COURSE CODE:	PCP 201
COURSE TITLE:	Principle of crop production (I)
NUMBER OF UNITS:	3Units
COURSE DURATION:	Three hours per week

COURSE DETAILS:

Course Coordinator: Dr. Sunday Gbenga Aderibigbe B.Agric., M.Sc.,PhD
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Other Lecturers: Profs. S.T.O. Lagoke, J.A. Adigun; Drs. S.O. Adigbo; T.O. Fabumi; P.O. Akintokun; A.O. Olaiya; O.R.Adeyemi; I.O. Lawal; P.M.Olorunmaiye

COURSE CONTENT:

History of agriculture and its relationships with other sciences.Agricultural ecology:ecosystem distribution of vegetation and animals.Cropping systems,tillage practices-convectional,minimum,no tillage.Farm tools and machinery,farm buildings and structures.General production practices of field crops.Derivation and characteristics of common varieties of cereals,grain legumes and pulses,roots and tubber species,plantain and bananas.Insects orders and diseases of economic importance in crop production in the topics.Seed viability,dormancy,germination testing.Crop propagation;Seed and vegetative.General role of extension in crop production.

Practicals:

Identification, usage and maintenance of farm tools and machinery. Identification of seedling materials of arable crops propagated by seed, sett, stem, vine, root, sucker corms and cormel and rhizomes etc. Methods of seed viability testing. Dormancy: causes and how to overcome them. Identification/collection of weed, insects and plant disease of economic importance. Field practice on various cultural management practices: land preparation, seedling, weeding, insect control fertilization, harvesting etc.

COURSE REQUIREMENTS:

This is a compulsory course for all students in the university.In view of this,students are expected to participate in all the course activities and have minimum of 75% attendance to be able to write the final examination.

READING LIST:

1. Philip O.Adetiloye, Kehinde A. Okeleye and Ganiyu O.Olatunde (2006). Principles and Practices of Crop Production.
2. Opeke, L.K. (2006). Essentials of Crop Farming
3. Nworgu, F. C. (2006). Prospects and Pitfalls of Agricultural Production in Nigeria
4. Akobundu I. O. (1987). Weed Science in the Tropics Principles and Practices
5. Opeke, L.K. (1987). Tropical Tree Crops. Spectrum, 327p.
6. Technical Centre for Agricultural and Rural Co-operation - CTA. (1998). Propagating Plants: An Organic Approach. 140p.

LECTURE NOTES

History of agriculture

The history of agriculture dates back to the history of the early man. This is grouped into four stages of develop before the advent of modern agriculture. Paleolithic or Stone Age, 2) Mesolithic or middle Stone Age, 3) Neolithic new stone age and 4) Bronze age

1. PALEOLITHIC OR STONE AGE: This is the earliest and longest period of human history which perhaps lasted for more than a million years. During this age, farming per se did not exist nor did the domestication of animal. Going by the historical background in the Bible Genesis 3:23, the LORD God sent man out of the garden of Eden to till the ground from which he was take. Consequently, the harrowing experience outside the comfort zone of the garden of Eden compelled the first man created by God to start wondering from one place to another in search of fruit to sustain his livelihood and that of the family. Therefore, early man in this age used fire, chipped piece of hard stone and rough implements such as crude hand axe and scraper. These were used for hunting and gathering fruit.

2. Mesolithic or middle Stone Age: This was from 12,000 to 6, 000 BC. During this period, men developed and lived with the spear, the bow and fishing net. Wandering in pursuit of game was replaced by primitive farming. Gradual shift from food gathering to food production appeared to have developed independently at different times in different parts of the world

3 Neolithic new Stone Age: This age began at about 6,000 BC. When polished stone tools were developed and used. By trial and error, early man identified those plants of greater value to him and found that the seeds of such plants could be saved and planted to produce more plants, thereby ensuring steady food supply

4) Bronze age: The stone advanced into Bronze Age and later the Iron age, during which better tools were developed to meet the agricultural need of man. Agricultural production evolved with the introduction of other scientific and cultural events. The appearance of plough in 3000 BC was a land mark in the development of crop cultivation. The replacement of the man-drawn plough by an ox-drawn one was also another major advancement.

DEVELOPMENT OF MODERN AGRICULTURE

Modern agriculture started in England in 18th century. By 1701 precisely, an English farmer called **Jethro Tull** inverted grain drill and horse-hoeing implement which gave rise to better methods of cultivation and ease mechanization through row-crop cultivation..

Investigation on the phenomenon of soil fertility and plant growth was made by **Van Helmont (**1577-1664). He regarded water as the sole nutrient for plants. Another renowned worker was John Woodward. In 1699, he obtained water from various sources and grew spearmint in them. He reasoned that since all these plants have abundant water all should have made equal growth if nothing more was needed. The amount of growth increased with quantity of impurities in the water.

He therefore concluded that vegetables are not made up of water alone but some other terrestrial material contributed by the impurities in water.

In search for plant nutrient between 1770 and 1800 many experiments were conducted and facts accumulated on the mode of plant nutrition. The most important contribution at this time was from Joseph Priestly (1775). He found that plant do not affect the air in the same way as animals and that plants actually reversed the effect of animals breathing or respiration on the air thereby keeping the atmosphere pure and wholesome. He discovered oxygen as vital for life but did not discover carbon dioxide, or its necessity in plant nutrition. His work pioneered the understanding of the photosynthetic process. 1779- Jan Ingen – Housz discovered that air purification goes on in light only whilst pollution by plants takes place in darkness. The effect of air on plants and nature and origin of salts in plants was studied by Theodure de Saussure (1782). He grew plants in air or in a known mixture of air and carbon dioxide and measured the gas in air and changes on plant weight. He was thus able to demonstrate the central facts of plant respiration i.e. absorption of O_2 and releasing of CO_2 in the dark. He further showed that carbon dioxide was absorbed and oxygen released in presence of light. He observed that carbon dioxide in a very small quantity was a vital necessity for plants. If furnished with carbon and oxygen, water is also decomposed and fixed by plants. On comparing the amount of material that can enter through the root under the most farvourable condition, he concluded that the soil furnished only a small part of the food.

At 1834, J.B. Boussingault carried out series of field experiment on his farm. These were the first of its kind. Boussingault therefore, pioneered the research method on which the new agriculture science was to be developed. Boussingault's work covered a wide range of agricultural practices and dealt with the cultivation of crops, soil studies and animal nutrition. Liebiy (1840) published a book titled "Chemistry in its Application in Agriculture and physiology" in which he presented the law of minimum. This law stated that if one crop nutrient is missing or deficient, plant growth will be poor, even if the other elements are abundant. This law is still valid today.

Relationship between Agriculture and other Sciences

The development of modern agriculture, benefited from advances in other science such as botany, engineering, plant physiology, chemistry etc. A lot of early work in chemistry led to our present understanding of plant nutrient requirements and later, the production of fertilizers. Advances in botany and physiology further enhanced our knowledge of forms and functions in crop plants. Early developments in engineering also facilitated the development of farm tool and machineries that reduce or eliminate the physical exertion in agriculture. This encouraged the establishment and maintenance of large scale farms. Further advances in biochemistry and toxicology led to the chemical control of weeds. Thus, modern day agriculture is an embodiment of all aspect of science and technology. Further advancement of the profession still requires the continuous application of innovations in science and technology.

