



**NATIONAL OPEN UNIVERSITY OF
NIGERIA**

SCHOOL OF EDUCATION

COURSE CODE:AGR 215

COURSE TITLE:AGRICULTURAL BOTANY

**COURSE
GUIDE****AGR 215
AGRICULTURAL BOTANY**

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CONTENTS	PAGE
Introduction.....	1
The Course.....	1
Course Aims.....	1
Course Objectives.....	2
What You Will Learn in the Course/Course Requirement.....	2
Course Materials.....	2
Study Units.....	3
Textbooks and References.....	3
Assessment	4
Tutor-Marked Assignment.....	4
Final Examination and Grading	4
Summary	5

Introduction

Agricultural botany is a branch of biology concerned with the study of plants (kingdom Plantae). Plants are now defined as multicellular organisms living on land that carry out photosynthesis. Organisms that had sometimes previously been called plants, however, such as algae and fungi, continue to be the province of botany, because of their historical connection with the discipline and their superficial similarities to true plants.

Botany is concerned with all aspects of plants, from the smallest and simplest forms to the largest and most complex, from the study of all aspects of an individual plant to the complex interactions of all the different members of a complicated botanical community of plants with their environment and with animals.

It is a core course for students of Biology and Agriculture; it is prerequisite for attaining Bsc. degree in Biology and Agriculture. The course consists of nine units. The materials have been developed to suit Nigerian students by using more practical examples from indigenous plants.

This course guide briefly explains to you what the course is about, what course materials you will be using and how you are to use them. It provides some general guidelines for the amount of time you might be spending in order to successfully complete each unit of the course. It also gives you some guidance on your tutor-marked assignments, details of which are to be found in separate "Assignment File". The course involves regular tutorials and you are advised to attend the sessions. Dates and locations of tutorials are included in the assignment file.

The Course

The study of this course will help you to know the plant world around him and while going through the course you will learn about the pure and applied botany classification of plant, as well as morphological physiological function of various economic plants.

Course Aims

The aim of this course is to provide an understanding and appreciation of varieties of plant in the context of agricultural production as an important factor of technological progress in agriculture. This is also geared toward the development and improvement of method of agricultural production.

Course Objectives

In order to achieve the said aim above, the course sets overall objectives. Each unit also has specific objectives which are always outlined at the beginning of each unit. You should read them before you start working through the unit. It is also necessary to refer to them during your study of the unit to check on your progress. Also after completing a unit, you should glance through the unit objectives. This will enable you to be sure that you have done what was required of you by the unit. This course has the following objectives in order to achieve the above aims:

- Understand the basic concept in Agricultural Botany
- Know the origin of cultivated plant
- Identify and classify some selected tropical plant
- Appreciate the morphological, anatomical structure of plant and their physiological functions
- To distinguish between pure and applied botany
- Know the relevance of botany to Agriculture

What You Will Learn In the Course/Course Requirements

The course Agricultural Botany demand enough time, to comprehend. The content of the course material is much with lot of new terms and nomenclatures that require an extra hard working. It is advisable to study units, read suggested books and other materials that will help you achieve the objectives, attend all the tutorials session and to ask questions on anything not clearly understood. It will be of much help in the process of learning if student try to acquaint himself or herself with a life example or specimen of some selected available plant. Each unit contains assessment exercise, and at intervals in the course you are required to submit assignments for assessment purposes. There will be a final examination at the end of the course.

Course Materials

You will be provided with the following:

1. Course guide
2. 3 modules of content of 9 units in all
3. List of recommended text books to supplement the course materials
4. Assignment file

Study Units

There are 10 units in this course. Each unit should take you 2-3 hours to work through. The nine units are divided into 3 modules. Each unit includes a table of contents, introduction, specific objectives, and summary.

The following are the study units contained in this course:

Module 1

Unit 1	Basic concept in Agricultural Botany
Unit 2	Classification of Kingdom Plantae
Unit 3	Relevance of Botany to Agriculture

Module 2

Unit 1	Morphology
Unit 2	Histology
Unit 3	Plant Physiology

Module 3

Unit 1	Cereals Plants
Unit 2	Legumes/Pulses
Unit 3	Roots and Tubers
Unit 4	Sugar Crops
Unit 5	Oil Crops
Unit 6	Vegetable Crops
Unit 7	Fiber Crops
Unit 8	Beverages and Stimulant Crops
Unit 9	Medicinal Plants
Unit 10	Other Crops

Textbooks and References

Baranov, V.D. Ustimenko, G.V.(1994). *Mir Kulturnih Rasteniyi*. Misl,. P.381.

Cobley, L.S. and Steele, W.M. (1976). *An Introduction to the Botany in the Tropics*, Second Edition. Longman Group Limited.

Dutta, A. C.(2000). *Botany for Degree Students* Oxford University Press 10th Edition.

Ebukanson and Bassey: (1992). *About Seed Plants*. Baraka Press and Publishers LTD.

Green, D.J., Stout, G.W.(2004). *Biological Science*, 3rd Edition. Cambridge University Press

James, W.O.(1975). *An Introduction to Plant Physiology* Seventh Edition, Oxford University Press. P.181

Kochhar, S. L. (2001). *Economic Botany in the Tropics* Second Edition, Macmillan India LTD

Murkin, B.M. Naumova, L.G. and Muldashev, A.A. (2000). *Vissheye Rasteniyе*. M. Logos P.264.

Pandey, S. N. Sinha, B.K.(2003). *Plant Physiology* Third Edition, Vikas Publishing House PVT LTD. P.581

Assessment

There are two component of assessment for this course. The Tutor Marked Assignment (TMA) and the End of Course Examination

Tutor-Marked Assignment

The TMA is the continuous assessment components of your course. It account for 30% of the total score. You will be given 4 TMA's to answer. Three of these must be answer before you are allowed to sit for the end of course examination. The TMA's would be given to you by your facilitator and returned after marking them. The best three scores out of the four TMAs you have submitted would be recorded for you as your continuous assessment. It is therefore very important that you do and submit all the four TMAs as scheduled.

Final Examination and Grading

You are advised to revise all the areas covered in the course. Revision of all the exercises and tutor-marked assignments before examination is necessary in preparation for the examination. It should start after you have finished studying the last unit. The final examination will be of three hours duration and it has a value of only 70% of the total course grade.

Summary

AGR 215 introduces you to the basic concept in Agricultural botany, definitions, its importance and relevance to Agricultural production and its development. At the completion of the course you will be acquainted with the basic knowledge about Agricultural Botany which will help you to apply the acquired knowledge in Agricultural Production. And you will be able to:

- Describe in detail what is Agricultural Botany? Nature, scope etc
- Classify Plant kingdom
- Describe the development of Agricultural Botany as a science
- Identify the relationship and relevance of Agricultural Botany to Agricultural Production
- State the Origin, Nomenclature, Characteristics, and Economic significance of some tropical crops
- Describe the physiology, anatomy and morphology of some agricultural crops

GOOD LUCK

**MAIN
COURSE**

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CONTENTS	PAGE
Module 1	1
Unit 1 Basic Concept in Agricultural Botany.....	1
Unit 2 Classification of Kingdom Plantae.....	4
Unit 3 Relevance of Botany to Agriculture.....	13
Module 2	19
Unit 1 Plant Morphology.....	19
Unit 2 Histology	33
Unit 3 Plant Physiology.....	44
Module 3	52
Unit 1 Cereals Plants.....	52
Unit 2 Legumes/Pulses.....	62
Unit 3 Roots and Tubers.....	65
Unit 4 Sugar Crops.....	72
Unit 5 Oil Crops.....	76
Unit 6 Vegetable Crops.....	82
Unit 7 Fiber Crops.....	88
Unit 8 Beverages and Stimulant Crops.....	94
Unit 9 Medicinal Plants.....	99
Unit 10 Other Crops.....	103

MODULE 1

Unit 1	Basic Concepts in Agricultural Botany
Unit 2	Classification of Kingdom Plantae
Unit 3	Relevance of Botany to Agriculture

UNIT 1 BASIC CONCEPTS IN AGRICULTURAL BOTANY

CONTENTS

1.0	Introduction
2.0	Objectives
3.0	Main Content
3.1	Definition
3.2	Scope
3.3	Importance of Green Plants
3.4	Branches
4.0	Conclusion
5.0	Summary
6.0	Tutor-Marked Assignment
7.0	References/Further Readings

1.0 INTRODUCTION

Botany as a subject developed out of the study of Agriculture and medicine. It was since 16th century that several attempts were made to systematize knowledge of the plant kingdom by classifying plant as a scientific life. From 18th century classification began to take a definite shape. 19th century was noted by remarkable development of the Science of Botany.

Botany is one of the earliest sciences since man started using plant as a source of food and medicine. In the present industrialized world, man's life depends fundamentally on agriculture since it's the backbone of his existence. The three basic necessities of life, food, shelter and clothing and other essentials are still derived mainly from the plant kingdom, thus man started domesticating wild plants for that purposes. Today all the success agriculture recorded is due to the tireless work of talented researches that work with plant resources.

2.0 OBJECTIVES

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

- define correctly Agricultural Botany
- outline briefly the scope of Agricultural Botany
- highlight the importance of green plant to Agricultural production
- describe the branches of botany.

3.0 MAIN CONTENT

3.1 Definition

Botany: The word botany means herbs, Is the science that deals with herb. Botany is the study of plant resources of the world.

Agriculture: Is the Science and art of producing food, industrial raw materials and their services.

Agricultural botany: is concern with those plants that are directly used for food production. It study internal and external structure of plant domesticated for agricultural purposes. It also studies their physiological characteristic in relation to nutrition, growth, movement and reproduction as well as the Plant reaction to various environmental conditions (Kochhar, 2001).

3.2 Scope of Agricultural Botany

It's the scope of Agricultural botany to study the cultivated crop origin, distribution in space and time, their life history relationship classification, taxonomy and principles of evolution from lower and simpler form to higher and more complex one as well as investigate about how to put them to uses and device different method that can be adopted to improve quantity and quality for agricultural purposes.

3.3 Importance of Green Plants

They are essential for the continuity of all kind of life including human life. It supports life. It support life in many ways, nourish living organism with oxygen by absorbing carbon dioxide, breaking down of water and releasing equal volume of pure oxygen.

It also prepares food using carbon dioxide from the air and water and inorganic salt from the soil with this manufacturing of food and purification of atmosphere as perform by plant make animal deeply indebted to plant for their basic needs and survival- (food and oxygen).

Hence Study of varieties plant in the context of agricultural production is an important factor of technological progress in agriculture.

3.4 Branches of Botany

Botany like other Science is studied from two perspectives as Pure Science and as Applied Science. Botany as Pure Science- it studies plants as they form a part of nature, while applied botany it look at economic perspective how it applied to the well being of mankind.

As Pure Science it studies morphology, histology, physiology, ecology, plant geography, taxonomy, systematic botany, organic evolution, Genetic and palaeobotany.

Applied botany- utilization of crop product for the well being of mankind, Agronomy, horticulture, pathology, pharmacognosy, forestry, plant breeding etc (A.C. Dutta, 200)

4.0 CONCLUSION

The concept and scope of Agricultural botany was given in this unit and branches of botany also where highlighted. The unit also showed the importance of studying botany in the context of agricultural production this is a gateway to technological progress in agriculture.

5.0 SUMMARY

- The term Agricultural Botany was clearly defined
- Concept and scope of Agricultural Botany were briefly outlined
- Importance of green plants to agricultural production was highlighted
- Branches of botany were described.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define the Agricultural Botany and briefly outline its scope
2. Discuss the relevance of Agricultural Botany to Agricultural production

7.0 REFERENCES/FURTHER READINGS

Dutta, A.C. (2000). *“Botany for Degree Students”* Sixth Edition.

Mirkin, B. M. Naumova, L.G. and Muldashev, A.A.. *“The Higher Plants”* Moscow-Logos.

UNIT 2 CLASSIFICATION OF KINGDOM PLANTAE

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Taxonomy
 - 3.2 Classifications
 - 3.2.1 Nomenclature
 - 3.2.2 Kingdom
 - 3.2.3 Phylum
 - 3.2.4 Class
 - 3.2.5 Order
 - 3.2.6 Family
 - 3.2.7 Genus
 - 3.2.8 Species
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Readings

1.0 INTRODUCTION

This unit introduces you to the branch of biology concerned with naming plants and placing them in groups i.e plant *taxonomy*, a science that deals with classifying plants. Classification in botany includes identification, naming and grouping plant into a formal system. Thus, vast number of plant forms must be named and arrange in orderly manner so that students can find it easy study the exact plant that is being examine and discussed in this course. The group of plant must be defined by selection of important characteristics or shared traits that make the members of each group similar to one another and unlike members of the other groups. In modern classification schemes, there is an attempt to place groups into categories that will reflect an understanding of the evolutionary process underlying the similarities and differences among plants. Such categories form a kind of pyramid, or hierarchy, in which the different levels should represent the different degrees of evolutionary relationship. The hierarchy extends upward from several million species, each made up of individual plants that are closely related, to a plant kingdom, which contain assemblage of plants many of which are only distantly related.

The classification scheme also is based on identification, naming, and grouping of organisms into a formal system based on similarities such as internal and external anatomy, physiological functions, genetic makeup, or evolutionary history. More than 1.5 million different groups have been identified and at least partly described, and many more remain to be studied. In this unit the student will be exposed only to indigenous tropical plants and few none indigene and rare plant.

2.0 OBJECTIVES

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

- describe Plant taxonomy as a science of classifying plant into groups
- explain the pyramidal structure of the grouping
- identify various indigenous plants.

3.0 MAIN CONTENT

3.1 Taxonomy

Science of classifying animals and plants. Probably the first scientific study of plants was the attempt to classify them. At first, because of the limited knowledge of plant structures, artificial classifications, beginning with the most ancient one into herbs, shrubs, and trees, were necessary. These simple categories merely catalogued, in a tentative way, the rapidly accumulating material, in preparation for a classification based on natural relationships. Modern taxonomic classification, based on the natural concepts and system of the Swedish botanist Carolus Linnaeus, has progressed steadily since the 18th century, modified by advances in knowledge of morphology, evolution, and genetics.

3.2 Classification

The identification, naming, and grouping of organisms into a formal system. The vast numbers of living forms must be named and arranged in an orderly manner so that biologists all over the world can be sure they know the exact organism that is being examined and discussed. Groups of organisms must be defined by the selection of important characteristics, or shared traits, that make the members of each group similar to one another and unlike members of other groups. Modern classification schemes also attempt to place groups into categories that will reflect an understanding of the evolutionary processes underlying the similarities and differences among organisms. Such categories form a kind of pyramid, or hierarchy, in which the different levels should represent the different degrees of evolutionary relationship. The

hierarchy extends upwards from several million species, each made up of individual organisms that are closely related, to a few kingdoms, each containing large assemblages of organisms, many of which are only distantly related.

To construct classification schemes that correspond as closely as possible to the natural world, biologists examine and compare the anatomy, functions, genetic systems, behaviour, ecology, and fossil histories of as many organisms as possible. More than 1.5 million different groups have been identified and at least partly described, and many more remain to be studied. All branches of biology contribute to such studies; the specialties that are immediately concerned with the problems of classification are Taxonomy and systematic. Although the two disciplines overlap considerably, taxonomy is more involved with nomenclature (naming) and with constructing hierarchical systems, and systematic with uncovering evolutionary relationships.

Each taxonomic category is called a taxon (plural-taxa). The major taxonomic categories or taxa most normally used are:

1. Kingdom
2. Phylum
3. Class
4. Order
5. Family
6. Genus
7. Species

Sub-categories such as sub-kingdom, sub-class etc are some times used.

3.2.1 Nomenclature

An important aspect of the classification of organisms is the need to identify each organism by assigning to it a specific name. The method universally adopted for this naming exercise is called the binomial system. The binomial system of nomenclature (naming) was devised by Karl Linnaeus, a man regarded as the father of modern taxonomy. Under the binomial system, each organism has two names of which one is generic name and the other the specific name. The generic name is the genus to which it belongs. There is generally only one kind of organism in species, so the specific name is usually a precise indication of the identity of an organism. As a matter of custom, the generic name always begins with a capital letter, the specific name with a small letter. When printed, generic and specific names are always put in italics, when handwritten or typed they are underlined. Thus the proper name Mango tree- *Mangifera indica*, Baobab is *Adansonia digitata*.

The naming of taxonomic categories is also systematize having a common suffix attach to each category as summarized in table below using.

Table 1.2 Classification of plant Kingdom (Plant taxonomy)

	Taxonomic category	suffice	Example (white oak)
1	Kingdom		plantae
2	Phylum	-ophyta	angiospermophyta
3	Class	-opsida/-ae	Angiospermopsida/ angiospermaeae
4	Order	-ales	fagales
5	Family	aceae	Fagaceae
6	Genus		quercus
7	species		alba

Source: Mirkin et. al., 2001

3.2.2 Kingdom

The kingdom mentioned above is the highest or broadest unit or category of classification. All plant which belong to one kingdom for example its members must have certain characteristics feature distinguish them from members of another kingdom such as animals. The members of each kingdom are then further classified or subdivided into further categories in a hierarchical order, with members of each category decreasing in diversity from the level of kingdom up to species.

Living organisms were originally divided by Linnaeus into two simple groups: Plantae (plants) and Animalia (animals). There is still some debate as to the method of division of organisms into kingdoms but the system most commonly used today has five kingdoms: Plant, Animal, Fungi and Algae and Protozoans. Plant kingdom is the highest classificatory group and of one of the three division of living world that comprises of a large diversity of plant ranging from lower and simpler to the higher and complex form.

Kingdom Plantae, immobile organisms which use the Sun's light to photosynthesize in order to obtain energy from inorganic molecules. Plants typically have rigid, cellulose cell walls. Included in this group are mosses, ferns, conifers, flowering plants, and horsetails.

3.2.3 Phylum

Phylum, in biology is a major category, or taxon, of organisms with a common design or organization. This design is shared by all members of the phylum, even though structural details may differ greatly because of evolution. The assumption is made by biologists that all members of a phylum have a common ancestry.

A phylum is part of the hierarchy of classification of organisms. It is an arbitrary grouping; that is, it is developed from a combination of scientific observation, theorizing, and guesswork in an attempt to find order in the complexity of living and extinct life forms. The same is true of all classification levels above and below it except for species, which consist of organisms known to be capable, at least potentially, of interbreeding (*see* Species and Speciation). Plant kingdom is made up of the following major phyla (group) of the plant kingdom as shown below:

1. Thallophyta
2. Bryophyta
3. Pteridophyta / Filicinophyta
4. Coniferophyta
5. Angiospermophyta

Table.2.2 Characteristics of plant major Phyla

	Phylum	Brief Description	Example
1	Thallophyta	Single-celled and simple multicellular	Algae, fungi, lichens
2	Bryophyta	More complex green plants usually with simple leaves no vascular tissues	Mosses, liverworts
3	Pteridophyta/Filicinophyta	Green plants with stem, leaves, true roots and vascular tissues but no flowers or seeds	Ferns
4	Coniferophyta	Higher plants It produces cones on which sporangia spores and seeds develop. Seeds are not enclosed in an ovary, they lived on the surface of specialized leaves called ovuliferous scales in structures called cones, it has no fruits.	Conifers

5	Angiospermophyta	produce flowers in which sporangia, spores and seeds developed seeds which are enclosed in an ovary, and after fertilization the ovary developed into a fruits	Mangoes, grasses
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Source: Mirkin et. al., 2001

3.2.4 Class

Closely related orders are group together to form class.

3.2.5 Order

Order, in taxonomy, the classificatory group which is below kingdom, phylum, and class, and above family, genus, and species. Orders may be divided into suborders. Members of the same order usually share certain characteristics or traits, which indicate a common evolutionary origin and which make them markedly dissimilar from those in other orders. For example, human beings are in the order of a primate, which groups them together with all other mammals that have fingers with sensitive pads and nails. The Latin names of many plant orders end in -ales.

3.2.6 Family

Closely related genera are grouped together to form a family. Family (biology), in biological classification, group of genera with related characteristics. The family is below the order and above the genus in biological groupings. The names of families in modern classification are usually derived from a genus of the family, called the type genus. The family names of animals always end in idae, as in Equidae, the horse family; those of plants almost always end in aceae, as in Dipsacaceae, the teasel family.

3.2.7 Genus

Genus, is a group of species closely related in structure and evolutionary origin, several closely related species sharing a good number of characteristic features are grouped together in genus (plural-genera). The position of a genus, in classification of the kingdoms of living forms, is below family or subfamily, and above species.

Species that do not interbreed with each other but are clearly related by important shared traits are grouped into a genus (plural, genera), and the

separate species are given a two-word name (binomial nomenclature). The first word is the genus name and the second word is an adjective, usually descriptive or geographic. This means of naming was established in 1758 by the Swedish naturalist Carolus Linnaeus, the founder of modern taxonomy. He used Latin names because the scholars of his day communicated in that language. Linnaeus gave humans the genus name *Homo* (man) and the species name *Homo sapiens* (wise man). To construct the hierarchy of classification, one or more genera are grouped into a family, families are grouped into orders, orders into classes, classes into phyla, and phyla into kingdoms. The groups of organisms within these seven major categories, at every level of the hierarchy, are termed taxa, and each taxon has a definition that encompasses the important traits shared by all its constituent taxa.

To allow further subdivision, the prefixes sub- and super- may be added to any category. In addition, special intermediate categories—such as branch (between kingdom and phylum), cohort (between class and order), and tribe (between family and genus)—may be used in complex classifications.

On any level, a taxon should indicate a common evolutionary background, that is, all its members should have evolved from a common ancestor. The taxon is then said to be monophyletic. Where an established taxon includes two or more members that have converged so that they have traits in common but have evolved from different ancestral lines, the taxon is said to be polyphyletic. An attempt is then usually made to divide and redefine the taxon so that monophyletic taxa result.

