas) and nuts.

In the broadest sense, the botanical term *vegetable* refers to any plant, edible or not, including trees, bushes, vines and vascular plants, and distinguishes plant material from animal material and from inorganic matter. There are two slightly different botanical definitions for the term *vegetable* as it relates to food. According to one, a vegetable is a *plant* cultivated for its edible part(s); according to the other, a vegetable is *the edible part(s) of a plant*, such as the stems and stalk (celery), root (carrot), tuber (potato), bulb (onion), leaves (spinach, lettuce), flower (globe artichoke), fruit (apple, cucumber, pumpkin, strawberries, tomato) or seeds (beans, peas).

3.1 Classification of fruits and vegetables

The popular distinction between vegetable and fruit is difficult to uphold. In general, those plants or plant parts that are usually consumed with the main course of a meal are popularly regarded as vegetables, while those mainly used as desserts are considered fruits. Broadly, fruits and vegetables can be classified based on the following criteria:

a) The part consumed
b) Season or area of production
c) Their botanical or taxonomy
d) Their frequency of cultivation
e) Their maturity time
f) Harvesting pattern
g) Growth habit

1) Based on the part consumed

Leafy vegetables
The leaves and succulent young shoots are picked for consumption.
Examples are amaranthus, celosia, pumpkin, lettuce, cabbage, bitter leaf, water leaf, and fluted pumpkin.

Fruit vegetables
This comprises of young, immature unripe fruits or mature ripe fruits of plants grown as vegetables. Examples are cucumber, tomato, okra, pumpkin, eggplant, garden egg, watermelon, sweet pepper and chili pepper.

Seed vegetables
This group is important for the seed produced. Examples are Egusi Melon.

Root vegetables
These include the sweet potato, Irish potato, carrot and radish.

Spices
Important for their flavor and colour in foods such as chili pepper, onion and garlic.

2) Based on Season/Climatic area/ area of cultivation

Cool season vegetables: These include cabbage, garlic, onion, radish, spinach, lettuce, potato and carrot.

Warm season vegetables: such as tomato, pepper, cucumber, okra, eggplant, garden egg, melon, pumpkin, sweet potato.

3) Botanical or Taxonomic Classification
Vegetables are classified according to family, genera and species. It is the most important and acceptable form of classification as it is recognised worldwide. This is also called scientific classification of plants

Table 2: Table of Classification of Vegetables by Family Name

Family	Botanical name	Common name
Amaranthaceae	*Amaranthus dubius* *Celosia argentea*	Amaranth Celosia
Cucurbitaceae	*Cucurbita maxima* *Cucumis sativus*	Pumpkin Cucumber
Malvaceae	*Abelmoschus esculentus* (L.) Moench	Okra
Solanaceae	*Solanum tuberosum* *Solanum melongena* L.	Irish potato Eggplant
Tiliaceae	*Corchorus olitorius* L.	Jews mallow
Compositae	*Vernonia colorata* *Lactuca sativa*	Bitter leaf Lettuce
Cruciferae	*Brassica oleraceae* *Raphanus sativus*	Cabbage Radish

Portulaceae	*Talinum triangulare*	Water leaf
Basellaceae	*Basella rubra*	Indian spinach

4) Frequency of Cultivation

Regularly cultivated vegetables – Onion, *Amaranthus*, Egusi melon, Okra; Eggplant, tomato and pepper. Occasionally we have wild vegetables such as: mushroom (*Agaricus* spp, *Celosia triguna* Ajefawo) *Basella Rubra* (White) – Indian spinach *Basella alba* (Red) *Crassocephallum biafrae* - Bologi, *C. crepidoidis* – Ebolo

5) Based on their maturity time

Vegetables with short growing period and harvested two or three times by topping or young leaf removal: This group consists of leafy vegetables such as *Amaranthus* spp and *Celosia argentea*.

6) Based on their harvesting pattern

Vegetables which can be harvested over several weeks or months: This group comprises of vegetables such as *Corchorus* spp, *Solanum* spp, *Capsicum* spp, tomato, okra, and cucurbits.

7) **Based on their growth habit**

Vegetables with Climbing growth habit: these are vegetables which are trained along a stake and on house walls. Examples are snake gourd, fluted pumpkin and melon

Vegetables with creeping stems: such as melon, cucumber and water melon.

Fig.1: Classes of fruits and vegetables

3.2 Economic importance of fruits and vegetables

Vegetables are increasingly recognised as essential for food and nutrition security. Vegetable production provides a promising economic opportunity for reducing rural poverty and unemployment in developing countries and is a key component of farm diversification strategies. Vegetables are mankind's most affordable source of vitamins and

minerals needed for good health. Today, the economic and nutritional importance of fruits and vegetables cannot be over-emphasized. Below are some of the economic importance of fruits and vegetables.

a) Eradicate extreme hunger and poverty

Fruits and vegetables generate more jobs per hectare, on-farm and off-farm, than staple based agricultural enterprises. This benefits farmers and landless laborers in both rural and urban areas. Value addition to fruits and vegetables generates further employment in the associated agri-businesses and further down the commodity chain from the producer to the consumer.

b) Promote gender equality and empower women

Fruits and vegetables production, in particular, provides women with economic opportunities. Women are the principal producers of most horticultural crops in developing countries and are predominantly involved in the value-addition activities from production to marketing.

c) Health benefits

Health benefits of fruits and vegetables are enormous. These include:

- Reduce child mortality

Malnutrition is one of the major causes of, or is a significant contributing factor to, child mortality in developing countries. The link between horticulture and child mortality is indirect, but important. The absence of essential micronutrients exacerbates poor children's vulnerability to diseases.

- Improve maternal health.

d) Pharmaceutical properties of fruits and vegetables

The potential of the Nigerian flora as a veritable source for pharmaceuticals and other therapeutic materials abound across the country. Fruits and vegetables have usually served as the repository of healing materials and have been acknowledged to be generally safe.

e) Ensure environmental sustainability

Legume vegetable crops increase soil fertility through atmospheric nitrogen fixation and the decomposition of the dry matter. This promotes our soil fertility level, through improved soil texture and structure.

f) New Jobs and Economic Opportunities

As new hands go into the production, processing and marketing of fruits and vegetables, more jobs are created thereby promoting economic wellbeing of the people.

g) Fruits and vegetables have aesthetic value

Well, establish orchards and gardens are ’beauty to behold’ as such places are venues for relaxation and pleasure.

3.3 Importance of Fruits and Vegetables in Global Food Economy

Food security has long been associated with a vision of an abundance of grains, roots, and tubers – the staple crops that provide affordable sources of dietary energy. But this picture is changing as the concept of nutrition security has become embedded in that of food security and the importance of dietary diversity for good health has moved to the fore. Healthy, high-quality diets require the consumption of a wide range of food categories in the right quantities. Globally, the prevalence of hunger has declined to 795 million in 2015 indicating progress in ensuring adequate access to staple foods as measured in terms of caloric intake. But an estimated 2 billion people are affected by insufficient intakes of micronutrients and a further 2.1 billion people are overweight or obese.

Fruits and vegetables are essential sources of the micronutrients needed for healthier diets. Potassium in vegetables helps to maintain healthy blood pressure, their dietary fiber content reduces blood cholesterol levels and may lower the risk of heart disease, folate (folic acid) reduces the risks of birth defects, and vitamin A keeps eyes and skin healthy, while vitamin C not only keeps teeth and gums healthy but also aids in iron absorption. Recognizing the important nutritional benefits of fruits and vegetables, the World Health Organisation (WHO) recommends a minimum intake of 400 g per day to prevent chronic diseases (especially heart diseases, cancers, and diabetes) and supply needed micronutrients (especially calcium, iron, iodine, vitamin A and zinc) However, consumers today, even those with higher incomes, are believed to be missing this target. More attention to filling this dietary gap and enabling consumers to tap the nutritional power of vegetables is required.

Expansion of fruit and vegetable production is an obvious first step. Growing populations and increased incomes, especially in urban areas, are already creating a rise in market demand as consumers seek to diversify their diets. Increasing vegetable production to respond to this demand creates important economic opportunities, especially for smallholder farmers. Data for Cambodia, Niger, and Vietnam show that profits per hectare are 3–14 times higher in vegetable production than in rice production while profits per labor-day are double. Vegetables also typically provide more employment per hectare than cereals. showed that vegetable production in six Asian countries used on average 297 labor-days per hectare per season against 116 labour-days for cereal production. Particularly for youth, vegetable farming may offer a profitable business opportunity.

Market-oriented vegetable farming not only creates income for smallholder farmers but also helps to build their resilience to external risks. Diversity of vegetable crops, short growing cycles, and efficient use of irrigation can reduce farmers' vulnerability to climate change. For economic resilience, farmers may either opt to integrate vegetables into existing staple cropping systems or move into specialized vegetable production.

Vegetable production, processing, and marketing offer potential opportunities that can be especially attractive to youth: production requires only small amounts of land, is technology-savvy, and high profits can be obtained in a relatively short period. Furthermore, low levels of mechanization in vegetable production and the need for careful handling of produce often create a specific demand for female labor. Public investments in infrastructure, training, and subsidies in support of vegetable value chains could advance such employment.

The potential of vegetables to generate positive economic and nutritional impacts, however, has been limited by the relatively low levels of support that national governments and international donors direct to public sector vegetable research and development. Public and private investments in agriculture are still largely focused on staple crops and oil crops, not on commodities rich in micronutrients To the extent that private sector investments in lower-income countries are directed at vegetables, these tend to be focused on a narrow range of globally important vegetables such as tomatoes, onions, green beans, peppers, lettuce, and cucumbers.

Vegetables in the global food economy

Few people appreciate the significant economic role already played by vegetables and their close cousins, fruits.[1] The FAO Food Price Index provides no information on the market conditions for fruit or vegetables, although the broader databases maintained by the UN Food and Agriculture Organization (FAO) include data on supply and availability of key vegetables as well as their farmgate value.[2] The FAO data underscore the global importance of these crops (Fig. 1). The estimated farm gate value of annual global fruit and vegetable production, at nearly $1 trillion per year, exceeds the farmgate value of all food grains combined (US$ 837 billion).

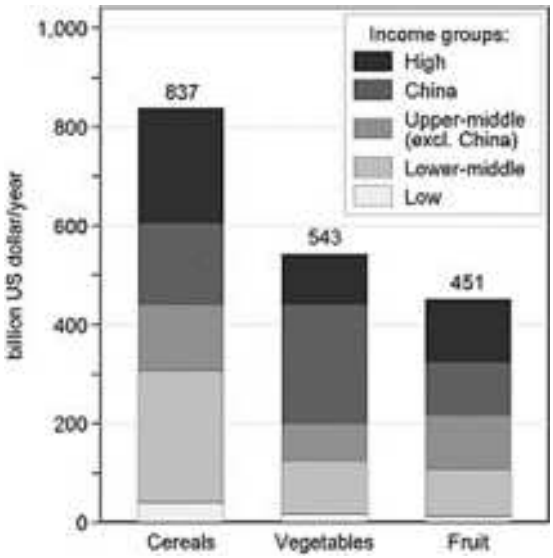

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Fig. 1. Farmgate value of the global production of food cereals, vegetables and fruit, average 2012–2013, by national income categories, current US dollars.

Source: FAO (2017): Database on the value of agricultural production.

The most dominant vegetables in the global food economy are tomatoes, cucurbits (pumpkins, squashes, cucumbers, and gherkins), alliums (onions, shallots, garlic) and chilies. These vegetables are consumed in nearly all countries—although with many variations in shapes, sizes, colors and tastes—and are rightly called “global.” As shown in Fig. 2, apart from okra, no data on what are often called “indigenous” or “traditional” vegetables (e.g. amaranth, bitter gourd, kangkong, and spider plant) are reported. While the marketing of global vegetables accounts for significant revenue streams, traditional vegetables often have superior nutritional properties. For instance, 100 g of leaves of amaranth, jute mallow, African nightshade or vegetable cowpea can provide over 100% of the vitamin A needs of pregnant women

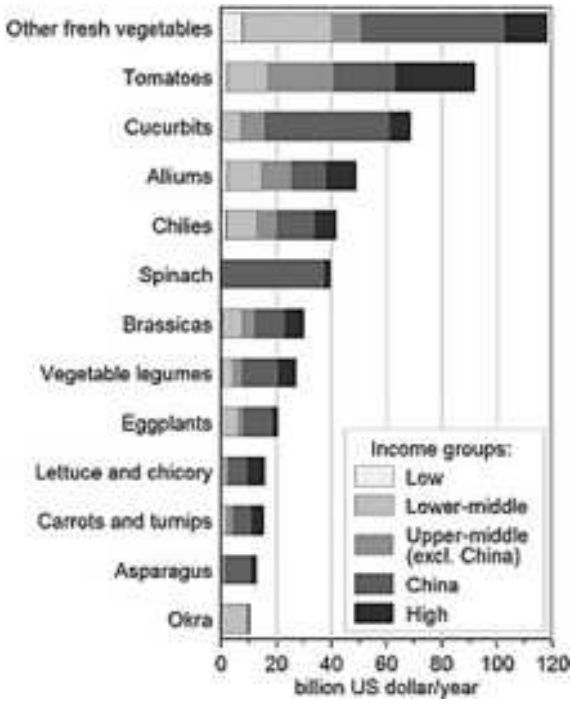

Fig. 2. Farmgate value of global vegetable production by income groups of countries, average 2012–2013, current US dollars.

Source: FAO (2017): Gross Production Value (current million US$).

Tomatoes alone are the fourth most economically valuable food crop produced in low- and middle-income countries, after rice, sugarcane and wheat. Tomatoes accounted for US$ 63 billion per year in traded value (at farmgate) in 2012–13, with 35% of this value produced in China.[3] Fig. 3 depicts the rapid growth in tomato production in middle-income countries since 1990, with the remarkable six-fold increase in per capita tomato production in China reflecting the country's overall growth in horticultural production and the potential for economic gain associated with tomatoes. These opportunities are foregone in low-income countries as the trend line for tomato production in these countries is nearly flat.

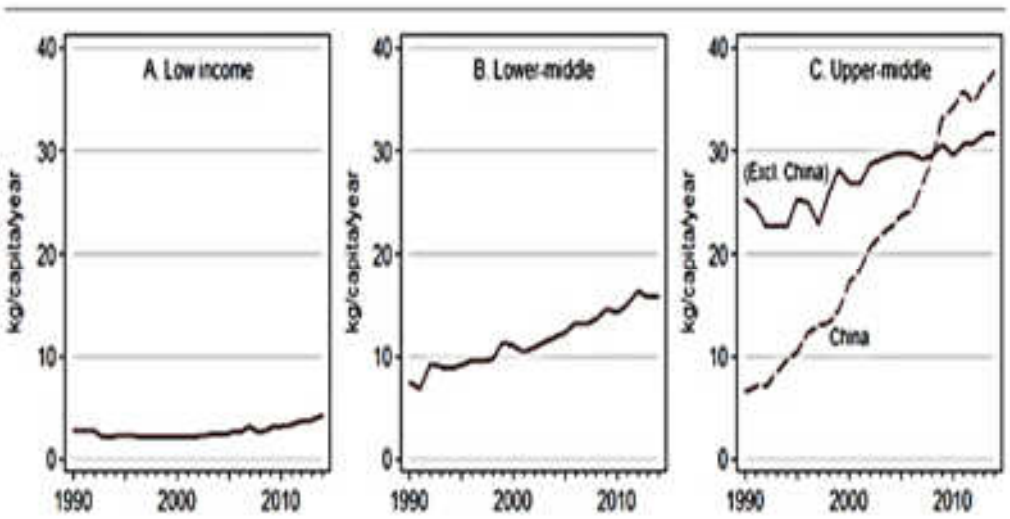

Fig. 3: Per capita tomato production in low-and middle-income countries, 1990–2014

Sources: FAO (2017): Crop production data. UN (2017): Total Population - Both Sexes.

Rising vegetable demand is driven by rising incomes as well as population growth. Globally, a 1% increase in per capita income in developing countries is associated with a 0.5% increase in per capita vegetable availability.[4] It follows that the bulk of the global supply of fruit and vegetables (77% of total value) is produced in populous middle-income countries.[5] China accounts for 45% of the global value of vegetable production and 24% of fruit production. India comes second, accounting for 8% and 7% of global vegetable and fruit production, respectively.

It is also likely that the productivity of vegetable farming is not rising as rapidly as it could be. Technological progress relies upon systematic research efforts to develop new varieties, crop management techniques, and innovations in postharvest handling and processing.

SELF-ASSESSMENT EXERCISE

As an extension agent posted to a location in the North Central part of Nigeria where the farmers produce mainly cereals and tuber crops with little or no trace of vegetables and fruits. Attempt to educate these farmers on the importance of producing and consuming fruits and vegetables.

4.0 CONCLUSION

Though fruits and vegetables belong to various classes with no definite lines of the divide, they collectively play very important roles in the nutrition and health of man especially as they contain substances that regulate or stimulate digestion, act as laxatives or diuretics and play a part in regulating the pH of the intestines. Fruits and vegetables also contribute to the income of both the rural and urban dwellers. The industrial potential of many fruits and vegetables available in Nigeria is enormous as the eventual establishment of these industries will lead to greater income generation and economic wellbeing of the nation.

