SENIOR SIX TERM 1

CONSTRUCT: CROP PRODUCTION

TOPIC 3/3: Crop Production and Husbandry

Competency: The learner applies evidence-based husbandry practices to ensure optimal quality production.

Business Model Canvas

An example Business Model Canvas (BMC) **for a coffee enterprise that integrates** optimal production practices **such as sustainable farming, quality control, and community engagement** is given below

Business Model Canvas – Coffee Enterprise (Optimal Production Practices)

Building Block	Details
Key Partners	- Local farmer cooperatives - Agricultural extension services - Certification bodies (Fairtrade, Organic) - NGOs supporting sustainability - Export agencies and logistics providers
Key Activities	- Sustainable coffee cultivation (shade-grown, organic inputs) - Quality control and grading - Processing (washing, drying, roasting) - Packaging and branding - Marketing and distribution
Key Resources	- Coffee plantations and farmer networks - Skilled agronomists and workers - Processing equipment (wet mills, roasters) - Certification and quality assurance systems - Strong brand identity

Value Proposition	- High-quality, sustainably produced coffee - Traceability from farm to cup - Fairtrade and organic certification - Unique flavor profiles (single-origin) - Contribution to community development
Customer Relationships	- Direct trade with roasters and cafes - Transparent communication about sustainability - Loyalty programs for retail customers - Storytelling about farmers and origins
Channels	- Export markets (Europe, US, Asia) - Local supermarkets and cafes - Online platforms (e-commerce) - Farmer's markets and specialty shops
Customer Segments	- International specialty coffee buyers - Local cafes and restaurants - Health-conscious consumers (organic buyers) - Ethical consumers (Fairtrade supporters)
Cost Structure	- Farm inputs (organic fertilizers, pest control) - Labor and training - Processing and packaging costs - Certification and compliance fees - Marketing and distribution expenses
Revenue Streams	- Coffee bean sales (green and roasted) - Premium pricing for certified coffee - Direct-to-consumer online sales - Value-added products (cold brew, flavored coffee) - Export contracts

Optimal Production Practices Integrated

(i) **Sustainable farming:** Shade-grown coffee, organic fertilizers, crop rotation.
(ii) **Quality assurance:** Grading, cupping tests, and certifications.
(iii) **Community empowerment:** Fair wages, training, and cooperative structures.
(iv) **Environmental stewardship:** Soil conservation, water management, biodiversity protection.
(v) **Innovation:** Exploring value-added products like cold brew and eco-friendly packaging.

Occupational Health Practices in crop production

(i) **Protective equipment:** Use of gloves, masks, boots, and goggles during pesticide application, harvesting, and processing.
(ii) **Training:** Educating workers on safe handling of chemicals, machinery, and tools.
(iii) **Medical check-ups:** Regular health screenings for workers exposed to dust, chemicals, or heavy labor.
(iv) **Ergonomics:** Providing proper tools and techniques to reduce strain during harvesting and processing.
(v) **Hygiene facilities:** Access to clean water, sanitation, and rest areas to maintain worker health.

Safety Practices in crop production

(i) **Safe chemical handling:** Proper storage, labeling, and controlled use of fertilizers and pesticides.
(ii) **Machinery safety:** Training operators and maintaining equipment (e.g., pulping machines, roasters) to prevent accidents.
(iii) **Emergency preparedness:** First aid kits, fire extinguishers, and evacuation plans at farms and processing plants.
(iv) **Workplace organization:** Clear pathways, safe storage of tools, and prevention of slips or falls.
(v) **Child labor prevention:** Ensuring compliance with labor laws to protect vulnerable groups.

Environmental Protection Practices in crop production

(i) **Soil conservation:** Techniques like terracing, mulching, and cover cropping to prevent erosion.
(ii) **Water management:** Recycling water in wet processing, preventing contamination of rivers and streams.
(iii) **Waste management:** Composting coffee pulp and husks instead of dumping them.
(iv) **Agroforestry:** Growing coffee under shade trees to preserve biodiversity and reduce deforestation.
(v) **Reduced chemical use:** Promoting organic fertilizers and integrated pest management (IPM).
(vi) **Climate adaptation:** Planting resilient coffee varieties and diversifying crops to withstand climate change.

Summary Table

Category	Practices	Benefits
Occupational Health	PPE, training, medical check-ups	Protects worker health, reduces illness
Safety	Safe chemical handling, machinery safety, emergency preparedness	Prevents accidents, ensures compliance
Environmental Protection	Soil conservation, water recycling, waste composting, agroforestry	Sustains ecosystems, improves long-term productivity

Why These Practices Matter

- **Worker well-being:** Healthy workers are more productive and motivated.
- **Community safety:** Reduces risks of accidents and chemical exposure.
- **Sustainability:** Protects soil, water, and biodiversity for future generations.
- **Market advantage:** Certified sustainable coffee (Fairtrade, Organic) fetches premium prices.

Plant propagation and breeding in agriculture

Plant propagation is the process by which new plants grow from various sources, including seeds, cuttings, and other plant parts. Plant propagation may refer to both man-made and natural means.

Types of propagation

- Sexual propagation: occurs through the natural growth of viable seeds.
- Asexual propagation: allows for the creation of new plants using cuttings from vegetative parts, like the roots, leaves, and stems.

Selection of planting material

In order for a farmer to reduce the expenses the need to select the planting material that he is sure of.

Characteristics of a good planting material

1. Should be readily available within locality to reduce transport expenses and time wasted in looking for it.
2. It should be pest and disease free to reduce the transmission of such diseases and pest to the seedling.
3. It should be easy to transport i.e. should not be bulky.
4. In case, of seeds should be of uniform size and shape to allow easy mechanization during planting.
5. It should be easy to store so that it can used in future when needed.
6 In case of seed they should have passed the dormancy stage.
7. The planting material should be highly viable to reduce the costs involved in filling up the gaps where they did not germinate.
8. Seeds should be of uniform colour to allow easy sorting and planting.
9. The planting material should be of high proven performance give high returns once planted.
10. Materials should be free from contamination by weeds.
11. Should be free from mechanical damage.
12. In case of seeds, should be large enough.

Seed propagation

This is where seeds of mature plant having desirable qualities are used for planting.

Qualities of good seed lot for planting

- Should be viable
- Should be disease
- Should be free from mechanical damage
- Should be mature
- Should have appropriate size to ensure enough food reserve
- Should be free from contamination
- Should be of desired genetic make up
- Should be plump i.e. well-formed and not wrinkled

Reasons for drying seeds before storage

- To prevent molds and rot: seeds with high moisture rot easily
- Properly dried seed have long shelf life
- To prevent germination before planting
- To reduce pathogenic contaminations
- Maintain seed quality such good color

Advantages of propagation from seeds

1. Seeds are not bulky and therefore are easy to handle and convenient to transport.
2. They can be stored for a long time while retaining viability
3. Seeds are easy to treat against pest and seed bone diseases
4. Minimizes spread of disease from parents to offspring
5. They are cheaper planting materials
6. Seeds are easy to use during machine planting.
7. Seed planting is a quick method of increasing a crop population in a short period.
8. Some crops are difficult to plant from vegetative parts.
9. Plants raised from seeds have a longer life span than those raised by vegetative means.

Disadvantages of propagation from seeds

1. Some seeds are delicate hence difficult to handle during planting.
2. They promote spread of seedling or seed borne disease.
3. Seeds require special field preparation before planting more especially those with small seeds.
4. Some seed may not breed true to type hence disappoint farmers
5. The formation of seeds requires special condition during pollination and fertilization.
6. Due to interference during pollination seeds may be formed but of a high degree of variability.
7. Crops raised from seeds take a longer time to mature.
8. Some plants do not have viable seeds.

Analysis of seed purity

This refers to the process of determining whether the purchased seed or processed seed have contamination such as weed seeds, inert materials, stones, other crop seeds etc.

Percentage purity = $\frac{weight\ of\ pure\ seed}{total\ weight\ of\ seed\ sample}$

Seed treatment

- **Seed dressing** –coating seeds with pesticides e.g. copper Sulphate.
- **Chitting** or encouraging sprouting e.g. in potato seeds.
- **Inoculation**, usually done legumes where seeds are coated with correct bacterial for nodule formation.

Importance of inoculation

- Promotes formation of root nodules
- Increases nitrogen fixation to the soil
- Minimizes use nitrogenous fertilizers

- **Hot water treatment** against viral diseases e.g. in sugarcane and cassava.
- **Fumigation of seeds** is use of volatile chemicals in seed store to kill pests in the room

Seed viability

It is the ability **of a seed to germinate and develop into a healthy seedling under favorable conditions.**

Seed longevity

It is the period of time that seeds remain viable

Germination

It is the development of a seed into a seedling

Physiological processes that take place during seed germination

- **Imbibition** is the uptake of water by diffusion due to presence of solid particles or colloids in the seed causing the seed to swell.
- **Activation of hydrolytic enzymes** following uptake of water.
- **Hydrolysis** of storage food material into soluble products by hydrolytic enzymes
- **Translocation/transport** of soluble products (glucose and amino acids) from endosperm (storage area) to the actively growing centres of the embryo.
- **Synthesis** of enzymes, nucleic acids, structural proteins
- **Respiration** to provide energy for cellular activities
- **Cell division, elongation and differentiation** lead to immergence of a seedling from a seed. measures

Measures to increase the ability of seeds germination

- Proper drying of seeds before storage reduce moisture content and risks of pests and diseases
- Harvesting mature seeds
- Controlling oxygen supply during storage of seeds
- Maintaining proper temperature
- Treatment of seeds to avoid pest and diseases
- Proper seed bed preparation especially for small seeds
- Soaking seeds in growth stimulants
- Soaking seeds in water overnight before planting to soften their testa.
- Prechilling of seeds with hard coats to ease entry of water and air.
- Avoid prolonged storage of seeds.

Methods to determine the viability of seeds

- **Germination Test**: Place a specific number of seeds (e.g., 100) on a moist paper towel, fold it, and place it in a plastic bag. Keep it in a warm place and check after a few days to see how many seeds have sprouted.
- **Water Test:** Place seeds in a container of water. Viable seeds will sink, while non-viable seeds will float.
- **Excised Embryo Test**: This involves removing the embryo from the seed and placing it in a nutrient solution to see if it grows.

- **Chemical Test**: Some seeds can be tested using chemicals that react with living tissues, indicating viability.
    - Viable seeds soaked in 0.1% tetrazolium salt solution and left for 24 hours will have their embryo stained red.
    - Viable seeds decolorize warm potassium permanganate solution
- The **electrical conductivity test** measures the leachate's conductivity when seeds are soaked in water, providing an indirect assessment of seed viability.

Seed dormancy

Seed dormancy is the **inability of a viable seed to germinate under conditions favorable for germination**.

Causes of seed dormancy

- **Seed coats impermeable to water**: dormancy remains until the testa layer decay by soil.
- **Seed coat impermeable to oxygen**: but later seeds become more permeable to oxygen so that it germinates afterwards.
- **Mechanically resistant seed coat**: In certain **seeds of weeds have hard seed coats** that prevent the expansion of embryo.
- **Immaturity of the embryo** that do not germinate until allowed time to mature.
- **Due to the effect of germination inhibitors** such as abscisic acid that prevent germination of seed.
- **Low temperature:** In certain plants the seeds **remain dormant after harvest because they require low temperature for germination.** The seeds germinate in the spring season.
- **Light sensitive seeds:** some seeds require light to germinate and will not germinate in its absence

Methods of breaking dormancy

- **By soaking the seeds** in growth stimulating hormone
- **By pre-chilling** i.e. seeds are exposed to very low temperature for a short time before planting in normal conditions
- **Soaking seeds in cold water** overnight before planting in normal condition
- **Scarification / mechanical removal of testa**
- **Heat treatment:** seeds are soaked in hot water at about 800C for 3 – 5 minutes before planting
- **Exposure to light:** some seeds need to be exposed to light in order to germinate.

