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DEPARTMENT OF AGRICULTURE AND ENVIRONMENTAL
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CROP PRODUCTION (NOTES)

Agriculture means cultivation of the land for the purpose of producing crops and management of livestock.
-It also involves the storage, processing and marketing of agricultural products.
- There are some disciplines that are directly or indirectly allied (related) to agriculture.

- Entomology (insects pests)
- Pathology (diseases)
- Agricultural engineering
- Agriculture economics
- Soil science etc

ROLES OF AGRICULTURE

a) **Provision of food –** A well fed nation is a healthy one. Agriculture therefore provides virtually all the food required to feed the population except in prolonged drought.
b) **Provision of employment**. Agriculture provides employment directly e.g. workers in ranches, coffee, tea, sisal estates, and on small farms.
In Kenya Agriculture and Agriculture related sectors employ large number of people e.g. food processing industries e.g. Kenya canners, textile manufacturing industries, mean canning, grains, milk et.c.
We also have field extension workers, scientist, Transporters, traders e.t.c.
c) **Foreign exchange earning.** The greatest percentage of exports from East Africa consists of Agricultural commodities. The foreign exchange earnings is important for the purchasing of other goods e.g. machines like tractors, fertilizers, oil from foreign countries.
d) **Revenue generation for the country** Agriculture earns the government much of its revenue from taxes imposed on the sale and exports of Agricultural products.
- This revenue can be used by the government to provide such services as medical services, schools, roads etc. for the public
e) **Provide raw materials for industries** Most Agriculture products needs some processing before they are eventually utilized e.g. cotton, sisal coffee, tea hides etc

PROBLEMS FACING AGRICULTURE

1. **Poor crop animal husbandry** – Due to low level of education the conservative farmers do not practice the recommended husbandly practices. They thus plant late, fail to control pests, plant poor seeds and as a result yields obtained are very low compared to the yield obtained in developed countries.

2. **Poor marketing facilities**- Some times the transport system is inefficient or unavailable thereby leading to spoilage of produce due to delay in delivery to the market. Some times the middlemen involved in marketing of the farmers produce take too large profit. As a result the farmer receives too low prices for his produce hence he has no incentive to produce more.
3. **Lack of capital** Every farmer requires capital to invest in the development of his farming e.g. installment of piped water in the farm, buying fencing materials, fertilizers etc.

Mostly farmers obtain capital or loans. Source of these loans include Commercial bank or AFC which is a government credit agent.
Security is required for one to get a loan and mast farmers don't have security hence the level of investment in their farms is low.

4. **Psychological and sociological factors:** poor Attitude towards Agriculture as an occupation has seen many people migrate in urban areas in search of white color jobs leaving behind the old and the less educated to attend to the land.
5. **Poor tools** – In most rural areas the farmers still use the traditional hand tools e.g. fork, pangas etc which are rather inefficient consequently critical operation such as seedbed operation and planting are often completed late and the quality of the same is poor. This leads to low yields and poor income to the farmer.
6. **Pest and disease:** The tropical climate in Central Africa encourages a wide range of pests and disease.

- The pests and diseases multiply much more rapidly here than in the cooler temperature countries hence farming is a constant battle between the farmer and the pest and diseases.

7. **Fluctuations of commodity prices:** Due to the change in supply and demand prices of most Agricultural products keep on changing from time to time with the unsettling effects on farming.
8. **Aridity: -** Large trucks of land receive very little rainfall per annum and are therefore either marginal for economical farming or are semi-deserts.
9. **Land tenure:** This is the state of ownership of land and conditions governing that ownership. The land tenure problem facing East Africa is that most of the land is owned either by a community or by a clan and therefore an individual has no real incentive to look after such land.
10. **Poor storage: -** This is a common problem amongst small scale farmers. Much spoilage is experienced via pest damage which results to considerable waste.

SOLUTION TO IMPROVE AGRICULTURE

1. **Adoption of irrigated agriculture:** Rather than depending on rain this will help overcome the problem of aridity hence boast agriculture even in marginal areas.
2. **Diseases and pest control measures:** If pests and diseases are keenly controlled the yields lost through attack by pest and diseases can be recovered and overall output increased.
3. **Implementation of new technology:** Moving from the old ways of farming practices to modern technology can highly boast the yields e.g. green house farming.
4. **Crop rotation: This** is an important crop husbandry practice since it can minimize build up of disease and pest of a given farm. Nutrients are also optimally utilized without extremely depleting the soil of particular nutrients.
5. **Investment in Agricultural Research: -** Research can be done to come up with crop varieties that are resistant to particular pests and diseases.
6. **Farmers trainings/Agriculture education and extension to farmers:** – farmers can be trained on matters of importance
7. **Good land policies/land tenure system:** – Systems that can motivate or encourage land construction measures as well as soil and water conservation are important e.g. individual owner operation system.

8. **Establishment of marketing agencies: –** Which are to research for good market and commodity prices.
9. **Timeliness of activities: -** Avoid late planting, late weeding and late harvesting as these can adversely affect crop output.

FARMING SYSTEM: - Refers to the decision and function that farmers make to utilize land in raising crops and livestock to produce food and other necessities not only for themselves but for the country as a whole.

DECISION FARMER MUST MAKE IN ADOPTING A FARMING SYSTEM

1. What to produce among the many alternatives available e.g. grow crops, keep livestock or grow both crops and keep livestock.
2. What method to be used e.g. settled, shifting/nomadic mechanized, intensive or extensive. A pastoralist may be settled or nomadic while the Arable farming may be mechanized or use traditional tools.
3. What will be the scale of operation e.g. may be small or largescale?

A. Shifting Cultivation

– This is a method of raising crops by pioneer farmers in large scarcely populated area. Here the farmer can occupy any piece of land without causing any undue land shortage to his neighbours

- The farmers rarely need to manure his farm because land which has been formerly under forest is usually fertile.
- When there is a sign of soil exhaustion indicated by a drop in yields the farmers shifts to another area to develop a new farm.
- The previous land is left fallow for some time and returns to bush that may be cleared several years later.
- As the population increases the farmers finds no option of new land to cultivate.
- In such case the farmer claims all the plots he uses though not simultaneously.
- The land which is resting is said to be fallow and remains so only for a few seasons.

Advantages of shifting cultivation

a) The farmer does not incur cost of maintaining land fertility.
b) Cropping is always done on a fertile ground.
c) Land deterioration is rare.

Disadvantages of shifting cultivation

a) The farmer has no permanent settlement
b) Production is normally on a very small scale.
c) Only practicable where the population is very low

B. PASTROLISM AND NOMADISM

Pastoralism- Involves raring of livestock by the pastoral community without growing of crops.
Nomadism Is the leading of unsettled way of life.
Nomadic pastrolism is therefore a term used to describe livestock keeping communities who move from place to place looking for pastures and water for their cattle, sheep, goats etc.

- These people occupy the drier parts of the country and depend mainly on the products of their livestock for food, clothing and shelter.

- Nomadic pastoralists are subsistence farmers in that although they may have large herds the level of production is very low. This is due to poor pastures, drought, poor breeding poor parasite control, and land deterioration due to over stocking.
- Where water sources, schools hospitals, administration centers and other necessities have been installed this farmers may form co-operative ranches and become settled farmers.
- This has been encouraged by the government in recent years. In this way the advisory services can reach the farmer more easily and livestock improvement is possible.

C. ARABLE FARMING AND PLANTATION

(a) **Arable farming: -** is the growing of crops where farmers may practice **Monocropping (monoculture)** in which they specialized in production of only one crop or **mixedcropping** where more than one crop is produced.

