**CROP PRODUCTION 1**

1. **INTRODUCTION TO AGRICULTURE IN KENYA**

* **Importance of agriculture in Kenya**

Agriculture is art and science of crop and livestock production.

* As a science, it involves experimentation and application of scientific knowledge in such areas as;
* Soil science,
* Control of pests and diseases,
* Entomology
* Agriculture engineering for example in farm machinery,
* Genetics as applied in crop and livestock breeding.
* As an art, it involves the use of learned skills in;
* Tilling the land,
* Construction,
* Measurement,
* Harvesting of crops,
* Feeding and handling of livestock
* Marketing.
* **Role of agriculture in the economy**
* Provide food to the nation
* Earn foreign exchange to the country through export of agricultural products
* Provide raw materials to industries e.g. milk
* Form market for industrial products e.g. fertilizers
* Source of capital to the farmer through sale of produce
* Provide direct and indirect employment.
* **Problems facing agriculture development in Kenya**
* **Climate**
* **Rainfall**
* Most part of the country receives very little rainfall per annum hence not suitable for agriculture. However, this area can be made more productive by embracing modern technology like irrigation which also calls for large capital investment that are lacking.
* Most areas have poor distribution and unreliable rainfall patterns. This calls for highest standard of crop and animal husbandry.
* **Social factors**
* Most people have a negative attitude towards agriculture as an occupation.
* **Technology**
* Low level of technology decreases inefficiency and increases production costs.
* **Infrastructure**
* Lack or inefficient transport system lead to spoilage of produce due to delay in delivering it to the market.
* **Capital**
* Every farmer needs capital to invest in agriculture. Lack of capital causes the level of investment in the farm to be low.
* **Marketing**
* Middlemen involved in marketing of produce take more profit at the expense of the farmer. The farmer therefore has no incentive to produce more
* **Price fluctuations**

Demand and supply of agricultural goods affect the prices.

* When demand is high the prices are high and vice
* Due to changes in supply and demand, prices of most agricultural products change from time to time. As a result the farmer ends up incurring losses and hence become discouraged from producing more goods.
* **Diseases and pests**
* Diseases and pests attack both plants and animals. Control of this is very expensive.
* If control is not done the farmer incurs heavy crop and animal loss.
* **Land use And tenure systems**
* Land tenure is the possession of right to the use of land. The land tenure problem facing farmers is that most land is owned collectively by a group of people. As a result individual farmer has no incentive to look after such land properly e.g. to prevent soil erosion.

Also farmer do not have title deed which can be used as a security to obtain bank loans for developing the land.

* Rainfall has determined the use to which land is put.
* **Future development of agriculture in Kenya**
* **Ways of solving the problems facing agriculture currently**
* Agriculture education being expanded and taught from primary to the university level. The graduates help the farmers to improve their farming techniques through teaching and carrying out practical demonstrations.
* Expanding research in agriculture and improving methods of communicating new findings to the farmers. Through research, improved crop varieties and breeds of livestock are produced and made available to the farmers e.g crops and animals that are high yielding, pest, disease and drought resistant. This will bring unutilized land into agriculture production.
* Use of government extension officers together with other staff working in private firms in selling agriculture-supporting services e.g fertilizers, herbicides and machinery.
* Improve efficiency in marketing of agricultural produce by use of marketing boards to handle the marketing of commodities. They include tea marketing board and cereals and produce board.

Improve transport system to ease collection and dispatch of various products to and from the markets.

* Formation of cooperative societies which may handle marketing and also supply members with other services like seeds and fertilizers on short term credit.
* Improving infrastructure.
* Government providing inputs at subsidised cost.
* **FARMING SYSTEMS**

**They include;**

* **Shifting cultivation-**

It involves farming on a piece of land continuously until it is exhausted after which a farmer moves to a more fertile ground.

* It practiced where;

Land is communally owned

Land is abundant

Population is sparse

Number of livestock per unit area is low.

* Advantages

Has low capital requirement

Soil structure is maintained

No land dispute as it is communally owned

There is no pest build up

* Disadvantages

A lot of time is wasted when a farmer is shifting.

Not applicable in areas with high population density

Farmer has no incentive to conserve and develop land.

* **Pastoralism-**

It is the practice of rearing livestock on natural pasture.

It is common in arid and semiarid areas, where land is abundant and communally owned.

* **Mixed farming-**

It involves growing of crops and rearing of livestock on the same farm.

Advantages

There is mutual benefit between the crops and livestock; crops provide feed to the livestock while livestock provide farmyard manure to crops.

When one enterprise fails the farmer can benefit from the other.

* **Arable farming**/ crop farming-

It is production of cops on cultivated land.

**It is subdivided into:**

* **Field crops Cultivation**: maize, beans, potatoes, coffee, tea, cotton to name but a few.
* **Horticulture:**

It involves the growing of perishable crops which have high value.

It is further subdivided into:

* **Floriculture -** the growing of flowers.
* **Olericulture** - the growing of vegetables.
* **Pomoculture** - the growing of fruits.