5.0 SUMMARY

A popular distinction between vegetables and fruit is difficult to uphold. There is no clear division in our attempt to classify fruits and vegetables as there are some situations where fruit or a vegetable will belong to more than one group in our classifications. Nevertheless, botanical (taxonomy)classification is universally accepted and emphasized. Fruits and vegetable production in Nigeria is a serious business because it provides a means of livelihood for many people and also plays an important role in the improvement of the health of Nigerians. What Nigerians need to do is embark on massive production of these fruits and vegetables not only for their high nutritive value but for enhancing the establishment of many processing industries.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1) How can you classify fruits and vegetables based on the parts consumed?
2) In our taxonomy type of classification of fruits and vegetables, give the botanical names of the followings
   (a) Okra
   (b) Bitter leaf
   (c) Water leaf
   (d) Cucumber
3) Explain the health benefits of fruits and vegetables

7.0 REFERENCES/FURTHER READING

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MODULE 2

Unit 1 Varieties and Adaptation of Exotic Fruits and Vegetables to the Nigerian Environment
Unit 2 Types and Systems of Production: Production Practices, Handling, Processing, Packaging, Storage, Marketing and Utilization of Tropical Fruits and Vegetables

UNIT 1 VARIETIES AND ADAPTATION OF EXOTIC FRUITS AND VEGETABLES TO THE NIGERIAN ENVIRONMENT

CONTENTS

1.0 INTRODUCTION

Adaptation of crop plants depends on many factors and is best considered concerning a set of conditions (environmental, edaphic and biotic) rather than to a single factor alone. In many situations, one factor (e.g. water availability) may dominate the prevailing conditions, and the nature of the plant's response then largely reflects its adaptation to the existing level of that factor. More typically, adaptation is expressed as a response to a combination of factors (e.g. temperature and day length) and the nature of the response then reflects the plant's adaptation to the factors in combination. The success of a plant in a particular environment rarely depends on the possession of a single adaptive character. Rather, fitness or adaptation to an environment depends on possession of an optimum combination of characters that minimizes the deleterious effects and maximizes the advantageous effects. The task of plant breeders is thus difficult and complex, as they generally have to develop genotypes with an optimum combination of adaptive characters, rather than ones with a single adaptive character

2.0 OBJECTIVES

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

- discuss the adaptation of fruits and vegetables
- discuss the adaptation procedures for new crop establishment
- identify factors that influence adaptation of fruits and vegetables in their new environments
- list some common varieties of fruits and vegetables in Nigeria.

3.0 MAIN CONTEXT

There are more than 30 types of vegetables that are grown in Nigeria, though some are in more in demand than others. Lettuce, onions, okra, cucumber, carrots, tomatoes and pepper are some of the vegetable type that are commonly cultivated in Nigeria due to their high demand**.** Major fruits produced in Nigeria include mango, pineapple, plantain/banana, citrus, guava, pawpaw. Most of these fruits and vegetables are not indigenous to Nigeria but were introduced from other countries after their domestication and later got adapted to the environment. Adaptation involves efforts to limit the vulnerability of crops to the effects of climate change without necessarily addressing the underlying causes. This is where climate mitigation strategies come handy. Mitigation involves reducing the overall significance of climate change primarily via emissions reductions and/or retention of agricultural land as opposed to conversion to urban land. It is important to recognise those adaptation scenarios are usually focused on modifying a particular crop (natural selection and genetic engineering) or controlling a pest or addressing the entire ecosystem, which can be counterproductive approach because of the inherent complexity of an eco- system. Manipulating the eco-system in other to create favourable environment for the crop is a strategy for the introduction of crops to new locations.

3.1 Adaptation of crops

An adaptation may be defined as any feature of an organism that has survival value under the existing conditions of its habitat. Such a feature or features may allow the plant to make fuller use of the nutrients, water, temperature or light, or may give protection against adverse factors such as temperature extremes, water stress, disease or insect pressures. Adaptation can be seen as the fitness of the plant to survive in its present environment.

Adaptation is also heritable, i.e. it is determined by the genotype of the plant. Hence the definition can be refined to ‘the heritable modifications

to a plant which enable it to survive, reproduce, or both, in a given environment'.

Fruits and vegetables have varying amounts of climatic adaptation. Most grow only in either the tropical, subtropical, or temperate zones. For example, fruits such as mango and pineapple grow best in a tropical climate without frosts, citrus grows best in a subtropical climate without hard winter freezes, and apricot grows best in a temperate, Mediterranean climate of uniformly cool winters and dry summers. However, strawberry has adaptation from the equator to the Arctic Circle and some apple genotypes will grow in low chill, subtropical climates while others will grow in high chill, temperate climates. Some fruits have more specific adaptation limitations than others as seen by their specialized areas of production. Fruit breeding is human-directed evolution for desired tree and fruit characteristics. Climatic adaptation precedes breeding for commercial fruit qualities. Without climatic adaptation, the breeder may not be able to make hybrids and cannot adequately fruit and evaluate them. Once the breeder finds climatic adaptation for tree growth and fruiting, selection for more specific climatic requirements is possible, and primary attention can then be given to fruit characteristics necessary for making the crop economically viable.

Adaptation of crop plants depends on many factors, and is best considered concerning a set of conditions (environmental, edaphic (soil) and biotic) rather than to a single factor alone. In many situations, one factor (e.g. water availability) may dominate the prevailing conditions, and the nature of the plant's response then largely reflects its adaptation to the existing level of that factor. More typically, adaptation is expressed as a response to a combination of factors (e.g. temperature and day length) and the nature of the response then reflects the plant's adaptation to the factors in combination. The success of a plant in a particular environment rarely depends on possession of a single adaptive character. Rather, fitness or adaptation to an environment depends on possession of an optimum combination of characters that minimises the deleterious effects and maximises the advantageous effects. The task of plant breeders is thus difficult and complex, as they generally have to develop genotypes with an optimum combination of adaptive characters, rather than ones with a single adaptive character (Evans, 1996). Whatever the growing conditions, the important consideration is the nature of the adaptive plant response itself and, for commercial purposes, the consequences of that response in terms of the economic output of the crop. For example, a plant that grows well under a given set of conditions, but fails to flower and set seed, is of little value as a grain crop in that situation. It may, however, be an excellent forage crop under those conditions, as the economic product (leaves and stems) is

not dependent on flowering and seed set. Adaptation was described by Wilsie (1962) thus: 'an adaptation may be defined as any feature of an organism which has survival value under the existing conditions of its habitat.

Such a feature or features may allow the plant to make fuller use of the nutrients, water, temperature or light, available, or may give protection against adverse factors such as temperature extremes, water stress, disease or insect pressures'. The concept of adaptation can be difficult to define, as it is used in respect to both the evolutionary origins of a character and its contribution to the fitness of the plant to survive in its present environment. Adaptation is also heritable, i.e. it is determined by the genotype of the plant. Hence the definition can be refined to 'the heritable modifications to a plant which enable it to survive, reproduce, or both, in a given environment' (Kramer, 1980). Reproduction, as well as survival, is a critical consideration in the commercial production of seed (grain) crops, as their economic product results from successful completion of the reproductive phase of their life cycles. In these crops, completion of all phases of development is fundamental to economic performance. In other crops such as sugar cane or forages, where the economic product is biomass (plant dry matter) that results from vegetative growth, development is a less important consideration than growth. The concepts of growth and development are important to an understanding of plant adaptation and are discussed below.

Acclimation of crops

In contrast to adaptation, acclimation (or hardening) is the non-heritable modification of plant characters caused by exposure to new environmental conditions such as warmer or drier weather. It results from temporary modifications to the plant phenotype caused by the changing environment. Generally, plants subjected to several cycles of mild water or low temperature stress suffer less injury from subsequent drought or very low temperature exposure than plants that have not been previously stressed (Kramer, 1980).

Crop Growth

Growth is the increase in plant biomass (dry matter) over time. About 95% of biomass is the net result of photosynthetic gains and respiratory losses, with the remaining 5% derived from nutrient uptake. Growth is affected by the supply and level of availability of all factors that are essential to normal plant metabolism and function. The major factors are:

- water
- nutrient elements

- light (the visible component of incoming solar radiation – it includes the red and blue wavelengths which provide energy for photosynthesis)
- gases, particularly carbon dioxide (CO_2) for photosynthesis and oxygen (O2) for respiration.

All of these are usually in finite supply and are frequently the subject of competition between plants or species in a community.

Crop Development

Development is the progression of a plant through the successive stages of its normal life cycle. The life cycle is best considered in two main phases, Vegetative and Reproductive, each of which includes one or more stages:

Vegetative

- Establishment – seed germination, emergence, and, ultimately, independence of seed reserves.
- Vegetative growth – initiation, development and expansion of leaves, stems and roots. Reproductive
- Floral initiation – the transition of stem apices (growing points) from vegetative (producing leaf and stem primordia [buds]) to reproductive (producing inflorescence structures and floral primordia).
- Flowering and pollination (anthesis), resulting in fertilised ovules which will develop into seeds (grains).
- Seed growth (grain filling) to a maximum wet weight at physiological maturity.
- Seed (grain) maturation – grain dries naturally to a moisture content suitable for harvesting and storage.
- Harvest ripeness – dry (12-14% moisture) grain ready for harvest.

Reproductive development in plants is controlled more by regulatory than by assimilator processes. The consequences of this are that reproductive development can proceed relatively independently of growth, and can be modified by selection more readily than growth. In many cases, the adaptation of crops to harsher environments has depended more on changes in the length and timing of their life cycles - allowing them to escape the most adverse conditions - than on changes in their ability to tolerate such environments. In contrast to those for growth, the external governing factors for development are principally environmental, with day length and temperature the most important. As the most regular and predictable component of climate, day length is the most potent and universal controlling element in the timing of life cycles of both wild and cultivated plants, and the modification of their

responses to day length has been a major factor in the spread and adaptation of many crop plants.

3.1.1 Adaptation procedures of fruits and vegetables to new environment

a) Flowering time

Flowering plants produce a meristem at the shoot tip where specialized tissue generates shoots at the appropriate time to differentiate into reproductive structures, pollinate and efficiently generate seeds. The complex set of molecular and phenological events culminating in development of a flowering meristem is referred to as 'flowering time'. Flowering time affects plant productivity because plants dedicate energy to produce flowers and seeds rather than vegetative tissue once the molecular decision to initiate flowering has been taken. Thus, initiation of flowering time is an important decision in plants, especially in annual plants including crops.

b) Latitudes and climate

Humans have introduced crops into latitudes and climate areas far from their origin or natural ecosystem, requiring in many cases modification of native flowering times. Recent molecular–genetic studies shed light on the genetic basis related to such introductions as well as the potential of other agricultural plants to be introduced into different climatic zones. Adaptation to climate change concerning crop production will have to occur at temporal, seasonal, and geospatial levels.

c) Crop selection (natural)
d) Genetics- gene manipulation through genetic engineering.
e) Artificial (induced) mutagenesis approaches can generate early-flowering alleles and late-flowering alleles
f) Carbon dioxide (CO_2) and temperature sensitivity
g) Resilience of crops.
h) Water resources availability
i) Technology, including sophisticated Geographic Information Systems (GIS)-based modeling, coupled with publically available soil and weather data that help farmers optimize production and conservation will be essential toward adaptation.
j) Communication of localized technical information to farmers by national research centres, federal, and state agencies to help farmers adapt and prepare for extreme events associated with climate change.

3.1.2 Adaptation factors

Adaptation for crop growth, flower bud formation, flowering, and fruit growth and maturation are dependent upon the following major factors

- Water
- Nutrient elements (including soil types)
- Light (the visible component of incoming solar radiation –it includes the red and blue wavelengths which provide energy for photosynthesis)
- Gases, particularly carbon dioxide (CO_2) for photosynthesis and oxygen (O_2) for respiration.
- Photoperiod
- Temperature

All of these are usually in finite supply and are frequently the subject of competition between plants or species in a community.

Let us look at these factors to see how they influence adaptation and distribution of fruits and vegetables

- Temperature

Temperature is an important factor affecting, and in many cases controlling, plant growth. While the concept of a limited supply does not apply to temperature (i.e. plants do not compete for it), the thermal environment in which a plant is grown has significant effects on growth rate and dry matter yield. Adaptation to temperature is a major factor governing the natural distribution of plants, and is a principal determinant in the selection of crop species for commercial production throughout the world. Plant adaptation and response to temperature is usually described in terms of so-called Cardinal Temperatures for growth. Cardinal temperatures for any species are: a Minimum, below which growth will not occur and above which growth rate will rise with temperature, to an optimum, at which growth rate is maximal, and above which growth rate will decline with increasing temperature, to a maximum, at which growth will cease.

- Photoperiod (Day length)

The physiological response of plants to the relative lengths of the diurnal cycles of light (day length) and dark periods is called Photoperiodism. The most fundamental aspect of this response is the transition from vegetative to reproductive phase in photoperiod sensitive plants, which includes most modern day crop species. Depending on their adaptation, photoperiod sensitive species are induced to progress from vegetative to reproductive phase when subjected to certain critical day lengths. Most species of tropical or subtropical adaptation are classed as Short Day (SD) plants –they grow vegetative through the long days of late-

spring/summer/early-autumn, and undergo floral initiation when autumn day length declines to a certain critical value. In contrast, most species of temperate adaptation are described as Long Day (LD) plants. Their vegetative phase occurs during the short-day late-autumn/winter/early-spring period, floral initiation occurring when spring day length increases to a certain critical value. In a third major group, floral initiation occurs after a certain period of vegetative growth has been completed, regardless of day length. Plants in this photoperiod-insensitive group are described as Day Neutral (DN).

Day length variation at any location depends on its latitude. Daylength increases with increasing latitude in summer, from 12 hours at the Equator to 24 at the Pole. In winter, it decreases with increasing latitude, from 12 hours at the Equator to zero at the Pole. Hence higher latitude locations experience greater day length variation through the year than those in the Equatorial zone – day length at the Equator itself remains constant at 12 hours throughout the year.

For example, the potato was domesticated on the equatorial highlands of South America. Wild potato varieties of the Andean region (*Solanum tuberosum* spp. *andigena*) make tubers underground under short days but not under long-day conditions, meaning that the tuber formation response is strictly dependent on day-length. However, modern potato cultivars in higher latitudes can make tubers under long days. The *CO–FT* module regulates not only photoperiodic flowering but also tuber formation

- Water

Adaptation to water-limited conditions reflects the ability of the plant to either access and use limited available water at the expense of its competitors, or to limit transpiration water loss better than its competitors, or both. Superior access to and use of water usually results from more rapid and extensive root growth, enabling the limited pool of available soil water to be exploited before the roots of less well-adapted competitors can reach it. Limiting water loss under stress conditions may result from adaptive characteristics such as rough leaf surfaces that shield stomata, and from leaf rolling. Both limit direct stomatal exposure to solar radiation and wind, thereby reducing transpiration.

- Nutrient elements (including soil types)

Adaptations that enable successful competition for nutrients include:

✓ More rapid and extensive root growth, which enables one competitor to access and exploit available nutrients at the expense of its neighbors;

- ✓ The capability to take up and use a nutrient which may be present in the soil in a chemical form which their competitors are not able to utilise;
- ✓ The ability to meet its requirements for an essential nutrient independently of soil supply (e.g. a legume growing in a nitrogen deficient soil);
- ✓ Tolerance of low levels of essential nutrients in the soil which enables normal growth at levels too low for other species to grow, or even survive.
- ✓ Tolerance of soil conditions such as low pH or high salinity which enables adequate uptake of essential nutrient elements under conditions where other species are unable to grow, or even survive

- Light intensity

Competition for light arises where one leaf shades another, regardless of whether the competing leaves are on the same or different plants. In contrast to water and nutrients, light energy cannot be redistributed internally in the plant unless it has been captured by chlorophyll in the photosynthetic tissue of the leaves or stems. Competition for light usually arises as the result of superior growth of one plant or species relative to another, which frequently reflects the outcomes of earlier competition for water and/or nutrients. The greater growth of the successful competitor results in shading of its neighbors, exacerbating the effects of existing competition for water and/or nutrients.

- Gases, particularly carbon dioxide (CO_2) for photosynthesis and oxygen (O_2) for respiration.

Competition for carbon dioxide may arise where a crop, well supplied with water and nutrients, and under high light intensity conditions around midday, is photosynthesizing at a high rate. Under these conditions, rapid uptake of CO_2 depletes its concentration in the air within the canopy, causing a decline in photosynthetic rate. This happens only under still conditions, where the absence of air mixing by wind prevents CO_2 being replenished from outside the canopy. It occurs mainly in intensive production systems, where irrigated and well fertilised crops are grown in typically high density monocultures.

Competition may also occur for oxygen (O_2), typically in waterlogged soils. Except for rice, no commercial crop species can survive continuous root inundation, although many can tolerate periodic inundation in waterlogged soils. Waterlogging severely reduces O_2 supply to root cells, inhibiting their respiration and hence normal nutrient uptake. Crop yellowing in waterlogged, low lying areas of paddocks during wet periods is a common occurrence and usually

reflects an induced nitrogen deficiency, as uptake is severely limited or even prevented.

3.2 Varieties of fruits and vegetables in Nigeria

Major fruits produced in Nigeria include mango, pineapple, plantain/banana, citrus, guava, pawpaw, while vegetables include onion, tomato, okra, pepper, amaranthus, carrot, melon, Corchorus olitorus (ewedu), Hibiscus sabdariffa (sobo), Adansonia digtata (baobab leaves). Fruits and vegetables are widely grown in almost every part of the country because of its nutritional qualities, ease of cultivation and all year-round demand.

