STANDARD HIGH SCHOOL-ZZANA

ADVANCED AGRICULTURE

INTROUDCTION TO CROP SCIENCE

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 is the preparation of land for planting. It includes;

Land 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 plants.
- 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:

1. 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 moldboard plough, a sub soiler, rotovator.

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.

2. 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.

Importance of secondary cultivation.

- Helps in leveling 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.

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

FACTORS THAT INFLUENCE THE CHOICE OF TOOLS AND IMPLEMENTS TO BE USED IN CULTIVATION.

Soil condition: Hard soil condition like dry soil requires the use of moldboard plough and disc plough while light soil requires hand hoes.

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.

Topography: Steep slope does not favors the use of tractor trailed implements like moldboard plough since tractor cannot move on hilly land. Flat land encourage the use of tractor while hilly areas can be cultivated by hand hoes.

Nature of surface vegetation: Thick vegetation limits the use of hand hoes and ox-plough while moldboard plough can easily crush on tall and thick vegetation .This is because tractor can easily roll through without blockage.

Availability of capital: Tractor is expensive to peasant farmers making hand hoes to dominate farming operation.

Availability of skilled personnel: Tractor trailed implements e.g. Moldboard plough, disc plough etc. requires skilled personnel to operate unlike hand hoes which does not require much skills to handle.

Land tenure system: Fragmented land does not favor tractor trailed implements since tractor cannot move in sub-divided land. Such areas need hand hoes while trailed implements operate best on extensive land.

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.

Physical condition of the seedbed after primary cultivation: Rough seedbed requires more operations than smooth seedbed.

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.

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.

Soil texture: Light soil break easily hence requiring fewer operation than heavy soils.

Amount of organic matter: Densely vegetated land e.g. sugar cane trash requires more operations than light vegetated land.

Moisture content of the soil: Wet soil does not need to be over worked on since it create puddle which destroys soil structure hence fewer operations.

Liability to erosion: If the soil is liable to erosion, less operations is required e.g. on hilly areas.

METHODS OF PREPRING 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.

Disadvantages 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 can not 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 laboure to do other farming operation since the use of tractor requires only one person.

Disadvantages 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.

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 areas need to be cultivated.

- It conserves soil moisture
- It also minimize 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. There are basically two methods of propagation i.e. propagation by mean of seeds (sexual propagation) and by use of vegetative organs (asexual propagation).

1. Vegetative propagation (asexual propagation).

This is the method by which plants reproduces themselves from the plant's part that is not associated with reproductive organs.

Advantages of vegetative propagation

- The offspring produced are identical to the parent plants
- The offspring grow fast and mature early
- The offspring are hard and strong compared to the seedlings obtained from seeds.
- It is the only methods of propagating crops which do not produce seeds.
- The young plant gets food from the parent plant until they are fully developed.
- There is easy multiplication of plant population.
- It promotes physical uniformity of crops in the garden due to lack of variation.
- It is easy to avoid genetic disintegration which is a case in sexual propagation.
- The method does not require elaborate seedbed preparation since the land does not need well preparation unlike in seeds.
- It helps in eliminating the problems of seed dormancy.
- Vegetative propagation has high chance of taking than seed germination.

Disadvantages of vegetative propagation.

- The planting materials are quite bulky therefore are difficult to handle and transport.
- Some methods of vegetative propagation require special skills e.g. grafting
- Only small areas can be covered during planting.
- The planting materials are difficult to store since they have high moisture content leading to rotting.
- It leads to overcrowdings g of crop plant in the field.
- It eases transmission of plant pest and diseases during planting when contaminated tools and equipment are used.
- It spread parent's disease to the offspring.
- There is no variation in plant since there is no crossing over.

FORMS OF VEGETATATIVE PROPAGATION

Stem tuber: This is a swollen underground stem with buds that can develop into a new plant when used e.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 with 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 e.g. in Star grass.

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

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 soil etc.

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

FACTORS THAT AFFECTS ROOTINGS OF CUTTTING.

Oxygen supply: Rooting processes requires ample supply of oxygen to provide the energy for rooting process.

Light intensity: Soft root 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 roots promote rooting because they reduce transpiration rate.

Relative humidity: High relative humidity to maintain turgidity within the leaf and to prevents desiccation and encourage rooting.

Chemical treatment: Rooting hormones applied at the basal end of cutting promote rooting.

Common rooting hormones includes;

IAA (Indole Acetic Acid)

IBA (Indole Butyric Acid)

NAA (Naphthalene Acetic Acid)

Layering: This is the method of vegetative propagation which involve induction of plant's stem to produce roots before being cut off from the parent plants for propagation. The 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 wounde

part to support rooting.

Type/forms of layering.

Tip Layering: The branch tip is bent to the ground and covered with soil to produce roots. It is held in position by pegs.

Simple 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.

Compound Layering: The branch is bent and covered in the ground at several points and pegged to provide roots. It is called serpentine because the branch is in a serpent-like shape.

Aerial Layering: 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.

Mound/Stool Layering: Soil is heaped around the base of the stem which give rise to new shoots.

Trench Layering: The shoot is bent and laid in a trench and covered with moist soil.

Propagation by means of grafting: Grafting is the union of two separate plants usually woody stem and allowing them to grow as one plant. The upper part is called the scion and the lower part is called the stalk. The scion should have one or more buds to give rise to the future fruiting plants.