A genus name always differs from the name used for any other genus of living forms. An organism is named by assigning it a binomial, consisting of a genus name followed by a species name. In the scientific name of the tiger lily, *Lilium tigrinum*, for example, *Lilium* is the genus name and *tigrinum* is the species name. In zoological nomenclature, the genus and species names may be identical; the gorilla, for example, is *Gorilla gorilla*. In botanical nomenclature, the genus name may never be assigned as a species name. The scientific name applied to a family is always a modification of the name of one of the genera; the genus.

3.2.8 Species

Biologists classify individual organisms at the basic level of the species, which is the only category that can be regarded as occurring in nature. The higher categories are abstract groupings of species. A species is composed of organisms that resemble one another in many important characteristics. Moreover, in organisms that have sexual reproduction, a

species is made up of interbreeding populations that, ideally, cannot produce fertile offspring with members of any other species.

As mentioned earlier the specie (plural- species) is the basic or least diversified taxonomic category Species ranks below genus and family, and contains subspecies. A species is a group of organisms which can interbreed freely with one another and share a great deal of similarity in their physical and other characteristics. For example all mango fruit belong to one species, *mangifera indica*. Although members of one species are very much alike, there are some varieties among them, eg, alponso, Julie, peter

There are many difficulties in the application of the biological species concept. Capacity to interbreed cannot always be tested, nor can the potential for interbreeding. It may not be possible to distinguish between a single polytypic species and a group of similar species occupying neighbouring areas. The museum taxonomist normally has to deal with dead material, with no information on breeding behaviour. The definition cannot readily be used for organisms, such as bacteria, which reproduce asexually for long periods, or plants which reproduce vegetatively. It cannot be applied in paleontology, where there is no evidence concerning breeding potential. In addition, the fossil sequence often lacks evidence of discontinuity within lineages, although different sections differ as much as modern species.

4.0 CONCLUSION

Grouping organisms according to shared characteristics is not a simple task, and scientists often disagree about the best way to classify organisms. Some think that organisms should be grouped according to differences or similarities in the way they look or act. Other scientists argue that classification should be based on characteristics derived from a shared evolution. Conflicting philosophies about classification have resulted in a variety of classification methods, each with their own set of assumptions, techniques, and results.

Scientists classify organisms using a series of hierarchical categories called taxa (taxon, singular). This hierarchical system moves upward from a base containing a large number of organisms with very specific characteristics. This base taxon is part of a larger taxon, which in turn becomes part of an even larger taxon. Each successive taxon is distinguished by a broader set of characteristics.

The base level in the taxonomic hierarchy is the species. Broadly speaking, a species is a group of closely related organisms that are able to interbreed and produce fertile offspring (*see* Species and Speciation).

On the next tier of the hierarchy, similar species are grouped into a broader taxon called a genus (genera, plural). The remaining tiers within the hierarchy are formed by grouping genera into families, then families into orders, and orders into classes. In the classification of animals, bacteria, protists (unicellular organisms, such as amoebas, with characteristics of both plants and animals), and fungi, classes are grouped into phyla (*see* Phylum), while plant classes are grouped into divisions. Both phyla and divisions are grouped into kingdoms. Some scientists go on to group kingdoms into domains.

5.0 SUMMARY

- Plant taxonomy as a science was described in this unit
- Pyramidal structure of plant group was explained clearly
- Various indigenous plant species were identified

6.0 TUTOR-MARKED ASSIGNMENT

1. Give the pyramidal structure of grouping plant kingdom
2. Identify the class, order, family, genus and species of the following crop -cowpea, -Sorghum, -Mango
3. Describe with example, how to name the given crop above

7.0 REFERENCES/FURTHER READINGS

Green, M.P.O. and Stout, G.W. (2004). *Biological Sciences*_Third Edition, Cambridge University Press.

Murkin, B.M. Naumova, L.G. and Muldashev, A.A. (2001). Visshye Rasteniye.

UNIT 3 RELEVANCE OF BOTANY TO AGRICULTURE

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Primitive Man used Plant as Source of his Food
 - 3.2 Period of Empirical Botany
 - 3.3 Period of Industrialized World
 - 3.4 Origin of Cultivated Crops
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Readings

1.0 INTRODUCTION

Because civilization depends in part on a knowledge of plants and their cultivation, botany can be said to have originated with the first cultivation of crops, which may date from between 9000B and 7000B BC. Not until about 2,300 years ago, however, did people become interested in plants for their own sake. The impetus towards increased food production in the era following World War II was a result of a new population explosion. A so-called green revolution, involving selective breeding of traditional crops for high yields, new hybrids, and intensive cultivation methods adapted to the climates and cultural conditions of densely populated countries such as India temporarily stemmed the pressure for more food. A worldwide shortage of petroleum in the mid-1970s, however, reduced the supplies of nitrogen fertilizer helpful to the success of the new varieties. Erratic weather and natural disasters such as drought and floods continue to reduce crop levels throughout the world.

Agriculture, art, science, and industry of managing the growth of plants and animals for human use. In a broad sense, agriculture includes cultivation of the soil (soil management), growing and harvesting of crops (crop farming), breeding and raising of livestock (animal husbandry), dairy farming, forestry, and poultry farming.

Modern agriculture depends heavily on engineering and technology and on the biological and physical sciences. Irrigation, drainage, conservation, and sanitary engineering—each of which is important in successful farming—are some of the fields requiring the specialized knowledge of agricultural engineers.

2.0 OBJECTIVES

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

- discuss the relevance of botany to agriculture
- mention seven center of plant diversity without or with minimal error
- describe briefly the historical development of botany.

3.0 MAIN CONTENT

3.1 Primitive Man Used Plant as Source of His Food

The development of Botany as a science started since when man used plant as his source of food. At the time of earliest and longest period of human history –palaeolithic / Old Stone Age, farming as such did not exist. The people of that age were living on berries, succulent herbage and wild game they could catch by primitive methods. Presumably agriculture began in the Mesolithic/ middle stone age (12000-6000 B.C.). Agriculture was also developed, people everywhere have discovered the food value of wild plants and have domesticated and bred them. The most important are cereals, such as wheat, rice, barley, corn, and rye; sugar cane and sugar beet; nuts, and oils. Fruits, vegetables, and olives are also major food sources for human beings. Feed grains for animals include Soya beans, field corn, and sorghum. Separate articles on individual plants, including grasses and silage (fodder), and animals contain further information.

3.2 Period of Empirical Botany

Botany as a science began since when the Greeks believed that plants derived their nourishment from the soil only. Not until the 17th century did the Belgian scientist Jan Batista van Helmont show that, although only water was added to a potted willow, it gained nearly 75 kg (165 lb), whereas the soil it stood in lost only about 60 g (2 oz) over a period of five years. This demonstrated that the soil contributes very little to the increase in the weight of plants. In the 18th century the English chemist Joseph Priestley demonstrated that growing plants “restore” air from which the oxygen has been removed (by the burning of candles or the breathing of animals), and the Dutch physiologist Jan Ingenhousz extended this observation by showing that light is required for plants to restore air. These and other discoveries formed the basis for modern plant physiology, that branch of botany dealing with basic plant functions.

The facts that water moves upward through the wood and that solutes move downward through the stems of plants were discovered

independently in the 17th century by Marcello Malpighi in Italy and Nehemiah Grew in England. These facts have now been known for some 300 years, but only in the past few years have acceptable theories explaining the movements of liquids in plants been developed, using a variety of refined analytical techniques.

3.3 Period of Industrialized World

When man lived by spear, the bow and the fishing net this shift from food gathering to food producing developed independently at different times in different parts of the world and agriculture continue to develop at Neolithic/ new stone age. As man's agricultural needs demanded increasingly better tools during the Iron Age. Now we are living in the space age. In this industrialized world of space age, modern man's life depends fundamentally on agriculture. Agriculture is the back bone of man's existence.

Botany as a subject developed out of the study of agriculture and medicine. It was from the 16th century that several attempts made to systematise the knowledge of the plant kingdom by classifying plants on scientific lines. From the 18th century, classification began to take a definite shape. 19th century was especially remarkable for the development of the science of Botany.

3.4 Origin of Cultivated Crops

According to carbon dating, wheat and barley were domesticated in the Middle East in the 8th millennium BC; millet and rice in China and south-eastern Asia by 5500 BC; and squash in Mexico about 8000 BC. Legumes found in Thessaly and Macedonia is dated as early as 6000 BC. Flax was grown and apparently woven into textiles early in the Neolithic period.

The farmer began, most probably, by noting which wild plants were edible or otherwise useful and learned to save the seed and to replant it in cleared land. Long cultivation of the most prolific and hardiest plants yielded a stable strain.

Grapes and wine were mentioned in Egyptian records about 2900 BC, and trade in olive oil and wine was widespread in the Mediterranean area in the 1st millennium BC. Rye and oats were cultivated in northern Europe about 1000 BC.

Many vegetables and fruits, including onions, melons, and cucumbers, were grown by the 3rd millennium BC in Ur. Dates and figs were an important source of sugar in the Near East, and apples, pomegranates, peaches, and mulberries were grown in the Mediterranean area. Cotton

was grown and spun in India about 2000 BC, and linen and silk were used extensively in 2nd-millennium China. Felt was made from the wool of sheep in central Asia and the Russian steppes.

The cultivation of plant is one of man's oldest occupations and probably began when he discovered that certain seeds spilled on disturbed ground grew in some mysterious way into new plants. For the discovery of many of these economic plants, their migrations from one continent to another, and knowledge of their properties and cultivation.

Alphonse De Candolle (1883) studied some species of cultivated plants and deduced that cultivated plants originated at some time in the remote past from wild ancestors in rather restricted areas of the world with no communication what so ever with each other. These are: China, southwest Asia including Egypt and inter-tropical America. In his contribution to the development of Botany Nikolai Ivanovitch Vavilov one of the greatest investigators in crop Geography and genetics identified world centers of origin of cultivated plant and made his deduction based on a variety of facts, obtained from sources different from those of his predecessors, such as morphology, anatomy, cytology, genetics, distribution and reaction to diseases.

At first Vavilov suggested six main geographical centers for cultivated plants, but subsequently increased their number to 11. The main world centers of diversity as recognized and mapped by Vavilov and his associate are listed as follows:

Table 1.3 World centers of origin of cultivated plants as compiled by Vavilov, N. I

S/N	Centers	Plant
1	Chinese	Millet, buckwheat, soybean, many legumes, bamboo, crucifers, onion, lettuce, eggplant, cucurbita, pear, cherry, quince, citrus, persimmon, sugarcane, cinnamon and tea.
2	India include Assam and Burma	Rice, sugarcane, many legumes, mango, orange and tangerine, jute, coconut palm, oriental cotton, black pepper, cinnamon tree, eggplant, yam
3	Indo-Malayan include Indo-china and Malay Archipelago	Banana, coconut, sugarcane, clove, nutmeg, black pepper, manila hemp, mangosteen
4	Central Asia includes Norwest India (Punjab,	Wheat, pea, beans, lentil, hemp, cotton, carrot, garlic, spinach,

	northwest Frontier Provinces and Kashmir), Afghanistan, Tadjikistan and Uzbekistan and west Tian-shan (China)	pistachio, apricot, almond, apple and pear.
5	Near east includes the interior Asia Minor, all of Transcaucasia, Iran and the highlands of Turkmenistan	Cherry, pomegranate, walnut, quince, almond and fig, alfalfa, Persian clove and vetch
6	Mediterranean	Garden beet, cabbage, turnips, rhubarb, asparagus, Egyptian clover, white clover, crimson clover, rape, black mustard, wheat, caraway, anise, peppermint, sage hops
7	Abyssinian includes Eritrea and part of Somalia	Wheat, barley, sesame, castor bean coffee and okra
8	South-Mexican and Central America Includes southern part of Mexico, Guatemala, Honduras and Costa Rica.	Maize, bean, squash, chayote, sweet potato, red pepper, upland cotton, sisal papaya guava, cacao and tobacco
9	South America , Peruvian-Ecuadorian-Bolivian	Potato species, tomato, lima bean, pumpkins, red pepper, coca, Egyptian cotton quinine tree and tobacco.
10	Chile	Common potato
11	Brazilian-Paraguayan	Groundnut, cassava, pineapple, rubber tree and cashew nut

Economic botany in tropics second edition, (2001)

4.0 CONCLUSION

It's now understood fairly the problem of how, where and when agriculture originated and developed as result of tremendous effort of botanist. It also pertinent to note that, centers of agricultural production of most of the important agricultural crops are far removed from the centers of their origin. This is because in the centers of production botany (pure science) as the major tool for agricultural development is well developed.

5.0 SUMMARY

- The relevance of botany to agriculture was discussed
- Seven centers of plant diversity were identified

- The historical development of botany was outlined in this unit

6.0 TUTOR-MARKED ASSIGNMENT

1. Describe the historical development of botany
2. Explain the center of origin of the following cultivated plant with reasons -Rice, -Tomato, -Cassava

7.0 REFERENCES/FURTHER READINGS

Baranov, V.D. and Ustimenko, G.V. (1994). *Mir Kulturnih Rasteniya* Misl.

Kochhar, S.L. (2001). *Economic Botany in Tropics* Second Edition.

MODULE 2

Unit 1	Plant Morphology
Unit 2	Histology

Unit 3 Plants Physiology

UNIT 1 PLANT MORPHOLOGY**CONTENTS**

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Root
 - 3.2 Leaf
 - 3.3 Stem
 - 3.4 Inflorescence
 - 3.5 Flower
 - 3.6 Seed
 - 3.7 Fruit
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Readings

1.0 INTRODUCTION

Botany as a pure science began in the 4th century BC with the Greek philosopher Theophrastus, whose treatises on the classification, morphology, and reproduction of plants heavily influenced the discipline until the 17th century. Indeed, modern botany began to develop only in about the 16th century, at least in part because of the invention of the microscope (1590) and of printing with movable type (1440).

Botany is a pure science concerned with investigating the basic nature of plants. Many aspects of botany, however, have direct importance to human welfare and advancement, and applied botany is an important field. Such fields as forestry and horticulture are closely tied to basic botanical studies, and others, such as pharmacology and agronomy, while not as closely related, still depend on basic botanical knowledge. In this unit various plant organs and their functions is described with the help of a cleared drawing (illustration).

2.0 OBJECTIVES

By the time you finish studying this unit, you should be able to:

- to appreciate the various plant morphological features and know their functions.
- to draw and label various plant parts
- to understand the function of various plant physical features.

3.0 MAIN CONTENT

3.1 Root System

The primary root and its branches form the **tap root system** of a plant, the primary/tap root normally grows vertically downward to a shorter or longer depth, while the branched roots (secondary roots tertiary etc) grow obliquely downwards in many cases spread horizontally outwards.

Another root system is **adventitious root system** –These are roots that grow from any part of the plant body other than the radicle it includes fibrous root of monocotyledons, foliar roots that come directly from the leaf petiole or vein.

Function

The tap root system is normally meant to absorb water and mineral salts from the soil, to conduct them upward to the stem and to give proper anchorage to the plant, but in order to perform some specialized functions it becomes modified into distinct shape.

1. Tap root modified for storage of food

- *Fusiform root* - is when the root hypocotyls are swollen in the middle and gradually tapering toward the apex and the base. e.g.- radish.
- *Napiform root* - this root swollen considerably at the upper part and become almost spherical and sharply tapering from the lower part. e.g.- turnip.
- *Conical root* - is when the root is broad at the base and gradually tapers toward the apex like a cone e.g. carrot.
- *Tubercular root* - is when the root is thick and fleshy but does not take a definite shape. e.g. four o'clock plant *Mirabilis*.

2. Branched root modified for respiration

- *Pneumatophores roots* - it developed in marshy places and salt lakes, such roots grow from the underground roots of the plant but rise vertically upward and come out of the water like so many in conical spikes. e.g. rhizophora, heritiera
3. Adventitious roots modified

For Storage of Food

- *Tubercular root* - this is a swollen root without any definite shape. e.g. sweet potato
- *Fasciculated root* - it is when several tubercular roots occur in a cluster or fascicle at the base of the stem. e.g. asparagus
- *Nodulose root* - when the slender root becomes suddenly swollen at the apex. e.g. mango ginger
- *Moniliform roots* - when there are swellings in the root at frequent intervals. E.g. Indian spinach
- *Annulated root* - when the root has a series of ring-like swellings on its body. e.g. ipecac a medicinal plant

For Mechanical Support

- *Prop or stilt root* - these roots are produced from the main stem and often from branches. They grow vertically downwards and penetrate into the soil, gradually they get stouter and act as pillars supporting the main stem and the whole plant. e.g. Indian-rubber plant
- *Climbing roots* - are produced from their nodes and internodes to ensure a foothold on neighbouring objects. E.g. black pepper
- *Buttress roots* - some of the stout roots in forest trees around the base of the main trunk show prolific abnormal growth, particularly on their upper side. They first grow obliquely downwards from the base of the trunk and then spread horizontally outwards at the ground level e.g. kapok tree (ceiba)

For Vital Function

- *Sucking roots or Haustoria* - they are parasites develop roots which penetrate into tissue of the host plant and suck it. e.g. cuscuta
- *Respiratory root* - in an aquatic plant the floating branches develop adventitious roots which are soft, light, spongy and colourless, they develop above the level of water and serve to store up air. e.g. Jussiaea
- *Epiphytic roots* – they grow perched on branches of trees, they never suck the supporting plant as do the parasites. Instead they develop a special kind of aerial roots which hang freely in the air. e.g. vanda
- *Assimilatory roots* - roots climbing on neighbouring trees produce long,

slender, hanging roots which develop chlorophyll and turn green in colour thus are assimilatory roots. e.g. tinospora.

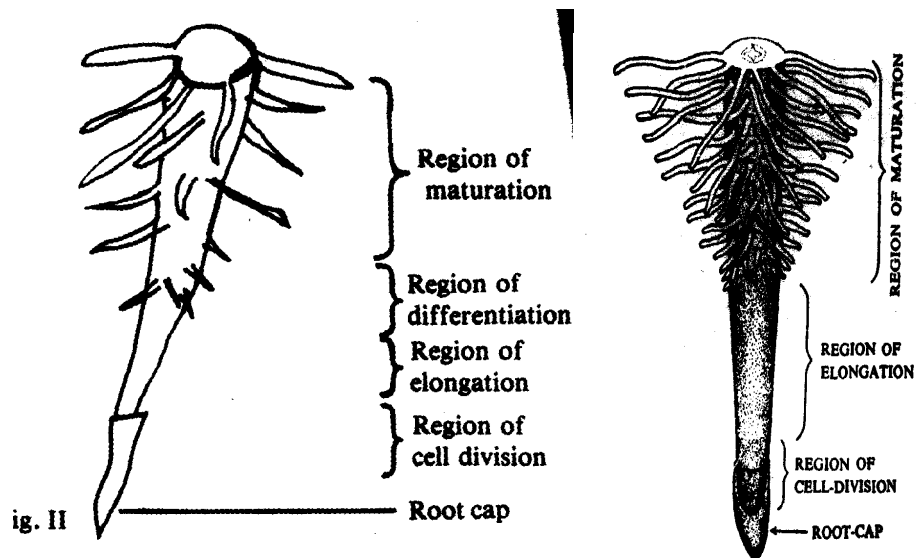


Figure 1.1 and 1.2 root hairs

Source: Dutta A.C. (2000) and Ebukason and Bassey(1992)

Root structure

It's made up of the following structures:

- root-cap- Each root is covered over at the apex by sort of cap or thimble known as the root cap, which protects the tender apex of the root as it makes its way through the soil. Due to the impact of the hard soil particles the outer part of the root-cap wears away and newer cells formed by these underlying growing tissues are added to it. The root-cap is usually absent in some aquatic plant.
- Region of cell division – This is the growing apex of the root lying within and a little beyond the root - cap and extends to a length of one to a few millimeters.
- Region of elongation – This lies above the meristematic region and extends to a length of a few millimeters
- Region of maturation – This region lies above the region of elongation and extends upwards.

Characteristic of Root

Root possesses some distinctive characteristic that distinguish it from the stem as follows:

- Is not normally green and is the descending portion of the axis of the plant

- It does not commonly bear buds except in sweet potato, wood apple
- Root bears unicellular hairs while the stem or shoot bears mostly multicellular hairs
- Lateral roots always develop from an inner layer (pericycle) while branches on the other hand develop from a few outer layers
- Nodes and internodes are absent in root unlike stem that are often present.

3.2 Stem

This is ascending portion of the axis of the plant, developing directly from the plumule, and bears leaves, branches and flowers. Stems are green at young stage and protected at the apex by a number of tiny leaves which arch over it.

Characteristics of the Stem

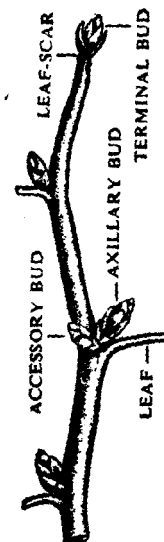
- It bears multicellular hairs of different kinds
- It branches exogenously and is provided with nodes and internodes
- Leaves and branches normally develop from the nodes. The space between two successive nodes is called internodes
- When the stem or branch end in a vegetative bud it continues to grow upwards or sideward
- If stem or branch ends in floral bud the growth ceases.
- A bud is a young undeveloped shoot consisting of a short stem and number of tender leaves arching over the growing apex.

Forms of stems

Varieties of stem structure adapted to perform diverse functions, they may be aerial or underground.