Advantages of seed dormancy

- Seed are able to withstand adverse external conditions such as very cold or very dry weather.
- It allows seed and fruits to disperse
- Prevents death of entire population in bad times since all seeds do not germinate at ago
- Prevents pre-harvest germination
- Facilitate proper storage of seed.

Methods of planting seeds

(a) Broad casting

This is the scattering of seeds all over the field in random manner. It is usually used for seeds which are very small that cannot easily put in holes

Advantage of planting seeds by broadcasting

- It quick
- Easy and simple
- Requires less labour
- Minimize soil erosion due to good crop cover
- Best for small seeds such as millet and simsim

Disadvantages of planting seeds by broadcasting

- Cannot be mechanized
- Difficult to weed
- Uneven distribution of seedlings
- Some seeds are eaten by birds

(b) Row planting

Here seeds are planted in holes, drills or furrows that are in rows/lines

Advantages of row planting of seeds

- Uses fewer seeds
- Gives optimum plant population
- Planting can be mechanized
- Promote uniform germination
- Easy to weed
- Plant get enough space

Disadvantages of row planting of seeds

- Requires a lot of labour
- Tedious
- Requires skill
- Not suitable for small seeds

Nursery bed

A nursery bed is a small portion of land prepared for raising seedlings before transplanting.

A seed bed is a piece of land which has been prepared and ready to receive the planting materials where they can grow up.

Advantages of raising seedlings in a nursery bed

- Many seedlings can be prepared in small area
- Make it easy to carry out routine management.
- Provide the best conditions for growth i.e. fine tilth.
- Allows transplanting of healthy and vigorous seedlings
- Preparing seedling is source of income/employment

Factors to consider when selecting a site for a nursery bed

- Source of water for irrigation
- Gentle slope to minimize soil erosin and flooding
- Security to protect from thieves, bird and animals
- Nursery bed should be sheltered from strong wind that would destroy seedling
- Nursery bed should point in north-south direction to expose the seedlings to adequate sunlight.

Nursery management

- Watering in the morning and afternoon
- Weeding
- Pricking out/remove of weak and unhealthy seeding and planting them in another nursery bed
- Providing a shade
- Mulching when necessary
- Pest control by applying the recommended pesticides
- Hardening off or gradual reduction of shade and watering before transplanting
- Disease control
-

Vegetative propagation

This is the reproduction of plants from plants part that are not associated with reproductive organs.

Advantages of vegetative propagation

- The offspring is similar to the parent in all ways hence preserve good mother characters.
- Offspring grows faster and mature early.
- Offspring are strong and hardly compare with seedling obtain from seeds.
- Vegetative propagation is the best way for propagating plants with no viable seeds.
- Daughter plants obtain food from their parents until they are sufficiently strong hence increasing chances of survival.
- Multiplication of the plant population is faster
- Over comes the problem of prolonged dormancy in some seeds
- Less risk of seedling disease
- Doesn't require much care
- Does not require pollinating agents

Disadvantages of vegetative propagation

- It may cause overcrowding due to the ability to establish quickly and grow fast.
- It may cause overcrowding due to the ability to establish quickly and grow fast.
- The planting materials are quite bulky and therefore difficult to handle store and transport.
- Due to their high moisture content vegetative materials are difficult to store.
- Some vegetative methods of propagation are complex and hence need a lot of skill to execute.
- A small hectare can be covered during planting as compared to seed propagation.

Methods of vegetative propagation

1. **Layering** - Mainly used in passion fruits.
2. **Grafting** - Used in most fruits like citrus, avocado, mangoes etc.
3. **Budding** - Can be used in fruits also like citrus.
4. **Tissue culture**- group of cells are developed into a new plant or plants

5 Use of storage structures

a. **Bulbs** - Used in onions and garlic.
b. **Bulbils** - Used in sisal
c. **Suckers** - Used in banana and pineapple
d. **Rhizomes.** - Used in ginger
e. **Runners** - Used in strawberry
f. **Corms** - Used in cocoyam
g. **Splits** - Used in pyrethrums
h. **Stem tubers** - Used in Irish potatoes.
i **Cutting** - Used in cassava sweet potato, clonal coffee.

GRAFTING

This is where two different stems are united in woody plants of the same species. The upper part of the union is called a scion while the lower part is called a stock.

PRINCIPLES OF GRAFTING

For successful grafting, there are about five principles which must be adhered to;

- Compatibility – The scion and stock must be related or close to facilitate sexual hybridization.
- The scion and the stock should be disease free.
- Use suitable equipment or tool for grafting
- Scion should have a bud
- Both scion and stock should be woody
- Both scion and stock should be from quality plant
- Graft quickly
- Cambial alignment – The cambium of the scion and root stock should be aligned for the union form.

- Timing of the grafting operation – Grafting must be done at a time when the root stock is in a proper physiological state.
- Avoiding desiccation – After grafting operation make sure that all the surface is sealed off using wax or grafting tape around the joining
- Pressure – Apply a pressure after aligning the cambium of the root stock and scion such that the xylem stays in contact.

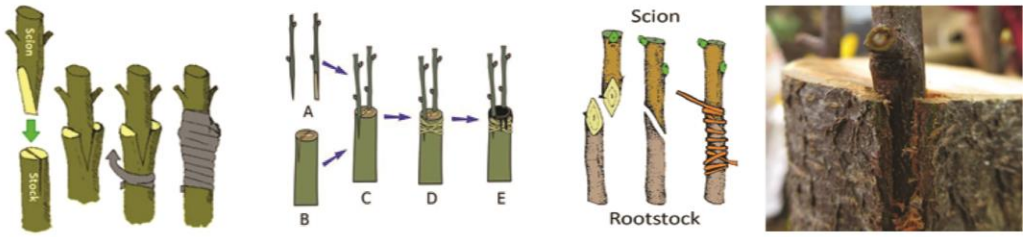
Advantages/reasons for grafting plants

1. It changes the tree top from being undesirable to desirable
2. It makes it possible to grow more than one fruit or flower in the same plant.
3. Root stocks with desirable character like disease resistance, problem of water logging are used which may be beneficial to the scion and farmer.
4. It helps to propagate clones that cannot be propagated by any means.
5. Can be used to repair damaged trees e.g. bridge grafting
6. It helps propagating special plants form e.g. seedless oranges.
7. Helps in change variety for more especially when the acid
8. Virus indexing – Plants having viral infection with no signs will show signs when grafted.

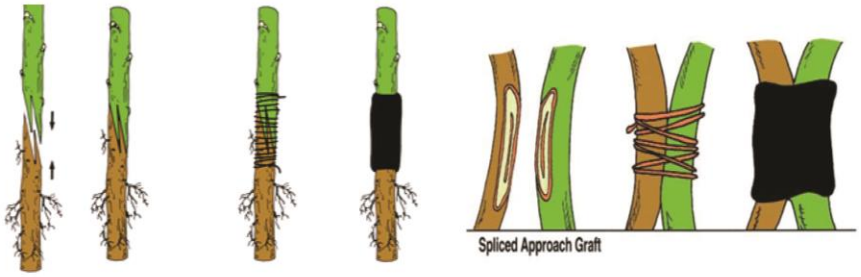
Disadvantages/limitation of grafting

1. Incompatibility – this failure of grafted material to survive due to a difference in genetic constitution.
2. Certain undesirable characteristic of the stock are transferred to offspring
3. Requires a lot of skills and experience for successful grafting to occur.
4. Requires a lot of time for tangible results to be got.
5. Absence of genetic variation
6. Apply to plant of the same species only
7. Leads to premature againg

Types of grafting



1.Top Wedge graft 2. Cleft Grafting 3. Splice grafting 4. Bark grafting

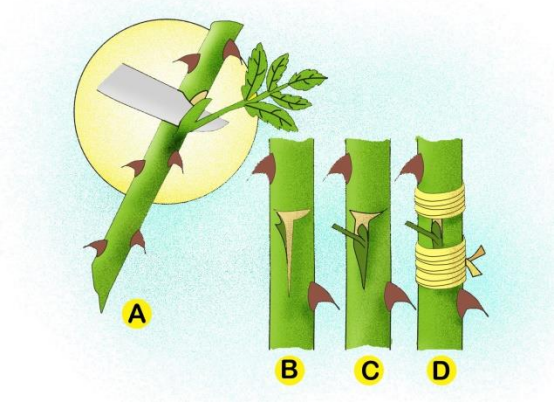


5. Whip and tongue grafting 6. Approach grafting

1. **Top Wedge: a** cut surface of the scion forms a wedge that is inserted into a vertical slit on the root stock that has been slash.
2. **Cleft Grafting / Top working grafting: t**his involves grafting a scion into a canopy of a relatively large established tree.
3. **Splice grafting**: a long slanting cut is made in both scion and root stock which is later tied together.
4. **Bark grafting**: a bark grafting is a plant made by slitting the back of the stock and inserting the scion beneath it. It is often used to regenerate an adult tree that has stopped being productive and to replace its structural branches. The cambium of the scion must line up as closely as possible with the cambium of the stock for a good graft union
5. **Whip and tongue grafting**: this is done if the root stock and scion have the same dimensions. A stanty cut is made at the base of the scion top of the root stock. The two are fitted together and waxed
6. **Approach grafting**: Here both the scion and stock remain attached to another plant until a secure union has been formed.
7. **Bridge grafting**: This is used in repairing damage free plant normally woody trunks of valuable established trees.

Budding

This type of vegetative propagation the bud or scion is united with a seedling or a mature tree.

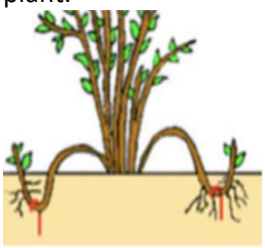


TYPES OF BUDDING

1. **T-budding:** a t-Shaped cut is made on the back of the root stock and a bud is made on the back of the root stock and the bud fitted in
2. **Patch budding:** a rectangular piece of bud is cut of the root stock. A matching piece of bark with a bud is cut from the bud wood and matched into the prepared root stock.
3. **Top budding: b**uds from young plants are inserted at desired location on the stock and after setting the original branches are cut.

LAYERING

This involves inducing a part of plant usually a branch to produce roots while still attached to the mother plant.



TYPES OF LAYERING.

1. **SIMPLE LAYERING**
   This involves bending a stem and covering it with soil to produce roots.
2. **TIP LAYERING**
   The whole shoot is bent and covered in the soil
3. **COMPOUND LAYERING (SERPENTINE)**
   This is achieved by bending a stem several times and sometimes at a point of covering.
4. **MOUNT / STOOL LAYERING.**
   A stem is cut just above the ground and the under shoot starts
5. **TRENCH LAYERING**
   Here a trench is dug near the plant and a branch is layed on the trench to facilitate root development.
6. **AIR / MACOTTING LAYERING.**

The bark of a tree is open at a point and a wet mass is placed around the ring bar to keep it open. This stimulates root to develop at that point.

Tissue culture

It is the development of organisms or organs from cells and tissues under sterile conditions and nutrient media

Advantages of tissue culture

- A large number of plants can be grown in a short period of time
- Healthy plants can be grown from diseased plants
- Plants without seeds can be multiplied
- Produces genetically uniform crops
- Requires small space to raise many plantlets
- Plantlets are not bulky and easy to transport
- Method can be used to produce useful chemicals for medicine

Disadvantages of tissue culture

- Requires all skills
- Since clones are identical can easily be wiped out by environmental disasters.
- expensive

Crop breeding / improvement

This is a process of changing crops genetically to suit man's needs of food, easy harvesting etc.

Or

It's a directed adjustment of crop plants to fit specific environment and production practices.

Germplasm is the genetic material that can be used to perpetuate a species or population. It is only has reproductive value, but through genetic manipulation (plant breeding), germplasm can be improved for better performance of the crop. Germplasm provides materials (parents) used to initiate breeding.