REASONS/BENEFITS OF GRAFTING

- To facilitate the changing of the top of the tree from being undesirable to desirable.
- It makes the growing of more than one type of fruits/flowers on one tree plant possible
- It helps to propagate clones which cannot be propagated by any means.
- It helps in obtaining a special plant in the garden.
- It is used for testing resistant to various diseases in plant.
- It is used for repairing damage tree.

CONDITIONS NECESSARY FOR SUCCESSFUL GRAFTING.

Compatibility i.e. Correct joining of the scion and the stalk. The cambium tissues of the stalk and the scion should be able to fit precisely to facilitate normal translocation to take place.

High relative humidity i.e. there should be low temperature to reduce on the rate of transpiration.

Grafting technique: Quality cut should be made to allow uniform joining of scion and stalk and care should be taken to protect the union.

Both the scion and stalk should be woody.

Use suitable tools or equipment when grafting i.e. sharp knife or blades

Grafted plants should be **dicotyledonous** because monocotyledonous plant does not undergo secondary thickening. Secondary thickening refers to the regeneration of new stem surface as the old ones are ruptured off.

Availability of grafting tape

The grafted part (union) should be **sealed/wrapped** properly preferably using grafting tape or polythene to avoid air entry which could lead to desiccation.

The two plants should be from the **same family.**

The scion should have some bud to allow photosynthesis takes to place in order to generate enough energy for growth.

Both the scion and stalk should be removed at the **right stage of growth**. Old plants should be avoided

The plants should **be free from pest and diseases**

METHODS OF GRAFTING

Slice grafting. This methods requires both the scion and the stalk to be of the same diameter. Slanting cut is then made from the surface of the stalk and from the base of the scion. The two plants are then fitted together to form a strong union.

Side grafting. This involve fitting scion of a very small diameter into a growing plant(tree).A cut is made into the stalk at suitable angle then the scion inserted to ensure contact between the cambium of both the stalk and the scion.

Wedge/Cleft grafting: This is used when the stalk diameter is bigger than that of the scion. The root stalk is cut to form a V- shape and the scion to form a wedge shape. The scion is then inserted into the stalk and wrapped together to form a strong union.

Bud grafting: This is a special form of grafting where vegetative bud of one plant is grafted onto another plant (root stalk).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 suitable tree species and get their buds and stocks.
- Make a T-cut on the stock and bark gently separated 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.

Propagation by seeds: Seed is the most common method of propagating self-pollinated plants. 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 vegetable plants.
- 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 vegetataively.
- The planting materials are easy to transport.

Disadvantages 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 choosing good quality seeds to be use planting.

Qualities of a good seed for planting

Seed vigour. The seed should be able to germinate freely over a wide range of environmental condition i.e. the seed should be strong enough to resist any climatic changes e.g. drought.

Cleanliness. The seed should be free from any contamination by weed seeds which lowers its quality.

Maturity. It should be matured enough with well-developed embryo in order to germinate quickly.

Freedom from pest and diseases. The seed should be free from pest and disease since they reduces seed viability by eating up seeds.

Size and shape. The seed should be large enough, larger seeds have large embryo and large food reserve which stores enough food for germination. Small sized seeds have low percentage of establishment once planted since the food reserve might get depleted before emergence of crop plants.

Good genetic makeup. A god seed should be from a variety that is high yielding, resistant to prevent pest and diseases, high germinability and early maturing.

It should have correct moisture content. Some seeds require proper drying before

they could be planted.

The seed should be plumped enough i.e. it should be well filled since wrinkled seeds lacks the necessary food reserve for germination.

It should not have **mechanical/physical defect,** this reduces seeds viability/.

The seed should have a long shelf life i.e. should be stored for long without getting spoilt.

It should not be dormant

It should be picked from a healthy plants.

SEED VIABILITY/GERMINABILITY.

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

Conditions for seed germination.

Suitable temperature

Enough supply of water.

Good internal conditions.

Adequate supply of oxygen.

Good physical and chemical conditions.

Conditions which hinders seed germination/factors affecting germination Efficiency.

Germination Efficiency refers to the proportion of seeds that germinate out of the seeds planted.

Physical damage to the seeds

Shallow planting which expose seeds to pest and prevent sees from obtaining enough moisture for growth.

Deep planting which make the food reserve within the seeds to get depleted before germination.

Immaturity of embryo.

Pest and diseases also lowers seed germination.

Good soil temperature is required. Very high and very low temperature reduces seed germination.

Good 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 the level.

Soil moisture, good soil moisture is required.

Analysis of seed purity: This refers to the process of determining whether the purchased or processed seeds have got any contamination e.g. Weed seeds, other crop seeds etc. It is determined using the formula

$$\text{Percentage seed purity} = \frac{\text{Weight of seeds only}}{\text{Total weight of seed sample}} * 100\%$$

Seed treatment

Seed can be treated by;

Drying

Seed dressing

Fumigation of seeds

Seed inoculation

Note: Seed inoculation is the treatment of legume seed with the right strain of nitrogen fixing bacteria while **seed fumigation** is the use of chemical which produce gases that fill the room, cracks on the wall to prevent the soil pest that attack seeds.

Seed dressing: This is the treatment of seeds using suitable chemicals before planting of storage

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.

Prechilling of seed with hard seed coat to ease entry of oxygen and water.

Avoid storing seeds for planting for a long period of time.

METHODS OF TESTING SEED VIABILITY/GERMINATION TEST.

There are mainly 3 methods;

i. The germination test method.
ii. The lackon technique.
iii. Using potassium permanganate solution.

(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 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 have germinated and express them as a percentage of the total seeds planted.