Arable farming could either be monocropping or intercropping.

Monocropping is of only one type of crop.

Intercropping is where different types of crops are grown on the same piece of land.

* **Livestock farming-**

It is keeping and rearing of domesticated animals that are of economic importance to human beings.

**It is further subdivided into:**

* **Pastoralism:** This is the rearing of mammalian livestock such as cattle, sheep, goats, rabbits, pigs and camels.
* **Fish Farming (Aquaculture):** This is the practice of rearing fish and other aquatic organisms in ponds.
* **Bee Keeping (Apiculture):** This involves the rearing of bees in structures known as beehives.
* **Poultry Keeping**: This is the keeping of domesticated birds.
* **Organic farming-**

It is growing of crops and rearing of animals without using agricultural chemicals. The method is environmentally friendly and the products do not have chemicals.

Naturally occurring materials are used instead of chemicals.

Organic manure is used instead of inorganic fertilizers.

It is also enhanced by mulching and crop rotation.

* **Ecological zones**
* Types of crops and livestock in each ecological zones

Agro-alpine; cattle, sheep

High potential; sheep, dairy, maize, barley,

Medium potential; tea, maize, pyrethrum, sheep

Semi-arid; maize, tea, coffee, sorghum, sunflower, cow peas, green grams, pigeon peas

Arid; maize, millet, sorghum, cow peas, green grams, pigeon peas

Very arid; cassava, cotton, groundnuts

Rest (waters etc); coconut, cashewnuts,

1. **PRINCIPLES OF CROP PRODUCTION**

* **Factors limiting crop production in Kenya**
* **External factors**

**Climatic factors**-

* **Rainfall**

Low and unreliable rainfall causes drying of crops leading to huge losses.

* **Temperature**
* High temperature
* leads to wilting
* Increases disease and pest infestation.
* Low temperatures
* Slow the growth rate of crops due to slowed photosynthesis and respiration.
* Have high incidences of disease infection.
* **Wind**
* Causes lodging of cereals and distorts perennial crops.
* Increases evapo-transpiration.
* Increases the spread of diseases and pests.
* Agent of soil erosion
* **Soil factors-** Soil is the natural material that covers the surface of the earth,

Soil texture, structure, constituents and profile determine aeration drainage and fertility of the soil. This has an impact on crop production.

**Pests**-

They are organisms that feed on plants and animal materials causing direct or indirect damage. They include insect, small animals and birds. Some pests act as vectors for disease causing organisms. They cause a lot of damage to crops both in the field and store.

They reduce the final products obtained from crop either by reducing the yields or the quality.

This can take place through the following effects;

They reduce the size and the shape of the product.

Their presence makes it unsuitable for consumption.

They affect the colour of the produce reducing its marketability.

Some insect pests burrow to make holes opening the product to secondary attack by fungal diseases.

Some transmit crop diseases from one plant to another.

**Disease-**

It is a condition that disturbs the normal performance of an organism. Diseases cause a lot of damage to crops both in the field and store.

**Weeds**-

They are plants which grow where they are not required and whose economic advantage outweighs the disadvantages.

They compete with other crops for nutrients, moisture and space.

They increase cost of production; more labour is required to control weeds.

Some produce poisonous substances which may inhibit germination of crops e.g. striga which produces chemical substances that hinder full growth of cereals.

**Plant factors-**

* **Cultivars/clones**-

Some cultivars are highly susceptible to pests and diseases.

Some plants have seed which undergo dormancy for certain duration of time.

* **Capital-** Lack of capital causes the level of investment in the farm to be low.
* **Attitude-** Most people have a negative attitude towards agriculture as an occupation.
* **Infrastructure-** lack of infrastructure that facilitates movement of goods and information limit crop production in Kenya. This is because agriculture produce should be taken from production area to consumers efficiently and cheaply. Most products are highly perishable and therefore require quick and efficient means of transport.

**Taboos-** These activities hinder important changes in a society that may bring agricultural development. They affect what people produce and consume.

**Markets-**

When demand is high the prices are high and vice versa.

* **CROP ECOLOGY**
* **Defination**-

They are environmental factors that surround a crop.

These factors could be biotic (living) or abiotic (non-living). The interaction of both biotic and abiotic factors with crops provides conditions which affect crop growth. There occurs a relationship between these factors and crops which constitute crop ecology. I.e ecology is the study of the relationship between organisms (crops) and their environment.

* **Ecological factors-**

Biotic – These are living factors which include weeds, pests, pathogens, pollinators, decomposers, nitrogen fixing bacteria.

Abiotic- these are the non-living factors which include soil, rainfall, temperature, light, wind and altitude.

* **Ecological zones (assignment)**

Classification-

Range of altitude-

Range of rainfall-

Temperature range

Soil types-

**Crop grown on each ecological zone-**

* **LAND PREPARATION**
* Reasons for seedbed preparation-
* To kill weeds either by burying them or by desiccation through exposure to sun.
* To aerate the soil and encourage water infiltration.
* To burry crop residues from previous seasons crop. This adds organic matter to the soil and makes it easy to plant.
* To break hard soil surface. This encourages penetration of roots to the soil.
* **Types of seedbed preparation**-

**Clearing-**

It is the removal of vegetative cover from the surface before land is tilled.