Aims of crop breeding / improvement

- To increase crop yields so as to save the problem of hunger and food shortage.
- To increase the nutrient content of the crop product to solve nutrient deficiency in consumers.
- Produce better size and colour of fruits / seeds that can attract consumers.
- To reduce the gestation period of a crop so as to solve food shortage.
- Conferring disease and pest resistance in crop.
- Production of crops that can tolerate adverse environmental conditions like drought, low soil fertility, high temperature.
- To change growth characteristics of a plant in order to suit harvesting spraying and weeding.
- to improve on the short life of the sowed crop production
- To improve on seed viability character in plants so that there is no wastage of seeds during planting.

- Improving the taste and flavour of certain crop products.
- To produce crop products that is easy to prepare as food for consumers.

Methods of crop breeding/improvement

They include

- Selection
- Introduction
- hybridization

1. Selection

It is a process of picking from a number of individuals with desirable characteristics to be parents of future generation. Selection can be natural or artificial but artificial selection is most important.

- **Natural selection: Here** crops or animals that are better suited to the environment survive and produce more offspring for the next generation while the less suitable dies off.
- **Artificial selection**: A farmer selectively breeds animals and crops with desirable traits.

Methods of in crop selection

(a) Pure line selection: in this method a single good looking plant is chosen and its offspring used to develop a new variety. It is a passive process since it eliminates variations instead of creating it. It is used to improve self-fertilized plants

Procedure of conducting pure line selection

- A large number of good looking plants with desirable qualities are identified.
- Seeds are collected from the plants from those with desirable qualities and kept separately
- The seeds from each plant are planted separately on isolated fields to prevent mix ups.
- The performance of the seeds from each plants and best performing plants noted.
- The seeds of the best performing plant are selected and identified as new variety.

(b) Mass selection

Seeds are collected from many good looking plants and mixed together. It used for breeding self-pollinated plants species (Dioecious plants)

Procedure of conducting mass selection

- Seeds from many plants with desirable characteristics are collected and mixed together.
- The seeds are planted on the same field and the result seeds from these crops are selected and marked as a new variety

Advantages of mass selection

- It simple
- fast
- cheap
- the cultivar is phenotypically fairly uniform even though it is a mixture of pure lines hence genetically broad based, adaptable and stable

Disadvantages of mass selection

- requires a uniform environment to achieve optimal results

- Phenotypic uniformity is less than that of pure line selection
- Desired qualities are a mixture of heterozygous and homozygous individuals thus a possibility of recessive traits in future generations.

(c) Pedigree selection

It a breeding method in which the breeder keeps records of the ancestry of the cultivar.
Hybridization is used to generate genetic variability
Procedure of pedigree selection

(i) The homologous parents of desirable qualities are identified and crossed.
(ii) Seeds (F1) from superior plants are selected, identifies, planted separately and records kept.
(iii) Procedure (ii) is repeated several time until cultivar of desired quality are produced.

Advantages of pedigree selection

- Record keeping provides a catalog of genetic information of the cultivar unavailable from other methods
- Selection is based not only on phenotype but also on genotype (progeny row) making it an effective method for selecting superior lines from among segregating plants.
- Using the records, the breeder is able to advance only the progeny lines in which plants that carry the genes for target traits occur.
- High degree of genetic purity is produced in cultivar

Disadvantage of pedigree selection

- Record keeping is slow, tedious and expensive
- The method is not suitable for species in which individual plants are difficult to isolate and characterize
- Pedigree selection is a lengthy process requiring 10 – 12 years or more to complete
- The method is more suitable for qualitative than quantitative breeding
- Selection in F2 (early generation testing) on the basis of quantitative traits such as yield may not be effective.

2. Introduction

This involves improvement of plants by introducing crops from their centers of origin or supposed centers of origins to other areas where they can survive and adapt to the environmental conditions. The introduced crops may be in form of planting material or pollen from suitable varieties for conducting artificial pollination.

Forms of introduction

- Direct for good economic use e.g. rubber and cocoa can be introduced and grown without any modification
- Can be used for selection of suitable crop cultivation
- Can be used for hybridization or other breeding programs.

Problems of crop introduction

- The introduction of plants needs other aspects of the environment for success such as pollinators.
- The introduced plant may not be adapted to the local environment
- Pests and diseases may be introduced with the new crops
- Requires a lot of research on climate and soil conditions before introducing a new crop.

3. Hybridization

It is the crossing of pure lines to produce a hybrid. Or it is the crossing of different varieties or species of plants to produce hybrids. It is mainly used in breeding for disease resistance.

Pure line cultivar are produced for species that are highly self-pollinated.

Hybrid cultivar are produced by crossing inbred lines that have been evaluated for their ability to produce hybrids with superior vigor above those of the parents

Procedure of hybridization

- Plants with desirable qualities are identified
- Seeds from the identified plants are collected and selfed to obtain homozygosity i.e. pure lines. This is only done in cross pollinated plants; self – pollinated plants are already homozygous due to natural selfing.
- Seeds of pure lines are then selected and planted.
- The male parts of the plant from one group and female parts from another group are removed before flowers are mature which allows cross pollination between the different groups.
- Seeds are then collected after maturity and sown.
- The offspring of F1 are tested at various research stations to find out the suitability to various environments.
- If found suitable, the seeds are multiplied, identified and released to the farmers.

Revision question 1

1. (a) What is genetic engineering? (02marks)

   Genetic engineering refers to the artificial manipulation of DNA to alter an organism's characteristics in a particular way.

   (b) Explain three benefits of genetic engineering in agriculture (03marks)

   - Faster growing plants and animals.
   - More nutritious food.
   - Tastier food.
   - Drought-resistant plants that require fewer environmental resources (such as water and fertilizer)
   - Pest and disease resistant crops and animals

- Increased supply of food with reduced cost and longer shelf life.
- Increased medicinal content

(c) Outline five challenges of genetic engineering in agriculture. (05marks)

- Loss of nutritional value of foods
- Low rate of seed germination
- Produce cause allergies and diseases
- It can lead to more birth defects.
- Immune suppression
- Antibiotic resistance
- Environmental concerns

2. (a) Give the meaning and one benefit of the following as used in crop breeding (06marks)

(i) Polyploidy

Polyploidy is a condition in which an organism's cells have more than two complete sets of chromosomes.

Benefits of polyploidy

- increased sized of plant
- reduced fertility
- high resistance to harsh climate
- increased yield
- increased resistance to diseases

(ii) Hybridization

Hybridization or cross breeding refers to the process of producing offspring by mating two parents from different varieties or species.

Benefits of hybridization in agriculture

Produces varieties that are

- disease resistant crops
- high yielding
- drought resistance

(iii) Back crossing

This is a cross between hybrids in F1 generation with one of the parents or an organism genetically equivalent to the parents.

Benefit of back crossing

Back crossing is mainly aimed at increasing the genetic contribution of one particular parent to the off spring.

(b) Describe the procedure of mass selection in crop improvement. (06marks)

- Seeds from many plants with desirable characteristics are collected and mixed together.
- The seeds are planted on the same field and the result seeds from these crops are selected and marked as a new variety.

(c) Outline the husbandry practices a farmer should adopt to obtain high maize yields. (08marks)

- Till the field remove weeds and improve on the soil aeration
- Timely planting at the beginning of the season
- Plant high yield, drought and disease resistant maize seeds
- Maintain proper spacing
- Apply fertilizers
- Keep the field free of weeds
- Spray pests and disease
- Practice crop rotation to maintain soil fertility.

3. (a) Give four reasons for drying seeds before storage. (04marks)
- To prevent molds and rot: seeds with high moisture rot easily
- Properly dried seed have long shelf life
- To prevent germination before planting
- To reduce pathogenic contaminations
- Maintain seed quality such good color

(b) Outline the physiological changes that take place during seed germination. (04marks)
- Hydrolysis of storage food material into soluble products
- Translocation of soluble products from storage area to the actively growing centres.
- Synthesis of enzymes, nucleic acids, structural proteins
- Respiration to provide energy for cellular activities
- Glucose and amino acids are translocated from the storage centres (endosperm or cotyledon) of the seed to the growing regions of the embryo.
- Cell division, elongation and differentiation leads to immergence of a seedling from a seed.

(c) Give the importance of air and temperature in the process of germination. (02marks)
- Air (oxygen) is required for respiration
- Optimum temperature activates enzymes

4. (a) What are the benefits of irrigation in Agriculture? (08marks)

- Provides water and reduce water stress of plants and increases crop yields
- Cools soil.
- Increases amount of cultivable land
- Reduces wind erosion
- Improves the quality of agricultural produce e.g. plumpness of seeds and fruits
- Provides food security
- Control some pests such as aphid that are more serious in dry weather

- Control weeds for instance in rice fields by flooding
- Soften soil to cultivation
- Enable timely planting
- It can help dilute toxins in the soil

(b) Explain the problems that may result from irrigation

- Promotes water borne diseases
- Leads to soil erosion
- Causes leaching
- Reduces soil aeration
- Leads to accumulation of salts in the soil causing soil salinity
- Make soil heavy for cultivation
- May cause death of microorganism due to poor aeration
- Cause denitrification due to poor aeration

5. (a) Give six consideration that should be made by a farmer when selecting and preparing seeds for planting. (06marks)

- Should be viable
- Should be disease
- Should be free from mechanical damage
- Should be mature
- Should have appropriate size to ensure enough food reserve
- Should be free from contamination
- Should be of desired genetic make up
- Should be plump i.e. well-formed and not wrinkled

(b) Four advantages of planting crops on ridges. (04marks)

- Improved weed control: ridges reduce weed density
- Warmer soil temperature: the ridges warm up sooner because the residue from the previous crop settle between them
- Better soil moisture
- Better aeration
- Erosion control: ridges act like mini terraces, reducing soil erosion
- Reduced herbicide costs due to the effective weed control
- Controlled traffic patterns: this system helps in managing traffic patterns, reducing soil compaction

Crop protection

It a practice of defending crops from weeds, pests and diseases as well as droughts and floods from the tine of planting to the harvest.

Weeds and weed control methods

Weeds are plants that compete with crops for nutrients, water, sunlight and space.

Importance of weeds

Positive importance /advantages

- provide humus and nutrients to the plants after decomposition
- Can be used for mulching
- Some of used as vegetables and source of vitamins
- Can act as soil cover to prevent soil erosion and excessive evaporation
- Are used as animal feeds
- Some fix nitrogen to the soil
- Some are used for medicinal purposes
- Take up and store nutrients thereby preventing leaching.
- Weeds, such as Chrysanthemum cinerariifolium, provide insecticide pyrethrum.
- Weeds tap nutrients from deeper soil layers and return them to the surface through litter leading to nutrient recycling
- Habitats for wild life

Negative importance/disadvantages

- Compete with plants for water, light, space, and nutrients and therefore reducing crop yields
- Are host for vectors and pests
- Some weeds are poisonous to livestock and man
- Weeding requires money
- Block irrigation and drainage channels
- Water weeds suffocate fish, impede fishing and water transport
- The presence of weeds limits farm size.

Effects of weeds on crop production

- Compete with plants for nutrients and light leading to low yield
- Parasitic weeds hinder plant growth
- Weeds lower the quality of crops through contamination e.g. black jack seeds
- Weed control is expensive

- Harbor pests and diseases
- May block irrigation channels
- Some weeds produce poisonous substances that reduce plant growth e.g. striga species.

Qualities/characteristic/factors than make weeds successful competitors

- Rapid rate of growth and maturation
- Drought resistant
- Resistant to pest and disease
- Some are parasitic
- Produce large volume of seed to increase their chance of survival
- Vegetative reproduction allows weeds to develop from any part of the plant
- Weeds employ various mechanisms of dispersal using wind, water, animals and self-dispersal mechanisms.
- Produce poisonous substances to crops
- Can obtain nitrogen from carnivorous behavior
- Are protected by structures such thorns and itching hairs that protect them herbivores.
- Some are resistant to herbicides

Farming practices that encourage weed infestation.