Center of origin of cultivated crops

Centre of origin are the region of the world where crops are believed to have existed naturally without being introduced there for the purposes of cultivation. Center of diversity is the region of the world where the greatest variability in crop species is believed to have occurred. A centre of diversity can also be center of origin.

Primary center of diversity: These are centres where maximum diversity occurs and where the crop is believed to have been first cultivated or domesticated.

Secondary centers are area of diversity to which plant have migrated from a primary centers

The lists of some of the plants that are supposed to have originated from various Centres are as follows:

1. **Southwest Asia**:-Barley, carrot, date palm, grapes, melon and wheat.
2. **Mediterranean**:- alfalafa, cabbage, clover, hops, lettuce and Olive.
3. **Ethiopia**:- barley, castor, coffee (arabica), finger millet, walnut, okra and sorghum.
4. **Central Asia**:- apples, foxtail millet and hemp.
5. **South East Asia**:- bamboo, banana, chinese yam, citrus, coconut and sugar cane.
6. **Indo-Burmese**:-cocoyam, cotton, garden egg, jute, mango, pigeon pea and rice.
7. **Chinese**:- onions orange, small bamboo & soybean.
8. **West central Africa**:- banboo, ground nut, coffee (robusta), kola., cowpea, sorghum, oil palm, red rice and yam.
9. **Central America and Mexico**:- Guava, kidney bean, maize, red pepper, sisal and cotton.
10. **Ecuador and Peru**:- Avocado pear, potato, paw-paw, cotton, sweet potato tobacco and tomato

11. **Brazil and Paraguay**:- cashew, cassava, cocoa, Ground nut, pine apple & rubber.

Importance of origin of crops

1. Breeders used it to identify diverse forms of the species with useful traits or characters for crop improvement.
2. Used by crop protectionist in designing biological control e.g. cassava meal bug

ECOLOGY AND VEGETATION OF NIGERIA

Ecology:- study of organism in relation to their environment. Ecological system or Ecosystem:- refers to the collection of organism that interact or have the potential to interact with physical environment they live. Agricultural activities in any given environment depend on ecology of the region. The components of ecology are climate and soil.

Climate component that interact to produce weather are as follows:

Temperature:-in the tropics, it ranges between 15 and 34 oC. With this crop can be grown throughout the year from January to December. However, temperate regions, temperate determine when agricultural activities commence.

Rainfall: Adequate moisture is essential for plant growth. Over most part of West Africa, the climate is dominated by two air masses namely: a) north-easterly hamattan or dry continental tropical air which originated over Sahara desert and

b) The humid oceanic air brought in by south west winds. These two air masses converge at the Inter-Tropical Convergence (ITC). These zone characterized by

1. Low dense clouds
2. Heavy rains
3. Violent thunderstorms.

A larger part of the agricultural areas of West Africa falls within the ITC zone The Southwest winds bring rain to a zone of 500 -550 km wide on either side of the ITC midline. The ITC follows seasonal variations depending on the apparent position of the sun, thus the occurrence of the alternating wet and dry season periods over most of the areas covered by West Africa. Another type rain of importance in West Africa is the convectional rain. This type of rain is characteristics of the coastal areas, which coincide strictly with the equatorial zone of West African sub-region. Convectional rainfall results from evaporation and precipitation phenomena.

Altitude:-is strictly a component of climate, nevertheless it affects the local weather of an area. The higher the altitude the cooler it gets thus, high altitude areas provide opportunity for crops like tea and coffee Arabica. Majority of agricultural crops of Nigeria can be profitably cultivated at low to medium altitude (0 – 2000 m above sea level) eg yam, cocoyams, maize, cowpea, plantains, cassava, cacao, oil palm, ruber and robusta coffee.

Photoperiod (day length):- is the length of daylight in every 24 hours. Photoperiodic variation is not pronounced in the major crop production areas of Nigeria. Although a few indigenous West Africa crops (e.g. pigeon peas, sorghum, cowpea, okra and millet) show clear photoperiodic response. Because of the variation in the day length crops are grouped into either- photo- neutral, long and short –day types.

Humidity:- measure the degree of moisture in the air within the atmosphere. Most Nigeria crops and animals adapted to the high humidity of the rainy months and the relatively low humidity of the harmattan season.

Soil : is another factor responsible for diversity of an ecosystem.

Agricultural ecological zones of Nigeria

Nigeria is one of the luckiest countries in the world which had all the vegetational belts (Fig 1) . They are:

1. Mangrove:-These are swampy discontinuous forest areas along the Atlantic coastal of Nigeria. They are most prominently noticeable at the deltas where the brivers empty into the Atlantic Ocean. Some of these mangrove forest are salty and can only support salt-tolerant mangrove plant species

e.g. raffia palms, obeche etc. The major agricultural activity of this vegetation zone lumbering and fishing

2. Rain forest: it is a discontinuous forest zone along the coast following the mangrove forest. The major agricultural activities include- timber, cocoa, kola, coffee, plantain banana, rubber oil palm coconut while arable crops are cassava, yams, cocoyam, maize etc.

3. Derived savannah: As the name implies, it was formerly forest but because of the activities of man (fire, overgrazing crop cultivation over time etc), the vegetation changed to savanna. common crops are yam, cassava, cereals-Maize, rice sweet potato, mango citrus guava, avocado etc.

4. Southern guinea savannah: Tall grasses, ground nut, cotton yam, cassava, ginger, legumes, cereal etc.

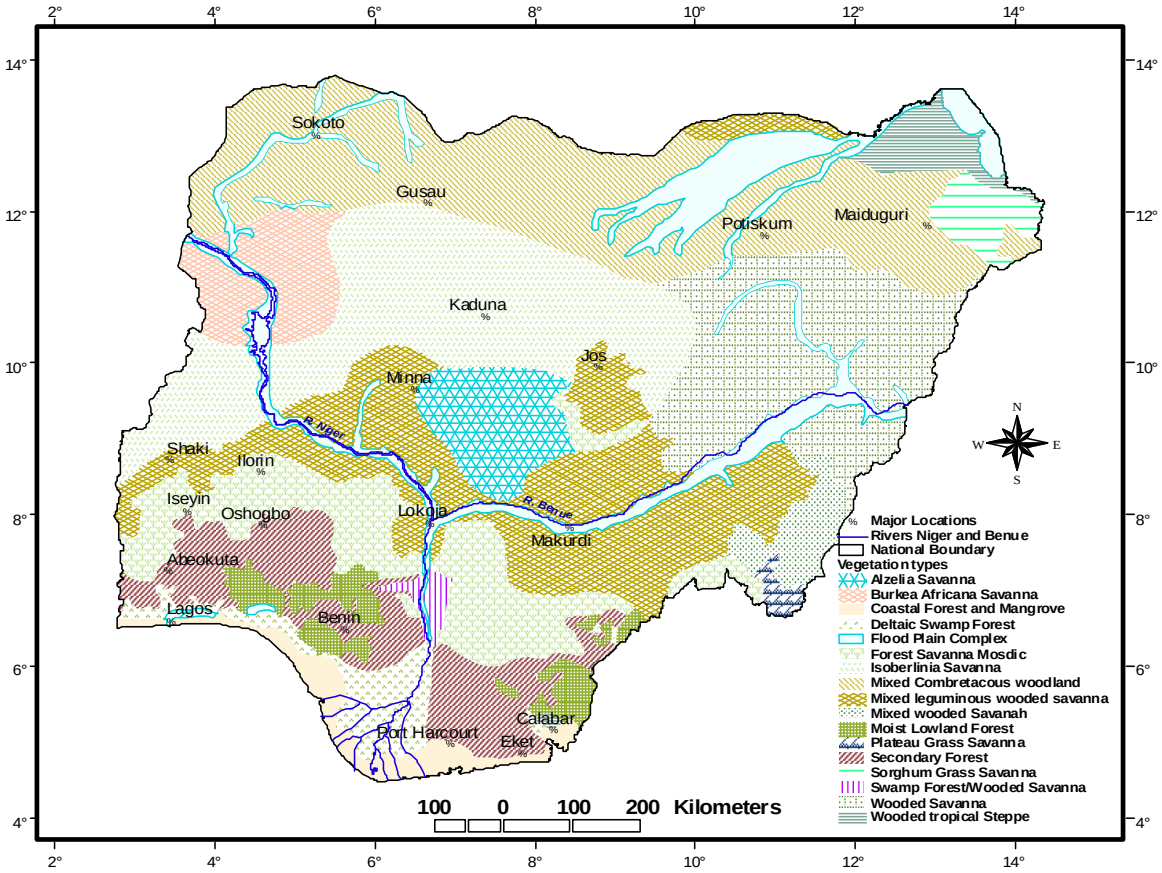
5. Northern guinea savannah:-in 4 above.

