**ADVANCED AGRICULTURE INTROUDCTION TO**

**PRINCIPLES OF CROP PRODUCTION:**

The principle of crop production refers to the activities/ practices that govern crop production to ensure proper growth and high crop yield. These activities are;

* Seedbed preparation
* Selection of planting materials
* Crop spacing
* Proper weeding of crop plants
* Timely planting
* Fertilizer application
* Pest and disease control
* Thinning
* Use of recommended planting depth
* Mulching
* Irrigation
* Earthing up
* Gapping
* Application of fertilizer and manure
* Pricking out, pruning etc.

**LAND PREPARATION:**

This refers to the process of making a piece of land/seedbed ready to receive the planting materials. It includes activities such as;

Land/bush clearing

Tillage.

**Reasons for Carrying out Land Preparation**

* To kill weeds by uprooting and burying them down or by exposing them to the drying action of the sun
* To break the soil and improve water infiltration, aeration and ease root penetration.
* To facilitate secondary cultivation by clearing bushes and uprooting tree stumps.
* To break the soil hard pan that impedes root growth. Soil hardpan refers to the hard layer of the soil found below the soil surface.
* To kill pest and disease organism that maybe in the soil by destroying their lifecycle and exposing them to the surface for desiccation.
* To destroy the tree shade that cut off light supply to the crop
* To mix the organic matter into the soil.
* To provide ideal condition for seed germination and plant growth.
* To bury the crop residues and organic matter and also increase the speed at which they rot.
* Helps in controlling soil erosion by improving on soil structure.
* To level the land for planting.

**Steps in Land Preparation.**

**1. Land clearing**: This involve clearing bushes, cutting down trees and removing tree stumps, roots and stones from the ground before actual cultivation.

**Importance of land clearing.**

* + It eases movement of machinery and animal during cultivation.
  + To kill weeds.
  + To remove obstacles that damage tyres and destroy the blade of implements.
  + To facilitate primary cultivation.
  + It also act as a basis for land reclamation.
  + Land clearing can be done through slashing of bushes, controlled burning, cutting down trees, digging out tree stumps, digging out anthill, removing of stones from the ground etc.

**2. Tillage (Land cultivation):** This is the act of breaking/ digging out soil using various implements before the crop is planted.

**Methods of tillage operation:**

**a) Primary tillage/ cultivation**: This is the initial stage of seedbed preparation. Seedbed is the land that has been prepared well enough for planting crops. The implements/ tools for primary cultivation include;

Ox-plough, disc plough, a mould-board plough, a sub-soiler, rotavator.

**Importance of primary cultivation**

* + To control pest by destroying their lifecycle and exposing them to the surface for desiccation.
  + Controls weed growth by damaging their roots.
  + It helps in improving porosity of the soil and drainage.
  + It eases secondary cultivation.
  + Breaks the soil hard pan that prevents water infiltration.
  + Helps in burying surface vegetation and crop residues from the previous season.
  + Exposes lower soil layers to weathering agents.

**b) Secondary tillage/ cultivation:** This is the second operation two weeks after primary cultivation to make the soil ready for planting. The time gap of two weeks is to allow the weed seeds buried during primary cultivation to germinate and hence be killed at their early stage of growth by secondary tillage.

The tools for secondary cultivation include; Rake, rollers, hand hoes, rotovator etc.

**Importance of s secondary cultivation.**

* + Helps in levelling land for planting
  + It controls weeds by destroying them at their early stage of growth.
  + It creates a suitable soil condition for seed germination.
  + It mixes well the rotten plant materials (organic matter).
  + Mixes fertilizer with the soil

**Factors that Influence the Choice of Tools and Implements to be used in Cultivation.**

1. Soil condition: Hard soil condition like dry soil requires the use of mouldboard plough and disc plough while light soil requires hand hoes.
2. Soil type: Heavy/ sticky soil like clay can easily be cultivated by disc plough while sandy loan soil can be worked upon by hand hoes and ox-plough.
3. Topography: Steep slope does not favours the use of tractor trailed implements like mouldboard plough since tractor cannot move on hilly land. Flat land encourage the use of tractor while hilly areas can be cultivated by hand hoes.
4. Nature of surface vegetation: Thick vegetation limits the use of hand hoes and ox- plough while mouldboard plough can easily crush on tall and thick vegetation .This is because tractor can easily roll through without blockage.
5. Availability of capital: Tractor is expensive to peasant farmers making hand hoes to dominate farming operation.
6. Availability of s killed personnel: Tractor trailed implements e.g. Mouldboard plough, disc plough etc. requires skilled personnel to operate unlike hand hoes which does not require much skills to handle.
7. Land tenure system: Fragmented land does not favour tractor trailed implements since tractor cannot move in sub-divided land. Such areas need hand hoes while trailed implements operate best on extensive land.
8. Conservativeness: This limits the use of mechanized equipment by farmers especially in north eastern part of Uganda. This makes farmers to continue using indigenous tools for cultivation e.g. Hand hoes.

**Factors that Determine the Number/ Frequency of Secondary Cultivation.**

1. Physical condition of the seedbed after primary cultivation: Rough seedbed requires more operations than smooth seedbed.
2. Size of the seed to be planted: Small seeds e.g. will require a finer seedbed than lager seeds like maize seeds. This is because small seeded crops need a fine tilt for smooth establishment during germination.
3. The types of weeds to be controlled: Rhizomatous weeds like couch grass, spear grass are difficult to control and therefore require more cultivation to effectively remove the rhizomes from the soil.
4. Soil texture: Light soil break easily hence requiring fewer operation than heavy soils.
5. Amount of organic matter: Densely vegetated land e.g. sugar cane trash requires more operations than light vegetated land.
6. Moisture content of the s oil: Wet soil does not need to be over worked on since it create puddle which destroys soil structure hence fewer operations.
7. Liability to erosion: If the soil is liable to erosion, less operations is required e.g. on hilly areas.

**METHODS OF PREPARING SEEDBED.**

**1. Hand method:** This involves the use of hand hoes, panga etc. and the power is provide manually by man.

**Advantages of hand method.**

* + It is not expensive
  + No special skills is required
  + Tools are reliable
  + It create employment opportunity
  + It is flexible i.e. can be used to perform varieties of farm operations.

**Dis advantages of hand method.**

* + It is slow in performing farming operations.
  + It operate to a limited depth
  + It is inefficient on hard piece of land.
  + It cannot work properly on thick vegetated land.
  + It can only cultivate a few acreage of land per day.
  + It delays planting program since it is slow.
  + It is expensive over large garden.

**2. Mechanical method:** This involve the use of motorized machine e.g. Tractor.

**Advantages of mechanical methods of land preparation.**

* + The method is fast
  + Large acreage of land can be cultivated per day.
  + It encourages timely farming operations e.g. timely planting.
  + It is effective in hard soil condition.
  + Increases depth of penetration of penetration of the plough which improves on drainage.
  + It is effective under thick vegetation cover
  + It is more economical than hand method on large garden.
  + It releases labour to do other farming operation since the use of tractor requires only one person.

**Dis advantages of Mechanical method**

* + Machines are expensive to buy.
  + It requires technical skills to operate.
  + It creates unemployment.
  + It may lead to soil capping if use intensively. Soil cap is hard layer formed on soil surface due intensive movement of machine on the land, overgrazing etc.
  + Exhaust fumes produced may pollute the environment.
  + Maintenance costs of machinery are high which discourages farmers.

1. **Ox cultivation**: this involves the use of animal drawn implements e.g. ox plough and the main source of power is farm animals i.e. castrated bulls (oxen), donkeys etc.

**Advantages of ox cultivation**:

* Faster than manual method
* It buries surface vegetation better than the manual method and mechanical method
* Requires little skills compared to mechanical method
* Ploughing depth can be maintained constant

**Disadvantages of ox cultivation:**

* It cannot be used efficiently in hilly, stony and densely vegetated areas
* Large land is left under pasture to graze the animals which limit crop production
* Efficiency depends on the health of the farm animal
* It is limited to areas with light soils only.

**4. Chemical method:** this involves the use of special chemical substances that kill or interfere with the growth of vegetation e.g. herbicides and aboricides.

**Advantages of chemical method:**

* It is a very fast method
* Less labour is involved
* Soil structure is maintained since tillage is minimised
* It is cheaper on a large scale compared to mechanical method

**Disadvantages of chemical method:**

* It causes pollution to the environment
* It requires skills to apply
* It is difficult to access most of the farm chemicals
* Improper usage may have related health disorders to farmers

**MINIMUM TILLAGE:**

This is a crop husbandry practices where seedbed is prepared with a little disturbance on soil surface. Minimum tillage is done by;

* Use of herbicide to kill weeds from the garden where crops will be planted.
* Mulching the area to suppress weed growth.
* Digging planting holes for planting and the rest of the land is undisturbed.

**Importance of Minimum Tillage**

* It maintain soil structure
* It reduces cost of production on the farm sine only a small area needs to be cultivated.
* It conserves soil moisture
* It also minimizes on the death of soil living organism since less are exposed on soil surface.
* It maintains soil aeration by minimizing on soil compaction.
* It reduces surface runoff thus controlling soil erosion.

**PLANT PROPAGATION**

This refers to the ways of increasing plant population in the field.

Or: It is the raising and multiplication of new plants of the same kind.

There are basically two methods of propagation i.e. propagation by mean of seeds (sexual propagation) and by use of vegetative organs (asexual propagation).

**VEGETATIVE PROPAGATION**

This refers to the raising of new plants using other plant parts or organs other than the seeds. The parts used have the ability to develop buds and roots.

Plants that arise from vegetative propagation are usually similar in characteristics and are referred to as ***clones***

**FORMS OF VEGETATATIVE PROPAGATION**

**Natural methods of vegetative propagation:**

This involves perennation; a condition where a plant part lies dormant in the soil over a period of time to avoid harsh environmental conditions and later grows into a new individual when the conditions become favourable. The examples of perenating organs include;

**Stem tuber:** This is a swollen underground stem with buds that can develop into a new plant when plantede.g. Irish potatoes, Sweet potatoes.

**Suckers:** These are plants that develop from the mother plant below the ground level and can be used for planting. It is common in banana

**Splits:** These are individual shoots that develop in tillering plants especially grasses e.g. Guinea grass, sorghum, etc.

**Bulbs:** These are underground stem with modified leaves to store food and between the modified leaves are auxiliary buds which grows into a new plant e.g. onion, Gallic etc.

**Rhizomes :** These are underground stem with nodes and internodes which stores food and are capable of germinating into new plants e.g. Couch grass, spear grass etc.

**Runners:** These are horizontal succulent stem growing above the ground surface producing adventitious roots and new plants at their nodes e.g.in Wandering J ew, sweet potatoes, pumpkin etc.