Common fruits and vegetables in Nigeria

Table 3: Some vegetables grown in Nigeria

Common Name	**Botanical Name**	**Family**	**Variety**
Efo Yarin (Yoruba) English Name:Dandelion greens	*Taraxacum officinale*	Asteraceae	T. *officinale or dandelion*
Bitter leaf Ewuro (Yoruba); Onugbu (Igbo); Shuwaka (Hausa), Etidot (Cross river state)	*Vernonia amygdalina*	Compositae	*Vernonia amygdalina; local forms and selections*
African Spinach Efo Tete (Yoruba)	*Amaranthus hybridus*	Amaranthaceae	*Amaranthus hybridus*
Lagos Spinach Shokoyokoto (Yoruba)	*Celosia argentea,*	Amaranthaceae	var. plumose
WaterLeaf Gbure (Yoruba)	*Talinum Triangulare*	Portulacaeae	Local forms and selections
Efo Igbo (Eggplant leaves) African Egg Plant leaf	*Solanum macrocarpon*	Solanaceae	S. macrocarpon
Afang (Ibibio), Okazi (Igbo)	*Gnetum africanum*	Gnetaceae	G. buchholzianum
fluted pumpkin leaf Ugu	*Telfairia occidentalis*	Cucurbitaceae	Local forms and selections
Jute leaves, saluyot leaves Ewedu (Yoruba), Ayoyo (Hausa)	*Corchorus*	Malvaceae	*Corchorus* olitorius
Eru "wild spinach" okazi/Ukazi (Igbo); Afang leaves (Ibibio)	*Gnetum Africanum*	Gnetaceae	G. **africanum**
Curry leaf "sweet neem; Efirin Oso(Yoruba)	*Murraya koenigii*	Rutaceae	Rue and satinwood

Eggplant; gargen egg	*Solanum melongena*	Solanaceae	s. incanum; S.melongena
Spring onions; Alubosa elewe (Yoruba)	*Scallion*	Amaryllidaceae	bunching onion, long *green onion*,
Cucumber	*Cucumis sativus*	Cucurbitaceae	Cucumber Var. Polaris
Cocoyam, Wild taro	*olocasia esculentum* (L.) Schott	Araceae	var. aquatilis
Broccoli	*Brassica oleracea*	Cruciferae	Italica, botrytis
Cocoyam	*Colocasia antiquorum*	araceae	c. esculanta
Okra	*Hibiscus esculantus*	Malvaceae	Green early dwarf, Clemson spineless, caribean
Bell pepper, sweet pepper	*Capsicum annum*	Solanaceae	C . grossum
Sweet melon	*Cucumis melo*	Cucurbitaceae	Caribean, 'Smiths perfect'
Sweet corn	*Zea mays*	Gramineae	Dentate, indurate,rugosa

Table 4: Some fruits grown in Nigeria

Common Name	**Botanical Name**	**Family**	**Local Name**	**Part (S) Used**
Ginger	*Zingiber officinale* (Rose)	Zingiberaceae	Jinga	Corm
Hibiscus	*Hibiscus acetosella*	Malvaceae	Akese	Leaves
African star apple	*Chrysophyllum albidum* (G. Don)	Sapotaceae	Agbalumo; Agwaliba	Fruit
Fruited gourd	*Coccinia barteri*	Cucurbitaceae	Ewe-oju	Whole plant
Tomatoes	*Solanum lycopersicum*	Solanaceae	Tomato	Fruit
Pepper, Chili	*Capsicum annuum* L.	Solanaceae	Tatashi	Fruit
Orange, Sweet	*Citrus sinensis* (Linn.)	Rutaceae	Osan Orom; Lem ; a	Fruits u
Cashew nut	*Anacardium occidentale* L.	Anacardiaceae	Kansu	Fruit
Mango	*Mangifera indica* L	Anacardiaceae	Mango	Fruit

Coconut	*Cocos nucifera*	Arecaceae	Aku-beke	Nut
Pepper fruit	*Dennettia tripetala*	Annonaceae	Igbere, Nmi-mi	Fruit, leaves, stem, twigs
Pineapple	*Ananas comosus*	Bromeliaceae	Ope oyinbo	Fruit
Fluted pumpkin	*Telfaria occidentalis* Hook. F.	Cucurbitaceae	Ugu	Leaf, fruit
Colocynth, wild gourd.	*Citrullus colocynthis*	Cucurbitaceae	Egunsi	Fruit, seed
Paw paw	*Carica papaya (*Linn.)	Caricaceae	Gwanda; Ibepe	fruit,
Garlic	*Allium sativum* L.	Alliaceae	Tafarunua	Bulb
Onion	*Allium cepa* Alabasa	Alliaceae	Alubosa; Alu-bosa; Yabasi	Bulb
Scent leaf, mint	*Ocimum gratissimum*	Lamiaceae	Efinrinnla; Dadoya	Leaf
Moringa	*Moringa oleifera* Lam.	Moringaceae	Ewe-ile, Eweigbale; zogale,	Leaves, roots, stem bark, fruit
Plantain	*Musa paradisiaca* L.	Musaceae	Ogede; ayaba	Unripe fruit
Guava	*Psidium guajava*	Myrtaceae	Gwaabaa	Fruit
Groundnut, peanut	*Arachis hypogaea*	Fabaceae	Jedda	Seed
Baobab	*dansonia digitata*	Bombacaceae	Ose, kukaa	Leaves

SELF-ASSESSMENT EXERCISE

Temperature regimes have been rather high in the tropics, sometimes exceeding 40^{O}c. In this regard crops do not compete for temperature as a growth factor but adapt necessary adjustments to cope with it. Given this situation, which factor of production or input should a farmer pay most attention to to maximize output?

4.0 CONCLUSION

Climate change will have variable impacts on agriculture based on multiple factors including changes in temperature, precipitation, and humidity. The magnitude and significance of these changes will be dependent on geography. These abiotic changes will select for different biotic organisms from micro-organisms to insects, to plants and livestock and poultry. Such changes are already affecting our current agricultural production systems. For example, increases in temperature and a corresponding loss of rainy days will lead to inhomogeneous and reduced crop yields for several major tree fruits and vegetables. The distribution and adaptation of fruits vegetables is largely influenced by climate and genetic manipulations including mutation.

5.0 SUMMARY

The production of fruits and vegetables constitute about 30 percentage of the Agricultural Production in Nigeria which is the main source of livelihood for 70 percentage of the country's population. Vegetables are crucial components of healthy daily diet. Thus, widely grown in almost every part of the country because of its nutritional qualities, ease of cultivation and all year round demand. The cultivation of vegetable as a business is very lucrative and profitable. There are over 30 varieties of fruits and vegetables in Nigeria, some are indigenous to Nigeria while some were introduced to the country by early explorers and missionaries. Climatic factors played central roles in their post domestication and adaptation processes.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1) Explain the influence of Day Length (photo period) in crop adaptation
2) In what ways has technology and communication assisted in crop adaptation in Nigeria?
3) List six factors that affect adaptation of fruits and vegetables in Nigeria.
4) List four common fruits and four vegetables in Nigeria with their respective common names, botanical names and their family names.

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UNIT 2 TYPES AND SYSTEMS OF PRODUCTION: PRODUCTION PRACTICES, HANDLING, PROCESSING, PACKAGING, STORAGE, MARKETING AND UTILIZATION OF TROPICAL FRUITS AND VEGETABLES

CONTENTS

1.0 INTRODUCTION

Fruits and vegetables are rich in minerals and vitamins which are essential for body growth and development. Some fruits plant parts and vegetables are also utilised for their medicinal and therapeutic properties. Their cultivation and production systems have become popular due to their short gestation period thus high rates of turnover and profitability. Less capital and labour requirements have make fruits and vegetable cultivation preferred and widely practiced in Nigeria. In Nigeria, the production statistics is not readily available because of the lack of proper recording and monitoring, but it is obvious that the vegetable market has high demand especially in the urban areas.

2.0 OBJECTIVES

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

- mention the types of production of fruits and vegetables
- explain the production systems of fruits and vegetables
- explain the production practices of fruits and vegetables.

3.0 MAIN CONTEXT

In fruits and vegetables production systems, resources both natural and human are combined in such a way that they are transformed into horticultural products. Within a production system there is a particular farming system, the cropping sequence, pattern and management practices that stands out that farm. It must be recognised that no two farms, even if adjacent, would have identical farming systems. This would even be more so for horticultural enterprises than for those producing grain.

3.1 Production systems of fruits and vegetables

There are four basic fruits and vegetables production systems in Nigeria, Subsistence production system, Home garden production system, Semi-intensive mixed commercial and Very intensive commercial production system

Subsistence production system
Subsistence horticulture will have as its main resource the availability of household labour, followed by land (whether titled, leased or squatted) and common-good essential resources such as water (as rainfall, surface flow, wells), solar radiation, CO2, and the more poorly recognised resources such as natural bio-logical pest management. In the true sense of subsistence agriculture, there is hardly any concerning horticulture. This is because of less emphasis on financial incomes in subsistence agriculture. But in fruit crops production, we have seen few stands of fruit trees within a compound which are mainly for family use.

Home garden production system
Home gardens are found in both rural and urban areas in predominantly small-scale subsistence agricultural systems. The household garden is a small-scale production system supplying fruits and vegetables to the family and nearby local markets. Home gardens can further be described as a mixed cropping system that encompasses vegetables, fruits, plantation crops, spices, herbs, ornamental and medicinal plants as well as livestock that can serve as a supplementary source of food and income. It is evident that home gardens are a part of the agriculture and food production systems in many developing countries and are widely used as a remedy to alleviate hunger and malnutrition in the face of a national food crisis.

Semi-intensive mixed commercial production system
This is an agricultural production system where there is high intensification and mechanization system that aims to maximize yields from available land through various means, such as heavy use of

pesticides and chemical fertilizers. Under this system, fruits and vegetables are s produced in large quantities with the help of chemical fertilizers and pesticides that are appropriately used in a sustainable manner that will ensure the productivity of the land from year to year. Land under this intensification is relatively small but under intensive cultivation with good management practices. Fruits and vegetables are always in high demand on daily basis especially in urban areas and to satisfy the demand, farmers have to intensify their production.

Very intensive Commercial production system
This is at the other extreme in terms of scale of production and financial resources. Commercial production systems have capital replacing labour as the most finite resource, and will have a plethora of technologies that ensure optimal supply of essential resources, like nutrients as fertilizer, water (irrigation) and even supplements of CO2 in controlled spaces, such as in greenhouses, to enhance growth. Commercial farmers often replace biological pest management with the use of agrochemical sprays. In some situations, operations are automated.

3.2 Types of Production of Fruits and Vegetables

Vegetable production operations range from small patches of crops, producing a few vegetables for family use or marketing, to the great, highly organised and mechanised farms common in the most technologically advanced countries. In homestead gardens and in technologically developed countries the three main types of vegetable farming are based on production of vegetables for the fresh market, for canning, freezing, dehydration, and pickling, and to obtain seeds for planting.

Production for the fresh market
This type of vegetable farming is normally divided into home gardening, market gardening, truck gardening and vegetable forcing.

Home gardening provides vegetables exclusively for family use. About one-tenth of a hectare of land is required to supply a family of six. Reasonable yields per unit of area of land are obtained from these gardens. Bean, cabbage, carrot, lettuce, onion, pea, pepper, spinach, and tomato are desirable home garden crops.

Market gardening produces assorted vegetables for a local market. The development of good roads and motor trucks are essential for the rapidly expanding urban markets for these market gardening producers. In some situations, large quantities of a particular type of vegetable or fruit are produced in large quantity and transported whole to urban markets.

In another method known as forcing, vegetables are produced out of their normal season of outdoor production under forcing structures that admit light and induce favourable environmental conditions for plant growth. Greenhouses, cold frames, and hotbeds are common structures used. Hydroponics, sometimes called soilless culture, allows the grower to practice automatic watering and fertilizing, thus reducing the cost of labour. To successfully compete with other fresh market producers, greenhouse vegetable growers must either produce crops when the outdoor supply is limited or produce quality products commanding premium prices.

Production for processing

Processed vegetables include canned, frozen, dehydrated, and pickled products. Although many kinds of vegetables can be processed, there are marked varietal differences within each species in adaptability to a given method. Specifications for vegetables for canning and freezing usually include small size, high quality, and uniformity. For many kinds of vegetables, a series of varieties having different dates of maturity is required to ensure a constant supply of raw material, thus enabling the factory to operate with an even flow of input over a long period. Acceptable processed vegetables should have a taste, odour, and appearance comparable with the fresh product, retain nutritive values, and have good storage stability.

Vegetables raised for seed production

This type of vegetable farming requires special skills and techniques. The crop is not ready for harvest when the edible portion of the plant reaches the stage of maturity; it must be carried through further stages of growth. Production under isolated conditions ensures the purity of seed yield. Special techniques are applied during the stage of flowering and seed development and also in harvesting and threshing the seeds. The outputs are quality premium seeds for other growers to plant.

3.3 Production factors

Profitable vegetable farming requires attention to all production operations, including insect, disease, and weed control and efficient marketing. The kind of vegetable grown is mainly determined by consumer demands, which can be defined in terms of variety, size, tenderness, flavour, freshness, and type of pack. Effective management involves the adoption of techniques resulting in a steady flow of the desired amount of produce over the whole of the natural growing season of the crop. Many vegetables can be grown throughout the year in some climates, although yield per acre for a given kind of vegetable varies according to the growing season and region where the crop is produced.

Climate
Climate involves the temperature, moisture, daylight, and wind conditions of a specific region. Climatic factors strongly affect all stages and processes of plant growth.

Temperature
Temperature requirements are based on the minimum, optimum, and maximum temperatures during both day and night throughout the period of plant growth. Requirements vary according to the type and variety of the specific crop. Based on their optimum temperature ranges, vegetables may be classed as cool-season or warm-season types. Cool-season vegetables thrive in areas where the mean daily emperature does not rise above 70° F (21° C). This group includes the artichoke, beet, broccoli, brussels sprouts, cabbage, carrot, cauliflower, celery, garlic, leek, lettuce, onion, parsley, pea, potato, radish, spinach, and turnip. Warm-season vegetables, requiring mean daily temperature of 70° F or above, are intolerant of frost. These include the bean, cucumber, eggplant, lima bean, okra, muskmelon, pepper, squash, sweet corn (maize), sweet potato, tomato, and watermelon.

Premature seeding, or bolting, is an undesirable condition that is sometimes seen in fields of cabbage, celery, lettuce, onion, and spinach. The condition occurs when the plant goes into the seeding stage before the edible portion reaches a marketable size. Bolting is attributed to either extremely low or high temperature conditions in combination with inherited traits. Specific vegetable strains or varieties may exhibit significant differences in their tendency to bolt. Young cabbage or onion plants of relatively large size may bolt upon exposure to low temperatures near 50° to 55° F (10° to 13° C). At high temperatures of 70° to 80° F (21° to 27° C) lettuce plants do not form heads and will show premature seeding. The fruit sets of tomatoes are adversely affected by relatively low and relatively high temperatures. Tomato breeders, however, have developed several new varieties, some setting fruits at a temperature as low as 40° F (4° C) and others at a temperature as high as 90° F (32° C).

Moisture
The amount and annual distribution of rainfall in a region, especially during certain periods of development, affects local crops. Irrigation may be required to compensate for insufficient rainfall. For optimum growth and development, plants require soil that supplies water as well as nutrients dissolved in water. Root growth determines the extent of a plant’s ability to absorb water and nutrients, and in dry soil root growth is greatly retarded. Extremely wet soil also retards root growth by restricting aeration. Atmospheric humidity, the moisture content of the air, also contributes moisture. Certain seacoast areas characterized by

high humidity are considered especially adapted to the production of such crops as the artichoke and lima bean. High humidity, however, also creates conditions favourable for the development of certain plant diseases.

Daylight

Light is the source of energy for plants. The response of plants to light is dependent upon light intensity, quality, and daily duration, or photoperiod. The seasonal variation in day length affects the growth and flowering of certain vegetable crops. Continuation of vegetative growth, rather than early flower formation, is desirable in such crops as spinach and lettuce. When planted very late in the spring, these crops tend to produce flowers and seeds during the long days of summer before they attain sufficient vegetative growth to produce maximum yields. The minimum photoperiod required for formation of bulbs in garlic and onion plants differs among varieties, and local day length is a determining factor in the selection of varieties.

Each of the climatic factors affects plant growth, and can be a limiting factor in plant development. Unless each factor is of optimum quantity or quality, plants do not achieve maximum growth. In addition to the importance of individual climatic factors, the interrelationship of all environmental factors affects growth.

Certain combinations may exert specific effects. Lettuce usually forms a seedstalk during the long days of summer, but the appearance of flowers may be delayed, or even prevented, by relatively low temperature. An unfavourable temperature combined with unfavourable moisture conditions may cause the dropping of the buds, flowers, and small fruits of the pepper, reducing the crop yield. Desirable areas for muskmelon production are characterized by low humidity combined with high temperature. In the production of seeds of many kinds of vegetables, absence of rain, or relatively light rainfall, and low humidity during ripening, harvesting, and curing of the seeds are very important.

Site

The choice of a site involves such factors as soil and climatic region. In addition, with the continued trend toward specialization and mechanization, relatively large areas are required for commercial production, and adequate water supply and transportation facilities are essential. Topography—that is, the surface of the soil and its relation to other areas—influences efficiency of operation. In modern mechanised farming, large, relatively level fields allow for lower operating costs. Power equipment may be used to modify topography, but the cost of such land renovation may be prohibitive. The amount of slope influences the type of culture possible. Fields with a moderate slope

should be contoured, a process that may involve added expense for the building of terraces and diversion ditches. The direction of a slope may influence the maturation time of a crop or may result in drought, winter injury, or wind damage. A level site is generally most desirable, although a slight slope may assist drainage. Exposed sites are not suitable for vegetable farming because of the risk of damage to plants by strong winds.