- Mixedcropping involves diversifying production and is preferred by some formers to specialization as a way of reducing risks where some crops may be more susceptible to severe ecological factors than others.

(b) **Plantation -** involve large scale farmers growing cash crops e.g. tea, coffee etc.
The plantation may have processing factories for the crop on the same farm e.g. tea estates or low fibre processing.

D. MIXED FARMING

-Involves growing crops and keeping livestock on the same farm. This farming system is common in high potential areas.

NB: If a farmer grows fodder e.g. Napier grass, Lucerne or maize for livestock feed he is a livestock farmer and not a mixed farmer.

Advantages

a) Mutual benefit between crops and animals i.e. crops supply feed to animals while animals supply manure to crops.
b) Insurance against total lose by the farmer since if one enterprise fails the farmer will benefit from the other.
c) Proper utilization of labour throughout the year.
d) Better soil conservation
e) Permits all-round the year harvesting

Disadvantages

(a) High initial capital investment
(b) Lack of specialization
(c) Requires high level of management skill for both enterprises
(d) Cannot be practicable where land is limited
(e) Only practiced in areas with high production potential.

E. LIVESTOCK FARMING

Livestock farming in East Africa is carried out in either of two system; subsistence system and commercial farming.

Subsistence system

-Under this method livestock keeping is a way of live and animals are kept to meet the basic needs of food and shelter.

-Management practices re aimed at the survival of the animals.

Commercial farming

-The aim of this farming system is to produce animal products in sufficient quantities for sale locally and overseas market.
-Under commercial farming animals are kept in small or large well managed farm. In these farms there is considerable capital investment.
-As a result, yields are considerably high.
-The products are marketed through organization such as K.C.C., K.M.C. and the Upland Bacon Factory.
-There is also ranching and dairy farming.
-Ranching involves improved pastoral-nomadic system because movement is restricted.

F. ORGANIC FARMING

-This involves farming without use of Agro Chemicals i.e. crops grown in a natural environment.
-This method of farming is environment friendly and products do not have any inorganic residue.
-Naturally occurring materials e.g. medicinal plants are used instead of chemicals.
-Organic manure is used to replenish soil nutrients.
-Soil structure is improved and soil water infiltration as well as aeration is enhanced.
-These farming also provide food for soil microbes which help is releasing minerals for crop nutrition.
-Mulching can also be done using organic material.
-Crop rotation is also used to enhance organic farming.

Advantages

a) It is cheap and cost effective
b) Makes use of locally available materials
c) Helps soil structure.
d) No environmental pollution
e) Enhances H_20 retention by the soil

Disadvantages

a) Low overall output.
b) Control of pests and disease is not easy. Since there is no use of Agrochemical.
c) It is laborious

G. EXTENSIVE FARMING SYSTEM

-Is a system that requires large tracts of land, low capital investment and low labour per unit area
-It is characterized by low yield per unit area.

H. INTENSIVE SYSTEM

-It is a system that requires high capital and high labour investment per unit area
-It is characterized by high yield per unit area
-It is both extensive and intensive and can be large scale or small scale.

i. Large Scale

- Involves use of large tracts of land
-Requires heavy capital investment
-Skilled labour

-High level management
-Mostly carried out for commercial purposes
-Operation costs per unit of production are low because it makes use economy of scale.

ii. Small Scale

- Practiced in a small piece of land
-Productivity depends on land potentiality
-Production can be on subsistence or commercial scale
-Surplus can be sold for cash benefit
-No heavy capital investment

I. CROP ROTATION

-This is the growing of different crops on the same field in an ordered sequence.
-In this practice the field is demarcated into a number of units, the main objective being to make maximum use of the soil by growing a variety of crops with different growth habits and nutrient requirement.

Guidelines to crop rotation

1. Crops with high nutrients requirement should come first in a newly cultivated land.
2. Deep rooted crops should alternate with shallow rooted crops.
3. A grass break should be incorporated in the rotation in order to rebuild soil structure.
4. Crops which are easy to weed should alternate with crops which are not so easy to weed.
5. Crops having similar pests and diseases should not succeed one another during rotation.

Advantages

-There is maximum use of soil resources by growing plant with different growth habits.
-There is efficient control of pests by breaking the life cycle of the pests.
-Efficient disease control i.e. life cycle of disease organism is interrupted.
-Parasitic weeds such as striga species which are specific to cereals can be controlled by planting non cereal crops for a period of time.
-Nitrogen content of the soil may be enhanced by including a legume in the rotation

PRINCIPLES OF CROP PRODUCTION

ECOLOGY- This is the study of how both plants and animals live and interact with each other and the environment. This interaction benefits each entity in the relationship. Plant ecology involves the interaction of plants/ crops with the environment. Environmental factors such as water, nutrients, warmth, and light determine the growth and yielding of the plant.

FACTORS INFLUENCING CROP PRODUCTION / AGRICULTURE

A. SOCIO–ECONOMIC FACTOR/HUMAN FACTORS:

1. **Market force –** Supply and demand forces affect Agriculture in a free market economy. prices for good are influenced by supply and demand forces.

- When supply is high, prices are low and demand subsequently increases.

2. Cultural practices, taboos, religious beliefs

This affects what people produce and consume, some pastoral communities rely on meat and milk while other communities rely on crop.

3. Transport and communication

- These allow agricultural products to move from production point to consumption point.
- All weather roads are necessary to avoid rotting of produce in farms since these affects their income.
- Road, railways and airways are important.
- Use of computers for communication has developed and these media helps access wider market.

4. Level of education and technology

- High level of education helps in hastening development in all farming activities e.g. use of improved methods, knowing why when or what should be done under certain conditions, accuracy of applying inputs and Assessing results. Generally decisions are made properly.

5. Health HIV/AIDs

- Some qualities such as Vigor, Strength, vision and determination are required for successful farming and can only be found in healthy people.
- increases in cases of HIV/AIDS have negative effects on Agriculture production
- As a result much government and NGO resources are channeled towards caring for the sick.

<u>Effect of HIV/AIDS in healthy Agriculture</u>

- Shortage of farm labour
- Increasing the cost of living of patients and their relatives.
- Low food production and poverty in general has increased criminal activities
- Low living standards lead to despondency, helplessness and lack of motivation to invest in agriculture
- The government and NGO's use a lot of time and resource in controlling the pandemic. This resource could be used in development of Agriculture.

6. Government policy

These are enactment of laws which govern production marketing and distribution.

The government regulates the amount of imported good by

(i) Heavy taxation of imports in order to protect local industries
(ii) Subsidizing the price of locally produced commodities
(iii) Quality control
(iv) Conservation of natural resources
(v) Stepping up the control of diseases of parasites that affect crop. Such regulations as quarantine, licensing of quality products and vaccination of animal against infectious and contagious diseases are followed wisely.

7. Economy

- Collapse of co-operative movement and factories have affected the sale of farm produce such as milk, sugar and cotton
- Rehabilitation of Kenyan and world trade has led to dumping of cheaply produced and cheaply imported goods that have flooded local market.
- This has forced prices of agricultural goods to drop resulting in low income for farmers.

B. <u>BIOTIC FACTORS</u>

- These are living organisms that affect Agricultural production

(i) **Pests** – Effects of pests. Pests feed on the whole or part of the plant.

These pests feed on leaves and reduce photosynthetic surface which further lowers quantity and quality of produce.

They transmit crop disease

Some pest injure the plant parts which they feed on and expose the plant to secondary infection

Pests increase the cost of producing crops in terms of money used in their control.

