Introduction to Agriculture

Definition of Agriculture

- Agriculture is the science and art of cultivation of crops and rearing of livestock.
- **As a science,** it involves ***experimentation*** and ***application of scientific knowledge*** in such areas as;
  - Soil analysis,
  - Control of pests and diseases,
  - Farm machinery and structures,
  - 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.

Branches of Agriculture

Crop Farming (Arable Farming)

- The practice of growing crops 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.

Livestock Farming

- This branch deals with the rearing of livestock for various products.

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 for high yield of honey and honey products.
- ***Poultry Keeping****:* This is the keeping of domesticated bird's i.e chicken, ducks, turkeys and geese.

Agricultural Economics

- It deals with the allocation of scarce resources (land, labour, capita)l and management for agricultural production. Its aims at creating the greatest output at lowest cost.

Agricultural Engineering

- This branch of agriculture deals with the use and maintenance of farm tools, machinery and structures. Also refers to the study of the construction and care of farm machinery, tools, buildings, water supply systems, irrigation systems and structures used in conserving the soil, draining wetlands and sorting and processing farm produce.

Farming Systems

- A farming system is the organization of the various enterprises in a farm.

It is determined by the following factors:

- Resources available (land, labour, capital and management). More resources one can practice large scale commercial farming
- Knowledge and Skills of the farmer. Commercial farming requires more skills and knowledge.
- Environmental factors such as climate, soil type and topography. In asals large parcels of land required for beef farming.
- Government policy on growing of given crops. I.e. policy on growing coffee as a pure stand.
- Farmer's choice and preference.
- Enterprise requirement. Wheat farming is economical on large scale
- Social-cultural factors-traditions and values ie Maasai belief in keeping large herds of cattle.

The following are systems of farming:

Extensive System:

- It is a system where a large piece of land with low investment of resources per unit area is carried out.

Advantages

- It is cheap.
- Does not require high level of management.
- Requires less labor, capital and technology to operate.
- High profit levels due to low input costs.

Disadvantages

- Low profit per unit area.
- Cannot be practiced where land is limited.
- Low output per unit area.
- The land is under-utilized,

Intensive Farming:

- This system utilizes the factors of production to the maximum and involves high level of management.

Advantages

- Maximum utilization of the resources.
- Can be practiced even where land is a limiting factor.
- Results in high yields.

Disadvantages

- Labour intensive.
- High capital investment is required.
- Requires high level of management.
- Can lead to high loses in case of poor management.

Large Scale Farming

- Refers to the farming practice under large areas of land over 20 hectares.
- It is used mainly for commercial purposes.
- The system is highly mechanized.

Advantages

- Results in high yields.
- Due to economics of scale high profit is realized.

Disadvantages

- Lack of diversification may lead to total failure in case of unfavorable conditions.
- High level of management is required.
- Heavy capital investment.
- Requires skilled and qualified manpower.

Small Scale Farming

- Refers to farming carried out on a small area of land less than 5 hectares.
- Family or casual labour can be engaged during the peak periods.
- Most of the Kenyan farmers are small scale due to unavailability of farmland.

Advantages

- Requires low capital investment.
- Possible where land is a limiting factor.
- Does not require high management level unless under intensive system.

Disadvantages

- Uneconomical 10 mechanize due to small size.
- Low production.
- Provides limited employment.
- Labour intensive.
- Difficult to specialize.

Methods of Farming

- A method of farming is an established way of carrying out farming activities.
- The following are the common methods of farming:

Mixed Farming

- It is the practice of growing crops and keeping of livestock on the same land.
- Its common in high potential areas.

Advantages

- Mutual benefit between crops and livestock.
- Crops supply feed for animals while animals supply manure for crops.
- Acts as an insurance against total loss by the farmer.
- The farmer is assured of an income throughout the year.
- There is maximum utilization of the resources.
- Animals can be used in the farm activities particularly draught animals.
- Ensures proper utilization of labour and land throughout the year.

Disadvantages

- High initial capital.
- Lack of specialization.
- Land can be a limiting factor if both enterprises are to be raised.
- Requires high level of management for both enterprises.

Nomadic-Pastoralism

- This is the practice of livestock rearing whereby animals are moved from one place to another in search of water and pastures.
- It is practiced in the arid and semi-arid areas where in most cases beef animals are kept.

Nomadic pastoralism is gradually changing to ranching with the introduction of:

- Improved pasture species, improved livestock breeds and supplementary feeding.
- Efficient disease and parasite control measures.
- Improved infra-structure such as roads, water supply, cattle dipping facilities.
- Extension services.

Advantages

- Serves as the backbone of beef industry in Kenya.
- Proper way of utilizing the arid and semi arid areas.
- Source of income to the pastoral communities.

Disadvantages

- It encourages the spread of livestock pests and diseases due to communal watering points, grazing and dipping facilities.
- There is a tendency to increased soil erosion and land degradation.
- Source of conflicts and ethnic tension among the nomadic communities for the control of good pastures and water.
- Difficult to control breeding and breeding diseases.
- High rate of inbreeding leading to poor quality livestock.
- Low production of milk, meat, hides and skins due to wastage of energy in traveling from one place to another in search of pastures and water.
- High death rates as a result of walking for long distances.

Shifting Cultivation

- It is a traditional method of cultivating a piece of land until the soil is exhausted and crop yields decline.
- The land is abandoned and the farmer shifts to a new field as the previous land is left fallow to regain its fertility.

Advantages

- Land is allowed to rest and regain its fertility.
- No build up of pests and diseases.
- Soil structure is restored.
- The cost of production is low since inorganic fertilizers and pesticides are not used.
- Crop produce are chemical free.

Disadvantages

- Not practical where land is a limiting factor.
- Farm planning and acquisition of credits for land development is 'not possible.
- It is a cumbersome method due to constant movement.
- Lack of soil conservation measures
- Not possible to grow perennial crops.
- Low output per unit area due to poor farming methods.
- Where fire is used to clear the land organic matter is destroyed.

Organic Farming

- It is a fanning method where crops are grown and livestock reared without the use of agro¬chemicals.
- It is a method of farming which has been adopted to reduce the long term effect of the agro-chemicals on crops which may eventually end up in man and livestock.
- Agro-chemicals are also expensive thus organic farming reduces the cost of production. Organically produced goods fetch high market prices.

Advantages

- Cheap and cost effective.
- Make use of the locally available materials
- Useful in improving the soil structures.
- No side effects from the crops and livestock products.
- No environmental pollution.

Agro-Forestry

- This is the practice of integrating trees and crops on the same piece of land.
- With land resources becoming more scarce, agro forestry is becoming more important.

Examples of common agroforestry trees and shrubs include:

- *Cajanus cajan*
- *Grevillea robusta*
- *Sesbania sesban*
- *Calliandra calothyrsus*
- *Casuarina equisetifolia*
- *Leucaena leucocephala*

Trees selected for agroforestry should have the following characteristics:

- Able to grow fast.
- Deep roots to minimize competition for nutrients.
- Should be preferably leguminous.

Advantages

- Trees reduce soil erosion in a given area.
- Leguminous trees add nitrates into the soil thus improving the *soil* fertility.
- Some trees can be used as livestock fodder to provide a high level of proteins.
- They are important sources of wood fuel and timber.
- There is maximum utilization of land.

Importance of Agriculture to the Economy of Kenya

- Provides ***food*** to the population to meet nutritional requirements and to enable man to engage in other activities of farming.
- Provides ***employment***. This for example can be direct as a labourer in the farm, tea plucker or indirect for example, working in agricultural based industries.
- Source of ***raw materials*** for industries for example cotton lint for textile industry.
- Provides ***foreign exchange*** - through exporting agricultural produce.
- Provides ***market for industrial goods*** ¬agriculture is a consumer of the finished goods from agro-based industries.
- Source of ***income*** - farmers as well as the government get revenue from the sale of agricultural produce and tax payment.

Factors Influencing Agriculture

Introduction

Agricultural production is influenced by external factors:

- Human factors
- Biotic factors
- Climatic factors
- Edaphic factors.

Human Factors

These are human characteristics which affect the way decisions are made and operations carried out.

- ***Level of education and technology***:
  - Skills
  - Technological ad van cements .
- ***Human health/HIV-AIDS***:
  - These affect the strength, the vigour, vision and the determination to work.
  - HIV/AIDS is the biggest threat to human health today and has long lasting effects on agriculture, such as;
  - Shortage of farm labour.
  - Loss of family support.
  - Low living standards leading to despondency and hopelessness.
  - Increased criminal activities.
  - More time spent by the Government and NGO's in Carring for the sick.
- ***Economy;***
  - Stability in the countries' economy affect agricultural production.
- **Government Policy:**
  - These are governmental laws which have been enacted to protect farmers, land and livestock.

  They include:
  - Food policy
  - Policies on control of livestock parasites and diseases.
  - Policies on marketing of both local and export products and others.
- ***Transport and communication***:
  - For agricultural goods to move from the farm to the consumers.
- ***Cultural practices and religious beliefs:***
  - These activities hinder important changes in a society that may bring agricultural development.
- ***Market forces:***
  - Demand and supply forces which affect prices of commodities in a free market.

Biotic Factors

These are living organisms which affect agricultural production.

- ***Pests -*** Destructive organisms which destroy crops.
- ***Parasites*** - These are invertebrates which live in or on other living organisms.
- ***Decomposers -*** Organisms which act on plants and animal tissues to form manure.
- ***Pathogens*** - Micro-organisms which cause diseases.
- ***Predators*** - Animals that kill and feed on other animals.
- ***Pollinators*** - They transfer pollen grains from the stamens to the pistil of a flower.
- ***Nitrogen fixing bacteria*** -They are micro-organisms which convert atmospheric nitrogen to nitrates ready for use by the plants.

Climatic Factors(weather elements).

- Rainfall,
- Temperature,
- Wind,
- Relative humidity
- Light.

Weather - Atmospheric conditions of a place at a given time period.
Climate - weather conditions of a place observed and recorded for a period of 30-40 years.

Rainfall

Supplies Water:

- Which is necessary for the life process in plants and animals.
- Which makes the plant turgid hence provides support.
- Acts as a solvent for plant nutrients.
- Cools the plant during transpiration.
- Which is used as a raw material in photosynthesis.

When plants lack enough water they respond in different ways as follows:

- By closing the stomata to restrict water loss.
- Hastens maturity.
- Some will roll their leaves.

Other plants have developed permanent adaptation to water stress such as:

- Growing needle like leaves.
- Develop fleshy leaves for water storage.
- Develop long roots.
- Wilting and death in extreme conditions.

Important Aspects of Rainfall:

- ***Rainfall reliability***;
  - This is the dependency on the timing of the onset of the rains.
- ***Amount of rainfall***;
  - Quantity of rain that falls in a given area within a given year.
- ***Rainfall distribution*** ;
  - The number of wet months in a year.
- ***Rainfall intensity***;
  - Amount of rainfall that falls in an area within a period of 1 hour.

Temperature

- This is the degree of hotness or coldness of a place measured in degrees Celsius.
- ***Cardinal range*** of temperature ¬ is the temperature required by plant to grow and thrive well.
- ***Optimum range of temperatures*** - the best temperature for the best performance of plants.

Effects of Temperatures on Crop Production:

Low temperatures:

- Slow the growth rate of crops due to slowed photosynthesis and respiration.
- High incidences of disease infection.
- Improves quality of crops such as tea and pyrethrum.

High Temperatures

- Increase evaporation rate leading to

- Wilting.
- Hastens the maturity of crops.
- Increase disease and pest infection.
- Improves quality of crops such as pineapples, oranges and pawpaws.

Wind

Wind is moving air.

Good effects of wind include:

- Seed dispersal
- Cooling of land
- Pollination in crops
- Brings rain bearing clouds

Negative effects of wind:

- Increases the rate of evaporation of water.
- Causes lodging of cereals and distorts perennial crops.
- Increases evapo-transpiration.
- Spreads diseases and pests.
- Destroys farm structures.

Relative humidity

- The amount of water vapour in the air
- Affects the rate of evapo-transpiration.
- Forms dew which supplies soil with moisture under dry conditions.
- High humidity induce rooting in cuttings.
- Increases disease multiplication and spread.

Light

- Provide radiant energy harnessed by green plant for photosynthesis.

Important aspects of light:

- ***Light intensity*** ;
  - The strength with which light is harnessed by chlorophyll for photosynthesis.
- ***Light duration***;
  - The period during which light is available to plants per day.
  - Plant response to light duration is known as ***photoperiodism.***
  - ***Short-day plants*** **-** require less than 12 hours of daylight to flower and seed.
  - ***Long-day plants*** - require more than 12 hours of daylight to flower and seed.
  - ***Day-neutral plants*** require 12 hours of daylight to flower and seed.
- ***Light wavelength;***
  - This is the distance between two - successive crests of a wavelength.
  - It dictates the difference between natural and artificial light.
  - Chlorophyll absorbs certain wavelengths of light.

Edaphic Factors Influencing Agriculture

- These are soil factors.
- Soil is the natural material that covers the surface of the earth,
- Made of weathered rock particles and decomposed animal and plant tissues, and on

which plants grow.

Importance of Soil

- Provides anchorage to the plants by holding their roots firmly.
- Provides plants with mineral salts/ nutrients which are necessary for their growth.
- Provide the plants with water.
- Contains oxygen necessary for respiration of the plants and soil micro-organisms.

Soil Formation:

- Soil is formed through weathering process.
- Weathering is the breakdown and alteration of the parent rock near the surface of the earth to a stable substance.
- Weathering process is a combination of disintegration (breakdown) and synthesis (build up) process.
- Weathering process is continuous.

Types of Weathering

- Physical weathering
- Chemical weathering
- Biological weathering

Agents of Weathering

Physical Agents of Weathering

- Include wind, water, moving ice and temperature.
- ***Wind -*** carry materials which hit against each other to break into fragments.
- ***Water*** - intensity of rainfall causes breakdown of rock.
- ***Moving ice*** - has grinding effects which tear off rock particles.
- ***Extreme temperature*** cause rocks to expand and contract suddenly peeling off their surface.

Chemical Weathering

- Affects the chemical composition and structure of the rock.
- Involves processes such as ;
  - Hydrolysis,
  - Hydration,
  - Carbonation
  - Oxidation.
- ***Hydration;***
  - The process by which soluble minerals in the rocks absorb water and expand weakening the rock thus leading to disintegration.
- ***Hydrolysis;***
  - The process whereby water dissolves soluble minerals in the rock weakening it.
- ***Oxidation****;*
  - *T*he reaction of rock minerals with oxygen to form oxides which break easily.
- ***Carbonation****;*
  - *T*he process whereby carbonic acids formed when rain water dissolves carbon dioxide,
  - It reacts with calcium carbonates in limestone causing it to disintegrate.

Biological Weathering

This involves the action of living organisms, plants and animals on the rocks.

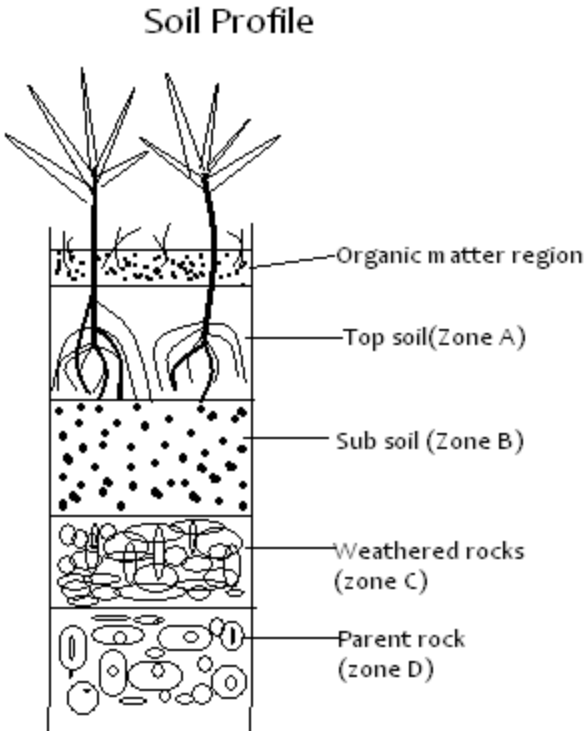
- ***Burrowing animals***, for example, termites and moles bring soil particles to the

surface exposing them to other agents of weathering.

- ***Big animals*** like, elephants, buffaloes, camels and cattle exert a lot of pressure on the rocks as they step on them due to their heavy weights causing the rocks to disintegrate.
- ***Earthworms*** take part in the decomposition of plant matter with the soil particles.
- ***Man's activities*** like, mining and quarrying expose rocks to the surface during excavation. These activities breakdown large rocks into smaller rock particles.
- ***Plant roots*** force their way through the cracks in the rocks thus widening and splitting them.
- ***Humic acids*** formed when plant tissues decompose react with the rocks weakening them further.
- ***Plant remains***-decompose adding humus into the soil.

Factors influencing soil formation

- ***Climate-*** (rainfall, temperature and wind)
- ***Biotic factors*** - living organisms.
- ***Parent material*** - Nature and properties of the original rock from which the soil is formed.
- **Time -** length of time during which the soil forming processes have taken place.
- ***Topography*** - influences the movement of disintegrated materials.



- It is the vertical arrangement of different layers of soil from the ground surface to the bedrock.
- These layers are also referred to as ***horizons.***
- The layers show differences in their contents and physical properties such as colour, texture and structure.

- The layers include: organic matter region, top soil, sub-soil, weathered rocks and parent material.

Organic Matter Region

- First layer of the soil found on the surface.
- Made up of leaves and other plant remains at various stages of decomposition.
- Some soil organisms may also be found here.

Top Soil

- Has a dark colour due to the presence of humus.
- Is rich in plant nutrients and well aerated.
- It is a zone of maximum leaching (zone of eluviations)

Sub-Soil

- It is compact and less aerated.
- It is a zone of accumulation of leached material (zone of aluviation) from the top layers.
- Deep rooted crops have their roots growing up to this region.
- Hard pans normally form in this layer

Weathered Rocks

- It is also called substratum.
- Rocks at various stages of disintegration are found in this zone.
- Most of the materials found in this zone originate from the parent rock.

Parent Rock

- It exists as a solid mass which is un-weathered.
- It is the source of the inorganic composition of the soil.
- The water table is on the surface of this rock.

Soils Formed in Situ and Soils Deposited

- Soil formed in the same place and remains there is said to be ***in situ.***
- However, soil can be formed due to deposition of soil particles carried from its original site of formation to another area which is usually in the lower areas of slopes.
- Such soils are said to have been formed through deposition.

Soil Formed in Situ	*Soil Deposited*
I.Has the colour of the parent rock	1. Has the characteristics of when: it came from
2. Shallower	2. Deeper
3. Less rich in plant nutrients	3. Richer in plant nutrients
4. Easily eroded	4. Not easily eroded
5. Less silty	5. More silty
6. Have the same chemical composition as that of the underlying parent rock.	6. Differ in chemical composition from the underlying parent rock.

Soil Depth

- This is the distance between top soil layer and the bottom soil layer in a profile.
- It dictates root penetration and growth
- Deep soils are more suitable for crop growth since they contain more nutrients.
- Have a larger surface are for root expansion.
- Deep soils facilitate good drainage and aeration.

Soil Constituents

- ***Organic Matter*** - Dead and decaying plants and animal remains
- ***Living Organisms*** - Soil organisms and plant roots.
  - Micro-organisms (bacteria, protozoa and fungi)
  - Invertebrates -termites,
  - Earthworms and molluscs.
  - Higher animals - rodents and others.
- ***Inorganic or Mineral Matter***
  - Formed from the parent materials.
  - Supply plant nutrients
  - Form the skeleton and framework of the soil.
- ***Air***
  - Found in the pore spaces of the soil.
  - Used for root and organism respiration
  - Used for germination of seeds.
  - Helps in decomposition of organic matter.
  - Regulates soil temperature.
  - Regulates the movement of water through capillary action.
- ***Water***
  - Dissolves mineral salts
  - Maintain turgidity in plants.
  - Used for germination of seeds
  - Used by soil organisms.
  - Regulate soil temperature
  - Dictates the amount of air in the soil.

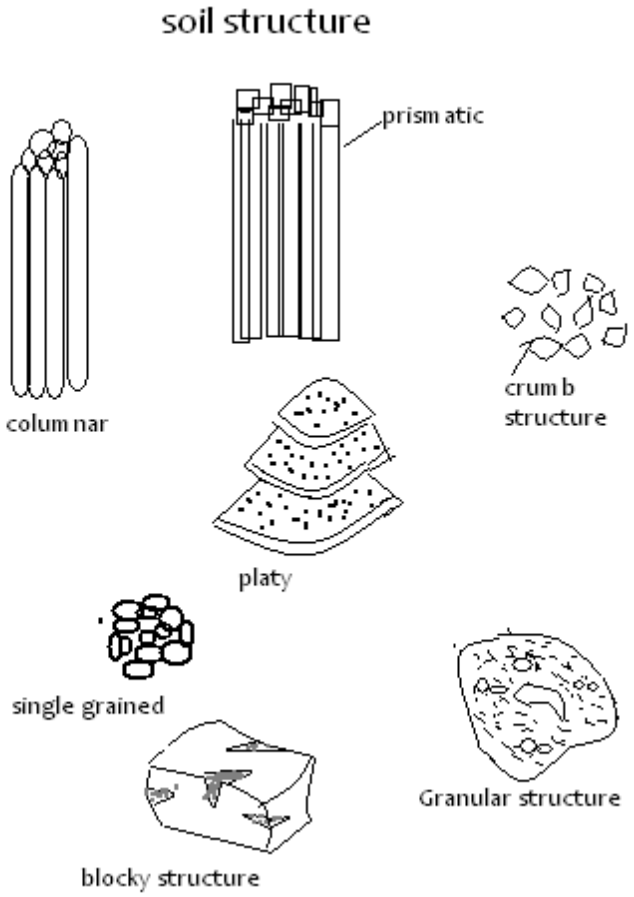
Water in the soil exists in three forms namely:

- ***Superfluous/Gravitational Water***
  - Found in the large spaces (macro-pores) in the soil particles.
  - Held by gravitation forces.
  - When the pores are saturated, the soil is said to be waterlogged.
  - It moves and may cause leaching.
- ***Hygroscopic Water***
  - Water found in thin films on the soil particles.
  - Held by strong adhesive forces between water and soil particles.
  - Does not move and hence not available for plant use.
- ***Capillary Water***
  - Occupy micro-pores in the soil particles.
  - Held by cohesive forces between water molecules.
  - Moves through capillary action
  - Available to plants for use.