- Late planting, make weeds to sprout before planting
- Use of weed contaminated planting materials promoting weed growth
- Continuous tillage destroy soil structure and break up weed rhizomes into pieces that are spread
- Big plant spacing provides room for growth of weeds
- Continuous use same herbicides promote resistant weeds
- Mono cropping promotes growth of the same weeds
- Poor spacing; large spacing leave room for weeds
- Not planting crops in line making it difficult to control weeds

Methods of weed control

(a) Tillage/cutivation to remove weeds with hand hoe or machines

Benefits/Advantages of weed control by tillage

- Cheap especially for small plots of land
- Improve soil aeration
- Loosen soil particles
- Nonpoisonous to the crop and does not pollute the environment like herbicides
- Requires little skill
- Break up life cycle of crop pests by burying them or exposing then to harsh climatic condition

- Burying of weeds promotes their decomposition to provide nutrients to the plant.
- Improves water filtration
- Fast when machines are used
- Allows simultaneous application of fertilizers and weeding
- It allows earthing up of crops such as potatoes
- Can be used to control both annual and perennial crops

Disadvantages of weed control by tillage/cultivation

- Destroy soil structure
- Tiresome and laborius
- Increase water loss through evaporation
- Damage roots of the crops
- Burry and encourage germination of weed seed
- Encourages soil erosion

(b) Mulching

Advantages of mulching

- Protects the soil from erosion
- Retains moisture in the soil and reduces evaporation
- Reduces the growth of weeds
- Improves the fertility and nutrient content of the soil
- Insulates the soil from extreme temperatures

(c) Lethal wilting with high heat; **Heat** is reflected from hard surfaces to cook weeds to death

(d) Burning of weeds

Advantages of burning as a method of control of weeds

- Quick and effective method of destroying weeds and their seeds
- Add nutrients to the soil
- Kill pests and disease causing organisms
- Non-toxic

Disadvantages of burning weeds as a method of weed control

- Risk of fire to unwanted parts of the farm
- Destroy soil structure
- Releases carbon dioxide that leads to global warming
- Promote leaching of the released nutrients.

(e) Controlled grazing/biological control or use of an animal to feed on weeds such as rabbits for example use rabbits to control McDonald's eye in banana plantation, beetles to control water hyacinth, control of lantana camara by bugs and goats.

Advantages of biological control of weeds

- Reducing the pest population by using a natural parasite, predator or pathogen of the pest.
- Does not pollute the environment
- Does not affect soil structure
- Enhancing crop yield by managing pests that damage crops, leading to more productive farming.
- Preventing economic damage to agricultural products.
- cheap

Disadvantages of biological control of weeds

- biological control agents are not selective for weed
- biological control agents do not control all weed
- cannot eliminate weeds with dormant seed

Precautions using a biological control

- carefully matching of climate conditions to ensure that they favor the natural enemy of the pest
- the biological control agent should be specific to the crop pests or weed
- control agent should be released when there is reasonable amounts of the target pest or weed

(f) Use of herbicides

An herbicide is a substance that is toxic to plants, used to destroy unwanted vegetation or weeds

Examples of herbicides

(i) Phenoxyalkanoic acids, such as 2,4-D, which are selective herbicides that kill broadleaf weeds but not grasses.

(ii) Substituted alkanoic acids, such as dicamba, which are also selective herbicides that control broadleaf weeds in crops like corn and soybeans.

(iii) Chlorinated aliphatic acids, such as dalapon, which are non-selective herbicides that kill grasses and sedges.

(iv) Substituted triazines, such as atrazine, which are selective herbicides that inhibit photosynthesis in weeds.

(v) Substituted triazoles, such as amitrole, which are non-selective herbicides that interfere with the synthesis of chlorophyll and other pigments in plants.

Advantages of using herbicides

- Requires less labour
- Herbicides can be applied before the weeds grow unlike other methods of weed control, it is possible to apply herbicides in the pre-plant and pre-emergence stages.
- Herbicides can get rid of deep-rooted weeds
- Herbicides prevent weeds from growing for a long time
- Herbicides can get rid of structurally similar weeds

Disadvantages of herbicides

- Poisonous to human
- Non-selective herbicide cause injury to crops.
- Lead to herbicide resistant weeds
- Expose soil to soil erosion
- Require high skill in measurement
- Pollute the environment

Factors affecting efficiency of herbicides or that affect weedresponse to herbicides. (03marks)

- Concentration of the herbicide
- Timing of application or stage of the weed to which the herbicide is applied
- Weather conditions at the time of application. Usually rain/dew may dilute the herbicide leading to ineffectiveness.
- Weed stress: stressed weed due to lack of moisture, oxygen, extreme temperature is harder to kill than health weed
- Type weeds whether grass or legumes
- Weed resistance to a herbicide
- Water quality such as pH, turbidity, dissolved salts may affect efficiency of herbicides

Precautions when using herbicides

- Read the instructions carefully before using the chemicals.
- Wear protective gears such as gloves, rubber boots, and overalls.
- Wash your hands clean after using the chemicals and before eating
- Keep the chemicals out of reach of children
- Dispose of empty containers safely from the reach of children and animals.
- Spray crops in the direction of wind
- Spray crops in the direction of wind
- Trousers with turn ups where granules or dust particles may collect should not be worn during herbicide application
- Wash off spills from the body as soon as possible

Pruning of plants

Pruning is an essential horticultural practice that involves selectively removing specific parts of a plant, such as branches, leaves, or buds.

Benefits of pruning

1. **Improve health and promote healthy growth** by removing dead or overgrown branches.
2. **Maintain plants and landscapes**, encouraging fruit and flower production.
3. **Safety/Protect your family and property** by reducing the risk of storm damage from broken branches.
4. **Creates unfavorable microclimate for pests**
5. **Ornamental characteristics:** pruning helps shapes and maintain ornamental appeal.
6. **Clearance:** proper pruning maintains clearance for vehicle and pedestrian traffic, clearance for power lines.
7. Helps in air circulation in the branches
8. Helps light penetration in the branches
9. removing diseased branches or parts

Revision question 2

1. Couch grass can be effectively controlled by
   A. Hand hoeing
   B. Burning to kill the shoots
   C. Spraying with translocated herbicides
   D. Spraying with contact herbicides
2. Transloacated herbicides differ from contact herbicides in that they
   A. Kill only weed that have emerged
   B. Require proper wetting of leaves
   C. Kill the shoot system of the perennials
   D. Require low volume spray
3. Which of the following weeds can be best controlled by a systemic herbicide?
   A. Brachiaria species
   B. Chloris gayana
   C. Commelina species
   D. Mperata cylidrica
4. Which of the following implements is not used for primary tillage
   A. Subsoiler
   B. Disc plough
   C. Chisel plough
   D. Ridger

5. How can a noxious weed such as striga best be controlled? By

A. Uprooting and burning
B. Crop rotation
C. Use of contact- non selective herbicide
D. Proper spacing

6. Which of the following herbicides would you advise a farmer to apply on a growing maize crop infested with couch grass?
   A. Selective, translocated, pre-emergence herbicide
   B. Selective, translocated, post-emergence herbicide
   C. Contact, post-emergence, non-selective herbicide
   D. Translocated post-emergence, non-selective.
7. Crop rotation may control weeds because
   A. It forms a thick canopy on the soil
   B. Different crop are affected by different weeds
   C. Different crops require different form of soil preparation
   D. Weeds cannot rotate
8. Which of the following weeds can best be controlled by a synthetic herbicide?
   A. Lantana
   B. Wandering Jew
   C. Couch grass
   D. Wild finger millet
9. Which of these weeds is very difficult to control
   A. Biden pilosa
   B. Galinsoga parviflora
   C. Oxalis latifolla
   D. Solanum incanum
10. A pre-emergence herbicide is one that is applied before emergence of
   A. Flowers in seeds
   B. A crop
   C. Weeds
   D. Flowers in a crop

Answers to objective questions

1. C 2. C 3.D 4.D 5. 6. B 7. B 8.C 9. C 10. B

11. (a) Distinguish between a systemic and non-systemic herbicide

A systemic herbicide is that which is absorbed and translocated or transported throughout the whole plants to kill it, whereas, a non-systemic herbicide is that which does not to be translocated to the whole plant in order to kill it

(b) Explain four factors which influence the selection of a herbicide

(i) Cost/price of herbicide; farmers prefer herbicides that are cheap

(ii) Effectiveness farmers prefer a herbicide that is effective against the weeds
(iii) Selectiveness of the herbicide; farmers select those herbicide that are selective especially when weeding
(iv) The age/stage of growth of weed determines the effectiveness of a herbicide
(v) A farmer selects a herbicide based on previous results or familiarity
(vi) Expiry date of herbicide; farmers prefer herbicides with long expiry date
(vii) Farmer preference and choice

(c) Mention four ways in which the effectiveness of a herbicide can achieved.

(i) Use of the right herbicide for the right weed
(ii) Applying the herbicides in right quantities and intervals/mixing herbicides according to manufacturers instructions
(iii) Ensuring proper wetting of the leaves
(iv) Apply the herbicides after the dew has dried to prevent dilution
(v) Apply the herbicide at the correct stage of the weed. Especially old weed tend to resist herbicides
(vi) Avoid spraying in windy weather to prevent drift i.e. the spray to follow the direction of wind

12. (a) What is meant by integrated control of pest management?

This involves the use of a wider range of skilled and practices to maintain a penitential pest population below the economic injury without harming the environment.

(b) State the advantage of integrated control of pest management?

- it reduces environmental pollution
- ensure complete destruction of the pest at all stages of development
- conservation/protection of important insects such as bees, lady bird beetles, true spiders and rove beetles etc. is achieved.
- Pest infestation can be controlled in the a very short time i.e. quick control pest is achieved.
- In build resistance of some pest to a certain control method is eradicated more than one method is used.
- The system is cost effective in the long run.

(c) Suggest factors that should be considered by a farmer when selecting a method of pest control

- Level of infestation by the pest. This help determine whether it is a necessary take measures and determining the method depending on the population in the garden.
- The type of pest, different pest can effectively be controlled using one or combination of several methods.
- The stage of pest growth. This ensures correct measure to take e.g. some pest become resistant to different kind of chemical at adult stage than at larval stage.

- The effect of weather conditions on the control method to be used. It is for instance a waste of time to spray a crop if it rains soon after.
- Also the farmer should consider availability of any method and its effectiveness experience, the labor available, the technology and economic worthiness of the selected method.

13. (a) How can disease spread in a crop?
    - Through wind/air currents blow spores from diseases crop plant.
    - Through rain splash
    - Contact of plant to plant i.e. disease healthy ones
    - Infected plant material/seed/cutting
    - Pruning knives, pangas etc. carry disease organism
    - Sucking pest injected infected saliva in the plant
    - Irrigation water carry disease causing organisms.
    - Infects mulches carry some pathogens
    - Infected crop waste/previous crop residue
    - Infected organic manure
    - Contaminated animal to plant contact

    (b) Describe the methods that can be used to control crop diseases
    - Plant resistant/tolerant cultivators which withstand disease attack.
    - Weeding to remove plants that may be alternate hosts a disease organism.
    - Draining the soil may prevent water borne diseases.
    - Spraying with recommended chemicals to control e.g. fungicides.
    - Spraying with recommended chemicals to control vectors.
    - Seed dressing to destroy spores on the seed
    - Heat treatment may be given to seeds to kill spores on seeds
    - Diseased parts of plants/whole plants/plant should be destroyed
    - Early planting for crops to escape disease build up.
    - Proper spacing of crops
    - Restrict movement /quarantine areas with diseased crops.
    - Pruning to reduce micro-climate that favor growth of micro-organism
    - Disinfect tools to prevent spread of diseases.

14. (a) Describe the various characteristics that have made weeds most successful in their competition with plants.

    (b) Outline the precautions to be taken by the farmers to ensure safe use of herbicides.