(ii) Parasites

- Parasites leaving on plants are plant parasites. Those living inside animals are endo-parasites e.g. round worms, tape warms etc. they absorb food substances from the digestive track of the animal
- Those leaving on the animal are called ecto-parasites. They suck blood from the animal cause irritation by biting on their skin.

(iii) Decomposers

- Are very important and they include large and small (micro) organisms which decompose organic remains from animals and plants hence producing nutrients.

(iv) Pathogens

Are microorganisms that transmit diseases. These can cause death. They also reduce both quality and quantity of agricultural products. They include Bacteria, viruses and fungi.

(v) **Predators** An animal that kills and feed on the animals. Those that feed on pest are beneficial to farmers as they reduce pest population.

(vi) **Pollinators –** Can be insects or birds. They transfer pollen grain from the stamen to the pistil of the flower causing cross pollination e.g. bee.

- Cross pollination helps in production of new and improved varieties of crops for the future generation.

(vii) Nitrogen fixing bacteria

- Useful in leguminous plants. They are found in nodules of the roots. They covert nitrogen from the air into nitrates. When these bacteria die, they release nitrates to the soil which helps other plants in the next season

(viii) Weeds

They compete with the crop plants for moisture, nutrients space, sunlight etc. They can also act as alternate host of disease-causing microorganism, vectors and also pests.

C. CLIMATIC FACTORS

Weather is the atmospheric condition of a place over a given short period of time
Climate is weather condition observed and recorded for a long period e.g. 30 – 40 years.
Rainfall:

- Is the main source of water required by all life processes?
- It must be adequate to sustain both animal and plant life.

Aspects of rainfall important in Agriculture

1. Rainfall reliability

- Depending on meteorological timing of the onset of rainfall. I.e. long rains begin around March- April of every year and continue for around 3 months.
- Short rains begin in October to November.
- Reliability determines the time for land preparation and planting.
- When rains fail to follow this expected patterns massive crop failure occur and sometimes domestic animals die due to lack of food and water.

ii. Rainfall quantity

- This is the amount of rain that falls in a given area within a given year measured in mm
- It determines the type of crop to be grown and the type of livestock to be reared in an area.

iii Rainfall **distribution**

- Is the number of wet months in a year.
- It influences the choice of crop varieties growing in a given area.

iv. Rainfall intensity

- this is the amount of rain that falls in an area with a period of one hour and is measured in mm/hour
- High rainfall intensity damage crops and causes soil erosion. It may also lead to destruction of soil structures.

2. Temperature

- This is the degree of hotness or coldness of a place measured in (C^0)

i. Cardinal temperature

-Is the temperature in which plants grow and thrive well.

ii. Optimum Temperature

Is temperature which has a narrow range within the cardinal range which allows the plant to thrive best and produce well.

Effects of temperature on crop production

Low Temperature

- Slow growth rate of crop as the process of photosynthesis is slowed.
- Increases incidences of disease infection to crop e.g. C.B.D. in coffee.
- Quality of crops such as tea and pyrethrum improves with lowering of temperatures.

High temperatures

-Increases evaporation leading to wilting of crops
Increases the rate of growth and hastens the maturity of crop
Improves the quality of crops such as Pineapples and oranges
Increases incidences of plant pests and diseases e.g. Aphids, Leaf rust.

- **Wind**

Effects of Strong Wind on Agriculture

- Increases evaporation leading to wilting of crops.
- Causing lodging of crops and damage to plants.
- Acting as an agent of soil erosion
- Blowing away or bring rain bearing clouds.
- Increasing the rate of evapotranspiration.
- Destroying farm structures
- Areas with high humidity tend to be hotter but when wind takes away atmospheric water a cooling effect occurs.

4. Relative Humidity

- Is the amount of water vapor held by air at a given temperature compared to what it would held when saturated.
- It affects the rate of evaporation and transpiration.
- At high relative humidity the rate of evapotranspiration is low.

5. Light

- It provides the energy required for photosynthesis.

Aspects of light important to crop growth

1. Light intensity

-Is the strength with which the light is harnessed by chloroplasts for the purpose of photosynthesis.
-The amount of light harnessed can be increased by pruning, thinning, weeding or wider spacing.

2. Light duration

- is the period during which light is available to plants per day.
- Plant varieties can be classified as long, short, or day neutral depending on the hours of light required for proper growth.

Short day plants – Require less than 12 hours of day light e.g. tobacco, rice, soya beans e.t.c.

Long day plants – Require more than 12 hours of day light e.g wheat varieties.
Day neutral plants - Require 12 hours of day light e.g. coffee, maize beans e.t.c.

3. Light Wave length

- Chlorophyll absorbs certain wave lengths of light which are not present in artificial light unless in case of U.v. or infra- red rays.
- This makes natural light more suitable for plant growth than artificial light.

D. EDAPHIC FACTORS OR SOIL FACTORS

- Soil formation
- Soil profile
- Soil structure
- Soil texture
- Soil constituent

ECOLOGICAL ZONES

(1) TROPICAL ALPHINE

(c) Found at the pick of high mountains e.g. Mt Kenya my Elgon etc.
(d) Found at an altitude of 3000m above sea level.
(e) Temperatures are low or below 10^{o}c
(f) Has moorland vegetation i.e. short grass and no trees
(g) Have two sub-zones.

Tropical Alpine (I) TA_1 and TA_2

Tropical alpine (1) (TA_1)

-Natural pasture utilized by cattle is found.
-The area is alienated with game parks.
-Soil erosion in experienced e.g. Areas near Mount Kenya.

Tropical alpine (2) TA_2

-Annual rainfall is lower than in TA_1 and drier than TA_1.
- soil erosion is experienced
-Good for wood production
-Livestock pasture found here
-Good for crop production

(2) UPPER HIGH LAND ZONES (UH)

- Altitude falls at 2200 – 3000m above sea level.
-Temperature range is between 10 – 17^{0}C
-Frost is experience
-Subdivided into four major sub-zones

UH_1
Good for keeping sheep, goat and dairy farming. Pastures are available there is negligible dry season. e.g. upper parts of Nyandarua and Nyahururu.

UH_2

-Pyrethrum and wheat zone
-No enough rainfall e.g. upper parts of Timau
-Temperatures are not optimum.

UH_3

- Wheat, berry zone
-Low production of pyrethrum

UH_4

-Ranching zone
-Rain can't support dairy farming e.g. Laikipia

Lower Highland

-Relatively wide area compared to UH
-Altitude of 1500 – 1800m above sea level
-Has five (5) Sub-zones

(1) Lower highland one (LH1)

-Good pastures for livestock
-Suitable for mixed enterprises
-Cool and humid areas
-Dominated by tea production e.g. Kericho

Lower high land (LH2)

-Wheat, maize, pyrethrum zone
-Small scale maize production
-Climate is cool e.g. Bomet

Lower highland (LH3)

-Wheat zone – maize is not very suitable.
-Sometimes we have crop failure due to drought e.g. Mweiga/Timau

Lower highland (LH4)

-Cattle and berry zone
-Drought escaping plants are grown

Lower Highland (LH5)

-Low Rainfall
-Not suitable for crop production
-Low grazing intensity
-E.g. Samburu

Upper Mid-land (UM)

-1300 – 1900m Above sea level.
- Temp 13 – 21^0C
-Supports coffee livestock keeping
-Have 5 sub-zones.