Soil Structure

- This is the arrangement of soil particles in a soil horizon.
- ***Types of Soil Structure –***
  - Single-grained
  - Crumby
  - Granular
  - Prismatic
  - Columnar
  - Platy

- Blocky



Importance of Soil Structure on Crop Production

Soil Structure Influences

- Soil aeration
- Soil drainage and water holding capacity.
- Plants root penetrability and anchorage.
- Microbial activities in the soil.
- Circulation of gases in the soil.

Farming practices which improve the soil structure are:

- Application of inorganic manure into the soil.
- Tilling the land at the right moisture content.
- Crop rotation.
- Minimum tillage.
- Cover cropping.
- Mulching.

Soil Texture

- It refers to the relative proportion of the various sizes of the mineral particles of soil.

Importance of Soil Texture on Crop Production;

- Influences soil fertility
- Affects the organic matter content
- Influences the drainage of the soil.
- Influences soil aeration.
- Influences water holding capacity.
- Influences the capillarity or movement of water in the soil.

Soil Textural Classes

Sandy Soils

- Made up largely of sand particles.
- Have large pore spaces hence poor in water retention.
- Easy to till (light soils).
- Freely draining.
- Low fertility due to leaching of minerals.
- Easily erodible.

Clayey Soils

- Made up largely of clayey particles.
- Have small pore spaces hence good in moisture retention.
- Difficult to till (heavy soils).
- Poorly 'drained.
- Expand when wet, crack when dry.
- High capillary.
- Rich in plant nutrients.

Loam Soils

- About equal amounts of sand and clay.
- Moderately good in both moisture and air retention.
- Fertile soils.

Soil Colour

- This depends on the, mineral composition of the parent rock and the organic matter content.
- Soils containing a lot of iron are brownish, yellowing and reddish in colour.
- Soils with a lot of silica are white.
- Soils with a lot of humus are dark or grey.

Soil pH

- This refers to the acidity or alkalinity of the soil solution/the concentration of hydrogen ions in the soil solution.
- Soil pH is determined by the concentration of hydrogen ions (H+) or the hydroxyl ions (OH) in the soil solution.
- A pH of less than 7 means that the soil is acidic.
- A pH of more than 7 means that the soil is alkaline.
- As the hydroxyl ions (OH) in the soil increase the soil becomes more alkaline.

Influence of Soil pH Crop Growth

- It determines the type of crop to be grown in a particular area.
- Most crops are affected by either very acidic or very basic soil pH.
- Soil pH affects the choice of fertilizers and the availability of nutrients to crops.
- At low pH the concentration of available iron and aluminium in the soil solution may increase to toxic levels, which is harmful to plants.
- Very acidic or low pH inhibit the activity of soil micro-organisms.

Farm Tools and Equipment

Introduction

- Farm tools and equipment perform specific jobs in the farm.

- They make work easier and more efficient.
- They can be classified according to their uses as follows:

Garden Tools and Equipment

Tools	Uses
Panga	Cutting and shallow cultivation, making holes.
Jembe/hand hoe	Cultivation, digging, shallow planting holes and trenches.
Fork iembe	Cultivation, digging out roots, harvesting of root crops.
Rake	Collecting trash, breaking large clods, levelling, removing stones from a seedbed and spreading organic manure.
Spade	Scooping and carrying of soil, sand, concrete mixture and manure.
Spring balance	Measuring weight.
Trowel	Scooping seedlings during transplanting and .digging planting holes for seedlings.
Pruning hook	Bending tall branches when pruning.
Secateur	Cutting young stems and pruning branches.
10. Tape measure	Measuring distances.
11. Axe	Cutting big trees and roots and splitting logs of wood.
12. Soil auger	Making holes for fencing posts.
13. mattock	Digging hard soils
14. sprinklers	Overhead irrigation.
15. Watering can	Watering plants in nursery bed.
16. Wheel barrow	Transportation of soil, fertilizers, farm produce, tools and equipment.
17. Levelling board	For levelling a nursery bed.
18. Pruning saw	Cutting old wood stems and pruning big branches.
19. Hose pipe	For conveying water from a tap to where it is need.
20. Knap sack sprayer	Applying agro-chemical by spraying.
21. Garden shear	Trimming hedges.
22. Pruning knife	Removal of small shoots.
23. Meter ruler	Measuring distances.
24. Garden fork	Shallow digging.

Livestock Production Tools and Equipment

Tools	Uses
Drenching gun	Administering liquid drugs to animals orally.
Bolus gun/dosing gun	Administering solid drugs or tablets to animals orally.
Wool Shears	Cutting off wool from sheep.
Hypodermic syringe	Administering drugs by injection for example in vaccination.
Stirrup (bucket) pump	Application of acaricide by hand spraying.
Thermometer	Taking body temperatures of farm animals.

Burdizzo	Used in bloodless method of castration.
Halter	Rope designed to restrain the animal.
Trimming knife	Cutting short the overgrown hooves.
Elastrator	Stretching rubber ring during castration, dehorning and docking of lambs.
Iron dehorner	Applies heat on the horn bud to prevent growth of horns.
Nose ring	Fixed into the nose of a bull to restrain it.
Strip cup	Detecting mastitis in milk products.
Trocar and cannula	Relieving a bloated animal of gases particularly ruminants.
Hard broom	For scrubbing the floor.
Ear notcher	Making ear notches in livestock.
Bucket	For holding milk during milking.
Milk chum	For holding milk after milking.
Milk strainer/sieve	Removing foreign particles from milk for example hairs and sediments
Rope	Tying or tethering animals.
Milking stool	Used by the milker to sit on while milking.
Weighing balance	Weighing milk after milking.
Teeth clipper	Removal of canine teeth of piglets soon after birth.
Chaff cutter	Cutting fodder into small bits.
Dehorning wire	Cutting grown horns.

Workshop Tools and Equipment

Tools	Uses
Spanner	Tightening and loosening nuts and bolts.
Pliers	Cutting small wires and thin metal and gripping firmly.
Files	Sharpening tools, smoothening or shaping edges of metals
Rasps	Smoothening and shaping of wooden structures.
Chisels (wood)	Making grooves in wood.
Cold chisel	Cutting and shaping metal
Screw drivers	Driving screws in or out of wood or metal.
Saws	
Cross cut saw	Cutting across the grain of wood.
Rip saw	Cutting along the grain of wood.
Hack saw Bow saw	Cutting metals.
Tenonlback saw	Cutting branches of
Coping saw	Cutting Joints on wood and fine sawing.
Compass/keyhole	Cutting curves on thin wood.

	Cutting either along or across the grain of wood when cutting key holes.
Tin snip	Cutting metal sheets.
Braces and bits	Boring holes in wood.
Drill and bits	Boring holes in metal work and woodwork.
Hammer	
Claw hammer	Driving in, removing and straightening nails.
Ball pein	Driving in nails, rivets and straightening metal. Also used on cold chisel
Mallet	Hammering or hitting wood chisel.
Jack plane	Fine finishing of wood.
Scrappers/spokesha	Smoothening curved surfaces of wood such as handles
Measuring	jembes, axes.
Metre ruler	Measuring short length -
Try square	Measuring length angles and to ascertain squareness.
Marking gauge	Marking parallel lines to the edge of wood.
Fencing pliers	Cutting wires, hammering staples when fencing.
Vice and clamps	Firmly holding pieces of work together.

Tools	Uses
Spirit level	Measuring horizontal or vertical levels.
Soldering gun	Melting soldering rods when repairing or fabricating metal sheets.
Wire brush	Brushing rough surfaces.
Divider	Marking and laying out.
Centre punch	Marking the point of drilling.
Paint brush	Applying paint on surfaces.
Sledge hammer	Ramming hardware, breaking stones.
Wire strainer	Tightening wires during fencing.
Riveting machine	Fix rivets when joining pieces of metal.
Claw bar	Removing long nails from wood, straining fencing wires and digging fencing holes.

Plumbing and Masonry Tools

Tools	Uses
Pipe wrench	Holding, tightening and loosing metallic pipes.
Pipe cutter	Cutting PVC pipes.
Levelling rod	Levelling the floor during construction.
Mason's trowel	Placing mortar between construction stones and bricks.
Wood float	Create a level surface on walls and floors.

Mason's square	Ascertain verticalness.
Plumb bob	Spreading screed over floors and walls.
Shovel	Mixing and scooping concrete or mortar, measuring cement.

Care and Maintenance of Tools and Equipment

Reasons for Maintenance

- To increase durability.
- To increase efficiency.
- Reduce costs of replacement.
- For safety of the user/avoid accidents.
- Avoid damage to the tool.

Methods

- Use tools for the right work.
- Proper handling when using tools or equipment.
- Clean and oil tools after work.
- Keep tools in there right place.
- Replace and repair worn-out parts
- Sharpen cutting or digging edges
- Grease moving parts to reduce friction
- Use safety devices in the workshop to reduce accidents and breakages

CROP PRODUCTION 1
(Land Preparation)

Introduction

- A piece of land which is prepared is known as seedbed.
- A seedbed is a piece of land that is prepared ready to receive planting materials.

Seedbed Preparation

Reasons for Seedbed Preparation;

- To enable water to infiltrate.
- To kill weeds
- To improve soil aeration.
- To destroy pests and diseases.
- To incorporate organic matter in the soil.
- For easy planting.
- To facilitate root penetration.

Operations in Land Preparation

Land Clearing

- Clearing of land is necessary when:
- Opening up a virgin land.
- A stalk growing crop was previously planted.
- There is long interval between primary and secondary cultivation.
- Land was left fallow for a long time.

Procedure

- Tree felling and removal of stumps and roots.
- Burning
- Slashing
- Use of chemicals.

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

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

Primary Cultivation

- This is the initial breaking of land.
- It is done early before the onset of the rains to:
  - Give time for soil organisms to act on organic matter.
  - Allow gaseous exchange to take place, thus carbon dioxide diffuses out of the soil while oxygen enters into the soil.
  - Allow other operations to take place in time.

Reasons for primary cultivation:

- Remove weeds.
- Burry organic matter.
- Open up soil for infiltration of water and air.
- Expose pests and disease causing organisms.
- Soften the soil for easy planting.

Operations in primary cultivation

- ***Hand digging*** ;

  Use of hand tools ;
  - Jembes,
  - Mattocks,
  - Fork-jembes.
- ***Mechanical cultivation*** ;

  Use of mouldboard ploughs;
  - Disc ploughs,
  - Chisel ploughs,
  - Subsoilers
  - Rippers.
- ***Use of Ox-Ploughs*** ;

  Which can be drawn by;
  - Oxen,
  - Donkeys,
  - Camels

Depth of Cultivation

Depends on:

- The type of crop to be planted/size of seed.
- The implements available.
- The type of soil.

Choice of Implement

Determined by:

- The condition of land.
- The type of tilth required/type of crop.
- Depth of cultivation.

Secondary Tillage

- These are refinement practices on the seedbed that follow primary cultivation.
- It is also known as harrowing.

Reasons for secondary Tillage:

- To remove the germinating weeds.
- To break soil clods to produce required tilth.
- To level the seedbed for uniform planting.
- To incorporate organic matter/manure into the soil.

Factors determining number of secondary cultivation:

- Soil moisture content.
- Size of the planting materials.
- Condition of the soil after primary cultivation.
- Slope of the land.

Tertiary Operations:

- ***Ridging ;***
  - The process of digging soil on a continuous line and heaping on one side to produce a furrow and a bund (ridge).
  - 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.
- ***Leveling;***
  - Production of an even, uniform surface which promotes uniform planting.

Sub-soiling:

- This is deep cultivation into the subsoil layer to break up any hardpan which might have developed.

It is done for the following reasons:-

- To facilitate drainage.
- Bring up leached nutrients to the surface.
- Increase aeration of the soil.
- To improve root penetration.
- The implements used include ***chisel plough*** and ***subsoilers.***

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.

Reasons for Minimum Tillage

- To reduce cost of cultivation.
- To control soil erosion.
- To preserve soil moisture.
- To prevent root exposure and damage.
- To reconstruct destroyed soil structure.

Water Supply, Irrigation and Drainage

Introduction

- Water is a very important natural resource.
- It is necessary for both crops and livestock.

Uses of water in the farm;

- Cleaning equipment.
- Irrigation in dry areas.
- Processing farm produce, for example, coffee.
- Drinking by livestock and man.
- Mixing agro-chemicals such as acaricide, fungicides and herbicides.
- Providing power in water mills to grind grain crops.
- Cooling engines.
- Construction work.
- Fish rearing
- Domestic use
- Recreation purposes ie swimming
- Used to operate some machines e.g turbines, maize mills, hydram.

Hydrological cycle

It refers to the unending circulation of water from the earth surface to the atmosphere and back in form of precipitation (rain, hailstones or snow). Water goes back to the atmosphere by the process of evapo-transpiration. Hygroscopic water held by soil particle is used by plants.

Sources of Water in the Farm

Three major sources of water in the farm:

- ***Surface water***:

Includes water from;

- Rivers,-they originate from water catchment areas i.e mountains, hills and forests.

Rivers are either permanent or temporary.
- Streams
- Lakes –are huge collections of water on land depressions. Are fed by rivers streams, springs and rain. They are either fresh water or salty.
- Dams- Dams and weirs are constructed on rivers to raise water levels (collect and store water

- ***Ground water***:

Includes water from;

- Spring- its where water comes out of the ground (in small or large amount) as a result of an impervious layer meeting the ground surface. Water is less contaminated. To increase water volumes construct a wall around the spring.
- Wells-are holes dug in the ground until the water table is reached. It s done during dry season. To prevent accidents fence around the wall and construct a lockable reinforced concrete slab.
- Boreholes – are deep holes drilled or sunk into the ground (parent rock) by the use of drilling machines. Water as pumped by either electricity or engines. They are common in areas with scarce rivers/streams.

- ***Rain water:***

This is water tapped in various ways such as;

- Rooftops
- Rock surface, when it is raining and stored in various ways.

Collection and Storage of Water

- **Dams:**
  - These are structures/barriers constructed across rivers/channels or dry valley to collect and store water. They hold water and raise its level. They are earthen.
  - The bottom part of the area behind the dam has impervious layer (clay or rock) to prevent water seepage. Grass/trees planted on the embankments prevent soil erosion.
  - They are constructed across the river beds to form sub surface reservoirs in dry areas.
- ***Weirs:***
  - These are structures/barriers constructed across rivers to raise the water level (allow water to flow over it) for easy pumping.
  - Unlike in the dam's water flows over the barrier created across the river.
- ***Water Tanks:***
  - These are structures made of concrete, stone, rubber, metal sheets and plastics.
  - They store water from rain or that which has been pumped from other sources i.e rivers, streams, lakes, rock catchment, wells and boreholes.
  - Tanks should be covered to prevent contamination from dust and cleaned when dirt has accumulated. Runoff water should be filtered before storage,
  - Reinforce stone/concrete tanks with a wire mesh.

- ***Roof and rock catchment***

Water storage

- Dams
- Ponds
- Tanks

- Retention ditches

Pumps and Pumping of Water

- Pumping is the lifting of water from one point to another by use of mechanical force.
- Water is pumped from the various sources and then conveyed to where it is required for use or storage.

Types of Water Pumps

Used to lift water from its source.

- Centrifugal pumps /Rota dynamic pumps- have metal discs with blades that rotate at high speed. Water is driven by a centrifugal force to the outlet. They are ideal for pumping water for irrigation (large quantities of water). Use electricity
- Piston or reciprocating pumps –they have pistons that move back and forth pushing water through the pipes. They are ideal for pumping water for domestic and livestock use. they use petrol or diesel or hand operated.
- Semi-rotary pumps- are manually operated to pump water from wells by hand for domestic and livestock use.
- Hydram – they use force of flowing water to pump water in slopy areas where water flows at high speeds.

Conveyance of Water

- This is the process of moving water from one point, usually the source or point of storage to where it will be used or stored.

Methods of conveying water

- ***Piping***;
  - This is where water is moved through pipes.

  The common types of pipes include:
  - Metal pipes –they can be either galvanized iron (are heavy and suitable for permanent installation of water systems) or aluminium pipes (light and used for irrigation systems).
  - Plastic pipes –are inexpensive and easy to install. Are durable however they burst under high pressure. They can also be gnawed by rodents.
  - Hose pipes – are either made of rubber (expensive and durable) or plastic (cheap and less durable). They convey water from taps to various areas.
- ***Use of Containers****:*
  - In this case water is drawn and put in containers ,drums, jerry cans, pots, gourds, tanks and buckets .
  - Water is then carried by animals, bicycles, human beings and vehicles.
- ***Use of Canals:***
  - In this case water is conveyed from a high point to a lower one along a gradual slope to avoid soil erosion.
  - Water conveyed through this way is mostly used for irrigation and livestock.

Water Treatment –Is the process of making it safe for use in the farm.

- Raw water contains impurities which may be dissolved, floating or suspended in water.

These impurities are grouped into three categories, namely:

- ***Physical impurities***: these are dissolved impurities detected by colour, taste and smell.
- ***Chemical impurities:*** these are dissolved impurities detected by use of chemical analysis.
- ***Biological impurities:*** these are microorganisms in water such as bacteria, viruses and algae.

Importance of Treating Water

- To kill disease causing microorganisms such as cholera and typhoid bacteria that thrive in dirty water.
- To remove chemical impurities such as excess fluoride which may be harmful to human beings.
- To remove smells and bad taste.
- To remove sediments of solid particles such as soil, sand and sticks.

Process of Water treatment.

- ***Filtration and water intake:*** water from the source pass through fine granular materials to remove solid particles and biological substances before entering intake pipe. Sieves used are of varying types.
- ***Softening of water-***water is mixed with soda ash (sodium bicarbonate) (to soften water) and alum (aluminium sulphate)(to coagulate solid particles) in a small tank
- ***Sedimentation:*** this is where water is put in large containers so that solid particles such as sand, metal and others can settle at the bottom.
- ***Coagulation:*** addition of chemicals which precipitate impurities and help in softening of hard water.
- ***Filtration*** passing of water with few impurities into a filtration tank
- ***Chlorination:*** Sterilization to destroy disease causing organisms.
- ***Storage-***water is stored in large tanks before distribution.

Irrigation

- It is the artificial application of water to crops in dry areas or where water is not enough.
- It is one of the methods of land reclamation in case of arid and semi arid areas.

Factors to Consider in Identifying and Assessing the Potential of Land for Irrigation Development

- Topography of the land
- Soil type
- Type of crop to be grown
- Water availability
- Human factors such as skill, capital availability and economic activities.

Types of Irrigation

- ***Surface irrigation***: type of irrigation in which water is brought to the crop fields from its source through canals or furrows.
  - This includes flood irrigation furrow and basin irrigation.
  - It is used in flat areas.
  - The problem with this method is loss of water through seepage.
  - It also increases soil salinity.

  Factors to consider when choosing furrow irrigation

  - Topography-ideal for fairly level land
  - Amount of water –requires a lot of water
  - Soil type –soil should not allow water seepage
- ***Flood irrigation***

  Its where water is allowed to flow into the field from a source such as a river or lake through furrows and canals. Its ideal in level fields. Its cheap to establish and maintain. Twater is unevenly distributed hence wastage.