**Corms:** These are vertical underground stem with short internodes and scaly leaves. They can be used as planting materials e.g.in Cocoyam.

**Crowns:** These are vegetative structure which are particularly found on top of a pine apple plants and establishes slower than the suckers when planted.

**Bulbils:** These are tiny plants produced in the inflorescence at the end of plant’s life cycle e.g. in Sisal, nut grass etc.

**Stolon:** These are horizontal creeping stem above the ground modified to store food

* 1. In Star grass.

**Root tubers**: These are swollen underground roots which can be used for planting e.g.in Sweet potatoes.

**Artificial methods of vegetative propagation:**

These methods involve inducing root growth from certain parts of the plant that later gives rise to a new plant.

**CUTTINGS:**

These are portion or part of plant that may be cut and used for multiplying plants e.g. stem cuttings in cassava, sugar cane and root cuttings in guava, apple and spear grass.

Some cuttings are planted directly into the soil e.g. cassava, sweet potatoes while others are delicate and has to be put in the rooting medium to encourage rapid rooting. The rooting medium includes sand, saw dust etc.

The rooting medium is first sterilized to avoid infection by soil pathogens.

**Factors that Affects Rooting of Cutting.**

* Oxygen s supply: Rooting processes requires ample supply of oxygen to provide the energy for rooting process.
* Light intensity: Soft cuttings and herbaceous cuttings use more light for synthesis of carbohydrate while for hard wood much light is not needed as the cutting supply enough carbohydrate
* Temperature: Cool to warm temperature around the cuttings promote rooting because they reduce transpiration rate.
* Relative humidity: High relative humidity to maintain turgidity within the cutting and to prevents desiccation and encourage rooting.
* Chemical treatment: Rooting hormones applied at the basal end of cutting promote rooting.

**Qualities of a good cutting for propagation:**

* It should be mature and preferably from the main stem
* It should have undamaged buds, capable of developing into a shoot
* Should have no visible signs of pests and diseases
* Should be highly adapted to the local environmental conditions of soil and water
* Should have the ability to sprout in a short time

**Common rooting hormones include;**

IAA (Indole Acetic Acid)

IBA (Indole Butyric Acid)

NAA (Naphthalene Acetic Acid)

**LAYERING:**

This is the method of vegetative propagation which involves inducing a plant’s stem to produce roots before being cut off from the parent plants for propagation. A part of the plant is wounded to expose the stem cambium to give rise to roots. The wounding of stem block downward movement of photosynthetic products which accumulate at the wound part to support rooting. The basis of layering is that some plants have natural ability to grow roots when their branches come into contact with the soil.

**Type/ forms of layering.**

1. Tip Layering: The branch tip is bent to the ground and covered with soil to produce roots. It is held in position by pegs.
2. Simple/ground Layering: This is done when a branch is bent into the soil at only one point reasonably away from the tip and then held in position by pegging.
3. Compound/serpentine Layering: The branch is bent and covered in the ground at several points and pegged to produce roots. It is called serpentine because the branch is in a serpent- like shape.
4. Aerial Layering/marcotting: This method is mainly used on plants which cannot be bent to the ground. The bark is removed from small section of the branch and moist fertile soil in a polythene bag is wrapped around the wounded section.
5. Mound/ Stool Layering: Soil is heaped around the base of the stem which give rise to new shoots.
6. Trench Layering: The shoot is bent and laid in a trench and covered with moist soil.

**GRAFTING:**

Grafting is the union of two separate plants usually woody stems and allowing them to grow as one plant. The upper part is called the scion and the lower part is called the stock. The scion should have one or more buds to give rise to the future fruiting plants.

**REASONS/ BENEFITS OF GRAFTING**

1. It makes the growing of more than one type of fruits/ flowers on one tree plant possible
2. It allows the propagation of clones which cannot be propagated by any other means.
3. It modifies the plant structure e.g. reduced height for easy harvesting
4. It is used for repairing damage tree; by supplying missing limbs lost through lightning.
5. To shorten the maturity time of a plant.
6. To impart disease resistance; by grafting a disease resistant variety to a susceptible one.
7. To supply the missing branches/sexes on a tree.

**CONDITIONS NECESSARY FOR SUCCESSFUL GRAFTING.**

1. Compatibility i.e. Correct joining of the scion and the stalk. The cambium tissues of the stock and the scion should be able to fit precisely to facilitate normal translocation to take place.
2. High relative humidity i.e. there should be low temperature to reduce on the rate of transpiration.
3. Grafting technique: Quality cut should be made to allow uniform joining of scion and stock and care should be taken to protect the union.
4. Both the scion and stock should be woody.
5. Use suitable tools or equipment when grafting i.e. sharp knife or blades
6. Grafted plants should be dicotyledonous because monocotyledonous plant do not undergo secondary thickening. Secondary thickening refers to the regeneration of new stem surface as the old ones are ruptured off.
7. Availability of grafting tape: The grafted part (union) should be s sealed/ wrapped properly preferably using grafting tape or polythene to avoid air entry which could lead to desiccation.
8. The two plants should be from the s same family.
9. The s cion s should have some bud to allow photosynthesis to take place in order to generate enough energy for growth.
10. Both the scion and stock should be removed at the right stage of growth. Old plants should be avoided
11. The plants should be free from pest and diseases

**Methods of Grafting:**

1. Slice/whip grafting. This methods requires both the scion and the stock to be of the same diameter. Slanting cut is then made from the surface of the stock and from the base of the scion. The two plants are then fitted together to form a strong union.
2. Side grafting. This involve fitting scion of a very small diameter into a growing plant(tree).A cut is made into the stock at suitable angle then the scion inserted to ensure contact between the cambium of both the stock and the scion.
3. Wedge/ cleft grafting: This is used when the stock diameter is bigger than that of the scion. The root stock is cut to form a V- shape and the scion to form a wedge shape. The scion is then inserted into the stock and wrapped together to form a strong union.
4. Bud grafting: This is a special form of grafting where vegetative bud of one plant is grafted onto another plant (root stock).The bud is inserted into a slit made on the bark of the stalk and held tight with a budding tape. After the bud has started to grow, the part of the stalk above the bud should be cut off.

**Procedures of budding**

* Select a well-developed vegetative bud (as opposed to the floral bud) from a desired tree species.
* Make a T-cut on the stock and gently separate the bark from the wood.
* Insert the bud into the T-cut
* The bud is bound onto the stock with polythene paper or tape to prevent water entry
* Apply wax or Vaseline on the outside of the wrapping to reduce bacteria or fungal entry.
* After two weeks remove the wrapping.
* If the bud is green, then the process is successful and if the bud is brown the process is not successful.
* When the green bud produces the shoot, the end part of the root stock is cut off to reduce transpiration.
* The buds are then transplanted to the field.

**Limitations of Grafting:**

* Certain undesirable characteristics are transferred to the off-springs.
* Requires skilled man power to carry out
* Expensive in terms of buying the grafting materials e.g. tapes.
* Only plants of the same family are used
* There is absence of genetic variation
* It is limited to only woody stems

**Advantages of vegetative propagation:**

There are reduced risks of seedling diseases

Plants propagated vegetatively mature faster

The method avoids dormancy associated with seed

The off-springs are genetically identical and similar to the parents

Off-springs are stronger and hardy

Does not require the use of a well prepared seed bed like when seeds are used

It is the only means of propagating plants that do not produce viable seed

It is associated with high yield

It is possible to produce two or more varieties on one plant

**Disadvantages of vegetative propagation:**

It is more expensive to use than seeds

Planting materials are bulky and not easy to handle and store

There is easy spread of diseases from parents to the off-springs

Difficult to transport the materials hence, reducing the chances of colonization of new areas

Difficult to mechanize propagation by vegetative means

Poor characteristics of the parents can be passed on to the off-springs

Materials are highly perishable since they contain a lot of moisture

Encourages of overcrowding in an area as they grow and establish quickly

There is no genetic variation in plants hence, maintaining undesirable characteristics

**PROPAGATION BY S SEEDS:**

Seed propagation is the most common method of propagating self- pollinated plants.

A seed is a fertilized ovule and it contain an embryo, food reserve and a protective cover called testa.

**Advantages of using seed.**

* It is convenient to handle and store.
* It is easy to mechanize in any crops.
* It controls the spread of parent disease that would have otherwise spread from using infected vegetative parts.
* It ensures variation among plants due to cross pollination and fertilization.
* Some plants cannot be propagated from vegetative parts e.g. Maize.
* It is cheaper than vegetative method.
* Plants propagated from seed have a long lifespan than plants propagated vegetatively.
* The planting materials are easy to transport.

**Dis advantages of using seeds**

* Easy spread of seed borne diseases.
* There is no uniformity among the plants due to variation.
* It requires proper land preparation.
* There is high risk of seedling diseases.
* Plants propagated from seed grow and mature late.
* Seeds have low germination percentage compared to offspring taken from parent plants.

**SEED SELECTION.**

This refer to process of identifying and isolating seed of good qualities for planting.

**Qualities of a good seed for planting**

* It should be free from pests and diseases damages
* It should be free from mechanical damages (i.e. be wholesome)
* Should have the correct moisture content
* Should have a high germinability
* Should be of a good size to have a good food reserve
* It should be mature as to germinate immediately
* Should be clean i.e. free from contamination by weeds, soil.
* Should be of the desired genetic makeup e.g. from a high yielding variety, early maturing etc.
* Should be plump i.e. well filled and not wrinkled
* Able to germinate in a wide range of conditions
* Uniform in shape, size and colour

**SEED VIABILITY/ GERMINABILITY.**

Seed viability is the ability of a seed to germinate if provided with all the necessary conditions after planting.

**Conditions for seed germination.**

Ample supply of moisture

Adequate supply of oxygen

Suitable temperature

Light for photo-blastic seeds

**Germination Efficiency:**

This refers to the proportion of the seeds planted that actually germinate.

**Factors that affect germination efficiency**

Planting depth; shallow planting which expose seeds to pest and prevent s seeds from obtaining enough moisture for growth while deep planting makes the food reserve within the seeds to get depleted before germination.

State of embryo; immature embryo may take longer to germinate than mature ones when planted hence, lowering germination efficiency.

Effect of pest and diseases; if present, lower seed germination.

Soil temperature; optimum soil temperature is required. Very high and very low temperature reduces seed germination.

Soil aeration; seeds need ample supply of oxygen to generate enough energy for germination process.

Soil type; e.g. clay resists penetration of roots and establishment of shoot above the ground level.

Soil moisture; good soil moisture is required to provide the necessary conditions for the action of hydrolytic enzymes that mobilise the food reserves.