6. Sudan savannah:- Few drought, fire resistant trees and shrubs, extensive grassland, millet, cotton, ground nut, tomatoes, watermelon etc.

7. Sahel savannah:- Short cereals, pulses, maize, bambara ground nut tomatoes, onions etc.

8. Montane forest:- tea, coffee, vegetables etc.

Every crop species has optimum sets of conditions for growth. As a general rule crops are not profitable unless they are adapted to the region to which they are produced. The map below gives graphic description of vegetation in Nigeria



Crop distribution

Going from the very wet mangrove to the rainforest in the south to the drier North, the diversity of the natural vegetation decrease, such that less tree and more shrubs and mainly grass predominate.

Crop diversity also follows the same trend as the natural vegetation. The high rainfall agro-ecologies in the south is dominated by tree crops (cocoa, rubber, oil palm, citrus, mango and kola), tuber crops(yam, cassava, cocoyam and sweet potato), cereals (maize, rice and sorghum)grain legumes (soybean, pigeon peas and cowpea) and vegetable crops. As one moves from the rainforest to the derived savanna, tree crops thin out. The major economic crops in the derived savanna and southern guinea are tuber (yam, cassava, sweet potatoes) and cereals (maize, sorghum, rice. As one proceeds to the drier north, with about three months of annual rainfall, tuber crops cannot be grown under rainfed agriculture because of their long growth cycle. Thus, the crops that thrive in the dry Sudan and Sahel savanna are early maturing cereals (sorghum and millet), legumes and vegetables.
The rainfall distribution and the quantity determine the crops cropping systems that can be grown in an environment. As rainfall diminishes from the south to the north, the total amount of solar radiation also increases because of less overcast skies. Every crop species has optimum set of condition for growth i.e. each crop has its own set of environmental condition under which it grows optimally.

CROPPING SYSTEMS

Man depends on crops for his food, clothing, feed for his livestock and for other uses.

Crop production basically aims at increasing the dry matter accumulation of crops as well as crop yields. This is achieved by manipulation of the genetic makeup of plants and through environmental manipulations.

Cropping systems on the other hand seeks to increase the benefits derived from crop production by efficient utilization of both natural and socioeconomic resources.

Natural resources include: land, solar radiation, water and soil.

Socio-economic resources are labour, credit, power sources, and market demand.

What is a system?

A system can be defined as an **arrangement of components** that are **interrelated**, and **interact** among themselves **according to some process** and **transforms inputs into outputs.**

Cropping systems

This can be defined as the **cropping pattern** used on a farm and **their interactions** with **farm resources**, other **farm enterprises** and available **technology that determine their makeup**.

Cropping pattern alone does not fully define a cropping system as it is only a component.

What is Cropping pattern?

This is the **yearly sequence** and **spatial arrangement** of crops or crops and fallow on a given area.

Cropping pattern therefore deals with the questions of:

- How crops follow one another in a year on a farm

- How the farmer arrange the crops within a given space on the farm.

It therefore follows that in cropping pattern answer questions like :

- Does the farmer grow just one or more crop at a given time within a year?
- If two or more crops are grown are they planted at the same time or another brought in at a stage in the growth cycle or after harvest of the first?
- Does he grow one crop year after year?
- Do the crops follow one another in a definite sequence? Etc.

Cropping pattern in space can either be:

a) Monocropping or

b) Intercropping

Mono cropping

This is also referred to as sole cropping and it defines growing of just one crop at a time from planting to harvest. This is not a common practice in the tropics amongst majority of farmers that are small holder. Sole crops of horticultural crops like tomato, pineapple and some times of maize, oil palm and others are however common.

Multiple cropping

This is a cropping situation where more than one crop is grown on a farm in a year. Multiple cropping can be in time or both in time and in spatial arrangement. Hence we have:

a) **Sequential cropping** – multiple cropping in **time**

b) **Intercropping-** Multiple cropping in **time** and in **space**

Intercropping can be:

a) Mixed

b) Row

c) Relay

d) Strip

 # Do you know some merits and demerits of sole and intercropping?

 # Can you distinguish between sequential cropping and intercropping?

Monoculture: This is the repetitive growing of the same crop on the same land that is the same crop is grown after harvesting same. This is common with low land rice.

GENERAL ROLE OF EXTENSION IN CROP PRODUCTION

The extension service is an organization set up by the government, commercial organization or groups of individuals with the primary aim of disseminating information to the target audience.

In indigenous or traditional agriculture farmers are engaged in several production practices and use several input that limit their output. Scientists from time to time come up with improved practices and input such as new methods of cultivation, soil conservation, planting, crop maintenance, harvesting and storing of crops and marketing of agricultural products; as well as information on techniques of applying fertilizers, insecticides an fungicides to the crops and enhance the output and increase farmer's efficiency. Farmer and such researchers stay miles apart, thus to pass across this new ideas for the benefits of farmers trained workers are needed.

Extension workers are specially trained for this purpose. They acquire skills in communication; they also acquire knowledge on human behaviour as it relates to effective discharge of their duty.

The bases of agricultural extension

Agricultural extension services and agricultural extension programmes have developed with the idea of helping farmers to help themselves in the identification and solution of their farm and home problems; especially in a predominantly subsistence rural agriculture where small scale farmers are less able to deal effectively with their individual problems.

The objectives of agricultural extension services are:

1) It gives assistance to rural people involved in agriculture to acquire knowledge, skills and abilities that will enable them produce, distribute, process and market agricultural products more effectively.
2) It increases the efficiency of agricultural production through the dissemination of scientific information and the application of new technology of production.
3) By assisting farmers to utilize agricultural services provided by government and private agencies and helping them adjust production to demand.