It is done by either use of chemicals, tree felling, burning or slashing.

**Note**: **Burning** should be avoided where possible since it;

* Leads to loss of organic matter,
* Kills soil organisms
* Destroys soil structure and plant nutrients.

It is necessary;

When opening a virgin land.

Where land was left fallow for a long time.

If a stalk crop was previously planted.

Where the interval between primary and secondary cultivation is long.

**Primary**-

It is initial opening of the land either after clearing the bush or following a previous crop.

In small scale jembe and fork jembe are used.

In large scale mouldboard and disc plough are used.

**Secondary**-

It is also called harrowing. They are operations which follow primary cultivation. It is seedbed refinement practices before planting.

In small scale, farmers use panga, jembe and fork jembe.

In large scale spike-toothed, spring-tine and disc harrow are used

**Tertiary**-

They are operations carried out to suit production of certain crops. They are carried out after secondary cultivation.

They include;

* **Ridging**; it is the process of digging soil in continuous line and heaping it on one side to form a ridge and a furrow.

It is important for root crops, to allow root expansion and for soil and water conservation.

* **Rolling:**

It is the compaction of the soil to produce a firm surface which increases seed-soil contact and prevents wind erosion.

* **Levelling;**

Production of an even, uniform surface which promotes uniform planting.

**Minimum tillage-**

This is the application of a combination of farming practices with the aim of reducing the disturbance of the soil.

Examples of which include:

* Use of herbicides.
* Mulching and cover-cropping.
* Timely operations to prevent weed infestation.
* Strip cultivation.
* Uprooting and slashing of weeds.
* **Methods of seedbed preparation**

**Hands-**

It is mainly the use of simple hand tools such as jembe to cut and turn furrow slices.

It is commonly practiced by small scale farmers.

**Disadvantages**;

It is a slow process.

Prepared seedbed has limited depth since the tools do not penetrate very deep.

**Mechanical**-

It is commonly practiced by large scale farmers. Tractor mounted implements are used which include mouldboard and disc plough. It is expensive.

**Advantages**

It is quick.

Better burrying of weeds.

Preparation is done on time.

Machinery can efficiently cope with difficult soil conditions.

Less laborious.

**Timing of operations-**

Very dry soils may be difficult to penetrate while very wet soils should never be worked on.

It should be prepared well before the onset of rains to give weeds enough time to dry up and decompose into organic matter.

Early preparation gives enough time for other subsequent operations to be done giving way to early planting.

It allows carbon dioxide and other gases to diffuse out of the soil while being replaced by oxygen which is important for seed germination and growth of soil organisms.

* **Planting**

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

* Planting materials

There are two types of planting materials.

1. **Seeds**-

Seeds are produced by flowering after pollination and fertilization. They contain the part of the plant that germinates and subsequently grows in to new plants.

**Advantages of using seeds as planting materials.**

* Seeds are easily treated against soil borne pests and diseases.
* They are not bulky therefore storage is easy.
* They are easy to handle during planting making operation easy.
* When planting seeds, it is easy to use machines like seed planters and drillers.
* It is easy to apply manures and fertilizers together with seeds during planting.
* Fertilizers and manures application can be easily mechanized.
* It is possible to develop new crop varieties due to cross pollination.

**Disadvantages of using seeds as planting materials.**

* Some seeds have long dormancy and they may need special treatment in order to germinate.
* Plants raised from seeds have variations from the mother plant due to cross pollination, this may introduce undesirable characteristics.
* Soil borne pests may damage seeds if left for sometime in the soil before rain falls.
* Some seeds may lose viability if stored for a long time. This leads to gaps in the farm.

1. **Vegetative materials**-These are plant parts which have the ability to produce roots, they grow and develop in to new plants. Plant parts such as leaves, roots or stems can be used for planting as long as they are capable of rooting.

**Advantages of using vegetative materials for planting.**

* Crops originating from vegetative materials matures faster than those from seeds.
* The crops shows uniformity in such qualities as disease resistance, seed size, colour, keeping or storing quality and chemical composition.
* It is possible to produce many varieties of compatible crops on the same root stock.
* Use of the vegetative materials is easier and faster, especially where seeds show prolonged dormancy.
* The resulting plant has desired shape and size for ease of harvesting and spraying.
* It facilitates the propagation of crops which are seedless or those that produce seeds which are not viable or have a long dormancy period.
* Such crops include sugar-cane, bananas, Napier grass and others.

**Disadvantages.**

* Vegetative propagation does not result in new crop varieties.
* Keeping the materials free of diseases is difficult.
* Materials cannot be stored for long.
* The materials are bulky and therefore difficult to store and transport.
* **Methods**

**Direct seeding-**

It is where planting materials are planted directly in a seedbed without taking them first in the nursery bed.