Size of the seed; larger seeds have more food reserves than smaller ones thus, a higher germination efficiency in larger seeds compared to smaller seeds.

**Analysis of seed purity:**

This refers to the process of determining whether the purchased or processed seeds have got any contaminations e.g. weed seeds, other crop seeds etc. It is determined using the formula.

Percentage seed purity = Weight of seeds only \* 100%

Total weight of seed sample

NB: seed purity is the measure of how free a given seed lot is from contaminations.

**Seed treatment**

Seeds can be treated by;

* Drying

This is the controlled reduction of the moisture content of the seeds ti acceptable amounts for storage.

* Seed dressing

It is the mixing of seeds with chemicals before storage or planting.

It is advantageous because;

It prevents attack by pests and diseases.

It ensures uniform germination.

It ensures good seed viability.

* Fumigation of seeds

This is the use of chemicals blown in form of mists/gasses to cover up the seed and the cracks in the walls or sack to prevent pests attack.

* Seed inoculation

Seed inoculation is the treatment of legume seed with the right strain of nitrogen fixing bacteria.

It is advantageous because;

It promotes root nodulation.

It increases nitrogen fixation in the soil.

It ensures economic use of nitrogenous fertilizers.

**Measures/ Ways of Increasing Germination Efficiency of Seeds.**

* Proper drying of seeds before storage; to reduce on the moisture content
* Maintaining optimum temperature within the seeds; during storage to avoid seed dormancy.
* Proper seedbed preparation; especially for small sized seeds to increase germinability.
* Soaking the seeds in water over night before planting; to soften seed coat and allow oxygen and water entry into the seeds.
* Proper seed treatment; to control attack by pest and diseases.
* Soaking seeds in growth stimulants/ hormones; to stimulate growth
* Avoid storing seeds for planting for a long period of time.

**METHODS OF TESTING SEED VIABILITY:**

There are mainly 3 methods;

i) The germination test method.

Material required:

Seed lot, cotton wool/ filter paper, water, Petri dish/ plate.

Procedure

* Put the cotton wool on the plate.
* Pick a counted number of seeds from a seed lot at random.
* Place the seeds in the plate and cover them.
* Water the seeds and cover them.
* Provide all the conditions necessary for germination.
* Continue watering the seeds.
* After 5-7 days, open the seeds and count those that would have germinated and express them as a percentage of the total number of seeds planted.

**Note:**

If the germination percentage is above 60%, then the seeds are good for commercial planting.

ii) The lackon technique/ tetrazolium s alt method.

Materials:

* + - Seed lot. o Petri dish
    - Tetrazolium salt solution (0.1%)
    - Razor blade

**Procedure**

* A counted number of seeds are soaked in a 0.1% tetrazolium salt solution.
* Allow the seeds to stay in the solution overnight.
* Cut the seeds open to expose the embryo.
* Count the number of seeds that have acquired pink/ reddish embryo. (These will be viable ones).
* Express their number as a percentage of the total seeds soaked/ tested.

**Observation**

Viable seeds will change into reddish or pink colour on the cut surface.

**Reason**

When the viable seeds respire, they produce carbon dioxide that turns tetrazolium salt solution pink or reddish.

**Note**

If the percentage of the seeds with pink/ reddish embryo is 60% and above, then the seeds are good for commercial planting.

iii) Us e of potassium permanganate

Materials used:

* Seed lot.
* Potassium permanganate solution.
* Beaker.
* Heat source.

**Procedure**

* Put a counted number of seeds in a beaker containing potassium permanganate solution.
* Heat the seeds in the beaker for some time to break the testa so that they can release the liquid in them.

**Observation**:

Potassium permanganate solution is usually purple in colour and will get discoloured if the seeds are viable.

**Note**

In this method, calculation of germination percentage is impossible because it is difficult to identify the seeds that release the liquid and those that have not.

However, the level of discolouration is used as a determinant of the seed viability; complete discolouration indicates higher viability while partial discolouration shows a low viability.

**THE MECHANISM OF SEED GERMINATION**

1. Imbibition: The initial stage in germination is absorption of water through the microphyl by osmosis .This is called imbibition and as a result, the embryo becomes hydrated and this activates the enzymes.
2. Cotyledon s wells: Expansion of food reserved due to imbibition will also create pressure in the cotyledon of the seed making the seed coat to rapture thereby allowing entrance of oxygen inside the seed; oxygen will increase on the necessary energy for germination process.
3. Metabolism of food reserve: This cause rapid transformation and expansion of food reserve i.e. the food reserves are broken/ hydrolysed into simple soluble products that can be moved to growing area e.g. Protein to amino acid by protease enzyme, starch to glucose by amylase, and lipids to fatty acid and glycerol by lipase.
4. Trans location: The soluble products are translocated and used in respiration and synthesis of new tissues e.g. Glucose and amino acid for ATP production
5. Cell division and cell differentiation: The plumule and radicle elongate and emerge out through the seed coat and develop into primary shoot system and root system respectively.
6. Appearance of first leaves: Plumule emerge out above the ground, get exposed to sunlight and the formation of leave starts (primordial leaves) to aids photosynthesis.

**Types of germination:**

**a) Epigeal germination:** this is a type of germination where the cotyledon appears above the ground.

It is due to the rapid elongation of the hypocotyl; a portion of the embryonic shoot below the cotyledon. E.g. in beans, peas.

**b) Hypogeal germination:** this is a type of germination where the cotyledon remains below the ground surface.

It is due to the rapid elongation of the epicotyl; a portion of the embryonic shoot just above the cotyledon. E.g. in maize, rice, sorghum, millet.

**SEED DORMANCY**

This is a condition in which viable seeds fail to germinate even when all the necessary conditions for seed germination exist.

Dormancy maybe primary or secondary;

**Primary dormancy** is sometimes referred to as true/rest dormancy.

It is where seeds are dormant right from the parent plants before dispersal. They may be inborn.

**Secondary dormancy** is a type of dormancy which develops in response to some external factors after release from the parent plants.

**CAUSES OF SEED DORMANCY**

1. Hard seed coat: a tough or hard and impermeable seed coat may forcefully enclose the embryo and prevent germination. Such a coat will not allow the entry of water and oxygen.
2. Germination inhibitors: some plants release chemical substances I the soil that inhibit other plants from germinating e.g. Abscissic acid.
3. Immature embryo; the outside of the seed coat may appear fully developed ye it has an immature embryo. This embryo still needs more time to grow before germination thus, will not germinate immediately when planted.
4. Inadequacy of food reserve mobilisers: the absence of enzymes that mobilise or oxidise the hydrolysed food reserves in the seed may inhibit germination for some time until when the growth promoters are induced. This is because germination is an active process that needs energy from the food reserves.
5. Shortage of growth stimulating hormones e.g. gibberellins which help in converting stored food materials into a form usable by the seeds.

**METHODS OF BREAKING SEED DORMANCY**

1. Mechanical scarification; this is the physical break down or reduction in the thickness of the seed coat to allow entry of water and air into the seed.

It can be done by the following;

* Rubbing the seeds between two sheets of sand paper coated with silicon carbide.
* Punching holes through the seed coat by using a sterile pin
* Hitting the seed coat with a hummer or stone to break the hard coat.
* Cutting off the hard coat of the seed to make it permeable to oxygen
* Exposing the seeds to termites to eat up the hard coat.

2. Chemical scarification; reagents such as sulphuric acid, ethylene, potassium nitrate and thiourea are used to break the hard seed coats by soaking the seeds in them.

They are then washed with water before planting.

3. Pre-chilling method; where seeds are soaked in cold water for some time before planting them. It helps to reduce on the hardness of the seed coat.

4. Heat treatment; seeds are soaked in nearly boiling water to a temperature of about 80oC for 3 to 5 minutes and then cooled to a room temperature before planting.

**Advantages of seed dormancy:**

* It preserves the species under harsh conditions.
* It prevents seed germination while still attached to the mother plant.
* It allows for convenient storage and transportation of seeds.
* It allows sufficient time for dispersal of seeds to enable them colonise new areas.

**Disadvantages of seed dormancy:**

* Prolonged storage of seeds leads to decrease in food reserves in the seeds, lowering germination efficiency.
* It increases chances of seed destruction by pets because of prolonged stay in the dormant phase.
* It adds costs of seed processing while breaking dormancy.

**FIELD PRACTICES USE IN GROWING CROPS**

**(THE AGRONOMIC PRACTICES)**

1. **Planting:**

This refers to the actual placement of planting materials e.g seeds in the nursery bed or the actual garden.

Planting material refers to any plant’s part that is used to raise a crop e.g. seed or vegetative part.

Nursery bed refers to a small portion of land prepared for raising seedling before transplanting. It’s always one meter wide with a length of any reasonable degree while a seedbed on the other side refers to a piece of land varying in size from hundred or even thousand acres which has been prepared and ready to receive planting materials where they can grow up.

**Importance of a nursery bed.**

* + Many seedlings can be raised in a small area.
  + Makes it easy to carry routine management practices.
  + It provides the best conditions for growth e.g. fine tilt.
  + Small seeds can be planted and raised into a form that can grow independently.
  + Excess seedlings can be sold by the farmers for income.

**Factors to consider when s electing site for nursery bed**

* Water source: It should be near permanent water source to facilitate watering, seedlings require a lot of water at early stage of growth.
* Type of soil: The soil should be deep, fertile and well drained.
* Topography: Sites for nursery bed should be gentle slopping to avoid soil erosion and flooding.
* Security: the site should be well protected from wild animals, birds and thieves.
* Distance from home: Site for nursery bed should be near homestead since seedling requires intensive management by the farmer.
* Pest and diseases: The site should be free from pest and diseases.

**METHOD OF PLANTING:**

There are basically two methods of planting crops i.e. broadcasting and row planting;

**Broadcasting Method:** This refers to random spreading/scattering of seeds as even as possible at the seedbed and then covered lightly with the soil.

**Advantages of broadcasting method**

* + The method is fast and large area is covered within relatively short time
  + It does not require special skills and therefore, fewer labourers.
  + It is a convenient methods of planting small seeded crops e.g. Sim sim, sorghum, millet etc.
  + It can be used to obtain higher plant population in the field.
  + It provides good ground cover quickly.

**Dis advantages of broadcasting method of planting**

* + It is difficult to regulate plant population since seeds are scattered uncontrollably.
  + It leads to overcrowding of crop plant in the field.
  + It makes subsequent management of crop plant difficult e.g. Weeding
  + It limits the use of machine in weeding, harvesting, pest and disease control etc.
  + It may lead to wastage of seeds unnecessarily
  + It may also lead to creation of empty gaps in the field.
  + It is difficult to regulate planting depth which may affect germination of seeds.
  + It pre-disposes seeds to birds and surface runoff due to shallow planting hence reducing total plant population per unit area of land.