Specific functions of extension service include:

1) Stimulation of farmers to try accept and use new agricultural practices
2) Dissemination of research results through the development of appropriate production packages and encouraging rural farmers in their use.
3) Organization of credit, marketing and farmer's cooperatives.
4) Provision of farm management advisory services
5) Guidance and general education.

Teaching methods in agricultural extension

Teaching is imparting of information. Extension teaching methods are devices which facilitate learning by farmers so that they become interested in, learn about, develop skills in, and make use of new agricultural technology. Methods used in extension teaching include:

1) Individual teaching method

- Farm and home visit
- Training and visit systems
- Farm supervision
- Letters
- Projects
- Telephones

2) Group teaching method

- Meetings
- Lectures
- Discussion panels
- Tours and field days
- Agricultural shows
- Method demonstration
- Result demonstration

3) Mass teaching method

- Radio
- Television
- Newspapers
- Bulletins and leaflets
- Circular letters
- Posters
- Cinema vans
- Public address systems

Agricultural extension brings help to farmers through education. Farmers are encouraged to organize cooperatively among themselves. Education in this context is voluntary, non-formal and purposeful.

INSECT PESTS OF ECONOMIC IMPORTANCE IN CROP PRODUCTION

Meaning of crop Pests: A pest can be described as any organism capable of causing damage to crop plants.

Classification of Insect Pests

Insect pests can be classified into various groups based on their mode of feeding (feeding habits) as follows:

a. Biting and chewing insects

b. Piercing and sucking insects

c. Boring insects

a. Biting and chewing insects

These possess strong mandible and maxillae (mouth parts) which enable them to bite and chew. Examples are: termites, grasshoppers, leaf worms, army worms, mantids, locusts, crickets and beetles

b. Piercing and sucking insects

The insects possess strong mouth parts called proboscis which enable them to pierce through plants and suck liquid materials from plant tissues. Examples are:

aphids, cotton stainers, mealy bugs, scale insects, white flies, minds and capsids.

c. Boring insects

These bore into plant parts and destroy the tissues of the plants or fruit or seeds. Examples include:

bean beetle, stem boners, maize weevils, rice weevils.

ECONOMIC IMPORTANCE OF INSECTS PESTS

1. Insects pests destroy crops in the field through their biting, chewing, boring sucking and defoliation activities.

2. They cause reduction in viability of stored produce.

3. Spot of injuries by insects may predispose crops to disease attack.

4. They increase the cost of production during the cause of controlling them.

5. They render vegetables and fruits unattractive and unmarketable.

6. Some are carriers or vectors of diseases.

7. The profits of farmers are reduced.

8. They reduce the quantity of produce either in store or in the field

9. They generally reduce the yield of crops.

10. They can also cause total death of crop plants.

Prevention and control of Pests

Pests of crops can be prevented or controlled through the following methods

1. Physical control
2. Cultural control
3. Biological control
4. Chemical control

5 Integrated control

1. Physical control

This involves the physical removal of pests by

Handpicking of insects and larva

ii. Setting of traps to catch rodents

iii. Shooting rodents with guns

iv. Fencing round the farm with wire nets

2. Cultural control

This involves the use of farm practices to prevent or control pests especially on the field. Examples of cultural control

Practice of crop rotation.

ii. Use of pest resistant varieties of crops.

iii. Appropriate tillage operation

iv. Use of insect traps

v. Hand-picking and destruction of insects

vi. Burning crop residues

vii. Timely planting of crops

viii. Proper weeding or sanitation

ix. Timely harvesting

x. Close season practices especially in cotton

3. Biological control

This involves the introduction of the natural enemies of pest to control or keep the pests population under control. Such enemies eat up or feed on these pests e.g Epidinocarsis lopezi

4. Chemical control

This involves the use of chemicals called pesticides to control pests of crop plants. Examples of chemicals used to control pests:

Pesticides- chemicals to control pests

ii. Insecticides- chemicals to control insects

iii. Rodenticicles- chemicals to rodents

iv. Avicides- chemicals to control birds

v. Nematicides- chemicals to control nematodes

5. Integrated control

This involves use of two or more of the above methods to achieve effective control. This type of pest control is more economical and more effective.

Side effects of chemical method of control

i. Some beneficial insects and soil organisms may be destroyed

ii. The chemical used may be toxic to man and domestic animals

iii. It may leave undesirable residue in the environment.

iv. Pests and diseases may develop resistance to chemicals.

v. Some are washed out of soil to rivers and streams where they can endanger aquatic life and cause pollution.

vi. Empty containers may be a source of poisoning when used as containers for consumables.

Side effects of biological method of pest control

i. The new organism introduced may start attacking crops which were originally free from attack.

ii, The predators expected to control others may rather feed on beneficial insects

iii. The activities of the new organism introduced may cause serious imbalance in the ecosystem

Side effects of cultural method

i. The use of fire to kill harmful pests may also result in destruction of other beneficial organisms.

ii. Resistant varieties may become adapted to the environment so that the resistance is short-lived where is used.

iii. If care is not taken fire may spread to other unintended places and farms.

iv. The use of fire may cause the destruction and loss of organic matter from the soil.

v. It may lead to destruction of soil structure and cause soil erosion.

Common storage pests and their control:

Different pests have been identified with farm produce some of which are found to be of economic importance even after such crops have been harvested and stored. This applied to both fruits and grains.

Examples of some common storage pests of grains

- Maize weevils – *Sitophilus zea mays*
- Rice weevils – *Sitophilus oryzae*

- Bean beetles – *Calosobruchus maculates*

Some common methods of controlling pests of stored produce:

Fruits crops:

The use of low temperatures by storing in refrigerators or cold room has proved effective.

Drying is also helpful to preserve some fruits from pest damage: tomato, pepper, okra etc.

Grains crops:

Storage under dry condition with the grains dried to about 14% moisture content

Storage under cool conditions in cold room has helped to maintain seed viability or storability

Storage in air in tight conditions at moisture content of about 14% in drums or even Jerry cans have been used over time.

Storage in jute bags with polythene inside and some tablets of phostoxin (Aluminum phosphide 57%) stored in a dry condition outside living room has proved efficient

Read up methods for storing:

- Yam
- Groundnut

COMMON DISEASES OF CROP PLANT

I. Meaning of Diseases

- A plant disease may be defined as a departure or deviation of the plant from the normal state of health with marked symptoms or outward visible signs.

II. Causes of plant diseases

A) Biotic factors (or pathogens)

(i) Viruses- a microscopic organism that cause infectious disease in plants and animals
(ii) Bacteria
(iii) Fungi
(iv) Nematodes

B) Abiotic factors (No pathogens)

(i) Too high temperature e.g. sun scald of fruits
(ii) Low soil moisture (drought)
(iii) High soil moisture (water logging)
(iv) Insufficient light
(v) Nutrient deficiency

III. General effects of diseases on crop production

Diseases cause lots of damage to crops which usually manifest in any the following effects:

(i) Diseases generally cause reduction in yield and productivity of crops.

(ii) They cause reduction in quality

(iii) They cause malformation of plant parts or the whole plant.

(iv) They can kill or cause the death of a whole plant.

(v) They cause reduction in the income of farmer.

(vi) They increase the cost of production in the course of controlling them.