1. Erect or strong stems

A bud is a young undeveloped shoot consisting of a short stem and a number of tender leaves



– They are unbranched erect, cylindrical and stout stems marked with scars of fallen leaves, this is called caudex e.g. Palms

Fig. 1.3 Stem and bud
Source: **Ebukason and Bassey(1992)**

2. *Weak stems* – They are of three kinds; i) trailers, ii) creepers and iii) climbers:
 - i. *trailers* - those plant whose thin and long or short branches trail on the ground with or without rooting at the nodes e.g. oralis, tridax, boerhaavia
 - ii. *Creepers* – weak-stemmed plants with their long or short branches creeing along the ground and rooting at the nodes. e.g. runner, stolon, offset sucker
 - iii. *Climbers* - those plant that attach themselves to any neighbouring object, often by means of some special devices and climb it to a long or short distance. e.g. pea, passion-flower, Vine.

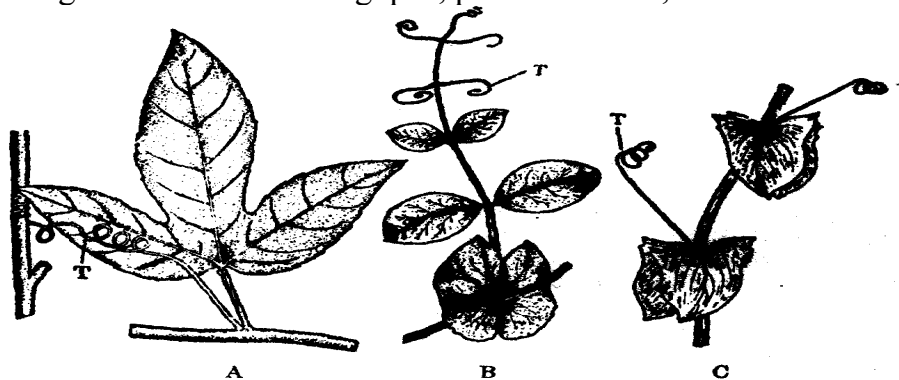


FIG. 20. Tendril Climbers. A, passion-flower; B, pea; C, wild pea (*Lathyrus*); T, tendril

Figure 1.4 Tendril climber

Source: Dutta A.C. (2000)

Modification of stem

Modified stems in plant perform mainly the following functions:

1. *perennation* - surviving from year to year through bad seasons by certain underground stems e.g.
 - rhizome (ginger, water lily, lotus)
 - tuber (potato, artichoke)
 - bulb (onion)
 - corn (taro, meadow saffron)

2. *Vegetative propagation* - by certain horizontal sub-aerial branches spreading out in different direction e.g.

- runner (strawberry)
- stolon (peppermint)
- offset (water lettuce)
- sucker (banana, bamboo, raspberry)

3. *Specialized functions* - by certain metamorphosed aerial organs. e.g.

- stem-tendrils (vine, passion-flower),
- thorn (lemon),
- phylloclade (cacti, coccoloba),
- cladode (butcher's broom),
- bulbil (oxalis repens, onion)

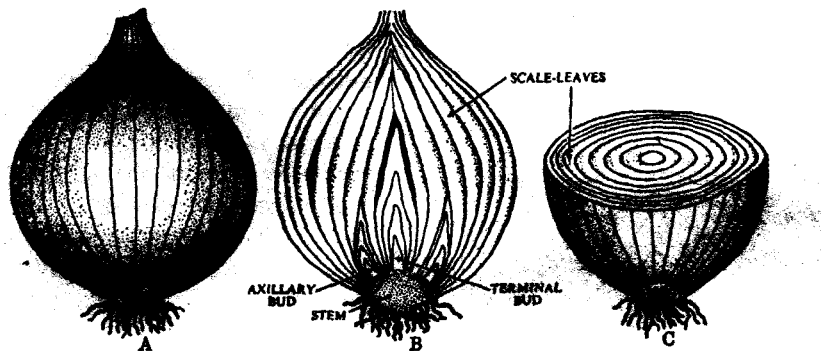


FIG. 30. Bulb of onion. *A*, an entire onion showing the lower part of the bulb with adventitious roots, and outer dry scale-leaves with distinct veins; *B*, an onion cut longitudinally; and *C*, an onion cut transversely

Figure.1.5 Bulb of onion

Source: Dutta A.C. (2000)

3.3 Leaf

This is flattened, lateral outgrowth of the stem or branch, developing exogenously (From superficial tissues) from a node and having a bud in its axil. This is the most important vegetative organ of the plant since food material is prepared in it.

Parts of a Leaf

A typical leaf consists of the following parts each with its function:

- *Leaf-base* – This is the part attached to the stem

- *Petiole* – It is the stalk of the leaf. A long petiole pushes out the leaf-blade and thus helps it to secure more sunlight.
- *Leaf-blade/Lamina* – Is the green, expanded portion. A strong vein, known as the mid-rib, runs centrally through the leaf-blade from its base to the apex. Lamina is the seat of food-manufacture for the entire plant.

A typical dicot leaf consists of the following parts:

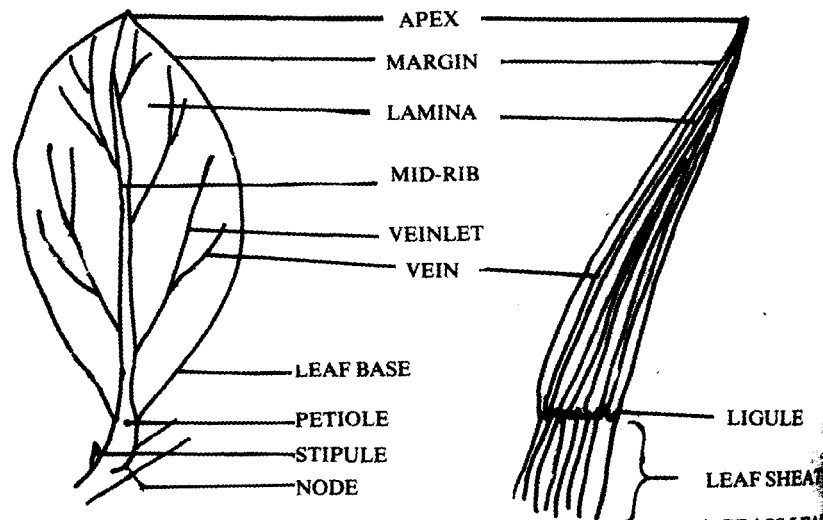


Figure.1.6 a typical dicot leaf structure

Source: Dutta A.C. (2000)

Type of Leaves

1. *Foliage leaves* – these are ordinary green, flat, lateral appendages of the stem or the branch borne at the node.
2. *Cotyledone leaves* – are attached to the axis of the embryo of the seed.
3. *Cataphylls or scale leaves* – are reduced forms of leaves, stalkless and often brownish.
4. *Stipules* – are the lateral appendages of the leaf born at its base.
5. *Ligules* – are minute, scaly fewer outgrowths born at the upper end of the leaf sheath, as in Gramineae.
6. *Hypsophylls or bract leaves*
7. *Floral leaves* – are members of a flower, forming into two accessory whorls (calyx and corolla) and two essential whorls (androecium and gynoecium)
8. *Sporophylls* – are the spore-bearing leaves concerned in asexual reproduction of plants.

Leaf Venation

This is a linear structure which arises from the petiole and the mid-rib and traverses the leaf-lamina in different directions. They are really

vascular ramifications made of conducting and mechanical tissues for distribution of water and dissolved mineral salts through the lamina and to carry away the prepared food from it and also give the necessary amount of strength and rigidity to the thin, flat leaf-lamina.

Modification of leaves

Leaves of many plants are to perform specialized functions, become modified or metamorphosed into distinct forms as follows:

1. Leaf-tendrils – it modified into slender, wiry, often closely coiled structures. Tendrils are always climbing organs and are sensitive to contact with a foreign body. Whenever they come in contact with a neighbouring object, they coil round it and help the plant to climb. e.g. pea, Venus flower
2. Leaf-Spines – It modified for defensive purposes into sharp, pointed structure known as spines. e.g Indian aloe, date palm
3. Scale-leave – These are thin, dry, stalkless, membranous structures, usually brownish in colour or sometimes colourless. Their function is to protect the axillary bud that they bear in their axil. e.g onion, ficus
4. Phyllode – When the petiole or any part of the rachis becomes flattened or winged, taking the shape of the leaf and turning green in colour. e.g acacia
5. Pitcher – The leaf becomes modified into a pitcher. There is a sort of slender stalk which often coils like tendril, holding the pitcher vertical, and the basal portion is flattened like leaf. e.g pitcher plant (Nepenthes)
6. Bladder – A rootless free-floating or slightly sub merged weed common in many tanks, the leaf is very much segmented. Some of these segments are modified to form bladder-like structure, with a trap-door entrance which allows aquatic animalcules to pass in, but never to come out.

Function of the Leaf

Leaves perform 3 normal functions:

1. manufacture of food by chloroplast in the presence of sunlight out of carbon dioxide and water obtained from the air and the soil respectively.
2. Interchange of gases, carbon dioxide and oxygen between the atmosphere and the plant body, the former for manufacture of food by green cells,
3. evaporation of water mainly through the lower surface of the leaf.

3.4 Inflorescence

This is the reproductive shoot bearing commonly number of flowers, or sometimes only single flower. It can be terminal or axillary and may be branched in various ways.

Depending on the mode of branching there exist different kinds of Inflorescence:

1. Racemose inflorescence. Inflorescence doesn't terminate in flower, but continues to grow and give off flowers laterally in acropetal succession e.g:- Raceme, spike, spikelets, catkin, spadix, corymb, umbel, head,
2. Cymose inflorescence. Inflorescence which growth of the main axis is soon checked by the development of flower at its apex and the lateral axis which develops below the terminal flower also ends in flower and therefore, its growth is also checked. The flower may be with or without stalks. eg:- uniparous, biparous, multiparous, compound and
3. Special types. This is a special kind of found in Euphorbia eg:- cyathium, verticillaster and hypanthodium.

3.5 Flower

This is a specialized shoot of limited growth, bearing reproductive organs- microsporophylls (Stamen) and megasporophylls (carpels or only one with accessory whorls- calyx and corolla, sometimes only one or even none at all. The flower serves as a means of sexual reproduction. A typical flower consists of four whorls- two lower accessory whorls- calyx and corolla, and two upper essential or reproductive whorls- androecium and gynoecium or pistil. The individual units of a calyx are sepals, of a corolla, petal' of an androecium, stamen or microsporophylls and of a gynoecium is collectively used for undifferentiated calyx and corolla and its members are called tepals. The four whorls develop in an ascending order from the swollen, suppressed end (thalamus) of floral axis or stalk (pedicel). The androecium is the male whorl and each of its stamen differentiated into filament, anther and connective. Gynoecium or pistil is the female whorl differentiated into the ovary, style and stigma.

Flowers have the following characteristics:

1. **Bisexual or hermaphrodite** - Flower that has both androecium
2. **Gynoecium** - Flower having only one of them unisexual either staminate (male or pistillate female).
3. **Monoecious** - Plant bearing both male and female flowers e.g. gourd
4. **Dioecious** - Plant bearing either male flowers or female flowers e.g. mulberry, pawpaw, palmyra-palm, etc.

5. **Polygomum** - A plant bearing bisexual, unisexual and even neuter flowers is said to be polygomum e.g.mango and wild mangosteen (Diospyros; B, Gab; H. kendu).
6. **Achmydeous** or naked - Flower without calyx and corolla as in betel.
7. **Monochlamydeous** - A flower with only one whorl is as in Polygonum
8. **Dichlamydeous** - flower with both whorls.
9. **Cyclic** - When a flower has its sepals, petals, stamens and carpels arranged in circles or whorls around the thalamus, as in most flowers.
10. **Acyclic** - when flowers are spirally arranged, as in water lily, Magnolia.
11. **Hemicyclic** - when some parts are cyclic and others acyclic as in rose.

3.6 Seed

Seed is matured developed fertilized ovule. Which undergo series of changes as a result the seed is formed. The fertilized egg cell or ovum grows and gives rise to the embryo, and the definitive nucleus to the endosperm. Other changes also take place in the ovule. Seed is made up of the following:

1. **Embryo:** After fertilization, the egg cell secretes a cellulose wall around itself and becomes the oospore, which finally gives rise to the embryo. The oospore normally divides by transvers wall into two cells. This two-celled stages is called the proembryo. Sometimes, the oospore may be divided by an obliquely placed vertical wall. The upper cell of proembryo (lying away from the micropyle), called the embryonal cell, developed into the embryo. The lower cell of the proembryo (lying towards the micropyle) forms the suspensor, which acts as a feeding organ for the developing embryo. Embryo development is divided into different type as follows:
 - piperad type (peperomia, balanophora)
 - crucifer type (cruciferae, ranunculaceae, liliaceae)
 - Asterad type (compositae)
 - Caryophyllad type (caryophyllaceae)
 - Soland type (solonaceae, Papavaraceae)
 - Chenopodil type (Chenopodiaceae)
2. **Endosperm:** This is the definitive nucleus which tends to grow into a food storage tissue, usually triploid (3n) and sometimes tetraploid (4n). There are two main type of endosperm development:

- Nuclear type. It immediately after double fertilization, endosperm nucleus divides repeatedly without corresponding wall formation.
 - Cellular type. As the endosperm nucleus divides there is corresponding formation of a cell wall around each nucleus.
3. **Seed-coat** the two integuments develop into two seed coats, of which the outer one is called the testa and the inner one the tegmen.

3.7 Fruit

This is a matured ripened ovary, and a fruit consist of two portions viz.

1. **Pericarp** (developed from the wall of ovary and the pericarp may be thick or thin, thus consisting of epicarp, mesocarp and endocarp when thick). Fruit can be of two types as follows:
 - True fruit - When only ovary of the flower grows into the fruit
 - False fruit - when other floral parts such as the thalamus, receptacle or calyx may grow and form a part of the fruit (cashew)
2. **Seed** (developed from the ovule).

Classification of Fruits

Fruits whether true or spurious, may be broadly classified into three groups

1. **Simple**- when the fruit develops from the single ovary (either of simple pistil or of syncarpous pistil) of a flower, with or without accessory parts. It can be:
 - Dry – Dehiscent (Legume or Pod, Follicle, Siliqua, Capsule)
 - Indehiscent (Caryopsis, Achene, Cypsela, Samra, Nut)
 - Schizocarpic (Lomentum, Cremocarp, Double Samara, Regma, Carcerule)
 - Fleshy – Drupe (mango, peach, coconut palm)
 - Bacca or Berry (tomato, guava, grapes, banana, pawpaw)

- Pepo (gourd, cucumber, melon, squash)
 - Pome (apple, pear)
 - Hesperidium (orange, lemon)
 - Balausta (Pomegranate)
2. **Aggregate** – Is collection of simple fruits developing from the apocarpous pistil or flower. An aggregate of simple fruits born by a single flower is otherwise known as an entaerio and common forms of etaerios are:
- Etario of follicle (Daemia extens, periwinkle)
 - Etario of achenes (Clematis, Naravelia, ranunculus, strawberry, rose and lotus)
 - Etario of drupe (raspberry)
 - Etario of berries (custard-apple, bullock’s heart)
3. **Multiple** – A is that which develops from a number of flowers juxtaposed together, or in other words, from an inflorescence. Such a fruits is otherwise known as an infructescence.
- Sorosis(Pineapple, screpine and jack-fruit)
 - Syconus (Ficus, banyan, peepul)

4.0 CONCLUSION

Study of plant morphology is very essential to understand the true nature of plant. In this unit a plant physical feature is described with simple and cleared illustration to enable you appreciate plant morphological structure.

5.0 SUMMARY

- Various morphological features and their functions were described in this unit
- Well labelled diagram of various plant organs were presented

6.0 TUTOR-MARKED ASSIGNMENT

1. Describe the function of the following:
-Root, -Leaves, -Stem, -Flowers
2. Draw and labeled the following structure:

-Fibrous root, -Adventitious root, -Bulb of onion, -Rhizome,
-Bisexual flower -Aggregate fruits

7.0 REFERENCES/FURTHER READINGS

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UNIT 2 HISTOLOGY

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Meristematic Tissues
 - 3.2 Permanent Tissues
 - 3.3 Complex Tissues
 - 3.4 Mechanical Systems
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Readings

1.0 INTRODUCTION

This is a Microscopic study of plant tissue—groups of similar cells interrelated for cooperative performance of a particular biological function. Cells grow and assume distinct shapes to perform definite functions. Cell of the same shape grow together and combine into a group for the discharge of a common function. Each group of such cells gives rise to tissue. A tissue is thus a group of cells of the same type or of mixed type, having a common origin and performing an identical function. Tissues may primarily be classified into:

1. Meristematic tissues
2. Permanent tissue

2.0 OBJECTIVES

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

- to identify different plant's tissues
- to know the function of various plant's tissues
- to be able to draw and labeled correctly vascular bundles of mono and dicotyledonous plant.

3.0 MAIN CONTENT

3.1 Meristematic Tissues

These are composed of cells that are in a stage of division or retain the power of dividing. These cells are essentially alike and isodiametric. They are of different shape: spherical, oval or polygonal and their walls thin and homogenous. They contain abundant protoplasm and the

protoplasm are active with large nuclei, and with small vacuoles or none. The meristem can be classified into the following on the basis of certain factors:

According to their origin

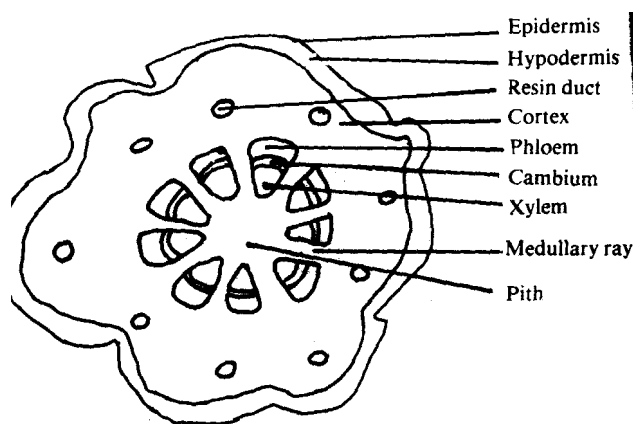
1. Promeristem or Primordial meristem –It consists of a group of meristematic cells representing the earliest or youngest stage of growing organ it occupies a small area at the tip of the stem and the root. Promeristem gives rise to the primary meristem by cell division.
2. Primary meristem – It is derived from the promeristem, and still fully retains its meristematic activity. As a matter of fact, its cells divide rapidly and become differentiated into distinct tissues the primary permanent tissues which make up the fundamental structure of the plant body. It is primarily the growing apical region of the root and the stem.
3. Secondary meristem – It appears later at a certain stage of the development of an organ of a plant. It is always lateral, lying along the side of the stem and the root. All lateral meristem (primary and secondary) give rise to the secondary permanent tissues, and are responsible for growth in the thickness of the plant body.

According to their position

1. Apical – Lies at the apex of the stem and the root, representing their growing region, and is of varying lengths. It includes the promeristem and primary meristem, gives rise to the primary permanent tissues and is responsible for growth in the length of the plant body.
2. Intercalary- Lies between masses of permanent tissues, either at the base of the leaf, as in pine, or at the base of the internode, as in some grasses and horsetail (*Equisetum*) or sometimes below the node, as in mint (*Mentha*). It is a detached portion of the apical meristem, separated from the latter due to growth of the organ. It generally short-lived, either disappearing soon or becoming transformed into permanent tissues.
3. Lateral – Lies laterally in strips of elongated cells, extending from the apical meristem, as in the stem of dicotyledons and gymnosperm. It divides mainly in the tangential direction, giving rise to secondary permanent tissues to the inside and outside of it, and is responsible for growth and the thickness of the plant body.

According to their function

1. Protoderm
2. Procambium
3. Ground or Fundamental meristem.....



Young Pine Stem in T.S.

Figure.2.1 Young pine stem

Source: Ebukanson and Bassey (1992)

3.2 Permanent Tissues

They are composed of cells that have lost the power of dividing, having attained their definite form and size. They may be living or dead and thin-walled or thick-walled. These permanent tissues are formed by differentiation of the cells of the meristem, and may be primary or secondary. The primary permanent tissues are derived from the apical meristems of the stem and the root, and the secondary permanent tissues from the lateral meristems, i.e. cambial layers. Cambium is present in dicotyledons and gymnosperms, and due to activity, secondary growth takes place in these cases, while in monocotyledons, there is no cambium and hence no secondary growth.

Classification of permanent tissues

As division of labour increases during growth, cells gradually assume various forms and give rise to permanent tissues. They may be classified into:

1. Simple Tissues

- a) ***Parenchyma*** - This consist of collection cells which are more or less isodiametric, that is equally expanded on all sides. Typically they are oval, spherical or polygonal. Their walls are thin and made of cellulose. They are usually living. Its main function is storage of

food material. And when parenchymatous tissue contains chloroplast, it is called- chlorenchyma if air is store in some aquatic plant is often called aerenchyma.

- b) **Collenchyma** - It consists of elongated, parenchymatous cells with oblique, slightly rounded or tapering end. The cells are much thickened at the corners against the intercellular spaces. They look circular, oval or polygonal in a transverse section of the stem. Although thickened the cells are never lignified. Simple pit can be found here and there in their walls. Collenchyma is found under the skin (epidermis) of herbaceous dicotyledons e.g. sunflower, gourd, etc. It is absent from the root and monocotyledon, except in special cases. The cells are living and often contain a few chloroplasts. Being flexible in nature, collenchyma gives tensile strength to the growing organs, and being extensible, it readily adapts its to rapid elongation of the stem.
- c) **Sclerenchyma** - Consists of very long, narrow, thick and lignified cells, usually pointed at both ends. They are fibre-like in appearance and hence, they are also called sclerenchymatous fibres, or simply fibres. Their walls often become so greatly thickened that the cell cavity is nearly obliterated. They have simple, often oblique, pits in their walls

1. PARENCHYMA:

These are usually oval, spherical or polygonal in shape. They possess thin walls made of cellulose.

They have abundant protoplasm hence are said to be living. The cells in a parenchyma tissue usually have lots of intercellular spaces because the cells are loosely packed.