15. (a) Outline the adaptations of water hyacinth for its survival
    - Has broad leaves to trap sunlight
    - It reproduces both sexually and asexually to increase the chances of multiplication and survival.
    - Has resistant seeds

- Easily dispersed by wind and running water
- Has extensive root system to accumulate mineral salts
- Has broad leaves to promote transpiration

(b) Suggest ecological dangers of water hyacinth

- Suffocate aquatic animals
- Block movement of animals and boats
- Clogging of drainage
- Reduce water quality

16. Give reasons to explain why farmers' efforts to eradicate weeds have not been successful (i.e. qualities that make weeds successful competitors).

17. **(a) Give three factors of weed that affect their response to herbicides. (03marks)**

- Concentration of the herbicide
- Timing of application or stage of the weed to which the herbicide is applied
- Weather conditions at the time of application. Usually rain/dew may dilute the herbicide leading to ineffectiveness.
- Weed stress: stressed weed due to lack of moisture, oxygen, extreme temperature is harder to kill than health weed
- Type weeds whether grass or legumes
- Weed resistance to a herbicide
- Water quality such as pH, turbidity, dissolved salts may affect efficiency of herbicides

(b) Explain seven cultural methods that could be used to control weeds. (07marks)

- **Crop rotation to break weed cycle and preventing adaptability of weed to single crop**
- **Cultivation to remove weed**
- **Mulching to prevent growth of weed**
- **Lethal wilting with high heat; Heat is reflected from hard surfaces to cook weeds to death**
- **Burning to destroy weeds and weed seeds**
- **Biological control or using a natural energy to weeds**
- **Hand pulling weeds from the farm**
- **Planting weed resistant varieties**
- **Appropriate crop spacing to suppress weed growth**
- **Early planting before weeds establish**
- **Intercropping minimizes space where weeds can emerge**

Pests and disease control in Plants

Pests are living organisms that cause damage to crops in form of quality and quantity.

Ways by which pests cause damage the crops

- Eat the buds, flowers, shoot, fruits e.g. grasshopper, caterpillars and beetles eat leaves/cause defoliation. Reducing fruit production and rate of photosynthesis.
- Introduce toxins to plants
- They bore into fruits and seeds e.g. bean bruchid/weevil, maize weevil etc. and eat inside causing holes, discoloring the tubers and causing them to have bitter taste e.g. sweet potato weevils.
- Suck plant sap and reduce plant vigor e.g. aphids, mearlybugs and scales
- Transmit diseases e.g. maize leaf hopper, white flies etc.
- Change crop's growth habits e.g. sorghum shoot flies
- Cause discoloration and bad smell reducing acceptability by customers
- They penetrate and damage plant roots thus preventing absorption of water and nutrients
- They reduce the yield of crops.
- Cause rotting of seeds hindering germination
- Contaminate products with their excreta

Characteristics that make pests successful in nature

- Have high rate of multiplication e.g. lay very many eggs.
- Most of them are small making it easy to hide
- They resemble the host crop for easy camouflage
- Have hard cuticle to protect them from adverse conditions
- Most fly leading fast dispersal
- Have defense mechanisms such as production of offensive smell
- Undergo metamorphosis such that different stages occupy different ecological niches to reduce competition
- Develop resistance to pesticides
- Have alternative source of food
- Have modified mouth parts to feed on crops such as mandibles for cutting and proboscises for sucking
- Resistant to diseases.

Pest control measures

1. **Principles of pest management and control**

   These are factors that need to be considered in order to fight a pest

   - Taxonomy: identifying the pest
   - Ecology the way of life of the pest to understand the effect of weather and seasons on the pest in order to identify the best time to attack the pest

- The biology: how the pest reproduces to identify the best stage to attack it.
- Estimating the population to identify the economic threshold of the pest.

2. Method of controlling of controlling crop pests

(a) Cultural methods of controlling crop pests

Cultural pest control refers to the manipulation of the crop production system or cultural practices to reduce or eliminate pest populations. These include: -

- Proper seed bed preparation: repeated tillage either exposes soil borne pests to their natural enemies on the surface or buries the pests very deep in the soil where they are suffocated and die.
- Crop rotation: this controls pests which feed on specific crops; by not growing such crops, pests either migrate or die due to lack of food
- Closed seasons: this involves foregoing cropping seasons without planting so as to control the build-up of pests in the field. Cropping is suspended for specific period to derive pests out of the host plants.
- Use of resistant crop varieties that tolerate pests. The resistant varieties have characteristics such as hairiness, thick or hard epidermis, unattractive color and/or smell to the pest and early maturation
- Destruction of crop residues after harvesting to eliminate breeding sites and kill the pests.
- Use of certified seeds and planting materials that carry no pests
- Regular weeding of the crops to eliminate breeding, hiding sites and alternative hosts.
- Proper spacing reduces spread of pests from one crop to another
- Proper pruning removes infected branches and micro habitats for the pests
- Thinning prevents overcrowding and spreading of pests
- Proper application of fertilizers ensures that crops grow faster or are able to tolerate pests
- Rogueing eradicates pests by removing and destroying pest affected crops from the garden.
- Mulching especially with black polythene controls nematodes in pineapple fields.
- Timely planting ensures that the crops grow and mature before destructive stages of the pest.
- Timely harvesting prevents attack of mature grains such as in millet, sorghum, rice and maize.
- Destroying volunteer plants i.e. plants that provide alternative source of food or breeding ground.
- Intercropping discourages spreading of pest from one crop to another and some crops like tobacco produce natural pest repellants.

Advantages of cultural pest control

- It is cheap and feasible for low value crops
- Does not pollute the environment
- It offers opportunity for integration of other methods
- Effect method of preventing pest establishment

Disadvantage of cultural method of pest control

- Does not eliminate pests
- Applied before pest attack thus reluctantly used
- Requires repeated use

(b) Physical methods of pest control

These involve use of specific physical/mechanical measures to reduce the number of pests. They include

- Hand picking and destruction of pests
- Construction of physical barriers e.g. greenhouse and screen houses
- Use extreme (high or low) temperatures to kill pests
- Use of radiations
- Dehydration of pest
- Use of irritating sound
- Use scarecrows
- Use insect traps

(c) Chemical pest control

It a pest control measures that involve use of chemical/pesticides. Natural chemicals used includes a mixture of urine and ash, some plant extracts etc. Synthetic chemicals include DDT, ambush, deldrine, malathion etc.

Terminologies relating use of pesticides

(i) Lethal dose (LD50) is the dose of agricultural chemical that will kill 50% of the pest/animal in a test population.

(ii) Selective pesticide is one that kills only the target organism but has little effects on others.

(iii) Pre-harvest period: it the duration/length of time which must elapse before crops sprayed with agricultural chemical can be consumed

(iv) Persistence: the period of time a pesticide remains in the environment (including within the organism) before being broken down.

(v) Specificity refers to the range of organism that a pesticide can affect/kill. Broad spectrum pesticides is one that kill many species of pests such as DDT while a narrow spectrum pesticide kills few species.

(vi) Tolerance limit refers to the maximum quantity of the chemical residues that is acceptable in the environment.

Ways of controlling storage pests.

- Hand picking and destruction of pests
- Use extreme (high or low) temperatures to kill pests
- Use of radiations

- Dehydration of pest
- Use of irritating sound
- Pick a storage facility with a good pest control policy.
- Use plastic storage containers with tight lids.
- Keep the storage area clean.
- Maintain a cool, dry climate.
- Use preventive pest control products.
- Use safe/appropriate pesticides

Desirable characteristics of a pesticide

- toxic to the target organism
- specific to the target organism
- biodegradable not to accumulate in the environment
- harmless to the plants and animals
- cheap and readily available
- easy to store and transport
- readily soluble in water
- not accumulate in ecosystem

Precautions to be taken by the farmers to ensure safe use of pesticides

- Read the instructions on the container or leaflet before using the pesticide
- Wear protective clothes such as overalls, gloves, rubber boots, head masks and eye shields.
- Chemical should be stored in safe places away from children.
- Do not eat or drink while working with pesticides
- Wash any spillage from your body as soon as possible
- Clean the equipment after use
- Dispose of empty containers safely as instructed by the manufacturer.
- Do not use empty containers for edible substances.

Factors that affect efficiency of a pesticide

- Concentration of the pesticide
- Timing of application or stage of the pest to which the pest is applied
- Weather conditions at the time of application. Usually rain/dew may dilute the pesticides leading to ineffectiveness.

Pesticide resistance

Pesticide resistance is the decreased effectiveness of a pesticide in controlling a pest population that was previously susceptible to it.

Factors that promote pesticide resistance in pest populations

- Genetic factors; high genetic variation promote resistance
- Mutation

- Prolonged use of a single pesticide
- Unwarranted use of pesticides
- Use of broad spectrum pesticides such as DDT that kill natural enemies of the pests.
- Use of sub-lethal concentration of pesticides
- High population of pesticide
- Non-uniform application of pesticides in the field

Advantages of chemical pest control

- It is very effective
- Easy to apply
- Chemicals are broad spectrum
- Easy to access

Factors that limit the use of or disadvantages pesticide by farmers

- they and application equipment are expensive
- application of pesticides requires skill especially in measuring and mixing
- Lead to chemical resistant pests on prolonged use of same pesticide
- They kill beneficial organism as well for example pollinator.
- They pollute the environment
- They lower the value and/quality of products
- Some pesticides can interfere with hormone systems, potentially leading to developmental and reproductive problems.
- They are poisonous to the farmer and livestock
- Lead to chemical resistant pests on prolonged use of same pesticide
- Some pesticides are inflammable and may cause fire hazards
- Some pesticides such as DDT accumulate in food chain leading to toxic levels and may eliminate organisms in top trophic levels.
- Exposure during pregnancy can increase the risk of birth defects and developmental delays in children

(d) Biological pest control

This is the control of the pest population below the economical threshold using their natural enemies in form of predator, pathogen, parasite etc.

Qualities of a good biological pest control agent

- Must have high searching ability
- Should be adaptable to wide range of environments
- Should be host specific
- Should have ability to multiply in order to control the target organism
- Should not cause a lot of damage to crops and animals

- Should be easily raised artificially
- Should be easy to distribute/apply

Advantages of controlling pest using biological control method

- It requires less labor
- It is selective to the target organism
- Long lasting from season to season
- Can be easily employed to remote areas
- cheap

Methods of using biological control agent

(i) **Introduction:** here the natural enemy is introduced from another area in the area of interest to control the pest.

(ii) Conservation: the natural enemy exists but there is still an outbreak of the pest. Conservation therefore refers to the adjustment of the farming system to favor multiplication of the agents

(iii) Argumentation: requires introduction of additional of the natural enemy to the existing population

(e) Integrated pest management (IPM)

It is a pest control measure involving use of a wide range of methods to control pests without harming the environment using methods such as biological control, burying/burning infected plant parts etc. use of chemicals is minimized.

Advantage of integrated pest management

- it reduces environmental pollution
- has less health side effects
- ensure complete destruction of the pest at all stages of development
- Conservation/protection of important insects such as bees, lady bird beetles, true spiders and rove beetles etc. is achieved.
- Pest infestation can be controlled in the a very short time i.e. quick control pest is achieved.
- In build resistance of some pest to a certain control method is eradicated more than one method is used.
- The system is cost effective in the long run.

Disadvantage of integrated pest management

- Requires skill
- Farmer are reluctant to use prevention measures
- Does not eliminate the pests

Crop diseases

A disease is any sub-normality or malfunctioning that occur in plants and becomes harmful to any part of its part or systems.

Effects of diseases on crop plants.