Note

If the germination percentage is above 80%, then the seeds are good for commercial planting.

(ii) The lackon technique/ tetrazolium salt method.

Materials

- Seed lot.
- Petri dish
- Tetrazolium salt solution.

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 and conclusion

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 80% and above, then the seeds are good for commercial planting.

(iii) Use 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 sometime to break the testa so that they can release the liquid in them.
- Potassium permanganate solution is usually purple in color and will get discolored 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.

THE MECHANISM OF SEED GERMINATION

Imbibitions: The initial stage in germination is absorption of water through the microphyl by osmosis .This is called imbibitions and as a result, the embryo becomes hydrated and this activates the enzymes.

Metabolisation of food reserve: This cause rapid transformation and expansion of food reserve i.e. the food reserves are broken/hydrolyzed 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.

Translocation: The soluble products are translocated and used in respiration and synthesis of new tissues e.g. Glucose and amino acid for ATP production

Cotyledon swells: Expansion of food reserved due to imbibitions 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.

Cell division and cell differentiation: The plumule and radicle elongate out through the seed coat and develop into primary shoot system and root system respectively.

Plumule emerge out above the ground due to rapid elongation of epicotyls, get exposed above the sunlight and the formation of leave starts (primordial leaves) to aids photosynthesis.

SEED DORMANCY

This is a condition in which viable seeds fail to germinate despite having all the necessary conditions for seed germination.

CAUSES OF SEED DORMANCY

- Presence of thick hard coat that is impermeable to water and oxygen
- Immature embryo in the seed
- Presence of germination inhibition in the seed e.g. abscicic acid
- Poor storage condition leading to death of embryo
- High environmental temperature which denature germination enzymes.

- 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

- Mechanical scarification ,which is the mechanical breaking of seed coat to facilitate entry of oxygen
- Use of heat treatment at controlled temperature (80 c) ,this is to enhance enzyme action.
- Use of chemical treatment e.g. sulphuric acid to soften the seed coat
- Pre-chilling this is when seeds are exposed to low temperature for a while before planting.
- Providing proper storage condition
- Soaking the seed in growth stimulating hormone e.g. Indole Acetic Acid (IAA)
- Soaking the seeds in cold water over night or for some days to soften the seed coat
- Cuttting off the hard coat of the seed to make it permeable to oxygen

FIELD PRACTICES USE IN GROWING CROPS (THE AGRONOMIC PRACTICES)

1. PLANTING: This refers to the actual placement of seed in the nursery bed or the actual garden.

Note: Planting materials 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, its 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 hectares 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 selecting site for nursery bed.

Water source: It should be near permanent water source to facilitate watering, seedlings requires 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 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. Simsim, sorghum, millet etc.
- It can be used to obtain higher plant population in the field.
- It provides good ground cover quickly.

Disadvantages of broadcasting method of planting

- It is difficult to regulate optimum plant population since sees 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 affects 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;

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.

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 germination of crop plants due to regulated planting depth.
- Easy subsequent management of crop plant in the field e.g. weeding, pest and disease control harvesting since thee is no over crowding.
- 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.

2. Timely planting: This refers to planting of crops at the onset of the rain so that crops get enough growth factors through out 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 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 comes at later stage of growth.
- Crops also get a good start against weeds since weeds comes when plants has grown .
- Early planted crops attract higher prices leading to increase income of the farmer.
- The farmers carry out hid farming operation on programmes without congestion.
- It promote high crop yield.

3. Timely seedbed preparation: Land should be opened at lease six weeks before planting. This will give ample times for weathering to give fine tilth for planting.

4. Use of correct planting depth: Planting depth refers to how deep the seed is planted 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 sees from exhausting all their food reserve during germination,.
- It promote uniform germination and uniform growth of crop plants in the field, this encourage good harvest.
- It encourage high crop yield due to good seedling establishment. Seedlings emerge successfully from the soil.
- It also protects the sees from drying due to too much heat.
- It prevent seeds from being exposed to birds and other animals which destroys seeds

5. Proper spacing of crops: Crop spacing refers to planting of seeds/seedlings at a specific distance from one another and from one line to another line.

Advantages of proper crop spacing.

- It promote high crop yield due to maximum 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 control 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 spacing of crops.

Growth habit of the crop: Crops that spread widely i.e. crops with lateral growth habit requires wider spacing than crops with erect/upright growth habit.

Planting method: Broadcasting method of planting necessitates close spacing unlike row plating with wider spacing.

Amount of moisture/rainfall: Close spacing is possible for areas with high moisture content than crops grown in arid areas where rainfall is inadequate.

Level of soil fertility: Close spacing is recommended in a very fertile soil than less fertile soils.

Purpose for which the crops is grown e.g. bean plants grown for green manure preparation is closely spaced than that for commercial purpose.

Necessity to use machines for weeding, pest and disease control. This will encourage wider spacing to leave enough space for machines to move.

Cropping system to be used. Mixed stand crops requires closer spacing than crops planted in a single stand.

Disease control measure: e.g. close spacing is used in G.nut to control G.nut resetting.

6. Seed selection and dressing: Seed selection refers to choosing best quality seed to be planted so that they are able to grow into mature crops and give high yield while

seed dressing is the coating/mixing of seeds with suitable strain of chemicals and pesticide to prevent attack and damage by storage pest.

7. Use of recommended seed rate: A seed rate refers to the quantity of seeds required per unit area of land. There are basically three type of seed rate on a farm;

High seed rate

Low seed rate

Optimum seed rate.