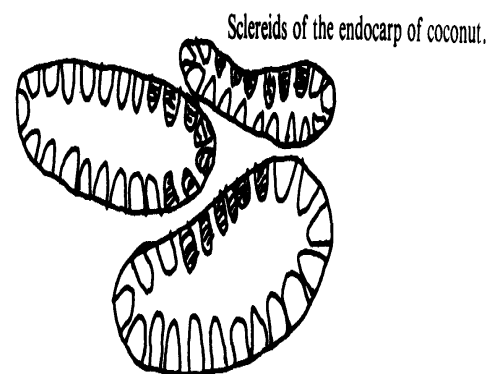
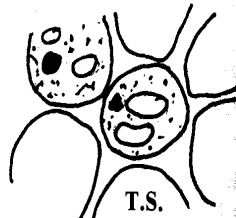


Figure.2.2 Parenchyma

Figure.2.3 Scleried of endocarp of coconut

Source: Dutta A.C. (2000)

2. COLLENCHYMA

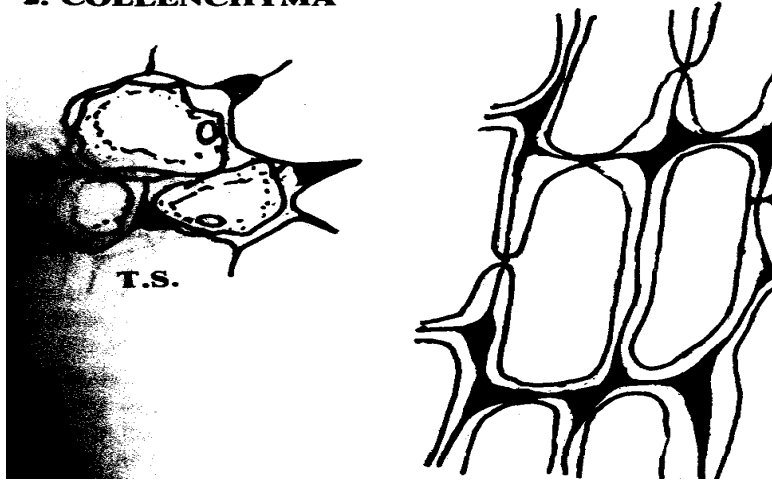
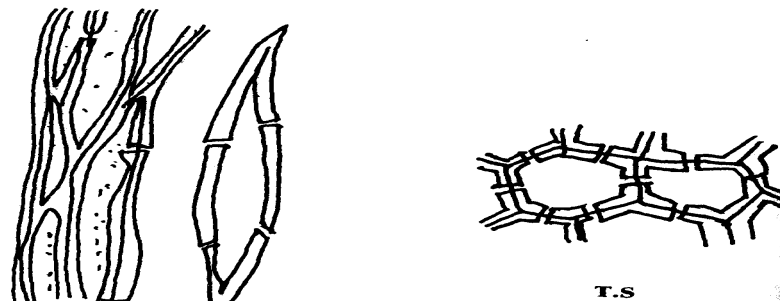


Figure.2.4 collenchyma

3. SCLERENCHYMA:

In longitudinal section (L.S.) these cells are long and narrow, tapering ends. They usually have thick lignified walls. The thickening fill up the cell cavity. Simple, sometimes oblique pits also occur in walls. The tissue may easily be recognised by the conspicuous m lamella. They are usually dead cells lacking (or having little) protopl



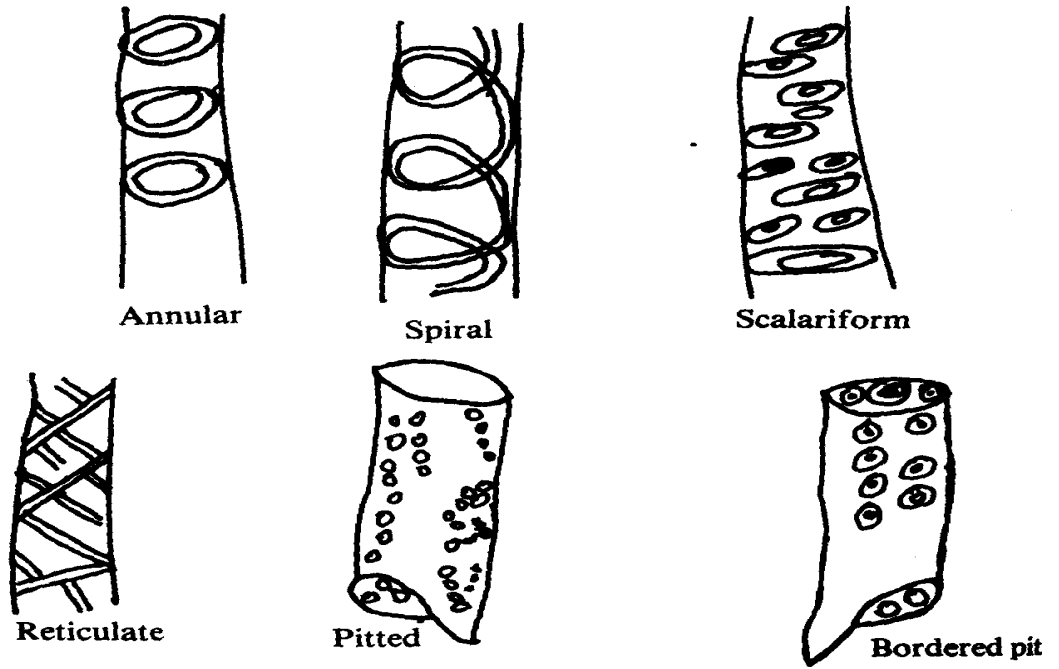


Figure.2.5 Xylem a conducting tissue
 Source: Dutta A.C. (2000)

A. SIEVE TUBES

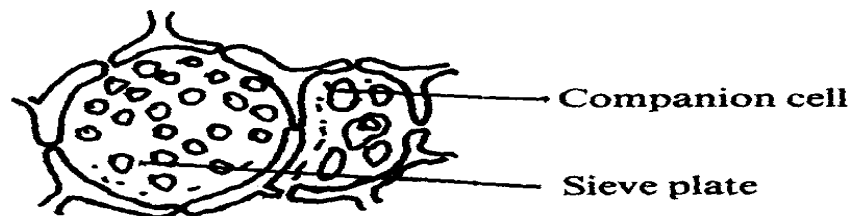
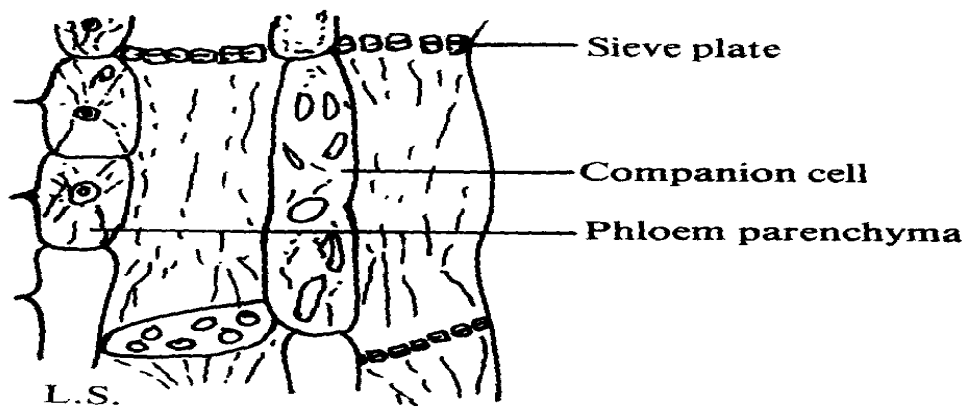


Figure.2.6 Sieve tubes
 Source: Dutta A.C. (2000)

3.3 Complex Tissues

- (A) *Xylem or wood* - is a conducting tissue and is composed of elements of different kinds, viz. (i) tracheids, (ii) vessels or tracheae (sin, trachea), (iii) wood fibres, and (iv) wood parenchyma. Xylem, as a whole, is meant to conduct water and mineral salts upward from the root to the leaf, and to give mechanical strength to the plant body.
- (i) Tracheids. These are elongated, tube-cells with hard, thick and lignified walls and large cell-cavities. Their ends are tapering, either rounded or chisel-like, and less frequently, pointed. They are dead, empty cells and their walls are provided with one or more rows or bordered pits. Tracheids may be annular, spiral, scalariform or pitted
- (ii) Vessels or tracheae. They are cylindrical, tube-like structures. They are formed from a row of cells placed end to end, from which the transverse partition walls break down. It is very much like a series of water pipes forming a pipe-line. Their walls are thickened in various ways, and vessels can be annular, spiral, scariform, reticulate, or pitted, according to the mode of thickening. Vessels and tracheids form the main elements of the wood or xylem of the vascular bundles. They serve to conduct water and mineral salts from the roots to leaves. They are dead, thick-walled and lignified and as such they also serve the mechanical function of strengthening the plant body.
- (iii) Wood fibres – Sclerenchymatous cells associated with wood or xylem are known as wood fibres. They occur abundantly in woody dicotyledons and add to the mechanical strength of the xylem and of the plant body as a whole.
- (iv) Wood parenchyma – Parenchymatous cells are frequent occurrence in the xylem, and are known as wood parenchyma. The cells are alive and generally thin-walled. The wood parenchyma assists, directly or indirectly, in the conduction of water, upwards, through the vessels and the tracheids. It also serves to store food.
- (B) *Phloem* - The phloem or bast is another conducting tissue, and is composed of the following elements: (i) sieve-tubes (ii) companion cells (iii) phloem parenchyma, and (iv) bast fibres (rarely). Phloem, as a whole, is meant to conduct prepared food materials from the leaf to the storage organs and growing regions.

- (i) Sieve-tube – They are slender, tube-like structures, composed of elongated cells which are placed end to end. Their walls are thin and made of cellulose. The transverse partition walls are however, perforated by a number pores. The transverse wall looks very much like a sieve and is called the sieve-plate.
 - (ii) Companion cells – When associated with each sieve-tube and connected with it by pores is a thin-walled, elongated cell known as the companion cell. It is living and contains protoplasm and an elongated nucleus. The companion cell is present only in angiosperms (both dicotyledons and monocotyledons). It assists the sieve-tube in the conducting of food.
 - (iii) Phloem parenchyma – There are always some parenchymatous cells forming a part of the phloem in all dicotyledons, gymnosperms and ferns. The cells are living, and often cylindrical. They stored up food materials and help conduct it. Phloem parenchyma is, however, absent in most monocotyledons.
 - (iv) Bast fibres – Sclerenchymatous cells occurring in the phloem or bast are known as bast fibres. These are generally absent in the primary phloem, but occur frequently in the secondary phloem.
- c) *Secretory tissues* -They are of the following types:
- (i) Laticiferous tissue - This consists of thin-walled, greatly elongated and greatly branched ducts and contains a milky juice known as latex. Lactiferous ducts are of two kinds: latex vessels and latex cells. They contain numerous nuclei which lie embedded in the thin layer of protoplasm lining the cell-wall which is usually thin and made of cellulose. They are irregular distributed in the mass of parenchymatous cells, and their function is not clearly understood. They may act as food storage organs or as reservoirs of waste products. They may also act as translocatory tissues. E.g. Latex vessels are found in poppy (papaver), e.g. opium poppy, garden poppy and prickly poppy, and also in some species of the sunflower family or compositae, e.g. sonchus. Latex cells are found in madar (colotropis), spurges (Euphorbia), oleander (Thevetia) periwinkles (vinca), ficus (e.g banyan fig, peepul), e.t.c
 - (ii) Glandular tissue - This tissue is made of glands, which are special structures containing some secretory products or excretory products. Glands may consist of single, isolated cells or small groups of cells, with or without a central cavity. They are of various kinds and may occur as external gland on the epidermis, or as internal glands lying embedded in other tissues in

the interior of the plant large nuclei and contains abundant protoplasm. They contain different substances and have manifold functions.

Internal glands are:

1. oil-glands secreting essential oils, as in the fruits and leaves of orange, lemon, pummelo, etc
2. Mucilage secreting glands, as in the betel leaf
3. Glands secreting gum, resin, tannin, etc.
4. Digestive glands secreting enzymes
5. Water-secreting glands known as hydathodes. They are special structure through which exudation of water takes place in liquid form. They are found mainly in aquatic plants and in some herbaceous plants growing in moist place. They occur at the apices of the veins at the tips of leaves or on their margins. Hydathodes are commonly seen in water lettuce (Pistia), water hyacinth ((Eichharnia), garden nasturtiums, many grasses, e.t.c

3.4 Mechanical System

The existence and stability of a plant depend on mechanical or strengthening tissues. They help the plant to not only maintain a particular shape but also to withstand the various kinds of mechanical strain and stress that they are often subjected to under the prevailing or changing environmental conditions.

Kind of mechanical tissues:

1. Sclerenchyma –widely distributed in plants for specific purpose of mechanical strength
2. Collenchyma – it has the power of growth, offers no resistance to the growing organs and is flexible.
3. Vessels or tracheids – Gives mechanical strength to the plant body
4. Scleroid – Often meet local strain

Tissue System

Tissues are arranged in three systems, each playing a definite role in the life of the plant. Each system may consist of only one tissue or a combination of tissues which may structurally be of similar or different nature, but perform a common function and have the same origin. There are three systems as follows:

1. Epidermal tissue system – This is derived from the dermatogen of apical meristem and forms the epidermis (epi, upon; derma, skin) or outermost skin layer, which extends over the entire surface of the plant body.
2. Ground or fundamental tissue system – It forms the main bulk of the plant's body and extends from below the epidermis to the centre (excluding the vascular bundles). It is partly derived from the periblem and partly from the plerome. Its primary functions are manufacture and storage of food materials and it also has a mechanical function. It contains of various kind of tissues e.g. parenchyma, sclerenchyma and collenchyma and sometimes laticiferous tissue and glandular tissue. It is differentiated into the following zones:
 - a) Cortex – Is the zone that lies between the epidermis and pericycle, varying in thickness from few to many layers it has the following sub-zones in dicotyledonous stem: *hypodermis*, *general cortex* or *cortical parenchyma*, and *endodermis*.
 - b) Pericycle – This forms a multi-layered zone between the endodermis and the vascular bundles and occurs as a cylinder encircling the vascular bundle and the pith, as in dicotyledonous stem.
 - c) Pith and pith rays – The pith or medulla forms the central core of the stem and the root and is usually made of large-celled parenchyma with abundant intercellular spaces. In dicotyledonous stem, the pith is often large and well developed, while in the monocotyledonous stem it is not distinguishable wing to the scatted distribution of vascular bundles
3. Vascular tissue system- This system consists of a number of vascular bundles which are distributed in the stele. This is the central cylinder of the stem and the root. Each bundle is made up of xylem and phloem, with cambium in dicotyledonous stems, or without a cambium in monocotyledonous stems, or of only one kind of tissue xylem or phloem as in roots. The function of this system is to conduct water and raw food materials from the roots to the leaves, and prepared food materials from leaves to the storage organs and the growing region

4.0 CONCLUSION

Histology as Study of plant tissues investigates structure, forms and functions of various plant tissues and tissue system. Cells of the same structure clustered to form a tissue and when various tissues are

arranged together to perform a particular function this makes a tissues system. Each system may consist of only one tissue or a combination of tissues which may structurally be of similar or different nature, but perform a common function and have the same origin. There are three tissue systems in plant, each playing a definite role in the life of the plant.

5.0SUMMARY

- Different plants tissues were identified in this unit
- Functions of various tissues were explained
- Well labeled diagrams of vascular bundles mono and dicotyledonous plant were given

6.0 TUTOR-MARKED ASSIGNMENT

1. What is a tissue? Give examples
2. Describe different tissue found in plant
3. Draw and label vascular bundles of a monocotyledon.

7.0 REFERENCES/FURTHER READINGS

- Cobley, L.S. and Steele, W.M. (1970). *An Introduction to Subtropica Crop*. Longman Group LTM.
- Ebunkanson and Bassey: (1992). *About Seed Plant*. Baraka Press and Publishers.
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UNIT 3 PLANTS PHYSIOLOGY

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Plant Water Relation
 - 3.1.1 Mechanism of Water Absorption
 - 3.1.2 Mechanism of Salt Absorption
 - 3.2 Transpiration
 - 3.3 Photosynthesis
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Readings

1.0 INTRODUCTION

Physiology, study of the physical and chemical processes that take place in living organisms during the performance of life functions. It is concerned with such basic activities as reproduction, growth, metabolism, respiration, excitation, and contraction as they are carried out within the fine structure, the cells, tissues, organs, and organ systems of the body.

Its emphasis on investigating biological mechanisms with the tools of physics and chemistry made physiology a distinct discipline in the 19th century; the tendency today, however, is towards a fragmentation and merging with the many specialized branches of the life sciences. This chapter deals plant physiology, which include Plant water relation, photosynthesis, growth, seed germination and physiological aspect of crop yield.

2.0 OBJECTIVES

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

- to comprehend the plant water relation
- to understand the mechanism of water and salt absorption
- to be able to observe the process of transpiration and determine its function to growing plant.

3.0 MAIN CONTENT

3.1 Plant Water Relation

This is some of the movement of water from cell to cell in a plant which is brought about by diffusion. Diffusion is a basic phenomenon of osmosis.

Diffusion- is the movement of molecules or ions of a solute or solvent or gas from a region of its higher concentration to that of its lower concentration. It can occur only when the concentrations of the diffusing substance are not uniform throughout the system and the process can continue until equilibrium is reached.

Osmosis - It involves the movement of solvent molecules, not a solution across a membrane permeable only to the solvent molecules but impermeable to the solutes, i.e. a semi permeable or differentially permeable membrane.

Water movement from cell to cell and in and out of the cells occurs along Diffusion Pressure Gradient instead of along gradients of osmotic pressure. Water is absorbed by the root hair due to its Diffusion Pressure Deficit. DPD is the difference between the diffusion pressure of pure water and that of water in solution at the same temperature. If this deficit is greater,, larger quantity of water will diffuse and greater amount of water will enter into cell. The force per unit area of entrance of water is termed suction pressure SP, the potentiality of which depends upon the DPD. The suction pressure of the cell is directly related to the DPD existing between the cell and the environment. The water that enters the root hair cell affects it in two ways including:

1. It brings down the concentration of the cell sap
2. It stretches the elastic wall of the cell.

When a plant cell is placed in a hypertonic solution, i.e. a solution having a higher concentration than that of the cell sap, exosmosis occurs and water comes out from within the protoplasm, as a result of which the protoplasm shrinks and leaves the cell wall this is what is called **Palsmolysis**.

3.1.1 Mechanism of Water Absorption

Kramer (1949) reported that changes in osmotic concentration responsible for water absorption are due to the results of two mechanisms that include:

1. **Passive absorption:** In this mechanism the forces responsible for water absorption into the roots are governed by other cells and the governing forces originate in the cells of transpiring shoots rather than in roots themselves. These forces originate from transpiration and the rate of water in-take is controlled basically by the rate of water loss. With the occurrence of transpiration, the DPD of leaf cells increases which results in the movement of water from the xylem cells to adjacent mesophyll cells.
2. **Active absorption:** Water is absorbed as a result of activities in the root itself and does not concern the shoot. Water is absorbed due to osmotic differences between soil water and that of root hair cell sap. The osmotic pressure of soil water is below one atmospheric pressure while that cell sap generally is from two atmospheres up to 8 atmospheres. Because of this difference, absorption directly requires no expenditure of metabolic energy and higher DPD of cell sap cause endosmosis of soil water across the semi permeable plasma membrane. There are other opinions which suggested that the absorption of water occurs due to non-osmotic reasons and against diffusion pressure deficit gradient or at accelerated rates. This process requires an expenditure of energy obtained as a result of respiration.

3.1.2 Mechanism of Salt Absorption

There are two methods of salts absorption by plant:

1. **Passive uptake** occurs when the driving force for salt uptake through the membrane is from the environment or outside the cell, e.g. diffusion dependent on concentration gradient. During this process ions move by diffusion through the cellulose wall which is permeable.
2. **Active uptake** occurs when the driving force for salts uptake originates from within the cell, i.e. energy from tissue respiration. Since the plasma membrane is semi permeable, it has the ability to selectively permit the entrance into the cell sap of some ions. This selective entrance of ions across the plasma membrane into cell sap is by active uptake. The energy required for active uptake of ions across the plasma membrane is released during tissue respiration in roots.

3.2 Transpiration

This is an evaporation process which refers to the loss of water vapour by plants. It occurs mainly from leaves and differs from simple evaporation in that it takes place from the living tissues of plant. Transpiration takes place chiefly through the stomata and to a much less extent through the cuticle and lenticel as stomatal, cuticular and lenticular transpiration respectively.

Transpiration mechanism is diffusion process through a few percent of the total leaf occupied by the area of opened stomata. When the diffusion in the leaf through stomata is compared to that from a free surface, it is found that diffusion from relatively large and free surface into still air tends to follow parallel path. If the total surface area is broken-up into small areas, as is the case in leaf with stomatal openings, then as the water molecules leave the pores, they will spread out fanwise with evaporation into dry air outside. Transpiration is regulated by the help of stomatal pores, sometimes they open and sometimes they close. The degree of stomatal opening is not directly linked with transpiration rate as shown by many years experiment. However, it is proved that transpiration has been greatly influenced by the water vapour in the intercellular spaces and substomatal cavities.