**Transplanting-**

It is where planting materials are planted first in the nursery bed and later transferred to the seedbed.

**Broadcasting**- This method involves scattering the seeds all over the field in a random manner. It is commonly adapted for light tiny seeds such as those of pasture grasses. It is easier, quicker and cheaper than row planting. However, it uses more seeds than row planting and the seeds are spread unevenly leading to crowding of plants in some places. This results in poor performance due to competition. Broadcasting gives a good ground cover, but weeding cannot be mechanized. For good results, the seedbed should be weed-free, firm and have a fine tilth.

**Row planting-** The seeds or other planting materials are placed in holes, drills or furrows in rows. The distance between one row to the other and from one hole to the other is known. In Kenya, both large and small – scale farmers practice row planting. It is practiced when planting many types of crops, especially perennial, annual and root crops.

**Advantages of row planting.**

* Machines can be used easily between the rows.
* It is easy to establish the correct plant population.
* Lower seed rate is used than if broadcasting is adopted.
* It is easy to carry out cultural practices such as weeding, spraying and harvesting.

**Disadvantages of row planting.**

* It does not provide an ample foliage cover. Thus the soil is liable to being eroded by wind and water.
* It is more expensive than broadcasting because of consuming a lot of labour and time.
* It requires some skill in measuring the distances between and within the rows.

Seeds can also be planted by dibbling where the planting holes are dug by use of pangas or jembe, or by a dibbling stick (dibbler). Most of the dibbling is done randomly although rows can also be used when using a planting line. Random dibbling is not popular in commercial farming due to low levels of production. It is only common among conservative farmers in planting of legumes such as beans, pigeon peas and cow peas.

**Ridge and furrow planting**- It is important for root crops, to allow root expansion and for soil and water conservation.

**Monocropping**- it is growing of only one type of crop.

**Intercropping** is where different types of crops are grown on the same piece of land.

* **Depth of planting**-

This is the distance from the soil surface to where the seed is placed. The correct depth of planting is determined by:

* **Soil type:** seeds will emerge from greater depths in sandy soil that are lighter than in clay soils.
* **Soil moisture content:** It is recommended that one plants deep in dry soils in order to place the seeds in a zone with moist soil.
* **Size of the seed:** Larger seeds are planted deeper in the soil because they have enough food reserves to make them shoot and emerge through the soil to the surface.
* **Type of germination:** seeds with epigeal type of germination (carry cotyledons above the soil surface) such as beans, should be planted shallower than those with hypogeal type of germination (leave cotyledons under the soil) such as maize.
* **Timing of planting-**

The timing of planting or sowing is influenced by the type of crop to be planted and the environmental conditions of the area.

**Factors to consider in timing planting.**

* The rainfall pattern/moisture condition of the soil.
* Type of crop to be planted.
* Soil type.
* Market demand.
* Prevalence of pests and diseases.
* Weed control.

Timely planting is necessary and should be done at the onset of rains. In some areas where rainfall is scarce dry planting is recommended.

* **SPACING**

It is the distance of plants between and within the rows.

Spacing determines plant population and the main aim of correct spacing is to obtain maximum number of plants per unit area which will make maximum use of environmental factors. Wider spacing leads to a reduced plant population which means lower yields, whereas closer spacing could lead to overcrowding of plants and competition for nutrients and other resources would occur. Correctly spaced crops produce yield of high quality that are acceptable in the market.

**Spacing is determined by the following factors:**

* **The type of machinery to be used.**
  + The space between the rows should allow free passage of the machinery which can be used in the field. For example, the spacing between rows of coffee is supposed to allow movement of tractor drawn implements.
* **Soil fertility**
  + A fertile soil can support high plant population. Therefore closer spacing is possible.
* **The size of plant**
  + Tall crop varieties require wider spacing while short varieties require closer spacing, for example, Kitale hybrid maize is widely spaced than Katumani maize.
* **Moisture availability.**
  + Areas with higher rainfall are capable of supporting a large number of plants hence closer spacing than areas of low rainfall.
* **Use of crop.**
  + Crop grown for the supply of forage or silage material is planted at a closer spacing than for grain production.
* **Pest and diseases control.**
  + When crops are properly spaced, pests might find it difficult to move from one place to the other, for example, aphids in groundnuts.
* **Growth habit.**
* Spreading and tillering crop varieties require wider spacing than erect type.
* **SEED RATE**-

Seed rate is the amount of seeds to be planted in a given unit area governed by ultimate crop stand which is desired. The objective of correct spacing of crop is to obtain the maximum yields from a unit area without sacrificing quality. Most crops are seeded at lighter rates under drier conditions than under wet or irrigated conditions. Seeds with low germination percentage are planted at higher rates than those which have about 100% germination percentage. There is an optimal seed rate for various crops. For example, the seed rate for maize is 22 kg per hectare, wheat is 110 kg per hectare and cotton is between 17 to 45 kg per hectare.