The soil stores mineral nutrients and water used by plants, as well as housing their roots. There are two general kinds of soils—mineral and the organic type called muck or peat. Mineral soils include sandy, loamy, and clayey types. Sandy and loamy soils are usually preferred for vegetable production. Soil reaction and degree of fertility can be determined by chemical analysis. The reaction of the soil determines to a great extent the availability of most plant nutrients. The degree of acid, alkaline, or neutral reaction of a soil is expressed as the pH, with a pH of 7 being neutral, points below 7 being acid, and those above 7 being alkaline. The optimum pH range for plant growth varies from one crop to another. A soil can be made more acid, or less alkaline, by applying an acid-producing chemical fertilizer such as ammonium sulfate.

The inherent fertility of soils affects production quantity, and a sound fertility program is required to maintain productivity. The ability of a soil to support plant life and produce abundant harvests is dependent on the immediately available nutrients in the soil and on the rate of release of additional nutrients that are present but not available to plants. The rate of release of these additional nutrients is affected by such factors as microbial action, soil temperature, soil moisture, and aeration. Depletion of soil fertility may occur as a result of crop removal, erosion, leaching, and volatilization, or evaporation, of nutrients.

3.3.1 Production practices of fruits and vegetables

Sustainable production management practices involve the adoption of techniques that will result in increased yields when compared with the traditional approaches in the production of these fruits and vegetables. The production practices highlighted here are general and applicable to both fruits and vegetables.

Site selection

The choice of a site involves such factors as the type of soil and its characteristics like topography, location/ accessibility, nearness to steady water supply, transportation facilities and nearness to markets.

Fields with a moderate slope should be contoured, a process that may involve added expense for the building of terraces and diversion ditches.

The direction of a slope may influence the maturation time of a crop or may result in drought or even wind damage. A level site is generally most desirable, although a slight slope may assist drainage.

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Depletion of soil fertility may occur as a result of crop removal, erosion, leaching, and volatilization, or even evaporation of nutrients. Good management practices on our production sites will ensure sustainable production of our fruits and vegetables over time.

Land preparation

In the tropics like Nigeria, land preparation starts from removing trees and underbrush the forest with shrubs and grasses. This operation is capital intensive and so most at times fruits are planted on those lands. In the guinea savannah where vegetation cover is light, land preparation becomes cheaper and easier. Land for vegetables are usually prepared using hoes or tractors where the area is large enough to justify its use. The ploughed land is then harrowed. Stones and dead tree stumps are removed preparatory to receive seedlings from the nursery. Ridges may be made especially during the rainy season and under water logged situation. When crops are grown in succession, soil needs to be ploughed more than once each year. Plowing incorporates sod, green-manure crops, and crop residues in the soil; destroys weeds and insects; and improves soil texture and aeration. Soils for vegetables should be fairly deep. A depth of 15 to 20 centimetres is sufficient in most soils for most vegetables.

Maintenance of the organic-matter content of the soil is essential. Organic matter is a source of plant nutrients and is valuable for its effect on certain properties of the soil. Loss of organic matter is the result of the action of micro-organisms that gradually decompose it to carbon dioxide. The addition of manures and the growing of soil-improving crops are efficient means of supplying soil organic matter. Soil-improving crops (peas, legumes and cover crops) are grown solely for the purpose of preparing the soil for the growth of succeeding crops.

Soil preparation for vegetable growing involves many of the usual operations required for other crops. Good drainage is especially important for early vegetables because wet soil retards development. Sands are valuable in growing early vegetables because they are more readily drained than the heavier soils. Soil drainage accomplished by

means of ditches or tiles is more desirable than the drainage obtained by planting crops on ridges because the former not only removes the excess water but also allows air to enter the soil. Air is essential to the growth of crop plants and to certain beneficial soil organisms making nutrients available to the plants. When crops are grown in succession, soil rarely needs to be plowed more than once each year. Plowing incorporates sod, green-manure crops, and crop residues in the soil; destroys weeds and insects; and improves soil texture and aeration. Soils for vegetables should be fairly deep. A depth of six to eight inches (15 to 20 centimetres) is sufficient in most soils.

Soil management involves the exercise of human judgment in the application of available knowledge of crop production, soil conservation, and economics. Management should be directed toward producing the desired crops with a minimum of labour. Control of soil erosion, maintenance of soil organic matter, the adoption of crop rotation, and clean culture are considered important soil- management practices.

Soil erosion, caused by water and wind, is a problem in many vegetable-growing regions because the topsoil is usually the richest in fertility and organic matter. Soil erosion by water can be controlled by various methods. Terracing divides the land into separate drainage areas, with each area having its own waterway above the terrace. The terrace holds the water on the land, allowing it to soak into the soil and reducing or preventing gullying. In the contouring system, crops are planted in rows at the same level across the field. Cultivation proceeds along the rows rather than up and down the hill. Strip cropping consists of growing crops in narrow strips across a slope, usually on the contour. Soil erosion by wind can be controlled by the use of windbreaks of various kinds, by keeping the soil well supplied with humus, and by growing cover crops to hold the soil when the land is not occupied by other crops.

Maintenance of the organic-matter content of the soil is essential. Organic matter is a source of plant nutrients and is valuable for its effect on certain properties of the soil. Loss of organic matter is the result of the action of micro-organisms that gradually decompose it to carbon dioxide. The addition of manures and the growing of soil-improving crops are efficient means of supplying soil organic matter. Soil-improving crops are grown solely for the purpose of preparing the soil for the growth of succeeding crops. Green-manure crops, grown especially for soil improvement, are turned under while still green and usually are grown during the same season of the year as the vegetable crops. Cover crops, raised for both soil protection and improvement, are only grown during seasons when vegetable crops do not occupy the

land. When a soil-improving crop is turned under, the various nutrients that have contributed to the growth of the crop are returned to the soil, adding a quantity of organic matter. Both legumes, those plants such as peas and beans having fruits and seeds formed in pods, and non-legumes are effective soil-improving crops. The legumes, however, are more valuable, because they contribute nitrogen as well as humus. The rate of decomposition of plant material depends on the kind of crop, its stage of growth, and soil temperature and moisture. The more succulent the material is at the time it is turned under, the more quickly it decomposes. Because dry material decomposes more slowly than green material, it is desirable to turn under soil-improving crops before they are mature, unless considerable time is to elapse between the plowing and the planting of the succeeding crop. Plant material decomposes most rapidly when the soil is warm and well supplied with moisture. If soil is dry when a soil-improving crop is turned under, little or no decomposition will occur until rain or irrigation supplies the necessary moisture.

The chief benefits derived from crop rotation are the control of disease and insects and the better use of the resources of the soil. Rotation is a systematic arrangement for the growing of different crops in a more or less regular sequence on the same land. It differs from succession cropping in that rotation cropping covers a period of two, three, or more years, while in succession cropping two or more crops are grown on the same land in one year. In many regions vegetable crops are grown in rotation with other farm crops. Most vegetables grown as annual crops fit into a four-or five-year rotation plan. The system of intercropping, or companion cropping, involves the growing of two or more kinds of vegetables on the same land in the same growing season. One of the vegetables must be a small-growing and quick-maturing crop; the other must be larger and late maturing.

In the practice of clean culture, commonly followed in vegetable growing the soil is kept free of all competing plants through frequent cultivation and the use of protective coverings, or mulches, and weed killers. In a clean vegetable field, the possibility of attack by insects and disease-incitant organisms, for which plant weeds serve as hosts, is reduced.

Plant propagation

Propagation of crop plants, involving the formation and development of new individuals in the establishment of new plantings, is usually accomplished by the use of either seeds or the vegetative parts of plants. The first type, known as sexual propagation, is used for asparagus, bean, broccoli, cabbage, carrot, cauliflower, celery, cucumber, eggplant, leek, lettuce, lima bean, okra, onion, muskmelon, parsley, pea, pepper, pumpkin, radish, spinach, sweet corn (maize), squash, tomato, turnip,

and watermelon. The second type, asexual propagation, is used for the artichoke, garlic, girasole, potato, rhubarb, and sweet potato.

Although seed cost is a small portion of the total cost of crop production, seed quality strongly affects crop success or failure. Good seed should be accurately labelled, clean, graded to size, viable, and free of diseases and insects. The reliability of the seed house is an important factor in obtaining good-quality seed. Viability, or ability to grow, and longevity, the period of viability, are characteristics of seeds of any vegetable kind. In cool, dry storage conditions, those vegetable seeds having comparatively short longevity of one to two years are okra, onion, parsley, and sweet corn. Seeds having three-year longevity are those of the asparagus, bean, carrot, leek, and pea; four-year longevity is characteristic of the beet, chard, pepper, pumpkin, and tomato seeds; longevity of five years characterizes the seeds of broccoli, cabbage, cauliflower, celery, cucumber, eggplant, lettuce, muskmelon, radish, spinach, squash, turnip, and watermelon. The dry seeds of all vegetables, when packed under vacuum in hermetically sealed cans, should remain viable for a longer period than seeds stored under less protective conditions.

Crops grown from hybrid seeds (the offspring of two or more selected parental varieties and known as F_1) yield vegetables of high quantity and quality. The hybrid-seed industry is based on the production of new seed each year from the controlled pollination of selected parents found to produce the desired combination of characters in the progeny. In the early 1980s the number of F_1 hybrids was increasing in Japan, the United States, and other technically advanced countries. The number of F_1 hybrids varied with the kind of vegetable, but none had yet been introduced for the bean, celery, lettuce, okra, parsley, or pea

Nursery operation

It is an accepted practice to grow some fruits and vegetables as seedling transplants on seed beds in a nursery while others are sown directly in the field.

There are advantages of using seed beds as nursery

- There is a better use of the land as the crop is grown for a shorter period than the one which is grown ‘in-situ’
- Seed beds provide better protection for the seedlings
- Pests and disease control is cheaper, easier and more efficient
- Germination is often better
- There is the opportunity to identify and select vigor stands for the permanent site

Seeds recommended to be sown in nursery before transplanting to the garden or permanent site include: tomato, eggplant, peppers, cabbage, cauliflower, onions, spinach (Amaranthus spp), lettuce, mango, guava, citrus, oil palm. Vegetable crops like okra, beet, carrots can be sown directly on the field. Also, most of the fruit trees can be planted direct but budded or grafted ones are usually prepared in nurseries.

Planting

Most vegetable crops are planted in the field where they are to grow to maturity. A few kinds are commonly started in a seedbed, established in the greenhouse or in the open, and transplanted as seedlings. Asparagus seeds are planted in a seedbed to produce crowns used for field setting. Some vegetables can be either directly seeded in the field or grown from transplants. These include broccoli, cabbage, cauliflower, celery, eggplant, leek, lettuce, onion, pepper, and tomato. The time and method of planting seeds and plants of a particular vegetable influence the success or failure of the crop. Important factors include the depth of planting, the rate of planting, and the spacing both between rows and between plants within a row. Factors to be considered in determining the time of planting include soil and weather conditions, kind of crop, and desired harvest time. When more than one planting of a crop is made, the second and later plantings should be timed to provide a continuous harvest for the period desired. The soil temperature required for germination of the planted seed varies markedly with the various kinds of vegetables. Vegetables that will not germinate at a temperature below 60° F (16° C) include the bean, cucumber, eggplant, lima bean, muskmelon, okra, pepper, pumpkin, squash, and watermelon. Temperatures higher than 90° F (32° C) are not favourable for the germination of seeds of celery, lettuce, lima bean, parsley, pea, and spinach.

The quantity of seeds planted, or rate of planting, is mainly determined by the characteristics of the vegetable plant. The size of seeds affects the number of plants raised in a given area. Watermelon varieties, for example, differ in seed size expressed as weight. The Sugar Baby variety has an average weight of 1.4 ounces (41 grams) for 1,000 seeds; those of Blackstone variety average 4.4 ounces (125 grams). If the two are grown on two separate plots of the same area and 4.4 ounces of seeds of each cultivar are planted, the result would be three times as many of the Sugar Baby plants as the Blackstone type. Seed size and plant-growth pattern of a vegetable are major factors that govern the number of plants raised in a given area. The trend in the early 1980s was to increase plant population for many crops to achieve the greatest yield possible without impairing quality. As plant population increases per unit area, a point is reached at which each plant begins to compete for certain essential growth factors—*e.g.*, nutrients, moisture, and light.

When the population is below the level in which competition between plants occurs, increased population will have no effect on individual plant performance, and the yield per unit area will increase in direct proportion to the increment of population. When competition for essential growth factors occurs, however, yield per plant decreases.

Early harvest and economical use of space are the principal objectives of growing vegetable crops from transplants produced in a greenhouse or outdoor seedbed. It is easier to care for young plants of the cabbage, cauliflower, celery, onion, and tomato in small seedbeds than to sow the seeds in the place where the crop is to grow and mature. Land is free longer for another crop, and weeds, insects, diseases, and irrigation are more readily and economically controlled. The production of transplants is often a specialty of growers who sell their produce to other vegetable growers. The seeds may be planted at a rate three to six times that commonly used for a direct-seeded field. The young plants are removed for use as transplants when they reach the desired size and age, approximately 40 to 60 days after seeding.

The time and method of planting seeds and plants of a particular vegetable influence the success or failure of the crop. Important factors include the depth of planting, the rate of planting (population density per hectare) and the spacing both between rows and between plants within a row. Transplanting of seedlings should be carried out during the early hours of the day or in the evenings onto a well prepared permanent site. Moisture is very critical for quick establishment of transplanted seedlings.

Seed size and plant-growth pattern of a fruit or vegetable are major factors that govern the number of plants raised in a given area. The trend in the early 1980s was to increase plant population for many crops to achieve the greatest yield possible without impairing quality. As plant population increases per unit area, a point is reached at which each plant begins to compete for certain essential growth factors—*e.g.,* nutrients, moisture, and light. When the population is below the level in which competition between plants occurs, increased population will have no effect on individual plant performance, and the yield per unit area will increase in direct proportion to the increment of population. When competition for essential growth factors occurs, however, yield per plant decreases.

Care of crops during growth

Practices required for a crop growing in the field include:

- Cultivation
- Irrigation
- Application of fertilizers

- Control of weeds
- Diseases, and insects control
- Application of growth regulators if necessary.

Cultivation

Cultivation refers to stirring the soil between rows of plants. Because weed control is the most important function of cultivation, this work should be performed at the most favourable time for weed killing, when the weeds are emerging. When the plants are grown on ridges, it is necessary to cover the basal plant portion with soil, an operation known as 'earthen up'

Irrigation

Vegetable production requires irrigation in arid and semi-arid regions, and is frequently used as insurance against drought in more humid regions. Irrigation is essential throughout the dry season and may also be needed between rainfalls in the rainy season. The two types of land irrigation generally suited to fruits and vegetables are surface irrigation and sprinkler irrigation. A level site is required for surface irrigation, in which the water is conveyed directly over the field in open ditches at a slow, non-erosive velocity. Where water is scarce, pipelines may be used, eliminating losses caused by seepage and evaporation. The distribution of water is accomplished by various control structures, and the furrow method of surface irrigation is frequently employed because most vegetable crops are grown in rows. Sprinkler irrigation conveys water through pipes for distribution under pressure as simulated rain.

Irrigation requirements are determined by both soil and plant factors. Soil factors include texture, structure, water-holding capacity, fertility, salinity, aeration, drainage, and temperature. Plant factors include type of crop, density/population and depth of the root system, stage of growth and drought tolerance.

Fertilizer application

Soil fertility is the capacity of the soil to supply the nutrients necessary for good crop production, and fertilizing is the addition of nutrients to the soil. Chemical fertilizers may be used to supply the needed nitrogen, phosphorus, and potassium. Chemical tests of soil, plant, or both are used to determine fertilizer needs. The rate of application is usually based on:

- The fertility of the soil
- The cropping system employed
- The kind of crop grown
- The financial return that might be expected from the crop.

Methods of fertilizer application include scattering and mixing with the soil before planting; application with a drill below the surface of the soil at the time of planting; row application before or at planting time; and row application during plant growth, also called side-dressing. Plowed down broadcast fertilizers have recently been used in combination with high analysis liquid fertilizers applied at planting or as a side-dressed band. Mechanical planting devices may employ fertilizer attachments to plant the fertilizer in the form of bands near the seed at depths of 5 to 7 cm.

Weed control

Weeds (plants growing where they are not wanted) reduce crop yield, increase production cost, and may harbour insects and diseases that attack crop plants. Methods employed to control weeds include hand weeding, mechanical cultivation, application of chemicals acting as herbicides, and a combination of mechanical and chemical means. Herbicides, selective chemical weed killers, are absorbed by the plant and induce a toxic reaction. The amount and type of herbicide that can be safely used to protect crops depends on the tolerance of the specific crops to the chemical. Most herbicides are applied as a spray, and the appropriate time for application is determined by the composition of the herbicide and the kind of crop to be treated. Pre-planting treatments are applied before the crop is planted; pre-emergence treatments are applied after the crop is planted but before its seedlings emerge from the soil; and post-emergence treatments are applied to the growing crop at a definite stage of growth.

Disease and insect control

The production of satisfactory crops requires rigorous disease- and insect-control measures. Crop yield may be lowered by disease or insect attack, and when plants are attacked at an early stage of growth the entire crop may be lost. Reduction in the quality of crops may also be caused by diseases and insects. Grades and standards for markets follow specified strict limits on the amount of disease and insect injury that may be present on fruits and vegetables in a designated grade. Fruits and vegetables remain susceptible to insect and disease damage after harvesting, during the marketing and handling processes. When a particular plant pest is identified, the grower can select and apply appropriate control measures. Application of insect control at the times specific insects usually appear or when the first insects are noticed is usually most effective. Preventive procedures are more effective in disease control.