**Row/ Line Planting**: This refers to planting of crop seeds in line. There are two types of row planting;

a) Hill dropping: This is the planting of crops at specific distance from one another and specific quantity in a hole is established and covered lightly with the soil.

b) Drilling: This is where seeds are dropped continuously in shallow furrows made in line and then covered lightly with the soil.

**Advantages of row/ line planting.**

* + It economises seeds since the planting materials can be regulated during planting.
  + It also encourages proper spacing. This gives plant enough space for growth.
  + It is easy to regulate planting depth during making of holes or planting furrows.
  + These methods also ensure uniformity in germination of crop plants due to regulated planting depth.
  + Easy subsequent management of crop plants in the field e.g. weeding, pest and disease control harvesting since there is no overcrowding.
  + It permits the use of machine for planting, weeding, pest and disease control etc.
  + It also avoids overcrowding of seeds in the field.
  + The methods also prevent creation of empty gaps in the field.

**Timely planting**:

This refers to planting of crops at the onset of the rain so that crops get enough growth factors throughout the growing season. Late planting often results into low crop yield.

**Advantages of timely planting.**

* + Crops benefits from nitrogen flush (birch effects).Birch effects refers to first nitrogen released during the dry season. The nitrogen will get locked up in the soil inform of ammonium compound and it is released at the onset of rain.
  + Crops get enough moisture from the soil at critical stages of growth.
  + It reduces the incidence of pest and disease attack on crop plants especially those that come at later stages of growth.
  + Crops also get a good start against weeds since weeds come when plants have grown.
  + Early planted crops attract higher prices leading to increase income of the farmer.
  + The farmers carry out their farming operations on programmes without congestion.
  + It promotes high crop yield.
  + Crops grow and mature early when conditions are suitable for harvesting.

1. **Us e of correct planting depth:**

Planting depth refers to how far the seed is covered below the soil. Planting depth is greatly influenced by the size of the seeds and soil moisture content.

**Advantages / Merits of correct planting depth.**

* + It enables the seeds to get enough water and oxygen for germination.
  + It prevents seeds from exhausting all their food reserves during germination,.
  + It promotes uniform germination and uniform growth of crop plants in the field, this encourages good harvest.
  + It encourages high crop yield due to good seedling establishment. Seedlings emerge successfully from the soil.
  + It also protects the seeds from drying due to too much heat.
  + It prevent seeds from being exposed to birds and other animals which destroy seeds

1. **Proper s pacing of crops:**

Spacing is the distance between plants within and between the row.

**Advantages of proper crop s pacing**

* + It promotes high crop yield due to optimum plant population per unit area of land.
  + It reduces overcrowding and competition for nutrients and light in the field.
  + It suppresses weeds by reducing the space that would have otherwise been left for them to grow.
  + It promotes subsequent management of crop plants e.g. weeding, mulching, pest and disease control since the farm can move round the field without congestion.
  + Plants get enough oxygen, sunlight and nutrients for maximum growth.
  + It controls pest and disease by opening enough space for oxygen sand light penetration e.g. closer spacing control groundnut rosette caused by Aphids.
  + It encourages mechanization.

**Factors that determines s pacing of crops**

1. Growth habit of the crop: Crops that spread widely i.e. crops with lateral growth habit require wider spacing than crops with erect/ upright growth habit.
2. Planting method: Broadcasting method of planting necessitates close spacing unlike row plating with wider spacing.
3. Amount of moisture/ rainfall: Close spacing is possible in areas with high moisture content than it is in crops grown in arid areas where rainfall is inadequate.
4. Level of soil fertility: Close spacing is recommended in a very fertile soil than less fertile soils.
5. Purpose for which the crops is grown e.g. bean plants grown for green manure preparation is closely spaced than that for commercial purpose.
6. Need to us e machines for weeding, pest and disease control; This will encourage wider spacing to leave enough space for machines to move.
7. Cropping system to be used; Mixed stand crops require closer spacing than crops planted in a single stand.
8. Disease control measures: e.g. close spacing is used in Groundnut to control Groundnut rosette.
9. **Us e of recommended seed rate:**

A seed rate refers to the quantity of seeds required per unit area of land. There are basically three types of seed rates on a farm;

High seed rate Low seed rate

Optimum seed rate.

**High seed rate**: This is when a farmer plants more seeds in an area than that which is recommended .It normally leads to;

* Overcrowding of crop plants
* Reduced crop yield due to competition
* Makes management of crop difficult e.g. weeding
* Reduced income due to poor quality.

**Low seed rate**: This is a situation where famers plant few seeds in a given area than that which is recommended. It normally results into low crop yield per given area but it increases individual yield of crop plants due to maximum use of nutrients for the crop plants.

**Optimum seed rate**: This is when a farmer uses the recommended quantity of seeds in a given unit of area. Optimum seed rate promotes;

* High yields of crops
* Easy management of crop
* High income due to high quality yields from crop plant.

**Note:** A seed rate is mostly determined by the growth habit of the crop plants and the quality of the seeds used.

1. **Gap filling:**

This is the replanting of crops in spaces where they did not germinate or where seedlings dried up after transplanting in the field to ensure optimum plant population.

Gap filling has advantages of regulating plant population and filling empty spaces to avoid wastage of land.

1. **Thinning:**

This is the removal of excess seedlings usually weak ones from the planting hole some days after germination to leave a correct spacing.

Examples of plants that can be thinned are maize, cotton etc.

Thinning is advantageous because;

It promote lateral growth of the crop plant.

It prevents overcrowding and reduces competition.

Reduces occurrence and spread of diseases.

1. **Pricking out:**

This is the removal of excess seedlings from the crowded area in the nursery bed.

1. **Pruning:**

This is the removal of plant’s parts which are less productive or unproductive all together e.g. injured or diseased branches of crop plants.

**Advantages of pruning.**

* It facilitates easy management of crop plants e.g. spraying, weeding etc.
* It gives the plant proper shape and to control its growth.
* To control pest and disease by interfering with the cool micro climate which favours their surviaval.eg antestia burgs in coffee?
* It also encourages healthy growth of crop plants by opening space for air circulation and light entry for photosynthesis.
* It economises on the use of chemicals by reducing the surface area to be covered with chemicals during spraying.
* To control over bearing of fruits e.g. in mangoes and tomatoes.
* It gives a convenient height for workers for easy harvesting.
* To improve on the longevity of crop’s productive life making the plant to produce regularly and yearly.eg in coffee.

1. **Staking:**

This refers to the process of supporting weak stemmed plants above the ground to access sunlight for growth. E.g. in passion fruit, tomatoes etc.

**Advantages of s taking**

* It exposes plants to get enough sunlight for maximum yield.
* It improves on the quality of the fruits by removing them from contact with the ground.
* It reduces the incidence of pest and disease existing within the soil especially fungal disease.
* It facilitates easy management of crop plants e.g. weeding, spraying.
* It also promotes free air circulation between the plants.
* The quality of fruits is maintained since they are not trampled on by the farmers.

1. **Earthing up:**

This is the drawing of enough soil around the base of shallow rooted crops.

Earthing up is common in cabbage, eggplants, onion etc. It’s a common practice during weeding.

**Advantages of earthing up.**

* It prevents lodging of crop plants.
* It facilitates growth of prop roots especially in cereals that support the plants.
* The soil heaped prevents the roots from being damaged during weeding.
* It enable the plant to withstand erosion in case of runoff.
* It also creates suitable condition for bulb formation in onion.

1. **Pest and disease control:**

Pests and disease should be effectively controlled as they lower the quality and quantity of crop in the field. This can be done through spraying using chemicals, cultural means, and biological means or mechanically as well as integrated approach.

1. **Application of manure**;

These supply mineral elements into the soil thus, enriching soil nutrient content for better yield.

1. **Irrigation:**

This is the artificial application of water from a reliable source to a dry land. It’s done to maintain adequate moisture in the soil for better crop yield.

1. **Drainage:**

This is done to remove excess water from the soil so as to create suitable conditions for crop growth.

1. **Mulching:**

This is the covering of soil surface using mulches to prevent excessive evaporation of soil moisture, control weed growth and soil erosion which lower crop yield.

1. **Timely weeding of crop plants**;

To minimize on competition for nutrients with the crop plants.

1. **Timely harvesting:**

Harvesting refers to removal of mature plant parts from the parent plants. It’s the climax of crop’s productive life in the field. Crops should be harvested in time to reduce crop losses caused by insect pests, birds, thieves, rodents, shattering and germination of seeds from the garden.

The plant is considered mature when the reproductive parts have accumulated maximum dry matter or change in colour especially for fruits.

**Effects of too early harvest.**

* It leads to inadequate drying of produce due to high moisture content.
* Seeds harvested prematurely have poor quality i.e. the seeds are deformed.
* It leads to reduced seed viability either due to immature embryo or accumulation of food reserve on the stem.
* It pre-disposes crop to pest attack due to soft testa.
* It’s difficult to process plant produce especially threshing.

**Effects of delayed harvest.**

* Loses of produce due to splitting of pods.
* Encourages rotting of fruits and vegetable.
* It encourages build-up of pest and diseases.

**POST-HARVEST PRCTICES**

**1. Drying of crops:**

This is the controlled reduction of moisture content in produce to reduce spoilage during storage.

**Reasons for drying of crop produce.**

* It prevents produce from rotting and decay caused by fungi.
* To reduce insect damage.
* To prevent mould growth on crop plants.
* To maintain seed viability and quality.
* To reduce bulkiness of crops for easy transportation.
* To prevent germination of seeds in store.
* To allow easy processing of crop produce into other forms e.g. maize grain to maize flour.
* To prolong the storage period for crop produce.

**2. Proper storage:**

This prevents spoilage of seeds caused by storage pests and makes produce available for future use.

**Characteristics of a good crop s tore.**

* The store must be of good construction and rain proof.
* The store must always be clean
* It must be well aerated
* The store must be dry.
* It should be vermin proof.
* It should be securely located to prevent thieves.
* It should be treated against pest and diseases.
* The store must be raised off above the ground 50cm to prevent dampness caused by capillarity.
* It should not have any cracks on the surface or from the wall. This attracts pest.
* It should be thoroughly smeared before new crop produce are brought in.

**Measures that can minimize crop losses during storage.**

* Proper drying of produce to approximate moisture content.
* Proper ventilation of the store to allow free air circulation and to prevent accumulation of heat.
* Carry out seed dressing before or during storage using suitable chemicals to control pests.
* Regular checking of stores should be done and avoid mixing old produce with new ones.
* Seal off all the cracks with mortar/ cow dung to destroy breeding ground for pest that destroy crops.
* Clean the store properly before introducing new crop produce in.
* Raise the store above the ground to avoid dampness.