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

- Over crowding 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 areas. It normally results into low crop yield per given area but it increase 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 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 drop plants and the quality of the seeds used.

8. Gap filling: This is the filling of empty spaces where seed did not germinate or where seedling dried up after transplanting in the field to ensure optimum plant population..It's done by replanting fresh seeds/seedling in the gap.

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

9. Thinning: This is the removal of excess seedlings usually weak ones from the planting holes

some days after germination to leave correct spacing. Examples of plant that can be thinned are maize, cotton etc.

10. Pricking out: This is the removal of excess seedlings from the crowded area in the nursery bed.

11. Prunung: 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.

12. 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 staking

- 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.

13.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.Its 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 incase of runoff.
- It also creates suitable condition for bulb formation in onion.

14. Pest and disease control: Pest and disease should be effectively controlled as they lower the qualities of crop in the field.

15. Application of manure to enrich on soil nutrients for better yield.

16. 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.

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

18. Mulching:This is the covering of soil surface using mulches to prevent it from excessive evaporation, control weed growth and soil erosion which lowers crop yield.

19. Timely weeding of crop plants to minimize on completion for nutrients with the crop plants.

20. Timely harvesting: Harvesting refers to removal of matured plant's parts from the parent plants. Its the climax of crop's productive life in the field. Crops should be harvested in time to reduce crop losses caused by insects pests, birds, thieves, rodents, shattering and germination of seeds from the garden.

The plant is considered matured when the reproductive parts has 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 ie 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, rotting of fruits and vegetable.

It encourages build up of pest and diseases.

21. Drying of crops: This practice is carried out especially on grain to obtain the correct moisture content for storage.

Reasons for drying of crop produce.

- It prevents produce from rotting and decay caused by fungi.
- To reduce insect damage.
- To prevent growth on crop plants.
- To maintain seed viability and quality.
- To reduce bulkiness of crops for easy transportation.
- To prevent germination of sees 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.

22. Proper storage: This prevents spoilage of seeds caused by storage pest and it also make produce available for future use.

Characteristics of a good crop store.

- The store must be of good construction and rain proof.
- The store must always be cleasn, aerated and 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 motors/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.

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

CROP PROTECTION

WEED AND WEED CONTROL

A weed is a plant growing where it is not wanted i.e. a plant which is out of place and is in competition with the crop plant e.g. a bean plant growing in a stand of maize is considered as a weed because it was not planted there.

Economic importance of weeds in crop production/Effects of weeds.

The economic effects refer to both positive and negative aspects of weeds in agriculture production.

Positive effects of weeds.

- They provide organic matter and mineral nutrients to the plant when rotten.
- They care used as roofing materials in rural areas e.g. Spear grass and thatch grass.
- They provide a good surface cover which minimize on the rate of evaporation and control soil erosion.
- It is a source of food for wild game.
- Some are used for house hold purpose e.g. for sweeping as brooms.
- Some species of weeds are used as herbal medicine e.g. black jack which is used to dress fresh wound.
- Some are used as vegetables in different location e.g. pig weeds (Amaranthus ssp)
- They also help in nutrient recycling since they are deep rooted.

Negative effects of weeds.

- They compete with plants for nutrients, space, light and water.
- Some weeds are poisonous to man and livestock e.g. thorn apple and lantana camara
- They reduce palatability of pasture for the animals leading to poor quality production by the animals in terms of milk and meat.

- They contaminate farm produce reducing their quality e.g. black jack seeds in cotton lint, while cotton which taint milk in cows.
- They increase cost of production as farmers tries to control them on a farm.
- Weeds harbor pest i.e. some weeds act as hiding ground for pest which attacks crops.
- Weeds highly affect the formation and distribution of roots of crop plant under heavy infestation.
- They reduces crop yield by depriving crop plants of the essential nutrients.
- They also reduce the market value of the crop plants due to poor quality.
- They increase the frequency of secondary cultivation and weeding which also increases production cost to the farmer e.g. spear grass.
- Weeds also affect crop harvest under heavy infestation.
- They make cultivation difficult by sticking on the blade of farm implements.
- They are allelopathic i.e. they produce poisonous substance which affects germination and growth of crop plants. E.g. striga.

Factors/characteristics/adaptations of weeds which make them more successful than crop plant in the field.

- Weeds have extensive root system which enables them to draw nutrients from deeper soil layers than crop.
- They are tolerant to harsh condition eh drought.
- Weeds are adapted to grow in all types of soil and can survive easily on few nutrients e.g. spear grass.
- Some weed seed can germinate even if they are immature making them outcompete crops in numbers.
- Weeds are prolific i.e. they produce very many seeds which increase their chances of multiplication.
- They have aggressive growth habit i.e. they grow faster than crop plants e.g. black jack, pig weed.
- Weeds are less affected by pest and disease than crops.
- They have high reproductive capacity e.g. they have many perenating organs for

reproduction such as stolon for couch grass, rhizome for spear grass.

- They have spreading growth habit i.e. they form many branches which covers the crop plants.
- They are unpalatable to the animals making them to continue growing as crop plants are destroyed down by animals.
- They have various dispersal mechanisms which increase their chances of colonizing new places in the field.
- Some weeds are allolopathic i.e. they produce poisonous substance which makes it hard for the plant growing around them to grow. Weeds have long dormancy periods i.e. they can remain dormant in the soil for long without dyeing.
- Some weeds have protective structures which prevent them from being destroyed by animals e.g. thorn apple, double thorn.

Classification of weeds

The weeds are mainly classified into 2 ways i.e.