- *Furrow irrigation*
  It's where water flows from irrigation canals through gates into furrows dug along the contours to reduce erosion. Crops are grown on ridges of the furrows. Repair furrows when eroded/worn out. Remove weeds and accumulated silt. Furrows prevent wetness of leaves hence reducing fungal diseases. Its cheap to establish and maintain. A lot of water is lost through seepage and evaporation.
- *Basin irrigation*
  Its where flooding of an area enclosed with embankments (dykes and levees)with water. Level basin refers to level ground surrounded with water. Water is allowed in via inlets. Its common in rice fields ie Mwea Tabere, Ahero, Bunyala, and West Kano-Kabonyo. It results in accumulation of salts. Its not applicable in areas that the land is not level.
- *Sub-surface Irrigation:*
  - This involves the use of porous pipes or perforated pipes underground to allow water to pass out through tiny holes and wet the soil around the root zones.
  - It is used in slopy areas and where water is inadequate.
- *Advantages of sub-surface irrigation*
  - Economizes on water usage
  - Minimizes of theft of pipes
  - Reduces soil erosion as it comes out in small amounts
  - Reduces fungal infection because water does not accumulate on leaves
  - No need of constructing dykes/level basins.
  - Reduces labour requirement (changing of water pipes)
- *Disadvantages of sub-surface irrigation*
  - Pipes can be broken during weeding or land reclamation
  - Blockage of nozzles/pipe perforations by soil/plant roots making then inefficient
  - Expensive ie purchase and laying of pipes
  - Interferes with field operations.
- *Overhead or Sprinkler Irrigation*:
  - It is used in any area which is not steep. Where water reaches the crops in form of fine droplets from above. Its practiced under use of (sprinklers, watering can and hose pipes)
- *Advantages of overhead irrigation*
  - It is water economical
  - Does not require leveling of land
  - Does not encourage soil erosion
  - Soluble fertilizers and pesticides can be mixed with the irrigation water
  - Clean the plnt surface for ease of photosynthesis and gaseous exchange.
  - Sprinkle irrigation helps to control crop pests i.e aphids
- *Disadvantages of overhead irrigation*
  - Its expensive
  - Encourages fungal diseases
  - Destroys the soil structure by compaction
  - May cause soil erosion if poorly managed
  - Requires the establishment of wind breaks
- *Drip or Trickle Irrigation:*
  - Its where the plant receive water in small quantities around the base of the plant using bottles or perforated plastic pipes.
  - It is used where water is little and in relatively sloppy and flat areas.
- *Advantages of drip irrigation*
  - It is water economical/little amount of water required.
  - Does not encourage growth of weeds between the rows

- Does not encourage fungal diseases CBD and blight
- Does not encourage soil erosion
- Can use water even under low pressure
- Does not require leveling of the land
- Soluble fertilizers and pesticides can be applied with irrigation water

- ***Advantages of drip irrigation***
  - Requires special skills
  - Very expensive to buy pipes
  - Requires water free from solid impurities
  - Requires clean water only dirty water blocks pipes

Drainage

- This is a method of removing excess water or lowering the water table from a marshy water-logged land.
- It is also a method of land reclamation.

Importance of Drainage as a Method of Land Reclamation

- To increase soil aeration.
- To raise soil temperature.
- To increase microbial activities in the soil.
- To reduce toxic substances from the soil.
- To increase soil volume for exploitation by plant roots.

Methods of Drainage

- Use of open ditches.
- Use of underground drain pipes.
- French drains.
- Cambered beds.
- Pumping out water from the soil.
- Planting tree species which absorb a lot of water for example eucalyptus.

Water Pollution

- This is the process by which harmful substances get into the water.
- The harmful substance is referred to as a **pollutant.**

Agricultural practices which pollute water include:

- Use of inorganic fertilizers.
- Use of pesticides.
- Poor cultivation practices such as over cultivation, cultivating along the river banks.
- Overgrazing which leads to erosion of soil thus causing siltation in water sources.

Methods of Preventing Water Pollution

- Soil conservation measures which minimize soil losses through erosion.
- Fencing off the water sources.
- Adopting organic farming practices for example controlling pests and weed using non -chemical techniques.
- Planting grass along river banks to minimize siltation in rivers.
- Proper disposal of empty chemical containers.

Soil Fertility I
(Organic Manures)

Introduction

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

Characteristics of a Fertile Soil

- ***Good depth*** - Good soils give roots greater volume to obtain plant nutrients and provide strong anchorage.
- ***Good aeration*** - for the respiration of plant roots and use by soil organisms.
- ***Good water holding capacity*** - ensures provision of adequate water for plant growth.
- ***Proper drainage*** - ensures provision of adequate air for plant growth.
- ***Correct soil pH*** - different crops have different soil pH requirements.
- ***Adequate nutrients supply*** - it should supply the required nutrients in the correct amounts and in a form available to plants.
- ***Free from excessive*** infestation of soil borne pests and diseases.

How soil loses fertility

- ***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.

Maintenance of Soil Fertility

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, quicklime, 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).

- *Use of Manure;*
  - Well decomposed manures release nutrients into the soil and increase its water holding capacity.

Organic Manures

- Manures are derived from plants and animal remains.
- They supply organic matter to the soil which after decomposition releases plant nutrients.
- The end product of this decomposition is known as humus.
- It influences soil chemical properties and soil temperature.
- Manures supply a wide range of essential plant nutrients.

Importance of Organic Matter in the Soil

- Increases the soil water holding capacity of the soil and the infiltration rate (colloidal)
- Improves soil fertility by releasing a wide range of nutrients into the soil.
- Provides food and shelter for soil micro-organisms responsible for decomposition.
- Improves the soil structure.

- Buffers soil pH/moderates soil pH.
- Reduces the toxicity of plant poisons in the soil.
- Moderates soil temperature by its dark colour.

Limitations in the Use of Manure

- They are bulky - low nutritive value per unit volume hence used in large quantities.
- Laborious in application and transport. –they increase production cost.
- They spread diseases, pests and weeds if the plant material used was infested with pests and diseases.
- Loss of nutrients if poorly stored (through leaching and evaporation).
- If not fully decomposed crops may not benefit from them nutrients released can scorch the crops.

Types of Organic Manures -according to the method of preparation

- Green manure.
- Farm yard manure.
- Compost manure

Green Manure

- Made from green plants which are grown for the purpose of incorporating into the soil to improve soil fertility. Mostly leguminous plants ie clovers, Lucerne, cowpeas, groundnuts, beans, and sun hemp are preferred. Maize sorghum sunflower and weeds can also be used.

Characteristics of plants used for preparation for green manure:

- Have fast growth rates.
- Have high nitrogen content.
- Capable of rotting quickly.
- Capable of growing in poor conditions (hardy).

Preparation of Green Manure

- Plant the green manure crop in the field.
- Allow the crop to grow up to flowering stage.
- Incorporate it into the soil through ploughing.
- Allow the crop to decompose for two weeks.
- Prepare the field for planting the major crop.

Reasons why green manure is not commonly used/limitations:

- Most of the plants used as green manure are food crops.
- Green manure crops may use most of the soil moisture.
- Most of the nutrients are used up by soil micro-organisms in the process of decomposing the green manure.
- Planting of the major crop is delayed –decomposition of green manure takes time.

Farm Yard Manure (FYM)

- Is a mixture of animal waste and crop residues used as beddings in animal houses.

Factors that Determine the Quality of FYM

- The types of the animal's used-poultry and pigs absorb fewer nutrients and give dung with more nutrients. Dung from fattening animals has high nutrients.
- Types of food eaten –highly nutritious feedstuffs make manure with high nutrients
- Types of litter used –litter with high urine absorption capacity sawdust and wood shaving absorb 1.5 times as much urine as their weight.
- Method of storage –should be stored in concrete floor and leak free roof to prevent loss of nutrients.

- Age of farmyard manure –well rotted manure is rich in nutrients and its easier to mix with the soil
- Age of the animals used.

Preparation of FYM

- Provide beddings in the houses of farm animals (grass, wood shavings, or sawdust).
- Animals deposit their droppings and urine on the beddings.
- Animals mix them through trampling.
- The beddings together with dung are removed and heaped under shed to decompose.
- After sometime, the materials decompose and FYM is formed.
- It can then be used in the farm

Compost Manure

- *Is* manure prepared from heaped (composted) organic materials (plant residues and animal waste or plant materials only). Avoid synthetic and infested plant/weeds.

Factors to consider in selecting site for making compost manure:

- A well drained place –to avoid water logging that may cause leaching
- Direction of the prevailing wind –to avoid bad odour from being blown to the homestead.
- Size of the farm – centrally placed to where the manure is to be used
- Accessibility –to ease transportation of needed materials

Preparation of Compost Manure

Two methods:

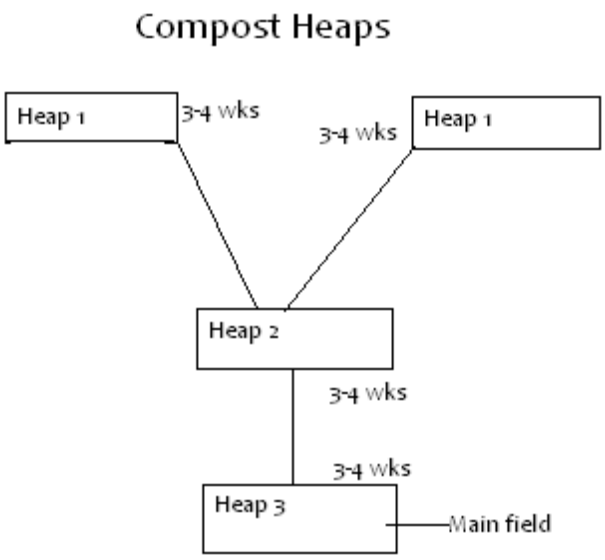
- ***Four heaps method***
- ***Indore Method (Pit Method)***

Indore Method (Pit Method)

Procedure ; -it was devised in india at indore

- Select a sheltered place with a shade and near the field.
- Dig a pit with the dimension 1.2m x 1.2m x 1.2m.
- Place the materials in the following order:
- Hedge cuttings or maize stalks to a depth of 30cm as a foundation
- A layer of grass, green weeds or leaves and kitchen wastes to 30cm.
- A well rotten manure/poultry droppings.
- Wood ash (to improve the level of phosphorus and potassium) and phosphatic fertilizers.
- A layer of topsoil to introduce micro¬organism for the decomposition of organic remains. Repeat the sequence until the pit is full.
- ***Note:*** Some water should be sprinkled to the materials to initiate the decomposition process and regulate temperatures. Use young vegetative material. To increase air circulation avoid compacting.

Four heaps method:



Composition of the heap

- ✓ Crop residue
- ✓ Animal waste
- ✓ Old farmyard or compost manure
- ✓ Inorganic fertilizer and topsoil

Procedure

- Clear the site to remove surface vegetation and topsoil.
- Level the site
- Four posts 2m high are fixed 1.2m apart from four corners of the heap.
- Fix wood planks on the sides.
- Materials are placed in two heaps (labeled 1) as in the pit method,
- The two heaps make up heap 1.
- After 3-4 weeks, the decomposed material from heap 1 is transferred to heap II.
- After another 3 - 4 weeks the material is transferred to heap III.
- After 3-4 weeks it is ready for use in the farm.
- Turn the material heap occasionally (every 3 months) to facilitate circulation of air and for proper decomposition.
- Long sharp pointed stick is driven into the pile at an angle to check temperatures within the heap. High temperature is corrected by adding water.

Indicators of well decomposed manure

- Absence of bad odour.
- Materials are lighter.
- Manure is brown in colour.

Advantages of Compost Manure

- One does not have to own livestock in order to prepare it.
- A lot of manure can be produced within a short time.
- A variety of materials can be used in its preparation.
- Uses locally available materials thus cheaper than the artificial fertilizers.
- Improves the soil structure.

Limitations of Compost Manure

- It releases nutrients slowly into the soil.

- Large quantities of compost manure are required to supply enough plant nutrients.
- Its preparation is labour intensive.
- It may induce soil-borne pests and diseases.

Livestock Production:

(Common Breeds)

Introduction

- The term livestock is used to refer to all domesticated animals on the farm for mans benefit.
- These animals include cattle, sheep, goats, poultry, pigs, rabbits, camels, bees, fish and donkeys.

The importance of keeping livestock:

- Source of food –animal products used as food include; meat, milk, eggs, honey and blood. They provide protein and energy.
- Source of income –animal product is sold to earn income for the farmer. They are exported for foreign exchange.
- Cultural values- are used as a status symbol (wealthy if you own a large herd of cattle, sheep, goats or camels). Its used as a medium of exchange in barter trade. Its used for social ceremonies ie marriage funerals as sacrifices. Its also used for recreation purposes ie bull and cock fighting, ostrich, camel, donkey and horse races.
- Source of animal power – they provide draught power for pulling carts and ploughs.
- Provision of raw materials for industries ie textile industries (wool, fur, mohair, hides and skins)animal waste is used in agricultural industryto produce biogas and maintain soil fertility.
- Farmyard manure from the animals is used in maintaining soil fertility.
- Cattle dung is used in the production of biogas.

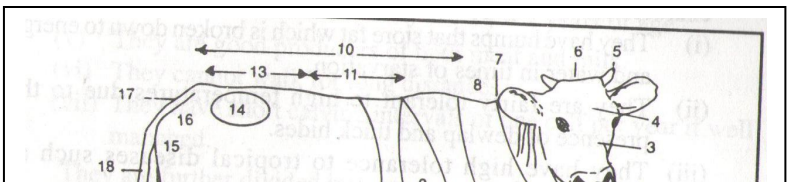
Common livestock breeds

Breed refers to a group of animals having the same characteristics and a common origin. Livestock type refer to the purpose for which the animal is kept. Livestock are reared for different type and breed.

Cattle Breeds

Definition of terms

Bull	mature male cattle
Bullock	mature castrated male cattle
Steer	young castrated male cattle
Heifer	young female cattle between wining and first calving
Cow	mature female cattle
Calf	young one of a cattle



- Cattle can be classified into two groups based on their origin.

These are;

- Indigenous cattle.
- Exotic cattle.

Indigenous Cattle (natives origin is within the tropics) –Bos indicus

Have varied characteristics due to uncontrolled breeding

Characteristics of indigenous cattle

- Have humps that store fat which is broken down to energy and water during starvation.
- Have fairly tolerant to high temperature because of the dewlap and thick hides
- High tolerance to tropical diseases ie trypanosomiasis
- Slow growth rate hence late maturity. Heifers are served at 2-3yrs.
- Low production of milk and meat.
- Walk for long distances in search of food and water
- Long calving intervals more than one year.
- ***Zebus*** –

They are small in size and with a distinct hump and include:

  - Nandi,
  - Bukedi
  - Maasai cattle.
- ***The Borana***
  - These are the cattle kept in the Northern parts of Kenya.
  - They are larger than the Zebus.
- Indigenous cattle are hardy hence able to tolerate the harsh environmental conditions in the tropics.
- They are the major suppliers of beef in Kenya. Long rump that's wide and dropping
- Grows slowly and matures late

- Has large hump and dewlap. Cow weighs 400-450kg and bull 550-650kgs

Exotic Cattle

- Foreign cattle from the temperate regions.
- They have distinct breed characteristics and are classified into various breeds.

General characteristics:

- They have no humps.
- They have low tolerance to high temperatures hence popular in cool climates of the Kenya highlands.
- They are highly susceptible to tropical diseases.
- They have fast growth rates leading to early maturity.
- They are good producers of both meat and milk.
- They cannot walk for long distances.
- Are served between 1.5yrs to 2yrs
- They have short calving intervals of one calf per year if well managed.

Exotic cattle breeds fall under the following groups:

- Dairy cattle breeds.
- Beef cattle breeds.
- Dual purpose breeds.

Dairy Cattle Breeds

- They include;
- Friesian,
- Ayrshire,
- Guernsey
- Jersey.

Characteristics of Dairy Cattle

- Wedge or triangular in shape.
- Large stomach for heavy feeding hence high milk production.
- Docile with mild temperament.
- Large, well suspended udders and teats.
- Lean bodies with little flesh.
- Straight top line
- Lean and smooth neck.
- Large and long mammary milk wells and veins.
- Cylindrical; uniform and well spaced teats.
- Wide and well set hindquarters to accommodate the udder.

Friesian-Holstein (largest of all dairy breeds)

- ***Origin:*** Holland and distributed all over the world.
- ***Colour:*** Black and white. Have awhite switch, forehead patch and leg parts below the knees.
- ***Size:*** *it's the largest of the dairy breeds.* Cow weighs 550-680kgs Bull weighs 950 kg calves have a birth weight of 35-40kgs.
- **Milk production:** Highest milk producers of all dairy breeds about 9150 kg per lactation of 305bdays. The milk has the least butterfat content; 3.5% . heifers are served at 21 months and calve at 30 months. Are good feeders and require large quantities of fodder.

Ayrshire

- ***Origin:*** Scotland
- ***Colour****:* White with brown markings or red/dark red with white markings.

- *Size:* Cow weighs 360-590kgs Bulls weighs *500-720kg.*

Conformation:

- Straight top lines, horns are long and face upwards.
- Milk production is second to Friesian about 5,185kg per lactation of 305days.the butter content of about 4%. Heifers served at21moths and calve down at 30months. They are hardy feeding 0n poor pastures.

Guernsey or channel island breed.

- ***Origin:*** Guernsey Island off the coast of France in the English channel.
- ***Colour:*** Yellowish brown to red with white legs, switch and girth ..
- ***Size:*** Bulls 540-770kg. Cow weighs 450- 500kgs. Calves weigh 25-30kgs at birth.

Conformation:

- Udders are less symmetrical.
- Average milk production is about 6100kg per lactation of 305 days with butterfat content of 4.5%-5.0% hence the yellow colour of milk. Heifers serve at 21 months and calve down at 30 months.

Jersey *(smallest of all the dairy breeds)*

- ***Origin:*** England at Jersey Island in the English Channel. Channel island breed.
- ***Colour:*** Yellow brown with black muzzle and tail sswitch.
- ***Size:*** Bulls weigh 540-700kg. Cow weighs 350-450kgs .calves weigh 20-25kgs at birth.

Conformation:

- Dished forehead, have straight top-line and level rumps with sharp withers.
- Have protruding black eyes.
- Average milk production 4270kg per lactation of 305days. They have butterfat content of 5% -5.3%.
- They tolerate high temperatures. Heifers served at 15-18 months and calve down at 24-27months. Have little pasture requirements. Feeds on poor pastures.

Beef Cattle

Examples:

- Aberdeen Angus,
- Hereford,
- Shorthorns,
- Galloway,
- American Brahman,
- charolais
- Santa Getrudis.

Characteristics of Beef Cattle

- Blocky or square conformation they appear square or rectangular with compact bodies.
- Have thick muscles or are well fleshed.
- Early maturing-grows faster.
- Deep chest and girth and short legs.
- Straight top and lower lines.
- Efficient converters of food into meat and fats
- Good foragers have reduced selective grazing.

- Breed regularly
- More resistant to diseases
- Able to maintain good weight even during adverse conditions.

AberdeenAngus

- ***Origin:*** North East Scotland in the country of aberdeen.
- ***Colour:*** Black with a long smooth coat of hair
- ***Shape:*** Cylindrical, compact and deep; It is polled. It matures early and cows have a good mothering ability.

Size:

- Mature bulls weigh 900kg.
- Mature cows weigh 72s0kgs.
- It is found in Timau area of Kenya

Hereford

- ***Origin:*** England.
- ***Colour:*** Deep red and white-faced.
- ***Size:*** Average weight of bulls is 1000kg.
- Cows weigh 840kgs.
- It is found in areas such as Naivasha.

Shorthorn

- ***Origin:*** England.
- Has easy fleshing ability
- ***Colour****:* Red, Roan or white
- ***Shape****:* Cylindrical, compact and deep.
- It is polled.

Size:

- Bulls weigh 700-900kg,
- cows weigh 545-630kgs.

Galloway

- ***Origin:*** Scotland.
- ***Colour:*** Black
- Kept in the highland areas like Molo in Kenya.

Charolais

- ***Origin:*** France.
- ***Colour:*** Creamy white.
- ***Size:*** Bulls weigh 1200kg, cows weigh 1000kgs.
- It is found in ranches in Laikipia District.

Dual Purpose Breeds

Examples: Sahiwal, Red Poll and Simmental.

Sahiwal

- ***Origin:*** India and Pakistan ..
- ***Colour****: r*eddish brown.
- ***Size:*** Bulls weigh 650kg, and **cows** 400kg.
- Milk production averages 2700-3000 per lactation with a butter fat content of 3.7%.

- It has a pendulous udders which does not let down milk easily.
- It is therefore said to be a difficult milker.
- It is kept in semi-arid areas such as Naivasha.

Red Poll

- ***Origin:*** England.
- ***Colour:*** Deep red with a white nose.
- ***Conformation:*** Polled-deep girth and short legs.
- *Kept in semi-arid* areas such as Nakuru, Mogotio.

Simmental

- ***Origin:*** Switzerland.
- ***Colour:*** Light red and white patches on the head.

Conformation:

- It has broad and straight back, with well-sprung ribs and deep girth.
- It is well fleshed at rear quarters, well suspended udders and large teats.

Sheep Breeds:

Purpose of Keeping Sheep;

- Meat (mutton).
- Wool production.

Exotic Sheep

- ***Wool breeds*** -for example merino.
- ***Dual purpose-*** for example Corriedale, Romney marsh.
- ***Mutton breeds*** -for example Hampshire Down, Dorpers.

Merino

- ***Origin:*** Spain

Characteristics:

- It has white face and its lips and nostrils are pink in colour.
- Rams have horns which are spiral in shape.
- It is susceptible to foot rot, worm and respiratory diseases.

Corriedale dual

- ***Origin:*** New Zealand.

- ***Size:*** Rams 85 - 90kg. Ewes 60-- 85 kg. fleece weigh 5-5.5kg.
- This is a dual-purpose breed with white open face and white spots on the legs.
- It is hornless and hardy.
- Has high quality wool and meat
- Moderately long legs covered with wool.
- Wool is of good length and low shrinkage.
- It's a crossbreed between merino and Lincoln.

Romney Marsh dual

- ***Origin:*** England.
- ***Size:*** Rams 102 - 115kg.
- Ewes 84- 100 kg
- It is a dual-purpose breed which s hornless with wide poll and black nostrils and lips.
- It is average in prolificacy.