Factors affecting transpiration:

1. Water - turgidity and flaccidity of the guard cells as caused by water presence in guard cells lead to the opening and closing of stomata respectively.
2. Light and darkness – Guard cells with chlorophyll use light to photosynthesize sugar which raises the osmotic concentration of guard cells thus making them turgid in the light with stomatal pores widely open. While in the dark, sugars are converted and stored as starch with a lowering of stomatic concentration, thus effecting flaccidity of guard cells and the closing of the stomata
3. Humidity of air – Rate of transpiration increase in dry and decreases in moist or humid air.
4. Air temperature – Transpiration is higher in high temperature with water evaporating more freely
5. Wind – high wind readily blows-off water vapour from transpiring surfaces with such surfaces not allowed to be saturated/wet in light with sugars formed that

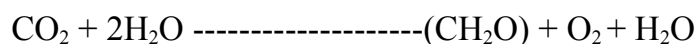
Importance of Transpiration

In spite of its possible harmfulness to the plant when excessive, resulting in wilting, transpiration has some advantages to plants.

1. An upward moving current of water transpiration stream is affected and this facilitates water absorption by roots.
2. It facilitates upward transport of solute in the xylem/translocation whence reach the leaf cells.
3. Evaporation of water from the transpiring surfaces helps to prevent excessive heating and at the same time leave the salts in the cells for use by the plants.
4. It aids the plants in getting rid of excess water.
5. It may help in salt absorption.

3.3 Photosynthesis

All living organisms are composed, among other things of organic compounds. These organic compounds are derived from simple inorganic substances present in the physical environment of living things. Only plant out of all the living things that which have a green pigment called chlorophyll, are capable of carrying out this transformation of inorganic substances (Carbon dioxide and water into organic compound)e.g. carbohydrates. Carbon dioxide which is present in the air, and in water in dissolved form, diffuses into the cells of land and water plants and where these cells contain chlorophyll the CO₂ is transformed to carbohydrates. This transformation occurs in the presence of and with the participation of water and light.



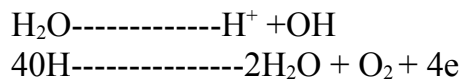
Carbon dioxide + water----- Carbohydrate + Oxygen + Water

The overall reaction is represented by the general equation above. Oxygen is evolved during the process and water is also a product. Light is the source of energy utilized in photosynthesis. A fundamental principle of photochemistry requires that for light to be active in chemical reaction, it must first be absorbed. In green plants, the pigments that serve for the absorption of light for photosynthetic purposes are the chlorophylls. The physical radiant energy that is trapped by the chlorophylls is converted to chemical energy, and stored in the organic compounds synthesized. Chlorophylls are insoluble in water but soluble in organic solvents and is of three types a, b and c. Chlorophylls a is the major and essential photosynthetic and is coloured bluish green while chlorophyll b is olive/yellow green. These pigments are contained in specialized structures called chloroplasts in algae and higher plants. Also present in the photosynthetic apparatus is another

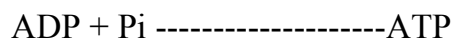
group of pigments called carotenoids which include carotenes and xanthophylls and are brightly coloured. The carotene is coloured orange while the xanthophylls are yellow in colour. These pigments may absorb light energy but this has to be passed to chlorophyll a before it can be used in photosynthesis and so these pigments are called – accessory pigments. The kind of light absorbed by carotenoids is such as may damage the chlorophyll pigment. Carotenoids therefore protect chlorophylls from photo destruction. Approximately 10% of the photosynthetic activity that occurs on earth is carried out by land plants. The remaining 90% occurs in phytoplankton, i.e. marine and fresh water algae. The process of photosynthesis consist of two phases.

- a) a light dependent phase or light reaction
- b) the light independent phase or dark reaction

Light Reaction: Adenosine triphosphate- ATP is formed in the light by the photosynthetic apparatus. This activity is called photophosphorylation and is a major activity of light reaction. The electron generated as a result of photolysis of water or ware split in light has to reach chlorophyll through several electron carriers. Water photolysis occurs thus:



Water photolysis is one of light reaction activities with Oxygen evolved and water produced. Since the electrons from chlorophyll are initially excited and energized on the absorption of light, they posses high energy. They lose this energy in little bits as inorganic phosphate (pi) during their transport. An enzyme, ATPase, takes advantage of this energy loss by the electrons, using the energy Pi to drive ATP formation



Where ADP = adenosine diphosphate and Pi – inorganic phosphate. It should be noted that during light reactions, two assimilatory products ATP and reduced NADPH₂ are formed for use in the Dark Reaction of **photosynthesis**.

Dark Reaction: The dark reaction of photosynthesis refers to the fixation / reduction / assimilation of carbon dioxide to yield organic compound and carbohydrates. For substance to be fixed there must be an acceptor molecule. In the cycle, as proposed by Calvin (1950) the acceptor molecule is Ribulose diphosphate (RuDP) generated in light from Ribulose (5PO₄) with ATP used. The Calvin cycle suggested that RuDP accepts a molecule of CO₂ under the influence of RUDP-

carboxylase enzyme to form an unstable C_6 intermediate (Ribulose diphosphoric acid) which immediately splits to form two molecules of 3-phosphoglyceric acid (3C-PGA). PGA is the first detectable stable organic compound formed during the fixation of CO_2 by the mechanism. PGA is then reduced under the influences of Triose phosphate dehydrogenase and light to form 3-phosphoglyceraldehyde and Dihydroxyacetone phosphate, both of which triose phosphates. This reduction requires reduced $NADPH_2$ and ATP as assimilatory products. The two trioses formed condense under the influence of an Adolase enzyme to form Fructose-1, 6-diphosphate which is further catalysed by a phosphate enzyme to form Fructose-6-phosphate sugar. To form molecule of fructose hexose sugar, the above cycle must go through thrice. Some of the PGA molecules are regenerated in light with ATP used to form Ribulose diphosphate (RuDP) for further CO_2 fixation. In this Calvin cycle, light intervenes twice and the first stable compound formed is a C_3 compound hence the reference C_3 pathway. There is also a C_4 pathway.

C_4 Pathway in C_4 -Plants: It was discovered by Hatch and Slack (1966) that during photosynthesis CO_2 fixation in certain tropical monocots, the first stable compound formed were C_4 organic acids like Oxaloacetate, aspartate and malate rather than phosphoglyceric acid (PGA) which is a C_3 compound.

It was discovered that tropical monocots contain an enzyme system that can catalyse CO_2 fixation at much lower concentrations of the gas than in Calvin (C_3) cycle. The CO_2 acceptor molecule here is phosphoenol Pyruvate (PEP). It is carboxylated under the influence of phosphoenol pyruvate carboxylase (PEPC) to form Oxaloacetate (OA) in mesophyll chlorophyll chroplasts.

Oxaloacetate is then reduced to Malate or Asparatae under the influence of Malate dehydrogenase. Malate is transported to bundle sheath chloroplasts and there undergoes decarboxylation and dehydrogenation reactions to form pyruvate. Pyruvate is then transported back to mesophyll chloroplasts and under the influence of Pyruvate Orthophosphate dikinase (PODK) is energized with the use of ATP to form/regerate phosphoenol Pyruvate (PEP). CO_2 in bundle sheath chloroplasts is fixed by Calvin C_3 enzymes to form carbohydrate. The importance of this pathway is that CO_2 at very low concentrations, i.e. 0-10ppm is fixed to form Oxaloacetate, Malate or Asparatae at much higher concentration in mesophyll chloroplasts. The C_4 pathway has also been detected in such dicots as Amaranthus, Euphorbia, Portulaca and Atriplex Ebukanson and Bassey (1992)

4.0 CONCLUSION

The study of life process of plants is called plant physiology. In this unit the question of how water, gasses and solutes enter plants, substances pass out of plants and how plants used these absorbed substances (inorganic) under the influenced of other environmental conditions to transform them into organic compound were discussed in detail.

5.0SUMMARY

- Plant water relation was explained in this unit
- The mechanism of water salt absorption was described
- The process of transpiration and photosynthesis were discussed

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the following terms:
-Diffusion, -Osmosis -Transpiration
2. Describe step by step the mechanism of water and salt absorption in a living plant

7.0 REFERENCES/FURTHER READINGS

Cobley, L.S. and Steele, W.M. (1970). *An Introduction to Subtropica Crop*. Longman Group LTM.

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MODULE 3 AGRICULTURAL CROPS

This Module focuses on only representative group of economic crops and has dealt with such in details to give impetus to beginners in economic botany. The representative enumerated are not by a means but to show the commonest that can be best comprehended by students in terms of familiarities and cultivation.

Unit 1	Cereals Plants
Unit 2	Legumes/Pulses
Unit 3	Roots and Tuber Crops
Unit 4	Sugar Crops
Unit 5	Oil Crops
Unit 6	Vegetable Crops
Unit 7	Fiber Crops
Unit 8	Beverages and Stimulant Crops
Unit 9	Medicinal Plants
Unit 10	Other Crops

UNIT 1 CEREALS PLANTS

CONTENTS

1.0	Introduction
2.0	Objectives
3.0	Main Content
3.1	Sorghum
3.2	Maize
3.3	Wheat
3.4	Rice
4.0	Conclusion
5.0	Summary
6.0	Tutor-Marked Assignment
7.0	References/Further Readings

1.0 INTRODUCTION

Cereals are grains producing plant that belong to the family poaceae and have species with seeds that are edible and mostly grasses. These groups of plants are highly adaptable to different environmental and climatic conditions. They are tillering plants that are easy to culture and grow because they produce shoots, especially when they are pruned. The cereals are compact and usually dry grains when they are harvested on time stored properly and can be transported elsewhere with ease. Cereals have very good nutritional values and thus called the 'stuff of life' e.g wheat, maize, sorghum, millet and barley.

2.0 OBJECTIVES

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

- to identify the following crops: Sorghum, Maize, Rice, and Wheat
- to know the origin, distribution, spread and taxonomy of the above listed crops
- to be able to describe morphological feature
- to know the economic importance of the listed crops.

3.0 MAIN CONTENT

3.1 Guinea corn (*Sorghum bicolor*), Family *Poaceae*

Origin: Sorghum was probably domesticated from the wild diploid species *S. arundinacem* in Africa 5,000-7,000 years ago, perhaps by the Cushite people in what is now Ethiopia, though an alternative interpretation suggests that it was domesticated independently in several parts of Africa. During its subsequent evolution in Africa natural hybridization between cultivars and their putative wild progenitor (which is still a weed of some sorghum crops in Africa) has given rise to diverse forms. It originated in Africa.

Taxonomy: Genus *Sorghum* belongs to the family *Gramineae* or *Poaceae* (cereals). *Sorghum* cultivars are classified into several groups depending to a large extent upon the size and shape of their panicles, their grain type and plant size.

- Milo -
- Durra
- Guinea-corn -
- Kafir - very compact panicles
- Kaoliang - Lax panicles and small, brown grain,
- Shallus - common in India
- Dwarf cultivars - with compact heads have been bred for mechanical harvest in America and India,

Morphology: The mature sorghum plant resembles maize, varying in height from 45 cm – 4 m. It is an annual grass with erect solid stems up to 3 cm in diameter at the base, and a profusely branching adventitious root system in the top meter of the soil, with a few roots which go much deeper. The single seminal root may function throughout the life of the plant. Supporting ‘prop’ roots burst through the sheathing leaf bases in whorls from a ring of extra-axillary buds at the base of each internodes low on stem. They are stiff and light-green, with anatomy intermediate between stem and root.



Figure

3.1 Different types of sorghum

Source: Baranov, V.D. Ustimenko, G.V. (1994)

The main stem in some cultivars is solitary; in others many tillers arise from the basal nodes, and sometimes there are branches from axillary buds higher up, but the primary, main stem usually predominates and its inflorescence is first to mature. The number of tillers produced varies between cultivars and is influenced by density of sowing; it is greatest when plants are widely spaced and on fertile soil. Each tiller has its own adventitious roots system and is independent of the main stem for its nutrition. The stem nodes are slightly thickened. The internodes are shortest near the bottom of the stem, but their length also varies between cultivars and its least in some dwarf types. Other early maturing types are dwarf because they have few leaves, and the shortest, earliest sorghum are those with short internodes and as few as 7 leaves on the main stem compared with as many as 24 in tall, late cultivars. The sheathing leaf bases closely slaps and protect the stem, they have membranous margins and usually exceed the length of the internode above their insertion. They also secrete wax which forms a white, powdery covering on it. A short membranous ligule and auricles are usually present at the junction of the sheath and the lamina which is 30-35 cm long, bluish-green, glabrous and waxy with a prominent midrib. The upper leaf is called the flag and its sheath enfolds and protects the developing panicle. The phase of crop development during which the lamina of the flag leaf is visible at the top of the plant, but

before the panicle extracts from the sheath, it is called the 'boot' stage in all cereals.

The large panicle may be 20-40 cm or more long. It is carried on a stout peduncle which may be erect, pendent or recurved. Its main axis is deeply furrowed, variable in length and bears numerous primary branches in loose whorls at the hairy nodes, or in a loose spiral. From these arise secondary and tertiary branches. Whether the panicle is dense and compact (as in Milo or Kafir sorghums) or lax (as in West African Guinea corn or Shallu) depends upon the length of the main axis and its branches. The ultimate branches of the panicle bear the spikelets which are of two kinds, occurring in pairs; one is sessile and hermaphrodite, the other is pedicelled and either male or sterile. This arrangement is characteristic of the tribe Andropogoneae and the male inflorescence of maize in the tribe Maydeae. At the ends of the ultimate branches spikelets occur in groups of three, one sessile and two pedicelled.

The sessile spikelets of sorghum is broad and relatively large (3-10 mm long), with two glumes of about the same size enclosing the immature floret completely. The glumes persist with the fruit, though they are only one-half to two-thirds of its length. The lower, outer glume of the sessile spikelets is the firmer of the two; it is often stiff and coloured with several prominent nerves. The lower glume overlaps the base of the upper, inner glume which has fewer nerves and tends to be keeled and slightly pointed. The sessile spikelets contains two florets, the upper one perfect, the lower sterile and represented only by lemma. The fertile florets have a thin, small palea and a narrow hairy lemma which is usually divided at the tip and sometimes has a twisted, kneed awn. These two bracts enclose three stamens, two lodicules and the ovary with its long styles and hairy stigmas.

The pedicelled spikelet is longer and narrower than the sessile spikelet. It is often deciduous. Its two glumes enclosed two florets, neither of which has a palea; the lower floret is represented only by its lemma, while the upper has a lemma and three stamens. Or even more rarely, it may contain an upper perfect floret which produces a fruit. (S.L. KOCHHAR, 2001)

3.2 Maize (*Zea mays L.*), Family *Poaceae*

Origin: It is generally agreed that the centers of origin are in Central America. Primarily Mexico and the Caribbean and that maize hence spread first through North and South America and after Columbus discovery of America, to Europe and other area where it is now grown.

Taxonomy: *Zea mays* L. is annual monocotyledonous diploid ($2n = 20$) belonging to the *Poaceae* family and the Maydeae tribe of which eight different genera have been recognized by taxonomists. Three of these are found in the Americas and the remaining five are Asiatic in distribution.

The three American genera, *Zea*, *Euchlaena* and *Tripsacum* are much closest relative is the annual weed teosinte (*Euchlaena Mexicana*) with which it crosses freely; the hybrids are normally completely fertile. Evidence available appears convincing that maize was derived from *E. mexicana* through mutation.

Morphology: The maize stalk is herbaceous and subdivided into nodes. The number of internodes ranges from 6-20. The stalks height varies from 1.0-3.5m. Most maize types form only one stalk, but there are types that form a number of side-stalks or tillers. The leaves arise from the nodes, alternately on opposite sides on the stalk.

The root system is fibrous, spreading in all direction. Primary roots develop from the seed at germination and supply most nutrition during the first week. Permanent roots arise from the crown just below the soil surface once the seedling is growing well. Later on, more adventitious roots develop from above-ground nodes and grow into the soil, their function being to anchor the plant and support its upright position.

Maize is monoecious grass with the male and female flowers separated on the same plant. Although it is self-fertile, the plant's monoecious character and protandry (pollen is matured before the stigma is receptive) ensure a cross-pollination (by wind) of 90-95%. The tassel or male inflorescence is terminal panicle, which stretches out from the enclosing leaves at the top of the stalk. While the female inflorescence, called the ear, develops on a short side-branch, which emerges from the axil of any of the middle leaves. Normally 1-2 buds develop into ears. An ear is a modified spike which the central axis or cob bear paired spikelets with one fertile flower each.



Fig.3.2

Maize plant with cob

Source: Baranov, V.D. Ustimenko, G.V. (1994)

3.3 Wheat (*Triticum aestivum*), Family *Poaceae*

Origin: The tetraploid and hexaploid wheat are believed to have originated from ancient diploid wheat and related wild grasses by natural hybridization. Wild einkorn is probably one of the ancestors of all other cultivated wheat and is believed to be native to the Middle East and Southeastern Europe, while eikorn seems to have been domesticated in southeastern Turkey or Southwestern Caucasus and spread to Europe from Spain to Scandinavia by the New Stone Age and is still grown in hilly areas in some parts of Europe and the Middle East.

Taxonomy: Genus *Triticum* belongs to the family *Poacea* it has following species:

1. Diploid - *T. aegiloides* (wild eikorn, $n = 7$, grains = hulled)
T. monococcum (eikorn, $n = 7$, grains = hulled)
2. Teteraploid – *T. dicoccoides* (wild emmer, $n = 14$, grains = hulled)
T. dicoccum (Emmer, $n = 14$ grains = hulled)
T. durum (Macaroni wheat, $n = 14$, grains = naked)
T. persicum (Persian wheat, $n = 14$, grains = naked)
T. turgidum (Rivet wheat, $n = 14$, grains = naked)
T. polonicum (Polish wheat wild eikorn, $n = 14$, grains = naked)
T. timopheevi ($n = 14$, grains = hulled)
3. Hexaploid: – *T. aestivum* (bread wheat, $2n = 21$, and has naked grain)
T. sphaerococcum (short wheat, $2n = 21$, and has naked grain)

T. compactum (club wheat, $2n = 21$, and has naked grains)

T. spelta, (spelt, $2n = 21$, and has hulled grain)

T. macha ($2n = 21$, and hulled grain)

Morphology: The wheat stem (culms) is erect and cylindrical (0.6-1.5 m in height), the nodes being solid whereas the internodes are hollow. There are two sets of roots, three to six seminal or seedling roots developing from the embryo and the adventitious roots (Coronal), arising later from the basal underground nodes of axis, representing the permanent root system. Secondary shoots or tillers arise from the axillary buds present on the underground portion of the stem and bear a similar series of coronal roots. Like other cereals, each leaf consists of four parts:

1. The blade or lamina which is narrowly linear to linear lanceolate, about 20-37 cm long and nearly 1-2 cm wide.
2. The leaf-sheath, which encircles the stem tightly
3. A membranous ligules with margins fringed by hairs (also known as rain-guard) growing at the junction of the blade and the leaf sheath
4. The auricles which are two claw-like appendages at the base of the blade.

The wheat inflorescence is terminal distichous spike, i.e. with spikelets borne singly at the nodes on alternate sides of the zig-zag rachis.



Figure 3.3 Wheat plant

Source: Baranov, V.D. Ustimenko, G.V. (1994)

Each spikelet consists of two to five florets attached alternatively on opposite sides of a short central axis called the 'rachilla' and is subtended by two sterile or empty glumes. Each floret has its own lemma and a thin two-nerved palea investing the essential organs (three stamens and single pistil with two feathery stigmas) and two lodicules representing the perianth – structure that regulates the opening of the flower. The lamaller midrib is often extended in the form of an awn.

Depending on its presence the spikes are referred to as awned (bearded) or awnless (beardless).

The wheat grain is dry, one-seeded, indehiscent fruit, known as a caryopsis. The grain may be either hard or soft in texture with a creamy white, amber, red or purple colour depending upon the variety. The dorsal convex surface of the kernel is smooth save for the base where the fruit-coat is wrinkled, indicating the position of the embryo. The ventral surface is flat and characterized by deep furrow or groove (crease). The tip of the grain has a tuft of persistent stiff hairs known as the 'brush'.

3.4 Rice (*Oryza sativa* $2n = 24$ some are 48), Family *Poaceae*

Origin: Rice is thought to have been domesticated in India more than 4,000 years ago from the wild species *O. perennis*. The only other cultivated species in genus is *O. glaberrima*, African rice which probably originated around the swampy headwaters of Niger River in West Africa. According to the most recent authority *O. barbii* was the wild progenitor of African rice; previously *O. barbii* and *O. perennis* were considered synonymous.

Taxonomy: Three sub-species are recognized in *O. sativa*, and they correspond with geographical races of the crop. Genus *Oryza* belongs to the tribe Oryzaceae and family Poaceae, and subfamily Pooideae. About 23 species were recognized, they are distributed in the tropical and subtropical regions of Africa, Asia, Australia and South America. The African continent, having the largest number of species, is usually considered to be the center of origin of the genus *Oryza*.

subsp. Indica is 'Indica' rice, which consist of a large group of reproductively photosensitive, short-day cultivars of the tropical monsoon region of South-east Asia. While subsp. Japonica is 'japonica' rice which is both sensitive and insensitive to photoperiod according to the cultivar. With insensitive cultivars, flowering date, and consequently the time of harvest, are determined by sowing date so that a single cultivar may be, at least physiologically, suitable for cultivation in more than one environment. While *O. glaberrima* Steud is confined to tropical West Africa.

Morphology: The rice plant is a semi-aquatic, free tillering annual grass with a cylindrical jointed stem (culm), about 50-150 cm tall, but may go up to 5 m in floating rice. The internodes are shortest at the base, becoming progressively longer. Above each node, there is a pronounced thickening 'pulvinus' with an intercalary meristem. Generally speaking, rice has a shallow root system, its extent being controlled by the nature

of the soil and the water supply. The first leaf at the base of main culm and each tiller is rudimentary, consisting of a bladeless 'prophyllum'. The leaves are born alternatively on the stem in two ranks – one at each node, each consisting of leaf sheath, leaf blade, ligule and auricles, the former encircling the whole or part of the internodes. At the junction of the leaf sheath and leaf blade, there is a triangular membranous, usually colourless ligule that tends to split with age and is flanked on either side by small sickle-like appendages, fringed with long hairs (auricles). The leaf blade is long, narrow, 30-50 cm or more in length AND 1-2 CM BROAD and some what pubescent having spiny hairs on the margins. The lamina of the uppermost leaf below the panicle ('flag' or 'boot') is wider and shorter than the others.