(vii) They render vegetable and fruits unattractive and unmarketable.

(viii) They cause retarded growth in crop plants.

IV. General control of diseases of crop plants

Diseases of crop plants can be controlled by the following methods

- Preventive method
- Cultural method
- Biological method
- Chemical method
- Integrated method

A. Preventive Control Method

(i) Roughing of infested plants

(ii) Sanitation measures

(iii) Plant quarantine

(iv) Use of clean seeds

B. Cultural control methods

(i) Crop rotation

(ii) Use of resistant varieties

(iii) Good tillage practices

(iv) Regular weeding

(v) Fallow (i.e. leaving a piece of land un-cropped for a period of time).

(vi) Timely planting

(vii) Pruning

(viii) Roughing uprooting and burning of infected plants to control or prevent disease

C. Biological control

This involves the use of natural enemies of the disease to reduce or totally element the disease.

D. Chemical control

This involves the use of chemical such as fungicides, insecticides and nematicides to dust or spray plants and plant materials in order to prevent or control plant diseases.

E. Integrated control: This involves the use of two or more methods

V. SELECTED DISEASES OF CROPS AND THEIR CONTROL

MAIZE

Maize smut

- Caused by a fungus called *Ustilago maydis*
- It is an air-borne disease
- Reduces crop yield
- Forms galls on ears, leaves and tarsel which later turn black
- Can be controlled by destroying
    (i) Disease plants
    (ii) Use resistant varieties
    (iii) Use seed treatment with fungicides
    (iv) Crop rotation management

(2) Maize Rust

- Caused by a fungus called *Puccinia polysora*
- It is air-borne
- Cause red spots on leaves
- Reduce crop yield
- Can cause death of crop plants

Control Measure

- Early planting
- Crop rotation
- Use of resistant varieties other diseases of maize

(3) **Leaf blight** of maize may be caused by *Helminthosporium maydis* or *Helminthhosporium tarcicum*

(4) **Bacterial wilt** caused by *Bacterium stewarts*

(5) **Brown spot** caused by *Physooderma Zeamaydis*

(6) ***Puccinia sorghi***

Maize dwarf mosaic virus (MDMV) and corm stunt virus (CSV) symptoms are the appearance of faint yellowish strips on plants 6 to 7 weeks old and shortened internodes excessive tilering with many grainless ears may be observed.

Bacterial wilt or stewarts disease caused by *Bacterium stewarti* found especially in sweat corm.

Brown spot caused by the fungus *Physooderma zeamaydis*.

(7) Downy mildew caused by *Peronosclerospora sorghi*

(8) Maize streak virus disease transmitted by leafhoppers of the *Cirdulina sp* for control use resistant varieties TESR, TZESR, DMR-ESR

VI Rice diseases

Rice blight

- Caused by fungus *Piricularia oryzae*
- Transmitted through airborne spores on leaves

Symptoms commonly observed include:

- Small longitudinal red spots on leaves which turn grey or brown.
- Reduce yield

Prevention control through:

- The use of clean seeds
- Avoid heavy use of N fertilizers
- Use resistant varieties

(ii) Seedling blight caused by *Sclerotium rolfii*

(iii) Brown leaf spot caused by *Helminthosporium oryzae*

(vi) Rice blast (or rotten neck) caused by *Piriicularia oryzae*

(vi) Stem rot caused by the fungus *Magraparthe salvinii*

Cassava

(i) Cassava mosaic disease caused by a virus transmitted by piercing and sucking insect (whitefly) *Bemisia nigerrensis* with system which include:

- Mosaic pattern on leaves
- Stem/leaf distortion
- Stunted plant
- Reduction in yield

Prevention and control by

- Use of resistant varieties
- Uproot and burn infected plants

- Spray insecticides to kill vector
- Use disease free stem
- Farm sanitation

(2) Leaf blight of cassava caused by a bacterium called *Xanthosomonas manihotis*

Symptoms include

- Wilting of plant
- Falling off of leaves
- Reduced yield
- Canker of stem – die back of stem

Prevention and Control

- Use resistant varieties
- Use disease-free cuttings
- Early planting
- Practice crop rotation

Cocoa Black Pod Disease

- Caused by fungus *Phytophithora palmivora*

Symptoms include

- Brown spot on pod
- Rottening of pods
- Entire pod turns black
- Low yield

Prevention and control measures

- Remove and destroy infected pods
- Regular weeding
- Spray with fungicides e.g. Bordeaux mixture
- Avoid overcrowding of cocoa plants.

Tomato

Root knot of tomato caused by:

- Nematode, it is soil borne

Symptoms include:

- Galling of roots
- Retarded growth

- Early death of plant
- Reduction in yield

Prevention and control by:

- Soil sterilization
- Crop rotation
- Use resistant varieties
- Uproot and burn infected plants

Disease of Tomato

Bacteria wilt (*Pseudomonas solanacerus)*

Collar rot (*Sclerotium rolfsii*)

Early blight (*Acternaria solani*)

Grey leaf spot (*Stemphiflium solani*)

Late blight (*Phytophtora infestions)*

Leaf mould (*Cladosporium fulvum*)

Septoriia leaf spot (*Septoria lycopersici*)

Target leaf spot (*Corynespora cassicola*)

Tomato wilt (*Fugarium oxyporum*)

Cowpea

Leaf spot of cowpea caused by a fungus *Cercopora*

Symptoms include:

- Reddish brown spot on leaves
- Lesion on leaves
- Chlorosis
- Dropping of leaves

Prevention and control by

- Spray with fungicides
- Crop rotation
- Use resistant varieties

WEEDS AND THEIR CONTROL

Definition of a Weed:

A weed is a plant out of place or a plant growing where it is not wanted. A plant is regarded as a weed either because it interferes with human activity / welfare or because it occurs spontaneously in human-disturbed habitats. Weeds are generally undesirable and may be prolific, persistent, competitive, harmful or even poisonous.

Characteristics of Weeds

1. *It is harmful to humans, animals and crops.* It may contain poisonous alkaloids e.g leaves of stinging nettle (*Fleurya aestuans*), pods of M*ucuna pruriens*, high level of nitrates in A*maranthus* is poisonous to animal, parasitic crop (*Striga spp)*

2. *Wild and rank (too thickly) growth*. It is wild and rank in growth habitat. E.g *Chromolaena odorata, Andropogon spp*. They grow rapidly, branch or tiller profusely and cover extensive areas.
3. *They are persistent and resistant to control or eradication* e.g purple and yellow nutsedge (*Cyperus rotundus), C. esculentus* have well developed tubers and viable seeds, I*mperata cylindrica* has extensive rhizome systems and seeds, *Bryophyllum pinnatum* spreads by seed and leaf bulbil (It is resistant to dessication)
4. *They have high reproductive capacity*. Some weeds produce large quantities of seeds e.g *Amaranthus spinosus* (235,00 seeds per plant)
5. *Ability to exhibit seed dormancy*. A condition in which a seed fails to germinate in the presence of environmental condition that are normally optimal or seed germination. The forms of dormancy so exhibited by weed species include induced dormancy, enforced dormancy and innate dormancy.