Factors to consider in choosing seed rates.

* **Seed purity.**
  + When planting seed which is pure or with a high germination percentage, less seed is required. On the contrary, more seeds are required when using impure or mixed seeds.
* **Germination percentage.**
  + Less seed is used when its germination percentage is higher. Seed of lower germination percentage is required in large amounts.
* **Spacing.**
  + At closer spacing, more seeds are used than in a wider spacing.
* **Number of seeds per hole.**
  + When two or more seeds are planted per hole, higher seed rate is required than when only one seed is planted per hole.
* **The purpose of the crop.**
* A crop to be used for silage making is spaced more closely than one meant for grain production. This would require use of more seeds. Maize to be used for silage making, for example, requires more seeds than that meant for production of grain.
* **NURSERY PRACTICES**
* **Definations**

Nursery practices refer to all the activities carried out throughout a nursery life to raise seedlings. .

* **Types of nurseries**
* **Vegetable Nursery**:
* They are used for raising the seedlings of vegetable crops. E.g. tomatoes, cabbages, kale, onions, brinjals and peppers.
* **Vegetative Propagation Nurseries:**
* They are used for inducing root production in cuttings before they are transplanted,
* The cuttings can be planted directly in the soil and hence called **bare root nurseries.**
* Or planted into containers such as pots, polythene bags and others, hence called **containerized nurseries**.
* **Tree Nurseries:**
* These are used for raising tree seedlings.

The seedlings can be raised in bare root nurseries or in containerized nurseries

* Site selection

**Factors to consider;**

* **Nearness to the water source.**
* **Type of soil**.-should be well drained, deep and fertile, preferably loam soil.
* **Topography**.-it should be situated on a gentle slope to prevent flooding and erosion through surface run-off.
* **Previous cropping**.-to avoid build up of pests and diseases associated with particular plant families, consider the preceding crops.
* **Security**.-select a site that is protected from theft and destruction by animals.
* **Protection against strong winds and heat of the sun**.-select a sheltered place. i.e. to avoid excessive evapotranspiration and uprooting seedlings.
* **Establishment-**
* **Vegetable crop nursery;**
* Clear vegetation
* Plough the land to remove all the perennial weeds
* A path of 60 cm is left between nurseries.
* In wet areas the nursery beds are raised
* In dry areas the nursery beds are sunken. This helps in conservation of the available moisture.
* Beds are harrowed to a fine tilth and well rotten manure or phosphatic fertilizer broadcasted.
* Leveling the bed is then done using a garden rake to mix manure or fertilizer and remove trash.
* Shallow drills 10-20 cm apart is made and seed drilled uniformly and then covered lightly with soil.
* **Management practices**-

These are the practices carried out in the nursery while the planting materials are growing.

**They include:**

* Mulching. –light mulch should be applied on the nursery bed. It should be removed on the 4th day
* Weed control.
* Shading.
* Pricking out.
* Pests and disease control.
* Hardening off
* Watering.
* **Media sterilization/ pasteurization**

Heat treatment- involves the use of hot water or burning the soil.

Chemical treatment- soil is dipped in specific chemicals to kill microorganisms.

* **Plant propagation**
* Defination
* Life cycle of plants
* Stratification and vernalization-
* Properties of plant cells (totipotency)
* Methods

Sexual/ seed-

Asexual

Stem cutting-

Storage structures-

Layering –

Grafting-

Budding-

* Factors affecting graft union
* Factors affecting rooting of cutting
* Biotechnology (tissue culture)
* Propagation structures

Green houses-

Lath houses-

Mist chambers-

* Propagation media
* **SOIL FERTILITY**
* **Definition-**

Soil fertility is the ability of the soil to provide crops with the required nutrients in their proper proportions.

* **Plant nutrients**
* Macro nutrients
* These are also referred to as major nutrients.
* They are required by the plant in large quantities.
* **They include*;***
* carbon,
* hydrogen,
* oxygen,
* nitrogen,
* phosphorus,
* potassium,
* sulphur,
* calcium
* Magnesium.
* Nitrogen, phosphorus and potassium are referred to as **fertilizer elements,**
* Calcium, magnesium and sulphur, are referred to as **liming elements.**
* Micro nutrients
* Also referred to as trace or minor nutrients.
* They are required in small quantities/traces.
* They are essential for proper growth and development of plants.

**They include;**

* Iron,
* Manganese,
* Copper,
* Boron,
* Molybdenum
* Chlorine.
* **Forms of nutrient availability-**

Plant nutrients occur in the soil in form of soluble substances.