- According to the lifecycle.
- According to the morphology

According to the lifecycle

In this classification, weeds are classified according to the length of their life cycle i.e. the time they take to grow, mature and die.

Under this classification, the following groups of weeds exist;

Annual weeds; These weeds complete their life cycle within a year or less e.g. black jack, goat weed, pig weed etc.

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

Bi- Annual weeds; these complete their lifecycle in more than one year but not more than 2 years. In the first year, it may exhibit vegetative growth and flowers and produce seeds in the second year.

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.

Perennial weeds; they complete their lifecycle in more than two years. E.g. coach grass, tick berry, oxalis. Perennial are often very difficult to control because they posses perenating organs e.g. rhizomes, bulbs, corns etc. Perennial weeds reproduce from both seeds and vegetative parts.

According to morphology; Classification under this one is based on the structure of the weed plants. It can be classified as

Sedges; These are weeds which grows mostly in water logged areas where water stand most of the time, this group has a triangular stem e.g. Cyprus rotundas, nut grass etc.

Wood weeds; they have strong woody stems and they are mainly controlled mechanically by uprooting e.g. Sodom apple, Lantana camara etc.

Herbaceous weeds; These are the weeds with thick water filled succulent stems e.g. water hyacinth, wandering J ew, pig weeds,

Grass weeds e.g. Spear, star, couch grass. They have weak stem and long narrow leaves.

According to botanical nature

Group	Common name	Botanical name	Lifespan	Propagation mode
Grass	Wild finger millet	Eleusine indica	Annual	Seed
	Spear grass	Imperetta cylindri	Perennial	Rhizome
	Love grass	Siteria verticilatta	Annual	Seed
	Star grass	Cynodon dactylon	Perennial	Stolon
	Couch grass	Digitaria scalarum	Perennial	Rhizome
	Nut grass	Cyperus rotundus	Perennial	Seed
Herbaceous	Pig weed	Amaranthus ssp	Annual	Seed
	Wandring jew	Commelina bengh	Perennial	splits
	Black jack	Biden pilosa	Annual	Seed
	Oxalis	Oxalis latifolia	Perennial	Seed
	Goat weed	Ageratum conyzoi	Annual	Seed
	Thorn apple	Datura stramoniu	Annual	Seed
	Sodom apple	Solanum incanum	Biannual	Seed
	Milk weed	Euphorbia heteropylla	annual	seed
	Double thorn	Oxygonum sinuatum		
	Macdonald's eye/ Gallant soldier	Galinsoga paviflora		

Methods of controlling weeds

These are number of methods used to control weeds by farmers and these include:

- Cultural method.
- Mechanical or physical method.
- Biological method.
- Chemical method.
- Legislative method.
- Integrated weed control.

The use of any of the above methods keeps on varying from one place to another depending on ; the type of weed, the type of plant grown, the economic status of the farmer and environmental conditions.

Cultural methods: This aims to give the crop the best conditions which will favour its growth so that it can outcompete weeds. These include;

Crop rotation: this helps to destroy the lifecycle of weeds that tend to follow particular crops e.g. striga spp in cereals.

Proper spacing: Well spaced plants give a good ground cover quickly with their leaves; this enables the crop to smother the weeds at an early stage when the weeds are still weak and not yet established.

Timely planting: enables the crops to establish and grow early before the weeds reach their competitive stage.

Mulching: this helps to suppress weed growth, deprives weeds off sunlight making them to die

Flooding; This kill non water loving weeds especially making them to die of suffocation. This is used in crops like paddy rice plantation.

Hand pulling: weeds are uprooted together with their roots and are left to die and dry.

Trap cropping: this allows weeds to grow on a host plant which is then ploughed into the soil when the weeds are still green before producing seeds.

Controlled grazing: this reduces overgrazing and ensures that desirable pastures are

not out competed by weeds.

Cover cropping: crops with dense foliage are planted to shade the ground and smoother weeds.

Intercropping: This reduces space and light available for the weeds to grow.

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.

Mechanical/physical method

This method involves physical destruction of the growing weeds.

The main aim of this method is to encourage the germination of as many weed seeds as possible so that they are destroyed at tender/young stage.

It is very effective for controlling annual weeds but for the case of perennial weeds, they must be weeded periodically because they continue to grow new shoots from their perenating organs.

The methods used in mechanical weed control include the following;

Hand pulling/ up rooting of individual weeds to expose their roots so that they eventually die.

Hand hoeing using garden tools like hand hoe, forked hoe.

Mechanical cultivation/tillage. Using ox-drawn implements or tractor drawn implements e.g. ox-plough, disc plough etc.

Slashing/mowing: This is done using cutlasses/ slashes/mowers to destroy the weeds. It is more effective in controlling tall and soft weeds than creeping weeds.

Advantages of mechanical method

- It does not pollutes the environment
- Requires little skills
- Non toxic to crop plants

- It is cheap in the long run as tools are used for long
- The method is quick especially when machines are used

Disadvantages of mechanical method

- It destroys soil structure.
- It may cause soil erosion
- It is laborious
- Crops maybe damaged in the process of weeding
- It is slow especially when hand tool is used.

Biological control

This involves the use of enemies to control weeds. These natural enemies are commonly animals that feed on weeds. Other living organisms also can be used.

Examples

Use of rabbits to control the Macdonald's eye in banana plantations.

Control of water hyacinth using beetles

Control of Lantana camara by Lantana burgs and goats

Advantages of biological method

Does not pollute the environment

Does not affect the soil structure

It is cheap once the biological agent has been identified

Disadvantages of biological method

The biological agent of weed control may later become a pest especially when the weed is eaten up.