Diseases are incited by such living organisms as bacteria, fungi, and viruses. Harmful material enters the plant, develops during an incubation period, and finally causes infection, the reaction of the plant to the

pathogen, or disease-producing organism. Control is possible during the inoculation and incubation phases, but when the plant reaches the infection stage it is already damaged. Typical plant diseases include mildew, leaf spots, rust, and wilt. Chemical fungicides may be used to control disease, but the use of disease-resistant plant varieties is the most effective means of control.

Insects are usually controlled by the use of chemical insecticides that kill through toxic action. Many insecticides are toxic to harmful insects but do not affect bees, which are valuable for their role in pollination.

Growth regulators

It is sometimes desirable to retard or accelerate maturity in vegetable crops. A chemical compound may be applied to prevent sprouting in onion crops. It is applied in the field sufficiently early for absorption by the still-green foliage but late enough to avoid suppressing the bulb yield. Another substance may be used to end the dormancy, or rest period, of newly harvested potato tubers intended for planting. The treated seed potatoes have uniform sprout emergence. A chemical compound, may be applied when adverse weather conditions prevail during the period of fruit setting in other to encourage fruit set.

Harvesting

The stage of development of fruits and vegetables when harvested affects the quality of the product reaching the consumer. In some fruits and vegetables, optimum quality is reached well in advance of full maturity and then deteriorates. Factors determining the harvest date include:

- The genetic constitution of the variety
- The planting date
- Environmental conditions during the growing season.

Hand harvesting is employed along with various mechanical aids. Many fruits and vegetables grown for processing and some destined for the fresh market are mechanically harvested. Plant breeders have been able to produce fruits and vegetables with characteristics suitable for machine harvesting, including compact plant growth, uniform development, and concentrated maturity.

Storage

Fresh fruits and vegetables are living organisms, and there is a continuation of life processes in them after harvesting. Changes that occur in the harvested, non-processed fruits and vegetables include water loss, conversion of starches to sugars, conversion of sugars to starches, flavour changes, colour changes, toughening, vitamin gain or loss, sprouting, rooting, softening, and decay.

Some changes result in quality deterioration; others improve quality in those fruits and vegetables that complete ripening after harvest. Postharvest changes are influenced by such factors as kind of crop, air temperature and circulation, oxygen and carbon dioxide contents and relative humidity of the atmosphere, and disease-incident organisms. To maintain the fresh fruits and vegetable in the living state, it is usually necessary to slow the life processes, through avoiding death of the tissues, which produces gross deterioration and drastic differences in flavour, texture, and appearance.

Importance of storage of fruits and vegetables include:

- Contribution to price stabilization by carrying over produce from periods of high production to periods of low production.
- It also extends the period of consumption of many kinds of vegetables.
- Prevention of deterioration through control of temperature, relative humidity.
- Sustained quality of the produce

Vegetables for storage must be free from mechanical, insect, and disease injury and should be at the proper stage of maturity.

Common (unrefrigerated) storage and cold (refrigerated) storage are the methods generally employed for fruits and vegetables.

Grading

Uniformity in size, shape, colour, and ripeness is of great importance in marketing any fruit and vegetable product, and can be secured through grading. The establishment of standard grades provides a basis for trade. Grade standards are based mainly on general appearance, size, trueness to type, and freedom from blemishes and defects.

Packaging

Prepackaging, or consumer packaging, has become a highly organised practice, often employing elaborate equipment. The product is placed in bags made of transparent film; trays or cartons overwrapped with transparent film, or mesh or paper bags. The production region is often the most satisfactory location for prepackaging, especially when a packaging centre serves a large vegetable-growing area.

Master containers for consumer packages are commonly made of paperboard. Cartons, bags, baskets, boxes and crates of various kinds and sizes are all used in packaging of fruits and vegetables for marketing. The type of container is selected to fit the kind of fruit or

vegetable; it furnishes a convenient means for, loading, stacking and transport with safety and economy of space. Uniform product throughout the package is an important consideration in packing.

3.3.2 Handling of fruits and vegetables

We know eating fresh fruits and vegetables will help to keep us healthy. However, it is always important to clean fresh produce with safe water, peeling root crops and removing outer leaves of leafy vegetables to reduce soil residue. The following precautions are necessary when handling fruits and vegetables.

- Do not buy damaged or bruised fresh fruits and vegetables.
- Wash hands with soap and warm water for at least 20 seconds before and after handling fresh fruits and vegetables.
- Wash all surfaces and utensils, such as cutting boards, counter tops or knives, with hot water and soap before and after preparing fresh fruits and vegetables.
- Rinse all fresh fruits and vegetables under running tap water, including those with skins and rinds that you will not be eating.
- While rinsing under running tap water, rub or scrub firm-skinned fruits and vegetables with a clean vegetable brush.
- Never use detergent or bleach to wash fresh fruits or vegetable
- When shopping, separate fresh fruits and vegetables from household chemicals and raw foods, such as meat, poultry and seafood.
- Store fresh fruits and vegetables separately from raw meat, poultry or seafood in the refrigerator.
- Always wash kitchen utensils and cutting boards with hot soapy water between preparation of fresh fruits and vegetables and raw meats, poultry and seafood.
- Remove and throw away bruised or damaged portions of fruits and vegetables before cooking or eating raw.
- Throw away any fruit or vegetable that will not be cooked if it has touched raw meat, poultry or seafood.
- Refrigerate all cut, peeled or cooked fresh fruits and vegetables within two hours of preparation.
- Throw away fresh cut-up, peeled or cooked fruits and vegetables that have not been refrigerated within two hours.
- Discard fruits and vegetables that have been stored beyond their shelf life, or that are shriveled or slimy

3.3.3 Processing of fruits and vegetables

The main objectives of processing fruits and vegetables are to supply wholesome, safe, nutritious and acceptable food to consumers throughout the year. It is also aimed as to preserve the color, flavor, texture, and nutrition qualities while prolonging the shelf life of perishable fruits and vegetables.

Practically any fruit and vegetable can be processed, but some important **factors** which determine whether it is worthwhile are:

a. the demand for a particular fruit or vegetable in the processed form;
b. the quality of the raw material, i.e. whether it can withstand processing;
c. regular supplies of the raw material.

For example, a particular variety of fruit which may be excellent to eat fresh is not necessarily good for processing. Processing requires frequent handling, high temperature and pressure.

Many of the ordinary table varieties of tomatoes, for instance, are not suitable for making paste or other processed products. A particular mango or pineapple may be very tasty eaten fresh, but when it goes to the processing centre it may fail to stand up to the processing requirements due to variations in its quality, size, maturity, variety and so on.

Even when a variety can be processed, it is not suitable unless large and regular supplies are made available. An important processing centre or a factory cannot be planned just to rely on seasonal gluts; although it can take care of the gluts it will not run economically unless regular supplies are guaranteed.

To operate a fruit and vegetable processing centre efficiently it is of utmost importance to pre-organise growth, collection and transport of suitable raw material, either on the nucleus farm basis or using out growers.

Economic importance of processing fruits and vegetables in Nigeria

The fruit and vegetable processing activities have been set up, or have to be established in Nigeria for one or other of the following reasons:

- diversification of the economy, in order to reduce present dependence on one export commodity;
- government industrialization policy;
- reduction of imports and meeting export demands;
- stimulate agricultural production by obtaining marketable products;
- generate both rural and urban employment;

- reduce fruit and vegetable losses;
- improve farmers' nutrition by allowing them to consume their own processed fruit and vegetables during the off-season;
- generate new sources of income for farmers/artisans;
- develop new value-added products.

3.3.4 Packing of fruits and vegetables

Packing and packaging fresh fruits and vegetables is one of the more important steps in the long and complicated journey from grower to consumer. Bags, crates, hampers, baskets, cartons, bulk bins, and palletized containers are convenient containers for handling, transporting, and marketing fresh produce. Packing and packaging materials contribute a significant cost to the produce industry; therefore, it is important that packers, shippers, buyers, and consumers have a clear understanding of the wide range of packaging options available.

The Function of Packaging

A significant percentage of produce buyer and consumer complaints may be traced to container failure because of poor design or inappropriate selection and use. A properly designed produce container should:

- Contain. The container must enclose the produce in convenient units for handling and distribution.
- Protect. The package must protect the produce from mechanical damage and poor environmental conditions during handling and distribution.
- Identify the produce. The package must identify and provide useful information about the produce.
- Satisfying everyone from grower to consumer.

Types of Packaging Materials

1) **Pallets.** Pallets literally form the base on which freshest produce is delivered to the consumer.
2) **Pallet Bins.** Substantial wooden pallet bins of milled lumber or plywood are primarily used to move produce from the field or orchard to the packing house.
3) **Wire-Bound Crates.** Although alternatives are available, wooden wire-bound crates are used extensively for snap beans, sweet corn and several other commodities that require hydro-cooling
4) **Wooden Crates and Lugs.** Wooden crates, once extensively used for apples, stone fruit, and potatoes have been almost totally replaced by other types of containers.

5) **Wooden Baskets and Hampers.** Wire-reinforced wood veneer baskets and hampers of different sizes were once used for a wide variety of crops from strawberries to sweet potatoes.
6) **Corrugated Fiberboard** Corrugated fiberboard (often mistakenly called cardboard or pasteboard) is manufactured in many different styles and weights. Because of its relativity low cost and versatility, it is the dominant produce container material and will probably remain so in the near future. The strength and serviceability of corrugated fiberboard have been improving in recent years.
7) **Pulp Containers.** Containers made from recycled paper pulp and a starch binder is mainly used for small consumer packages of fresh produce.
8) **Paper and Mesh Bags.** Consumer packs of potatoes and onions are about the only produce items now packed in paper bags.
9) **Plastic Bags.** Plastic bags (polyethylene film) are the predominant material for fruit and vegetable consumer packaging due to its very low material costs.
10) **Shrink Wrap.** One of the newest trends in produce packaging is the shrink wrapping of individual produce items. Shrink wrapping with an engineered plastic wrap can reduce shrinkage, protect the produce from disease, reduce mechanical damage and provide a good surface for stick-on labels.
11) **Rigid Plastic Packages.** Packages with a top and bottom that are heat formed from one or two pieces of plastic are known as clamshells. Clamshells are gaining in popularity because they are inexpensive, versatile, provide excellent protection to the produce, and present a very pleasing consumer package.

3.3.5 Marketing of fruits and vegetables

Fruits and vegetables are produced seasonally, but of the production is during the wet season due to abundance of moisture. For many decades with particular reference to fruits, the problem of matching product availability with consumer demand could be solved in two ways:

- Selling fresh products during harvest and shortly thereafter
- Processing the rest to meet demand during the rest of the year

As technology improved and consumer incomes increased, it became possible to provide fresh produce year-round.

In Nigeria, crops grown for sale in local markets do not usually present marketing problems. The grower can arrange to take his produce to market either on foot or by lorry. But once the produce has reached the market, then the problems of marketing may be become complex. There are several channels through which products could be sold:

- Direct sale to consumer
- Selling to or through market agents (middle men)
- Cooperative society sales
- Selling on a contract basis

Direct sale to consumer

A grower can arrange for a member of the family to sell his produce direct to the public through open display. In some situations, shades are provided at a fee to house sellers and in event delayed sale or poor prices, these products could be kept in these shades for sale at a later date. Under this method of sale, producers are mindful not to over supply the market.

Advantages of dealing directly with the consumer

- Growers may be paid at time of delivery.
- Growers can bargain for price levels.
- Packing costs may decrease and special containers may not be necessary.
- Producers replace middlemen in the marketing process.

Disadvantages of dealing with directly with the consumer:

- Superior quality produce may be demanded.
- Producers need time and extra planning to develop client contracts and deliver produce.
- There is the possibility of high transportation costs per unit volume.

Selling to or through market agents (middle men)

Some producers may be unable for some reasons sell directly to consumers and may be obliged to sell to an intermediary such as an agent, a wholesale buyer or what we call the ‘middle men’.

Advantages of this method of sale include:

- Transportation to the final consumer is eliminated
- Final packaging and its cost is avoided
- Local or community taxes are avoided
- The producer has time to concentrate on production.
- Handling on the part of the producer stops here which is a big relieve with respect to storage and perishability associated with fruits and vegetables

Disadvantages of Selling to or through market agents (middle men)

- Low producer price
- Deliberate low grading of produce
- Delays in fixing of prices by the agents

- Few buyers leading to artificial glut
- Imposition of local taxes in community markets

Cooperative selling

Many of the producer's marketing problems are reduced if he belongs to a cooperative society formed for the purpose of retailing fruits and vegetables to the public. The society adopts some form of grading and markets the produce of the members. some societies may be responsible for the collection of produce from the point of producer, supplying of containers, handling and retailing of produce supplied by members. The society may undertake other services like procurement of inputs and loans for their members.

Advantages of fruit and vegetable cooperatives:

- Growers gain benefits of large volume marketing.
- Often a sales specialist is available.
- Growers gain benefits of increased bargaining strength.
- Producers may reduce level of market risk.

Disadvantages of fruit and vegetable cooperatives:

- Producers lose some independence by selling through a cooperative.
- Members may only sell through the cooperative when prices are high, and then use other marketing channels which hurt cooperatives' reputation.
- More experienced, better producers might subsidize inexperienced producers and, therefore, not reach their profit potentials.
- It does not create opportunities for learning for the members. Only the few members assigned to marketing are experts

Selling on contract basis

This is another form of marketing of fruits and vegetables. Under this method the producer is empowered financially or with production inputs to grow specified fruits and vegetables. The producer has the advantage of land and family labour to produce but he is obliged to sell only to the financier. The basic principle of the system is the agreement between the producer and the buyer. The buyer must buy and the seller must sell at the guaranteed price for state quantities of the produce. A firm agreement is then reached on the price to be paid during the period of the contract, which is usually a season. The grower then agrees to supply the buyer with the stated quantities of the commodity at definite intervals, graded to a standard quality. He is in turn guaranteed payment at the agreed rate.

Advantages of contract growing

- Price is assured irrespective of changes
- Resources to produce are guaranteed.
- Steady flow of income to the producer
- Productivity and expertise are enhanced
- Family labour are adequately utilised in other to meet target.

Disadvantages of contract growing

- Most at times the producer is at the losing end due to low prices offered at contract time
- Loss of marketing knowledge on the part of producer
- During periods of weather adversity, the producer is the looser
- Failure of the producer to deliver on time and in the right quantity and quality
- Likely litigation may ensue.

3.3.6 Utilisation of fruits and vegetables

Fruits and vegetables have been in the human diet over the entirety of human history. We eat them raw, cooked, chilled, frozen, and in ever creative combinations with other fruits and vegetables. Fruits and vegetables contain important vitamins, minerals, fibre and plant chemicals. A diet high in fruit and vegetables can help protect you against cancer, diabetes and heart disease.

As fruits & vegetables are perishable, their wastes get rotten quickly. So, waste disposal is a serious problem as it causes flies & rats around. Therefore, waste needs to be utilized properly and efficiently. Reducing waste and using it for by-products a have a good impact on climate. By-products from food industries are rich in nutrients so have many health benefits. By-product utilization gives another source of income to industries, so it helps to increase economic productivity.

SELF-ASSESMENT EXERCISE

In an attempt to guarantee producer prices of fruits and vegetables, farmers sometimes sell their harvests through their cooperative societies. With the current situation of daily inflation and increasing market prices, do you consider selling produce through cooperative societies as a wise economic decision?

4.0 CONCLUSION

Quality production of fruits and vegetables greatly depends on the horticultural production systems, environmental factors and management practices used. Climatic conditions such as temperature

and light intensity have strong influence on the nutritional quality of our fruits and vegetables as it was reported that, soil type, rootstock used for fruit trees, mulching, irrigation, fertilization, and other cultural practices influence composition and quality attributes of the harvested plant parts. Proper and professional post-harvest operations including marketing will ensure a wholesome package of fruits and vegetables on our tables.

5.0 SUMMARY

Profitable fruits and vegetable farming requires attention to all production operations, including insect, disease, and weed control and efficient marketing. The kind of fruits and vegetables grown is mainly determined by consumer demands, which can be defined in terms of variety, size, tenderness, flavour, freshness, and type of pack. Ability to synchronise production with seasonal demand is essential in our understanding of the production of fruits and vegetables

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1) List the productions systems in fruits and vegetables and explain one.
2) Mention the practices required for a crop growing in the field with respect to fruits and vegetables.
3) Explain in detail the economic importance of processing fruits and vegetables.
4) Explain the principle involved in the marketing of fruits and vegetables through selling on contract.

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MODULE 3

Unit 1 Horticultural Machines and Equipment
Unit 2 Methods of Plant Propagation, Nursery Systems, Diseases and Pests of Fruits and Vegetables

UNIT 1 HORTICULTURAL MACHINES AND EQUIPMENT

CONTENTS

1.0 INTRODUCTION

The cultivation of horticultural crops is predominantly dependent upon human labour, since commercial cultivation is only on a limited scale. Farm tools and equipment help to make farm work easier and effective. There are very many of them designed to do one or several functions. Animal/power tiller or tractor-drawn mouldboard ploughs, disc ploughs, harrows, cultivators and motivators are available and used for land preparation. There are numerous hand tools and simple equipment designed to hasten farm operations.

2.0 OBJECTIVES

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

- identify simple horticultural machines and equipment
- explain how to care and maintain horticultural machines and equipment.

3.0 MAIN CONTEXT

Horticultural machines, tools and equipment used in tropical countries vary in size, shape and method of use. Farm sizes vary and types of crops grown also vary. It is not possible for all farms to have all types of

tools, machines, and equipment, though there are basic ones that cut across most farms. It is important to state that farm shades and houses are considered as essential items in the horticultural and gardening enterprises.

3.1 Some essential machines and equipment

The list presented below is unexhausted as farmers continue to add one or more tools and equipment as the farm expands.