   Induced dormancy = inability of a mature viable seed to germinate because of an after ripening experience(exposure to high CO_2 level, hard seed coat or allelochemicals)

   Enforced dormancy= result of exposure of mature viable seeds to adverse environmental condition e.g low moisture or high temperature and poor aeration.

   Innate dormancy= occurs if a viable mature seed fails to germinate when exposed to environmental conditions that are favorable to vegetative growth because of immature embryo or the presence of inhibitor chemicals either in the seed coat in the fruit.
6. *Weeds may grow in an undesirable location*. They can be found in cultivated fields, tennis courts or recreational sites and cracks of concrete.
7. *Weeds have large populations*. E. g *Euphorbia heterophylla, Ageratum conyzoides, Aspilia africana.* They are able to compeete better with crops because of this numerical superiority.
8. *Humans often find them useless, unwanted, undesirable*. Many weeds have some morphological features such as thorns, prickles etc which make them objectionable e.g *Amaranthus spinosus*.
9. *Spontaneous growth, appearing without being sown*. Such weeds have small, obscured seeds that are buried in soil e.g *Amaranthus spinosus, Talinum triangulare.*
10. *Aggresiveness*: Many weeds rapid seedling growth and wide tolerance to edaphic and environmental factors. Some are very competitive and deep roots and have the ability to form canopy over associated crops e.g *Euphorbia heterophylla*.
11. *Unsightly.* Many weeds have unattractive flowers and foliage and tend to disfigure the landscape e.g *Panicum spp,Aandropogon spp and Pennisetum spp.*

Economic Importance of Weeds

Direct Losses by weeds

1. Weeds cause reduction in crop yield through competition for light, nutrient, water and space. They can also reduce the yield of crop through the release of toxic substances or exudates which inhibit crop growth. This is called **allelopathy**. Uncontrolled weed infestation can lead to 95% yield loss in cassava, 40% in maize, 53% in cowpea, soyabean and pigeon pea.
2. Weeds can reduce the quality of harvested agricultural products.
3. Weeds interfere with harvest operations and increase the cost of harvesting in both small holder and large scale farms.
4. Weeds may poison animals e.g *Amaranthus spp* can adversely affect livestock because of the high nitrate content of the shoots.
5. The cost of controlling weeds is high.

6. The presence of weeds can impede water flow in irrigation canals.
7. The presence of weeds in lakes and reservoir can increase loss of water by transpiration.

Indirect Losses caused by weeds

1. Weeds serve as alternate hosts to many plant diseases and animal pests e.g insects, rodents, birds etc that attack crops.
2. The presence of weeds imposes a limit on farm size.
3. The presence of weeds can also reduce the economic value of lakes by preventing or limiting fishing activities.
4. Weeds such as Imperata *cylindrica* become fire hazards in the dry season throughout the savanna vegetation zone.

Non Agricultural Losses

1. Weeds affect health of humans, stinging nettle can cause skin rashes and the flowers of some other weeds can be associated with allergies in humans
2. Weeds impair visibility along roads and railway lines.
3. Uncontrolled weed growth reduces the value of real estates.
4. In situations where farmers depend on human labour for weeding, children have to miss school at peak of weeding periods. This reduces the quality of education that these children can get during their early years.

Beneficial Effects of Weeds

1. Weeds provide a vegetative cover that protects the soil surface against erosive action of rain and wind.
2. Weeds play an important part in nutrient recycling. Roots of weeds tap nutrients from the lower soil depths and return these to the soil surface as litter when the weeds shed their leaves or when the entire plant plants dies and decays.
3. Weeds add organic matter to the soil both from the roots and from the above ground parts.
4. Many plants that are designated weeds are used as potherbs e.g *Talinum triangulare*.
5. Weeds are sources of pesticides e.g *Chrysanthemum cinerariifolium* which provides insecticide pyrethrum.
6. Weeds provide food and cover for animal. Wildlife generally depend on weeds for survival as food and shelter.
7. Weeds serve as an important source of genetic materials for crop improvement such as breeding for resistance to pests and diseases which are made possible by genetic materials provided by wild species of the crop plants.
8. Weeds serve as hosts beneficial insects, and at the same time provide nectar for bees.
9. Many weeds help to beautify the landscape. E.g a good ground cover of *Cynodon dactylon* beautifies the home.

Classification of Weeds

Weeds can be classified based on:

1. *Morphology*
2. *Life cycle(ontogeny)*
3. *Growth habit*
4. *Botanical consideration*
5. *Habitat*

Classification Based on Morphology of weeds

The criterion defines classification on the basis of leaf shape.

(a) **Grasses**: the leaf lamina in relation to the breadth is very high e.g *Panicum maximum, Andropogon gayanus, Eleusine indica*

(b) **Broadleaves**: the ratio of leaf lamina to the breadth is smaller e.g *Sida acuta, Talinum triangulare, Euphorbia heterophylla, Ageratum conyzoides*

(c) **Sedges** : all the leaves tend to arise from the same point e.g *Cyperus rotundus, Cyperus esculentus, Mariscus alternifolius.*

Classification based on Life cycle

- Ephemerals e.g *Euphorbia, Digitaria, Eluesine, Spigelia anthelmia*.
- Annuals e.g. *Pennisettum spp, Rottboelia cochinchinensis*,
- Biennial e.g *Taraxacum officinale*
- Perennials e.g *Imperata cylindrica, Sida acuta.*

Classification based on Growth habit

- Free living weeds e.g Siam weed
- Parasitic weeds e.g *Sriga spp*

Classification based on Habitat

- Terrestrial weeds or upland weeds e.g *Imperata cylindrica, Euphorbia heterophylla.*
- Aquatic weeds e.g. water hyacinth, water lily.

Weed Control Methods

Weed control involves any action that seeks to restrict the spread of weeds and destroys or reduce their population in a given location.

Generally weeds can be controlled using the following methods:

1. *Preventive Weed control*
2. *Cultural Weed control*
3. *Biological Weed control*
4. *Chemical Weed control*
5. *Integrated Weed control*

Preventive Weed control

Preventive weed control refers those measures necessary to prevent the introduction of new weed species into a given geographical area as well as the multiplication and spread of existing weed species.

Preventive weed control includes the following:

- Use of clean crop seeds for planting
- Fallowing
- Preventing weeds from setting seeds
- Use of clean machinery
- Controlled movement of livestock
- Screening of irrigated canals to prevent weeds from being transported from infested field to clean areas
- Quarantine laws and services to prevent accidental introduction of exotic plants or their propagules.

Cultural Weed Control

This involves all aspect of good crop husbandry used by farmer to minimize weed interference with crop or any practice adopted by the farmers which aid in weed suppression.