- Suitable for high altitude
- Has black hooves
- It is resistant to foot rot diseases and worm infestation.
- Produces medium length wool. 3.6-4.1kgs

Hampshire Down dual

- ***Origin:*** England.
- ***Size:*** Rams 125kg.
- Ewes 80-100 kg
- It is a mutton breed which is early maturing, hardy and prolific.
- Fleece is of poor quality because of the black fibres.
- Lambing percentage is 125-140.

Dorper

- Is a crossbreed of Dorset horn and black head Persian sheep.
- It is mutton breed.

Dorset Horn

- Dual purpose breed of sheep.
- Indigenous Breeds of Sheep
- Their bodies are covered with hair.
- Their classification is based on their tails and their names vary according to different tribes.

Characteristics;

- Thin tailed sheep found in West Africa.
- Fat tailed such as Maasai sheep.
- Fat rumped sheep.

Maasai Sheep

- Found in South Western Kenya and Northern Tanzania. Its an indigenous breed
- It has an ability of utilizing poor pastures.
- Size: Ram 38kg,
- Ewe 20-30kg.
- Colour: Red and brown.
- These are early maturing with long legs and small pointed horns.

Black Head Persian Sheep

- ***Origin:*** Arabia now in northern kenya–its indigenous breed
- ***Colour:*** White with black head and neck.
- It is polled with a big dewlap, fat rump and a curved tail.
- Its tolerant to harsh conditions.
- Has a fat tail and prolific with long legs.
- Weighs 50kgs when mature.

Goats

Billy or Buck –mature male goat

Nanny/Doe –mature female goat

Kid – young one of a goat

Goats well adapted to a wide range of environmental conditions because of the following characteristics:

- They feed on a wide range of vegetation.
- They require very little amount of water.
- They are tolerant to high temperatures.
- They are fairly resistant to diseases.
- They can walk long distances without losing weight.

Goat breeds

Classified into

- Dairy goats (temperate/exotic and tropical/indigenous dairy goats)
- Meat goats
- Hair goats
- Indigenous
- Exotic

Indigenous Goat Breeds

- Galla (white in colour). Adult female can weigh 25kg.
- Somali (Boran): Found in Northern Kenya (white in colour).
- Turkana/Samburu: (Long hair and bearded.
- Mubende: (Black) (40-45kg). These are small and hardy and are kept for meat and milked by the pastoralists.
- Has good quality meat.

Exotic Breeds

Boer goat meat goat

- ***Origin:*** South Africa
- ***Colour:*** White
- Has long ears and long hair on their bodies.
- Has an ability to twin and triplet
- Has a rapid body growth and weight gain

Anglo-Nubian -tropical dairy goat

- ***Origin:*** North East Africa
- ***Colour:*** Roan and White
- These have long legs, lopped or flopping ears and are polled.
- They produce 1-2 liters of milk per day.

Jumnapari –tropical dairy goat

- Crossbreed between Indian jamnapari and Egyptian Nubian.
- ***Origin:*** India
- ***Colour:*** White, black and frawn.
- They are horned, have large lopped ears
- Produce 1-1.5_litres of milk per day.
- Adult female weigh 45-60kgs

Toggenburg dairy goat

- ***Origin:*** Switzerland

- ***Colour:*** White patches on the body, white stripes on the face and neck.
- Erect forward pointing ears and polled.
- Can produce 2-3 of milk per day.

Saanen dairy goat

- ***Origin:*** Switzerland.
- ***Colour:*** White
- They have erect, forward pointing ears and polled.
- Can produce 3-3.5 litres of milk per day. Has 3.5 butterfat percentage

British alpine dairy goat

- ***Origin*** *Britain*
- *Distribution widely distributed in Kenya*
- *Lower than saanen and toggenberg*

Angora hair goat

- ***Origin:*** Angora in Asia.
- ***Colour****:* White
- It is kept for woo/hair(mohair) production.
- Its vulnerable to internal parasites

French alpine. Pigs

Characteristics:

- They are sparsely haired and therefore cannot withstand cold.
- Pigs wallow when it is hot due to absence of sweat glands.
- They breathe fast when it is hot.
- They have bristles instead of hair.

Breeds

Large White

- ***Origin:*** Britain
- _ Kept for bacon and pork production.
- Long, large and white in colour.
- Ears straight and erect.
- Has dished face and snout.
- Most prolific and with good mothering ability.
- Fairly hardy.

Landrace

- ***Origin:*** Denmark
- White and longer than large white. _
- Ears drooping.
- Good for bacon production.
- Very prolific with good mothering ability. _
- Requires high level of management.

Wessex Saddle

- ***Back Origin:*** England
- ***Colour:*** Black with white forelegs and shoulders.
- Straight snout and drooping ears. _
- Good for bacon and pork.
- Good for keeping outdoors.
- Excellent mothering instincts.

Other pig breeds include:

- Berkshire,
- Middle-white
- Duroc Jersey pig.

Pigs can be crossed to obtain hybrids or crosses.

Advantages of Crosses

- Increased litter size. _
- Early maturing.
- _ Increase in body length.
- _ High proportion of lean meat to fat.

Poultry Breeds

There are three types of chicken breeds:

- The light breeds kept for egg production.
- The heavy breeds kept for meat production.
- Dual purpose breeds - kept for both eggs and meat production.

Characteristics of Light Breeds

- Never go broody hence poor sitters.
- Excellent layers (over 220 eggs per year).
- Poor meat producers (hens can attain 2kg; cocks 3kgs)
- Very nervous and exhibit high degree of cannibalism.
- Hen's comb is large and bent over one eye and cock's comb is large with 5 - 6 serrations.

Examples:

- Leghorns,
- Anconas,
- Silkies,
- Minorcas.

Characteristics of Heavy Breeds

- Can lay few eggs and provide good meat as broilers.
- Can go broody.
- Heavier and bigger in size.
- Grow fast.

Examples:

- Light Sussex,
- Cornish Dark
- White.

Characteristics of Dual-Purpose Breeds

- Go broody.
- Have good meat.
- Disease resistant (do not require high standard of management).
- Rarely exhibit cannibalism.

Examples: Rhode Island Red.

Hybrids

- These are developed by crossing two different breeds.
- They are superior in performance.
- Can attain 2kg in 56 days for broilers and layover 200 eggs per year for layers.

Examples:

- Shavers,
- Thombers
- Isabrown.

Rabbits

Kindling *young one of a rabbit*

Doe *mature female rabbit*

Buck *mature male rabbit*

They do well in nearly all the environmental conditions

They low food and space requirement.

Kept for the following reasons:

- To provide meat, fur, hair or wool.
- To provide skin for leather.
- To provide manure for maintaining soil fertility.
- As pet animals.
- Used for research purposes.

Breeds

- ***Californian white****:* white, very prolific black ears, paws, tail, nose and feet).
- ***New Zealand white/Kenya white****:* (white with pink eyes - good for meat). Weighs 4-5.0kgs at maturity.
- ***Flemish giant*** (dark grey - good for meat).
- ***Angora rabbit*** (white, kept for wool production).
- ***Chinchillah*** (greyish, kept for its fur and meat production).
- ***Earlops*** (white with droopy ears).
- ***Kenya white*** (white, smallest of breeds).
- ***Earlops*** *has dropping ears and white in color.*

Camels

Kept in arid and semi arid areas for;

- Animal power -Transportation,
- Racing,
- To provide milk (9l per day per lactation of 300days) milk contain 4% butterfat, meat and wool.
- Production of hides for the textile industry

There are two species of camels.

Dromedary (Camelus dromedarius)

- ***Origin:*** Arabia and Syria
- Are single humped, have light body
- Good for racing and rapid transport.

Bacterian (Camelus bacterianus)

- ***Origin:*** Central Asia
- Has double humps, heavier and has shorter legs.
- Its smaller than dromedary
- Can live in cold regions hence its thick and long coat/fur acts as insulation.
- Yields 5-12kg of fur per shearing season
- Capable of shedding the coat during spring.

Donkey

Kept for
Provision of animal power i.e carrying of loads, pulling of carts and ploughs.

Terms used to describe livestock in different age, sex and use.

Livestock		*Adult*	*Replacement Stock*		*Young*	*Users)*
Species	*Male*	*Female*	*Male*	*Female*	*One*	
Cattle	Bull	Cow	Bullock	Heifer	Calf	Dairy - milk Beef-meat
Sheep	Ram	Ewe	Ram	Hogget	Lamb	Mutton - meat Wool sheep -wool
Goat	Buck or	Doe or	Buck Billy	Doe Nanny	Kid	Dairy - milk Mutton - meat
Pigs	Boar	Sow	Boar	Gilt	Piglet	Pork - meat Bacon -cured
Poultry	Cock	Hen	Cockerel	Pullet	Chick	Broilers - meat Layers - eggs
Rabbits	Buck	Doe	Buck	Doe	Kindling	Meat
Camel	Bull	Cow	Bull	Heifer	Calf	Pack, trained for riding, racing milk, meat, fur

Agricultural Economics I
(Basic Concepts and Farm Records)

Introduction

- Economics is the study of how man and society chooses to allocate scarce productive resources to produce various commodities, over time, and distribute them among various consumers in society.
- It's also an applied science that aims at maximizing output while minimizing costs, by combining the limited supplies of land, capital, labour and management to produce goods and services for use by the society over a period of time.
- It attempts to explain how man can best use the limited resources to produce goods and services which satisfies his needs with minimum wastage or loss of these resources

Example;

- food,
- clothing
- shelter

- Agricultural economics is therefore defined as a science that aims at maximizing output while minimizing costs by combining the limited supplies of goods and services for use by the society over a certain period of time.

- **These are;**
  - land,
  - capital,
  - labour
  - management

Basic economic Principles

Scarcity

- Economic scarcity means resources are limited in supply relative to demand.
- This principle implies that there is no time that man can have enough resources to satisfy all his need or desires

Choice/Preference

- Human wants are many and varied and means of satisfying them are limited.
- Therefore, man has to make a choice among the alternatives in order to use the resources available.
- Man does this by satisfying the most pressing needs first.
- This is called **scale of preference.**

Opportunity Cost

- Opportunity cost is the revenue forgone from the best alternative.
- It exists only where there are alternatives.
- Where there are no alternatives the opportunity cost is equal to zero.
- Opportunity cost helps in decision making.

Farm Records

- Farm records are documents kept in the farm
- They show farm activities carried out over a long period of time
- Or information kept in the farm in written form, about the farm and all activities in it.

Uses of Farm Records

- Show the history of the farm
- Show whether the farm is making a profit or loss.
- Show all the assets and liabilities of the farm which can be used to value the farm.
- Help in supporting insurance claims on death, theft, fire or loss of farm assets.
- Help in tax assessment to avoid over taxation.
- Used as a guide in planning and budgeting.
- Helps to detect losses or theft in the farm.
- Make it easy to share profits or losses in partnerships.
- Help in settling disputes among heirs to estate if the farmer dies without a will.
- Provide labour information on terminal benefits for a worker.

Type of Farm Records

- **Production Records** - Show the total yield and yield per unit of each enterprise.

- **Inventory Records** - A record of all permanent and consumable goods in the farm.

Consumable Goods Inventory

Date	*Commodity Item*	*Quantity*	*Date*	*Issued to*	*Quantity*	*balallce Stock*

- **Field Operation Records** - Show in details all field practices carried out together with the input used for all the crop enterprises.
- **Breeding Records** –
  - Show all the breeding activities in the farm.
  - From these records it is possible to select the prolific animals and cull the infertile ones.
- **Feeding Records** – A record of the types of feeds used in the farm and their quantities.
- **Health Records** –
  - Indicates the health conditions of the animals in the farm.

  From these records it is possible to:

  Select and cull animals on health grounds.
  - Know the course of action to be taken in the event of a disease and maintenance of good health.
  - Know the prevalent diseases.
  - Calculate the cost of treatment.
- **Marketing Records** show commodities sold, quantities and value of all the sales.

Labour Records - show labour utilization and labour costs.

Soil Fertility II

(Inorganic Fertilizers)

Introduction

- Plant nutrients occur in the soil in form of soluble substances. Others occur in the atm
- These substances are taken in by the plants in different quantities depending on their roles in the plant tissues.

Essential Elements

- These are nutrients needed by plants for various uses.
- They are divided into two broad categories namely:
  - Macronutrients
  - micronutrients.

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,
- phophorus,
- potassium,
- sulphur,
- calcium
- magnesium.

- Nitrogen, phosphorus and potassium are referred to as **fertilizer elements,**
- Calcium, magnesium and sulphur, are referred to as **liming elements.**

Role of Macronutrients in Plants

Nitrogen (NO_3,$NH4^{++}$)

Sources:

- Artificial fertilizers
- Organic matter
- Atmospheric fixation by lightning
- Nitrogen fixing bacteria.

Role of Nitrogen in Plants

- Vegetative growth
- Chlorophyll formation
- Build up of protoplasm.
- Improves leaf quality in leafy crops such as tea and cabbages.

Deficiency Symptoms

- Yellowing of the leaves/chlorosis.
- Stunted growth.
- Premature ripening.
- Premature shedding of the leaves.
- Light seeds.

Effect of Excess Nitrogen

- Scorching of the leaves.
- Delayed maturity.

Loss of Nitrogen From the Soil:

- Soil erosion.
- Leaching.
- Volatilization.
- Crop removal.
- Used by microorganisms.

Phosphorus ($H_2 P0_4$, HPO^{2-}_4 P_2O_5)

Sources:

- Organic manures
- Commercial fertilizers
- Phosphate rocks

Role of Phosphorus

- Encourages fast growth of the roots.
- Improves the quality of the plant.
- Hastens maturity of the crops.
- Influences cell division.
- Stimulates nodule formation in legumes.

Deficiency symptoms

- Growth of the plant is slow.
- Maturity is delayed.
- Leaves become grey, purple in colour.
- Yield of grains, fruits and seed is lowered.

Loss of Phosphorus From the Soil

- Soil erosion.
- Leaching
- Crop removal
- Fixation by iron and aluminium oxide.

Potasium (K^+, K_2O)

Sources;

- Crop residue and organic manures.
- Commercial fertilizers
- Potassium bearing minerals e.g. feldspar and mica.

Role of Potassium in Plants

- Increases plant vigour and disease resistance.
- Increases the size of grains and seeds.
- Reduces the ill-effects due to excess nitrogen.
- Prevents too rapid maturation due to phosphorus.

Deficiency Symptoms

- Plants have short joints and poor growth.
- Plants lodge before maturing.
- Leaves develop a burnt appearance on the margin.
- Leaves at the lower end of the plant become mottled, spotted or streaked.
- In maize, grains and grasses firing starts at the tip of the leaf and proceeds from the edge usually leaving the midrib green.

Loss of Potassium From the Soil

- Crop removal.
- Leaching.
- Soil erosion.
- Fixation in the soil.

Calcium (Ca^2+)

Source:

- Crop residues and organic manures.
- Commercial fertilizers.
- weathering of soil minerals.
- Agricultural limes for example ***dolomite, limestone***.

Role of Calcium in Plants

- Improves the vigour and stiffness of straw.
- Neutralizes the poisonous secretions of the plants.
- Helps in grain and seed formation.
- Improves the soil structure.
- Promotes bacterial activity in the soil.
- Corrects the soil acidity.

Deficiency symptoms

- Young leaves remain closed.
- There are light green bands along the margins of the leaves.
- Leaves in the terminal bud become hooked in appearance there is a die-¬back at the tip and along the margins.

Loss of Calcium

- Crop removal
- Leaching
- Soil erosion

Magnesium (Mg2+)

Sources:

- Crop residues and organic manures
- Commercial fertilizers
- Weathering of soil minerals.
- Agricultural limes.

Role of Magnesium in Plants

- Forms part of chlorophyll.
- Promotes the growth of the soil bacteria and enhances the nitrogen fixing power of the legumes.
- Activates the production and transport of carbohydrates and proteins in the growing plant.

Deficiency symptoms

- Loss in green colour which starts from the bottom leaves and gradually moves upwards.
- The veins remain green.
- Leaves curve upwards along the margins.
- Stalks become weak and the plant develops long branched roots.
- The leaves become streaked.

Sulphur (SO_4^{2-}, SO_2)

Sources:

- Commercial fertilizers.
- Soil mineral containing sulphides
- Atmospheric sulphur from industries.
- Rain water

Role of Sulphur in Plants

- Formation and activation of coenzyme-A.
- Sulphur is a constituent of amino acids.
- Influence plant physiological processes.

Deficiency Symptoms

- Small plants/stunted growth.
- Poor nodulation in legumes.
- Light green to yellowish leaves/ chlorosis.
- Delayed maturity.

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.

Role of Micronutrients and Their Deficiency Symptoms

- *Copper*
  - Role in oxidation-reduction reactions.
  - Respiration and utilization of iron
  - Deficiency symptoms-**yellowing of young leaves**.
- *Iron*
  - Synthesis of proteins.
  - Takes part in oxidation-¬reduction reactions.
  - Deficiency symptoms - **leaf chlorosis**
- *Molybdenum*
  - Nitrogen transformation in plants.
  - Metabolization of nitrates to amino acids and proteins
  - Deficiency symptoms -**leaf curl and scathing.**
- ***Manganese -*** Same as molybdenum.
- *Zinc*
  - Formation of growth hormone.
  - Reproduction process
  - Deficiency symptoms - **white bud formation.**
- **Boron –**
  - Absorption of water.
  - Translocation of sugar

Inorganic Fertilizers

- These are chemically produced substances added to the soil to improve fertility.

Classification According to:

- **Nutrients contained**
  - ***Straight -*** contain only one primary macronutrient. Ie nitrogen, phosphorous, or potassium. Fertilizers named based on the nutrients contained in ;

    Nitrogenous fertilizers- the primary macronutrient is nitrogen ie CAN, ASN, UREA and SA (sulphate of ammonia

    Phosphatic fertilizers contain phosphorus as a macronutrient. Ie SSP. DSP. TSP

    Potassic fertilizers –they contain potassium as a macronutrient ie muriate of potash kcl and potassium sulphate or sulphate of potash K2SO4

- ***Compound/Mixed/Complex fertilizers*** - contain more than one macronutrient. It can either be a complete or incomplete fertilizer

Complete compound fertilizer- is one that contains all the three primary macro nutrients ie 20-10-10, 25-55-5, 17-17-17 0r 15-15-15

Incomplete compound fertilizer – is one that contains only two of the primary macronutrients ie DAP 18-46-0

- ***Time of application***
  - Some applied when planting.
  - Top dressing after crop emergence
- ***Effects on the soil pH.***
  - Acidic fertilizers.
  - Neutral fertilizers.
  - Basic fertilizers.

Properties and Identification of Fertilizers

Fertilizers have unique properties that aid in their identification.

Nitrogenous Fertilizers

Characteristics

- Highly soluble in soil water.
- Highly mobile in the soil hence it is applied as a top dress.
- Easily leached because of the high solubility hence does not have residual effect on the soil.
- Have short residual effect therefore applied frequently.
-
- Has scorching effect on young crops during wet seasons.
- Easy to volatilize during hot season.
- They have a tendency to cake under moist conditions.
- They are hygroscopic(they absorb moisture hence form cakes hence should be stored in dry conditions.

Examples:

- ***Sulphate of Ammonia $(NH_4)\ 2\ SO_4$***

  Physical appearance:
  - white crystals,
  - Has acidic effect,
  - Contains 20% N.
- ***Ammonium Sulphate Nitrate $[(NH_4)_2\ SO_4 + NH_4\ NO_3]$***
  - Colour: granules which appear yellow orange,
  - less acidic,
  - contains 26% N.
- ***Calcium Ammonium Nitrate (CAN)***
  - Colour: greyish granules,
  - neutral in nature,
  - contains 21 % N.
- ***Urea***
  - Colour: small whitish granules
  - Easily leached or volatilized,
  - contains 45- 46%N.

Phosphate Fertilizers

- Has low solubility and immobile.
- Non-scorching.
- Has a high residual effect hence benefit the next season's crop.
- Easy to store because they are not hygroscopic.

Examples;

- ***Single super-phosphate***
  - Appearance: whitish, creamy white granules,
  - contains **20-21 %** P_2O_5
- ***Double super-phosphate***
  - Appearance: dark greyish granules,
  - Contains ***40-42%*** P_2O_5
- ***Triple super-phosphate***
  - Appearance: small greyish granules,
  - Contain ***44-48% P2O5***

Potassic Fertilizers

Characteristics:

- Has moderate scorching effect.
- Moderately soluble in water.
- Most Kenyan soils have sufficient potassium.

Examples;

- ***Muriate of Potash (KCl)***
  - Contain 60 - 62% K_2O
  - Slightly hygroscopic.
  - Appearance amorphous white.
- ***Sulphate of Potash (50%*** K_2O***)***

Compound or Mixed Fertilizers

- These are fertilizers which supply 2 or more of the macronutrients. Ntrient content is expressed in two ways
- Fertilizer grade: indicating a guarantee of minimum content as a percentage of N:P2O5:K2O ie 14-46-0
- Fertilizer ratio- where the relative percentage is expressed as a ratio of NPK present. Ie 10-20-0 as 1:2:0

Examples of compound fertilisers;

- ***Mono ammonium phosphate MAP.***

  Moderately acidic. Contains both nitrogen and phosphorus. Applied during planting.
- ***Di-ammonium phosphate DAP***

  Moderately acidic. Contains both nitrogen and phosphorus. Applied during planting. Grade is 18-46-0
- ***Nitrophos -20:20:0,-*** *Moderately acidic. Contains both nitrogen and phosphorus. Applied during planting.*

Advantages of application of compound fertilizers

- Saves time and money.