1) Gloves

While gardening can be a wonderful hobby, it can quickly turn into a thorny and splintery hassle without the right pair of gloves. Gloves are used to protect your hand

2) Secateurs

Hand pruners, Pruning Shears, also called Secateurs, help in training plants that are getting out of control and taking over the immediate environment.

3) Loppers

Loppers are long-handled pruners used to trim hard-to-reach areas and cut thicker branches.

4) Garden Fork

An efficient tool for turning soil, garden forks can dig into dense soil better than a spade.

5) Hand trowel

Trowels are wonderful for transplanting bedding plants and herbs, planting containers, and taking out weeds.

6) Spade

They make easy work of digging holes for plants, edging, lifting sod, and moving small mounds of dirt from one area to another

7) Rake

When leaves and debris fall, you use rake to pack them away

8) Hoe

Your type of garden will dictate what type of hoe is best for you. A vegetable garden may require a sturdy, wide hoe. If you have perennial gardens that require a delicate touch, then a thinner hoe may be required. Hoes are useful in preparing garden and flower beds and cutting down weeds.

9) Cutlass

Every garden or farm should have this tool for weeding, slashing herbs etc

10) Garden hose with adjustable nozzle

Water is the foundation of your garden's life and it's important that your garden hose can reach and spray every area. There are three basic hose diameters. Use the one that best suits your farm size. An adjustable nozzle puts you in control of the water pressure and spray radius.

11) Watering can

There are 2 basic types of watering cans, plastic or metal. There are hundreds of styles, colours, sizes and nozzle options.

12) Wheelbarrow

If your backyard has extra soil to be moved around, compost or mulch that needs to be added to garden beds, or any other heavy lifting and moving project, a wheelbarrow can help you haul hundreds of kilograms

13) Boots

Mainly light rubber boots to protect your legs.

14) Axe

Necessary for cutting down hardwoods that cutlasses cannot cut.

15) Lawnmower-

To trim grasses around the office building

16) Saw

Saw is used for pruning large and small branches.

17) Dibber

Dibber is used to make a hole in soil to sow the seed.

18) Sickle

Sickle is used for harvesting large crops.

19) Spray bottle

When you are growing plants in pots, use a 5-liter spray bottle for spraying pesticides and fertilizers.

20) Auger

An auger is a hand tool, drilling device, or drill bit, that is visibly similar to a large screw, which is used for making holes in the ground for planting.

21) Broadcast sprayer

Most home gardeners will not need a sprayer that is quite this heavy-duty. A broadcast sprayer is used for spraying insecticides and pesticides, and is made of industrial-grade materials to cover a lot of ground very quickly.

22) Hand cultivator

A hand cultivator is a gardening tool that is used to turn and till the soil where you plan on planting and removing all weeds. In small flower or vegetable gardens, it can also be used as a mini-plow to help dig the planting rows.

23) Kneeler

A garden kneeler is a device that prevents sore knees caused by kneeling on the ground and back pain caused by stooping and bending from performing gardening tasks. Garden kneelers allow gardeners to kneel with a cushioned comfort and support, keeping clothes clean and protected from dirt and grass stains.

24) Rotary tiller

A rotary tiller is a gardening tool with a set of curved tines that are attached to a rotating shaft which is powered by a tractor’s PTO to dig

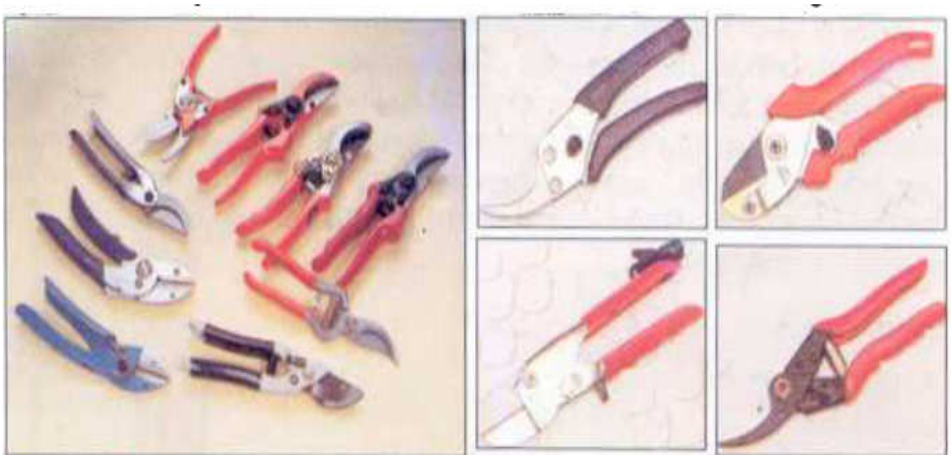
into garden soil, churning it into a fine, clod-free seedbed. Rotary tillers are typically used in the rainy season before planting to help prepare your garden beds for the season.

25) Knapsack sprayer

Knapsack sprayers are necessary to spray large area of farmland and for the application of insecticides. They come with different nozzle types and sizes. Choose the right nozzle that best suits the task.

26) Water pump

Water pumps are used to transfer water mechanically from the source to the point of need. They come in sizes with appropriate hoses. Water pumps are indispensable during the dry season and at intervals of reduced rainfall.



Pruning secateurs also known as pruning shear

The hedge shear

Horticultural tools

Wheelbarrow

Garden Trowel

Fork Hoe

Garden Knife

Garden Secateurs

Golden Gark

The Golden Gark is a multipurpose garden maintenance tool, it is a rake, shovel and soil sift in one. This lightweight tool is ideal for clearing up weeds or fallen leaves etc

Sickle
Used for harvesting large crops

Dibber
Dibbers are useful for making planting holes for seeds, bulbs, and seedlings.

3.2 Farm Special structures

Two special structures are important here.

- Nursery house or shade
- Tool and equipment store

Plant house or nursery shade
Young seedlings usually require protection from excessive sun and rainfall. A plant house will be needed if large quantities of seedlings are being raised. The materials required for the construction of this type of house may be expensive if you use angle steel and aluminum roofing sheets, then covered with plastic transparent material. This may be too costly for our small-scale farmers. Alternatively, a building made of locally sourced materials will be adequate. In these structures, you can construct two side tables to support your seedboxes. The local materials should overlap the sides of the building in other to protect your seedlings from excessive sun.

Tool and equipment store
Machinery, equipment and tools should be kept clean whenever they are not in use and kept in a waterproof building. The size of your building depends on the type and number of items available. Even your tractor should not be kept in the open. Your equipment house should have these apartments.

1) Half-open compartment to house tractors, movers and implements
2) Sealed compartment to house tools, light equipment
3) Agro-chemical compartment to store pesticides and fertilisers

3.3 Maintenance and care of horticultural machines and equipment

It is so important to do proper maintenance on farm machinery. Farm machinery is hardly cheap and the breakdowns are often just as expensive to repair. Untimely breakdowns can also affect your productivity and income when you are not able to bring in that harvest on time.

Safety is a huge issue with machinery that isn't properly maintained and can result in property damage and operator injuries. Properly maintained machinery has a much lower chance of breaking down when you need it the most and these machines pose much less risk to those working with them and your resell value is a lot higher when you take great care of your machinery.

So why do so many farmers neglect the maintenance of their machinery when they always end up paying for negligence? Well, the answer is simple. Most people just don't know how to properly care for these big, bulky and expensive machines.

Here are a few tips to ensure that your farm machinery is always maintained properly.

Get the Right Operator Training
Most farms have quite a few operators using the same machinery. It is important to get all operators up to date on maintenance and operation requirements as well as the manager or supervisor. If everyone knows how to effectively man, the farm machinery then the chances of missing out on maintenance are much lower. Employees or operators will also know how to properly handle and maintain their machinery.

Another good tip is to keep manuals close by so operators can brush up on their understanding of the machine whenever needed. If manuals are particularly challenging, then the maintenance sections should be rewritten in easy-to-understand terms.

Remember to Lubricate Your Machinery
Lubricants should be used on all moving parts of farm machinery. Lubricants reduce friction and enhance the life expectancy of machinery and parts. It is important to use a good quality lubricant and to always clear up dirt and messes found on the machine before adding new lubricant. Buildups and dirt should be cleared out so your machine parts can run smoothly at all times.

Know the Signs of Wear and Damage
If you know your machine well enough then you should be able to tell the moment something goes wrong. Vibration, shock, overheating, friction, and strange noises are all signs of wear or damage. It is important to keep an eye or ear out for these signs so you can get your farm machinery serviced before a major breakdown happens.

Keep Machinery Clean
It is tough to spot signs of breakdowns and wear and tear when your farm machinery is too dirty. Keep your machinery clean so you can spot danger signs such as oil leaks and grease build-ups easily. It is also important to do proper cleaning maintenance such as filter cleaning, buildup removal, vacuuming, and dusting inside farm machinery so your machinery will look great for a long time to come.

Keep a Schedule
Farm life can be quite busy and it can be easy to forget when a machine is due for service or repairs. Create a schedule of the time your farm machinery should be maintained and keep a track record of previous repairs and maintenance that have been done on the equipment.
It is also important to keep track of the operators that man and maintain farm machinery so you will know exactly who is slacking off in their job or who is damaging your machinery by working the farm equipment too hard.

With proper maintenance, your farm machinery will stay in great shape for a long time to come and your farm machinery will be much more reliable.

Care of tools
Garden tools will last longer if the following simple rules are observed:
1) Use each tool only for the purpose for which it was designed.
2) Handle the tools with care and do not throw them down anyhow and anywhere
3) Always clean tools after use.
4) Do not use water to clean cutlasses and hoes in other to avoid rust
5) Store tools in a safe and dry place

Care of machines and equipment
1) Read manufacturers' manuals that accompany the machine and equipment
2) If you doubt your ability to assembly or install, call an accredited technician
3) Use the right equipment for the purpose-designed for use
4) After use, clean the parts that were used for the job eg the blades, disc, nozzles, etc.

5) Apply grease to moveable portions in other to reduce tear and wear
6) Draw a maintenance roaster based on hours of use for each machine and equipment
7) Dismember parts from your machine when it is not in use
8) Keep all machines under the shade
9) Keep all equipment in the store at the appropriate places/shelves
10) Be consistent in the order of placement of your machines and the accompanying parts
11) Keep enough spares of items that are likely to be frequently replaced

SELF-ASSESSMENT EXERCISE

Study these two farm working materials; a secateurs and a knapsack sprayer. Is secateurs a tool or a machine? Is a knapsack sprayer a tool or a machine? Give reasons

4.0 CONCLUSION

It is not possible to have a successful horticultural garden without a few tools. These machines, equipment and tools will greatly reduce drudgery and add funfair to your garden operations. You shouldn't overpopulate your farm with machines, equipment and tools. Buy items that are extremely necessary as they add to the cost of production.

5.0 SUMMARY

In many parts of Nigeria, the production of fruits and vegetables is expanding fast due to increased awareness on the benefits of these crops and increased urbanization. In other to meet the demands of these consumers, there is the need to increase the area cropped to these fruits and vegetables. This cannot take place successfully without the deployment of appropriate machines, equipment, and tools. These machines and tools come in various sizes and shapes. They range from simple tools like hoes and cutlasses to sophisticated machines like drillers and pumps. Your choice is driven by the type of jobs available and your scale of operation.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1) Name ten horticultural tools and equipment and their functions.
2) Mention the apartments that your tool and equipment house should have.
3) Enumerate how to care for your farm tools.

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UNIT 2 METHODS OF PLANT PROPAGATION, NURSERY SYSTEMS, DISEASES AND PESTS OF FRUITS AND VEGETABLES

CONTENTS

1.0 INTRODUCTION

The success of fruit orchards and vegetable farms depends on reliable planting material. Diseased and genetically inferior plants have catastrophic effects on the productivity of fruit industry. All plants multiply themselves by sexual propagation (seed) or by asexual propagation (vegetative) methods. However, researchers/propagators have developed some other techniques for the rapid and better multiplication of plants. To increase the life span of fruit trees, production of good quality fruits, and to establish a successful nursery business, a nursery must be established on scientific lines. The selection of nursery site, nursery structures, media and their sterilization, mother stock, and rootstocks are major factors that should be considered carefully in other to produce good quality nursery plants.

2.0 OBJECTIVES

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

- explain asexual and sexual propagation in plants
- explain the principles in nursery operations and their management
- identify the common pests and diseases of fruits and vegetables and their control.

3.0 MAIN CONTEXT

Various plant species occupy a wide variety of habitats. To be able to adapt to the environment, they have to device method to perpetuate in the particular environment by producing their offsprings to survive. This can happen by different reproduction methods viz. by sexual reproduction which is most important method for many plants and asexual reproduction method when reproduction by seed is limited. A vegetative reproduction is the process of multiplication in which a portion of fragment of the plant body functions as propagules and develops into a new individual plant which involves the production of new plants without the act of fertilization or sexual union. Further can be said that, vegetative propagation of the plant is a form of plant propagation in which the new individual plant arises from any vegetative part of the parents (root, stem, leaf and other organs), and possesses the same characteristics of their parent plant from which it was obtained.

3.1 Vegetative propagation (asexual propagation)

In higher plants, any part of the body may be capable of vegetative propagation. Many plants produce modified stems, roots, and leaves, especially for natural vegetative propagation. In the other words, asexual means of reproduction produce new individuals without the fusion of gametes, genetically identical to the parent plants and each other, except when sudden change, 'mutation', occurs. Man has developed artificial vegetative propagation for many useful plants which are widely used in the horticultural industry. The main asexual methods of propagation include:

A. CUTTINGS

Many types of plants, both woody and herbaceous, are frequently propagated by cuttings. A cutting is a vegetative plant part that is severed from the parent plant to regenerate itself, thereby forming a whole new plant. Below are the various types of cuttings.

Stem Cuttings

Numerous plant species are propagated by stem cuttings. Some can be taken at any time of the year, but stem cuttings of many woody plants must be taken in the rainy season.

Leaf Cuttings

Leaf cuttings are used almost exclusively for a few indoor plants. The leaves of most plants will either produce a few roots but no plant or just decay.

Root Cuttings

Root cuttings are usually taken from 2 to 3-year-old plants during the wet season when they have a large carbohydrate supply. Root cuttings of some species produce new shoots, which then form their root systems, while root cuttings of other plants develop root systems before producing new shoots.

Layering

Stems still attached to their parent plants may form roots where they touch a rooting medium. Severed from the parent plant, the rooted stem becomes a new plant. This method of vegetative propagation, called layering, promotes a high success rate because it prevents the water stress and carbohydrate shortage those plague cuttings.

Some plants layer themselves naturally, but sometimes plant propagators assist the process. Layering is enhanced by wounding one side of the stem or by bending it very sharply. The rooting medium should always provide aeration and a constant supply of moisture.

B. GRAFTING

Grafting and budding are methods of asexual plant propagation that join plant parts so they will grow as one plant. These techniques are used to propagate cultivars that will not root well as cuttings or whose own root systems are inadequate. One or more new cultivars can be added to existing fruit and nut trees by grafting or budding.

The portion of the cultivar that is to be propagated is called the scion. It consists of a piece of the shoot with dormant buds that will produce the stem and branches. The rootstock, or stock, provides the new plant's root system and sometimes the lower part of the stem. The cambium is a layer of cells located between the wood and bark of a stem from which new bark and wood cells originate.

Four conditions must be met for grafting to be successful:

1. The scion and rootstock must be compatible
2. Each must be at the proper physiological stage
3. The cambial layers of the scion and stock must meet
4. The graft union must be kept moist until the wound has healed.

TYPES OF GRAFTING

Cleft grafting

Cleft grafting is often used to change the cultivar or top growth of a shoot or a young tree (usually a seedling). It is especially successful if done early into the wet season. Collect scion wood 3/8 to 5/8 inch in diameter. Cut the limb or small tree trunk to be reworked, perpendicular

to its length. Make a 2-inch vertical cut through the center of the previous cut. Be careful not to tear the bark. Keep this cut wedged apart. Cut the lower end of each scion piece into a wedge. Prepare two scion pieces 3 to 4 inches long. Insert the scions at the outer edges of the cut in the stock. Tilt the top of the scion slightly outward and the bottom slightly inward to be sure the cambial layers of the scion and stock touch. Remove the wedge propping the slit open and cover all cut surfaces with grafting wax.

Bark grafting

Unlike most grafting methods, bark grafting can be used on large limbs, although these are often infected before the wound can completely heal. Collect scion wood 3/8 to 1/2 inch in diameter when the plant is dormant, and store the wood wrapped in moist paper in a plastic bag in the refrigerator. Saw off the limb or trunk of the rootstock at a right angle to itself. In the spring, when the bark is easy to separate from the wood, make a 12-inch diagonal cut on one side of the scion, and a 1½-inch diagonal cut on the other side. Leave two buds above the longer cut. Cut through the bark of the stock, a little wider than the scion. Remove the top third of the bark from this cut. Insert the scion with the longer cut against the wood. Nail the graft in place with flat-headed wire nails. Cover all wounds with grafting wax.

Whip or tongue grafting

This method is often used for material 1/4 to ½ inch in diameter. The scion and rootstock are usually of the same diameter, but the scion may be narrower than the stock. This strong graft heals quickly and provides excellent cambial contact. Make one 2½-inch long sloping cut at the top of the rootstock and a matching cut on the bottom of the scion. On the cut surface, slice downward into the stock and up into the scion so the pieces will interlock. Fit the pieces together, then tie and wax the union.