* **Ways of losing nutrients from the soil-**
* **Leaching**: vertical movement of dissolved minerals from the top to the lower horizons of the soil profile.
* **Soil erosion**- The removal and carrying away of the top fertile soil from one place to another.
* **Monocropping** - This is the practice of growing one type of crop on a piece' of a land over a long time.
* **Continuous cropping -** crops take away a lot of nutrients from the soil which are never returned.
* **Growing crops continuously** without giving the soil time to rest makes the soil infertile.
* **Change in soil pH**- changes in soil pH affect the activity of soil microorganisms as well as the availability of soil nutrients.
* **Burning of vegetation**- burning of vegetation cover destroys organic matter. It also exposes the soil to the agents of soil erosion.
* **Accumulation of salts**- soils with a lot of salts are said to be saline. State of having too much salt in the soil is referred to as soil salinity.
* Salts accumulation cause water deficiency in plants. It may also lead to change in soil pH.
* **Methods of maintaining soil fertilit**

**Soil fertility is maintained through the following methods:**

* **Control of Soil Erosion ;**
* Terracing,
* Contour cultivation,
* Strip cropping,
* Cut off drains
* Planting cover crops.
* **Crop Rotation;**
* Practice of growing different crops on the same field in different seasons in an orderly sequence.
* **Control of Soil pH**:
* Application of liming materials such as **limestone, quick lime, magnesium carbonate and slaked lime if the soil is acidic.**
* Application of acidic fertilizers if the soil is alkaline.
* Application of manures.
* **Proper drainage;**

**Done through:**

* Breaking hard pan.
* Construction of water channels.
* Growing crops on cambered bed
* Pumping out water from the soil.
* **Weed control:**
* Use of herbicides.
* Slashing
* Uprooting.
* Mulching
* Use of proper farming practices such as early planting, correct spacing and cover crops.
* **Intercropping** –
* Farming practice where different crops species are grown together in the field.
* **Minimum Tillage;**
* Use of herbicides.
* Uprooting of weeds.
* Slashing weeds
* Mulching
* Strip cultivation.
* **Use of Inorganic Fertilizer** ;
* Chemical compounds manufactured to apply specific plant nutrients for example calcium ammonium nitrate (CAN).
* **Manure and fertilizers**
* Definition**-**
* Types of manure and fertilizers-
* properties of manure and fertilizers-
* fertilizer calculations-
* timing of applications-
* methods of application-
* **WEEDS AND THEIR CONTROL**
* **Definition-**

They are plants which grow where they are not required and whose economic advantage outweighs the disadvantages. They compete with other crops for nutrients, moisture and space.

* **Types of weeds**-

Weeds are grouped on the basis of;

1. Growth cycle

* Annual weeds- they complete their lifecycle in the field within a period of less than one year or less. E.g black jack

They are easy to control especially if done before flowering

* Biennial weeds- they complete their lifecycle in two years e.g. American wild carrot.
* Perennial weeds- they complete their lifecycle in more than two years e.g. kikuyu grass.

They are most difficult to control.

1. Plant morphology

* Narrow leaved weeds- they are mostly grass weeds e.g couch grass.

They may be annual or perennial.

* Broad leaved weeds- they include pig weed black jack and others. They are either annual or perennial.
* **Economic importance of weeds in crop production-**
* They reduce the quality of farm products

Mexican marigoldgives undesirable flavor to milk if dairy cows are fed on it.

Black jack get attached to sheep wool lowering it quality.

* Some act as alternate host for pests and diseases
* Some are poisonous to man and livestock e.g. thorn apple
* Some weeds like witch weed are parasitic to cultivated crops like maize
* Some weeds block irrigation channels making it difficult for water to flow freely in irrigated lands
* Some weeds are difficult to handle and control because they irritate workers thus reducing the efficiency in which they are controlled. E.g. stinging nettle
* Some weeds lower the quality of pastures e.g. nut grass.
* Some weeds have medicinal effects e.g. Sodom apple
* They add organic matter to the soil when they decompose
* Leguminous weeds fix nitrogen to the soil
* Some weeds are edible to both man and livestock e.g. pigweed
* **Methods of weed control**

**Cultural methods –**

* Mulching

Mulch smothers/ oppresses weed, thus preventing weed growth

* Crop rotation

Some weeds only grows well in association with certain crops. E.g. striga grows only where there are some cereal crops or sugarcane.

* Cover cropping

They smothers weeds

* Proper spacing

Create little space for weed growth hence suppressing them.

* Timely planting

Allow crops to establish early before weeds suppressing them

* Use of clean planting materials

It prevent introduction of weeds to the farm.

* Clean seedbed

This starts off the crops on a clean bed so that they effectively compete with weeds.

* Flooding

It discourages the growth of all non aquatic weeds. It is mainly practiced in rice fields.

**Chemical methods-**

It is use of chemical called herbicide to control weeds.

Herbicides are classified according to;

* Formulation

Liquid-they are soluble in either water or oil. E.g. dalapon

Wettable powder-these are finely ground particles. They are mixed with water to form a suspension. E.g. duron.

* Time of application

Pre-emergence- they are applied soon after seed crops have been sown but before they emerge.

Post-emergence- they are applied after crop germination or transplanting.

* Selectivity

Selective- they injure one plant and allow the other to escape injury

Non-selective- they injure all the plants

**Mechanical/physical-**

* Cultivation/ tillage- it dessicate the weeds by exposing the roots to the air. It also burries the weeds thus killing them.