It requires a lot of research in establishing the biological agent hence making it tiresome.

It does not destroy the underground parts of weed.

It takes a long time for the weed to be eaten up from the garden thus becoming expensive.

Chemical method

This method involves the use of poisonous substance to control weeds. The chemical use to control weeds is called herbicide.

Classification of herbicide.

There are two ways of classifying herbicide

(a)Classification based on time of application

Pre-planting herbicide/soil sterilant herbicide: These are herbicide that are applied into a prepared seedbed before planting crops e.g. bromacil

Pre-emergence herbicide: These are herbicide that are applied after planting of seeds but before germination e.g. simazine, atrazine.

Post-emergence herbicide: these are herbicide applied after the crop has emerged or germinated. They ate largely used to suppress the growth of weeds without killing or affecting the growth of crop plants in the area.

(b) Classification based on the basis of action.

Contact non selective herbicide: These are herbicides which kills any crops with which they come in contact with e.g. paraquat (gramaxone), Glyphosphate, diquat

Translocated/systemic herbicide: these are herbicide which kill the entire plant even if they come in contact with only the leaves. They are absorbed through the leaves/stem and transported through plant system slowly thereby killing and damaging plant cells.eg 2,4-D,2,4,5-T,Touch down glyphosphate,Glufosinate.

Selective herbicide: These are herbicides that kill a particular plant only e.g. there are those that are meant to kill broad leaved weeds without affecting narrow leaved weeds e.g. simazine,2,4-D,MCPA,MCPP.

Factors that influence selectivity of herbicide

Selectivity is the ability of the herbicide to kill certain plants and leave others unaffected.

The degree of wetting; the leaves of the plant should be thoroughly wetted e.g. broad leaved weeds has large surface to be attracted with chemicals.

Structure of the plant; some plant have natural protection e.g. waxy cuticles and tough scale leaves which prevent penetration of herbicide.

Resistance of the weeds to herbicide: Some weeds have inbuilt physiological resistance and can detoxify the herbicide making it harmless.

Time of application e.g. post emergence herbicide when applied before emergence of the crop selectivity will not be achieved.

Advantages of using chemical method/herbicide

- It can be used in good time before competition set in e.g. pre emergence herbicide.
- It lowers the cost of production on the farm sine only one person is employed.
- The method is fast
- It does not destroy soil structure
- There is no root damage
- Where the crop morphology does not encourage mechanical weeding like in sugar cane, chemical method is used.
- Where the topography of the land does not favor mechanical weeding, chemical method is used.
- It is used to control perennial weeds which are difficult to control mechanically.
- It is used to control weds on a large scale.
- It is cheaper than using hand labor in the long run.

Disadvantages of chemical method of weed control.

- It is expensive sine it involve buying of chemical,
- The use of chemical requires specialized skills which most farmers lacks.
- It is difficult to get chemical for use.
- Chemical is poisonous to human being and farm animals.

- If not used carefully, chemical can destroy crops.
- It pollutes air, water and soil.
- It causes unemployment since less people are employed in the use of herbicide on the farm.
- Some herbicide has long residual effects in the soil and may cause to crops grown in the next[i] season.

Factors that influence the choice of herbicide.

- The prevalent weed species.
- The climate of the area I.e. rainfall condition, wind etc.
- The soil type i.e. some soil keeps herbicide for long while others does not.
- The type of crops in which weeds are to be controlled.
- The stage of wed growth.
- The stage of crop growth.
- The cost of the application.

Factors that influence effectiveness of herbicide

- Application of herbicide in wet weather/ rainy condition since the herbicide will; be washed away.
- Late application of herbicide, herbicide should be applied at the correct stage of weed growth. Older weeds tend to resist herbicide and they need high dosage.
- Poor formulation and mixing of herbicide which alters the concentration of chemicals, this make herbicide less effective.
- Use of chemical on the crop not intended for.
- Spraying in windy weather which make chemical to get drifted out of the intended place.

- Use of expired herbicide.

SAFETY PRECAUTIONS WHEN HANDLING HERBICIDE/CHEMICALS

- The user should the manufactures instruction before mixing and spraying the chemical.
- The user should not eat/smoke when spraying herbicide.
- Avoid inhaling (breathing in) the herbicide since it is poisonous to human being.
- The operator should wear protective clothes like gumboots, gloves, overall, mask, cap etc when using chemical
- Avoid spraying in windy condition to minimize drift of chemical to unintended places and always spray following wind direction.
- Dispose off empty container after use either by burying them under ground or by burning.
- Wash yourself thoroughly after spraying the chemical.
- The operators thoroughly wash the spraying equipment after spraying, not in or around the compound and water source.
- One should not spray when it is about to rain or immediately after the rain to avoid dilution of chemical.
- Do not keep the herbicide in unlabelled container to avoid being mistaken for water or other drinks.
- Seek medical attention incase you eel unwell after spraying the herbicide.
- Incase the herbicide enters your eye during spraying, flush it immediately using clean water and soap.
- Animal should not be allowed to pass through the sprayed area as they will cause drift of chemical.
- All chemicals should be kept in a safe place out of reach of children i.e. in a locked room.
- Do not unblock the blocked nozzles using your mouth incase it get blocked.

CROP PEST.

Pests are living organisms that destroys crop in terms of quality and quantity.

Economic importance of pests.