Care of the Graft

Very little success in grafting will be obtained unless proper care is maintained for the following year or two. If a binding material such as a strong cord or nursery tape is used on the graft, this must be cut shortly after growth starts to prevent girdling. Rubber budding strips have some advantages over other materials. They expand with growth and usually do not need to be cut, as they deteriorate and break after a short time. It is also an excellent idea to inspect the grafts after 2 or 3 weeks to see if the wax has cracked, and if necessary, rewax the exposed areas. After this, the union will probably be strong enough and no more waxing will be necessary.

Limbs of the old variety which are not selected for grafting should be cut back at the time of grafting. The total leaf surface of the old variety

should be gradually reduced as the new one increases until at the end of 1 or 2 years, the new variety has completely taken over. Completely removing all the limbs of the old variety at the time of grafting increases the shock to the tree and causes excessive suckering. Also, the scions may grow too fast, making them susceptible to wind damage.

C. BUDDING

Budding, or bud grafting, is the union of one bud and a small piece of bark from the scion with a rootstock. It is especially useful when scion material is limited. It is also faster and forms a stronger union than grafting.

TYPES OF BUDDING

Patch budding

Plants with thick bark should be patch budded. This is done while the plants are actively growing, so their bark slips easily. Remove a rectangular piece of bark from the rootstock. Cover this wound with a bud and matching piece of bark from the scion. If the rootstock's bark is thicker than that of the scion, pare it down to meet the thinner bark so that when the union is wrapped the patch will be held firmly in place.

Chip budding

This budding method can be used when the bark is not slipping. Slice downward into the rootstock at a 45-degree angle through 1/4 of the wood. Make a second cut upward from the first cut, about one inch. Remove a bud and attending chip of bark and wood from the scion shaped so that it fits the rootstock wound. Fit the bud chip to the stock and wrap the union.

T-budding

This is the most commonly used budding technique. When the bark is slipping, make a vertical cut (same axis as the rootstock) through the bark of the rootstock, avoiding any buds on the stock. Make a horizontal cut at the top of the vertical cut (in a T shape) and loosen the bark by twisting the knife at the intersection. Remove a shield-shaped piece of the scion, including a bud, bark, and a thin section of wood. Push the shield under the loosened stock bark. Wrap the union, leaving the bud exposed.

Care of Buds

Place the bud in the stock during the rainy season. Force the bud to develop, then cut the stock off 5 to 6 cm above the bud. The new shoot may be tied to the resulting stub to prevent damage from the wind. After the shoot has made a strong union with the stock, cut the stub off close to the budded area.

OTHER TYPES OF ASEXUAL REPRODUCTION

- **Division**

The division is another type of asexual reproduction that stands on its own. Here, plants with more than one rooted crown may be divided and the crowns planted separately. If the stems are not joined, gently pull the plants apart. If the crowns are united by horizontal stems, cut the stems and roots with a sharp knife to minimize injury. Divisions of some outdoor plants should be dusted with a fungicide before they are replanted. Examples: dahlias, iris, rhubarb, daylilies.

- **Separation**

Separation is a term applied to a form of propagation by which plants that produce bulbs or corms multiply. For example

- **Bulbs**

New bulbs form beside the originally planted bulb. Separate these bulb clumps every 3 to 5 years for the largest blooms and to increase bulb population

- **Corms**

Large new corm forms on top of the old corm, and tiny cormels form around the large corm. After the leaves wither, dig up the corms and allow them to dry in indirect light for 2 or 3 weeks. Remove the cormels, and then gently separate the new corm from the old corm. Dust all-new corms with a fungicide and store them in a cool place until planting time.

Advantages of Asexual propagation

1. The horticultural crops which do not produce viable seeds are propagated by the vegetative method.
2. Most of the important fruit crops are cross-pollinated and are highly heterozygous. When propagated through seeds, the progenies show large variation, so vegetative propagation is a remedy for these crops.
3. The asexual propagation method gives true to type plants.
4. The vegetative way propagated plants bear fruits early.
5. In the case of fruit crops where rootstocks are used, the rootstocks impart insect or disease resistance to the plant.
6. Vegetative propagation helps to alter the size of the plant. i.e. dwarfing effect. This helps for spraying, intercropping & harvesting of crops easy and economical.
7. By grafting method different variety of fruit crop can be grown & harvested.
8. Inferior quality fruit plants can be converted into good quality plants.
9. Utilizing bridge grafting a repairing of injured plants can be done.

Disadvantages of the vegetative propagation

1. By vegetative propagation new variety cannot be developed.

2. It is an expensive method of propagation and required specialized skills.
3. The life span of vegetative propagated plants is short as compared to sexually propagated plants.
4. As all the plants are homozygous the whole plantation may get attacked by a particular pest or disease.
5. Viral diseases could be transferred through vegetative parts.

3.2 Sexual propagation

The Sexual reproduction method produces offspring by the fusion of gametes, resulting in offspring genetically different from the parent plants due to genetic exchange that occurred during fertilization which came from both parents. The outcome of this fusion is the **seed.**

- A **seed** is an embryonic plant enclosed in a protective outer covering. The formation of the seed is part of the process of reproduction in seed plants, the spermatophytes, including the gymnosperm and angiosperm plants.
- Seeds are the product of the ripened ovule, after fertilization by pollen and some growth within the mother plant. The embryo develops from the zygote, and the seed coat from the integuments of the ovule.
- Seeds have been an important development in the reproduction and success of gymnosperm and angiosperm plants, relative to more primitive plants such as ferns, mosses and liverworts, which do not have seeds and use water-dependent means to propagate themselves. Seed plants now dominate biological niches on land, from forests to grasslands both in hot and cold climates.
- The term "seed" also has a general meaning that antedates the above – anything that can be sown, e.g. "seed" potatoes, "seeds" of corn or sunflower "seeds". In the case of sunflower and corn "seeds", what is sown is the seed enclosed in a shell or husk, whereas the potato is a tuber.
- In the angiosperms (flowering plants), the ovary ripens to a fruit which contains the seed and serves to disseminate it. Many structures commonly referred to as "seeds" are dry fruits. Sunflower seeds are sometimes sold commercially while still enclosed within the hard wall of the fruit, which must be split open to reach the seed. Different groups of plants have other modifications, the so-called stone fruits (such as the peach) have a hardened fruit layer (the endocarp) fused to and surrounding the actual seed. Nuts are the one-seeded, hard-shelled fruit of some plants with an indehiscent seed, such as an acorn or hazelnut.

Seed collection

Seeds may be collected from the field or bought from a market. Selection and collection of good seeds before sowing are directly related to the success of nursery business Therefore, the following points should be considered during the selection and collection of seeds:

- Select healthy and vigorous plants with desirable characters, i.e. plant shape, size, and fruit yield and quality etc.
- It is preferred to collect seeds from several plants in a particular area.
- Select mature, ripe, uniform and healthy fruits for seed extraction
- Seeds should be extracted safely using proper method.
- Make the seeds free from pulp/juice by washing or cleaning.
- Select undamaged, healthy and viable seeds
- Label the seeds when collected or describe the plant for later identification.

Advantages of Sexual Propagation

1) This is very simple and easy method of propagation.
2) Some species of trees, ornamental annuals and vegetables which cannot be propagated by asexual means should be propagated by this method. E.g. Papaya, Marigold, Tomato etc.
3) Hybrid seeds can be developed by this method.
4) New variety of crops are developed only by sexual method of propagation.
5) Root stocks for budding and grafting can be raised by this method.
6) The plants propagated by this method are long lived and are resistant to water stress.
7) Transmission of viruses can be prevented by sexual method.
8) Seed can be transported and stored for longer time for propagation.

Disadvantages of sexual propagation

1) Characteristics of seedling propagated by this method are not genetically true to type to that of their mother plant.
2) Plants propagated by sexual method requires long period for fruiting.
3) Plants grow very high, so they are difficult for intercultural practices like spraying, harvesting etc.
4) The plants which have no seeds cannot be propagated by this method. E.g. Banana, fig, Rose etc.

3.3 Nursery systems and management

A nursery is a place, where different type of plants are propagated and grown to usable sizes. A comprehensive definition of nursery is “the place, where seedlings, saplings, trees, shrubs and other plant materials

are grown and maintained until they are shifted to a permanent place" Nursery plants need to be protected from extremes of environmental conditions until they are strong enough to withstand them.

The following operations are essential for a successful nursery for vegetables and fruits

Modern Nursery Structures

Young plants and newly emerged seedlings need special care for nutrition, protection against adverse weather, insect-pests and diseases. Therefore, a nursery should have advanced structures to facilitate seeds to germinate, initiate roots and to protect the seedlings against adverse climate and diseases.

The canvas of horticulture and plantation in middle-income and advanced nations is broad based and multifaceted with fruits, vegetables, potato, tubers, ornamentals, medicinal and aromatic plants, spices, plantation crops and mushroom. It is envisaged and even now to an extent temperate fruits, vegetables, flowers and spices are grown in the Jos/ Manbila regions while subtropical and tropical fruits, vegetables, ornamentals, mushroom, spices could be cultivated in the rest of Nigeria.

Modern horticulture has enormous advantages of readily:

- Improving the economic conditions of the farmers and entrepreneurs
- Creating diversification opportunities with high value crops
- Increasing the productivity of land
- Providing nutritional security
- Generating employment
- Ensuring ecological sustainability
- Enhancing the export earnings.

Analysts are of the view that the emergence of Agri-Business ventures in Nigeria, is directly correlated to the progress in the plantation and horticulture sector. Cultivation of traditional fruit crops comprising tropical and sub-tropical fruits like mango, banana, pineapple, grape, citrus and which has the potential to provide sustainable livelihood to the small land holders both under irrigated as well as rainfed conditions. However, timely availability quality planting material for perennial horticulture crops and absence of standardisation and certification are the major issues in the promotion of modern horticultural practice. area expansion under these crops across the States. While several state governments have established nursery production facilities under respective line departments, the demand far exceeds the production from the government nursery units. Thus there exists good scope for

establishing commercial nursery production unit to meet. Because good quality planting material fetch a premium price, investment in a commercial nursery unit is considered to be a viable and profitable proposition.

Apart from perennial horticulture crops, there is an increasing demand for nursery plants for ornamental flowers and foliage plants. Exclusive production of vegetable seedling and supplying the same to farmers is also emerging as a profitable horticulture enterprise in major vegetable growing belts across the States. The model scheme envisages production of quality planting material of major perennial horticulture crops viz., mango, guava, citrus, pear, cashew, etc, adopting improved propagation techniques, in special growing structures adhering to quality standards.

A modern nursery can have the following structures

Establishment and Care of Mother plant

Stocks Success of a nursery depends on genetical purity of mother plants. It is because the mother plants are main source of buds for budding and grafting. Therefore, a separate block is allotted for planting of desired varieties. Mother plants are selected based on good characteristics and are planted at recommended distances. Management practices such as control of pests, diseases, weeds, balanced nutrition and irrigation are performed regularly for good and healthy vegetative growth.

Establishment and Care of Rootstocks

In modern fruit culture, due to established effects of rootstocks on scion cultivars, rootstocks have now become the integral part of fruit industry. Rootstock cannot be changed during the life time of a plant; therefore, it is very important to give due attention at the time of its selection.

Rootstock influences the following growth characters

- Production,
- Vigour
- Fruit characters (fruit weight, rind/peel thickness, seed number etc.),
- Precocity in bearing
- Fruit maturity
- Fruit quality
- Resistance against diseases, insects

Proper irrigation, nutrition, weed management, insects and diseases control practices are performed regularly and properly to raise healthy rootstocks

Nursery containers

The following containers are commonly used for growing and propagating plants in nursery.

Flats
These are shallow earthen, reed, Polyvinyl chloride (PVC), Reinforced Cement Concrete (RCC) metal or plastic trays, having drainage holes at bottom. Size can vary according to the purpose or type of nursery plants.

Clay pots
Different sizes and shapes are available in the market. Round types occupy more area in nursery and are avoided. These are porous in nature and permit aeration and water movement.

Polythene bags
These are now widely used mainly because they are comparatively cheaper, light in weight and easily available. They are available in different sizes and thickness, and in white or black colour. Polythene bags of usually 10 × 6 cm size are used for raising vegetable seedlings.

Other materials used in nurseries apart from these containers for raising seedlings are peat pots, fiber pots, fiber blocks, root trainers etc.

Irrigation Practices in Nurseries
Nursery plants are very sensitive to salts; therefore, it is very important that before making decision to establish a fruit plants nursery, the quality of irrigation water should be examined. All types of irrigation water contain different soluble salts such as calcium, sodium, magnesium and others. Excess amount of any component in water can degrade the quality of water and develop toxicity. The analysis of irrigation water especially the underground one should be properly analyzed to ascertain its purity. Optimum irrigation is required to maintain the adequate soil moisture for both field and container grown nurseries. Irrigation of nursery plants depends on the weather but over irrigation and drought are harmful for plants.

Organic Manures
Bulk organic manures have been major traditional means of sustaining plant nutrients in soils throughout history and equally as important as today. Below are the types of organic manures that are available in nurseries.

Green manure
It refers to incorporation of green twigs and leaves collected from shrubs and trees grown on ridges, wasteland and forests. e.g. Neem, Glyricidia, moringa. On dry weight basis, the nitrogen content of green leaf manure crop various from above 1.5-2.5%.

Livestock waste
It includes cattle and other animal dung and urine, by product of slotter house and animal carcass such as blood, meat, bones, horns, hooves, leather and hair waste.

Inorganic fertilizers
This becomes necessary when organic manures and bio-fertilizers are incapable to fulfill the entire nutrients requirement of individual plant. Cultivars need additional quantities of nutrients due to their high yield potential. It is very necessary to provide them other nutrient to fulfill the entire nutrient requirement of the plants. Inorganic fertilizers play a vital role in satisfying the nutrient requirement of these plants. It has been adequately established that the efficiency of inorganic fertilizer can be greatly increased through its integration with organic manure. Increasing efficiency of applied fertilizer through its integration with organic manure therefore appears to be an ideal way for sustained crop production.

Sterilization of soils
Many nursery growers sterilize soils and other mixes before use. Sterilization is a costly and labour intensive technique. Sterilization controls

- Nematodes
- Soil-borne pathogens ie bacteria, fungi algae
- Kills weeds seeds

Various liquid, granular and gaseous compounds are being used for soil sterilization.

Sterilization depends on various factors like

- Soil temperature
- Soil moisture,
- Soil cover
- Plant residues (crop debris, weeds etc.) present

Most of the nursery problems are associated with contaminated media used for plant propagation. Pathogenic and weed problems can successfully be minimized by regular use of clean and sterilized media

3.4 Diseases and pests of fruits and vegetables and their control

Many insect-pests and diseases attack nursery seedlings; therefore, protection from insects-pest and diseases is very important.

Practices are used to decrease the risk of pests and disease attack.

- Produce healthy and strong seedlings.

- Grow varieties/cultivars, resistant to specific diseases and pests.
- Follow crop rotation to prevent soil-borne diseases. This is also helpful in maintaining soil fertility.
- Remove crop debris and weeds as these act as hosts for pests and diseases.
- Monitor the crops regularly so that problems are detected earlier.
- Hand destruction of pests especially larvae and egg masses is also beneficial.
- Use recommended pesticides to treat and control the spread of pests and diseases.

SELF-ASSESSMENT EXERCISE

In a situation of good scion/root stock compatibility, you can either bud or graft your desired material. What advantages does grafting has over budding.

4.0 CONCLUSION

All plants multiply themselves by sexual propagation (seed) or by asexual propagation (vegetative) methods. In fruits and vegetable production any of the methods can be used. The result of the propagation is the young plant from seed after germination or from the vegetatively propagated plant. Nursery plants need to be protected from extremes of environmental conditions until they are strong enough to withstand them.

5.0 SUMMARY

The major methods of asexual propagation are cuttings, layering, division, budding and grafting while sexual reproduction is the use of seed that is the product of fertilization. It is usually not possible to get true to type offspring from sexual reproduction but in asexual reproduction, the offspring is a complete replica of the parents. Nursery systems and operations are aimed at ensuring healthy growth of the young plants to the stage of being transplanted to the permanent site.

6.0 TUTOR MARKED ASSIGNMENT (TMA)

1) What do you understand by a “cutting” in vegetative propagation? Mention four examples of cuttings that you know
2) What do you understand by grafting/budding in vegetative propagation? Mention four conditions necessary for successful grafting.

3) Differentiate between ‘Division’ and ‘Separation’ in asexual reproduction.
4) What are the advantages and disadvantages of sexual propagation?

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MODULE 4

Unit 1 Requirements for Sitting Fruit Tree Orchards and Vegetable Farms
Unit 2 Principles of Producing, Planting and Maintaining Ornamental Trees, Shrubs, Perennials and Fruits in the Nursery, Homes and Parks

UNIT 1 REQUIREMENTS FOR SITTING FRUIT TREE ORCHARDS AND VEGETABLE FARMS.

CONTENTS

1.0 INTRODUCTION

A commercial garden that is poorly sited may produce inferior crops despite the use of appropriate methods of cultivation. Site and site requirements are essential for successful fruits and vegetable farms. Establishing a profitable orchard is costly. It's important to do it the right way at the beginning because you only have one chance. Once the orchard is established, it is difficult and costly to correct site problems in later years.

2.0 OBJECTIVES

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

- mention the topography and altitudes of a site for fruits and vegetable farming
- mention the climatic requirements of your fruit and vegetable farm
- mental the types of soils that are suitable for fruits and vegetable farming.