It should be done during dry season to ensure better drying of weeds

* Slashing – it is the mechanical removal of shoots from weeds.it is effective in control of weeds if done repeatedly
* Uprooting- it is done where the weeds are scattered or where the crops are too close to allow mechanical cultivation.

**Biological-**

It is use of living organisms to control weeds.

They include;

* Use of certain weed eating fish to control aquatic weeds
* Use of livestock such as goats to graze and control growth of weeds in plantation like coconut.

**Integrated-**

It involves a combination of different methods to control weed.

**Legislative-**

It involves laws and regulations set by the government which prevents introduction of noxious weeds into the country or spreading of foreign weeds from one part of the country to another. All imported plant materials are tested for purity before they are released to ensure no foreign weed seeds are introduced into the country.

* **PESTS AND THEIR CONTROL**
* **Definition**-

They are organisms that feed on plants materials causing direct or indirect damage.

* **Economic importance**-

They increase cost of production due to expensive pesticides.

They reduce the yield of the crop or in serious attack cause total failure.

Some transmit viral disease from one plant to another.

They lower the quality of crop products such as rotting of fruits.

Some deprive/ take away the plant food by sucking sap resulting in retarded growth.

* **Classification of pests**-

They are classified according to;

1. Crops attacked

Some pests feed only on specific crops. E.g

Stalk borer on maize

Bollworms on cotton.

1. Stage of growth of crop

They are pests that attack crops at certain stages of growth.

Cutworms attack seedlings

American bollworm bore into fruits or attack crop during flowering stage.

1. The place where they are found/ habitat

This includes;

Field pests- they cause damage to crops in the field

Storage pests- they cause damage to crops in storage.

1. Their mode of feeding

It includes;

Biting and chewing pests

Piercing and sucking pests

1. Scientific classification

They include insects, birds, nematodes and mites.

1. The level of damage

They include;

Minor pests- they cause less damage to particular crops

Major pests- They cause great damage to particular crops.

* **Ecological factors favouring pests-**

Warm temperatures and humid climate favour multiplication of pests.

* **Methods of pest control**
* **Choice of method and timing-**
* **Cultural methods-**

It includes use of all good farming practices to minimize and discourage pests from attacking crops.

They include;

1. Crop rotation.

Crops which are more preferred by particular pest are rotated with those that are not. This starves the pests to death hence interferes with the lifecycle.

1. Destruction of alternative host.

Some weeds act as alternate hosts to pests. Control of these weeds reduces pest infestation.

1. Close season

It is the period when a susceptible crop is not grown inorder to control a certain pest or group of pests.

1. Planting varieties that are resistant to pests

Some plants are able to resist attack of certain pests. E.g goose necked sorghum against birds and ruiru 11 which is resistant to coffee berry disease.

1. Proper drying

Well dried maize resists pest attack.

1. Proper spacing

Proper spacing makes it difficult for pest to move from one plant to another.

1. Growing of trap crop

A trap crop is the one which is planted either before or together with the main crop for attracting pests away from the main crop.

1. Timely harvesting

Some storage pests like grain weevil attack the crop while in the field; therefore early harvesting will enable the crop to escape an attack.

1. Use of clean planting materials

It helps to prevent introduction and spreading of crop pests.

1. Field hygiene

It involves keeping the field free from any planting materials harbouring pests. It includes rogueing; ie the removal and destruction of plants infested with pests.

1. Timely planting

Early planted crops are more likely to escape pest attack than late planted ones.

1. Irrigation

Overhead irrigation control aphid in cabbages.

1. Use of organic manure

Organic manure such as farmyard manure discourage certain pests particularly nematodes.

* **Mechanical/ physical-**

It is use of physical measures to kill or discourage pests. They include;

1. Use of scare crows

They are used in scaring birds and large animals out of the farm

1. Use of physical barriers

Include use of materials to prevent pests from getting to the crops for example;

Construction of fences around the field to control large animals.

Rat guard in store

1. Use of extreme temperatures in store to discourage pests.
2. Proper drying of produce.

This makes the grain too hard for pest to penetrate. Grains should be dried to a moisture content of 11-13%

1. Flooding. It will cause some pests like cutworms to drown.

* **Biological-**

It involves use of living organisms to control pests. This organism is usually an enemy to the pest. E.g

Cat on rat, mole and mice

Wasps on mealy bugs

Ladybird on aphids

* **Chemical-**

It is use of chemicals called pesticides to control pests.

It is the most effective and efficient method.

They are highly poisonous and therefore should be handled with great care.

* **Quarantine-**

It aims at preventing introduction of new pests into the country or area, or spread of already existing pests to other areas in the country which have been free of pest.