**3. Processing:**

This is the transformation of raw materials into final utilizable products. It includes activities like threshing, winnowing, sorting and grading the crop products.

**Reasons for processing.**

* To reduce bulkiness and make transportation easier.
* To reduce wastage due to spoilage.
* It adds values to crop produce by improving its quality.
* It converts products into a form that can be used easily e.g. maize flour from maize grain,
* It prolongs the lifespan of crop produce making it available for long time e.g. milk.

**4. Packaging:**

This refers to the wrapping of crop produce in special containers to ease handling and transportation.

**5. Marketing:**

This is the disposition of the produce for sale. It allows the exchange of a commodity for another, allowing farmers to acquire what they do not produce.

**CROP PROTECTION**

**WEEDS AND WEED CONTROL**

**WEEDS**:

These may be defined as;

1) Plants growing out of a place.

2) The unwanted plants that grow in the garden and interfere with the normal crop growth.

**IDENTITY OF WEEDS:**

Weeds are identified by their common names or their botanical/scientific names, which are internationally known and accepted.

They are named and classified according to; specific features, place where they are found and persons who discovered them.

The international system of naming requires that, no two plants share the same name. The first name is the Genus and the second one, the Species.

**Examples of Common Weeds in East Africa**

A). **Narrow Leaved Weeds**

|  |  |  |  |
| --- | --- | --- | --- |
| COMMON NAME | SCIENTIFIC NAME | LIFE SPAN | MODE OF PROPAGATION |
| Nut grass | *Cyperus rotundus* | Perennial | Bulbs |
| Couch grass | *Digitaria scalarum* | Perennial | Rhizomes |
| Lemon grass | *Cymbopogon afronadus* | Perennial | Root splits |
| Star grass | *Cynodon dactylon* | Perennial | Stolons |
| Bristly foxtail | *Setaria verticillata* | Annual | Seeds, splits |
| Wild finger millet | *Eleusine indica* | Annual | Seeds |
| Cat's tail | *Sporobolus pyramidalis* | Perennial | Seeds, splits |
|  |  |  |  |

B). **Broad Leaved Weeds.**

|  |  |  |  |
| --- | --- | --- | --- |
| **COMMON NAME** | **SCIENTIFIC NAME** | **LIFE SPAN** | **MODE OF PROPAGATION** |
| Black jack | *Bidens pilosa* | Annual | Seeds |
| Tick berry | *Lantana camara* | Perennial | Seeds |
| Pig weed | *Amaranthus spp* | Annual | Seeds |
| Goat weed | *Ageratum conyzoids* | Annual | Seeds |
| Witch weed | *Striga spp* | Annual | Seeds |
| Oxalis | *Oxalis spp* | Perennial | Bulbs |
| Sodom apple | *Solanum incanum* | Perennial | Seeds |
| Thorn apple | *Datura stramonium* | Annual | Seeds |
| Macdonald's eye | *Galinsoga parviflora* | Annual | Seeds |
| Black night shade | *Solanum nigrem* | Annual | Seeds |
| Tridax | *Tridax procumbens* | Annual | Seeds |

**CLASSIFICATION OF WEEDS:**

a) **ACCORDING TO LIFE SPAN (GROWTH CYCLE)**

**1. Annual Weeds**

These grow and complete their life cycle within one year. They have rapid growth rate and in case they are left in an area for a long period of time without any control, they become difficult to control e.g. goat weed, thorn apple.

**Characteristics of annual weeds**

* They complete their lifecycle in one year
* Reproduces only by mean of seeds
* Produces abundant number of seeds
* They become difficult to remove if left in an area for long

**2. Biennial Weeds**

These grow and complete their life cycle within two years.

Vegetative growth is achieved in the first year followed by abundant production of seeds in the second year. They reproduce only from seeds and infest crops which are poorly managed.

**Characteristics of bi-annual weeds**

* They complete their lifecycle in two years’ time.
* They produce vegetative growth in the first year and produce seeds in the second year then die.
* They reproduce from seeds only.

**3. Perennial Weeds**

These require more than two years to complete their life cycle.

They reproduce by seeds and vegetatively. Their stems may grow above or below the ground. They are adapted to long season crops e.g. star grass, spear grass etc.

b). **ACCORDING TO LEAF MORPHOLOGY:**

**1. Broad Leaved Weeds**

These occur mostly in arable land. The leaves have net venation.

They are both annual and perennial. They include the herbaceous weeds.

**Herbaceous weeds**; have water filled succulent stems. They are hard to control using chemical means due their succulent nature e.g. pig weed, black jack, goat weed, black night shade, wondering Jew etc.

**2. Narrow Leaved Weeds**

These include grasses and sedges.

The leaves have parallel veins and the growing point is protected by the leaf sheath at early stages of vegetative growth. They include the sedges.

**Sedges**; are monocots with solid and triangular stem. They are found in poorly drained soils.

Propagation is through modified structures such as rhizomes in Cyperus rotundas. They also reproduce by means of underground tubers and are difficult to control.

c). **ACCORDING TO HABITAT:**

**1. Aquatic Weeds**

These grow in soils that have either standing water or are permanently wet.

They are further divided into; **Floating hydrophytes, Emergent hydrophytes, and Sub-mergent hydrophytes** e.g. water lettuce, water hyacinth and Elodea spp.

**2. Terrestrial Weeds**

These cannot compete their life cycle in moisture regime as for aquatic weeds i.e. they grow well in well drained soils e.g. black jack, tick berry etc.

**Factors Contributing to Competitive Ability of Weeds:**

* Produce large quantities of seeds which increase their chances of survival.
* Have long dormancy periods allowing them to escape harsh conditions of the environment i.e. they remain viable in the soils for a long period of time awaiting conducive germination conditions.
* Seeds have several modes of dispersal, allowing easy spread over a wide area.
* Ability to propagate vegetatively, increases their chances of multiplication e.g. couch grass.
* Elaborate and extensive rooting system to compete in limited supply of nutrients.
* Short life cycle, allowing quicker multiplication. I.e. can complete their life cycle within restricted rain regime.
* They are hardy, therefore, able to thrive even under conditions of limited moisture, adverse soil conditions and climate.

**Benefits of Weeds/ Positive Effects of Weeds:**

* Some weeds have medicinal value to humans and farm animals e.g. roots of Sodom apple, used to treat constipation.
* Leguminous weeds fix nitrogen in the soil.
* Act as soil cover, preventing soil capping due to the impact of rain drops.
* Add organic matter to the soil up on decomposition.
* Some are edible to both man and livestock e.g. pig weeds, wondering Jew.
* Some weeds are used for thatching during construction of farm buildings e.g. spear grass, thatching grass.
* Some weeds are used for fencing e.g. Lantana for hedge fencing.

**Harmful Effects of Weeds:**

* Compete with crops for nutrients, space, light, moisture therefore reducing crop yield.
* They are parasitic to cultivated crops e.g. witch weed.
* Lower quality of Agricultural produce e.g. Mexican marigold give an unpleasant flavour t milk when dairy cows feed on them.
* Some weeds are poisonous to man and livestock e. g thorn apple, unripe Sodom apple.
* Some produce poisonous substances that suppress the growth or germination of cultivated crops i.e. they are **Allelopathic** e.g. couch grass.
* Some act as alternate hosts for insect pests and diseases e.g. black jack for Aphids.
* They block irrigation channels, making it difficult for water to flow freely in irrigated land.
* Aquatic weeds block navigation and deprive aquatic animals off oxygen.
* Lower the quality of pasture e.g. tick berry suppresses pasture undergrowth.
* Irritate workers thus, reducing their efficiency e.g. double thorn.

**WEED CONTROL:**

Weed control involves the elimination of weed population or stopping the introduction of weeds in an area not previously infested with weeds. This is done to minimise competition with crops for growth factors.

***Several methods are employed in the control of weeds and these include;***

1. mechanical/physical weeds control
2. cultural weed control
3. biological weed control
4. chemical weed control
5. Legislative method.

**FACTORS TO CONSIDER WHILE CHOOSING A WEED CONTROL METHOD:**

* Applicability of the method; e.g. weed control by cultivation cannot apply in areas with extremely steep slopes due to increased rates of soil erosion.
* Availability and suitability of tools; e.g. in case a farmer needs to use herbicides for weed control, there is need to have a knap sack sprayer.
* Cost of weed control; where possible, go for cheaper methods to avoid unnecessary costs that lower farm profits.
* Dispersal of seeds; weeds can be controlled effectively if the way in which the weed seeds disseminate are known and counter measures under take.
* Dormancy periods; while controlling weeds, dormancy period is to be considered as they have long dormancy periods.
* Environmental factors; rainfall, wind, temperature and humidity should be suitable for a method to choose for use.
* Habitats of the weeds; a xerophyte weed thriving under dry and arid conditions will die if the field is flooded with water.
* Life cycle of the weeds; annual and biennial weeds can be controlled effectively if the land is cultivated before seeding stage of the weeds. Perennial weeds require deep cultivation to dig out rhizomes, bulbs etc. by which they propagate.
* Method of reproduction; weeds propagate by either seeds or vegetative parts or even both. Seeded weeds should be removed or smothered before seeds formation stage while vegetatively propagated weeds should be exposed to sun heat to dry and die.
* The extent of weed infestation; if the weeds have established themselves and widely spread, they need an extensive controlling programme e.g. integrated management.

**1. MECHANICAL WEED CONTROL:**

This involves suppression of or elimination of weed growth through the use of farm implements/tools like panga, hoes, slashers etc.

It involves the application of physical energy.

***Methods of mechanical weed control include;***

a) Tillage or cultivation;

This is the opening and loosening of the soil by hand tools or tractor drawn implements.

**How Tillage Controls Weeds**:

It buries the entire plant, allowing it to rot thus, killing it completely.

It causes depletion of food reserves, by repeatedly removing top growth whenever it reaches sufficient size.

It exposes the underground parts to extreme temperature for desiccation.

**Advantages of Tillage in Weed Control:**

* Cheap for small scale farmers.
* Incorporates crop residues into the soil.
* Increases water infiltration of the soil
* Improves air circulation within the soil.
* Earthing up during tillage encourages root growth.

**Disadvantages of Tillage in Weed Control:**

* It pulverises the soil, destroying soil structure.
* Encourages water loss by evaporation.
* It is expensive in large scale production.
* It is laborious to farmers under large scale production.
* Creates suitable conditions for germination of buried weed seeds.
* May encourage spread of soil borne diseases through tillage implements.
* Encourages loss of organic matter and soil nutrients.
* May encourage soil erosion.
* May not effectively control perennial weeds.
* May damage crop roots.

b). Slashing or Mowing;

It is the mechanical removal of shoots from growing weeds. It can be used to prevent tall growing weeds from flowering and setting seeds.

c). Uprooting of weeds;

This is done where weeds are scattered or crops are too close to allow mechanical cultivation.