Upper mid-land 1(UM1)

-Tea, Coffee zone
-Mixed farming can be practiced
-Thin and transitional e.g. Kiambu and Nyeri

Upper mid-land 2 (UM2)

-Coffee zone
-Dairy and zero grazing is practiced
-Food crops grown e.g. maize, cabbages and tomatoes

Upper mid-land 3(UM3)

- Marginal coffee zone
-Established pastures for livestock
-Coffee grown under irrigation. Drought escaping crop can be grown e.g. Makuyu, Mbeere and Tigania
-Irrigation is necessary for this region.

Upper mid-land 4(UM4)

-Sunflower zone
-Rainfall is insufficient thus drought resistant crops are grown.

Upper mid-land 5 (UM5)

-Millet is grown
-Livestock and sorghum zones

Lower –mid lands (LM)

-Altitude 800-1300m above sea level
-Average temp 24^0C e.g. Western Kenya
-Has six sub-zones.

Lower mid-land (LM 1)

-Sugar cane zone
-High and reliable rainfall. E.g. South Nyanza
-Maize can also do well

Lower mid-land (LM 2)

-Marginal sugar cane zone
-Maize and tomatoes do well e.g. Miwani in Mohoroni

Lower mid-land (LM 3)

-Cotton zone
-Maize planted depending on the type of soil.

Lower mid-land (LM 4)

-Marginal cotton zone
-Maize growing is also practiced.
-The place is warm and very transitional e.g. lake Victoria Mbita.

Lower mid-land (LM 5)

-Livestock/Millet zone
-Sorghum sisal pigeon peas and cow peas are also grown.
-Low stocking rates e.g Lusinga island in Lake Victoria.

Lower mid-land (LM 6)

-Ranching zone warm and semi-arid
-Unreliable rainfall
-Lower parts of Tigania

Lowlands (LL)

-Found in coastal areas
-Altitude 0 – 1800m above sea level.
-Has seven sub-zones.

Low land 1(LL 1)
-Does not exist in Kenya
Low land 2(LL 2)
-Sugar cane zone cassava, maize, coconuts and citrus fruits are grown.
Hot humid area e.g. Mombasa town and Kilifi
Low land 3(LL 3)
-Coconut and cassava zone e.g. Kilifi and Kaloleni
Low land 4(LL 4)
Cashew Nut, cassava zone. Cotton also grown but not well spread.
-Composite varieties of Maize "Katumani"
Low land 5 (LL 5)
-Livestock, millet zone

Cow peas, green grams and sisal e.g. Magarini Central scheme in Lamu

Low land 6(LL 6)
-Ranching zone, hot and semiarid, no crop exists. rainfall unpredictable.
Low land 7 (LL 7)
-Nomadism zone e.g. Eastern Kenya except Marsabit
-60% meat comes from the area
-Hot and arid areas

LAND PREPARATION

SEEDBED: A piece of land varying in size from a few square meters to hundreds of acres that has been prepared in such a way that is ready to receive the planting material where planting materials are planted and remain there until the crop is ready for harvesting
Nursery bed: Small plot or bed where planting materials of low viability that need special attention are planted and allowed to grow until ready for transplanting.

Reasons for seedbed preparation

1. To kill weeds either by burying them or desiccation by exposure to the sun.
2. Help in breaking hard soil surface thus allowing infiltration to rain H_20.
3. Helps in improving soil aeration.
4. Encourages penetration of roots into the soil
5. To incorporate or distribute manure and other organic matter into the soil.
6. To make subsequent operations possible e.g. planting, fertilize application etc.
7. Destroy different stages of crop pest such as egg, larvae, pupae and adult by either burying them in the soil or exposing them to sun's heat.

Stages of land preparation

A. Land clearing

-This involves removal of vegetative cover from the surface before land is tilled.
-It is necessary when opening a virgin land or land that has been left fallow for a long period of time or when one wants to remove stalks of previous crops.
-It may include tree felling, use of chemical, slashing or burning.
Burning is discouraged because a lot of organic matter is lost and soil micro-organisms as well as plant nutrients are killed.

B. Primary Cultivation

-This is the initial opening of the land after clearing the bush
-Its done:

- To remove weeds and incorporate organic matter.
- Expose pests and disease causing micro-organism to the sun
- Improve soil aeration.
- Allow easy planting

It includes hand digging where simple tools are used e.g. Jembes, hoes etc.

It may also include mechanical cultivation where mould board ploughs and ox-ploughs are used.

Cultivation should be done before the onset of rain in order to:-

1. Give weeds and other vegetative plants enough time to dry and decompose into Organic Manure.
2. Allow carbon dioxide and other gases to defuse out of the soil and be replaced by oxygen necessary for germination and microbial activities.
3. Allow enough time for subsequent operation before planting.

The choice for the primary cultivation implements depends on:-

a) Condition of land
b) Type of tilth required
c) Depth of cultivation
d) Size of seeds.

C. Secondary cultivation/harrowing

These are the **s**eed bed refinement practices that follow primary tillage before planting process.

Reasons for secondary tillage/ cultivation include:

i. Removing weeds that have germinate after primary cultivation
ii. Helps also in breaking soil clods to smaller pieces for easy planting.
iii. To level land to achieve uniform depth for planting
iv. Incorporating organic matter into the soil.

The number of harrowing depend on

a) Size of planting material
b) Slope of the land
c) Moisture content of the soil
d) Condition of land after primary cultivation.

D. Tertiary cultivation

These are operations carried out to suit production of a certain crop. They include:

i.Ridging- Process of digging soil in a continuous size and heaping it on one side to form a ridge and furrow suitable for root crops e.g. Irish potatoes.

Ridges are used for:-

a) Allowing for the expansion of tubers
b) Allowing easy harvest
c) Conservation of soil moisture

ii. Rolling - Carried out in small seeded, crops e.g. wheat to prevent seed from being carried away by wind and increases seed – soil contact.

iii.Leveling- Soil surface made flat and uniform to promote easy germination of small seeded crops and facilities uniform germination.

iv. Sub- soiling- Breaking sub-soil that might be as a result of use of heavy machinery.

-Helps in breaking up hard pans formed after land preparation.

-Helps in soil aeration

MINIMUM TILLAGE

- These is practice aimed at a reduction in the disturbance of the soil structure e.g. use of mulch on soil surface and application of herbicides to control weeds, timely cultivation, use of cover crops, uprooting and slashing of perennial weeds etc.

Reasons for carrying out minimum Tillage

1. Reduce cost of cultivation by reducing plough operations
2. To maintain soil structure
3. To maintain soil moisture
4. To prevent soil erosion
5. To prevent disturbance of crop roots and other underground structure like tubers.
6. Prevent exposure of Humus and important soil micro organism to sun's heat.

PLANTING MATERIALS

Planting is the placement of planting material in the soil for the purpose of regeneration to produce more of the plant species.

Types of planting materials

1. Seed
2. Vegetative propagation materials.

1. Seeds

Advantages of using seeds

1. Seeds are less bulky compared to vegetative material thus easy to store
2. Use of machines can easily be practiced e.g. seed drillers and planters
3. Seeds are easy to treat against soil borne pest and diseases.
4. Easy to handle during planting making operation easier
5. Possible to apply manure and fertilizers together during seed planting.
6. Possible to develop new varieties due to cross pollination.

Disadvantages

1. Some seed have long dormancy hence may need special treatment in order to germinate.
2. Some seed may lose viability if stored for long
3. Cross pollination may produce undesirable characteristics
4. Some soil borne pest may damage seed if left in the soil for some time before onset of the rain.