Figure 3.4 Rice plant

Source: Baranov, V.D. Ustimenko, G.V.(1994)

The rice inflorescence is a loose terminal panicle, 7.5-38.0 cm long. The spikelets are usually borne singly, but clustered forms with two to seven spikelets together are known. Each spikelets is laterally compressed and one-flowered, born on a short pedicel and is subtended by two diminutive sterile glumes that are lanceolate, leathery, shiny structures ranging in colour from white, yellow to red or black. The flower is usually self-pollinated and is surrounded by lemma and palea that make up the hull or husk and remains attached to the grains in threshing. The lemma is tough, papery and may be fully awned, partially awned or awnless, while the palea is somewhat smaller, sometimes awned.

Enclosed within the lemma and palea are two broad, thick, fleshy lodicules, six stamens in two alternating whorls, and a pistil with two plumose stigmas on two styles.

The mature rice grain is a caryopsis. Rice invested in the hull is called 'rough rice' or 'paddy', while that with the hull removed is known as 'brown', 'husked' or 'cleaned' rice. Rough rice consists of about 20% hull. The grain coat is often pigmented and is differentiated into epicarp, mesocarp, cross cells, tube cells and spermoderm or integument. The remnants of the nucellar tissue are present just underneath the integument. The endosperm consists of a single aleurone layer of polygonal cells with a central mass of thin walled parenchymatous tissue containing mostly starch. The embryo is located near the base towards the lemma or ventral side of the grain and consists of strongly differentiated scutellum, plumule and radicle. The plumule is ensheathed by the coleoptile and the radicle by the coleorhiza.

The pericarp, nucellus, aleurone layer and the embryo (germ) collectively constitute the 'bran' which is quite rich in oils, proteins, mineral salts and vitamins; but most of the nutritional parts are lost during the milling operation.

4.0 CONCLUSION

Origin, taxonomy morphological features and economic values of some common cereals were discussed in this unit. The representative enumerated is to show the commonest that can be better comprehended by students in terms of familiarities and cultivation.

5.0 SUMMARY

- The following crop were identified: Sorghum, maize wheat and rice
- Origin, distribution, spread and taxonomy of the above listed were described
- Morphological features were also described
- Economic importance of the listed crop was given

6.0 TUTOR-MARKED ASSIGNMENT

1. State the origin, spread and taxonomy of the following crops: Maize, Rice, wheat and sorghum
2. Describe the morphological features of the crop listed above
3. Outline the economic importance of the crop listed above

7.0 REFERENCES/FURTHER READINGS

Cobley, L.S. and Steele, W.M. (1970). *An Introduction to Subtropical Crop*. Longman Group LTM.

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UNIT 2 LEGUMES/PULSES

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Cowpea
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Readings

1.0 INTRODUCTION

Grain legumes are important in human nutrition in the less humid parts of the tropics, where they contribute substantially to total protein intake. In addition to their food value, the legumes are widely grown in Tropics as green manures. The grain legumes are made up of large number of species, this unit will only look at the most common legumes.

2.0 OBJECTIVES

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

- to identify the following crops: Cowpea
- to know the origin, distribution and taxonomy of the above listed crops
- to be able to describe morphological feature
- to know the economic importance of the listed crops.

3.0 MAIN CONTENT

3.1 Cowpea (*Vigna unguiculata* L. (n =11)), Family *Fabaceae*

Origin: The cultivated cowpea originated in central Africa from where it spread in early times through Egypt or Arabia to Asia and the Mediterranean. It was brought to the West Indies in the sixteenth

century by the Spaniards and was introduced to America in about 1700 A.D.

Taxonomy: The genus *Vigna* Family *Fabaceae* is represented by about 150 species, with the greatest number in the Old World, particularly the African Continent. There three major varieties of *Vigna unguiculata*:

- var. *unguiculata*- The pods are 80-130mm long, erect or ascending when mature and are not flabby or inflated. The seeds are 5-6 mm long and are oblong or cylindrical
- var. *sinensis* – common cowpea. The fruits are 200-300 mm in length, are not flabby and are pendant when mature. The seeds are between 6-9 mm in length and are subreinform to subglobose.
- var. *sesquipedalis* is a yard-long bean or asparagus bean and is most widely grown in the Far East, mostly for its immature pods. The fruit is 30-100 cm long, fleshy and inflated when green but shrivels on drying. The seeds are elongate, kidney-shape and 8-12 mm long.

Morphology: Cowpeas are low-growing, vigorously bushy or trailing, annual herbs attaining a height of about 0.9-1.5 m. The leaves are trifoliate with a long petiole. The leaflets are large, hairy, dark green, cordate and subtended by inconspicuous stipels. The few flowers, often occurring in alternate pairs on thickened nodes, are crowded together near the tip of the long axillary peduncle. The flowers are white, light pink or purple or light blue in colour, with their keel incurved and arched upward (bent at right angle), not spirally coiled as in *Phaseolus* spp. The pods are long (variables in size), smooth, cylindrical and somewhat constricted between the seeds. The seeds are globular to kidney-shape, 5-12 mm long, smooth or wrinkled and are of many colours, ranging from white, cream, yellow, red, brown to black, sometimes speckled or blotched. The seeds are characteristic in having a marked white hilum surrounded by a dark ring. The most commonly grown are the white types or those with a black mark around the hilum, the latter being called 'black-eyed'. Black-eyed cowpeas are widely grown in California.



Fig.3.2.1 Cow pea

Source: Baranov, V.D. Ustimenko, G.V.(1994)

4.0 CONCLUSION

Origin, taxonomy, morphological features and economic values of Cowpea and Soya bean were discussed in this unit. These representatives are the commonest that can be better comprehended by students in terms of familiarities and cultivation.

5.0 SUMMARY

- Origin, distribution, spread and taxonomy of a cow pea plant was given in this unit
- Morphological features were also described
- Economic importance of cow pea was given

6.0 TUTOR-MARKED ASSIGNMENT

1. State the origin, spread and taxonomy of the following crops: Cowpea and Soya bean
2. Describe the morphological features of the crop listed above
3. Outline the economic importance of the crop listed above

7.0 REFERENCES/FURTHER READINGS

- Cobley, L.S. and Steele, W.M. (1970). *An Introduction to Subtropical Crop*. Longman Group LTM.
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UNIT 3 ROOTS AND TUBER CROPS

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Cassava
 - 3.2 Yam
 - 3.3 Potato
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Readings

1.0 INTRODUCTION

Root crop or earth vegetable are forms in which food is stored in the swollen underground parts such as true roots, and modified stems like tubers, corms, bulbs, and rhizomes that are particularly adapted to storage because of their protected positions. Root crops such as potato, sweet potato, yam and cassava, provide about 8 percent of the total human energy intake. Most root crops contain about 25 percent starch and other forms of carbohydrate.

2.0 OBJECTIVES

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

- to identify the following crops: Cassava, yam and Potato
- to know the origin, distribution and taxonomy of the above listed crops
- to be able to describe the crop morphological features
- to know the economic importance of the listed crops.

3.0 MAIN CONTENT

3.1 Cassava (*Manihot esculenta Crantz*), Family *Euphorbiaceae*

Origin: *Manihot esculenta* originated from the north of South America. The cultivated species no longer exists in the wild state. It spread rapidly, mainly to West Africa central Africa and to the countries bordering the Gulf of Guinea, from where it penetrated further inland via the basin of the River Congo.

Most of the species belong to two centers of diversities; first center is said to be North-eastern Brazil and stretching south as far as Paraguay and the second center is southern and western parts of Mexico.

Taxonomy: *M. esculenta* Crantz ($2n = 36$) is belong to the family Euphorbiaceae. Cassava is tetraploid according to some authors. The Genus *Manihot* comprises numerous species, all of them occurring in the wild state in South America.

Morphology: It is a shubby, semi-woody plant, cassava may grow to a height of 2-3m. It is a perennial but usually grown as an annual or biennial. Like all the *Euphorbiaceae* the plant parts contain latex.

The root system of cassava is well developed and this gives the crop a good tolerance. The effectiveness of its root hairs is accentuated by the presence of endomycorrhizas (symbiotic association between the root and lower fungi growing in the external root tissue). The main root tends to tuberize; they are rich in starch, arranged in bundles and measure 30-80 cm length and 5-10 cm diameter. Their weight usually varies from 1 to 4 kg under certain circumstances they may grow to a length 1m and weight 20-25 kg. They have brownish or reddish peel and the fibre content rises as the plant gets older.

The stem, whose diameter is not more than 2-4 cm are for the most part, filled with pith and because of this are very fragile until lignifications is complete. The leaves are spirally arranged to phyllotaxy of 2\5 and have multiple lobes (usually five sometimes three or seven lobes) of variable shape. A single plant may have two or three different leaf shapes. This is called folial polymorphism. The colour of leaves, some times crimson when young, is light to dark green.



Figure 3.3.1 Cassava plant
Source: Baranov, V.D. Ustimenko, G.V. (1994)

The leaves are born on petioles. Which are longer than the leaf blade and measure 5-30 cm in length? The petioles, like the leaf veins, are green, red to crimson and, more rarely whitish.

Cassava is monocious plants. The inflorescence is terminal raceme consisting of unisexual flowers. The female flowers are located at the base of the raceme and are pink, crimson, yellowish or greenish in colour. They have no corolla. The male flowers are located at the top of the inflorescence. Within the same raceme, the male flowers bloom a week later than the female ones. (protogeny) a situation that favours cross pollination by insects.

The fruit is dehiscent, three-lobed capsule that burst noisily at maturity when it releases three seeds. The cells of tuberized roots contain a cyanogenic glycoside, linamarin, formally known as manihottoxin. This substance, when exposed to the air or water it decomposed into glucose and hydrocyanic acid (HCN) by the action of the enzyme linamarase present in the latex. HCN is volatile and evaporates rapidly at temperature above 280C. Exposure to the sun or boiling will speed up this decomposition.

3.2 Yam (*Dioscorea spp*), Family *Dioscoreaceae*

Origin: Domesticated yam comes mainly from the transitional regions between forest and savanna and to a lesser extent from forest zones. *Dioscorea alata* (water yam, greater yam) is thought to have originated in Southeast Asia (northern Burma) and *D. esculenta* (lesser yam) is believed to have the same origin. A center of diversity subsists today for both species in Papua New Guinea. Both species were transferred to Madagascar at the time of ancient Malaysian migrations. While *D. cayenensis* (yellow yam) originated in the forest zones of West Africa, where it is widely grown. *D. rotundata* (white yam) is botanically very similar to *D. cayenensis*, but it has certain characteristics of some of the savanna *Dioscoreaceae*. At present, most authors agree that *D. cayenensis* and *D. rotundata* can be considered as belonging to the same complex *D. cayenensis-rotundata*.

In Africa the main yam species under cultivation are the complex *D. cayenensis-rotundata* of which *D. rotundata* is grown the most and, *D. alata*, which possibly has a higher yield potential. All over Africa, yam tends to be replaced by sweet potato and above all by cassava.

Taxonomy: Yam comprises several species of different origin:

1. *Dioscorea alata* (water yam, greater yam)
2. *D. esculenta* (lesser yam)

3. *D. cayenensis* (yellow yam)
4. *D. dumetorum* (bitter yam)
5. *D. trifida* (cush-cush yam)
6. *D. bulbifera* (aerial yam, potato yam, air-potato yam)

Morphology: It is a monocotyledon plant with edible tubers, belongs to the family Dioscoreaceae. These are climbing plants with glabrous leaves and twining stems, which coil readily around a stake. They are perennial through the root system but are grown as annual.

Yam is dioecious (male and female flowers on separated plants) with inflorescence (rare in some species) in the leaf axils. Bulbils form frequently in this leaf axil. The fruit is 1-3 cm long capsule with three locules. When seeds are produced, they are winged, pollination is entomophous. Yam produces mealy tubers with white or slightly coloured flesh (yellow for example). Depending on the species or the variety. Some old varieties have anthocyanin spots. Almost all *Dioscorea* spp. contain a bitter alkaloid called dioscorein or dihydrodioscorein, which gradually diminishes and disappears at full maturity in most cultivated varieties. Tuberization only begins towards the end of the fourth month after planting. (Aliyu Y., 2007).



Figure.3.3.2 Yam tuber

Source: Baranov, V.D. Ustimenko, G.V. (1994)

3.3 Potato (*Solanum tuberosum*), Family *Solonaceae*

Origin: It came from the highland of Peru and Bolivia, probably in the high plateau in the neighbourhood of Lake Titica which is about 3,512m above the sea level. Potato was introduced into Europe from the Northern areas by the Spanish in the later half of the 16th century. It was introduced independently to England in 1586 and Sister Walter was accredited with its introduction in Ireland from England. From Europe it spread to other parts of the world including Nigeria and African continent.

Taxonomy: Majority of cultivars of *Solanum tuberosum* is tetraploids with $2n = 48$, but diploid and triploid forms are also in occurrence and existence. Genus *Solanum* belong to the family *solanaceae*

Morphology: *Solanum tuberosum* is a tuber bearing herbaceous perennial but is treated as an annual under cultivation. The aerial part of the stem is erect in the early stage of growth but later it becomes more spreading. Except for the nodes, the aerial stem is hollow. The underground portion of the stem is more or less rounded and solid, sending forth horizontal branches (stolons) that arise from the axillary buds. Adventitious roots are produced in groups of three or four at the nodes of the main underground stem as well as the stolon.

The first few leaves developing from the 'seed' piece are usually simple but subsequent ones are compound, being irregularly imparipinnate. The leaves are 0.3 – 0.6 m long, each consisting of one terminal leaflets with entire or serrate margins and small secondary leaflets (folioles) interspersed between the primary leaflets. The leaflets are more or less opposite and are densely hairy when young but at maturity the hairs are confined to the midribs and lateral veins. The leaves are spirally arranged on the main stem with two small basal leaf-like stipules clasping the main stem.

The tuber is the short, greatly enlarged apical portion of the stolon, full of stored food. Morphologically, it is a shortened thickened stem bearing a group of buds or 'eyes' protected by scale-like leaves which are soon shed, leaving a rudimentary leaf scars (eyebrow) or ridge. The eyes may be shallow, medium or deep, the 'eyebrow' being well marked (semi circular) towards the heel or attachment end where the tuber is attached to the stolon. Each eye consists of a rudimentary leaf scar and a cluster of at least three buds lying in a slight depression, representing a lateral branch with under-developed internodes. The eyes are arranged spirally around the tuber and are more crowded towards the apical or rose end of the tuber than towards the heel or basal end. The size, shape and colour of the tubers vary greatly, the most common colours being white, red or purplish and yellow. The skin may be smooth or rough.

**Figure 3.3.3****Potato**

Source: Baranov, V.D. Ustimenko, G.V. (1994)

Anatomically, the potato tuber is a typical stem consisting of the following principal regions; the periderm, the cortex, the vascular cylinder (consisting of patches of external phloem and a ring of distinct xylem bundles), the outer medulla representing the internal phloem and the inner medulla or pith with only a narrow parenchyma zone in the interior and without phloem elements. The phloem elements, both internal and external, are in numerous groups. The internal phloem is rich in parenchyma and appears to be the principal storage tissue of the tuber. The inner medulla is the central axis of the tuber, forming a continuous connection from the stem end to the apical eye and to the buds in each eye. It is not as rich in starch as the outer medulla or the cortex. The starch is normally most dense in the tissue surrounding the vascular ring. The periderm and xylem bundles contain little storage parenchyma. The thin corky periderm forms the outer protective layer (the skin) which can be easily peeled off. The skin is pitted with lenticels or 'breathing pores.' The greater part of the proteins, minerals, tannins, crystal and pigment (in coloured varieties) is localized in the outer layers of the cortex. Deep peeling of the potatoes should always be avoided as it removes the valuable nutritional ingredients.

Flowers may or may not be produced, depending upon the variety; flowering may or may not result in formation of berries. The flowers when present are born in terminal clusters. The flower structure is typically solanaceous, consisting of five fused sepals, five epipetalous stamens and a bicarpellate gynoecium. The fruits (seed or potato ball) are spherical and 1.2-2.5 cm in diameter. They are green when immature and yellow, purple or black at maturity. Each berry may contain as many as 200 seed. (Aliyu, 2007 and S.L. Kochhar)

4.0 CONCLUSION

Origin, taxonomy morphological features and economic values of Cassava, Yam and Potato were discussed in this unit. These representatives are the commonest that can be better comprehended by students in terms of familiarities and cultivation.

5.0 SUMMARY

- The following crop were identified: Cassava, Yam and Potato
- Origin, distribution, spread and taxonomy of the above listed were described
- Morphological features were also described
- Economic importance of the listed crop was given

6.0 TUTOR-MARKED ASSIGNMENT

1. State the origin, spread and taxonomy of the following crops: Cassava, Yam and Potato
2. Describe the morphological features of the crop listed above
3. Outline the economic importance of the crop listed above

7.0 REFERENCES/FURTHER READINGS

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UNIT 4 SUGAR CROPS

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Sugar Cane
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Readings

1.0 INTRODUCTION

Sugar is not only an essential food but also used as raw materials in various industries, for the manufacturing alcoholic beverages, soft drinks, ice-cream and confectionery. The common sugar producing crop is sugar cane, this unit will give descriptive information about the origin, taxonomy, morphology and economic value of sugar cane.

2.0 OBJECTIVES

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

- to identify the following a sugar cane
- to know the origin, distribution and taxonomy of a sugar cane
- to be able to describe morphological feature
- to know the economic importance of a sugar cane.

3.0 MAIN CONTENT

3.1 Sugar Cane (*Saccharum officinarum L.*), Family *Poaceae*

Origin: Sugar cane was reportedly domesticated as early as 8,000 B.C in Melanesia, probably New Guinea, from where it said to have progressed westwards. Meanwhile, natural hybridization occurred between *S. officinarum* and *S. spontaneum*, producing 2 hardy species *S. sinensis* (in China) and *S. barberi* in India.

Taxonomy: Sugar cane *Saccharum officinarum* L. ($2n = 80$) family Poaceae is a monocotyledonous perennial belonging to the family Poaceae (Gramineae) and the tribe Andropogoneae. Besides *S. barberi* and *S. sinensis* Rox, which are no longer cultivated, the same genus also includes the wild species *S. spontaneum* L. and *S. robustum* Brandes which are disease resistant and renowned for their excellent vigour and hardiness.

Morphology

Sugar cane is grown as a perennial plant and can be cut to times in succession depending upon the fertility of the site and the care with which it is grown. Two to three weeks after harvesting the stumps shoot again, producing the ratoon crop. The growth cycle, which stretches from the time of planting to the harvest or from the preceding harvest to the next, is called the annual cycle or harvest cycle and usually extends over a period which varies from year (in environments where sugar cane flowers) to two years (in areas where flowering inhibited on account of altitude and or latitude). The cycle in between two successive plantings called the crop cycle, may last up to four years (in highly intensive, mechanized growing) or to even twelve years (in more extensive agriculture or smallholder farming). The first vegetation produced after planting is called virgin cane.

The cylindrical or slightly flattened stalk of the sugar cane plant reaches a height of 2-4m with a diameter of 3-5cm. The cane has more or less protruding nodes and slightly bulging internodes. It is yellow, green, yellowish-green, red, purple or brown in colour; sometimes it is striped (striped cane). By harvest, 20 to 30 internodes, each 10-20cm long, can be expected.

The internode is usually glabrous and, for the most part, covered with a waxy coating. It is filled with sugary pith, which in relation to its total weight contains 11-16% sugar. The alternate leaves are 1-2 m long and 5-7 cm wide. The leaves grow from the stalk at node level. Thanks to its total leaf surface, which may be up to seven times the soil surface area covered, sugar cane is one of those plants that can capture a maximum of solar energy per hectare and per month it is a C₄ plant.

At each node there is a leaf scar, a bud (or eye) and a band of root primordia. The buds alternate and are protected at their base by the leaf sheath. Above ground, the buds and roots remain dormant while below ground the roots grow and the buds may produce new stalks (or tillers), which themselves have nodes, internodes and bud. A well-tillering sugar cane plant may form a tuft of 5 to 20 canes.

The terminal meristem may turn into an inflorescence (or arrow) during short-day periods, but sugar cane rarely flowers. However, flowering stalks use up sucrose and the quality of the cane deteriorates as a result. After producing, the cane dies.

The inflorescence is 0.5-1m long pyramidal panicles, the terminal ramifications of which are thin and have uniflorous spikelets.

The flower is bisexual, with only ovule. Fructification is rarely observed. However, it cannot be ruled out. The small seed is a caryopsis as in other grasses.



Figure 3.3 Sugar cane

Source: Baranov, V.D. Ustimenko, G.V. (1994)

In young cane, sugar occurs mainly in the form of glucose and fructose, whereas during ripening it is stored in the form of sucrose. Sugar cane can be distinguished from other plants by a metabolism that favours most accumulation of sucrose in stalks. (Aliyu Y., 2007).

4.0 CONCLUSION

Origin, taxonomy morphological features and economic values of sugar cane were discussed in this unit. Sugar cane is the commonest sugar producing crop that can be better comprehended by students in terms of familiarities and cultivation.

5.0 SUMMARY

- The Sugar crop was identified.
- Origin, distribution, spread and taxonomy of sugar cane was described
- Morphological features was also described
- Economic importance of the sugar cane crop was given

6.0 TUTOR-MARKED ASSIGNMENT

1. State the origin, spread and taxonomy of a sugar cane
2. Describe the morphological features of a sugar cane
3. Outline the economic importance of a sugar cane

7.0 REFERENCES/FURTHER READINGS

Cobley, L.S. and Steele, W.M. (1970). *An Introduction to Subtropical Crop*. Longman Group LTM.