- Mixture gives improved storage properties and better handling.

Disadvantages of compound fertilizers application

- Expensive.
- Wasteful.
- Mixing may not be thorough.
- Incompatibility of the individual fertilizers.

Methods of fertilizer application

- ***Broadcasting*** - random scattering of the fertilizers on the ground. For potassic and nitrogenous fertilizers. Its done when the soil is moist. Shallowly dig the fertilizer into the soil to prevent volatilization.
- **Placement method** - application of fertilizers in the planting holes or drills. Thoroughly mix the fertilizer with the soil before seed placement. Ideal for phosphatic fertilizers.
- ***Side dressing*** - fertilizer is placed at the side of the plant within the root zone, in bands or spot-rings. Ideal for nitrogenous fertilizers. Its achieved through ring applicationplacement around an individual crop beneath the canopy) or band application(in between rows of crops in a band)
- ***Foliar spraying*** - specially formulated fertilizer solution applied on the foliage in spray form. Fertilizer is directly absorbed by leaves. Preferred during prolonged dry season or topdressing closely spaced crops ie wheat.
- ***Drip method*** - applied through irrigation water. Its applied through perforated pipes or bottles. Commonly used in horticultural crop fields.

Determination of Fertilizer Rates

Contents of fertilizers are expressed as fertilizer grade or fertilizer analysis.

- Fertilizer grade indicate the guaranteed minimum of the active ingredients (N, P_2O_5, K_2O) in the mixture or amount of each nutrient contained in a fertilizer. Its calculated by finding out chemically the percentage of each nutrient present in a fertilizer

  Percentage of nutrient= nutrient content/total weight of the fertilizer. Its in terms of the three macronutrients NPK. 10-10-10 grade contains 10kg N 10kg of P2O5 and 10kgs of K2O. 30kgs forms active elements with 70kgs filler material.
- Fertilizer ratio-gives relative proportion of the three primary macronutrients. A 10:10:10 has N:P2O5:K2O in the ratio of 1:1:1
- The amount of fertilizer or nutrient required per unit area-it depends on the amount of nutrients needed and fertilizer grade.
- It is expressed as a percentage on a weight to weight basis or percentage by weight

Example 10:20:0 means for every 10kg of the mixture there are 10kg of nitrogen, 20kg of P_2O_5 and 0kg of K_2O.

Amount of fertilizer applied in the field is determined by the amount of plant nutrients available.

Example

A farmer was asked to apply fertilizers as follows:

- 60 kg/ha nitrogen (top dressing)
- 60 kg/ha P_2O_5 (in planting hole).
- 60 kg/ha K_2O.

How much sulphate of ammonia (20%) would be required per hectare?
How much double super-phosphate (40%) P_2O_5would be required per hectare?
How much muriate of potash *(50%* K_2O) would be required per hectare?

Answer/Solution

- Sulphate of ammonia (SA) which gives 60kg/ha N

  $= \frac{60}{20} \times 100 = 300\text{kg SA}$

- Double super phosphate (40% P_2O_5)which gives 60kg/ha P_2O_5

  $= \frac{60}{40} \times 100 = 150\text{kg DSP}$

- Muriate of potash (60% K_2O) which gives 60kg/hK_2O

  $= \frac{60}{60} \times 100 = 100\text{kg muriate of potash}$

Example

A farmer was asked to apply fertilizers as follows:

- 200kg/ha of DSP (40% P_2O_5
- 150kg/ha of muriate of potash (60% K_2O)
- 150kg/ha of sulphate of ammonia (20% N)

How much P_2O_5 did the farmer apply per acre?
How much K_2O did the farmer apply per hectare?
How much N did the farmer apply per hectare?

Solution/Answer

- P_2O_5 applied per hectare from 200kg of DSP

  $= \frac{40}{100} \times 200 = 80\text{kg/ha } P_2O_5$

- K_2O_5 applied per hectare from 150kg of muriate of potash

  $= \frac{60}{100} \times 150 = 90\text{kg/ha } K_2O$

- ***N*** applied per hectare from 150kg/ha sulphate of ammonia

  $= \frac{20}{100} \times 150 = 30\text{kg/ha N}$

Carbon cycle

Carbon cycle refers to a series of changes which, carbon undergoes in the atmosphere, water soil and leaving organisms.

Occurs inform of carbon dioxide and forms 0.03% by volume. Plants acquire carbon inform of carbon dioxide.

Ways in which carbon is removed from the atmosphere

i) Photosynthesis-carbon dioxide combines with water in presence of sunlight to form carbohydrates in green plants. Oxygen is given out as a by product

ii) $6CO_2 + 6H_2O \ldots\ldots\ldots\ldots C_6H_{12}O_6 + 6O_2$

iii) It dissolves in rain water forming carbonic acid that gets into the soil leading to weathering.

Ways in which carbon is returned into the atmosphere

i) Respiration- carbon dioxide is given off during aerobic respiration in living cells

ii) Combustion- burning of carbon containing material releases carbon dioxide into the atmosphere.

iii) Decomposition- when plants and animals decay

Importance of the carbon cycle

- Maintains the volume of carbon dioxide in the atmosphere
- Ensures constant supply of carbon dioxide for plant user
- Ensures balance between carbon dioxide and oxygen to prevent the build up of carbon dioxide to a toxic level.

Nitrogen cycle

Refers to a series of changes which nitrogen undergoes between the atmosphere, water, soil and living organisms. Nitrogen occurs naturally in form of nitrogen forming 78% by volume.

Ways in which nitrogen is removed from the atmosphere

i) Nitrogen fixation by lighting- it involves nitrogen combining with oxygen to form nitric oxide. The oxide is oxidized to nitrogen dioxide that dissolves forming nitric acid

$N_2 + O_2$--------$2NO$

$NO + O_2$--------NO_2

$NO_2 + H_2O$ -------$H_2NO_2 + H_2NO_3$

Nitric acid ionizes to form nitrate ions readily available to plants.

ii) Nitrogen fixation by nitrogen fixing bacteria

It involves both symbiotic and non symbiotic nitrogen fixation.

Symbiotic nitrogen fixation involves rhizobium bacteria in root nodules of leguminous plants

Non-symbiotic - involves fixation by free living bacteria found in the soil ie azotobacter and clostridium

iii) Nitrification-the process by which ammonium compounds are converted into nitrates and nitrites by nitrobacter and nitrosomonas bacteria.

iv) The Harber –Bosch process is a process that results in formation of ammonia

$N_2 + 3H_2$……$2NH_3$

Amonia formed is used to prepare SA and CAN

Ways in which nitrogen is returned into the atmosphere

i) Denitrification

Is the conversion of nitrates into ammonia gas and ammonium ions that escapes into the atmosphere.its common in water logged and compacted areas.

ii) Combustion

Some nitrogeneous compounds are converted into ammonia and nitrogen oxide when vegetation is burned.

iii) Volatilization

Some ammonium compounds sublime forming ammonia gas that escapes into the atmosphere.

Importance of nitrogen cycle

i. Ensures availability of nitrogeneous compounds in the soil for plant use

ii. Ensures survival of anaerobic microorganisms ie clostridium.

Soil Sampling

- Refers to the process of obtaining of small quantity of soil from the field to be a representative in all aspects of the entire farm. Its done to test for soil nutrients and soil PH. It also gives information about soil status.

Soil Sampling Procedures

It varies based on the local situations.

- Clear the vegetation over the site.
- Dig out soil at depths of 15-25cm for crop land and 5cm for pasture land.
- Place the dug out soil (using soil auger) in a clean container.
- Repeat the procedure in 15-20 spots
- Mix thoroughly the soil in the container.
- Take a sample and send it to National Agricultural Laboratory for analysis.
- The container carrying the sub-sample or composite sample should be properly labeled as follows:
  - Name of the farmer,
  - Location,
  - District
  - Address of the farmer.
  - Field number
  - Date of sampling

Sites to Avoid –this areas give misleading information

- Dead furrows, ditches.
- Swamps
- Near manure heaps.
- Recently fertilized fields
- Ant hills.
- Under big trees.
- Near fence lines or foot paths.
- Do not put them in containers which are contaminated with fertilizers or other chemical containers.

Methods Of Soil Sampling:

- Zigzag method –locations for taking soil samples are arranged in a zigzag way.
- Traverse method –determine the four corners of a field and take samples diagonally

Soil Testing

- It's the process of analyzing soil samples to determine the ability to supply the essential elements or the analyzing of the soil sample to determine certain qualities of the soil.

Importance of Soil testing:

- To determine the value of the soil hence determine the crop to grow.
- To determine the nutrient content hence find out the type and amount of fertilizer to apply.
- To determine whether it is necessary to modify the soil pH for a crop.
- Helps to diagnose the cause of low crop yields.

Soil PH

Refers to the potential hydrogen or hydrogen ions concentration in a soil solution. It's a

measure of the acidity(H^+) or alkalinity(OH^-) of the soil solution. It's the negative of the logarithm to base 10 of the hydrogen ion concentration. PH= -log $[H^+]$ For $[H^+]=10^{-6}$ PH is 6.

How Soil pH affects Crop Production

- Influences the physical and chemical properties of the soil.
- Affects the availability of nutrients.
- Influences the incidences of soil borne diseases.
- Determine the type of crop to be grown at a given area.

Methods of pH Testing

- Universal indicator solution (colour indicator dyes)-it's a commonly used method
- pH meter –only used in research institutes, colleges, universities and some college training institutes.

Procedures of determining soil PH using colour indicator

i. BDH universal indicator method

- Place small quantity of soil on a porcelain plate and add 1-2cm3 of the indicator
- Wash the soil with the indicator and allow the indicator to drain away into a clean part of the porcelain.
- Observe the colour of the solution against the PH colour chart.
- Estimate the acidity or alkalinity of the solution.

ii. Soil test with universal indicator papers

- Add a small amount of soil sample to cm3 of 25boiled distilled water
- Shake the mixture thoroughly and deep a piece of the PH paper.
- Check the colour of the PH paper against the colour chart to find out the PH value.

iii. Field test using printed colour standards

- Fill the test tubes with barium sulphate to a 3cm depth (for fine soil use more barium sulphate less for course soils) to ensure flocculation and precipitation of colloidal clay,
- Add soil to a depth of 55cm in each test tube
- Add boiled distilled water upto the upper mark
- Add 8 drops of BDH soil indicator to one of the test tube and leave the others without

- Shake the test tube for one minute and allow it to settle
- Hold the test tubes side by side and view the colour on the chart through the blank tubes.
- Slide the chart along until the printed colour viewed through the blank tube matches the colour of suspension containing indicator

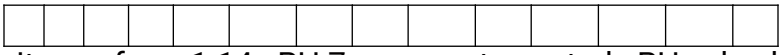
  NB red colour indicate acidic while blue indicate alkaline or basic

iv. Using commercial soil testing kit

- Add distilled water to a small soil sample to make soil solution
- Add afew drops of colour indicator
- Compare the colour of the soil solution to that on the chart

The PH scale

It's a scale used to estimate the degree of acidity or alkalinity of a solution.



It runs from 1-14. PH 7 represents neutral. PH value below 7 indicates acidic condition while above 7 alkaline conditions. Soil PH influences availability of various nutrients in the soil.
Most nutrients are readily available at neutrality. Phosphates (6-5 7-5)
At PH 8.5 –potassium, manganese, boron, iron and zinc are unavailable
Low PH –lowers availability of phosphorous

How soil PH affects crop production

- Influences the physical and chemical properties of the soil
- Affects availability of nutrients
- Influences incidences of soil borne diseases
- Determine the type of crop to be grown at a given area

Importance of soil PH to crops

- It determine presence or absence of nutrients
- It controls the activities of soil microorganism- low PH inhibits soil microorganism activity ie nitrogen fixation hence low nutrient levels. Optimum PH for microbial activity is 5.5-7.8
- Soil PH may determine the survival of pests ie nematodes seriously damage plants in acidic soils. Low PH lowers plant resistance to pests
- Determines the type of crop to be grown- different crops species react differently to soil PH. barley is affected by low PH. Tea dos well at low PH oats does well at both

low and high PH.

Importance of soil testing

- To determine the nutrient content hence find out the type of fertilizer to apply
- To determine whether it is necessary to modify the soil PH for a crop
- To determine the value of the soil hence determine the crop to grow

Crop production II (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.

Types of planting materials

i) 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.

ii) Vegetative materials.

- These are plant parts which have the ability to produce roots, they grow and develop in to new plants.

- They include leaves, roots, or stems. They are used a 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 there fore difficult to store and transport.

Plant parts used for vegetative propagation.

i) Bulbils.

- These are tiny sisal plants produced in the inflorescence almost at the end of the plant growth cycle.
- They resemble the mother plant except that they are smaller in size.
- They are produced by the branches of the sisal pole.
- When manure they mature they develop rudimentary roots and fall off to the ground just below the pole.
- They are then collected and raised in the nurseries before they are transplanted t\o the main field.
- One sisal pole may produce as many as 3,000 bulbils. They are usually 10cm long. They make good planting materials and are better than suckers

ii) Splits

- These are plantlets divided from the existing mother plant with complete with complete leaves and rooting system.
- They are used to propagate most pasture grasses and pyrethrum.

- Pyrethrum splits are raised first in nursery and then transplanted to the field.

iii) Crowns and slips

- These are materials used to propagate pineapples
- Crowns are born on top of the fruits and are broken off and prepared for planting.
- They are more preferred to suckers because they give uniform growth and take two years to reach maturity.
- Slips are borne to the base of the pineapple fruits.
- They are cut and prepared for plantings.
- Their growth rate is faster than for crowns giving average uniformity.
- They take 22 months from planting to maturity.
- Crowns and slips are planted in the nurseries first before transplanting to the main seed bed.

iv) Suckers

- These are small plants that grow from the base of the main stem.
- They have adventitious roots which grow quickly when planted to form a new plant.
- They are used to propagate bananas, sisal, and pineapples.
- When planted, suckers give uneven growth leading to maturity at different times. They should be planted when they are young.

v) Tubers

- These are underground food storage organs which are short and thick.
- They are used as vegetative propagation materials because they sprout and produce roots for growth.
- There are mainly two types of tubers, the stem and root tubers.
- Root tubers develop from the thickening of the adventitious roots.
- Root tubers are not commonly used for propagation since they produce weak stems.
- A good example of a root tuber is the sweet potato.
- On the other hand stem tubers have some auxiliary buds which are sometimes referred to as ‘eyes’.
- These eyes sprout to produce stems which grow into plants. Stem tubers are therefore swollen stems with scales leaves.
- A good example of a stem tuber is Irish potato.

vi) Vines.

- These are soft wood cuttings which produce roots easily upon planting to give rise to new plants.
- They are cut from the mother plants and planted directly into the field.
- Soft wood cuttings (vines) are taken from rapidly growing shoots.
- The soft upper parts of the shoots are preferred.
- When preparing the cuttings, some leaves and nodes are included.
- Roots are produced from the nodes.

vii) Cuttings and setts

- Cuttings are portion of plants parts which are cut and then planted.
- They may be from stems, roots or leaves.
- A stem cutting must have a bud which develops into shoot.
- The root cutting must have an eye. Cutting must have an eye.
- Cuttings must produce leaves as soon as possible so that they can start making their own food.
- Sometimes cuttings are induced to produce roots by use of rooting hormones.
- Once the cuttings have developed roots, they give rise to new plants.
- In some crops, the cuttings are big enough to be planted directly to the main seedbed whereas there are some plants whose cuttings are first raised in special nurseries before they are transplanted to the seedbed.
- The cuttings of Napier grass and sugar-cane are planted directly on the seedbed but those of tea; have to be raised in special nursery before they are transferred to the seed bed.
- Examples of crops which are propagated by use of stem cuttings include: tea, cassava, and sugar -cane and Napier grass.
- The stem cuttings used to propagate sugar-cane are known as ‘setts’. Setts are stem cuttings which have 3-5 nodes are usually 30-45 cm long.

Factors affecting rooting of cuttings.

- **Temperature:** for the cuttings to produce roots warm temperatures are required around the root zone while cool temperatures are important for the aerial part of the cuttings. For most species optimum day and light temperatures for rooting are 22 -27°c and 15-21° c respectively.

a) **Relative humidity:** Proper rooting of cuttings requires high humidity which lower the transpiration rate. It also increases and maintains leaf turgidity all the time. As such, cuttings should be rooted in green houses or under shady conditions, where relative humidity can be regulated. Sometimes the propagation area can be sprayed with water to keep it moist.

b) **Light intensity:** soft wood cuttings need high intensity light to produce roots. This is because

light promotes the production of roots since it affects the rate of photosynthesis. Hard wood cuttings do well in dark conditions since they have high amount of stored carbohydrates and therefore rooting is excellent in darkness.

c) **Oxygen supply:** plentiful supply of oxygen is required for root formation. The rooting medium used must therefore be capable of allowing proper aeration.

d) **Chemical treatment**: these rooting hormones which promote the production of roots in cuttings. The common ones include IAA (Indoleacetic acid).

e) **Leaf area:** Soft woods cuttings require a lot of leaves for photosynthesis while hardwood cuttings will produce roots better without leaves.

Selection of planting materials

When selecting materials for planting the following factors must be considered:

- **Suitability to the ecological conditions** – the selected planting materials should be well adapted to the soil conditions, temperatures and amount of rainfall in the area. There are many varieties of maize, for example, which are suitable to different ecological conditions. Hybrid 622f or example is mainly for the high altitudes areas of Kenya 513 for the medium altitudes and the Katumani composites for the low rainfall areas while the coast composites are suitable for the coastal conditions each variety will grow well and produce high yields if grown under the correct conditions

- **Purity of the materials** - planting materials should be pure and not mixed with other off types the percentage purity of planting materials will affect the seed while higher seeds rates are used for impure seeds.

- **Germination percentage** - This is a measure of the germination potential of seeds it is expressed as a percentage for example a germination percentage of 80 means that for every 10 seeds planted 80 of them are expected to germinate. Germination percentage helps to determine the seed rates of crops lower seed rates are used for crops with higher germination percentage while higher seed rates are used for those with lower germination percentage.

- **Certified seeds** - These are seeds which have been tested and proven to have 100 germination potential and free from diseases and pests they give high yields after the first planting but the subsequent yields decline if replaced therefore in this case it is always advisable to buy new seeds which are certified every time planting is done

  In Kenya certified seeds are produced by the Kenya seed company (KSC) and distributed by Kenya Farmers Association (KFA) and other agents.

PREPARATION OF PLANTING MATERIALS.

After the planting materials are selected they are prepared in different ways before they are planted. Some of the methods used to prepare planting materials include the following:

(a)Breaking the seed dormancy.

Some seeds undergo a dormancy period between maturity and the time they sprout. The dormancy period is the stage whereby a seed cannot germinate, the stage of inhibited growth of seed. It

should be broken before the seed is planted.

Methods of breaking seed dormancy.

The following methods are used to break seed dormancy**:**

(I) ***Mechanical method:*** This is a method which aims at scratching the seed coat to make it permeable to water. Scarification is done by rubbing small sized seeds against hard surface such as sand paper, while filling or nicking the seed coat with a knife is done to large sized seeds such as croton seeds.

(ii) ***Heat treatment:*** this involves the use of hot water or burning the seeds lightly. It softens the seed coat making it permeable to water and thus is able to germinate. The seeds are soaked in hot water about 80'c for 3-4 minutes after which the water is allowed to drain off. Example of seeds treated in this way include: leucean $7a^2 + 3^2 = 2^2$ calliadra and acacia.

Light burning also serves the same purpose as hot water treatment. In this case trash is spread over the seeds which are already covered with a thin layer of soil. The trash is burned, after which the seeds are retrieved and planted. Examples include acacia and wattle tree seeds. Overheating should be avoided as this will cook the seeds.

(iii)Chemical treatment: seeds are dipped in specific chemicals such as concentrated sulphuric acid, for two minutes and then removed. The chemical wears off the seed coat making it permeable to water. Care should be taken not to leave the seeds in the chemicals for too long as this will kill the embryo. Cotton seeds are normally treated with chemicals to remove the lint or fibres.

iv) Soaking in water: seeds are soaked in water for a period of between 24 – 48 hours until they swell. They are then removed and planted immediately. The seeds treated thus germinate very fast. Pre-germinated seeds are used when raising rice in the nurseries.

b) Seed dressing

This is the coating of seeds with fungicides or an insecticide or a combination of the two chemicals. This is particularly common with cereals, sugar-cane and legumes.

The chemicals protect the seedlings from soil-borne diseases and pests. Certified seeds which are sold by seed merchants in Kenya have been dressed with these chemicals. Farmers can also buy the chemicals and dress their own seeds.