2. Vegetative Materials

These are plant parts which have ability to produce roots then grow to develop into new plants.
Advantages of vegetative material:

a) Fast crop maturity compared to seeds

b) Crops show uniformity in various characteristics like disease resistance. Seed colour and composition
c) It Possible to produce similar varieties from the same stock
d) Resulting plant has desirable characteristics like shape and size making field practices like spraying and harvesting easier.
e) Use of vegetative material is found easier and faster especially when seeds show prolonged seed dormancy.
f) They facilitate propagation of crops which are seedless.

Disadvantages

1. Does not result to new crop varieties
2. Keeping materials free from diseases is found to be difficult.
3. Materials cannot be stored for long.
4. The planting materials are bulky to store and transport.
5. It's not easy to mechanize the planting of vegetative materials.

Vegetative material include

1. Suckers – e.g. Bananas
2. Bulbs – e.g. Onion
3. Cuttings - cassava
4. Setts - Sugar cane
5. Vines - Sweet potatoes
6. Bulbils - sisal
7. Tubers - Irish Potatoes
8. Crowns - Pineapples
9. Splits - Grass/pyrethrum
10. Runners - Straw berry
11. Stolons - Star grass
12. Rhizomes - Couch grass
13. Slips - Pineapples

PLANTING METHODS

-Direct seeding – Seeds are planted directly into the main field (seed bed) without use of nursery bed establishment.
-Transplanting – Seeds are established in nursery bed first to grow into seedlings before being transferred into the main field.

Common methods of planting include

1. **Broadcasting**-Seed are scattered all over the field in a random manner by hand or spreaders. It is common in light and tiny seeded crops like grasses. The scattering or spreading is followed by harrowing to cover the seeds. For best outcome or result for broadcasting the seedbed should be weed free.

Advantages
-quicker than row planting

-Cheaper and easier compared to row planting
-Cops planed by broadcasting have a good soil cover preventing soil erosion
-No special skills required

Disadvantages

-Plant population cannot be established easily since spacing is not known
-More seeds are used
-Not easily mechanized
-Uneven germination of seeds due to uneven depth of planting
-Because seeds are scattered randomly there is overcrowding

2. **Row Planting** –It is the planting of crops using rows where spacing between rows and within rows is known. Seeds are placed in holes or drills and the distance between one hole to another is uniform. This is common in planting various field crops and root crops. This can be done manually or mechanically

Advantages

1. Easy to use machines in farm operation
2. Cultural practices like weeding, spraying and harvesting are easily carried out
3. Lower seed rate is used compared to broadcasting
4. Easy to establish correct plant population.
5. Proper utilization of nutrients, light and moisture because crops are in the correct spacing.

Disadvantage

a. More expensive, in term of labour and time
b. Requires skilled labor to measure distance

3.Ridge and furrow planting

-Seed are planted either on the ridges or furrows
-Suitable for root crops like Irish potatoes
-These helps in soil conservation.

4. Under-sowing

This is the establishment of pasture under a cover crop e.g. maize is planted as recommended and weeded two to three weeks after onset of rains. Pastures seed are then broadcasted with a half the recommended basal fertilizer
No further weeding is done, and maize is harvested early to expose the young pasture to sunlight. It facilitates more intensive land utilization and encourages early establishment of pasture.

5.Over-sowing

Introduction of a pasture legume like desmodium in an existing pasture.

DEPTH OF PLANTING

Depth of planting is determined by:

1.Seed type (size) – The larger the seed the greater the depth and therefore large seeds are planted deep since they can easily emerge from the soil and can accommodate large quantities of material. They therefore produce vigorous seedlings with enough stock.

2. Type of germination

Influence the ability of seedling to emerge from great depth e.g. Epigeal germinating seeds are able to push the cotyledon to the surface therefore have the ability to emerge from deep depth.

3. Moisture status of the soil

As wet soil dries out after rains or irrigation, upper surfaces are the first to dry while deeper layers maintain moisture for long. Under dry condition seeds need to be sown deeper in order to place them into contact with moist soil.

4. Soil Type

Other factors being constant, seed can emerge from great soil depth in sand soil than in clay soil therefore the planting depth can be adjusted according to the soil texture.

5. Time of sowing

Each crop has an optimum sowing time. The actual time of sowing is determined by moisture condition of the soil.

Excessive moisture and water logging conditions at sowing can lead to;

1. Swelling and bursting of seeds during germination
2. anaerobic condition in the soil.
3. Favouring of bacterial and fungal pathogen development

A farmer may be forced to saw a crop even when the moisture in the soil is less ideal.
This practice can lead to risk whereby the present moisture will initiate but not complete the process of germination.
Rooting of seeds will not occur unless there is rainfall within a few days of planting.
Sowing in the tropics is also determined by the temperature where certain crops will require certain minimum soil temperature before germination occurs.
Sowing in cold areas increases the likelihood of deterioration of seed germination.
A soil temperature of 18^0C is required for satisfactory germination of crops like maize. Delayed sowing may later lead to water deficiency during Anthesis period (flowering period and post flowering period).

1. BIRCH EFFECT

-During the rain most of nitrogen is leached below root zone. During the dry period a lot of nitrogen moves up with capillary water and concentrates on the root zone.
-Microorganisms tend to disappear during dry seasons.
-At the beginning of rains the seed spores absorb some water and microorganisms multiply by fusion.

-Soon the population of microorganisms increases. More organic matter is broken down at a high rate. --The yield in plant nutrients like nitrogen increases. This is referred to a Nitrogen flush bunch effect. For this reason, it's advisable to plant crops like maize before the onset of rains.

Seed Rate

-This is determined by **Germination Rate.** That is if the germination rate (%) is low, the number of seeds planted per hole is increased.
-Germination rate of 70% will only require 2 seeds per planting hole and seedlings are well established.
- Extra plants are removed to remain with desired number a process referred to as ***Thinning.***

Seed Rate depends on

- Seed quality
- Type/method of sowing
- Moisture content of the soil
- Soil fertility
- Growth habit of the plant/crop

Plant population

-It is the number of plants per unit area
-The decision on the appropriate number of plants in a given area is based on experimental evidence and the kind of crop e.g. for large sized crops like tree crops - one (1) crop per stand.
-Medium sized crops 2 plants per stand.
-The spaces between the stand will be determined by the roots and shoot system of the crop.

$$\textbf{PLANT POPULATION} = \frac{\textbf{Area (units}^{2)}}{\textbf{Spacing (units}^{2}\textbf{)}}$$

Example

(a) Calculate the number of beans seeds required to plant in one hectare where a spacing of 40cmx40cm is used.

Plant population = Since $\frac{\text{Area } (M^2)}{\text{Spacing } (M^2)}$

1 ha X $1000m^2$

1m=100cm Thus 40cm =0.4m

$$\text{Plant pop} = \frac{1000\ M^2}{0.4\text{mx}0.4\text{m}} = \frac{10{,}000\ M^2}{0.16\ M^2} = 62500$$

(b) Assuming a hundred (100) seed weigh 50 grams, establish the amount of beans seeds required per ha

$$\frac{62500}{} \quad \frac{625 \text{ X } 50\text{gm}}{} = \frac{31250\text{gm.}}{} = = 31.25\text{kg.}$$

100 100

1. Calculate the number of seeds required to plant maize in 100 M^2 of land at a spacing of 20 by 10cm

   Plant population = $\frac{100\ M^2}{}$ = $\frac{100\ M^2}{}$ 20 X 10 = 200cm^2

   $\frac{200}{10000\ M^2}$ 0.02

   = 500 seeds

2. Mugendi has 10ha of land on which he plans to plant bean. Calculate the number of seeds he requires if he uses a spacing of 50cm by 40cm.