- Stunted growth
- Malformation of plant
- cause plant death
- Reduced crop yield
- Reduced quality of crop yield

Ways by which disease spread in crops

- Through wind/air current blow spores from one diseased crop to another
- Through rain splash
- Contact between health and diseased plant
- Infected planting materials/seedlings/cuttings
- Pruning knives, pangas carry disease causing organisms
- Transfer of disease causing organisms by pests and vectors
- Irrigation with contaminated water
- Application of infected mulches
- Through infected crop wastes/residues
- Through infected organic manure
- Through contact with infected animals

Cultural methods that can be used to control crop diseases

- Plant resistant/tolerant plants to diseases
- Timely weeding to remove alternative hosts or breeding grounds
- Crop rotation to prevent building up host specific diseases
- Spraying with recommended chemicals to control vectors or to kill disease causing agents
- Seed dressing can be used to destroy spores on the seeds
- Heat treatment can be used to destroy spores on the seeds.
- Sterilizing soil by heat to kill pathogens
- Early planting to escape buildup of pests and diseases
- Proper spacing to minimize spreading of diseases
- Quarantine to restrict movement of diseased plant materials
- Destruction of crop residues that contain pathogens
- Pruning to reduce micro-climate that favor growth of microorganisms
- Disinfect tools to prevent spread of diseases
- Proper hygiene

Symptoms of plant disease

(a) **Mosaic:** these are yellow patches on the leaves forming a mosaic pattern, followed by leaf curling. They are caused by viruses e.g. cassava and tomato mosaic.

(b) **Rusts:** these are rusty orange/white colored sports that result in rupturing of the epidermis and formation of swellings. They are caused by fungi that attack leaves and stems e.g. coffee rust, bean rust

(c) **Smuts** are black dusty masses that resemble soot normally found in cereals like maize, wheat, sugar cane and sorghum. They are caused by fungi.

(d) **Anthrocnose** are small sunken water soaked lesions on leaves, stems and ponds. They caused by fungi e.g. bean anthrocnose.



(e) **Rots** are degeneration of plant tissues due attack by pathogens. They are common in vegetables and fruits

(f) **Rosette** occurs in leaves and makes the leaves to be grouped closely and packed together with limited spaces and there appears to be no internodes. E.g. groundnut rosette cause by viruses.

(g) **Galls** are swellings along the structure of a plant that may interfere with transportation and absorption of water and nutrients. They are caused by nematodes and fungi.

(h) **Chlorosis** is the uniform yellowing of leaves

(i) **Necrosis** is the death of plant tissues resulting from attack by pathogens.

(j) **Wilts:** plant tissues become flaccid and drop/collapse caused by fungi.

(k) **Leaf spot and blights** are limited non-expanding necrosis patches on leaves. If the spots are fast spreading, they kill the whole part of the plant and become blights.

(l) **Dumping off** is the rotting or collapse of the seedlings at the ground level. It is caused by fungi.

Dumping is promoted by

- Heavy soil/poor drainage
- Very high plant population
- Heavy weed infestation
- Excess soil moisture and nitrogen

(m) **Mildew** is the massive production of spores and mycelia that rapidly covers the leaf surface producing a powdery substance e.g. downy mildew.

(n) **Cankers** are wounds created on plant tissue due to attack by pathogens

(o) **Hypotrophy** is the production of small sized cells induced by pathogens.

(p) **Hypertrophy** is the **abnormal increase in the size of the plant organs** due to increase in the size of the cells of a particular tissue

(q) **Hyperplasia** is the abnormal increase in the size of the plant organs due to increase in the number of cells of which the tissue or organ is composed, owing to increased cell division.

(r) **Phyllody** is the abnormal development of floral parts into leafy structures

(s) **Mottling** is the yellowing of leaves but with no pattern.

The environmental factors that cause diseases in plants

(a) Temperature
- Sun scald exposed sites of fresh fruits and vegetables
- Wilting due to high evaporation
- Over sweetening of potatoes due to low temperature

(b) Soil
- Cause stunted growth due to inadequate nutrients
- Increase yellowing and leaf senescence due to lack of water
- Rotting due to too much water
- Chlorosis and early senescence due to inadequate supply of nitrogen

(c) Lack of soil moisture cause wilting and stunted growth

(d) Limited sunshine/shadows causes etiolation and weakening of plant stems

(e) Air pollutants such as sulphur dioxide cause plant lesions

The nursery bed maintenance and how they can contribute to pest management

- Irrigation and water leads to healthy seedlings that can tolerate pests.
- Appropriate and regular watering wash off pests from seedlings
- Weeding eliminate weeds that act as breeding ground for pests
- Thinning reduces congestion and spread of pests
- Monitoring and picking out infected seedlings prevents spread of pests and diseases
- Spraying kills pesticides

- Application of fertilizers boot seedlings vigour which help them to tolerate pests and diseases
- Soil sterilization by heating soil kills pest

Factors that make fungi the most successful plant pathogens

- They have wide range of host
- They are saprophytic in nature and thus have food available
- Produce vast amount of spores to increase chance of survival
- Light spore is easily dispersed
- Can exist in different forms
- Readily undergo mutation
- Resistant to chemicals

Factors that contribute to the prevalence (increase) of pests in tropics

- **Crop improvement** that has made crops of better quality which favor multiplication of pests.
- **Change in farming system** the introduction of large supply of food to pests hence favoring their existence.
- **Decline in species diversity** elimination of species diversity disturbs the ecosystem through bush burning deforestation hence increasing pressure of pests to crops.
- **Climatic change** that leads to destruction of ecosystem and habitats for the organism.
- **Introduction of new crops** that come with new crop pests.
- **Increased use pesticides** leading to pesticide resistance.
- **Crop storage** that enables pests to hide for long time
- **Improved transport** that enable transport of pests.
- Change in demand patterns for crops; crops that are not in demand are neglected and their pests left to multiply for instance it happens with coffee when prices fall.

Revision question 3

1. Painting of wood on a farm structure is done in order to
   A. Block entry of air
   B. Prevent termites attack
   C. Block penetration of moisture
   D. Seal off wood defects
2. Frequent use of pesticide like DDT in an ecosystem is discouraged because it
   A. Accumulates in consumer tissue
   B. Cause migration of beneficial organisms from the areas
   C. Leads to emergence of secondary pests in an area
   D. Is too strong and cannot be diluted
3. The best way of controlling scale insect pest in a sugar cane plantation is to
   A. Spray the field with soil sterilants
   B. Fumigate the soil
   C. Crop rotation with legume
   D. Expose them to their predators
4. Which of the following does not affect sprayer performance
   A. Operating pressure
   B. Forward speed of operator
   C. Height of the crop
   D. Distance from the crop
5. The best way of controlling scale insects pest in a sugar cane plantation is to
   A. Spray the field with soil sterilants
   B. Fumigate the soil
   C. Crop rotation with legumes
   D. Expose them to their predators

6. Which one of the following does not affect sprayer performance?
   A. Operating pressure
   B. Forward speed of operator
   C. Height of the crop
   D. Distance from the crop

7. Which of these sets of diseases given below are protozoan?
   (i) Fowl pox
   (ii) Trypanosomiasis
   (iii) Riderpest
   (iv) black quarter
   (v) anaphlasmosis
   (vi) Hog cholera
   A. (i), (iv) (v)

B. (ii), (iv)
C. (i), (iii), (iv)
D. (iii), (vi)

8. Which of the following types of pesticides is the most effective in controlling aphids?
   A. Contact pesticide
   B. Surface sterilants
   C. Fumigants
   D. systematics
9. one of the reasons for not treating millet seeds with chemicals during storage is the
   A. it is difficult to clean off chemicals before consumption
   B. the grain embryo is easily killed by chemicals
   C. the tough grain coat resist pest attack
   D. the small grain sizes discourage pest attack
10. Pesticide like DDT have been discouraged mainly because
   A. They are highly toxic to use
   B. They are not easily degraded
   C. They kill beneficial insects
   D. They are not expensive
11. Anaphlamosis is caused by
   A. Ticks
   B. Protozoa
   C. Bacteria
   D. viruses
12. Which one of the following is a vector of the lift valley disease of sheep?
   A. Mosquito
   B. Tick
   C. Tsetse fly
   D. snail
13. Which of the following is an example of an irregular pest?
   A. Aphids
   B. Locust
   C. Grasshopper
   D. White flies
14. Which of the following agricultural chemicals is out of place
   A. Agrocide
   B. Gramoxone
   C. Dalapon
   D. agroxone
15. which of the following pesticides is most suitable for controlling sap sucking pests

A. Contact pesticide
B. Surface sterilant
C. Systematic pesticide
D. fumigant

16. The animal disease that is vector borne is
A. Anthrax
B. Foot and mouth
C. Rinderpest
D. Trypanosomiasis
E.

17. The bean characterized by brown, sunken and soaked lesions on the pond is
A. Bean mosaic
B. Bean rust
C. Bean anthrocnose
D. Angular leaf spot

18. The fungus that causes browning in cotton lint is transmitted by
A. Taybrgus sp.
B. Dysdercus sp.
C. Emposca sp.
D. Cryptophlebia sp.

19. Which one of the following is a vector of Nairobi sheep disease?
A. Mosquito
B. Tick
C. Tsetse fly
D. snail

20. Which of the following is a disinfectant on the farm?
A. Copper sulphate
B. Deknav
C. Terramycin
D. Dithane

21. Maize streak is characterized by
A. Dark brown patches on the underside of leaves
B. Papery lesion on leaves
B. Narrow yellow stripes parallel to the leaf veins
C. Sooty appearance on the cob

22. A cotton pest controlled by growing the hairy cotton variety is
A. Cotton stainer
B. American boll worm

C. Jassids
C. Spiny boll worm

23. Scale and mealy bugs cause damage to crops through
    D. Sucking
    A. Chewing
    B. Biting
    C. Boring
24. How does close spacing of ground nuts prevent rosette?
    A. So much moisture kill virus
    E. Aphids are controlled
    B. Host plants are suppressed
    C. Maximum use of nutrients hinder viral growth
25. The best option for prevention of fusarium within banana plantation is to kill the disposing factors using
    A. Bacteria
    B. Virucides
    C. Nematocides
    F. fungicides
26. How a noxious weed such as stringa best is be controlled? By
    G. Uprooting and burning
    H. Crop rotation
    I. Use of contact-non selective herbicide
    J. Proper spacing

Answers to objective questions

1B	2C	3D	4D	5D	6D	7B	8D	9C	10B	11B	12A	13C
14A	15A	16D	17C	18B	19B	20A	21C	22C	23A	24B	26D	26B

27. (a) Give five desirable characteristics of a pesticide

    Should be
    - toxic to the target organism
    - specific to the target organism
    - biodegradable not to accumulate in the environment
    - harmless to the plants and animals
    - cheap and readily available
    - easy to store and transport
    - readily soluble in water
    - not accumulate in ecosystem

(b) State five factors that limit the use of pesticide by farmers

- they and application equipment are expensive
- application of pesticides requires skill especially in measuring and mixing
- they kill beneficial organism as well for example pollinator.
- They pollute the environment
- They lower the value and/quality of products
- They are poisonous to the farmer and livestock
- Lead to chemical resistant pests
- Accumulate in ecosystem

28. What is biological control?

This is the control of the pest population below the economical threshold using their natural enemies in form of predator, pathogen, parasite etc.

29. (a) Give the meaning of the following as applied in pesticide use

(i) Pre-harvest period: it the duration/length of time which must elapse before crops sprayed with agricultural chemical can be consumed

(ii) Lethal dose 50 (LD50) is the dose of agricultural chemical that will kill 50% of the pest/animal in a test population.

(b) Explain characteristics that make pests successful in nature

- Have high rate of multiplication e.g. lay very many eggs.
- Most of them are small making it easy to hide
- They resemble the host crop for easy camouflage
- Have hard cuticle to protect them from adverse conditions
- Most fly leading fast dispersal
- Have defense mechanisms such as production of offensive smell
- Undergo metamorphosis such that different stages occupy different ecological niches to reduce competition
- Develop resistance to pesticides
- Have alternative source of food
- Have modified mouth parts to feed on crops such as mandibles for cutting and proboscises for sucking
- Resistant to diseases.