C) Seed inoculation

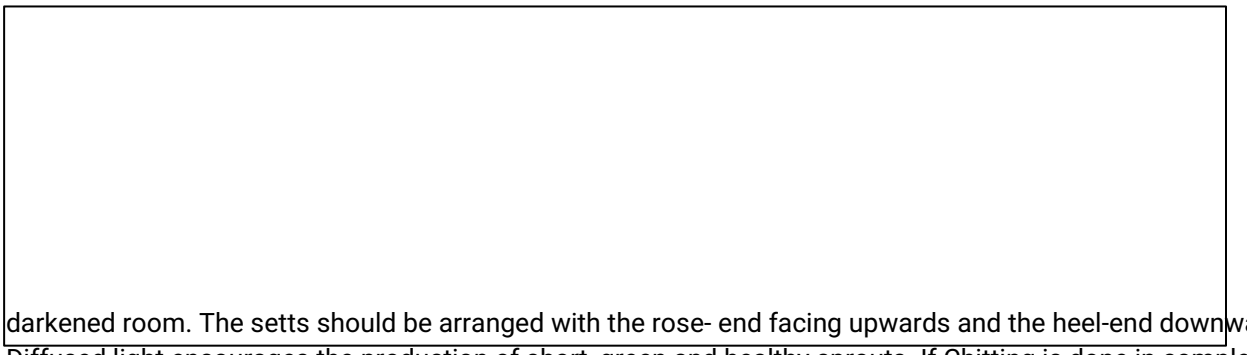
In areas where soils are deficient in nitrogen, legumes such as beans, clovers and peas should be coated with an inoculant. An innoculant is a preparation which contains the right strain of Rhizobium depending on the type of legume and encourages nodulation, hence nitrogen fixation. Below is a table showing different legume crops and their right strain of Rhizobium.

Crop inoculation group	**Rhizobium Species**
Lucerne	*R. melioti*
Clover	*R. trifoli*
Pea	*R. leguminosarum*
Bean	*R. phaseoli*
Lupin	*R. lupine*
Soyabean	*R. japonicum*

When handling inoculated seeds, care should be taken to prevent them from coming in contact with chemicals. This means that inoculated seeds should not be dressed with chemicals as these will kill the bacterium. They should also be planted when the soil is moist to avoid dehydration which kills the bacterium.

d) Chitting

This practice is also referred to as sprouting. The selected seed potatoes 'setts' which are used as planting materials are sprouted before planting to break their dormancy. The setts of about 3-6 cm in diameter are arranged in layers of 2 or 3 tubers deep in a partially



darkened room. The setts should be arranged with the rose- end facing upwards and the heel-end downwards. Diffused light encourages the production of short, green and healthy sprouts. If Chitting is done in complete darkness, long, pale thin sprouts develop which break easily during planting. During Chitting potato aphids and tuber months should be controlled by dusting or spraying the sett with dimethoate. Sometimes a chemical known as Rendite is used to break dormancy, thus inducing sprouting. Chitting is done mainly to make sure that growth commences immediately the seed is planted so as to make maximum use of rains for high yields.

Time 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 scare dry planting is recommended.

Advantages of timely planting.

- Crops make maximum use of rainfall and suitable soil temperature, leading to vigorous growth.
- Crops usually escape serious pests and diseases attack.
- Crops benefit from nitrogen flush which is available at the beginning of the rain.
- For horticultural crops, proper timing ensures that the produce is marketed when prices are high.
- Crops establish earlier than the weeds, hence smothering them.

Methods of planting.

There are two main methods of planting :-

- Broadcasting.
- Row planting.

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.

Over-sowing.

This is the introduction of a pasture legume such as desmodium in an existing grass pasture. Some form of growth suppression of existing grass such as burning, slashing or hard grazing plus slight soil disturbance is recommended before over sowing. A heavy dose of superphosphate, preferably single supers at a rate of 200-400 kg/ha is applied. The grass must be kept short until the legume is fully established. Regardless of the method of establishment, the pastures and fodder stands should be ready for light grazing 4-5 months after planting if rainfall and soil fertility are not limiting.

Under-sowing.

This refers to the establishment of pasture under a cover crop, usually maize. Maize is planted as recommended and weeded 2-3 weeks after the onset of rains. Pasture seeds are then broadcasted with half the

recommended basal fertilizer. No further weeding should be done and maize should be harvested early to expose the young pasture seedlings to sunlight. The benefits of under sowing include facilitating more intensive land utilization and encouraging an early establishment of pastures.

Fodder crops and vegetetively propagated pasture species may also be under sown as long as rainfall is adequate for their establishment. Timing is not very crucial in this case and planting can be done as late as 6-8 weeks after the onset of rains.

Plant population

This refers to the ideal number of plants that can be comfortably accommodated in any given area, without overcrowding or too few to waste space. Agricultural research has arrived at the optimum number of various crop plants to be recommended to farmers. Plant population is determined by dividing the planting area by spacing of the crop. This may be simplified thus:

$$\textbf{Plant population} = \frac{\text{Area of land}}{\text{Pacing of crop}}$$

Example

Given that maize is planted at a spacing of 75 x25 cm, calculate the plant population in a plot of land measuring 4x3 m.

Working

$$\text{Plant population} = \frac{\text{Area of land}}{\text{Pacing of crop}}$$

Area of land = 400cm x 300 cm

Spacing of maize = 75 cm x 25 cm

Therefore, plant population $= \frac{400 \text{ cm} \times 300 \text{ cm}}{75 \text{ cm} \times 25 \text{ cm}}$

= 64 plants.

Spacing

It is the distance of plants between and within the rows. Correct spacing for each crop has been established as shown in table below.

Crop	Spacing
Maize (Kitale) Hybrids	75 – 90 cm x 23 – 30 cm
Coffee (Arabica) tall varieties	2.75 cm x 2.75m
Tea	1.5 m by 0.75 m
Beans (erect type)	45 -60 m by 25 cm
Bananas	3.6 – 6.0 m by 3.6 – 4.5 m
Coconut	9 m x 9 m

Tomatoes (Money maker)	100 x 50 cm
Kales	60 x 60 cm

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.

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 grater 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.

Suggested Activities.

1. Learners to carry out planting using broadcasting method and planting rows.
2. Learners to identify different vegetative propagation materials displayed by the teacher.
3. Learners to determine the correct plant population for a given area by mathematical calculations.
4. Learners to collect samples of different tree seeds and prepare them for planting by various methods of breaking seed dormancy.
5. Learners to determine the germination percentage of different samples of cereals and legume seeds.

Crop Production III

(Nursery Practices)

Introduction

- Planting materials are either planted directly in a seedbed or indirectly through a nursery bed.
- A seedbed is a piece of land which could be small or large and prepared to receive planting materials.
- A nursery bed on the other hand is a small plot of land specially prepared for raising seedlings or planting materials before transplanting.
- It is usually 1m wide and any convenient length depending on the quantity of seedlings to be raised.
- A seedling bed is a special type of nursery bed used for raising seedlings pricked out from the nursery bed due to overcrowding before they are ready for transplanting.
- Pricking out refers to the removal of seedlings from a nursery bed to a seedling bed.
- Nursery practices refer to all the activities carried out throughout a nursery life to raise seedlings. .

Importance of Nursery Bed in Crop Production

- To facilitate the production of many seedlings in a small area.
- It is easy to carry out management practices in a nursery than in the seedbed.
- It facilitates the planting of small seeds which develop into strong seedlings that are easily transplanted.
- It ensures transplanting of only healthy and vigorous growing seedlings.
- It reduces the period taken by the crop in the field.
- Excess seedlings from the nursery may be sold to earn income.

Selection of a Nursery Site

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 evapo-transpiration and uprooting seedlings.

Types of Nurseries

Categories of nurseries:

- ***Vegetable Nursery****:*
  - They are used for raising the seedlings of vegetable crops.
  - **Tomatoes, cabbages, kale, onions, brinjals and peppers.**
- ***Vegetable 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.

Erect wooden hoops over the sleeved cuttings

Place a polythene sheet on the hoops. Burry the sheet into the ground at the edges.

Water the sleeves once per 3weeks.

Nursery 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 be should be removed on the 4^{th} day when seedlings start to emerge. It prevents excessive evaporation also moderates soil temperature.
- Weed control –remove weeds by uprooting.
- Shading. – NB dark conditions make seedlings to be etiolated and pale
- Pricking out- involves removing overcrowded seedlings and planting them in a second nursery at a spacing of 3-4cm apart. Its done to avoid competition and allow seedlings to grow strong and healthy.
- Pests and disease control-begins when the soil is sterilized through heat treatment or use of chemicals i.e furadan during nursery establishment.
- Hardening off – it's a practice of preparing seedlings to adapt to the ecological conditions prevailing in the seed bed. Involves reducing the shade and watering 1-2weeks before transplanting.

- Watering – done regularly in the morning and evenings.

Preparation of vegetative materials for planting:

- *Grafting –*
  - It is the practice of uniting two separate woody stems. One part provides the base and has a rooting system. The other part is obtained from another plant.
  - The part bearing the roots is referred to as ***root stock*** while the part which is grafted onto the rootstock is known as ***scion.***
  - The scion has buds which develop into the future plant.
  - The ability of the rootstock and the scion to form a successful union is termed as ***compatibility.***

Methods of Grafting

- *Whip or tongue grafting:*
  - In this case the diameter of the rootstock and the scion are the same. Make a slanting cut using a sterilized knife on the scion and top of the stock.
  - It is carried out when the diameter of the scion and the rootstock is 'pencil' thick. Fit together the two separate parts and wrap with a grafting tape or polythene strip.

- *Side grafting:* In this case the diameter of the rootstock is bigger than that of the scion. Scion is inserted into the side of the stock.

Other types of grafting include ;

- *Approach grafting,*
- *Notch grafting*
- *Bark grafting*.

Budding:

- It is the practice of uniting a vegetative bud (scion) to a seedling of another plant.
- The scion has only one bud and some bark with or without wood.
- The bud is inserted in a slit made on the bark of the stock.
- It is held tightly on the stock by tying with a budding tape until it produces a shoot.

Methods of Budding:

- T-budding –prepared by making a T shaped incision 15-20cm above the ground through the bark down to the wood. A sharp knife known as budding knife is used. Bark is raised and bud slided downwards through the raised bark until it lies between the edges of the bark. Bud is firmly tied using either adhesive tapes or polythene papers. Remove the wrapping after 2weeks to inspect the bud. The green bud develops to produce a shoot. The stock is then cut a few cm from the scion. At 25cm the shoot is tied to a stake to prevent it from being blown by wind.
- Top budding –involves budding young or small trees by inserting the bud at desired locations. It allows for production of different fruits on the same root stock.
- Patch budding- its where a bud from the scion stem is removed and inserted into a patch where the bark has been removed from the root stock.

Importance of Budding and Grafting:

- Plants with desirable root characteristics but with undesirable products may be used to produce desirable products for example lemon¬-orange graft.
- They facilitate the changing of the top of the tree from being undesirable to desirable
- They make it possible to grow more than one type of fruit or flower on the same plant.
- They help to propagate clones that cannot be propagated in any other way.
- They help to shorten the maturity period. Ie grafted mangoes take 3.5yrs to mature non-grafted takes 7yrs to mature.
- Grafting helps to repair damaged trees.

Layering

- It is the process by which a part of a plant is induced to produce roots while still attached to the mother plant.
- Once the roots have been produced, the stem is then cut off and planted.

Types of layering;

- Marcotting or aerial layering – used on hard wood plants where the stem cant be bend easily. It involves heaping moist rooting media around a section of a branch whose bark and cambium layer have been removed. Wrap the rooting media with polythene sheet to maintain it moist. Auxins accumulate inducing root development.
- Trench layering- it involves bending a stem and laying it in a trench. Hold it using pegs. Cover it with moist soil. Roots develop at the base and the buds develop into shoots cut off. The shoot is then cut from the mother plant.
- Tip layering.- it involves bending the terminal bud bearing shoot to the ground and covering with a layer of moist soil. It is held in position using a peg. After rooting the shoot is cut from the mother plant and transplanted.
- Compound or serpentine –involves bending a branch several times and hold it in position with pegs to produce several new rooted planting material.

Tissue Culture for Crop Propagation

- Tissue culture is a biotechnology used in cloning vegetatively propagated plants.
- It is based on the ability of plant tissue (or cells) to regenerate other parts of the plant. Tissues are also known as propagules or explants.
- The tissues are derived from shoot tips where cells are undergoing rapid cell division and are not differentiated.
- The cells are then provided with the right conditions which enable them to multiply and develop roots.

The Right Conditions for tissue culture:

- Culture medium containing correct nutrients and growth regulators
- Correct temperature.
- Correct light intensity and
- Correct relative humidity.

Stages in plant tissue culture propagation.

Stage 1- asceptic culture is established and a propagule developed by enhancing cell division and enlargement. Void contamination using disinfectants (alcohol, calcium or sodium hypochlorite, mercury chloride and antibiotics). Sterilize all tools. Culture medium is made of inorganic minerals, carbon and energy source(sugar) vitamins. Organic suppliments and growth regulators.

Stage 2- subculture to rapidly multiply the propagules through somatic development of embryos to produce auxillary buds and adventitious roots. The culture medium is enriched with substances that enhance plant organ development.

Stage 3- involves preparation of the propagule for establishment in the soil. It includes:

i) Rooting of the regenerated plantlets

ii) Hardening the plantlets by imparting tolerance to moisture stress and attack by pathogens. Occurs due to change in physical environments ie increasing the temperatures and light intensity and exposing plantlets to conditions similar to those in the field.

iii) Converting the plantlets from heterotrophic mode of nutrition to autotrophic mode of nutrition. Rooting is promoted by leaving out the growth hormone in the medium or supplementing the medium with auxins.

Importance of Tissue Culture in Crop Propagation

- It is used to recover and establish pathogen-free plants especially in the control of viral diseases.
- It is used in mass production of plantlets or propagules.
- It is fast and requires less space than the cultural methods of using cutting which requires a bigger space.

Tissue culture requires highly skilled manpower and special structures where temperature and humidity are controlled.

Transplanting Seedlings

- Vegetable seedlings are ready for transplanting when they are one month old or have 4 -6 leaves or are about 10-15cm in height.
- Before transplanting, the nursery bed is adequately watered 3 - 4 hours before lifting the seedling.
- This ensures the seedlings are lifted easily with a ball of earth around the roots to minimize root damage.
- Healthy and vigorous seedlings are lifted using a garden trowel.
- Transplanting is done when the weather is cool preferably morning or evening.
- Seedling is planted at the same depth it was in the nursery. Lower leaves should not touch the soil.
- Apply a little mulch and water the seedling regularly.

Transplanting tree seedlings.

- They take a little longer to reach transplanting age compared to vegetable seedlings.
- Dig the holes for seedling long before transplanting. Top soil is kept for refilling.
- Transplanting should be done at the onset of the long rains to give the young trees a good start.
- Water the seedlings well a day before transplanting to make soil to stick around roots.
- Remove polythene sleeves
- The roots are trimmed before lifting the seedlings for those raised in the nursery bed.
- Place the seedlings at the centre of the hole. Use a sharp knife to cut and remove polythene sleeves.
- Add more soil until the hole is full. Plant the seedling at the same depth it was in the nursery.
- Water and mulch the seedlings after transplanting. Provide a temporary shade to conserve moisture.

- After transplanting the young trees should be protected from damage by animals for a period of about one year.
- Tree seedlings take a little longer to reach transplanting age compared to vegetable crop seedlings.

Crop production IV (Field Practices I)

Introduction

- Field practices are activities carried out on the field to facilitate proper growth and maximum yield of the various crops grown.

They include the following:

- Crop Rotation
- Mulching
- R0utine field practices
- Crop protection
- Harvesting

Crop Rotation

- This is the growing of different types on the same piece of land in different seasons, in an orderly sequence.

Importance of Crop Rotation

- Maximizes use of nutrients and moisture.
- Breaks the life cycle of pests and disease agents.
- Maintains good soil structure.
- Reduces soil erosion due to adequate soil cover.
- Controls weeds that are specific to certain crops e.g. striga on cereals
- Improves soil fertility when legumes are included in crop rotation.

Factors Influencing Rotational Programme

- Growth habits and nutrient requirements.
- Liability to soil erosion.
- Crops attacked by the same pests and diseases should not follow one another in the programme.
- Availability of capital and market for example beans or peas in legumes.

Rotational programme

A decision is made on which crops to be included in a rotation system. The sequence in which they follow each other is established. To arrive at the sequence consider:

Heavy feeder crops

Light feeder crops

Deep rooted crops

Legume crops

Devote equal hectarage to each course. All fields should be similar in size. Include a whole field at each stage in the rotation.

For a four – it involves planting of four crops from different families in a rotation programme. It works well if the farm is divided into one, two, or four fields in an eight field's farm system

Examples

i) Four course rotation (a)

1st year	yams
2nd year	groundnuts
3r year	maize or any other cereal
4th year	cassava

ii) Four course rotation (b)

1st year	irish potatoes
2nd year	beans
3rd year	maize
4th year	sweet potatoes

iii) Three course rotation

First year	peas
2nd year	sorghurm
3rd year	cassava

Terms used in crop production

Mono cropping/ monoculture

It's the practice of growing one type of crop in a farm or one piece of land. The crops uses only the nutrients it needs while others remain unused hence leading to their deficiency. It leads to build up of pests and diseases if one crop I grown continuously.

Intercropping

It's the practice of growing of two or more crops in the same field at the same time. The crops take a long time growing together although may not be harvested together. Examples: maize/beans, beans/potatoes, bananas/coffee. It helps in controlling soil erosion.

Mixed cropping

It's the practice of growing two or more crops in the same field in specific sections at the same time.

Mulching

- This is the placement of materials such as banana leaves or polythene sheets on the ground next to the growing crop.

- These materials should not come into contact with the base of the crop as they may encourage pest attack.

Importance of Mulching

It's an important and popular practice especially dry areas

- Reduction of evaporation rate.
- Smothers weeds.
- Moderation of soil temperature.
- Reduction of speed of run offs.

Types of Mulching Materials

- ***Organic mulching*** materials such as;
  - Sawdust, wood shavings, coffee pulps, rice husks,
  - Dry grass, banana leaves, dry maize stalk, napier grass.
- ***Inorganic or synthetic materials*** commonly used are either black or transparent polythene sheets. They are used in highly profitable crops ie pineapple production.

Advantages of Mulching

- Prevents water evaporation thus maintaining moisture in the soil for crop use.
- Acts as an insulator thus modifying or regulating the soil temperature.
- It helps to control soil erosion by reducing the speed of running water, intercepting rain drops and increasing infiltration.
- It controls weeds by suppressing them.
- After decomposition organic mulch add nutrients to the soil thus improving its fertility.
- Humus produced after the decomposition of organic mulch improves soil structure and the water holding capacity of the soil.

Disadvantages of Mulching

- It is a fire risk.
- Provides a breeding ground as well as a hiding place for pests that finally may attack the crops.
- Traps the light showers of rainfall thus lowering the chances of rain drops reaching the soil.
- It is expensive to acquire, transport and apply.

Routine Field Practices

Thinning

- It's the uprooting or Removal of excess, weak, damaged or diseased seedlings to allow space for the remaining seedlings.
- Allows the remaining seedlings to get enough nutrients and moisture.
- It is aimed at obtaining optimum plant population. It's done when the soil is wet to prevent destruction of roots of the remaining seedlings.

Gapping

- It's the replacement or Filling up of gaps(dead seedings) so as to maintain proper plant population.
- Gaps occur as a result of failure of seeds to germinate (due to poor viability) or dying of seedlings.
- It should be done early enough for the seedlings to catch up with the other plants and to avoid shading of newly planted seedlings. It ensures optimum plant population.

Rogueing

- This is the removal and destruction of a diseased part of a plant or the whole plant.
- The destruction can be achieved through burning of the uprooted plant. It's done to prevent spread of pests and diseases. It's used to control pests ie maize stalk borer and bean fly. Diseases ie amillaria root rot in tea.

Pruning

- It's the removal of extra unwanted parts of the plant. It can be unwanted due to overcrowding, breakage, disease attack or unproductive.

Reasons for pruning are:

- To train the plant so that it can have the required shape – formative pruning in tea restricts upward growth encouraging lateral growth. Multiple stem pruning the seedling is capped at 38cm in the nursery to encourage growth of suckers.
- To remove old, unproductive or diseased, damaged parts of the plant – ie extra suckers, leaves, branches, flowers or even stems.
- To train plants to take a desirable shape for example formative pruning in tea.
- To control crop leave ratio hence avoiding overbearing.
- To control diseases and pests for example antestia bugs in coffee and coffee berry disease. –it discourages breeding and spreading of diseases that thrive well in humid conditions.
- To facilitate other operations such as spraying, picking and seeding- tea and coffee bushes are pruned to maintain low plucking table and bearing head respectively. It ensures that the spray penetrates into the bush.
- To reduce wastage of chemicals applied on the crop.
- To remove branches that interferes with traffic, telephone lines and view.
- Open up the plant to allow free air circulation and exposure of leaves to sunlight.

Note*:* Tools used are ***secateur, pruning saw pruning shears and pruning knife.***

Methods of pruning

They include:

Pinching out:

Is the removal of terminal buds. In tomatoes the terminal bud is pinched out at a height of 1.6-1.8cm. in flue-cured tobacco it's done after bearing 16-20 leaves. The practice is known as capping.

Annual pruning:

It's the removal of branches that have borne two crops with undesirable growth characteristics. Dry, diseased, broken branches are also removed

Coppicing or pollarding:

It's carried out in tree crops. It involves cutting branches at specified points to achieve a desired shape.

N/B ensures the plant is not injured because it lowers production due to healing. Protect the cut surfaces by applying paint or Stockholm tar to prevent the entry of disease causing organisms. This keeps off vectors ie aphids.