   (h) Assuming 100 seeds weigh 50 grams establish the amount of seed required per 1 ha of beans.

3. Christine practices pomology. She has a 1 ha piece of land on which she wishes to grow citrus trees. Calculate the number of seeds required by her to plant on the 1 ha piece of land if she uses a spacing of 4m by 5m.

   Area = 10ha X 10,000 = 100,000 M^2.

   50 X 40 = $\frac{2000\ cm^2}{10,000}$ = 0.2 M^2.

   $\frac{100,000\ M^2.}{0.2\ M^2.}$

   500,000 seeds

   $\frac{500,00}{100}$ = 50,000 p.a ha

   $\frac{50,000}{100}$ = 500 X 50 = 25000 grams

   $\frac{25000}{1000}$

   25kgs

   1 ha X 10,000 = 10,000 M^2.

   4x5= 20 M^2. $\frac{10,000\ M^2.}{20\ M^2.}$

   = 500 seeds

Example 2

(a) Mugendi has 10ha of land on which to plant he plans to plant beans. Calculate the number of seeds he requires if he use a spacing of 50cmx40cm
(b) Assuming 100seeds weigh 50 gms establish then amount of seeds required per hectare of beans

Example3

Christine practices pomology and has a 1ha piece of land on which she wishes to grow Citrus tree trees. Culculate the number of seeds she requires if the spacing is 4mx5m

Ans

Plant population = Since $\frac{\text{Area } (M^2)}{\text{Spacing } (M^2)}$

$1 \text{ ha} \times 1000m^2$

$\text{Plant pop} = \frac{10000\ M^2}{4m \times 5m} = \frac{10{,}000\ M^2}{20\ M^2} = 500 \text{ seeds}$

PLANT PROPAGATION

Propagation Involves the formation and development of new individuals which are established as new plant.

IMPORTANCE OF PLANT PROPAGATION

1. Perpetuate plant as independent units
2. Through propagation and selection of cultivated plant with desirable characteristics as well as plants of great economic importance from naturally existing species with disease characteristics. Through propagation and selection plants with desired characteristics and great economic importance from natural existing species are developed.

Methods of propagation

1. Propagation by seed (sexual) propagation
2. Vegetative propagation (Asexual propagation)

1.Sexual propagation

(i) Seed formation is presented by the union of female (ovule) and male (pollen grains) gametes during the process of fertilization.
(j) The production by seeds is expected to show variability in regards to various characteristics like plant height, vigour and yields expected.

(k) Except for the highly homozygous plants which are self pollinated there characteristics remains similar.

Advantages of sexual propagation

1. Cheap compared to asexual
2. Easy to treat seeds against soil borne diseases
3. Easy to handle planting materials (seeds) during planting.
4. Easy to use machines like planters
5. Easy storage of planting materials (seed)
6. Fertilizer and manure application can be mechanized.

Disadvantages

1. Seeds can easily be damaged by soil born diseases. If left in the soil for a long time without germination.
2. Cross pollination may introduce undesirable characteristics.
3. Some seeds may lose viability if stored for long.
4. Some seeds have long dormancy thus need special treatment inorder to germinate.

2. Asexual propagation

- This includes all methods of propagation other than the seed propagation which do not depend on seed formation.
- This method depends on vegetative structures like stems, leaves, tubers, root, etc to perpetuate the parent plant. Vegetative parts develop buds which give rise to new individuals e.g. in sweet potatoes and Irish potatoes.

Advantages

1. It results in plants which are identical copy of the parent crop.
2. From one plant a few plants with desirable characteristics can be produced.
3. Crops mature faster than those propagated by seeds.
4. Easier and faster especially where seed shows prolonged dormancy.
5. Facilitates propagation of seeds less crops or those that produce unviable seeds or with long dormancy.

Disadvantages

- Does not result into formation of new crop varieties.
- Storage of materials is difficult.
- Materials are bulky for transport

WEEDS AND WEEDS CONTROL

- **A weed** is any plant growing where it is not wanted.

Any plant whose economic disadvantages outweigh its economic advantages.

Types of weeds (Weed classification)

These are based on:-

(a) Lifecycle

(i) **Annual weeds** – Complete their life cycle in one season/year.

(ii) **Biennial** - Compete their lifecycle in 2 seasons

(iii) **Perennial**: - Take more than 2 seasons to complete their lifecycle.

(b) Morphology

- Leaf formation e.g. size, shape venation
  - broad leaved weeds e.g. blackjack
  - Narrow leafed weed e.g. cough grass.

(c) Habitat

Some are terrestrial while others are aquatic

Weed identification

- Weeds are identified by their common/ individual local names and by their botanical /scientific names.

Some common weeds include:

COMMON NAME	**SCIENTIFIC NAME**
Blackjack	*Bidens pilosa*
Pig weed	*Amaranthus aspera*
Mexican marigold	*Tagetes minuta*
Oxalis/sorrel	*Oxalis* spp
Double thorn	*Oxygonum sinuatum*
Thorn apple	*Datura stramonium*
Couch grass	*Digitaria scalarum*
Wondering dew	*Cimmelina bangahlensis*
Nut grass	*Cyperus rotundus*
Saw thistle	*Sonchus oleraceus*
Devil horse whip	*Achyranthes aspera*
Macdonald eye/Gallet solder	*Galisoga parviflora*
Black night shade (managu)	*Solanum nigrum*
Chinese lantern	*Nicandra plysalode*
Blacken fern	*Pteridium aqullium*
Love grass/ Bristly foxtail	*Setallia verticillata*
Cleavers	*Gallium purium*
Stinging nettle	*Urtica massaica*
Fat hen goose feet	Chenopodium spp
Rape weed	*Brassica napus*
Wild oat	*Avena Fatua*
Lantana/Tick Berry	*Cantana camara*
Water hyacinth	*Eichonia crassipes*
Striga/witch weed	*Striga hermonthaea*

Creeping indigo	*Indigotera specata*
Lions ear	*Leonites nepetifolia*
Sodom apple	*Solanum incanum*
Manyatta Grass	*Eleusin jaegeri*
Star grass	*Cynodon dactylon*
Kikuyu grass	*Pennisetum clandestinum*
Flea bane	*conyza spp*

ECONOMIC IMPORTANCE OF WEED IN CROP PRODUCTION

1. Compete with crops for nutrients, space light and soil moisture.
2. Some weds are parasitic to cultivated crop e.g. Striga weed.
3. some weeds lower the quality of Agricultural produce
4. Some weeds are poisonous to human beings and livestock.
5. Some weeds are allelopathic (produce toxic substances)
6. Some weeds block irrigation channels.
7. Some weeds are alternative host for insect pests and nematode.
8. Weeds lower the quality of pasture.
9. Some weeds irritate workers thus lowering their efficiency
10. Weeds increase cost of production.
11. Some are Source of food for man and livestock
12. Some weeds have medicinal value.
13. When weeds decompose they add organic matter to the soil
14. They provide soil cover thus reducing chances of soil erosion

Factors contributing to the competitive ability of weeds

Weeds produce many seeds
Heir seeds remain viable for a long time
They have effective seed dispersal mechanisms
Most of them are efficient in utilization of little moisture, nutrients and sun light
Some are gross feeders and aggressive
Some propagate by means of underground food storage structures

METHODS OF WEED CONTROL

(a) Cultural method

It involves

(i) **Mulching**: - use of vegetable matter/or synthetic material to cover the soil surface.
(ii) **Cover cropping** - Establishment of correct plan density by adopting the recommended spacing to ensure covering of the ground.
(iii) **Crop rotation**- Some crops are difficult to weed and thus encourage weed multiplication

(iv) **Timely planting** – These gives crops an early and healthy start which enable them to outcompete the weeds.
(v) Use of clean seed/ planting materials.
(vi) Proper spacing.
(vii) Proper seedbed preparation
(viii) Flooding
(ix) Burning
(x) Controlled grazing.