- They reduce the market value of crop plants in terms of quality.
- It increases cost of production on the farmers pest are being controlled.
- Crop pest result into low production which affect National income of the country.
- Pest damage may result into food shortage (famine) for both people and animals. This may lead to migration, death and buying of food.
- Use of chemicals to control pest interferes with the environment.
- Some pests are eaten as food.

Effects /damages of pests in agricultural production.

- Pest sucks plant juice and introduces pathogens like virus.
- Pest also lowers the quality of crop produce e.g. maize weevil on maize grain.
- Some pests like termite attack plant roots leading to total death of the whole plant.
- Storage pest reduces viability of seed e.g. bean bruchids by eating up the albumen.
- Some pests feed on the plant leaves reducing on the rate of photosynthesis e.g. army worms and locusts.
- Some pest weakens sacs in store resulting into spilling of stored produce e.g. rats
- Pest makes tunnels inside the stem which interferes with translocation within the plant.
- They eat up flowers which reduce on the rate of reproduction of crop plants.
- Pest also create wound on the crop plants which act as an entry point for pathogens.
- Pest also feed on the plant sap containing minerals leading to mineral deficiency.
- Pests also lower the quality of crop plants directly by defecating on stored

produce, laying eggs in produce etc.

- Pest also introduces toxic saliva into the plant tissues which interferes with growth e.g. nematodes feed on leave leading to gall formation.
- They cause honey dew around the wounded part of crop plant. This attracts flies that bring in pathogens to crop.
- They also deplete the leaves of crop plant (defoliation)
- Pest also introduce toxin into the crop plants making them inedible e.g. aflatoxin in ground nuts caused by fungus (Aspergillus species).
- Insect pest also suck plant juice from the growing point causing wilting of the plants hence death.
- Pest also increases costs of production on the farm as farmers tries to control them.

Classification of pest.

According to the plant parts they affect

Root pests e.g. termites, rodents, nematodes

Leaf eater e.g. Locusts, grasshoppers, caterpillars.

Stem borer e.g. Maize stalk borer and sugar cane stalk borer

According to where they attack crops

Field pests: Attack plants when they are still in the field/garden e.g. rats, birds, termites, monkeys, coffee leaf miners.

Storage pests: Attack the produce in stores e.g. Maize weevil, bean bruchid, red flour beetle.

According to the number of plant species they attack

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

Oliphagous pests: Feeds on few species of plants that are normally of the same family e.g. stalk bores that feed on cereal, boll worms which feed on vegetables.

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

According to stage of crop attacked.

Seedling pests e.g. cut worms which attacks all cereals at young stage.

Target pests: These attack crops at all stages of growth e.g. maize stalk borer and sugar cane stalk borer.

According levels of pest damage

Major pests which cause significant damage e.g. locusts

Minor pests which cause little damages which are not always recognized e.g. butterflies.

According to the mode of feeding (mouth part)

Biting and chewing pests: These are pests with strong mandibles for biting and chewing of plant parts. They mostly eat the leaves, roots and fruits.

Examples of biting and chewing pests are monkey, termites, rodents, larva stage of butter fly (caterpillars

Damages caused by biting and chewing pest.

- They cause physical injury to the stem, roots and leaves of crop plants.
- They expose plant cells which make pathogens to enter into the plant tissues.
- They eat leaves of plants reducing on the rate of photosynthesis.
- They cause rotting to stem and tubers after creating wound.
- They reduces crop yield.

Piercing and sucking pests: These are pests with sharp stylets/proboscis that they

use to pierce plant tissues and suck plant sap. Examples include the following;

Cotton stainer, aphids, butter flies, mealy bugs, cotton leaf hoppers, thrips etc

Damages caused by sucking and piercing pests.

- They are vector for disease causing organism e.g. virus.
- They introduce toxic saliva into the plant tissues which interfere with plant growth e.g. abnormal swelling (gall) in coffee leaves caused by antestia bug.

Reasons why insects are the major successful pests/Reasons why most pest are insects.

- They have high rate of reproduction to ensure survival.
- They have short lifecycles and so increase in numbers very fast.
- Presence of cuticles that prevents water loss and protect insects against chemical.
- They are small in size and therefore not easily detected by predators.
- They have defensive mechanisms e.g. stings, spines and they pungent chemicals against predators.
- Some insects can camouflage to hide from predators.
- They are adversely distributed environment giving them advantage to survive continuously.
- They are able to move very fast from predation hence escaping from attack.
- Some pests are oviparous i.e. produces their young ones alive e.g. Aphids.
- The agro system adopted by farmers increase their chances of survival.
- Minimum tillage promotes the build up of pests on the farm.
- They have the ability to transform into dormant stage when there is food shortage, extereme climatic condition etc.
- Insects are well adapted since they have stayed on earth for long.
- They little food requirements and they feeds on wide range of materials.
- They are small in size and can fit precisely in habitat hence escaping predation.

- They have an exo-skeleton protect the inner organs against mechanical damage.
- Insects secrete uric acid which requires little water for excretion hence preserving water in their body.

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 antesia 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.
- **Phytosanitary control:** this involves methods of control that ensure use of materials that do not carry pests.
- **Lethal dosage (LD_{50}):** the concentration of the pesticide that kills 50% of the pest population e.g. **LD_{50}** is the concentration that kills **50%** of the referred organisms.

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

- **Crop improvement** that has made crops of better quality which favors multiplication of pests.
- **Change in farming systems**: the introduction of large supply of food to pests hence favoring 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 use 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 popuraium 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. antensia 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 pest control.