It is best done when the soil is moist and before seeds are produced.

d). Heat treatment;

This involves exposure of weeds to strong heat.

Burning weeds over an extended area destroys valuable surface trash that would normally be returned to the soil through decay or cultivation.

**2. CULTURAL WEED CONTROL:**

These are the crop husbandry practices carried out on the farm during crop growth without the use of chemicals.

***Methods of cultural weed control include;***

* Mulching; smothers weeds thus, preventing weed growth.
* Cover cropping; smother weeds.
* Crop rotation; weeds associated with certain crops will not germinate when rotated e.g. striga in cereals and sugar cane.
* Use of clean planting materials; prevents introduction of weeds into the farm.
* Proper spacing; creates little space for weeds growth or form a canopy which suppresses weeds.
* Clean seedbed; starts off crops on clean bed to effectively compete with weeds.
* Flooding; discourages growth of all non-aquatic weeds.
* Intercropping; provides a dense plant population to suppress weeds.
* Cleaning of farm tools and implements properly before or after use on the farm to avoid introduction of weeds & weeds seeds.

**Advantages of cultural methods of weed control**

* + There is no danger of environmental pollution.
  + There is no danger of poisoning to plants and animals.
  + It requires little or no technical knowledge compared to chemical control.
  + Its cheaper method compared to other methods.

**3. BIOLOGICAL WEED CONTROL:**

This is the use of living organisms to control weeds.

It aims at reuniting weeds and their natural enemies to achieve sustainable weed control. These natural enemies of weeds are often referred to as biological control agents.

Care should be taken to ensure that the biological agent does not have adverse effects on the crop plants.

Examples of biological control agents include;

1. Grazing livestock e.g. goats in coconut and cashew nut plantation.
2. Use of herbivores fish to control aquatic weeds.
3. Use of moths to control cacti.
4. Beetles to control water hyacinth.

**Conditions for Use of Biological Weed Control:**

* Inaccessible areas such as rocky and steep locations.
* Low priority areas for weed control.
* Situations where biological control is the only option.
* Where chemical control may not be too expensive or not effective.

**Characteristics of a Good Biological Agent:**

* Should be economical to maintain by the farmer.
* Should be specific in action to attack only the target weeds.
* Should multiply faster to over weigh the weed population.
* It should be easy to eradicate.
* Not transmit other infections to the crops.

**Advantages of Biological Weed Control:**

* It is environmentally friendly.
* It saves on labour.
* No additional inputs needed hence, cheaper.
* It is host specific i.e. does not kill soil micro-organisms.

**Disadvantages of Biological Weed Control:**

* It requires a lot of research.
* The agents may destroy predators as well.
* Control is slow in case of low population of the agent.
* High initial costs.

**4. LEGISLATIVE/PREVENTIVE WEED CONTROL:**

This involves government laws which prevent the introduction of noxious weeds in a country or the spread from one part of the country to another.

OR. It involves measures taken to prevent the introduction, establishment and spread of some weeds in non-infected areas.

Imported materials such as seeds, food and clothes are tested to certify they are weed free.

**5. CHEMICAL WEED CONTROL:**

Toxic chemicals known as herbicides are used to kill, suppress or modify weed growth in such a way to prevent weed interference with crop establishment, growth and yield.

Herbicides are chemicals used to kill and inhibit the growth and development of weeds.

**Ways in Which Herbicides Work to Kill Weeds;**

* Inhibiting the nitrogen metabolism.
* Killing the cells.
* Causing abnormal tissue development.
* Inhibiting photosynthesis.
* Inhibiting respiration.

**CLASSIFICATION OF HERBICIDES:**

This may be based on one of the following:

* Formulation
* Time of application
* Mode of application
* Selectivity.

1). **Formulation**:

This is the physical form of herbicides i.e.

a) **Liquids**.; are soluble in water or oil.

They are highly concentrated or toxic e.g. Dalapon, paraquat.

b) **Wettable powder**; finely ground particles, that form suspensions with water before application. Constant agitation is required to avoid clustering e.g. Atrazine, Simazine, and Duron.

c) **Granules**; occur in form of granules e.g. Duron.

2). **Time of Application:**

a) **Pre-emergence Herbicides**; are applied soon after crop seeds have been sown but before they emerge. They kill the germinated weeds such that crops germinate in a weed free environment e.g. Atrazine, Simazine.

b) **Post-emergence Herbicides;** are applied after crop germination or transplanting or at different stages of crop growth.

e.g. 2, 4-D, M.C.P.A, paraquat Glyphosate etc.

3. **Mode of Action**:

a) **Contact Herbicides**; kill only the parts of the plant with which it comes into contact. They are applied to the foliage e.g. paraquat, propanol.

b) **Translocated/Systemic Herbicides;** kill the whole plant eve if it comes into contact with only a small part of it i.e. they are absorbed into the plant and translocated to all parts of the plant. e.g. 2, 4-D, amitrole, atrazine.

4. **Selectivity**:

a) **Selective Herbicides**; this will kill or impair the growth of certain plant species when applied to a mixed plant population but cause no injury to others e.g. 2, 4-Diamine, Atrazine, Basagran etc.

b) **Non-selective Herbicides**; this is will indiscriminately kill all plants that they may come into contact with e.g. Glyphosate (round up), Gramaxone (paraquat)

**Factors Affecting Selectivity & Effectiveness of Herbicides:**

1. Stage of growth of the plant; young plants are more susceptible to herbicides action because of their high growth activity.
2. Physiological/metabolic factors; the ability of a crop to neutralise toxic herbicides varies and thus, affects selectivity and efficiency of herbicides.
3. Herbicide characteristic; herbicides which interfere with photosynthesis are non-selective.
4. Concentration; under high concentration, herbicides kill all kinds of plants.
5. Formulation; oil formulations are more toxic to plants.
6. Method of application; high selectivity is attained by placing the herbicide where the weed is and away from the crop.
7. Leaf angle; leaf angles which are inclined e.g. grasses are less susceptible as compared to horizontal angles such as dicots.
8. Nature of leaf surface; plants with thick and waxy cuticles on the surfaces retain less herbicides e.g. cactus, wondering Jew.
9. Height of the plant; selectivity is attained when weeds are shorter than when the crops or taller than the crops.
10. Location of the growing points; dicots are more susceptible to herbicides because their growing/terminal buds are more exposed than monocots.
11. Difference in rooting system; shallow rooted plants are more susceptible to herbicides than deep rooted which require herbicides with long residual effect.
12. Specialised structure; plants with underground structures such as rhizomes, and bulbs e.g. Oxalis are not easily killed by herbicides.

**How Maximum Effectiveness of Herbicides can be achieved:**

* Apply the herbicide at the correct stage of weed growth.
* Apply at recommended rate; avoid over dilution of herbicides.
* Avoid spraying in windy weather for uniform spraying.
* Avoid spraying on rainy days because rain can dilute the herbicides before it acts on weeds.
* Ensure correct speed of operation while spraying herbicides.
* Ensure adequate moisture in the soil for pre-emergence herbicides.
* Ensure adequate wetting during spraying for proper dosage to kill weeds.
* Correct timing of pre-emergence herbicides.
* The spray equipment should be in a good working condition.
* Use clean water for mixing the herbicides.
* Do not use expired herbicides for effective killing of weeds.
* Use of correct herbicides for the intended purpose to ensure faster action of the chemical.

**Factors Influencing the Choice of Herbicides:**

* Climatic factors e.g. wind, temperature.
* Costs of the herbicides.
* Methods of application of the herbicides.
* Methods of crop propagation and management.
* Stages of crop and weed growth.
* Type of crop in which weeds are to be controlled.
* Weed species present in the field.

**Advantages of Using Herbicides**:

* Requires less labour than mechanical cultivation.
* Adapted to control notorious/bothersome weeds e.g. couch grass
* Does not disturb crop roots and underground structures.
* Makes control of weeds in certain crops easier e.g. wheat, barley
* Efficient in both wet and dry soil conditions as compared to mechanical cultivation.
* Maintains soil structure.
* Cheaper than mechanical means on large scale farming.
* It is a quick method of weed control.
* It is suitable for crops with difficult morphology like sisal
* Reduces the number of tillage hence, controlling soil erosion.

**Disadvantages of Using Herbicides**

* Requires skilled labour in mixing and application.
* Poisonous to the environment and the user.
* It is uneconomical/expensive in small scale farming.
* May not be locally available.

**Safety Precautions in the Use Of Agro-Chemicals.**

* Carefully read and follow manufacturer's instructions.
* Wear protective clothing like overalls, breathing masks, gloves and boots.
* Bath thoroughly after handling the chemicals.
* Do not unblock nozzles by blowing with the mouth.
* Avoid spraying against wind/ do not spray on a windy day.
* Dispose off empty containers and left overs e.g. by burying them.
* Do not wash spraying equipment in water sources used by livestock and humans.
* Store chemicals out of reach of children and away from food.
* Never smoke or eat while spraying
* Keep finger nails short and clean.
* Clean the spraying equipment thoroughly before and after use.
* Check the sprayers for proper performance e.g. trigger valves and nozzles for leaks.

**CROP PESTS:**

**Definition:**

A crop pest refers to any organism that is harmful or destructive to plants.

Their effects may be seen directly by damaging the plant or indirectly through introduction of disease causing organisms.

**CATEGORIES OF PESTS:**

Pest are drawn from a wide range of organisms.

Most important crop pests include; insects, mites, nematodes, rodents, birds, fungi, bacteria, and viruses.

However, of the above, insects are the most commonly identified pests of major crops i.e. they are more successful than others.

**CLASSIFICATION OF PESTS:**

**1). According to the nature of the mouth parts:**

a) **Biting and chewing pests;**

These have their mouth parts modified into mandibles.

They bite and chew succulent or less fibrous plant parts e.g. leaves, stems, fruits etc.

They also create tunnels into plant parts and produce.

Examples include; termites, grass hoppers, locust, rodents, crickets, caterpillars, etc.

b). **Piercing and sucking pests;**

These have their mouth parts modified into proboscis.

They pierce through and withdraw juices from plant parts like leaves, fruits, and stems causing withering.

They spread disease causing organisms from infected to uninfected plants through saliva.

Examples include; mealy bugs, white flies, aphids, adult butter flies etc.

**2). According to the time of attack/where damage takes place:**

a) **Field pests;**

These attack the crops while still in the garden.