(b) Biological method

- This involves use of living organism to control weeds e.g.
- Use of livestock to graze
- Use of weed eating fish to control aquatic weed.
- Use of moths to control weeds.

(c) Chemical method

- This is the use of chemical known as herbicides to control weeds.

Classification of herbicides

- Classification is based on:

(i) Formulations - The physical form of herbicides e.g. liquids, wettable powders (WP), emulsifiable concentrates (EC), dust.

(ii) Time of application
- **pre-emergence** - applied before the crop germinates.
- **post emergence** applied after the crop plant germinates

(iii) Selectivity It can either be selective or nonselective (e.g. round up)

(iv) Mode of action
- Contact: - kills only the parts it gets into contact.
- Translocated / systemic

Methods of herbicides Application

(i) Spraying
Application of solutions

(ii) Dusting
Application of dust

(iii) Fumigation
Application of fumigants.

Safety measure in use of chemical

1. Read manufacturer's instructions and follow them.
2. Wear protective clothing, breathing mask, gloves, boots
3. Avoid inhaling herbicides
4. Wash thoroughly after handling chemicals

5. Do not blow or suck blocked nozzles
6. Avoid chemical drift to livestock feed and water.
7. Avoid spilling chemicals to pastures and fodder crops.
8. Dispose off the empty containers properly (burry them in the soil).
9. Store chemical in safe place.
10. Wash spraying equipment thoroughly.
11. Sink left chemical into the soil after work.

Merits/Advantages of chemical weed control

1. It is less laborious
2. Effective in control of difficult weeds
3. Does not disturb crop roots and other underground structure
4. Make control of weed in certain crops easier.
5. Efficient in both dry and wet conditions.
6. Does not destroy soil structure.
7. Cheaper in large scale production.

Disadvantages (Demerits)

1. Requires skilled labour in mixing and application
2. It causes environmental pollution
3. Some chemicals have long residual effect that may interfere with future crops.
4. very expensive

D. Mechanical/physical weed control

It involves the following operations;

1.Tillage/ cultivation

This is the opening and loosening up of the soil. It can be done using hand tools or tractor drawn implements.

Advantages of tillage/cultivation

1. Cheap in small scale production.
2. Increases water and air infiltration into the soil.
3. It incorporates crops residue into the soil.
4. The earthing up done during tillage encourages root growth.

Disadvantages of tillage

1. Destroy soil structure when done repeatedly
2. Laborious and expensive in large scale production.
3. May not be effective controlling some weeds
4. It may lead to soil erosion and loss of soil moisture
5. Damage crop roots.

2.Slashing/ Mowing - Mechanical removal of shoots from weeds. Effective on annual weeds.

3. **Uprooting -** Done when the crops are too close to allow mechanical cultivation.

E. Integrated Methods of weed control

- These involves deployment of different methods of weeds prevention and control in right proportion and appropriate time against the target weed without damaging the environment in any way.

F. Legislative/Quarantine

- Involves law and regulations which prevents the introduction of foreign weeds in a country or area.

PEST AND PEST CONTROL

Crop pests: - This refers to living organisms that destroy crops/ trees either directly or indirectly by introducing pathogen (disease causing organism).

Economic importance of pests

1. Some transmit disease e.g. Aphid
2. Pests such as squirrels and rodents unearth planted seeds resulting in poor germination.
3. Some pests like termites, mice nematode and moles damage crop root causing wilting and death of the crop.
4. They lower the quality and quantity of crop produce.
5. They increase the cost of production.
6. Chemical used to control pest cause pollution to the environment.
7. They exterminate the crops by feeding on them e.g. eating the embryo.
8.

Classification of pests

Pests are Classified according to:

1. **The type of mouth parts**

(a) Pests with biting and chewing mouth parts They cause physical damage and reduce the photosynthetic area

(b) Pest with piercing and sucking mouth parts. They suck out the nutritious plant sap and the process may introduce disease causing organisms.

Example of pests with biting and chewing mouth parts

Cotton stainer	*Dysdercus superstitious*
Rhinocerus beetle	*Orycetes monoceros*
Black citrus Aphid	*Toxopera sordidus*
Mearly bugs	*Planococus citrs*
Bean Weevil	*Archanthoscelides dotecteus*

Maize stalk borer
Grasshopper

2. Crop Attacked

Some crops pests attack specific crops e.g. stem borers prefer cereal crops

3. Stage of growth of crop attacked

- Some pests attack young seedling e.g. cut worm
- Pest of fruit: - It attacks crop at fruiting age.
- Pest of grains: - Attack crops when grains are formed e.g. bird.

4. Some classification based in field and storage pest.

- Some pests attack crops in the field while some attacked after crops have been harvested and stored e.g. weevils

METHODS OF CONTROLING PESTS

a) Cultural
b) Biological
c) Chemical
d) Physical/mechanical
e) Integrated pest management (IPM)

1. Cultural Method

- Farming practices that aim at reducing the pest population by destroying the life cycle of the pest either by exposing them to adverse conditions or denying them food.

They include

a) Timely planting
b) Timely harvesting
c) Proper tillage
d) Closed season – period where susceptible crop is not grown in a given field in order to control a certain pest.
e) Trap cropping: - Trap crops are crops which attracts pest diverting them from the main crop. Trap crops are grown together with the main crops.
f) Crop rotation
g) Planting resistance varieties: - these are plants with natural protective mechanisms against pests.
h) Alteration of environmental condition
i) Field hygiene include rogueing and removal of crop residue which harbour pest from field,
j) Crop nutrition – application of fertilizers and manure to make the crop strong and able to escape pests attack.
k) Destruction of alternative host e.g. weeds like mallow which harbuors cotton stainers.
l) Use of clean planting materials: - this help to prevent introduction of crop pests.

m) Proper spacing: - if well spaced some pests find it difficult to move from one plant to another.
n) Use of organic manure.

2. Chemical Control of pests

- Chemicals used to control pests are known as pesticides
- pesticides are administered through dusting, spraying or fumigation
-

Factors that affect the efficiency of pesticides include:

1. concentration
2. Time of application - efficiency is high if the application is done when the pest is most susceptible.
3. Weather condition at the time of application
4. Resistance to the pest

Advantages of chemical methods

1. faster
2. immediate results are achieved
3. low labour required

Disadvantages

1. Expensive to buy
2. cause pollution
3. require skilled labour
4. some pesticides may kill beneficial organism and predators
5. Some target pest may build up resistance.

3. Mechanical Pest control

It involves killing of pest using physical method or creating physical barriers to prevent pests from getting into contact with the crops.

1. Flooding/irrigation e.g. moles are suffocated through flooding
2. Use extreme temperature either too cold or too hot.
3. suffocation commonly used in grain storage by being made air tight
4. Trapping and killing e.g. rat
5. Creation of physical barrier
6. proper drying
7. Scaring devices e.g. scare craws

4. Biological Methods

Predators	Target pests

Parasitic wasp	-White flies in citrus -bollworm and stalk borer
Birds	Crickets, locusts, caterpillar
Ladybird beetles	Aphids
Track and flies	Cotton stainers
Praying mantis	Giant looper
Cat	Moles, mice, rat
Brachonid wasp	Mearly bugs
Majimoto ant	Scales
chicken	Larvae, cotton Stainer, crickets

Advantages of biological method.