3.0 MAIN CONTEXT

Commercial orchard production can be a financially and emotionally rewarding venture. However, a desire to grow fruit is not sufficient reason to establish a commercial orchard. A small backyard or hobby orchard can be a satisfying avocation, but establishing a successful commercial operation takes time, skill, experience, and capital. Commercial apple growing is an increasingly complex operation requiring operators to keep abreast of current developments in plant materials, cultural techniques, pest management, and business management. Marketing is also crucial: producing fruit without a market will lead to financial loss. Because orchards are a perennial crop, mistakes made when the trees are young can affect the orchard for many years. For example, an apple orchard should last for 20—25 years. Proper planning of a proposed orchard can point out weaknesses in the plan and will be required by lending institutions. The orchard plan should include the site, the rootstocks and cultivars to be planted, pollination, the size of the orchard and tree spacing, the training and pruning system to be used, the method of harvest and marketing, market analysis for the potential market, and a review of the expertise of the management team.

After considering all of these factors, you can make an informed decision whether to plant the orchard, revise the plan, or invest elsewhere. If you have no prior experience in orchard management or operation, consider working for a successful grower for at least a year to learn the operation. If that is not possible, be certain an experienced manager or consultant is available before you plant or purchase the orchard. Fruit production cannot be learned adequately from books. Nothing can replace experience in orchard management. The site of a fruit-growing enterprise is as significant in determining its success as the varieties grown. Variety and site together set a ceiling on the productivity and profit that can be realised under the best management. Most of our fruits and vegetables originated from the temperate and

subtropical regions of the world. This calls for some special considerations when selecting sites for these crops.

3.1 Previous Crops

If residual herbicides have been used on the site, for example, atrazine for corn, you must wait at least one year before an orchard can be established. If the site was previously an orchard, remove the old trees along with as many roots as possible and prepare the soil for at least one year and preferably two years before planting new trees.

3.2 Topography

Topography and altitude should be seriously considered when trying to identify a site for your gardens. Land which slopes steeply can be difficult to cultivate as it is prone to erosion of the topsoil. Sloppy site is a serious problem in locations with heavy rainfall. Level land is generally preferable, although a slight slope can be an advantage because it assists drainage and ensures that surface water does not collect after heavy rainfall.

Exposed sites are suitable owing to the risk of damage to plants by strong winds. The most productive sites are those which are protected from wind by higher plants/trees and this requirement is often met by selecting sites near streams and rivers.

3.3 Altitude

Altitude or height above sea level plays a vital role in our consideration of the selection of sites for fruit and vegetable gardens. This is because most of these crops originate from the temperate and sub-tropical regions of the world where the temperature is a major factor in their growth. Elevations above 1,000 meters above sea level will give the best results through coastal regions that are slightly above sea level that equally support the growth of some of these crops.

3.4 Climatic requirements of a good site

Most tree crops in Nigeria do best under humid tropical conditions. Therefore, the major climatic factors that must be considered in selecting a site are the following: -

(i) Temperature – an annual average temperature of 250C to 290C is ideal for most tree crops in Nigeria.

(ii) Rainfall – When considering rainfall, it must be noted that the tree crops of Nigeria are predominantly evergreen in a few cases semi-deciduous. Therefore, they require a satisfactory supply of

moisture all year-round. Most of these tree crops are adapted to an annual rainfall up to 1000mm and above. Few, however, like cashew, mango, guava and date palm can do well in low rainfall areas (<1000mm). What is more important than the amount of rainfall is its distribution. The available rainfall should be distributed as evenly as possible over at least nine months of the year.

(iii) Sunshine - Tree crops of Nigeria require much sunshine. Growth becomes poor in areas of frequent and dense cloud covers yield reductions of over 30 percent in cocoa have been attributed to cloudiness in some parts of Nigeria.

3.4 Types of soils for fruit and vegetable farms

Before buying or renting land for your crops, the soil must be inspected and a detailed soil test conducted to ascertain the fertility status of that soil. This will help you to plan on how and what nutrient elements to apply in the future or now. Information on the structure, texture, and organic content, acidity and alkalinity (pH) value is important. Permanent crops, as tree crops, occupy the same site all through their life and their performance over the year is related to the characteristics of the soil in that location. Therefore, the soils should be deep, fertile, well-drained, free from soil-borne pathogens and supply sufficient water, air and nutrients.

3.4.1 Drainage and Aeration

Orchard soils must be well-drained and aerated. Soils that remain waterlogged for extended periods are unacceptable for orchards. In these soils the pore spaces between the soil particles become filled with water while oxygen, which is required for root growth and survival, is excluded. Trees planted in poorly drained soils tend to have roots only in the shallow surface layers of the soil. Trees with weakened, shallow root systems will be poorly anchored and more susceptible to drought and root diseases. Although clay soils are more commonly poorly drained, even sandy, porous soils can become waterlogged if there is a tight subsoil that prevents drainage of excess water. If you suspect poor drainage, examine the subsoil. Poorly drained subsoils typically are mottled in color and have prominent gray streaks and rusty brown spots indicating inadequate soil aeration. To detect poorly drained soil, dig test holes. If water stands within one meter of the surface for several weeks during the rainy season, the site is probably unsuitable for an orchard. While drainage can be improved on some soils and sites through installing tile drainage or by land reformation, it will increase the cost of orchard establishment.

3.4.2 Acidity and Soil Fertility

Tree crops prefer soil with a pH of 5.8—6.8. It is best to plant on soils with appropriate pH. However, soil pH can be temporarily raised by adding lime or lowered by adding elemental sulfur. These soil amendments should be incorporated before trees are planted, if required, and cannot be readily repeated once the trees are planted. The fertility of soils can be amended with the addition of chemical fertilisers, so soil fertility is of secondary importance. If a soil test indicates a deficiency in some nutrient elements, sufficient nutrients or lime can be incorporated before planting.

3.5 Orchard planning

Before any trees are planted, a master plan for the orchard operation should be made Components of the plan include: method of marketing; choice of cultivars, pollinisers, and rootstocks; tree spacing and layout on the land; orchard floor management; irrigation system; equipment, location of on-farm roads; etc. After you have made these decisions, you can arrange financing and order trees.

3.6 Location for Marketing

Method of marketing is an important consideration for locating an orchard. Pick-your-own operations and roadside stands are most successful near metropolitan areas and along heavily traveled roads. If the fruit is to be directly marketed at farmers' markets, proximity to such markets is desirable. If the fruit is to be marketed through wholesale channels, then the orchard should have, or be near, a packing/processing facility. Transportation to markets can be a sizable cost of selling fruit

3.6.1 Marketing

The first decision in orchard planning is the method of marketing. This decision will dictate many other facets of the operation. There are essentially three methods of marketing apples, and most growers use more than one method. For more marketing information, contact your county extension office or local Chamber of Commerce to advise on the most profitable marketing strategy.

3.6.2 Farm Markets

A more direct marketing technique is to use roadside stands or farmers' markets. Roadside stands should be established only on highways with sufficient traffic to provide enough customers for selling the crop. On-

site grading facilities will need to be established or contracts made to grade the fruit off-farm.

3.6.3 Wholesale Markets

Marketing through produce wholesalers is used most often by larger growers who can consistently provide quality fruit to wholesalers. A large number of apples can be moved through these well-established networks. Wholesale marketing requires ample picking labor and equipment for harvesting, storing, and transporting fruit. A grading and packing facility will need to be constructed or contracts established to have the fruit packed off-farm. It is perhaps more economical to have fruit graded and packed off-farm than to build a small packing line that is run for only a few weeks each season. These decisions should be made before the orchard is planted. Contact produce wholesalers while the orchard is still in the planning stage. Ask if they are interested in purchasing the cultivars you intend to plant. They may be able to offer suggestions about what their customers want in terms of cultivars, grades, and packs. They may also give you a price history for apples for the last several years so that your price expectations are realistic.

3.6.4 Orchard Size

An orchard of 20—30 hectares can provide sufficient income for a family. An orchard of this size utilizes equipment efficiently and allows one person to do most of the routine work. Additional labor will be required for pruning and harvest. When deciding orchard size, determine whether additional labor will be available. The method of marketing may also affect orchard size. For instance, pick-your-own orchards should not be larger than the market they serve requires. Otherwise, unharvested fruit will remain on the trees and potential income will be lost.

SELF-ASSESSMENT EXERCISE

Take a close look at the family citrus plantations in the middle belt and southwest parts of Nigeria and the enormous yields that are wasted annually. In your opinion, what other marketing arrangements would advocate that these producers should adapt to drastically reduce waste.

4.0 CONCLUSION

Wrong-site selection could be very costly as it is irreversible when made. Extra care should therefore be taken as you make your mind to select a site for your fruits and vegetable gardening. A commercial orchard should be reasonable in size with planned operations and

marketing strategies. This will reduce yield wastage and guarantee family sustenance.

5.0 SUMMARY

In our consideration to site our garden in a location, there is the need to consider that most of the vegetables and fruits originated from other places outside the tropics and so environmental conditions closest to their places of origin should be considered. In this regard, we have to look at the temperature, rainfall, sunshine, height above sea level and the soils of the site.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1) Discuss topography as a factor to consider in our search for a suitable site for vegetables and fruits.
2) Mention the main climatic factors to consider in the selection of sites for vegetables and fruits.
3) What is an ideal soil for our vegetable and fruit gardens?

7.0 REFERENCES/FURTHER READING

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UNIT 2 PRINCIPLES OF PRODUCING, PLANTING AND MAINTAINING ORNAMENTAL TREES, SHRUBS, PERENNIALS AND FRUITS IN THE NURSERY, HOMES AND PARKS

CONTENTS

1.0 INTRODUCTION

The art of producing ornamental plants also called floriculture has become one of the important commercial activities in Nigerian agriculture pre and post-independence. Floriculture industry comprises cut flowers, cut-foliages, dry flowers, potted plants, bulbs and seed production. They also include the production of micro- propagated planting materials and the extraction of essential oils from flowers.

In addition, floriculture business includes protected cultivation, plug plant production of bedding and annual flowers in a large scale, corporate landscaping for beautification, making of pot- flowers from cut flowers, herbs and spices, production of dyes, phytochemicals and herbal medicines from native flowers and open-pollinated hybrid seed production of flowering annuals. Major flower growing states in Nigeria are those that have major cities and town especially the various state capitals. This is because the industry is demand-driven by the elites, young and elderly that can afford. The floriculture industry is an issue of ‘want’ and not ‘need’.

The floriculture nursery industry has been a growth industry throughout the developed countries for several decades. Globally, there is a rapidly growing demand for potted plants; the major consumers of potted plants are USA, Germany, Italy, and France. The main exporting countries of potted plants are the Netherlands, Denmark and Belgium. The US is considered the world’s largest producer of nursery crops.

2.0 OBJECTIVES

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

- explain the importance of ornamental plants
- state the factors that influence the establishment of the ornamental nursery business
- discuss the procedures involved in planting ornamental plants
- discuss the Special Planting Requirements for Container-Grown Plants
- explain how to take care of your ornamentals after planting.

3.0 MAIN CONTEXT

Ornamental plants are plants that are grown for decorative purposes in gardens and landscape design projects, as houseplants, cut flowers and specimen display. The cultivation of ornamental plants is called floriculture, which forms a major branch of horticulture. Commonly, ornamental garden plants are grown for the display of aesthetic features including: flowers, leaves, scent, overall foliage texture, fruit, stem and bark, and aesthetic form. In some cases, unusual features may be considered to be of interest, such as the prominent thorns of *Rosa sericea* and *cacti*. In all cases, their purpose is for the enjoyment of gardeners, visitors, and public institutions.

Similarly, certain trees may be called ornamental trees. This term is used when they are used as part of a garden, park, or landscape setting, for instance for their flowers, their texture, form, size and shape, and other aesthetic characteristics. In some countries trees in 'utilitarian' landscape use such as screening, and roadside plantings are called *amenity trees*. Grasses are not left out as we also have Ornamental grasses. They are grasses grown as ornamental plants

3.1 Importance of ornamental plants

Generally, ornamental plants are grown for decorative purposes in gardens and landscape design projects, as house plants, for cut flowers and specimen display.

Besides, ornamental plants play important roles in human health and psychology. Other important roles include:

1) Natural air purifiers. Gaseous exchanges are balanced. Flowering scents, photosynthesis are purifiers of the atmosphere.
2) Amazing beauty. Ornamental plants, both flowering and non-flowering, climbers, hedges are a beauty to behold
3) Ornamental plants prevent soil erosion
4) Creates its ecosystem
5) Ornamental plants can reduce stress. Many believe that indoor plants in offices and homes can reduce stress and refresh them.
6) Some ornamental plants are edibles like the leaves, stems, and roots
7) It helps to reduce global warming
8) Provides employment

3.2 General planting procedures of ornamental plants

Each plant form—bare-root, balled, and container-grown—has specific requirements to consider when planting. However, some planting procedures are universal across the plant forms. These procedures are outlined below.

1. The sides of the planting hole should be tapered, with the opening being wider than the bottom and large enough to accommodate the roots and soil ball.
2. The sides of the planting hole should be roughened or scored with a shovel or pickax to break up any smooth surface or glazing created from the backward pressure of the shovel while digging

the hole. This polished or compressed layer of soil around the sides of the planting hole will often be dense enough to slow the outward movement of new roots into the soil surrounding the hole.

3. Do not dig too deep—the root flare or collar of the tree should be at the final soil grade or slightly higher. The root collar is the juncture between the stem of the plant and the root system. This point is often associated with a gentle flare when the stem merges into the root system.
4. Before backfilling, make sure the tree or shrub is properly positioned and upright in the planting hole. The plant may require some support while you backfill.
5. Gradually add backfill soil over and among the roots of bare-root plants, and firmly pack soil against the root ball of balled and bur lapped and container-grown plants to eliminate air pockets.
6. Continue filling the planting hole and firming the soil until the hole is about half full. At this point, fill the hole with a gentle stream of water and allow it to soak into the soil to settle it and remove air pockets. Avoid a strong stream of water, which may puddle the soil and damage the smaller pores needed for soil aeration for the roots. When the water has drained, continue filling the hole with soil as recommended under the specific planting system below.
7. Once the hole is filled as directed and all specific planting directions are met, provide a ring of soil several inches high around the edge of the planting hole to hold moisture and fill again with water.

3.3 Special planting requirements for Container-Grown Plants

When planting container-grown plants, follow the same preparation in hole size and planting depth as you would for balled and bur lapped plants. The container has to be removed from this type of plant before it is set in the ground. Even some of the paper materials used for containers break down slowly enough to restrict optimum root development in the soil.

Guying

Research findings suggest that trees and larger shrubs that are allowed to flex in the wind after planting tend to have stronger stems and trunks. The regular movement of the stems builds a stronger cell system internally in the trunk while it is in the nursery. However, there is also the possibility that such plants will tip or lean slightly before sale. Minor adjustments to the position of the plant in the planting hole can alleviate minor twists or curves in the trunk or stem.

Wrapping

Protecting the trunks and branches of newly planted deciduous trees with tree wrap has become a questionable practice. It has often been suggested that such wrap harbors insect pests that may bore into the trunk. Tree wrap applied in the nursery or garden center before the plants are sold often covers serious defects, such as pruning wounds, bark damage, cankers, or insect injury on the trunk.

Mulching

Another useful practice to help conserve moisture for the plant's use is mulching. By placing a layer of mulch over the root system and surrounding soil, you will prevent the evaporation of moisture from the soil surface. The mulch will also help to stabilise soil temperatures, control weed growth, and reduce bark damage from mowers and weed whips.

Watering

Watering newly set plants after the initial planting is essential for survival. The amount of water needed and when to apply it will depend upon rainfall, the moisture-holding capacity of the soil, drainage, and the type and texture of the soil. Watering at 5- to 7-day intervals during the first growing season is usually advisable unless the site dries out faster. Light watering will keep the soil surface wet and encourage undesirable shallow root development.

3.4 Care After Planting

Attention to the following items will help ensure proper establishment of your newly set plants, whether they are specimen, shade, or evergreen trees; small flowering trees; or shrubs and ground covers set in a landscape border.

1. Maintain optimum moisture in the soil at all times. Do not overwater so the soil becomes saturated. Slightly dry roots will go dormant and come back with moisture, but roots injured from overwatering are gone forever and weaken the plant.
2. On larger plants that are staked or guyed, maintain solid support for the first year or until the plant has established during its first growing season.
3. Keep the mulch layer at an optimum depth on the soil surface under the plants. Keep all mulch material from touching the plant stems.
4. No fertilisation is needed for at least the first growing season after planting. Fertilisation can start the second season after planting for most landscape plants and the third season for larger trees. Fertiliser application rates should follow a soil test report recommendation relative to the plants chosen. However, if a test

report is not available, a light application of a slow-release fertiliser.

4.0 CONCLUSION

Ornamental plants are grown for decorative purposes in gardens and landscape design projects, as house plants, for cut flowers and specimen display. In well-functioning ecosystems, ornamental plants play important role in human health and psychology. This special field in agriculture commonly called floriculture becomes more important and popular among the urban elites that are fairly wealthy. It offers good employment for the urban youths in addition to the beautification of our cities and towns

5.0 SUMMARY

An ornamental nursery is where plants are multiplied and grown to usable sizes for sale. It may be retail nurseries that sell to the general public; wholesale nurseries which sell to other nurseries and commercial gardeners and private nurseries which supply to institutions or private estates. The principles of successful planting of ornamental plants do not differ greatly from the usual vegetable gardens but each step in the planting process—digging the correct shape and sized planting hole, preparing the planting soil, setting the plant in the hole, watering, and mulching—requires careful attention.

6.0 TUTOR-MARKED ASSIGNMENT (TMA)

1) Why is it important to grow ornamental plants?
2) Explain the general planting procedure of ornamental plants.
3) Mention post-planting care for our ornamental plants.

7.0 REFERENCES/FURTHER READING

https://en.wikipedia.org/wiki/Ornamental_plant

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