This method include:

- Hand weeding. This can be done by using hand pulling, hand hoeing, handslashing or push type weeders.
- Mechanical weeding: This can be done with animal drawn weeders or machine-powered weeders.
- Tillage
- Burning
- Flooding
- Mulching
- Crop rotation

Biological Weed Control

This refers to the control or suppression of weeds by the action of one or more organisms through natural means or by manipulation of the weed, organism or environment. This involves the use of the following:

- **Live mulch**: This is a crop production system in which a food crop is planted directly in the living cover of an established cover crop without destruction of the fallow vegetation.
- **Biological control with invetebrate animals** e.g the use of insects to control weeds; use of *cactoblastis* moth on *Opuntia* (Prickly pear) in India; the use of grasshoppers(*Paulina acuminata*) to control *Salvinia molesta* in Zambia.
- **Biological control with vertebrate animal** e.g. goats to graze down woody weeds; ducks and fish for control of aquatic weeds.
- **Microbial weed control** . This involves the use of microorganisms such as fungi, bacterial, bacteria, nematodes and viruses. E.g. of microbial weed control is the use of soil borne fungi (*Phytophthora palmivora*) now sold as mycoherbicides – sevine to control strangler vine (*Morrenia odorata).* **Mycoherbicides** is the use of plant pathogens to control weeds. The use of aerial fungus *Collectotrichum gloeosporoides* (sold as mycoherbicides- collego) for the control northernjointvetch in paddy rice.
- **Allelopathy**; This is the detrimental effect of chemical or exudates produced by one living plant species on the germination, growth or development of another plant species, or microorganisms sharing the same habitat.
- **Plant canopy**: The major effect of plant canopy is to shade the understorey plants and limit their ability to synthesize carbohydrates.

Chemical Weed Control

The practice whereby undesirable vegetation (weeds) is killed with herbicide is called chemical weed control

A chemical used to control,suppress or kill plants or to severely interrupt their normal growth process is called **herbicides**.

Herbicides can be *selective or non-selective*

Selective herbicides are those that have the ability to suppress certain member of weeds species and leave others unhurt. Eg. Atrazine, propanil, dalapon etc

Non selective herbicides are those that are generally toxic to all plants (they destroy any weeds that come their way) e.g glyphosate, paraquat.

Integrated Weed Management

This is a form of weed management that involves the combination of two or more weed control methods at low inputs to obtain a level of weed suppression superior to the ordinarily obtained when one weed management system is used. e.g.

Chemical +cultural method

Herbicide + organic mulch

Biological +Chemical +Cultural method

CROP PROPAGATION: SEED AND VEGETATIVE

To propagate means to multiply. Crop propagation means to increase or multiply crop plants. This can be done either through the use of seed or other plant parts (stem, root, leaves).

Propagation through the use of seed (**Sexual Propagation**)

In sexual propagation seeds are planted. In order to properly comprehend why multiplication of crop plants through the use of seed is termed sexual propagation a review of how seeds are formed is important.

Seed formation in flowering plants

At a stage during the development of a plant flowering plants move from the vegetative to the reproductive phase. During this time flowers are produced. A typical flower consists of both the male reproductive part known as the ***stamen*** and it is made up of the anther and the filament. The female reproductive part consist the stigma, style and the ovary and they are collectively known as ***pistil.*** In the ovary are found several ovules***.*** Through the process of pollination pollen grains are transferred from the anther to the stigma. ***One pollen grain fertilizes one ovule***. After successful fertilization, **the ovules develop to form the seeds while the ovary becomes the fruit**. Seeds that are produced thus possess genes obtained from both the male and the female parents.

Some plants produce flowers in which the male part matures first, produce and shed pollen grains before the stigma becomes receptive; such plants are known as ***protandrous plants.***

On the other hand the female reproductive parts in some flower mature earlier and are withered before the pollens are shed and they are known as ***protogynous plants***. Conditions mentioned above favour cross pollination in crop plants and they are important considerations in merits and demerits of sexual propagation.

Advantages of propagation by seed

- Seeds can easily be transported compared with materials used for asexual propagation
- Seeds can remain viable at least till the subsequent growing season when properly stored
- Transfer of diseases and disease causing agents to subsequent generation is milder in seed compared than in vegetative propagation

Disadvantages of propagation by seed

- Raising plants from seeds may not result in the same plant like the parent plant, for example maleness in pawpaw.

- Propagation from seeds may result in non uniform field.

- Propagation by seed might result in production of off-type due to genetic reconstitution.

- Fruit production is delayed in fruit trees when propagated from seed compared to asexual propagation.

- Tuber crops like cassava will not produce economic yield in the first year if propagated from seed rather than from stem cutting.

- There are plants that do not produce seeds at all or in situation where the seeds are produced, they are not viable.

  The above constraints to sexual propagation leave us with the option of vegetative propagation.

Asexual or Vegetative Propagation

Asexual propagation is a way of multiplying plants using other plant parts other than seeds.
Asexual propagation has a number of advantages which include the following:

- Plants that are propagated vegetatively mature early and fruit trees propagated vegetatively produce fruits earlier than when propagated from seeds.
- Offspring of plants propagated asexually are exactly like the mother plant genetically. This could help in predicting the characteristics of the offspring ahead of time.
- Vegetative propagation gives a more uniform field of crops relative to sexual propagation, this is important in calibration of machines in mechanization; crop management can also be synchronized.
- Qualities of fruits like flavour and sometimes sizes have been improved upon where grafting or budding was involved.

Asexual propagation has some demerits which include

- Diseases can easily be spread from the parent plant to the offspring in vegetative propagation.
- The field stands the danger of being completely wiped out in case of disease incidence as all the population will be susceptible.
- Vegetative propagation requires more skill and equipment than sexual propagation which makes it more costly.
- Transporting materials used for vegetative propagation are bulky and transporting them is not easy compared to seeds used for sexual propagation.
- Preserving materials used for vegetative propagation is more demanding than preservation of seeds.
-

  Types of vegetative propagation

1. Use of specialized food storing plant part

Certain plants have some adaptive features that make them survive adverse environmental conditions such as drought or cold. Such plants produce leaves and have vigorous growth under favourable environmental conditions. When the conditions become adverse the above ground plant part dries up while the plant remain alive but in a dormant form in the soil. This is possible as food is stored in the below ground part; this dormant form also posses bud from which new growth commences when favourable conditions resumes depending on the stored food.

Examples in this category are:

- Bulb for example onion and garlic

Fig 1: Onion bulb

Bulbs are globular in shape and consist mainly of fleshy food storing leaves. Onion production starts by planting the seeds in the nursery, the seedlings generated with their little bulbs are later transplanted out on the field.

Garlic is also another kind of bulbs. In garlic however, new plants are generated by separating the different cloves that form the bulb and planting them out.

- Corm for example cocoyam

Fig2: Corm of cocoyam
Corms are propagated by planting whole small corms or by dividing larger corms into segments each with three or more buds.

- Tubers for example Irish potato and yam
  Some plants have underground stems which are enlarged and are used to store food examples are yam and Irish potatoes. Such enlarged stems have spirally arranged nodes with buds which develop into new plants. Yam can be propagated by planting small tubers known as mini sets or by planting fragments of cut large tubers.
- Tuberous root for example sweet potato
  Roots of some plants serve as storage organs examples are cassava and sweet potato. While sweet potato produces root tubers with active buds which can be as propagating material, tuberous root of cassava are not suitable as propagating material; however the conventional method of propagating sweet potato is by using the stem cuttings. When the stems are not available stems can be generated from the root tubers by planting the tubers in well aerated and well watered (preferable sandy) soil. When the shoots are well formed they are severed and used as stem cuttings.