Examples include; mites, nematodes, birds, rodents.

**Damages Caused By Field Pests:**

* They attack roots, reducing water and nutrient uptake.
* Cause tattering of leaves.
* Cause wilting of crops.
* They cause defoliation (i.e. loss of leaves), reducing photosynthetic area.
* Introduce toxic saliva that injure crops e.g. nematodes.
* Premature fall of fruits e.g. fruit flies.
* Eat leaves reducing quantity of produce.
* Introduce disease causing organisms.
* Tunnelling of stems e.g. maize stalk borer.

b). **Storage Pests:**

These attack and destroy crop produce while in the stores.

Examples include; maize weevil, bean bruchid, rodents, Angoumois grain moth etc.

**Damages Caused By Storage Pests**:

* Introduce bad smell on produce.
* Bore holes into seeds, reducing viability.
* Cause a change in taste of produce, by mixing produce with excreta.
* Discolouration of produce/tainting produce.
* Eat produce, reducing quantity.
* Loss of nutritional value, by eating contents.
* Lumping of produce, making processing difficult.
* They mix with produce, lowering quality.

**HOW CROP LOSSES DURING STORAGE CAN BE CONTROLLED:**

* Avoid mixing of new and old produce.
* Proper drying of produce before storage to reduce moisture content.
* Cleaning and disinfecting the store to reducing hiding grounds.
* Keep the stores rain proof, to reduce moisture in the store.
* Proper ventilation, to reduce humidity.
* Sealing off cracks to prevent entry by pests.
* Seed dressing with chemicals before storage.

**REASONS FOR DRYING CROPS BEFORE STORAGE:**

* Controls seed borne diseases.
* Meets market requirement.
* Preserves seed viability.
* Prevents germination in store.
* Maintains quality.
* Reduces total weight.
* Reduces decay or rotting.
* Reduces pests’ damage in stores.

**REASONS FOR THE SUCCESS OF INSECTS AS CROP PESTS:**

* High rates of multiplication; due to high fertility rates.
* Small sizes; for hiding from predators.
* Possession of wings; for flight allowing dispersal over a wide area.
* Possession of legs; for movement on land.
* Dormant stages; that allow survival during food shortage.
* Possession of waxy cuticle; prevents desiccation in terrestrial environment.
* Dull colours; for camouflage in presence of predators.

**3. According to the number of plant s species they attack:**

a) **Monophagous pests:** These feed on only one crop e.g. banana weevil.

b**) Oliphagous pests:** Feeds on few species of plants that are normally of the same family

* 1. Stalk bores that feed on cereal, boll worms which feed on vegetables.

c) **Polyphagous pests** : These feeds on many species of plants and are very difficult to control e.g. American boll worms which attack maize, cotton, bean, tomatoes, sorghum etc.

**4. According levels of pest damage:**

**a) Major pests**; which cause significant damage e.g. locusts

**b) Minor pests;** which cause little damages which are not always recognized e.g. butterflies.

**Terms used in pest control**

**Pest status**: an organism gets a pest status when it causes losses in crops.

**Economic injury level**: it is the pest population that can cause economic damage.

**Economic injury level is determined by the following factors**

* Type of pest: e.g. one antestia bug can affect the whole plant.
* Climatic conditions: during the dry season, the sweet potato butterfly is more damaging than the wet season.
* Environmental factors i.e.: presence of natural enemies to the pest.

**Economic threshold**: it is the pest population where control is to be done to reduce losses.

**Phyto-sanitary control**: this involves methods of control that ensure use of materials that do not carry pests

**Lethal dosage (LD):** the concentration of the pesticide that kills a given proportion of the pest population e.g. LD50 is the concentration that kills 50% of the referred organisms.

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

* Crop improvement that has made crops of better quality which favours multiplication of pests.
* Change in farming systems: the introduction of large supply of food to pests hence favouring their existence.
* Decline in species diversity: elimination of species diversity disturbs the eco- system through bush burning, deforestation hence increasing pressure on available crop plants.
* Climatic change that leads to destruction of the ecosystem and the habitats for the organisms.
* Introduction of new crops that come along with new crop pests.
* Increase in us e of pesticides: this leads to increase in pesticide resistance.
* Crop storage, this enables pests to hide for long in the stored crops. It also concentrates the food supply in the dry grains and ensures a prolonged period of food availability.
* Minimum tillage techniques, this enables pests to form puparium in the soil.
* Also insect eggs laid in the soil are not exposed to desiccation by the sun.
* Improved transport has enabled importation of infested crops from elsewhere into formerly clean environment.
* Cyclic or periodic occurrences, cyclic climatic changes such as Elnino droughts are often followed by pest out breaks.

***The following factors are considered when assessing pest damage/ factors which determine the need for pest control.***

* + - Part of the plant attacked. If the plant is attacked on the most vital part, then the pest affects the commercial yield of the plant and control is needed.
    - Population of the pest: if the pest population is high, then control is needed.
    - Feeding habits of the pest: biting and chewing pest cause major losses because they destroy important points of the plant while sucking pests cause indirect losses.
    - Presence or absence of predators: most predators eat their prey or weaken them immediately therefore control may not be needed.
    - Effect of climate on the pest. Climatic conditions like high humidity favours the multiplication of pests e.g. antestia bugs in coffee.
    - Stage of development of the pest. Certain insects are destructive at particular stages in the lifecycle e.g. larva stage in butterflies.
    - Mobility of the pest: mobile pests can cause a lot of damage than less mobile pests therefore control is needed.
    - Presence of alternate hosts to the pest: alternate host even when the major crop is out of season therefore causing limited damage than less mobile pests therefore causing limited damage the crop than the alternate pest.
    - Plant resistance: plants that have resistance to damage by particular pests are affected by the pest.

**METHODS OF PESTS CONTROL:**

**1). CULTURAL METHODS;**

1. Weed control; to destroy alternate hosts for pests e.g. in control of aphids.
2. Use of clean tools and equipment; to prevent the spread of pests.
3. Use of clean planting materials; to prevent the spread of pests and ensure a healthy start of the crops.
4. Trap cropping; to reduce the population of the pests.
5. Here, a trap crop is planted early to attract pests and then destroyed together with pests e.g. in bean leaf beetles.
6. Timely planting; to give the crops an early start before the build-up of pests. Planting early avoids infestation and damage because the plant is beyond the vulnerable stage.
7. Timely harvesting; the harvesting dates of some crops can be altered to reduce or avoid potential pests’ damage.
8. Proper tillage; to expose pests to harsh conditions.
9. Proper spacing of crops; too control movement and attack by pests e.g. in ground nuts to control aphids.
10. Proper pruning; to discourage favourable micro-climate leading to reduced build-up of pests.
11. Proper drying of produce; to give the produce resistance against pests attack.
12. Mulching; reduces the movement of pests eg. Banana weevils and improves soil conditions for proper growth of crops.
13. Flooding; to suffocate the pests to death.
14. Growing resistant varieties; to reduce the chances of pests’ damage on crops and crop produce.
15. Manuring; to discourage some pests e.g. Eel worms before their attack on crops.
16. Closed seasoning; to deny the pests hosts to survive on hence, starvation to death.
17. Crop rotation; to destroy or break the life cycle of pests on the field.
18. Field hygiene; which involves destruction of all crop residues from the previous planting to deny the pests hide outs.

**2). CHEMICAL METHOD;**

This is the reduction/ prevention of pest damage by use of chemical compound to kill pest. The chemical use to control pest are called pesticides.

It involves dusting, spraying or fumigating a crop or crop produce with a substance specifically harmful to that particular organism.

A pesticide is therefore, a chemical used to control, repel, attack or kill pests.

Examples of common pesticides include; Aldrine, DDT, Lindane dust, Malathion dust, Rogor etc.

**Classification of pesticide**

**1. According to mode of action**

a) **Stomach poisons**: These target the digestive system and enter after being eaten by the pest e.g. Dieldrin and lindane.

b) **Contact poisons**: This go through the skin after dissolving the cuticles e.g. Marathion, and DDT

c) **Fumigants:** These are carried by air current and they enter through skin pores on the body of the pests

**2. According to the organism killed by the pesticide** Insecticides; kill insects

Acaricides; kill ticks

Rodenticide; kill rodents

Antibiotic; kill bacteria

Fungicide; kill fungi

**Terms used in chemical pest control.**

**Persistence**: This refers to the length of time that the pesticides remain in the environment (including within the organism) without being broken down.

**Specificity:** This refers to the range of organisms that the pesticide can affect e.g. DDT is a broad spectrum pesticide.

Narrow spectrum pesticide only affects restricted range of organisms.

Broad spectrum pesticide can lead to pest resurgence. Pest resurgence is condition where by the population of pest increase after treatment to more than before the treatment because the pesticide would have killed even the natural enemies of pests.

**Tolerance limit**: This refers to the quantity of chemical residues that id accepted to remain in the product that is to be used as food.

**Pre-harvest period**: This is the period that must elapse after applying a chemical before harvesting to allow the plant break down the chemical to a level below the tolerance limit.

**Lethal time (LT):** This refers to the length of time that is needed to kill a given number of pest e.g. LT50 refers to the time needed to kill 50% of the total pest population.

**Lethal dosage (LD):** This is the concentration of pesticide that kills a given proportion of the pest population e.g. LD50 is the concentration that kill 50% of the referred organism.LT figure determines the strength of the chemicals.

**Factors that affect efficiency of pesticide**

1. Concentration of pesticide: Pesticide should be of right concentration to give the right strength in killing the target pest.
2. Time of application: It should be applied at the time of developmental stage when the pest is more vulnerable.
3. Weather condition at application time: there should be no rain at the time of applying pesticide otherwise its action will be rendered harmless since rain will dilute and alter the concentration of chemical.
4. Persistence: The pesticide should be persistence enough in order to be effective and to achieve desired effects.

**MODE OF ACTION OF PESTICIDES:**

**a) Destruction by Ingestion;**

Here, stomach poisons must be eaten by the target organisms.

It is selective in the sense that, it only kills those organisms that consume it. E.g. Di-eldrine, Fluorine, Lead arsenate.

**b). Destruction by Contact;**

These include broad spectrum pesticides that kill any organisms that come into contact with them.

They are absorbed through the skin or cuticle of the pests.

They can be sprayed directly on the pests or on the foliage of the crop at risk.

**c). Destruction by Suffocation;**

These act by interfering with respiration and are applied as fumigants e.g. methyl-bromide.

**Characteristics of a Good Pesticide:**

* Should not be harmful to man and the livestock.
* Should be non-toxic to the environment.
* Non-toxic to useful organisms.
* Should have a long term residual effect to reduce rates of application.
* Should not have residual effects on crops.
* Highly poisonous to the target organisms.
* Readily available.
* Affordable to most farmers.
* Require least possible skills to apply.