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UNIT 5 OIL CROPS

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Ground Nut
 - 3.2 Oil Palm
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Readings

1.0 INTRODUCTION

Vegetable Fats and oil are located in the form of small insoluble droplets within the plants' cells. They occur predominantly in seeds' endosperms and cotyledons. There are many plants yielding oils that are edible and used for industrial purpose in high percentages. Examples of oil-yielding plants are oil-palm tree, coconut palm tree, groundnut plant, mustard oil, castor oil and gingerly plants.

2.0 OBJECTIVES

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

- to identify the following crops: Ground nut and Oil palm
- to know the origin, distribution and taxonomy of the above listed crops
- to be able to describe morphological features
- to know the economic importance of the listed crops.

3.0 MAIN CONTENT

3.1 Ground nut (*Arachis hypogaea* L.), Family *Fabaceae* (n =20)

Origin: All species of *Arachis* are geocarpic, ripening their fruits underground. A native of Brazil, it became widely distributed throughout South America at an early date. In the sixteenth century, the Portuguese brought them from Brazil to West Africa and the Spaniards took tree across the Pacific to the Philippines from where they were introduced to China, Japan, Malaysia, India and Malagasy Republic.

Taxonomy: *Arachis hypogaea* L. belong to the Family *Fabaceae* (n =20) has two commonly varieties.

1. Bunch or erect - are short duration, maturing in three to four months. The small or medium-sized pods are born in clusters near the base of plant. One to two small round seeds are produced within each thin-shelled fruit.
2. Runner or spreading – Runner types produce medium-sized pods born all along the length of the branches and contain one to three oval seeds in a comparatively thicker shell. This variety takes about four to six months to ripen.

Morphology: Groundnut is a low-growing annual herb, 0.3-0.6m tall with moderately hairy compound leaves, each having two pairs of opposite leaflets. The flowers are 5-7cm long, yellow and sessile and develop singly or in clusters of two to four. The five fused sepals form a long calyx tube, often mistaken for a pedicel. The papilionaceous corolla and the staminal column (consisting of ten monadelphous stamens) are adnate at the base and inserted on the rim of the calyx tube. The monocarpellary ovary is surmounted by a long filiform style. Self-pollination is usual.

After fertilization, the ovaries are pushed downward to the soil due to the formation of a positively geotropic stipe or gynophore (peg) resulting from the active division of the meristem just underneath the receptacle. Little change occurs in the ovary until it is buried, save for the development of lignified tissue which forms a protective cap at the anterior end. After penetrating the soil to a depth of 2-5cm, the peg loses its geotropic characters, growing horizontally, and the ovary develops rapidly into a fruit. In some cases, fruits are actually produced from underground flowers.

The fruit is an elongated oblong, indehiscent pod, containing one to three seeds (occasionally up to six), constricted slightly between the seeds. The dry pericarp (shell or hull) of the mature fruit is fairly fibrous, characterized by reticulate markings. It constitutes about 20-30% of the weight of the whole fruit. The mature seeds vary in size and shape, often ovoid or cylindrical, 1-2 x 0.5-1.0 cm. The seed coat is represented by a papery covering (skin), the colour ranging from white to pink, purple shades of brown or red. The embryo consists of a large radicle, a leafy plumule and two massive white fleshy cotyledons. The seeds are non-endospermic.



Figure 3.3.1 Ground nut
Source: Baranov, V.D. Ustimenko, G.V. (1994)

3.2 Oil palm (*Elaeis guineensis* Jacq), Family Palmae

Origin: Oil palm originated in West Africa. Its extensive natural stands, which have been tapped and harvested for years, can still, be seen between latitudes 16°N and 10°S. The tree is not one of the characteristic species of the dense forest, where it cannot grow due to a lack of light. It's found, instead, in the gallery forests bordering the major rivers of West and central Africa, where it is often associate with raffia palm (*Raphia* spp.).

Introduction into South America coincided with the migratory movements of African slaves shipped to the colonizers of the New World. Once there it grew and spread alongside the related American species, *Elaeis melanococca* Gaetner. Its Introduction into Southeast Asia dates back to around 1850. The first plantations were established in Sumatra in 1911.

Taxonomy: *Elaeis Jacq* ($2n = 32$) is monocotyledon of the order Palmales, Family Palmae, subfamily Coccoideae and tribe Coccoineae. The genus *Elaeis* includes two other species besides *E. guineensis*, manely *E. odora* (syn. *Barcella odora*), The American oil palm, and *E. oleifera* (syn. *E. malanococa*) –distinguished by its procumbent stipe—that occurs in the tropical regions of Central and South America. *E. guineensis* goes by many common names in the various countries where it is found, e.g. coquito and home palm in Nicaragua, Coroza noli in Colombia, palmiche in Costa Rica and calane or dende do para in Brazil. *E. madagascariensis* Becc., the Madagascar oil palm, is thought to be merely a distinct variety of *E. guineensis*, despite its morphological differences. *E. guineensis* subsp. *Poissonii* is known as diwakawaka or ear palm because of its ear shaped fruits which are due to the presence of flower organs that have evolved into oil producing tissue.

Morphology

E. guineensis can grow to a height of 30m in tall forest but elsewhere its height does not usually exceed 15-18m. Its life span, which is difficult to determine, may exceed 200 years in the wild.

The branchless trunk or stripe is 60-80 cm in diameter. It remains covered by old bases of fallen or cut leaves (or fronds) for the first 12 to 14 years. Thereafter a suberized protective layer replaces the petiole bases, which gradually disappear. The age of 18-20 years, the palm's trunk is smooth over almost its entire length, except at the base and close to the crown. Each year 20-25 new leaves are formed. The crown of the adult palm comprises, on average, 40-50 pinnate leaves, each 5-6.5m long. Each pinnate leaf consists of 1-1.7m long petiole that is extended by the midrib, which carries the 0.70 – 1.20m long leaflets. The petiole, which is much wider at the base, is studded with spines that are modifications of the lower leaflets. The terminal bud or palm cabbage composed of soft, ivory-coloured tissue is located at the heart of the bouquet of leaves that crown the stripe.

The root system consists at every early age of a main axis. This is soon replaced by dense mat of adventitious roots that can grow to great lengths. These roots have two types of ramification. Respiratory roots with pneumathodes and lateral feeder roots. The primary roots are constantly renewed from the base of the stripe or bole.



Figure

3.5.2 Palm oil

Source: Baranov, V.D. Ustimenko, G.V. (1994)

From which they branch out into a thick mat extending in all directions. The size of the root network depends mainly on the level of nutrients in the soil and, above all, on its moisture content. The depth to which the root system extends depends on the depth of the water table. Thus, Lambourne reports that its development is limited to a depth of 45 cm in a soil where the water table in the dry season is at less than 1m from the

surface. Similarly the roots can extend horizontally for several meters. Under normal growing conditions most of the roots are found at depth of 20-60 cm and within a 3.5-4.5m radius.

Oil palm is **monoecious**, but the inflorescences are normally unisexual. It bears male and female inflorescences simultaneously, but the flower buds most frequently give rise to alternating series, more or less long of female and male inflorescence in response to various factors. Mixed inflorescences, which are relatively rare, appear when the tree switches from the male to the female-cycle or vice versa.

The flower buds develop in the leaf axils, except during the first two years of growth. Oil palm normally starts flowering in its third year. The male inflorescence is composed of thick, central axis carrying some 200 spikes, on each of which develop some 700-800 tightly packed flowers. The entire male inflorescence is surrounded by two sheath or spathes that open before the flowering proper. The female inflorescence has an almost identical composition. The somewhat shorter peduncle extends into a thick main axis, the rachis, which bears the spikes with flowers. Each female flower developing in the axil of spiny bract is flanked by two accompanying non-functional male flowers.

Oil palm is considered to be allogamous female and male flowers rarely bloom together. Consequently, oil palm is considered to be allogamous. Dry weather favours the development of female inflorescence. Pollination is mainly entomophilous. *Elaeis* sp. (curculionidae) is the main pollinator in Africa, whereas the Hawaiian flowers thrips (*Thrips hawaiiensis*) pollinates the majority of the palms in Malaysia.

The fruit ripen about six month after fertilization. A fully developed bunch weights 1-70 kg or more and contains 1,000-4,000 fruit, depending on the tree's age and vigour. On a mature plantation the average bunch weight is usually within the 15-25 kg range. Depending on the type of palm, a ripe bunch consists of 50-75% fruit and 25-50% stalks by weight. Normally, a palm produces 5-15 bunches a year. The number of bunches decreases with age. In contrast, their weights increase. On plantations established, with selected seeds, the mature palms mean annual yields exceed 100 kg of bunches/palm, or more than 14t/ha.

The pericarp, which makes up 60% of the fruit's weight consist of a waxy outer envelope (epicarp) and an oleiferous pulp (mesocarp) with a 50-55% oil content. This pulp surrounds a woody shell (endocarp) that varies in thickness from 0-7mm and accounts for some 32% of the fruit's weight. The endocarp contains one or more oleaginous kernels which make up 8% of the fruit's weight and contain about 50% palm

kernel oil. The endocarp and kernels together are commonly known as the oil palm seed, whereas the entire fruit is called oil palm nut. The oval fruit is 3-6 cm long, 2-4cm wide and weight 4-20g. The bunches have an oval shape, but are broader at the base and more pointed at the tip. They are protected by spiny bracts.

4.0 CONCLUSION

Origin, taxonomy morphological features and economic values of Ground nut and Oil palm were discussed in this unit. The representative enumerated is to show the commonest that can be better comprehended by students in terms of familiarities and cultivation.

5.0 SUMMARY

- The following oil crops were identified: Ground nut and palm oil
- Origin, distribution, spread and taxonomy of Ground nut and palm oil were described
- Morphological features were also described
- Economic importances of the oil crops were given.

6.0 TUTOR-MARKED ASSIGNMENT

1. State the origin, spread and taxonomy of the following crops:
Ground nut, oil palm
2. Describe the morphological features of the crop listed above
3. Outline the economic importance of the crop listed above

7.0 REFERENCES/FURTHER READINGS

- Cobley, L.S. and Steele, W.M. (1970). *An Introduction to Subtropical Crop*. Longman Group LTM.
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UNIT 6 VEGETABLE CROPS

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Tomato
 - 3.2 Pepper
 - 3.3 Onion
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Readings

1.0 INTRODUCTION

These are the groups of economic plants that have attracted least attention even though they are used on daily basis. They are classified into the following:

- Vegetable fruits plants: okro, tomato, cucumber etc
- Leafy plant e.g: lotus.

2.0 OBJECTIVES

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

- to identify the following crops: Tomato, pepper and onion
- to know the origin, distribution and taxonomy of the above listed crops
- to be able to describe morphological feature of the above mentioned crops
- to know the economic importance of the listed crops.

3.0 MAIN CONTENT

3.1 Tomato (*Lycopersicon esculentum.*), Family Solonaceae

Origin: Is a native to tropical, central and South America of Peru and Ecuador, the tomato had spread in pre-Columbian times as far as Mexico. It was introduced into Europe from Mexico and to Africa by Spanish in 1523. Cherry Tomato was the wild progenital stock of tomato that was found growing in the wild around the equator. The modern tomatoes are more complex due to the process of hybridization with several other lycopersicum species.

Taxonomy: The genus *Lycopersicon* belongs to the Family Solonaceae. On the basis of its reaction to light response to day light, the cultivars

are categorized into many types which can be cultivated throughout the year in temperate and tropical countries. Therefore, there are determinate and indeterminate cultivars, and berry-fleshy cultivar.

The following five main varieties are sometimes recognized:

1. cherry tomato *L. esculentum* var. *cerasiforme* (Dune)
2. pear tomato L.e. var. *pyriform* Alef
3. common tomato, L.e var. *Bailey*
4. upright tomato L.e var. *validum* Bailey
5. potato-leaved tomato, L.e var. *grandifolium* Bailey

Morphology: The tomato is a weak-stemmed, trailing, much branched, short-lived perennial but treated as an annual under cultivation. Branching at the base of the stem is often monopodial, becoming sympodial higher up. Small glistening reddish-yellow glandular hairs as well as long pointed non-glandular trichomes clothe the stem, petiole and peduncle. The leaves are spirally arranged, unevenly imparipinnate compound (15-30 x 10-25 cm) with variously indented or lobed margins. The flowers are borne in clusters on the main axis and on lateral branches. Inflorescences which develop from the apical bud appear to be opposite to the leaves because vegetable growth is continued by the development of the axillary bud of a leaf just below the apex.



Figure 3.6.1 Tomato

Source: Baranov, V.D. Ustimenko, G.V.(1994

The fruits are fleshy berries and are hairy when young but becoming smooth, juicy and shiny when ripe. They are smooth or furrowed, usually globose with a hollow at the calyx end. The ovary becomes six to twenty loculed due to the formation of false septa and the numerous ovules are borne on the fleshy placenta. Tomato cultivars differ a great deal in size, shape and colour. The range is from small cocktail or cherry to large, beefy table tomatoes weighing up to 0.5kg. Tomatoes are known with yellow, orange, pink and green fruits besides the familiar red types. The red colouration of the fruit is due to the presence of two

pigments carotene and lycopersicin (lycopene); the latter being absent in yellow-fruited varieties. The seeds are flat and raniform, embedded in a jelly-like mass of tissues containing large quantities of phosphorus.

3.2 Chillies, sweet or bell Pepper (*Capsicum ssp.*), Family Solonaceae (x =12)

Origin: A number of species of capsicum were domesticated for their pungent fruits in tropical America. These have long been used as a condiment as well as for food.

Taxonomy: *Capsicum ssp.* Is belong to the family solonaceae. There are about five cultivated species of Capsicum:

- *C. annum* L. – is widely grown all over the world and almost all the varieties cultivated in the United State of America and Europe belong to it. The fruit of *C. annum* are much less pungent than those of *C. frutescens*.



Figure 3.6.2 Peppy

Source: Baranov, V.D. Ustimenko, G.V.(1994)

It includes nearly all the large sweet or bell peppers as well as the small-fruited stronger tasting types producing paprika.

- *C. frutescens* L. – Is cultivated mainly in the tropics and in the warmer regions of the U.S.A. On the whole, it is much more pungent, some of the types being extremely fiery.
- *C. pendulum* Willd – are found only in southern Peru, Bolivia and southern Brazil.
- *C. pubescens* Ruiz – They are from the highlands of South America.

Morphology: *C. annum* produces both pungent and sweet fruits which vary in length from 1-30cm, and in colour when ripe from green through yellow, orange and red to brown or purple. The plants are small, bushy annuals 30cm to 1.5m tall. They are sometimes woody. The angular stems bear alternate, simple leaves which are very variable in size and shape. They are commonly lanceolate to ovate with a pointed tip, and around 6cm long, though rarely as long as 12cm. The petioles are about 2cm long, and there are no stipules. The regular floweres are born singly in the axils of the leaves, not in clusters of two or more as they are in *C. frutescens*. Each flowere has a cup-shaped calyx of five fused sepals which swell and persist with the fruit. The corolla has five or six white or greenish-white petals which are fused together at their bases, but expanded above into lobes. The five to six stamens are inserted at the base of the corolla and have dark-blue anthers which dehisce longitudinally (not by apical pores, as in many other genera of the Solanaceae). The superior ovary has two locules or sometimes more due to the intrusive growth of false septa, with many ovules in axile placentation.

3.3 Onion (*Allium cepa.*), Family Alliaceae (n =8)

Origin: It is believed to have come from the eastern Mediterranean region, including Iran, Pakistan and the mountainous countries to the north where onions have been cultivated as a food crop since the earliest times.

Taxonomy: *A. cepa* known for great number of botanical varieties and cultivars is cultivated throughout the world. The Plant is belongs to the genus *Allium*, and species *cepa* family Alliaceae. Prominent among genus *Allium* are:

1. Shallots - *A. ascalonicum* L.
2. Garlic - *A. sativum* L.
3. Chives – *A. schoenoprasum* L.
4. Welsh onion, ciboule or Japanese bunching onion – *A. fistulosum* L.
5. Chinese
6. Onion or rakkyo – *A. chinensis* G.
7. Don and Leek – *A. porrum* L.

Morphology: Onion is a biennial crop, storing food in the bulb during the first season and flowering in the second season when the days become long and warm enough. The root system of onion is shallow and fibrous. Each leaf consist of two main parts; a sheathing leaf base and a hollow, linear, cylindrical or flattened blade, both being separated by a short plate-like stem surrounded by a number of concentric layers of fleshy leaf bases. The outer leaf bases are thin, fibrous and dry, forming a protective covering or tunic around the inner fleshy ones, which are

laden with food. The innermost leaves also have thickened leaf bases but with aborted lamina.

Towards the end of the first season's growth, the apical meristem or shoot apex grows to produce a leafless flowering stalk the scape, 0.6-0.9m tall, which pushes up through the centre of the pseudo stem formed by the sheathing leaf bases. The scape is hallowed, cylindrical, swollen near the middle and tapering towards the ends. The developing inflorescence is protected by a membranous spathe which at maturity splits to form two to three persistent bracts. Numerous greenish-white flowers are arranged in an umbellate cymose manner. Each flower has six free, greenish-white tepals which open widely, six stamens and a tricarpellate gynoecium. The fruit is a globular capsule.



Figure 3.6.3 Onion

Source: Baranov, V.D. Ustimenko, G.V.(1994)

4.0 CONCLUSION

Origin, taxonomy morphological features and economic values of some common vegetable crops were discussed in this unit. The representative enumerated is to show the commonest that can be better comprehended by students in terms of familiarities and cultivation.

5.0 SUMMARY

- The following crop were identified: Tomato, peppy and onion
- Origin, distribution, spread and taxonomy of the above listed were described
- Morphological features were also described
- Economic importance of the listed crop was given

6.0 TUTOR-MARKED ASSIGNMENT

1. State the origin, spread and taxonomy of the following crops: Tomato, pepper and onion.
2. Describe the morphological features of the crop listed above.
3. Outline the economic importance of the crop listed above.

7.0 REFERENCES/FURTHER READINGS

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UNIT 7 FIBER CROPS

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Cotton

3.2	Jute
3.3	Kenaf
4.0	Conclusion
5.0	Summary
6.0	Tutor-Marked Assignment
7.0	References/Further Readings

1.0 INTRODUCTION

Fibre may be defined as the unit of matter that has hair like dimension and length may be 200 times greater than the width. Fibres botanically consist of very long narrow cells that are many times longer than they are broad. The long cells can be between 1-3 mm and can be up to 55 mm in Rammie. These sheets of tissues occurring either singly or in groups can be overlapping lignified or elastic substances in plants which are potential sources of raw materials to industries.

There are many schemes for classifying fibres. They can be classified based on structural properties, functions and sources and morphology:

Bast or soft fibres eg: fibres from flax, jute and hemp.

2.0 OBJECTIVES

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

- to identify the following crops: Cotton, Jute and Kenaf
- to know the origin, distribution and taxonomy of the above listed crops
- to be able to describe morphological feature
- to know the economic importance of the listed crops.

3.0 MAIN CONTENT

3.1 Cotton (*Gossypium spp x = 13*), Family - *Malvaceae*

It is the world most important non-food agricultural commodity. It was one of the first vegetable fibres used for textile purposes.

Origin: About 20 species were recognized taking into consideration the cytological, genetical geographical and archaeological evidences available at that time. The 16 wild *Gossypium* species are found in Australia, Asia Africa and America where they occur as perennial drought enduring shrubs or small trees growing on the fringes of deserts dry river beds and rocky hillsides. *G. hirsutum* and *G. barbadense* are commonly two species in cultural practice. It gives an average yield in Africa 0.94t/ha, Europe and Australia 3.71 t/ha 2.52 t/ha

Morphology: Te plant is shrubby, reaching a height of 1-1.3 m. The leaves are divide into three to five lobes (rarely seven), the incisions extending up to half of the length of the lamina. The boll is three celled, rounded, beaked, smooth surfaced and rarely with prominent pits or shoulders. Glands are fewer in number and inconspicuous. The fruit open slightly at maturity into three or four loculi, each containing up to 11 seeds, the seeds usually bear two coats of hairs, long lint hair (staple of floss) and short fuzz hairs (linter). The staple is short (9.5-19mm) and grey in colour.

The two species are further divided into five geographic races.

Gossypium barbadense L. (n = 26) is a native of South America and is highly esteemed for the length and finness of its lint. The plants are tall, annual shrubs, reaching up to three meters in height, bearing a few many strong ascending vegetative branches. The leaves are three to five lobed. Corolla is bright yellow in colour with red or purple spots near base. The bolls are usually large (3.5 to 6cm long), dark green, prominently pitted with plenty of oil glands. Fruits may be three or four-valved, each containing five to eight or more seeds that are fuzzy at the ends.



Figure 3.7.1 Cotton

Source: Baranov, V.D. Ustimenko, G.V. (1994)

Gossipium hirssutum L. (n =26) Native of Mexico and Central America. These plants are usually small shrubs or trees with few vegetative branches. The leaves are large codate, hairy and three or five lobed. The flowers are white or pale yellow in colour, usually without purplish spot at the base, turning pink or red on the second day of blooming The boll are large and rounded but unlike. *Gossipium Barbadense* they are usually green and smooth with few oil glands. The seed are covered all over with a white fuzzy coating.

3.2 Jute (*Corchorus spp x =7*), family *Tiliaceae*

Origin: The primary center of origin of *C. olitoris* is Africa with a secondary center in India or indo-Burma. *C. capsularis* is, however, not found in Africa and Australia its center of origin is thought to be Indo-Burma.

Jute is the least expensive, but most important of all bast fibres and comes second in production only to cotton among all the natural fibres. The fibre is obtained from the stems of two cultivated species of *Cochurus*, namely *C. capsularis* L. (white jute) and *C. olitoris* L. (tossa jute). It occupies an important place in Indian economy, being the largest earner of foreign exchange.