(c) State the qualities of a good biological agent for pest control

- Must have high searching ability
- Should be adaptable to wide range of environments
- Should be host specific
- Should have ability to multiply in order to control the target organism
- Should not cause a lot of damage to crops and animals
- Should be easily raised artificially
- Should be easy to distribute/apply

30. Give the advantages of controlling pest using biological control method

- It requires less labour
- It is selective to the target organism
- Long lasting from season to season
- Can be easily employed to remote areas
- cheap

31. Explain the environmental factors that cause diseases in plants

(a) Temperature
- Sun scald exposed sites of fresh fruits and vegetables
- Wilting due to high evaporation
- Over sweetening of potatoes due to low temperature

(b) Soil moisture
- Cause stunted growth due to inadequate nutrients
- Increase yellowing and leaf senescence due to lack of water
- Rotting due to much water
- Chlorosis and early senescence due to inadequate supply of nitrogen

(c) Limited sunshine/shadows
- Causes etiolation and weakening of plant stems

(d) Water scarcity/drought/lack of rainfall
- Causes stunted growth

32. (a) What is meant by biological control of a crop pest (02marks)
(b) Explain characteristics of a good biological control agent (09marks)
(c) Give the advantages of controlling pest using biological control method (09marks)

33. (a) Outline the various ways in which pests cause damage the crops
(b) Explain the cultural methods of controlling crop pests (12marks)

- Proper seed bed preparation: repeated tillage either exposes soil borne pests to their natural enemies on the surface or buries the pests very deep in the soil where they are suffocated and die.
- Crop rotation: this controls pests which feed on specific crops; by not growing such crops, pests either migrate or die due to lack of food
- Closed seasons: this involves foregoing cropping seasons without planting so as to control the build-up of pests in the field. Cropping is suspended for specific period to derive pests out of the host plants.
- Use of resistant crop varieties that tolerate pests. The resistant varieties have characteristics such as hairiness, thick or hard epidermis, unattractive color and/or smell to the pest and early maturation
- Destruction of crop residues after harvesting to eliminate breeding sites and kill the pests.
- Use of certified seeds and planting materials that carry no pests
- Regular weeding of the crops to eliminate breeding, hiding sites and alternative hosts.

- Proper spacing reduces spread of pests from one crop to another
- Proper pruning removes infected branches and micro habitats for the pests
- Thinning prevents overcrowding and spreading of pests
- Proper application of fertilizers ensures that crops grow faster or are able to tolerate pests
- Rogueing eradicates pests by removing and destroying pest affected crops from the garden.
- Mulching especially with black polythene controls nematodes in pineapple fields.
- Timely planting ensures that the crops grow and mature before destructive stages of the pest.
- Timely harvesting prevents attack of mature grains such as in millet, sorghum, rice and maize.
- Destroying volunteer plants i.e. plants that provide alternative source of food or breeding ground.
- Intercropping discourages spreading of pest from one crop to another and some crops like tobacco produce natural pest repellants.

34. (a) Describe the dangers associated with the use of pesticides in agricultural production
    - Pesticides can be poisonous to farmers and their animals
    - Pollute the environment i.e. water, land and air
    - Some pesticides are inflammable and may cause fire hazards
    - Some pesticides such as DDT accumulate in food chain leading to toxic levels and may eliminate organisms in top food levels.
    - Continuous use of same pesticides leads to resurgence due to development of resistance.
    - Eliminate non-targeted organism such as pollinators that are useful to the farmers.
    - Expensive

    (b) Outline the precautions to be taken by the farmers to ensure safe use of pesticides

    - Read the instructions on the container or leaflet before using the pesticide
    - Wear protective clothes such as overalls, gloves, rubber boots, head masks and eye shields.
    - Chemical should be stored in safe places away from children.
    - Do not eat or drink while working with pesticides
    - Wash any spillage from your body as soon as possible
    - Clean the equipment after use
    - Dispose of empty containers safely as instructed by the manufacturer.
    - Do not use empty containers for edible substances.

35. (a) What is meant by pesticide resistance

    It is a situation where the pest population remains relatively unaffected by application of a recommended pesticide in the right quantities and concentrations. Or it is a situation where pests acquire characteristics/traits that enable them to survive despite the recommended levels of pesticides.

(b) Describe the factors that promote pesticide resistance in pest populations

- Genetic factors; high genetic variation promote resistance
- Mutation
- Prolonged t use of a single pesticide
- Unwarranted use of pesticides
- Use of broad spectrum pesticides such as DDT that kill natural enemies of the pests.
- Use of sub-lethal concentration of pesticides
- High population of pesticide
- Non-uniform application of pesticides in the field

36. (a) Write short notes on the following

(i) Integrated pest management (IPM)

It is a pest control measure involving use of a wide range of methods to control pests without harming the environment using methods such as biological control, burying/burning infected plant parts etc. use of chemicals is minimized.

(ii) Biological control

(iii) Cultural pest control

It is a pest control measure involving application of agronomic practices that interfere with the life cycle of pests such as proper seed bed, early planting, crop rotation, proper hygiene during harvesting and use of resistant varieties.

(iv) Chemical pest control

It a pest control measures that involve use of chemicals. Natural chemicals use includes a mixture of urine and ash, some plant extracts etc. Synthetic chemicals include DDT, ambush, deldrine, malathion etc.

(b) Discuss the nursery bed maintenance and how they can contribute to pest management

- Irrigation and water leads to healthy seedlings that can tolerate pests.
- Appropriate and regular watering wash off pests from seedlings
- Weeding eliminate weeds that act as breeding ground for pests
- Thinning reduces congestion and spread of pests
- Monitoring and picking out infected seedlings prevents spread of pests and diseases
- Spraying kills pesticides
- Application of fertilizers boot seedlings vigour which help them to tolerate pests and diseases
- Soil sterilization by heating soil kills pest

37. (a) How can disease spread in crops?

- Through wind/air current blow spores from one diseased crop to another
- Through rain splash
- Contact between health and diseased plant
- Infected planting materials/seedlings/cuttings
- Pruning knives, pangas carry disease causing organisms

- Transfer of disease causing organisms by pests and vectors
- Irrigation with contaminated water
- Application of infected mulches
- Through infected crop wastes/residues
- Through infected organic manure
- Through contact with infected animals

(b) Describe the methods that can be used to control crop diseases

- Plant resistant/tolerant plants to diseases
- Timely weeding to remove alternative hosts or breeding grounds
- Crop rotation to prevent building up host specific diseases
- Spraying with recommended chemicals to control vectors or to kill disease causing agents
- Seed dressing can be used to destroy spores on the seeds
- Heat treatment can be used to destroy spores on the seeds.
- Sterilizing soil by heat to kill pathogens
- Early planting to escape buildup of pests and diseases
- Proper spacing to minimize spreading of diseases
- Quarantine to restrict movement of diseased plant materials
- Destruction of crop residues that contain pathogens
- Pruning to reduce micro-climate that favor growth of microorganisms
- Disinfect tools to prevent spread of diseases
- Proper hygiene

38. **(a) Explain six ways through which crop diseases spread on farms. (06marks)**

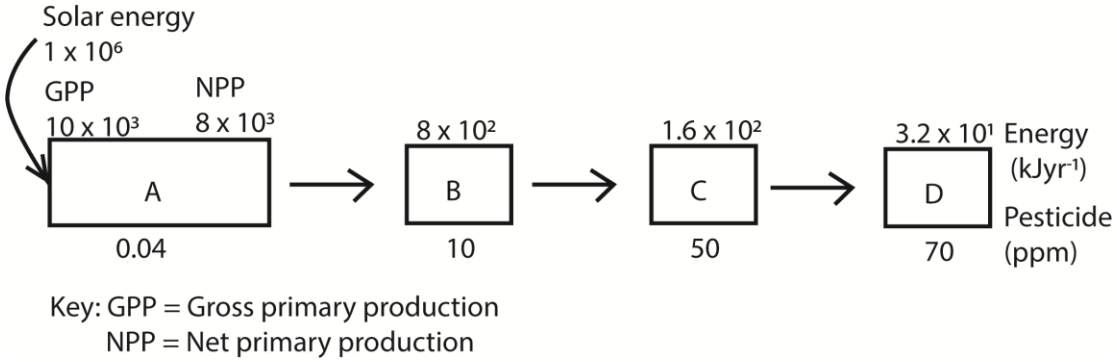
- Through wind/air current blow spores from one diseased crop to another
- Through rain splash
- Contact between health and diseased plant
- Infected planting materials/seedlings/cuttings
- Pruning knives, pangas carry disease causing organisms
- Transfer of disease causing organisms by pests and vectors
- Irrigation with contaminated water
- Application of infected mulches
- Through infected crop wastes/residues
- Through infected organic manure
- Through contact with infected animals

(b) Suggest four conditions necessary for successful disease infection of a crop in a field? (04marks)

- **There must be pathogen host contact**
- **Plant must be susceptible to the pathogen**
- **The pathogen must be in pathogenic stage**

- **Presence of favorable temperature**
- **Favorable humidity**

39. The figure below shows the transfer of energy in kJyr-1 (on top) and the amount of pesticide in parts per million (at the bottom) at different levels in the food chain in an ecosystem. Study the figure and answer the questions that follow:



Key: GPP = Gross primary production
NPP = Net primary production

(a)(i)What organisms occupy A on the diagram?

Producers

(ii) What is the percentage of incident energy absorbed by the organisms at level A?
Percentage = $\frac{GPP}{solar\ energy} x\ 100\%$

$= \frac{10\ x\ 10^3}{1\ x\ 10^6}\ x\ 100\% = 1\%$

(iii) Where does the rest of the energy which is not absorbed at level A Go?
It is reflected into the atmosphere as heat or absorbed by non-living organism

(b) Calculate the percentage of energy of the net primary production in the organism at level A which is transferred to organism at

(i) Level B

$\frac{8\ x\ 10^2}{8\ x\ 10^3}\ x\ 100\% = 10\%$

(ii) Level C

$\frac{3.2\ x\ 10^1}{8\ x\ 10^3}\ x\ 100\% = 0.4\%$

(c) What conclusions can be made from your answer in (b) about the transfer of energy along trophic levels?
The energy transfer from producers along the trophic levels reduces

(d) Explain why all the energy at one trophic level is not transferred to the next trophic level

- Energy is lost through respiration, excretion, egestion death and decomposition
- Not all materials ingested is digested.

(e) (i) Describe the trend of the pesticide concentration from organisms at level A to those of level D.

In pesticide concentration in organisms increases with the increase in trophic levels from A to D.

(ii) Explain the trend of the concentration of pesticide in e(i)

The consumer at high trophic eats several organism and accumulates the pesticide in its tissues

(iii) Suggest one property of the pesticides. Explain your answer

It is non-biodegradable because it accumulates in the organisms along the trophic levels.

(f) What is meant by pesticide resistance

It is a situation where the pest population remains relatively unaffected by application of a recommended pesticide in the right quantities and concentrations. Or it is a situation where pests acquire characteristics/traits that enable them to survive despite the recommended levels of pesticides.