Tools used in pruning

Pruning saw- used for cutting hard branches and stems in coffee and citrus.

Pruning knife-used for cutting or pruning tea by use of strokes

Pruning shear-used for trimming hedges

Secateurs –used for pruning or cutting soft branches in coffee and citrus.

Tea

It's pruned to convert it into a low spreading bush. Pruning encourages vigorous vegetative growth maintaining a convenient plucking table.

Plucking table formation

This involves formation of a frame (wide plucking table) by encouraging development of lateral branches.

Methods of frame formation

i) Formative pruning

ii) Pegging

Formative pruning method

The plant is capped at different heights to discourage vertical growth and encourage lateral growth. The method is not common because it takes long to bring tea into bearing.

Pegging

Its where a young tea plant grows for a year to a height of 25-30cm and cut at 15cm above the ground level. More branches develop and grow to 60-75cm high. The branches are then forced to grow at an angle of 30-45^0 by use of pegs and tips nipped off. Dormant buds grow into shoots.

Pegging is carried out using:

- ✓ Individual hooked pegs
- ✓ Rings and pegs
- ✓ Parallel sticks and pegs

Use of individual hooked pegs

It's where each branch is held down by a 50cm long wooden or metallic peg.

Use of rings and pegs

It's where a 30cm diameter, stick or wire ring is placed on branches that are forced to bend sideways at an angle of 30-45^0. Its held using three pegs. Shoot tips are then nipped to encourage growth of more shoots.

Using parallel sticks ("fitos") and pegs

This is where two parallel straight light fitos are placed on either side of a row of tea bushes. 45cm light sticks are then placed under the parallel sticks to hold in position any branch

between the fitos. Fitos are held down using pegs.

Tipping

It's the cutting back of shoots to the desired table height (20cm above the pegging height). It is done three months after table formation or last cutting. Three leaves and a bud are removed above each shoot to acquire required height. Its done at an interval of 2-3 weeks. It encourages formation of uniform plucking table. For a uniform plucking table two 2m Y shaped are used. A straight pruning stick is then placed on the Y shaped sticks that touch the ground and leaves/buds tipped off.

Maintenance of plucking table

Maintenance pruning is carried out to prevent rise of the plucking table. It involves cutting back the tea bush to 5cm above the last pruning height after 2-5yrs. Its followed with tipping after 3 months.

Rehabilitation it is the cutting back of the bush to 45cm above the ground after 40-50yrs.

Pruning mature tree

It involves cutting all branches to a specific height above the ground level.

Observe the following:

i) Don't cut side branches growing below the pruning height because it reduces spreading of the bush and the yield.

ii) Outside edge of the bush should not be cut at a higher level than the centre. Also avoid disc shaped frame.

iii) Prune the bush parallel with the slope of the ground

iv) Cut the branches across to minimize the area of the wounds long slopping cuts increase die back and infection

v) Remove small branches and twigs with the hand-avoid cleaning up using the knife.

vi) Leave all branches on the ground to act as mulch and to rot and release nutrients.

vii) After several pruning cut back the tea bushes to the original table to change the cycle.

viii) Place a protective cup of several branches on top of the frame for protection during dry areas in places ie Meru and west of rift valley.

ix) Prune the tea bushes back to 5cm above the previous pruning level after every three years. This practice prevents development of the callus tissue.

Coffee

It's pruned to regulate the quality and quantity of coffee Berries.

Reasons for pruning:

i) To regulate bearing-
ii) To remove old and unproductive branches
iii) To regulate the height of trees hence making harvesting easy.
iv) To open up the bush hence allowing air circulation
v) To facilitate penetration of sprays/chemicals

Systems of pruning

a) Single stem pruning
b) Multiple stem pruning.

Single stem pruning

This is where one permanent stem is established with a strong framework of primary branches. It's done by capping the main stem at various heights (at 53cm, 114cm and 168cm). The best growing sucker is allowed to grow upwards at each capping. Cappings encourage development of strong primary branches.

The height of a single stem is between 1.5-1.8m. Crops are borne on primary braches when young and later on secondaries and tertiaries. Annual pruning is carried out (after harvesting) to remove suckers, dead, branches touching the ground, branches with undesirable growth habits (those growing inwards, outwards, crossing and touching each other) and damaged branches. Removal of suckers is done throughout.

Single stem pruning:

Advantages

i) Allows easy spraying and picking
ii) Minimizes breakage

Disadvantages

i) Requires skilled labour to establish
ii) It takes time to bring bushes to bearing

NB To avoid scorching top branches and fruits shade the trees.

Multiple stem pruning

It involves establishing two or three main upright stems with laterals to bear the crop.

Types of multiple stem pruning:

Capped multiple stem pruning

Non-capped multiple stem pruning

Capped multiple stem pruning involves capping at 38cm, and allowing two or three shoots to grow to a height of 1.5-1.8m.

Non-capped involves capping main stem at 38cm and then allowing suckers 2-3 to grow. The crop/berries is borne on the laterals. The stems grow tall and bend outwards due to the weight of the berries

After 4-6 yrs the stems are removed and new ones are allowed to grow

Referred to as the change of cycle (prune the inner laterals to allow light to penetrate and encourage growth of new suckers to replace old stems)

Advantages of non-capped

i) It requires less skills to establish
ii) It's easy to prune
iii) It does not allow accumulation of coffee berry disease because old stems are removed.

Disadvantages

i) Breaking of stems and branches is common
ii) Difficulty to gather berries from top points
iii) Difficult to spray the tall branches
iv) Stumps rot with age.

Annual pruning

It involves the removal of laterals that have borne two crops those that are too close, dry, broken and those that are with undesirable growth characteristics

Capping

This is the process of cutting the main stem at a height of 53cm when the young coffee plant is 69cm tall. Second capping at 114ccm is done when the stem if 130cm and third capping at 168cm when its at a height of 183cm. one upright branch is allowed to develop after each capping.

De-suckering

This is the removal of suckers from coffee bushes and its done through out the year as suckers appear

Changing the cycle

It's the replacement of old bearing stems by suckers. Its changed after 4-6yrs.

Banana stool management.

Done as follows

- Remove extra suckers in the stool.
- Leave 3-6 stems per stool depending on the area.

- The suckers left should be in different stages of development ie

i) 1 starting to grow

ii) 1 bearing

iii) 1 half grown

- To remove suckers Cut the suckers deeply at the root
- Remove dry diseased leaves using sickle or a panga to open up the stool.

Cutting up in pyrethrum.

This is the removal of old pyrethrum stems down to the level of foliage at the end of the dry season

This reduces bud disease

It increases yield, prevents declining yield in the following season.

Training

It's the practice of manipulating plants to grow in a designed direction and shape through staking, propping, and trelishing.

Staking- it's the supporting of plants with weak stems ie tomatoes, garden peas and some bean varieties with thin strong sticks.

Propping – it's the practice of providing support to tall banana varieties and those with heavy bunches with a forked stake.

Trelishing- it's the practice of providing support to crops with vines using wire or sisal strings. Wires and strings are held by posts at definite spacing.

Earthing-up

- This is the placement of soil in form of a heap around the base of the plant.
- It is mostly carried out in tuber crops such as Irish and sweet potatoes to improve tuber formation.
- It is also carried out in groundnuts and maize during first weeding.
- In groundnuts it promotes production of pods while in maize it provides support to prevent lodging.
- Tools used include: forked jembe, jembe, or a hoe.

Crop Protection

Weed Control

- Weeds are plants growing where they are not wanted, that is a plant out of place.
- Such plants include blackjack, couch grass, Sodom apple, thorn apple and McDonald's eye wandering jew.

- Such plants should be eradicated or controlled using recommended methods.

Pest Control

- Crop pests are living organisms that are harmful to the crops.
- They include; insects, nematodes, rodents, thrips and mites.
- They cause great damage to crops in the field and stored produce. They reduce crop product quality and quantity.

Control of Crop Diseases

- A disease is any alteration in the state of an organism and functions of a plant or its parts.
- Disease causing organisms are known as pathogens.
- They include **fungi, viruses and bacteria.**
- Diseases caused by fungi are referred to as fungal diseases i.e CBD in coffee, rust in maize, smut in sorghum, armilaria root rot in tea, while those caused by viruses and bacteria are referred to as viral i.e ratoon standing in sugarcane, and bacterial i.e bacteria wilt in tomatoes, black rot in cabbages, and black arm of cotton respectively.
- Diseases can also be caused by: nutritional imbalances and physiological disorders.

Harvesting

- It is the gathering or of the farm produce after maturity. It's the final operation in crop production. Preceding operations determine the amount of harvest. Harvesting at wrong stage causes loss in quantity and quality

Staging and timing of harvesting

Time of harvesting depends 0n

- The purpose of the crop or the use for which the crop was intended.-
  Maize for silage-plants harvested before flowering

  Maize for grain-plants harvested when the grains mature
- Concentration of the required chemicals in the pat being harvested ie caffeine in coffee, and sucrose in sugarcane.
- Stage of maturity of the crops.
- Market demand/Tastes and preferences of consumers. This depends on consumer preference eg green or dry maize
- Prevailing market prices and profit margins-Harvesting is delayed for higher market prices
- Weather conditions, hence liability to spoilage- harvest most crops during dry season. Synchronization of planting and harvesting involves timing of planting so that the crop matures at the right time.
- Moisture.

Methods of harvesting is determined by:

- Scale of farming for example large scale farming machines are used and manual harvesting for small scale farmers..
- Type of crop for example pyrethrum, spinach and kales are harvested by hand.
- Uniformity in ripening of the crop for example wheat is harvested by use of combined harvester while coffee is harvested by hand.
- Uniformity in height of the crop and size of seed, fruits and flowers.
- Financial status of the farmer.
- Part of the plant to be harvested.

Methods of harvesting

Crop	*Method of harvesting*
Coffee	picking the ripe cherries for pulping in the factory
Tea	picking two leaves and a terminal bud
Irish potato	lifting tubers with sticks, panga, or forked jembe
Beans	picking green pods depending on the market. Dry beans the whole plant is uprooted after drying, spread on mats to dry followed by threshing.

Precautions during harvesting

The produce should not be affected both in quality and quantity.

Harvest at the right stage depending on intended use.

Ensure right timing when the weather conditions are dry

Avoid delayed harvesting to prevent spoilage.

Make the store ready to receive the produce.

Post-Harvest Practices

- These are the preparations carried out on crop produce before it gets to the consumer. **They include;**
- Threshing/shelling –it's the removal of maize grains from maize cobs, beans from pods and sorghum from heads. It's the first operation after harvest.
- Drying –dry the grains to attain correct moisture content for storage to prevent rotting and fungal attack. For maize dry to 13% moisture content.
- Cleaning –it involves winnowing in cereals to remove chaff from grains.
- Sorting and grading – the produce is sorted and graded according to the quality ie grade1 (big and well ripened) grade II (under-ripe, diseased and small) for coffee
- Dusting- it's the application of chemical powders on seeds to prevent attack by storage pests.
- Processing –it's the transformation of raw material into a final product. The produce is processed in order to
    - Improve the flavor ie tobacco and tea
    - Improve the keeping quality as in fruits when canned or made into juices or sauces
    - Reduce bulkiness hence lowering transportation and storage costs ie sugarcane.
- Packaging –is the placement of produce into containers for storage, sale or transportation. It reduces damaging to the produce. It makes it easier for the farmer to quantify the produce and set prices.

Storage

Purpose of storage is to;

- Prevent spoilage.
- Make the produce available for future use.
- To await good market prices.

Requirements for proper store are:

- It should be clean.

- It should be well ventilated.
- It should be raised from the ground to prevent damp conditions.
- It should be dry.
- It should be strong to hold crop produce.
- It should be easy to clean.
- It should be vermin-proof.
- It should be secure from theft.
- It should be treated against pests such as weevils.

Types of Storage

- Traditional storage structures.
  It includes
  i) Putting shelled grains in pots and gourd stored inside or outside the house.
  ii) Storing in traditional granaries that were elevated from the ground with posts. They were made of wooden twigs woven together and roofed with thatching materials ie grass, reeds or plant leaves.
  Disadvantages of traditional storage
  i) Food is prone to rat and weevils attack
  ii) Rotting of grain is common
  iii) Limited in size

- Modern storage structures.
  They are characterized by improved storage conditions of produce to prevent losses. Grains are threshed, dried and dusted. They are then bagged and stack in stores or directly.

Preparation of the Store

- Cleaning the store to remove debris of the previous crop that might be harboring storage pests.
- Maintenance –it involves repair or replacing of broken and worn out parts. Replace the thatch or other roofing materials.
- Dusting the store with appropriate chemicals to control storage pests.
- Clearing the vegetation around the store to keep off vermin.

Crop Production V: (Vegetables)

Introduction

- A vegetable is any crop that is grown and eaten fresh. They are horticultural crops. They are popular because they mature early hence quick returns.
- Vegetables are important both for nutritional and commercial reasons. They grown both for foreign and local consumption.
- They are categorized on the basis of the part used as food.
- Such parts include;
  - Leaves,
  - Stems,

- Roots,
- Fruits,
- Flowers,
- Pods
- Bulbs.

Importance of vegetable crops

a) Nutritional importance

Are sources of vitamin and minerals hence they are protective foods. They contain vitamins A, B, and C. deficiency of these vitamins may lead to diseases i.e night blindness, scurvy and beriberi. Minerals in vegetables include: iron phosphorus, and calcium.

b) Commercial importance

Vegetables processed into sauces, juices, and jams are sold to earn income regularly.

Vegetables are grown either for home use or commercial purposes. Vegetables can be grown during rainy season but fetch low prices because they are in plenty, those grown under irrigation system in dry season fetch high prices due to scarcity.

Types of vegetables

Vegetables are grouped into the following categories:

- ***Leaf vegetables*** for example kales, spinach, amaranthus, cowpeas and cabbages. They are used as food and require a lot of nitrogen to stimulate vegetative growth.
- ***Root vegetables*** for example carrots, beets, radishes and tulips. They are used as food.
- ***Fruit vegetables*** for example cucumbers, tomatoes, melons, brinjals, pumpkins, squashes and pepper, they are used as food.
- ***Stem vegetables*** for example asparagus, leeks and spring onions. They are used as food.
- ***Bulb vegetables*** for example bulbed onions and garlic. They are used as food.
- ***Pod vegetables –***examples legumes French beans pigeon peas. They can be eaten while green.

Tomatoes (Lycopersicon esculentum)

- It originated from the slopes of Andes Mountains in South America. Development of varieties was done in Europe spreading worldwide. Tomatoes are fruit vegetables widely grown in Kenya.
- The ripe fruit may be eaten raw cooked or processed to make tomato sauces, juices and pastes. Tomato fruits are rich in vitamins A, B and C

Ecological Requirements

- Warm climate.
- Altitude: 0-2100m above sea level.
- Rainfall: 760-1300mm per annum. It can tolerate upt o 2300mm. rain should be well distributed over the growing period.

- Soils: deep, fertile and well drained.

Varieties

- ***Fresh market varieties***: -are fleshy, round in appearance, with smooth skins and with a poor keeping quality.
  - Money maker, - it's the most popular, fast growing and high yielding.
  - Marglobe, hundred fold,
  - Bee eater,
  - Ailsa craig
  - Hot set,
  - Super marmande
  - Ponderosa.
- ***Processing varieties***: Are elongated or oval shaped. Have good keeping quality and plum.
  - Cal J
  - Kenya beauty,
  - San -marzano,
  - Roma,
  - Heinz 13S0,
  - Primabel,
  - Rutgers hybrid
  - 10X HYBRID

Nursery Practices (establishment and management)

- It's established in a fine tilth.
- Choose a site which has not been grown ***Solanaceae (brinjals, pepers, tobacco, & goose berry)***crop in the last three years.
- Nursery beds are raised about 15cm above the ground level, on a gently sloping ground.
- Make the nursery bed fine and level.
- Make drills of 20cm apart and 1cm deep drill drop in the seeds singly and cover the seeds.
- More than 1cm lowers germination percentage.
- Provide shade or mulch material. Avoid dark and damp conditions for they cause seedlings to grow thin, tall and unhealthy.
- Water twice a day.
- Apply phosphatic fertilizers during planting.
- Harden the seedlings 2-3weeks before transplanting.
- Transplant seedlings at 10cm height. Or 4-5 true leaves.

Seedbed /landPreparation

- The land should be dug deeply to control weeds(perennial)
- Dig halls 15cm deep at a spacing of 90cm x 60cm or 100 x 50 cm.

Transplanting

- Seedlings are ready for transplanting when they are 10-15cmhigh after about one month.
- Holes are made at a spacing of 90cm x 60cm.
- Apply 20gm of DSP or a handful of well rotten manure in the planting hole. Thoroughly mix with the top soil.
- Water the nursery before lifting of the seedlings to ensure that they are lifted with a lamp of soil.
- Transplant with a ball of soil around the roots. One seedling per hole.
- Apply mulch around each seedling.
- Transplanting is normally in the evening or on a cloudy day.

Field Maintenance

- Gapping –replace seedlings that dry up. Its done to maintain correct plant population.
- Weeding -Early control of weeds is necessary to reduce competition for nutrients, and chances of diseases/pests spreading. When hand cultivating avoid stem/root injury. Too much fruit shaking cause immature fruit fall.
- Top dressing-it is done after crop establishes at a height of 25-30cm. use CAN 100KG/Ha (20kg of nitrogen/Ha). Apply one teaspoonful per plant. Too much fertilizer causes
    - Prolonged maturity
    - Cracking of fruits before maturity
    - Blossom end rot
    - Too much vegetative growth hindering fruit formation.
- Pruning- s the removal of the many tomato shoots to remain with 1-3 main shoots per plant for good yields. Remove leaves near the ground to reduce chances of blight attack. A bushy plant uses nutrients for vegetative growth and not fruit development.
- Staking-staking is done to train the plants to grow vertically. Dwarf varieties can support themselves but tall varieties are supported with sticks about 2m high firmly fixed to the ground. Use a sisal string, or banana fibre to tie the plants at 20cm intervals.

  Reasons for staking
    - Production of clean fruits
    - Facilitates spraying and harvesting of the crop
    - Controls incidences of disease outbreaks
    - Prevents infestation by soil borne pests.

Pests Controls

- ***American Bollworm (Heliothis amigera)***
  - Larva stage of a moth. Its brown, green, or pink in color. Its destructive attacking fruits ie tomatoes, citrus, cotton, and maize, beans, and sorghum stems.
  - ***Nature of damage****:* boring holes on the fruits. They feed with head inside the tomato fruit and rest of the body outside.
  - ***Control:*** spraying insecticides.
- ***Cutworms, red spider, mites and nematodes are minor tomato pests***
- ***Control***
- Use crop rotation apply suitable pesticides
- ***Tobacco White Fly***
  - ***Nature of damage****:* suck plant sap from the underside of the leaf, hence may transmit viral diseases.

- ***Control:*** Destroy infected plant and spray insecticides.

Disease Control

- ***Tomato Late Blight***
  - ***Cause:*** Fungus *phytophthora infestans.*
  - ***Symptoms:***
    - dry brown patches/lesions on the leaves, stems and fruits.
    - Rotting and Premature falling of affected fruits
  - It's common during wet and cold weather. Fungal spores germinate and spread on moist leaves.
  - ***Control:*** use of fungicides, crop rotation and destruction of affected materials.
- ***Bacterial wilt***
  - ***Cause –*** *bacteria* ***(pseudomonas Solanacearum)***
  - Tomato plants dry and wither even in wet conditions
  - No chemical control. Uproot and burn infected plants.
  - Control by use of certified seeds and crop rotation.
- ***Blossom-end Rot***
- It's a physiological disease

  Caused by;
  - Too much nitrogen in early stages.
  - Irregular or infrequent watering.
  - Calcium deficiency in young fruits.
  - ***Control:***
    - Apply calcium ammonium nitrate and correction of the above problems.
    - Regular watering
    - Application of calcium compounds

Harvesting

- For canning, fruits should be fully ripe before harvesting.
- For fresh market, fruits should be partially ripe and packed in crates to avoid damage.
- Transport using large wooden crates. Fruits should be level with the top of rhe crate to allow piling of crates on top of each other to avoid squashing fruits.
- The fruits should be graded according to;
  - Size,
  - Colour,
  - Ripeness
  - Freedom from blemishes.

Cabbage (Brassica spp)

- It originated from Europe and has spread to most parts of the world. The leaves are rich in vitamin A and D and minerals ie iron potassium, phosphorus and calcium.
- Has a high nutrition value when eaten fresh.
- It is a leaf vegetable closely related to other brassica crops such as kales, cauliflower, Chinese cabbage, cerely cabbage and Brussels sprouts. This vegetables have similar management practices.
- Cabbage leaves may be eaten raw in salads, steamed, boiled or cooked in a variety of ways.

- Leaves are tightly compacted to form ovoid or spherical head.
- The leaves can also be fed to livestock.

Ecological Requirements

- ***Altitude: high altitudes***
  - Those with small heads: *900-1500m* above sea level
  - Those with Large heads: 1800-2900m above sea level.
- ***Temperature:*** require cool condition.
- ***Rainfall:***
  - ***750-2000mm*** per annum.
  - Should be well distributed throughout the growing period.
- ***Soils:***
  - Deep,
  - Fertile or rich
  - Well drained.
  - Slightly acidic PH of 6.5

Varieties

Early maturing:

Brunswick,

Sugar loaf,

Early jersey,

Copenhagen market,

Chinese cabbage,

Celery cabbage,

Cafe splits kool

Gloria, mukuki,

Golden acre .