Table.1.7 Area, production and yield per hectare of jute + jute like fibers (1993-94)

Continent	Area (ha)	Production (t)	Yield (kg\ha)
Africa	21000	15000	725
North and central America	11000	11000	1034
South America	24000	30000	1248
Asia	1808000	2951000	1632
World total	1864000	3053000	1638

Source: FAO production yearbook, 1994. Volume 48

Morphology: Both the cultivated species are woody, little branched annual having simple, ovate, serrate margined leaves with peculiar curved bristles (auricles) near the base. Flowers are solitary or arranged in few flowered cymes. The two species are quite similar botanically, but differ in number of ways.

C. capsularis is a tall, little branched annual (3-3.7m tall) with ovate glabrous leaves containing a bitter glycoside corchorin. Hence it is often referred to as tita or bitter pat. Small yellow flowers at maturity give rise to small, more or less globular, much wrinkled capsules, flattened at the top, and enclosing chocolate brown seeds. Although the fibers of *C. capsularis* are normally whitish, they are considered inferior to *C. olitorius* and sell at a low price. The plant can withstand water logging in the later stages of growth.

C. olitorius is a much taller species having leaves with a shining upper and a rough undersurface and with no bitter taste.



Figure 3.7.2 Jute

Source: Baranov, V.D. Ustimenko, G.V. (1994)

The leaves are almost tasteless when chewed (known as mitha or sweet pat) the yellowish flowers are larger in size than *C. capsularis*, each developing into a long, cylindrical, ridged capsule with an elongated beak. Seeds are small (500 to 1 g).

3.3 Kenaf (*Hibiscus cannabinus* L.), Family Malvaceae

Origin: Kenaf is found in the wild state in tropical and subtropical Africa. It is also a wild plant in India, which is regarded as a second centre of origin. The cultivated forms are mainly grown for fiber production. It has wide range adaptation and is grown in Africa, Asia Cuba, Florida and the southern region of Russia.

Taxonomy: The genus *Hibiscus*, which belongs to the Malvaceae family. Comprises many herbaceous species known for the production of fibre, food, and decoration:

- Fibre = *H. cannabinus*, *H. sabdariffa*
- Edible plant parts = *H. esculentus*, *H. sabdariffa*
- Ornamental plants = *H. rosa-sinensis*

Morphology: Kenaf (*H. cannabinus* L.) ($2n = 36$) is generally grown an annual plants, but can become perennial in certain environments. The stem is erect rigid 1.5-3m or more in height, with lateral branches. It can be glabrous or prickly. Usually is green in colour, but it can also be red or purple. The bark contains relatively long fibres and its root has a well – developed tap-root.



Figure 3.3.3 Potato

Source: Baranov, V.D. Ustimenko, G.V.(1994)

4.0 CONCLUSION

Origin, taxonomy morphological features and economic values of cotton Jute and kenaf were discussed in this unit. These crops are the commonest that can be better comprehended by students in terms of familiarities and cultivation.

5.0 SUMMARY

- The following crop were identified: Cotton, Jute and Kenaf
- Origin, distribution, spread and taxonomy of the above listed were described
- Morphological features were also described
- Economic importance of the listed crop was given

6.0 TUTOR-MARKED ASSIGNMENT

1. State the origin, spread and taxonomy of the following crops: cotton, jute and kenaf
2. Describe the morphological features of the crop listed above
3. Outline the economic importance of the crop listed above

7.0 REFERENCES/FURTHER READINGS

Cobley, L.S. and Steele, W.M. (1970). *An Introduction to Subtropical Crop*. Longman Group LTM.

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UNIT 8 BEVERAGES AND STIMULANT CROPS

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content

3.1	Cacao
3.2	Tea
4.0	Conclusion
5.0	Summary
6.0	Tutor-Marked Assignment
7.0	References/Further Readings

1.0 INTRODUCTION

These are plant for refreshing and stimulating, they are mild, agreeable and stimulating liquors meant for drinking. The tea, coffee and cocoa plants are few examples of non-alcoholic beverages.

2.0 OBJECTIVES

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

- to identify the following crops: Cacao and Tea
- to know the origin, distribution and taxonomy of the above listed crops
- to be able to describe morphological feature
- to know the economic importance of the listed crops.

3.0 MAIN CONTENT

3.1 Cacao (*Theobroma cacao L.*), Family *Sterculiaceae*

Origin: Cacao originated in South America. On the edges of the Amazon and Orinoco basins, in the equatorial regions of the Americas and on the eastern slope of Andes Cordillera. The name *Theobroma* given by Linnaeus in 1720 recalls show its divine origin that seed had been brought from paradise by prophet Quetzalcoatl, this name is drives from the Greek “food of gods” The word cacao originates from the Aztec terms cacahuatl (cacao beans), cacahuatzintle (cacao pod and cacahuaquahultl (cacao tree))

Taxonomy: The genus *Theobroma* of the family *Sterculiaceae*, includes about twenty species of which only *T. cacao L.* ($2n = 20$) is of economic interest

Cheesman (1944) classified all cultivated cacao into a single species, *T. cacao*. He suggested subdividing cacao into certain well-defined groups, to which the various local populations are related. The three main recognized groups are Criollo, Amazonian Forastero and Trinitario.

Morphology: The cacao tree is small 8-10 m tall in the wild, but rarely exceeding 4-6 m when cultivated. The trunk is straight, relatively short and covered by a grayish-brown bark.

Cacao has tap-root that can reach a depth of 1-1.5 m and secondary vertical roots often develop from there downwards. The lateral roots generally clustered in whorls are located in the top fifty centimeter of soil. The majority of the fibrous rootless extending from these are in the superficial humus-containing soil layers.

Towards the age of 12 to 18 months, the stem, which has by then reached 1-1.5 m in height, stop developing vertically and grows out into a whorl of three to five branches, called the crown or 'jorquette'. The suckers called chupons have an orthotropic growth habit, as the stem does, whereas the branches have a clear plagiotropic habit.

The leaves, which are simple, alternate and lanceolate, are 20-30 cm long and 7-12 cm wide. They are coriaceous and shiny, with a drooping habit initially light green to mauvish in colour, they turn green when they mature.

The flowers appear on the trunk (cauliflory) and framework branches (ramiflory), in the axils of old leaf scars, which have developed into flower cushions. They are hermaphroditic, solitary or clustered into small groups whitish or yellowish in colour and hanging downwards. Protogyny occurs i.e. the stigmas are receptive approximately 12 hours



before the pollen matures. Flowering is usually abundant and each cacao tree produces several thousand flowers.

Cacao may be autogamous, but there are many cases of self-incompatibility.

Figure 3.8.1 Cacao

Source: Baranov, V.D. Ustimenko, G.V. (1994)

This phenomenon must be borne in mind when dealing with the Upper Amazonian and hybrid (Trinitario) populations. However, the Upper Amazonians are intercompatible, unlike the Trinitarios, which will often accept pollen only from self-compatible trees. The lower Amazonian Forestero types and in particular, Amelonado, are normally self-compatible.

Pollination is essentially entomophilous the main agent being a small fly *Forcipomyia* sp. Only the females are able to carry out the process. Thrips and ants (*Crematogaster* sp.) would also seem to be able to assist in natural pollination. However, the percentage of pollinated flowers is low 5-20% depending on fluctuation in these insects' populations and their activity levels. Due to incompatibility factors, satisfactory fertilization of the ovules will only occur in small percentages of pollinated flowers. Only about 1.5% of the flowers produced are fertilized. Not more than 10-30% of the young fruits reach maturity because of the spontaneous abortion of young fruits (cherelles) during the first eight weeks after fruit-setting. This phenomenon of abortion called wilt would appear to be due to mineral or hormonal deficiency or to a moisture deficit. Thus about 0.15% of all flowers produced develop pods through to maturity.

The fruit, called a pod is kind of berry and is elongated to spherical in shape. The pod, which may be smooth or warty depending on the variety, has ten furrows, five of which are superficial and five more or less deep. Coloration varieties from green to dark red. Depending on the initial shade, it turns yellow orange or scarlet on ripening. The inside of the pod, which is protected by a hard thick covering (pericarp or cortex) is made up of five loculi whose walls disintegrate on ripening to form a sweet, mushy, whitish and slightly acidic pulp, surrounding around 30-40 seeds or beans. These are usually arranged in five longitudinal rows. The kernel, contained in a papery integument called a shell is made up of the embryo and two thick cotyledons. Depending on the variety the colour of the cotyledons varies from a more or less pure white to dark violet. In cacao hybrids, a single pod may contain both white and violet kernels.

3.2 *Camellia sinensis* (L.) n=15 syn. *Thea* (*Thea sinensis* L.), Family Theaceae

Origin: Tea is believed to have originated from India or China or even both. Although there is no doubt that tea was being cultivated in China as early as 2700 B.C. it has never been found to grow there in truly wild state.

Taxonomy: The genus *Thea* of the family Theaceae includes about four principal varieties:

- *Camellia sinensis*
- *Bohea* Pierre
- *Cantoniensis* Pierre
- *Viridid* Pierre

- *Assamica Pierre*

For practical purposes the cultivated forms are generally grouped into two types, namely the Chinese teas (var. *sinensis*) and Assam teas (*Camellia sinensis* var. *assamica* mast)

Morphology: The tea for commercial purposes consists of the processed tender leaves and the leaf buds of *Camellia sinensis*. It was once designated as a species of the genus *Thea* (*T. sinensis* L.) but was later shifted to *Camellia* tea Link (now named *C. sinensis*).

Under natural conditions, the tea plant is an evergreen or semi-evergreen woody shrub, attaining a height of 9.1-15.2 m, but under cultivation it is never allowed to grow beyond plucking height. The bushes are often pruned back to encourage maximum leaf production. The leaves are alternate, generally elliptic to lanceolate with toothed margins. The older leaves are leathery, bright green in colour and 5-30 cm long. The undersurface of young tender leaves is densely covered with soft hairs that vanish as they age. The characteristic fragrance and aroma of the leaves is due to the presence of numerous oil glands. Yellow-centered white or pinkish fragrant flowers are born in leaf axils either singly or in groups of two to four and produce at maturity three-celled woody capsules, each compartment of which contains a brown seed, about 1.25 cm in diameter. S.L. Kochhar (1998).

4.0 CONCLUSION

Origin, taxonomy morphological features and economic values of some common Beverage and Stimulant crops were discussed in this unit. The representative enumerated is to show the commonest that can be better comprehended by students in terms of familiarities and cultivation.

5.0 SUMMARY

- The following crop were identified: Cacao and Tea
- Origin, distribution, spread and taxonomy of the above listed were described
- Morphological features were also described
- Economic importance of the listed crop was given

6.0 TUTOR-MARKED ASSIGNMENT

1. State the origin, spread and taxonomy of the following crops:
Cacao and tea
2. Describe the morphological features of the crop listed above
3. Outline the economic importance of the crop listed above

7.0 REFERENCES/FURTHER READINGS

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UNIT 9 MEDICINAL PLANTS

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content

3.1	Cinchona
3.2	Bellodonia
4.0	Conclusion
5.0	Summary
6.0	Tutor-Marked Assignment
7.0	References/Further Readings

1.0 INTRODUCTION

These are plant used for curing various human ailments. In the last two decades there had been more interest to obtain active ingredients from vegetable sources than at any time in the history of mankind and plants. The active ingredients of plants drugs are more commonly concentrated in storage organs. Such storage organs are the roots, seeds and fruits, bark and leaves. Flowers are less commonly used for drugs purposes. The roots and woody parts of herbaceous plants are usually relatively inert in nature. E.g: Bellodonia, cinchona.

2.0 OBJECTIVES

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

- to identify the following crops: Cinchona and Bellodonia
- to know the origin, distribution and taxonomy of the above listed crops
- to be able to describe morphological features
- to know the economic importance of the listed crops.

3.0 MAIN CONTENT

3.1 Cinchona-Fever Bark Tree (*Cinchona ledgeriana* Moens) Family *Rubiacea*

Origin: Cinchona is native to India, Ireland, Indonesia, highland of South America.

The anti-malarial property of cinchona bark was discovered since early times. The bulk of the commercial supply of drugs is derived from the bark of several species of cinchona.

Taxonomy: The genus Cinchona is otherwise called quinine tree. It belongs to the family rubiaceae. It has some thirty-five well-known species, but *C. ledgeriana* Moens is the most widely cultivated for the production of cinchona-derived alkaloids

Table. 1.9

Taxonomy of *Cinchona ledgeriana*

S/N	Common name	Native name	Botanical name	variety
1	Yellow bark	calisaya	<i>Cinchona calisaya</i>	wedd
2	Ledger bark	ledger	<i>Cinchona ledgeriana</i>	moens
3	Ledger bark	calisaya	<i>Cinchona calisaya</i>	edgeriana
4	Pale bark of commerce	loxa	<i>Cinchona officinalis</i>	;
5	Red bark of commerce	calisaya	<i>Cinchona succirubra</i>	Pav.
6	;	ledger	<i>Cinchona micrantha</i>	pruiz
7	;	cinchona	<i>Cinchona nitida</i>	Pav.
8	;	calisaya	<i>Cinchona pitayensis</i>	;

Source: Kochhar, S.L. (1998)

Morphology: *Cinchona ledgeriana* is a small tree that can reach a height of 10 m. It has a pyramidal crown that is often split into several central axes. The leaves have short petioles and are opposite, single narrow, approximately 20 cm long and dark green. Domatia (small cavities) occur at the origins of the secondary veins on the underside of the leaves. The small, creamy-white, heterostyled flowers are arranged in custers of cymes. They are cross-fertilized by insects. The fruits are ovoid capsules containing numerous small, winged seeds. The bark of the trunk, branches and roots is the useful part of the plant. It contains a series of alkaloids such as quinine, quinidine, cinchonidine and various minor alkaloids.

The red cinchona, *C. pubescens* Vahl (syn. *C. succirubra* pavon) is used primarily as rootstock. It produces so-called pharmaceutical bark. Hybrids are also grown. They are of interest because of their great hardiness. As a rule their bark contains relatively little quinine.

3.2 Belladonna (*Atropia belladosia*) (n = 36) is Called Deadly Night Shade Tree

Origin: it has been extensively used in European medicine since the earliest time and is still one of the most important drugs of plant origin.

Taxonomy: The genus *Atropia* belongs to the family **solanaceae**

Morphology: Herbaceous perennial plant with creeping root stock growing from a height of 90cm to 120cm. It posses alternately arranged

ovate leaves and bell-shaped purple flowers. It bears shining brownish or black berries.

All parts of the plant including leaves, roots and stem contain alkaloids which are abundant in the physiologically active cells. The alkaloids that are isolated or extracted are collectively called belladonna alkaloids. However there are variations like Atropine and Hyoscyamine and scopolamine. These three are the most commonly used in medicine. Others such as Apocarpine, belladonnine, noratropine, norhyoscyamine, tropacocaine and metolindine are relatively unimportant therapeutically.

4.0 CONCLUSION

Origin, taxonomy morphological features and economic values of some common Medicinal crops were discussed in this unit. The representative enumerated is to show the commonest that can be better comprehended by students in terms of familiarities and cultivation.

5.0 SUMMARY

- The following crops were identified: Cinchona and Belladonna
- Origin, distribution, spread and taxonomy of the above listed were described
- Morphological features were also described
- Economic importance of the listed crop was given

6.0 TUTOR-MARKED ASSIGNMENT

1. State the origin, spread and taxonomy of the following crops: Belladonna and cinchona
2. Describe the morphological features of the crop listed above
3. Outline the economic importance of the crop listed above

7.0 REFERENCES/FURTHER READINGS

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UNIT 10 OTHER CROPS

CONTENTS

- 1.0 Introduction
- 2.0 Objectives
- 3.0 Main Content
 - 3.1 Paper and Paper-Making Plants
 - 3.2 Plants for Gums and Resins
 - 3.3 Rubber Plants and Rubber Product
 - 3.4 Fumitory and Masticatory Plants

- 3.5 Forest and Forest Products
- 3.6 Ornamental Plants
- 4.0 Conclusion
- 5.0 Summary
- 6.0 Tutor-Marked Assignment
- 7.0 References/Further Readings

1.0 INTRODUCTION

This unit treats those plants that are useful to man that are not necessarily cultivated but grows wild in the forest. Paper making plants, gum and resins, rubber yielding plants, Fumitory and Masticatory Plants and ornamental plants where highlighted.

2.0 OBJECTIVES

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

- identify those plants that are used by man making papers, gum, resin, rubber, fumitory and ornamentals.
- describe forest trees that are used as timber
- identify and differentiate the different ornamental plants.

3.0 MAIN CONTENT

3.1 Paper and Paper-Making Plants

Anciently paper-making plant was associated with plant *Cyperus papyrus* which grew around 2,400 BC. Paper is made from any fibre but the paper making quality or value depends on the amount, nature, softness and pliability of the cellulose that is present in the cells wall of fibres.

3.2 Plants for Gums and Resins

Gums and resins are plant products human being used on daily basis for binding works, and used as stiffening agents in ice cream, stabilizers and builders in medicinal pills and tablets. Resins are obtainable from plant familie eg: *Fabiaceae* e.g. Congo copd, copaiba balsam.

3.3 Rubber Plants and Rubber Product

Rubber plants include: *Hevea brasilliensis*, *Manihot glaziovii*, *Castilloa elastica* and *Ficus elastica*.

3.4 Fumitory and Masticatory Plants

They are type of plant men smoked or chewed for pleasure or exhilaration in order to escape harsh realities of life. They consist of ingredients which are stimulatory or digressive to the Central Nervous system. Examples of these plants are tobacco, cocoa and beverages.

3.5 Forest and Forest Products

This is a vegetation covers on the earth. Vegetation may be natural or artificial and latter is represented by afforestation programme in Nigeria. A good percentage of the earth comprises of forest which are represented I region where rain is distributed throughout the year.

Type of wood and wood items are used in various form either a coniferous types of forest wood or non-coniferous forest wood.

Woods are made up of xylem tissue. Once the stem is cut from the plant it becomes a log, which is an unprocessed cut stem of the tree. The log is processed to become timber, this wood is the major product of any forest.

The commercial wood is grown mainly for timber purpose is mainly are

3.6 Ornamental Plants

Ornamental plants are confined to plants grown for aesthetic values. They are used for decorative purposes and to beautify landscape in homes, parks, and offices. Horticulturally a plant is classified as ornamental when it is used to decorate a landscape or when it is grown to satisfy a desire for beauty. The purpose for growing a plant depends on whether it is classified as ornamental or as agricultural crops. For example people grow mango and citrus as vegetable fruits for aesthetic values.

The production of ornamental plants is known as floriculture or landscape horticulture. Floriculture is the art of growing and selling, dressing and arranging flowers and foliage plants. There are many habits of horticultural trees, shrubs and over important ornaments for homes, parks, public buildings and even recreational centers. Turf grasses receive considerable attention as ornamental plants. The vast number of football fields, play grounds, highways, cemeteries and many homes has considerable demands for turf grasses.

Ornamental plants are classified into the following:

1. Ornamental woody eg:- flowering trees, foliage trees, palm trees and conifer trees/ they provide shade absorb noise pollution and provide shelter for both human and animals.
2. Ornamental herbaceous plants. They are present in the home and home ground and they contribute with colour interest to the scene. Eg:- palms, azola and hyacinth
3. Ornamental vine. This is for making walls and fences, English Ivy is commonly used.
4. Ornamental roses. E.g.:- rugosa, florigunda
5. Ground covers and lawns. They are of reducing maintenance cost in yards and homes, absorbing heat and radiation and for protecting soil against erosion e.g.:- wild spinach (*Amaranthus spinasus*), gamba grass (*Andropogon gayemus*), carpet grass (*Anexopus species*)
6. Hedges. They make uniform growth within any season from dense to the top. They give formal appearance to landscape. Eg:- acalypha species, *Ageve sisalina* Aloe barteri, camphor plant

4.0 CONCLUSION

Most of today's important economic plants are known to the early agriculturist and modern man's contribution to agricultural development have been more in terms of yield improvement than in discovering new species with economic potentials. The primary needs of mankind are three folds:

1. Food, obtainable from plants
2. Clothing obtainable from plants
3. Shelter, obtainable from plants

Apart from the three primary functions of plants to man, they provide us with many secondary products such as dyes, tannins, waxes, resins, flavourings agents, medicine and drugs, rubber, latex and a host of others. The Literature behind the present distribution of economic plants, many of which are now cultivated on the continents far from where they originated, are fascinating studies in themselves. Thus, the study of economic botany is recognised as human wealth, riches and health.

5.0 SUMMARY

Botany as a science has contributed a lot toward the present development level in agricultural production. We also understand that plant will continue to provide the tree basic necessities of life as well as other useful items. Nevertheless, the problem of food production is acute and will become more critical with each passing years. Therefore the

world's food supply will more or less depend on improvement of crop plant and animals through plant sciences i.e.:- Botany.

Economic botany covers vast variety of subjects and topics. Is branch of biology as well as botany, which covers the following:

1. Forest and forest products, the usefulness of specific plants and plant product, consumable varieties of plant effects of weeds on cultivated plants and its economic losses.
2. it deals with the use of plants and their products for improved human health drugs and medicinal plants and their active ingredient or composition of:
 - ornamental plants
 - Fiber producing plants and textile raw materials
 - Root and tubers crop
 - Gum and resins
 - oil and fat producing plants
 - Stimulants and beverages
 - Fumitory and masticatory materials
 - Cereals

6.0 TUTOR-MARKED ASSIGNMENT

1. Outline the economic importance of the (A) Gum and Resin B) Rubber (C) Paper making plants (D) Fumitory plants
2. Classify ornamental plants

7.0 REFERENCES/FURTHER READINGS

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