(g) Describe the factors that promote pesticide resistance in pest populations

- Genetic factors; high genetic variation promote resistance
- Mutation
- Prolonged t use of a single pesticide
- Unwarranted use of pesticides
- Use of broad spectrum pesticides such as DDT that kill natural enemies of the pests.
- Use of sub-lethal concentration of pesticides
- High population of pesticide
- Non-uniform application of pesticides in the field

-

Revision question

1. Painting of wood on a farm structure is done in order to
   E. Block entry of air
   F. Prevent termites attack
   G. Block penetration of moisture
   H. Seal off wood defects
2. Frequent use of pesticide like DDT in an ecosystem is discouraged because it
   E. Accumulates in consumer tissue
   F. Cause migration of beneficial organisms from the areas
   G. Leads to emergence of secondary pests in an area
   H. Is too strong and cannot be diluted
3. The best way of controlling scale insect pest in a sugar cane plantation is to
   E. Spray the field with soil sterilants
   F. Fumigate the soil
   G. Crop rotation with legume
   H. Expose them to their predators

4. Which of the following does not affect sprayer performance
   E. Operating pressure
   F. Forward speed of operator
   G. Height of the crop
   H. Distance from the crop
5. The best way of controlling scale insects pest in a sugar cane plantation is to
   E. Spray the field with soil sterilants
   F. Fumigate the soil
   G. Crop rotation with legumes
   H. Expose them to their predators

6. Which one of the following does not affect sprayer performance?
   E. Operating pressure
   F. Forward speed of operator
   G. Height of the crop
   H. Distance from the crop

7. Which of these sets of diseases given below are protozoan?

(iv) Fowl pox	(iv) black quarter
(v) Trypanosomiasis	(v) anaphlasmosis
(vi) Riderpest	(vi) Hog cholera

   E. (i), (iv) (v)
   F. (ii), (iv)
   G. (i), (iii), (iv)
   H. (iii), (vi)
8. Which of the following types of pesticides is the most effective in controlling aphids?
   E. Contact pesticide
   F. Surface sterilants
   G. Fumigants
   H. systematics
9. one of the reasons for not treating millet seeds with chemicals during storage is the
   E. it is difficult to clean off chemicals before consumption
   F. the grain embryo is easily killed by chemicals
   G. the tough grain coat resist pest attack
   H. the small grain sizes discourage pest attack
10. Pesticide like DDT have been discouraged mainly because
   E. They are highly toxic to use
   F. They are not easily degraded
   G. They kill beneficial insects

H. They are not expensive

11. Anaphlamosis is caused by
    E. Ticks
    F. Protozoa
    G. Bacteria
    H. viruses
12. Which one of the following is a vector of the lift valley disease of sheep?
    E. Mosquito
    F. Tick
    G. Tsetse fly
    H. snail
13. Which of the following is an example of an irregular pest?
    E. Aphids
    F. Locust
    G. Grasshopper
    H. White flies
14. Which of the following agricultural chemicals is out of place
    E. Agrocide
    F. Gramoxone
    G. Dalapon
    H. agroxone
15. which of the following pesticides is most suitable for controlling sap sucking pests
    E. Contact pesticide
    F. Surface sterilant
    G. Systematic pesticide
    H. fumigant
16. The animal disease that is vector borne is
    F. Anthrax
    G. Foot and mouth
    H. Rinderpest
    I. Trypanosomiasis
    J.
17. The bean characterized by brown, sunken and soaked lesions on the pond is
    E. Bean mosaic
    F. Bean rust
    G. Bean anthrocnose
    H. Angular leaf spot
18. The fungus that causes browning in cotton lint is transmitted by
    E. Taybrgus sp.

F. Dysdercus sp.
G. Emposca sp.
H. Cryptophlebia sp.

19. Which one of the following is a vector of Nairobi sheep disease?
    E. Mosquito
    F. Tick
    G. Tsetse fly
    H. snail

20. Which of the following is a disinfectant on the farm?
    K. Copper sulphate
    E. Deknav
    F. Terramycin
    G. Dithane
21. Maize streak is characterized by
    D. Dark brown patches on the underside of leaves
    E. Papery lesion on leaves
    L. Narrow yellow stripes parallel to the leaf veins
    F. Sooty appearance on the cob
22. A cotton pest controlled by growing the hairy cotton variety is
    D. Cotton stainer
    E. American boll worm
    M. Jassids
    F. Spiny boll worm
23. Scale and mealy bugs cause damage to crops through
    N. Sucking
    D. Chewing
    E. Biting
    F. Boring
24. How does close spacing of ground nuts prevent rosette?
    D. So much moisture kill virus
    O. Aphids are controlled
    E. Host plants are suppressed
    F. Maximum use of nutrients hinder viral growth
25. The best option for prevention of fusarium within banana plantation is to kill the disposing factors using
    D. Bacteria
    E. Virucides
    F. Nematocides

P. fungicides

26. How a noxious weed such as stringa best is be controlled? By
    Q. Uprooting and burning
    R. Crop rotation
    S. Use of contact-non selective herbicide
    T. Proper spacing

Answers to objective questions

1B	2C	3D	4D	5D	6D	7B	8D	9C	10B	11B	12A	13C
14A	15A	16D	17C	18B	19B	20A	21C	22C	23A	24B	26D	26B

SECTION B

1. (a) Give five desirable characteristics of a pesticide
   Should be
   - toxic to the target organism
   - specific to the target organism
   - biodegradable not to accumulate in the environment
   - harmless to the plants and animals
   - cheap and readily available
   - easy to store and transport
   - readily soluble in water
   - not accumulate in ecosystem

   (b) State five factors that limit the use of pesticide by farmers
   - they and application equipment are expensive
   - application of pesticides requires skill especially in measuring and mixing
   - they kill beneficial organism as well for example pollinator.
   - They pollute the environment
   - They lower the value and/quality of products
   - They are poisonous to the farmer and livestock
   - Lead to chemical resistant pests
   - Accumulate in ecosystem

2. What is biological control?
   This is the control of the pest population below the economical threshold using their natural enemies in form of predator, pathogen, parasite etc.

3. (a) Give the meaning of the following as applied in pesticide use
   (iii) Pre-harvest period: it the duration/length of time which must elapse before crops sprayed with agricultural chemical can be consumed

(iv) Lethal dose 50 (LD50) is the dose of agricultural chemical that will kill 50% of the pest/animal in a test population.

(b) Explain characteristics that make pests successful in nature

- Have high rate of multiplication e.g. lay very many eggs.
- Most of them are small making it easy to hide
- They resemble the host crop for easy camouflage
- Have hard cuticle to protect them from adverse conditions
- Most fly leading fast dispersal
- Have defense mechanisms such as production of offensive smell
- Undergo metamorphosis such that different stages occupy different ecological niches to reduce competition
- Develop resistance to pesticides
- Have alternative source of food
- Have modified mouth parts to feed on crops such as mandibles for cutting and proboscises for sucking
- Resistant to diseases.

(c) State the qualities of a good biological agent for pest control

- Must have high searching ability
- Should be adaptable to wide range of environments
- Should be host specific
- Should have ability to multiply in order to control the target organism
- Should not cause a lot of damage to crops and animals
- Should be easily raised artificially
- Should be easy to distribute/apply

4. Give the advantages of controlling pest using biological control method

- It requires less labour
- It is selective to the target organism
- Long lasting from season to season
- Can be easily employed to remote areas
- cheap

5. Explain the environmental factors that cause diseases in plants

(f) Temperature

- Sun scald exposed sites of fresh fruits and vegetables
- Wilting due to high evaporation
- Over sweetening of potatoes due to low temperature

(g) Soil moisture

- Cause stunted growth due to inadequate nutrients
- Increase yellowing and leaf senescence due to lack of water

- Rotting due to much water
- Chlorosis and early senescence due to inadequate supply of nitrogen

(h) Limited sunshine/shadows

- Causes etiolation and weakening ofplant stems

(i) Water scarcity/drought/lack of rainfall

- Causes stunted growth

6. (a) What is meant by biological control of a crop pest (02marks)

   (b) Explain characteristics of a good biological control agent (09marks)

   (c) Give the advantages of controlling pest using biological control method (09marks)

7. (a) Outline the various ways in which pests cause damage the crops

   - Eat the buds, flowers, shoot, fruits e.g. grasshopper, caterpillars and beetles eat leaves/cause defoliation
   - They bore into fruits and seeds e.g. bean bruchid, maize weevil etc. and eat inside causing holes, discoloring the tubers and causing them to have bitter taste e.g. sweet potato weevils.
   - Suck plant sap and reduce plant vigour e.g. aphids, mearly bugs and scales
   - Transmit diseases e.g. maize leaf hopper, white flies etc.
   - Change crop's growth habits e.g. sorghum shoot flies
   - Cause loss of quality of crops
   - They penetrate and damage plant roots thus preventing absorption of water and nutrients
   - They reduce the yield of crops.

   (b) Explain the cultural methods of controlling crop pests (12marks)

   - Proper seed bed preparation: repeated tillage either exposes soil borne pests to their natural enemies on the surface or buries the pests very deep in the soil where they are suffocated and die.
   - Crop rotation: this controls pests which feed on specific crops; by not growing such crops, pests either migrate or die due to lack of food
   - Closed seasons: this involves foregoing cropping seasons without planting so as to control the build-up of pests in the field. Cropping is suspended for specific period to derive pests out of the host plants.
   - Use of resistant crop varieties that tolerate pests. The resistant varieties have characteristics such as hairiness, thick or hard epidermis, unattractive color and/or smell to the pest and early maturation
   - Destruction of crop residues after harvesting to eliminate breeding sites and kill the pests.
   - Use of certified seeds and planting materials that carry no pests
   - Regular weeding of the crops to eliminate breeding, hiding sites and alternative hosts.
   - Proper spacing reduces spread of pests from one crop to another
   - Proper pruning removes infected branches and micro habitats for the pests

- Thinning prevents overcrowding and spreading of pests
- Proper application of fertilizers ensures that crops grow faster or are able to tolerate pests
- Rogueing eradicates pests by removing and destroying pest affected crops from the garden.
- Mulching especially with black polythene controls nematodes in pineapple fields.
- Timely planting ensures that the crops grow and mature before destructive stages of the pest.
- Timely harvesting prevents attack of mature grains such as in millet, sorghum, rice and maize.
- Destroying volunteer plants i.e. plants that provide alternative source of food or breeding ground.
- Intercropping discourages spreading of pest from one crop to another and some crops like tobacco produce natural pest repellants.

8. (a) Describe the dangers associated with the use of pesticides in agricultural production
   - Pesticides can be poisonous to farmers and their animals
   - Pollute the environment i.e. water, land and air
   - Some pesticides are inflammable and may cause fire hazards
   - Some pesticides such as DDT accumulate in food chain leading to toxic levels and may eliminate organisms in top food levels.
   - Continuous use of same pesticides leads to resurgence due to development of resistance.
   - Eliminate non-targeted organism such as pollinators that are useful to the farmers.
   - Expensive

   (b) Outline the precautions to be taken by the farmers to ensure safe use of pesticides

   - Read the instructions on the container or leaflet before using the pesticide
   - Wear protective clothes such as overalls, gloves, rubber boots, head masks and eye shields.
   - Chemical should be stored in safe places away from children.
   - Do not eat or drink while working with pesticides
   - Wash any spillage from your body as soon as possible
   - Clean the equipment after use
   - Dispose of empty containers safely as instructed by the manufacturer.
   - Do not use empty containers for edible substances.

9. (a) What is meant by pesticide resistance

   It is a situation where the pest population remains relatively unaffected by application of a recommended pesticide in the right quantities and concentrations. Or it is a situation where pests acquire characteristics/traits that enable them to survive despite the recommended levels of pesticides.

   (b) Describe the factors that promote pesticide resistance in pest populations
   - Genetic factors; high genetic variation promote resistance

- Mutation
- Prolonged t use of a single pesticide
- Unwarranted use of pesticides
- Use of broad spectrum pesticides such as DDT that kill natural enemies of the pests.
- Use of sub-lethal concentration of pesticides
- High population of pesticide
- Non-uniform application of pesticides in the field

10. (a) Write short notes on the following

(i) Integrated pest management (IPM)

It is a pest control measure involving use of a wide range of methods to control pests without harming the environment using methods such as biological control, burying/burning infected plant parts etc. use of chemicals is minimized.

(ii) Biological control

(iii) Cultural pest control

It is a pest control measure involving application of agronomic practices that interfere with the life cycle of pests such as proper seed bed, early planting, crop rotation, proper hygiene during harvesting and use of resistant varieties.

(iv) Chemical pest control

It a pest control measures that involve use of chemicals. Natural chemicals use includes a mixture of urine and ash, some plant extracts etc. Synthetic chemicals include DDT, ambush, deldrine, malathion etc.

(b) Discuss the nursery bed maintenance and how they can contribute to pest management

- Irrigation and water leads to healthy seedlings that can tolerate pests.
- Appropriate and regular watering wash off pests from seedlings
- Weeding eliminate weeds that act as breeding ground for pests
- Thinning reduces congestion and spread of pests
- Monitoring and picking out infected seedlings prevents spread of pests and diseases
- Spraying kills pesticides
- Application of fertilizers boot seedlings vigour which help them to tolerate pests and diseases
- Soil sterilization by heating soil kills pest

Thank You

Dr. Bbosa Science