**PRECAUTIONS WHEN HANDLING & APPLYING PESTICIDES:**

* All equipment used in spraying pesticides should be thoroughly washed before and after use.
* Allow correct time lag between spraying and harvesting of produce for consumption.
* Empty containers of pesticides should be burnt.
* Wear protective clothing when applying pesticides for protection against spray wash.
* In case the pesticide is taken in by mistake, seek medication immediately.
* Keep all records of pesticides application for effectiveness.
* Do not eat, drink or smoke while spraying to avoid inhaling the pesticides.
* Do not blow blocked nozzles with mouth to avoid taking in chemicals.
* Spray facing the direction of wind.
* Read and carefully follow manufacturer's instructions.
* Avoid rainy conditions to ensure correct concentrations.
* Ensure proper mixing of the pesticides for effectiveness.

**ADVANTAGES OF CHEMICAL PESTS CONTROL:**

* It is less laborious i.e. it’s an easy method to use.
* It is a quick method of pests’ control.
* May have a broad spectrum action i.e. killing even complex pests.
* It is more predictable compared to biological methods.
* Relatively cheaper on large scale production.

**DIADVANTAGES OF CHEMICAL METHODS:**

* Expensive to buy chemicals especially for small scale use.
* Application requires skills.
* Some pests may develop resistance (the residual population).
* May be toxic to the environment.

**3). PHYSICAL/MECHANICAL METHODS:**

It involves using barriers, traps, or any physical means to prevent or reduce pest problems.

Mechanical control methods can be rapid and effective but are mostly suited to small, acute pest problems.

**MEHTODS OF MECHANICAL PESTS CONTROL:**

* Air suffocation; to encourage build-up of carbon dioxide which inhibits pests’ multiplication or survival leading to death of pests.
* Creation of physical barriers; e.g. rat guards on post of granaries prevent rats from climbing into the stores.
* Hand picking and killing; to destroy the pests hence, reducing their population. Special traps may be used here.
* Use of explosives; to scare away birds causing them to migrate or die.
* Use of lethal temperature; involves application of extremes of temperature i.e too high or too low to control pests development.
* Scare crows; these are human figure-like objects set to scare away birds and other animals from crop fields.

**4). BIOLOGICAL METHODS:**

This is the deliberate use of a living agent or natural enemy or predator to control pests.

The control agents can either control the pests by feeding on them e.g.

Lady bugs on aphids, or by causing fatal diseases to the pests e.g. Virus sprays on army worm caterpillars.

**WAYS OF USING NATURAL ENEMIES;**

1). Importation/Classical;

Involves control of insect pests using introduced natural enemies.

2). Augmentation;

It is the mass culturing and periodic release of natural enemies.

3). Conservation;

Is the enhancement of numbers of already existing natural enemies.

**FACTORS THAT AFFECT THE EFFECTIVENESS OF A BIOLOGICAL AGENT:**

* Age of the agent.
* Level of training offered to the agent.
* Adaptability of the agent to the conditions of the environment.
* Population of the agent in relation to that of the pests.
* Type of pests in question.
* Rate of multiplication of the pests and the agent.
* Searching ability of the agent.

**CHARACTERISTICS OF A GOOD BIO-CONTROL AGENT:**

* Should adapt to a wide range of environmental conditions.
* Have a faster growth rate i.e. early maturing.
* Easy to eradicate should need arise.
* Should be specific in action.
* Easily accessible.
* High reproductive potential, to multiply in a short time.
* Should be environmentally friendly.
* Should have a narrow host range.
* Should have efficient search ability.

**ADVANTAGES OF BIOLOGICAL PEST CONTROL:**

* It is cheaper to use.
* Requires little attention by the farmer.
* It is environmentally friendly.
* Not harmful to non-target organisms.
* Development of resistance by pests is unlikely.

**DISADVANTAGES**:

* May not be locally available.
* Effects are unpredictable i.e. farmer has no control over the agent.
* Level of pests control may not be sufficient.
* Requires a lot of research which may be expensive.
* The method is slow i.e. may not save the crops faster.

**5). INTEGRATED PESTS MANAGEMENT (IPM):**

This is the combination of all effective, economical and environmentally friendly pests control methods into a single but flexible approach to managing pests.

It gives priority to non-chemical methods first and resorts to chemical means when all the other methods have failed.

**ADVANTAGES OF IPM:**

* Environmentally friendly since it reduces pesticide use.
* Reduces hazards to agricultural labour.
* Easy to adopt i.e. simple method.

**LIMITATIONS TO IPM:**

* It is difficult to come up with standard combination of methods.
* Less knowledge of farmers on IPM.
* Reluctance of farmers in adopting IPM strategies.
* Requires clear understanding of pest ecology and agro-ecosystem.

**PLANT DISEASES:**

**A disease may be defined in any of the following ways;**

i). It is a harmful physiological disorder on a plant.

ii). It is any abnormal condition that damages a plant and reduces its productivity or usefulness to man.

iii). It is a condition that interferes with, impairs or disturbs the normal performance of a plant.

iv). It is a deviation from good health resulting into poor performance of a plant.

**GENERAL SYMPTOMS OF CROP DISEASES:**

* Chlorosis i.e. yellowing of leaves due to chlorophyll degradation or failure in its formation.
* Rotting of roots or rooting systems.
* Rotting of storage organs.
* Sunken lesions on the stems.
* Stunted growth of the plant or plant organs (Hypoplasia).
* Excessive growth of the plant pr plant parts (Hyperplasia).
* Swelling of plant organs (Hypertrophy).
* Wilting i.e. partial drying of the plant.
* Excessive gum formation on trees.
* Spots/patches on the leaves, flowers and fruits.
* Mottling of leaves.
* Curling of leaves.
* Reduced internodes.
* Low yield of plants.
* Yellow strips on the leaves, along the mid ribs/veins.

**CLASSIFICATION OF PLANT DISEASES:**

Plant diseases can be classified in many different ways, however, the most important one is based on the causal agents thus;

i). Fungal diseases.

ii). Viral diseases.

iii). Bacterial diseases.

iv). Deficiency/Nutritional diseases.

**REASONS WHY FUNGAL DISEASES ARE DIFFICULT TO CONTROL:**

**(XTICS WHICH HAVE CONTRIBUTED TO THE SUCCESS OF FUNGI AS PLANT PATHOGENS):**

* They have a high reproductive rate; producing several spores for rapid multiplication.
* Have perenating structures for survival.
* They produce resistant spores allowing continuity of the species.
* Several species exist making them hard to control.
* Few people have knowledge on control of fungal pathogens, allowing their survival.
* Chemicals for their control are expensive.
* Exhibit greater diversity in form of formation and habitats thus, hard to control.
* They have a wide host range, surviving from season to season.

**ECONOMIC IMPORTANCE OF FUNGI:**

* They cause a majority of known plant diseases.
* They cause some diseases of man.
* They act as food for human beings e.g. mushrooms.
* Some of them are very poisonous to man and his livestock e.g. causing irreversible loss of appetite.
* They are employed in commercial preparation of some vitamins.
* Employed in production of organic acids.

**HOW DISEAESES SPREAD FROM ONE PLANT TO ANOTHER:**

* By contact of animals containing pathogens to plants.
* By contact of plants to plants i.e. infected plants to a healthy one.
* Through infected planting materials such as seeds, cuttings.
* Through irrigation water.
* Rain splash that may carry fungal spores from infected to healthy plants.
* Sucking pests like Aphids from infected groundnuts to healthy ones.
* Through crop residues allowing survival of pathogens.
* Organic manure e.g. compost that contains pathogens.
* Mulching materials.
* Through weeds; hosting vectors or pathogens of crop diseases.
* Through wind in form of air currents that spread fungal spores.
* Use of infected implements e.g. tillage implements.

**HOW CROP DISEASES ARE CONTROLLED:**

**a) CULTURAL METHODS;**

* Crop rotation; to break the life-cycle of disease pathogens and prevent the buildup of diseases on the farm.
* Use of healthy planting materials that are free from pathogens.
* Planting tolerant or disease resistant varieties which can withstand disease attack.
* Weeding to remove plants that may be alternative hosts of the disease causing organisms.
* Proper drainage of the soil, to prevent water borne diseases.
* Removal and burning of diseased plants, to avoid spread of pathogens.
* Timely planting of crops, to escape disease build up.
* Practicing closed season, in order to starve the disease causing organisms to death.
* Pruning, to reduce the micro-climate for microorganisms which spread diseases.
* Close spacing; to create a micro-climate for micro-organisms which spread diseases e.g. groundnut rosette hence, minimizing their spread.
* Use of disinfected tools; to prevent the spread of some diseases.
* Soil sterilization by heat treatment; to destroy spores of fungi.
* Timely harvesting of crops; to escape attack by pathogens that emerge later in the rainy season.
* Proper storage of crop produce; to minimize mould attack on seeds.
* Timely seedbed preparation; to expose the pathogens to harsh environmental conditions.
* Irrigation/flooding of crop fields; to suffocate the pathogens.
* Field hygiene by burning of crop residues; to kill pathogens.
* Proper drying of crop produce before storage; to prevent mould attack.
* Destruction of volunteer crops; that may be a source of infection.
* Manuring; to increase the rate of crop growth for resistance against diseases.

**b). CHEMICAL METHODS:**

* Seed dressing with chemicals to destroy the pathogens.
* Chemical soil sterilization to destroy the pathogens.
* Spraying with chemicals against the pathogens.

**c). LEGISLATIVE MEASURES:**

By imposing quarantine to resist the movement of planting materials or crop produce from the affected areas.

**d). BIOLOGICAL METHODS:**

By using a living agent (bio-control agent) against the pathogens or vectors.

**e). INTEGRATED DISEASE MANAGEMENT:**

Involves combining all the other methods of disease control while giving priority to non-chemical methods

**REVISION/GUIDING QUESTIONS**

1 a). Define the term weeds.

b). State the benefits and harmful effects of weeds.

2 a). How would you classify weeds?

b). Discuss the various methods of weed control including their advantages and disadvantages.

c). Discuss the factors affecting herbicide selectivity and effectiveness.

3 a). What are storage pests?

b). Describe the damages caused by storage pests.

c). what are the features that contribute to pests persistence?

4 a). What is a disease?

b). Discuss the general symptoms of crop diseases.

c). How does a disease spread in crops?

d). Discuss the various methods of disease control.

5 a). State the factors that you would consider before adopting a pest control method.

b). Discuss the various pests control measures.

c).Define IPM and discuss the elements of IPM.

**\*THE END\***