1. Cheap
2. No environmental pollution
3. Saves on labour

Disadvantage

1. Take too long to get the agent
2. difficult to control the pest effectively

5. Integrated Pest Management I.P.M.

- Involves the combination of all the methods mentioned above.
- The aim is to have least hazards to the user and to the environment.

6. Legislative /Quarantine

- This measure of pest control are effected by KEPHIs

CROP DISEASES AND THEIR CONTROL

Disease- A disease is any deviation from the normal performance or functioning of an organism

- A PLANT DISEASE: - it is any harmful physiological disorder in a plant caused by a pathogenic agent such as virus, bacterial and fungi.

Economic importance of crop diseases

1. lower crop yield
2. They reduce the quality of the produce
3. they reduce the market value of the crops
4. They increase the cost of production
5. They cause food poisoning e.g. Ergot in wheat
6. They reduce photosynthetic area of the plant.

Classification and identification of plant diseases

- Plant diseases are classified according to their causal agent.

a) Fungal
b) Bacterial
c) Viral

1. FUNGAL DISEASES

- Fungi are non-green plants.
- Some are parasitic others are saprophytic

Parasitic fungi are divided into

- Obligate
- Facultative

Obligate parasites are organism that depend on other living organism for food.
Facultative parasites are organism that are able to leave on both living and dead tissue.

Examples of fungal diseases

a) Late blight (*Phytophthora infestans*)

Attacked -members of solaneceae family e.g. potatoes and tomatoes.

Symptoms

- Dry patches on the leaves and fruit (necrotic lesions)

Control measure

- Crop rotation
- Use of effective fungicide.
- Use of treated seeds
- Use of resistance variety.

b) Rust

Crops attacked - Rice, wheat barley, oats, grasses, sorghum.

Symptoms of attack

- Red and brown pustules on the leaves
- Shriveled grains

Control measure

- Use of resistant varieties
- Use recommended fungicides

c) Smuts (ustilago spp)

Crops attacked - Maize, wheat, sorghum

Symptoms

Black powder mass on the spike/ears

Control measure

1) Use field hygiene to control
2) Use of certified seeds
3) Use of resistant varieties
4) Crop rotation

d) Blast (Pricularia oryzae)

Attacked Rice

Symptoms

- Stained bluish spots on leaves with grayish centre
- Attacks inflorescence to cause empty heads.

Control

Seed dressing
Use resistant varieties e.g. Sindano
Destruction of attacked plants
Use of fungicides.

e) Coffee berry disease (colletotrichum kahawae)

Crops attacked: coffee

Symptoms

- Dark blue blotches on flowers
- Brown concentric rings on the leaves
- Dark sunken wounds on the berries.

Control measures

- Use of resistance varieties such as Ruiru II
- Proper pruning
- Use of effective fungicides
- Stripping

Other fungal diseases are

- Panama disease – banana
- Cigar end rot – banana
- Die back – attacks the tips of shoots and roots
- Mildew – Both powdery and downey mildew attacks several crops
- Amillaria root rot – (Armillaria mellea) attacks coffee, tea
- -Damping off disease in seedling in nurseries
- Anthracnose – (colletotricum spp) in coffee, beans, tomatoes.

2. BACTERIAL DISEASES

- Bacteria are microscopic single cell organism which reproduce by binary fission **Transmission -** Transmitted through irrigation water, seeds, fertilizers, manure, weed, raindropsplashes, insects, and through mechanical means.

General symptoms

1. Wilting
2. cankers (necrotic tissues)
3. Gall formation in the infected tissue

Examples

1. Halo blight (*Pseudomonas phaseolicolae*)

Crops attacked include beans

Symptoms

1. irregular dark lesion on leaves and pods
2. Yellow bands around the lesion referred to as halo
3. Water soaked lesions

Control

1. Use of resistant varieties (e.g. wairimu and rose coco)
2. Use of effective bactericides
3. crop rotation

2. Fusarium wilt (*Fusarium oxysporum*)

Attacks tomatoes

Symptoms

1. Stunted growth
2. Yellowing and shading of leaves.
3. Wilting of the plant

Control

- Use of resistance varieties

3. Black arm (*Xanthomonas oxysporum*)

Crop attaked include cotton

Symptoms

- Small round spots on the cotyledons of young seedlings
- The spots elongate to form black lesion on the stem.

Control measures

1. Field hygiene
2. Use of certified seeds from Kenya Seed company Simlaw seeds etc

4 Bacterial wilt (*Pseudomonas solanacearum*)

Crops attacked include potatoes and tomatoes

Symptoms

Uniform wilting of the whole plant even with adequate supply of soil moisture

Control measures

- use certified seeds
- crop rotation

3. Viral diseases

- Viruses are small living organisms which can only be seen under a very powerful electronic microscopic
- Viruses interfere with photosynthesis, respiration, transpiration and nitrogen utilization.

Symptoms of viral infections

1. leaf chlorosis – yellowing of leaves
2. leaf curling
3. mosaic – light green and yellow patches
4. malformation/distortion of plant parts
5. Rosetting (shortening of internodes)

Transmission

1. Through the use of infected vegetative materials and insect vector like Aphids mealy bugs and leafhoppers.

Examples

1. Ratoon stunting disease

- crop attacked – sugar cane

Symptoms

- Red discolorations on the vascular bundles (Xylem and phloem)

Control measures

- use clean planting material
- Treat seed canes.

2. Maize streak

Crops attacked: - maize

Symptoms of attack

- Yellow strips alternating with green parallel to the mid-rib.

Control measure

- control leafhoppers
- use of certified seeds
- field sanitation

3. Greening disease.

Crop attacked citrus e.g. Orange

Symptoms

- Yellow mottling in the leaves.
- Die back.
- Premature leaf fall

Control

-Use of clean tools when budding.
-Control of insect vectors.

4. Leaf Mosaic

Crop attacked are sugar cane, cassava, sweet potatoes

Symptoms

- Yellow mottling
- Necrosis of stem

Control measure

1. Control of aphids
2. use clean materials
3. seed treatment

5. Tristeza

Crop attacked: citrus

Symptoms of attack

- Die back
- Dwarfing of the plants

Control measure

-Striping affected fruits
-Use of clean equipment for budding

Other causes of crop diseases

(a) **Flooding: - Leads to formation ammonia** which is poisonous to the crops causing a burning effect on leaves.
(b) Chemicals: - Some chemicals may be toxic e.g. **Aflatoxins**
(c) **Poor weather: -**Extremes' of day and night temperature.

(d) **Stress:** - such as irregular watering as in tomato blossom end lot.

Control of diseases

1. Cultural method of disease control

This involves: -

- Use of healthy planting materials
- Practicing field hygiene
- Proper seedbed preparation
- Proper spacing
- Heat treatment of planting material e.g. sugar cane
- Proper drying of cereals to 12- 13% moisture content
- Growing disease resistance varieties.
- Crop rotaion
- Pruning
- Proper spacing

2. Legislative Method

-Imposing quarantine -this involves the imposing of regulations and law especially in the case of disease outbreaks to prevent the introduction and spread of diseases.

3. Chemical Control of diseases

- It is used as a last resort
- Chemical control measures include:

1. Seed dressing before planting
2. Soil fumigation to control soil borne diseases
3. Spraying e.g. application of fungicides and bactericides.

4. Integrated method of Disease control

This involves combination of more than one control method.