* **Integrated-**
* **Safety precautions on use of pesticides**
* Read the manufactures instructions and follow them
* They should be applied in the right amounts and concentration
* Farmer should wear protective clothing when applying pesticides
* Spraying should be done when facing towards the direction of wind
* No eating, smoking or drinking should be done when speraying
* The farmer should not unblock nozzles by blowing with the mouth
* All agro chemicals should be kept under lock and key and away from children
* All agro containers should be buried deep in the soil. They should not be burnt because they may produce toxic fumes which can be harmful.p
* Pesticides should not be applied immediately after a downpour or shortly before rains because rain water dilutes the concentration of chemicals lowering their effectiveness.
* **DISEASES AND THEIR CONTROL**
* **Definition**-

It is a condition that disturbs the normal performance of an organism.

* **Causes**

Bacterial-

Fungi-

Virus-

Mycoplasma-

Nematodes-

Nutritional disorders-

when crops do not get enough nutriens, deficiency symptoms may appear. They include;

Yellowing of leaves

Stunted growth

Falling of fruits, flowers and leaves

Death in extreme conditions.

* **Economic importance-**

They lower crop yields

They lower the quality of products

Some produce toxic substances which cause food poisoning. Example is a fungus by the name *Aspergillus* spp. which produces aflatoxin which grows in moist maize which can cause death if consumed.

* Mode of transmission-
* **Methods of control**

Choice of method and timing-

Cultural methods-

These are crop husbandry practices which are used to control diseases without the use of chemicals. They include;

Planting of resistant varieties such as Ruiru 11 which is resistant to CBD

Use of healthy planting materials

Proper drying of cereals and pulses before storage.

Proper spacing to control damping off in cabbage seedling in the nursery

Heat treatment of some planting materials. Eg treating sugarcane setts with water at 500 C for 30 minutes control ratoon stunting disease.

Mechanical/ physical-

Biological-

Chemical-

It should be practiced only when the other method are ineffective and is economical. It involves use of chemicals to control diseases. They include;

Fungicides, fumigants and bacteriocides.

Chemical control measures include;

* Spraying- the application of chemical using a sprayer to control diseases like CBD.
* Seed dressing- the application of fungicides before planting seeds.
* Soil fumigation- the application of fumigants in the soil to control soil borne diseases like bacterial wilt in potatoes.

Quarantine-

It is restriction of movement of plants from and into affected areas incase of an outbreak of a disease. It prevents introduction and spread of diseases

Integrated-

* **Harvesting**
* Definition-
* Stage of maturity

Physiological maturity-

Horticultural maturity-

Indices of maturity-

Methods-

Timing of harvesting-

1. **PLANT BREEDING**

* **Objectives of crop breeding**
* **importance of crop breeding**
* **Evolution of crops**
* Definition
* History-
* Charles Darwins theory of evolution-
* Role of natural selection
* Introgression
* Hybridization
* **Reproductive systems in cultivated crops**
* **techniques of crop improvement**
* selection of breeding materials
* selection methods
* hybridization
* back crossing
* male sterility
* **Heterosis**
* Definition
* **Breeding methods for self pollinated crops**
* **Breeding methods for cross- pollinated crops**
* **Apomixis**
* Definition
* polyembrony
* **Clones and clonal selection**
* Definition
* Selected methods
* **Polyploidy and mutation breeding**
* Definition
* Selected methods
* **Breeding for disease and pest resistance**
* **Maintenance and distribution of improved cultivars**

1. **AGROFORESTRY**

* **Definition**

Agroforestry is the practice of integrating trees and crops on the same piece of land.

* **Importance**
* Environmental protection.
* Source of income.
* Afforestation for timber production.
* Maintenance of soil fertility.
* Aesthetic value.
* Labour saving in firewood collection.
* Source of food and feed.
* Source of fuel wood.
* **Multipurpose trees and shrubs**
* Trees

*Grevillea robusta*

*Sesbania sesban*

* Fruit trees

*Cassia* spp.

Macadamia nuts

Whistling pine

Shrubs

*Leucaenea* spp.

*Acacia* spp.

*Makhmia* spp.

Other indigenous and exotic spp.

* **Seed procurement**
* Sources of seeds for shrubs and trees
* Storage of seeds
* Collection of seeds
* **Nursery practice**
* Site selection
* Site preparation and establishment
* Management
* Transplanting
* **Agroforestry systems and practices**
* Alley cropping
* Live mulches
* Hedge row intercropping
* **Problems and prospects**

1. **PASTURES AND FODDER**

* **Definition**
* **Types**
* **Pasture and fodder establishment**
* **Management**
* **Conservation**
* Silage
* Hay

1. **SEED PRODUCTION AND TESTING**

* **Seed legislation**
* Agriculture act in relation to seed production
* **Types of seeds**
* Breeder
* Foundation
* Multiplication
* Registered
* Certified
* **Agronomy and field maintenance of selected crops**
* **Agronomy**
* Planting arrangement
* Rogueing of the off types
* Site selection
* **Field maintenance**
* Controlled pollination
* Detasselling
* Field hygiene
* **Harvesting and storage**
* **Field inspection, testing and certification**
* Field crop inspection
* Seed testing

Viability

Germination

Purity

Vigour

Freedom from diseases and pests

* **Certification and release**