Cultural method

Mechanical method

Biological method

Chemical method

Legislative control

Integrated pest management

1. CULTURAL METHOD.

Thus is the elimination of pest damage by employing agricultural practices normally used in the growing of crops such that it make environment unsuitable for continuous survival of pests. They include;

Timely planting: This enable the crops to grow vigorously and reach harvesting stage early before pest population build up top a point that cause damage.

Crop rotation: Alternation of crops in a planned sequence helps in breaking the lifecycle of pest and starving them to death when the host crop is eliminated.

Tillage: Tillage improve on soil conditions which enable proper growth of crop plants against pest attack as well as exposing the lifecycle of pest to harsh environmental conditions.

Use of recommended spacing: This create a micro climate that is discouraging for the survival of pest e.g. close spacing control antestia bug and Aphids in coffee and ground nuts respectively.

Proper spacing also allows plant to have enough growth factors for hence proper growth that resist pest attack.

Field hygiene: e.g. Rogueing which is the removal and destruction of affected plant by burning or burying them, burning of crop residues to kill pest hiding in them

Flooding: This is a common practice of controlling pest in rice field, it kill the pest suffocation.

Use of resistant varieties that can withstand attack by pest e.g. hairy structure in cotton and the inbuilt physiological resistance in some crops.

Use of trap crops: A trap crop is used to attract the pest from reaching the main garden where the desired crop is growing. Palatable crop is planted around the main garden to trap the pest and it's later destroyed before the pest completes its lifecycle.

Close/dead season: This is a period during which a susceptible crop to certain pest is not planted. It controls the pest by denying them food hence starving to death.

Destruction of alternate: Some weeds act as alternate hosts of some pest and therefore proper weeding is effective in the control of pest since they provide alternative hiding places for pest which affect crop plants.

Use of clean planting materials free from pest to avoid introduction of pest in the field e.g. banana weevils, sweet potato weevils etc.

Proper pruning: This removes infected part of plant to avoid secondary infection; it also destroys hiding ground for pest hence discouraging their survival.

Timely harvesting to avoid contamination of crops by the pest while still in the field

Advantages of cultural pest control.

- The method is cheap
- It has no side effects on the environment
- It can be integrated with other method at the same time
- It's effective in controlling pest before the population build up.

Disadvantage of cultural pest control.

- It only reduces pest population but does not kill all.
- There is need to use the method repeatedly which discourage farmers

2. MECHANICAL METHOD.

This involve the use of specific physical/mechanical measures to control pest damage, it include the following;

- Hand picking and destruction of pest
- Use of sound to scare away pests.
- Use of traps to kill pests.

- Use of male sterilization technique

3. BIOLOGICAL METHOD.

This involves the use of natural enemies of pest to reduce pest damge.The enemies can be predators, parasite etc e.g. Use of cats to control rats, Use of ladybirds to control Aphids, wasps to control caterpillars etc

Advantages of biological pest control.

- It does not affect the environment
- No pest resistant to the pest control methods.

Disadvantage of biological pest control.

- The method is slow
- It is difficult to completely eradicate pests.
- A lot of research is required to identify biological agent for a particular pest.
- The biological agent may turn to be a pest to the crop if not studied properly.

Characteristics of a good biological agent

- It must be host specific
- It must have a high searching ability
- It must be able to multiply faster to check on pest population.
- It must be adapted to the environment
- It should attack the pest at the most damaging stage
- The biological agent should be selective in nature.

4. 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.

Classification of pesticide

According to mode of action

Stomach poisons: This target the digestive system and it enters after being eaten by the pest e.g. Dieldrin and lindane.

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

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

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 ace[ted 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 (LD50): This is the concentration of pesticide that kills 50% 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.

Concentration of pesticide: Pesticide should be of right concentration to give the right strength in killing the target pest.

Time of application: It should be applied at the time of developmental stage when the pest is more vulnerable.

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.

Persistence: The pesticide should be persistence enough in order to be effective and to achieve desired effects.

Advantages of chemical pest control.

- It is very effective in controlling pests.
- The concentration of chemical can be controlled to control pest population.
- Some chemicals are broad spectrum and therefore kills variety of pests hence becoming cheap,
- Individual action can easily be taken by farmers to control pests.
- It can be use in time when pests are most destructive.

Disadvantages of chemical pest control.

- The chemicals may kill predators and other useful organisms.
- The chemicals are poisonous to human being and animal.
- Most chemicals pollute the environment.
- The chemical may enter the food chain hence affecting many organisms.
- Some pest may develop resistance t chemicals if used repeatedly.
- The chemicals are relatively expensive to the local farmers.

Characteristics of good pesticide.

- It must be toxic to the pest.

- It must not be toxic to bio9logicak agents.
- It should be harmless to human and other mammals.
- It must be persistence
- It should be easy to apply.
- It should be affordable to farmers.

5. LEGISLATIVE CONTROL METHOD (QUARANTINE)

This is a lawful regulation of areas to prevent pest damage. Quarantine is done to;

Reduce population of already establishes pests

Prevent introduction of spread of pests in areas where they have not reached.

6. INTEGRATEED PEST MANAGEMENT (IPM)

This is the use of many pest control methods to bring down the population of pest to a level which is not harmful.

Advantages of IPM.

- It provides permanent solution to pest problem since one method reinforce the other.
- It is environmentally friendly sine the use of chemical is put last.

Disadvantages of IPM.

- Farmers are not well equipped with the knowledge of carrying out IPM.
- The method rarely kills all pests but only reduces their numbers.
- It takes a lot of time.

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