- **Suckers** for example banana and plantain
  Suckers are new plants developed attached to the stem of the mother plant; they may have their own roots right in the soil. Such plants can be cut off from the main stem and planted elsewhere to commence independent life example include pineapple. Four types of suckers are identified in plantain and banana these are peepers, water suckers, sword suckers and maiden suckers. Sword and maiden suckers are suitable as propagating materials. In the actual sense however, the stem of plantain and banana can best be describe as a corm.
- **Rhizomes** are stems which grow horizontally underground. They posses nodes internodes and axillary buds which can generate a new plant when severed from the main stem. Examples of plants propagated by rhizomes include ginger, sugar cane, bamboo.
- **Runners** these are plants with stems that grow horizontally above the soil. They posses nodes, internodes, and axillary bud. Roots and new plants are produced

where the nodes touch the soil, thus the plant can be severed at such points to commence independent life for example sweet potato. In sweet potato the stems are cut into fractions with at least four nodes. Planting of the stem cutting is done by inserting the stem into the soil two nodes deep.

Figure3: Runners of sweet potato

2. **Layering:**
   This involves causing a branch of a plant to produce roots while still attached to the main stem; after such plant is detach and planted out to commence an independent life. Examples of plants propagated in this way include tomato, guava, and mango.
3. **Grafting and budding**
   Layering and budding are also means of propagating plant vegetatively. In ***grafting*** parts of two individual plants are taken and are joined to form a single plant. One of the two plants will supply the root and it is also known as the **stock, root stock** or **under stock** in the union, the other part supplies the stem and is known as the **scion** example citrus**. *Budding*** is similar to grafting the difference however is that while the scion consist of several bud in grafting, the scion is usually consist of a single bud in budding.

4. **Cutting**

Some plants are also propagated by cuttings. Stem, root, or leaves of certain plants are used to regenerate them. Whole plants develop by production of either roots, shoots or both root and shoot from stem cutting, root cutting or leaf cutting respectively. Example is in cassava, rose and sweet potato

Fig4: Sweet potato stem cutting- note the projection at the nodes and the internodes

Fig5: Cassava stem cuttings- note the active buds at the nodes

The above is a summary of the most common methods of crop propagation, additional information will be given during the course of the lectures and practical.

FARM BUILDING AND STRUCTURES, FARM TOOLS AND FARM MACHINERY

Farm structures include existing building or facilities previously for non-agricultural uses but which are either remodeled or converted to be used for an agricultural purpose. Farm structures are classified based on:

a) Materials of construction e.g. earth, wooden, concrete, steel building or structure.
b) Utilization of the structure e.g farm building for crop production, building for livestock, building for product storage, building for processing, building for equipment and supplies.

1. **Farm houses:** There are for human habitation providing accommodation for all farm workers that have to be accommodated on the farm. It provides facilities and conveniences suitable for a comfortable living such as sleeping, laundry, cooking and realization. They protect against some weather condition such as rain, sunshine and cold and serve as security against wide animals.

2. **Livestock Structures:** The play major roles in regulation of environmental condition such as temperature and relative humidity to the desired range for optimum development of animals. Examples are Barns, sheds, Pens, Yards For goats sheep, pigs and cattle, Hutches for rabbits, Battery cages and deep Litters houses for poultry.

3. **Building for Crop Production:** These are provided where ambient conditions require some modification for crop production. They are used mostly for ornamentals plants and experimental studies e.g Green houses, Screen houses, Glass house, Growth chambers.

4. **Building for Agricultural Processing:** There are to provide convenient environment in term of space and health-wise for processing activities to be carried out. The provide conducive working environment for those who may be engaged in the processing activities. Examples of the processing unit are :Oil palm processing centre,Cassava processing centre, Fish smoking centre, Abattoir

5. **Storage Structures:** Provides conducive environment for the long term storage of agricultural materials. They are to have adequate capacity to meet the required volume of storage and strong enough to resist the imposse loads. e.g cribs, silos, warehouses platform barns, cold room and underground pit.

6. **Building for equipment and supplies:** There are used for the storage of items needed on the farm or for the provision of shelters where relevant services may be carried out e.g. implement sheds, garages, farm sheds, fuel depot.

Generally, a good farm structures play major role in regulation of environmental factors to the comfort of both man, his livestock's and stored products. They also offer shelter to man, crops, animals and machinery during unfavorable weather conditions.

Characteristics of Farm Structures

a) It should be able to stand the test of time for what is meant for and easy to re-shape or altered to accommodate future expansion of the farm.
b) The design and construction technology should be localized i.e not foreign to the environment (indigenous).

c) The materials should be locally available.

d) The farm structures/building should be able to cope with stress in term of need (bumper harvest)

SOME CROP STORAGE STRUCTURE AND STORAGE DURATION. Class participation

S/N	Storage Structure	Possible Storage Duration (month(s)	Crops
1.	Bags/sacks	3-16	(A) Grains, legumes pepper, melon, kola nut etc
2.	Palm frond/woven basket	1-3	Above list Plus cassava tubers
3.	Earthen pots and gourds	2-20	Grain pepper legumes etc
4.	Drum/plastic container	1-20	Grain and legumes
5.	Unoccupied room	1-16	<Class participation>
6.	Cribs	1-12	<Class participation>
7.	Trenches and Underground pills	1-6	Yam/grain cassava
8.	Barns	1-12	Yam, tobacco
9.	Local Huts	1-12	Yam, tobacco
10.	Mud	7-20	
11.	Silos	Up to 36	Grains legumes

LIVESTOCK STRUCTURES INCLUDE THE FOLLOWING

S/N	Structures	Animals	
1.	Basket "(kuku)"	Poultry	
2.	Hutches and cages	Rabbits Poultry	
3.	Deep litter horns	Poultry	
4.	Battery cages	Poultry	
5.	Low cost elevated pen	Goat and Sheep	
6.	Pens	Goat, Sheep Pig,	
7.	Sheds/Yards	Cattle mostly but can be used for sheep and goat	

FARM MACHINERY

To mechanize means to use machines to accomplish task of farm operation hence Farm machineries are Instruments of Farm mechanization in agricultural production. Hand-tool technology is of old age.

It is the most basic level of agricultural mechanization where a human being is the power source using simple tools and implements such as hoes, machetes sickles, wooden diggers.

A machine can now be defined as a device with two or more components which is energized by a power source to transmit force and motion to achieve a desired Farm work.

A tool is a human powered Instrument or implement usually without parts that move relative to one another like hoe to archived mechanical operation.

Machinery for field operation includes both primary and secondary tillage implements.

Primary tillage implement cut and shatter the soil. Primary tillage in an aggressive deep operation which usually leaves the surface rough. The implement of primary tillage include, mold board, chisel and disk plows a ridgers. Subsoilers, disk harrows, rotary fillers.

Secondary tillage implement work the soil to a shallower depth, pulverize level and firm the soil, kill weeds and help conserve moisture. The secondary tillage tools include.

- Spring spike and tine-tooth harrows field cultivator. Desk harmouns. Row crop cultivator

The goal of tillage is to provide a suitable environment for seed germination and root growth and to control weeds. Tillage therefore includes all mechanical, soil stiring actions carried out for the purpose of nurturing crops.
Tillage operation aim to achieve the following Good:

- Seed germination
- Root growth
- Weed control
- Soil erosion control
- Moisture control

Other machinery such as planters is responsible for sowing of seeds to ensure a uniform crop and optimum yield examples of mechanical planter are:

- Row crop planters
- Grain drills
- Broad cast seeders