Late maturing:

Drumhead,

Savoy,

Perfection,

Winningstadt.

Nursery Practices (establishment and management)

Establish in an area where brassica family crops have not been grown for the last 3yrs.

Prepare the nursery to a fine tilth by removing all roots, stones and perennial weeds.

The beds should be raised, dimension 1 m wide and any convenient length (usually 2-3m in length).

Make drills of *10-20cm* apart.

Sow seeds by drilling and cover to a depth of 1 cm.

Provide shade or mulch material. Mulch material is removed at the emergence of seedlings.

Apply phosphatic fertilizers and mix thoroughly with soil during planting.

Water twice a day.

Harden off two weeks before planting.

Seedbed/Land Preparation

Cultivation (ploughing and harrowing) should be done during the dry season so that all the weeds are killed. This gives seedlings time to grow before weeds come up.

Dig holes at the spacing of 60cm x 60cm or 90cm x60cm depending on the variety.

Incorporate well rotten farm yard manure in the soil.

Transplanting

Water the seedlings before uprooting.

Seedlings are ready for transplanting after one month that is when they are 1O-15cm in height.

Select healthy and vigorous seedlings.

Transplant the seedlings with balls of soil to prevent root damage.

Plant to the same depth as they were in the nursery. Its done in the evening or during cloudy day.

Field Maintenance/management practices.

Top dressing-it's done at 20-25cm height. Apply a tablespoon full of CAN or SA. Repeat 3-4 weeks after first treatment.

Weeding-Control weeds to reduce competition. It's done by hand. Care should be taken not to break leaves they affect head formation.

Cabbage pests and their control

Pest Control

Aphids

Affects cabbage heads during dry season.

They are rare in wet conditions.

Irrigate to control during dry season.

Diamond Black Moth

Damage: Eats the underside of the leaf making windows or holes in the leaf.

Control: Spray recommended insecticides.

Sawfly- control use crop rotation and insecticides

Cutworms –larva stage of a moth that stays hidden in soil or moist rubbish. It's found curled in the soil.

Damage: Attacks the stem at the ground level causing he plant to fall.

Control: Spray recommended insecticides. Mix appropriate insecticide powder with the soil in each soil hole during transplanting.

Disease Control

Black Rot

Cause: Bacteria of Brassicas

Symptoms: Leaves turn yellow and rotting of the stem(at the pith where the bacteria destroys the tissue) giving an offensive odour,

Control: Closed season, crop rotation, use certified seeds and spray appropriate chemicals.

Damping off

Cause –fungus. Attacks cabbage seedlings in the nursery in heavily watered and shaded nursery beds.

Symptoms-cobweb –like black mass of fungi forms a ring on the stem base above the soil. Withering and death of seedlings.

control -remove shade, thinning of overcrowded seedlings, use of less water, apply copper fungicides.

Downy mildew

Cause-fungus in areas where heavy mists are frequent

Control –uproot and burn affected plants, practice crop rotation and nursery hygiene. Apply fungicides incase of heavy infection.

Black Leg

Cause: Fungus

Symptoms: Brown to black spots on seedlings and dark canker on the stem.

Control: crop rotation, destroy infected materials.

Harvesting

Cabbages are ready for harvesting 3-4 months after transplanting.

The heads are cut when they are solid and compact.

Harvested cabbages are sold immediately.

During rainy season heads crack and start rotting.

Flowers may grow from split heads to form seeds.

They are sold mostly in urban areas either on wholesale in bags or singly in retail

Carrots (Daucus carota)

It's a hardy biennal root vegetable that originated from Europe and spread to many parts of the world.

It is a root vegetable grown in the cool areas of Kenya. Contains carotene that is necessary for manufacture of vitamin A.

It is commonly eaten raw in salads but can also be cooked.

Ecological Requirements

Altitude: 0-2,900m above sea level.

Rainfall:

750 - 1,000mm.

Well distributed throughout the growing period.

Soils:

It requires deep,

Fine tilth

Well drained soils that are free from obstacles to allow for root expansion.

Temperatures: it requires cool to warm temperatures as very high temperatures result in the production of pale and short roots.

Varieties

Fresh market varieties for example Chantenay and Nantes.

Canning varieties for example Nantes

Fodder varieties (livestock feed) for example Oxhast.

Land Preparation

The field should be well dug to a depth of about 20cm.

The soil clods should be broken to give a fine tilth before planting.

Manure should not be applied as it induces forking which reduces the crop quality.

Planting

Carrots are planted directly into the main seedbed.

Seeds are drilled into rows made 20-30cm apart.

The seeds are then covered lightly and the soil pressed down.

90kg/ha of DSP should be applied at planting time in the drills.

It should be mixed well with the soils before placing the seeds.

Field management Practice

Thinning -- it is done 2 weeks after germination.

Weed control- the field should be kept weed free.

Earthing up should be done while weeding to encourage root expansion ..

Topdressing*:* after weeding 60kg of nitrogen per hectare should be applied as top dress.

Irrigation - this should be carried out where or when there is not enough rainfall.

Pest Control

Carrots do not have many field pests except the green aphids.

These can be controlled by use of the appropriate pesticides.

Disease Control

Occasionally attached by the mildews especially in wet and humid environment.

Thinning can be done to reduce humid conditions.

Harvesting and Marketing

Carrots are ready for harvesting 3-5 months after planting depending on the variety.

They are lifted from the soil and sold fresh or canned.

Onions (Allium cepa)

Origin- Mediterranean region of south East Asia spreading to many other parts. It's a biennial crop.

Onions are bulb vegetables grown in the warm areas of Kenya.

They are used as a vegetable in salads and for flavouring foods, soups and stews.

Ecological Requirements

Altitude: 0-2, 100m above sea level.

Rainfall:

1,000mm of rain per year

Irrigation in dry areas.

Soils:

Requires well drained fertile soils

pH of 6.0 - 7.0 .

Temperatures:

Onions are a warm climate crops.

However, some varieties prefer cool conditions.

They require a fairly long dry period for ripening.

Varieties

Red creole,

Tropicana hybrid

White creole.

Land Preparation

The land should be well prepared leaving a fine tilth.

Farm yard manure at 40 - 50 tonnes per hectare should be applied and mixed well with the soil.

Planting

Direct: Seeds are drilled in rows 30cm apart and 8cm within the rows. 20kg/ha of DSP fertilizer is used.

Indirect: Seeds are established in the nurseries before transplanting them in rows 30cm apart and 8 cm within the rows.

Shallow planting is recommended for bulb expansion.

Field Management Practices

Thinning

It is carried out only in the crop that has been directly planted so as to achieve spacing of 8cm between two plants within the row.

The thinned plants referred to as **spring onions** are used as vegetables in salads.

Topdressing

Calcium ammonium nitrate at the rate of 250kg per hectare is recommended for topdressing onions.

This is done 3 months after planting.

Pest Control

Onion Thrips:

These cause silvering and withering of leaves from the tips downwards.

They are controlled by spraying with appropriate insecticides such as *Diazinon* or *fenthion.*

Disease Control

Purple Blotch and Downey Mildew

Purple blotch;

Characterized by oval greyish lesions with purple centres on leaves.

This causes leaf curling and die back.

Downey mildew;

Characterized by brown spores covering the leaves leading to death of the whole plant.

The two diseases are effectively controlled by crop rotation and application of appropriate

fungicides.

Harvesting and Marketing

Onions are ready for harvesting 5 months after planting.

When leaves start drying the tops are broken or bent at the neck.

This hastens the withering of the stems.

The bulbs are then dug out and left to dry in a shade for a few days.

Onions are graded according to size and marketed in nets of about 14 -16kgs.

Livestock Health I

(Introduction to Livestock Health)

Introduction

- Health is the state of the body in which all the organs and systems are normal and functioning normally.
- Disease is any deviation or alteration from the normal health of the animal or state of the body of the animal.
- Profitable animal production requires: good husbandry of healthy animals, correct feeding, grazing control, adequate water supplies and proper breeding programme.

Importance of Keeping Livestock Healthy:

- Healthy animals give high income due to low treatment costs.
- Animals grow well and reach maturity quickly.
- The economic and productive life span of a healthy animal is longer.
- High production –they give maximum production or performance.
- Healthy animals give good quality products and consequently command high market value.
- Healthy animals can multiply regularly.
- Healthy animals are economical and easy to keep because the farmer spends less on disease treatment.
- Healthy animals do not spread diseases to either other animals or human beings.
- Safety of consumers of livestock products.

Signs of good healthy in livestock.

Good health requires constant observations. Signs of good health are categorized into three:

- Physical appearance.

  Its examined in the following terms

  - ✓ Behavior of the animal- healthy animals are gentle/docile. Excitement and aggressiveness is a sign of ill health

- ✓ General appearance of the animal- healthy animal is a lert, bright in manner and carries its body weight evenly. Dullness and restleness is a sign of ill heath.
- ✓ Movement of the animal- they have normal gait moving with a a lot of eas. Limping or straining is a sign of ill health.
- ✓ Poster- they have normal poster while standing and lying down.

- Physiological body functions.

  Its examined under the following:

  - ✓ Appetite and feeding- appetite is the desire the animals have for food. They have good appetite eating to satisfaction if given food of the right color, taste and smell. They eat and drink well and regularly. Excessive of lack of appetite are signs of ill health.
  - ✓ Defecation-they defecate normally and regularly. Inconsistence in texture, color, smell and frequency of defecation indicates ill health. Dung with blood stains, parasite larvae shows ill health.
  - ✓ Urination- they urinate regularly and normally pale –straw urine in color. Difficulties in urinating, red or heavy yellow urine are a sign of ill health.
  - ✓ Body temperature- they have a body temperature within a normal range. Body temperature is measure by a clinical or vetinary thermometer by inserting in the rectum or under the wings in birds. A temperature above or below the norm is a sign of ill health
  - ✓ Respiratory rate-they have normal respiratory rate per minute. Its measured with a respirometer.

Animal	Temperature	pulse rate	Respiration
Cattle	38.5-39.5	50-70	10-30
Sheep	38.5-40.5	70-80	12-20
Goat	38.5-40.5	70-80	10-20
Chicken	40.4-43.0	200-400	15-30
Pig	38.0-39.0	60-80	8-18
Horse/Donkey	37.5-38.5	28-40	8-16

Respiration rate involves the rhythmic inspiration and expiration. It varies from species to species as shown above.

Factors influencing respiration rate

i) The boy size of the animal

ii) The amount of exercise done by the animal

iii) The degree of excitement

iv) The ambient or environmental temperature

Difficult or fast breathing rate shows ill health.

- ✓ Production level- they have steady yield of milk, eggs, and other products. Reduced production or weight loss is a sign of ill health.
- ✓ Pulse rate-they have a normal pulse rate (wave of blood passing through the arterial blood stream, corresponding to the beats of the heart. Its measured by placing the finger or thumb on the artery under the tail or lower edge of the jaw of the animal. It varies from specie to species.

Factors influencing the pulse rate

i) The degree of excitement

ii) Age of the animal

iii) Sex of the animal

iv) Physiological status of the animal ie pregnancy or ill health.

- Morphological conditions of the body.

  They are observed in the following areas:

  - ✓ The visible mucous membranes- they have a pink, moist, soft and elastic, smooth and well lubricated mucous membrane. Bright red, pale and anaemic, yellowish or bluish mucous membrane is a sign of ill health.
  - ✓ The skin and animal's coat- they have; warm smooth, soft, pliable and moist skin. Extreme dry hair, staring coat where the hair sticks up, excessive sweating, loss of hair, abnormal outgrowths or swellings on the skin of animals are signs of ill health.

Predisposing Factors to Livestock Diseases

- These are conditions within or around the animal that make it easy for an animal to contract a disease.

They include:

- ***Animal factors such as;***

➢ Species- species type determines the type of disease likely to affect the species.ie swine fever affects only pigs, new castle affects only poultry.

- ➢ Breed of the animal- it influences the kind of disease influencing a breed ie cancer of the eye for Hereford
- ➢ Age-some diseases are associated with animals of a given age group only ie piglet anaemia, lamb dysentry, and calf pneumonia.
- ➢ sex –ome diseases only affect certain sex due to the arrangement of organs ie mastitis , vaginitis for female and orchitis for male

- colour of the animal-heat stress likely affect animals with black skin color and photosensitization for light pigmented animals.

- ***Environmental factors such as;***
  - Chilling,
  - Being rained on,
  - Exposure to hot sun
  - Dampness.
- ***Management factors such as;***
  - poor feeding,
  - housing,
  - handling
  - hygiene,
  - overcrowding.

Signs of ILL-Health in Livestock

- **Abnormal behavior** for example separation from the rest of the herd and restlessness.
- **Abnormal posture** for example limping and lameness.
- **Alimentary canal disfunction** such as blood stained faeces and abnormal defecation, diarrhoea and dysentery.
- **Urination:** high frequency or too low and having strange colour.
- **Skin:** rough with scaly skin, blisters on the skin and hair loss.

Causes of Diseases

- **Pathogenic causes/infectios disease causing organisms ;**
  - Viruses- are extremely small organisms. They contain a nucleic acid core in a protein coat. Not seen using ordinary microscope instead an electronic microscope. They grow and multiply in living cells. They lead to cell death due to tissue damage and disfunction. They affect only certain tissues and one host only. Viral conditions are infectious and contagious. Examples of viral diseases:

Disease	Causal organism/Vector	Animal affected
Rinderpest	Virus attacking mainly the mucous membrane of the alimentary tract.	Cattle
Foot and mouth	Virus attacks the mucous membranes of the mouth and coronet.	Cattle, sheep, goats and pigs
Swine fever	Virus	Pigs
Newcastle	Virus	Poultry
Marek's disease(fowl paralysis	Virus	Poultry
Gumboro disease of poultry	Virus	Chicks

  - Bacteria – are unicecullar micro-organisms of diverse shapes; cocci/spherical, bacilli/cylindrical, spirilla/spiral and vibrio/comma shaped. They are found in soil, air, food, and water. Some are pathogenic while others are non-pathogenic ie those in the ruminant digest cellulose. They cause the largest number of diseases (pathogenic). Examples of bacterial diseases.

Disease	Causal organism/Vector	Animal affected
Anthrax	Bacillus anthracis	Cattle sheep, goats and pigs
Blackquater	Clostridiums spp	Cattle, sheep, goats

Brucellosis (contagious abortion)	Brucella abortus	Cattle, goats
Calf pneumonia	Pasteurella spp	Calves
foot rot	Spherophorus necrophorus Staphylococcus spp	Cattle, goats
Fowl typhoid	Salmonella gallinarum	Domestic fowls
Mastitis	Streptococcus spp Staphylococcus spp	Cattle goats
Enterotoxemia (pulpy kidney)	Clostridium welchii	Sheep
Pullorum diseases of poultry/Bacillary white diarrhea	Salmonella pullorum	Poultry
Lamb dysentery	Clostridium welchii	Young lambs

- protozoa – are microscopic single –celled organisms. Some are pathogenic and parasitic. Are spread by arthropod vectors ie ticks, tsetse flyies and mosquitoes. They also produce toxic disease causing substances. Common disease include:

Disease	Causal organism	Vector	Animal affected
East coast fever	Theilera parva	Brown ticks	Cattle
Red water (Babesiosis)	Babesia spp	Blue and brown ear ticks	Cattle and sheep
Anaplasmosis (gall –sickness)	Anaplasma marginale	Blue ticks	Cattle, sheep and goats
Heart water	Cowdria ruminantium (rickettsia)	Bont tick	Cattle sheep and goats
Trypanosomiasis	Trypanosome spp	Tsetse flies	Most animals
Coccidiosis	Eimeria spp	Coccidian	Poultry and young animals

- parasitic organisms- they suck blood and transmit other organisms that cause diseases. Can block internal organs in the animal causing injuries to the body organs. They are divided into external parasites (ticks, fleas, lice, keds, tsetse flies and biting flies) and internal parasites (round worms, tapeworms, and flukes).
- fungi.
- rickettsia,

- ***Physical causes;***
  - Physical injuries to the body or parts ie traumatic injury due to sudden and violent physical force. Pressure on a particular part of the body ie robe causes physical injury. Excessive heat causes blisters or burns.
  - Fractures and tearing of the skin.
  - Dislocation,
  - Sprains .
- Nutritional/metabolic disorders for example milk fever- arise from body malfunctions, or mineral deficiency in the diet or mineral imbalances. Its common in rapidly growing animals. It may result in:
  - Piglet anaemia due to lack of iron.
  - Curled toe paralysis in poultry due to lack of calcium and phosphorus.
  - Milk fever 9parturient paresis) due to lack of calcium.
  - Goiter in young calves due to lack of iodine.
  - Bovine ketosis or acetonaemia due to impaired metabolism of carbohydrates and volatile fatty acids.

- Enzootic ataxia or swayback in lambs due to lack of copper.
- Osteomalacia due to lack of phosphorus.

- **Chemical causes for example poisoning by agrochemicals.** Chemicals ie acids, alkalis, insecticides and herbicides causes poisoning. A poison is any substance which will interfere with the normal structure or physiological mechanism of an animal's body on coming in contact with internal or external body organs. Chemicals cause irritation, corrosion and burning of tissues. Most are poisonous. Others interfere with membrane permeability. Weeds ie *Datura stramonium* (thorn apple) are poisonous to animals.
- **Living organisms- are the most common causes.** They include parasites and those living creatures that invade animal's body. Examples bacteria, virus, protozoa, worms, insects and arthropods. Pathogens are divided into infectious and those that are typically parasitic in nature.
- **Amount of food eaten by an animal**- excessive intake of lush pasture cause bloat or ruminal tympany. Results due to production of excess methane in the rumen during fermentation. Animals become emaciated when they lack: proteins, carbohydrates, minerals and vitamins.feeds with aflatoxin cause ill-health or death.

Categories of Diseases

- ***Notifiable diseases ;***
  - These are diseases which cause high economic losses.
  - Any case/outbreak, should be reported to the government authority ie Chiefs, D.O.s, veterinary officers or the police.
- ***Tick-borne diseases*** - Transmitted by ticks.
- ***Breeding diseases -*** Transmitted through mating.
- ***Nutritional diseases*** for example milk fever and bloat.
- ***Parasitic diseases*** for example ascariosis.

General Methods of Disease Control

This involves both routine management practices and preventive measures;

PREVENTIVE MEASURES

- **Quarantine**- is the restriction of movement of animals and their products from and into the affected areas in the event of an outbreak of a notifiable disease. It's based on the principal of enclosure in which affected animals are isolated and their movement restricted.
- **Vaccination**-vaccines are weakened forms of disease causing organisms injected in the animal's blood stream. It stimulates production of antibodies in animals. Examples vaccines against; foot and mouth, Newcastle, rinderpest, rabies and fowl pox, anthrax, fowl typhoid and blackwater.
- **Control of vectors by use of acaricides and rotational grazing** –a vector is an organism that transmits a disease from an infected animal to a healthy one ie ticks, tsetse flies, keds and mites.
- **Disinfecting the equipment and buildings using antiseptics and disinfectants**- disinfectants are used to kill bacteria in buildings, troughs and pigsty floors. Antiseptics are preparations of mild antibacterial drugs for use on the skin or wounds in cream or liquid form.
- **Use of prophylactic and treatment measures/preventive drugs**- it involves
  - Use of prophylactic drugs-ie providing coccidiodants in water or food to control coccidiosis, drenching animals with antihelminthes against internal parasites in sheep, use of long acting drugs ie sulphanomides to control trypasonomiasis.
- **Slaughtering the affected animals** for highly contagious and infectious

diseases ie rinderpest, foot and mouth disease, Newcastle, swine fever and brucellosis isolate and slaughter the infected animals. It prevents any further spread. Burry deeply or burn their carcasses

- **Isolating sick animals**- it's the separation or confinement of a sick animal from healthy ones when its sick or suspected to have contracted a disease. It's done to avoid further spreading of highly infectious and contagious diseases.

ROUTINE MANAGEMENT PRACTICES

- **Proper feeding of livestock**-done to avoid deficiency diseases and to make animals strong. Give a balanced ration, diets that are adequate in quantity and quality. Well balanced ration act as a measure of preventing nutritional or metabolic disorders.
- Culling of the animals which are carriers/slaughtering the affected animals.
- Use of artificial insemination to control breeding diseases.
- **Proper selection and breeding of animals** –health animals free from disease are selected for breeding. Susceptible animals to diseases are culled. To avoid transmission of congenitall diseases appropriate breeding policies are needed
- **Proper housing and hygiene-** houses for rabbits, calves,poultry, pigs, zero-grazing and young stock should meet the following requirements:
  - Well ventilated but free from drought and cold winds,
  - Leak proof
  - Well lit and easy to clean
  - Allow proper drainage
  - Have adequate space for the number of animals housed.

  Proper housing helps to control diseases ie mastitis, scours in young animals and parasites ie mites. High level of farm hygiene controls many diseases. Place a footbath made of 2% copper sulphate solution at the entrance .5-10% cuso4 is used to control disease ie foot rot.

Appropriate Methods of Handling Livestock

Handle animals in a humane and technical way

Animals are handled for the following reasons:

- When inspecting the animal to ascertain any abnormality or signs of diseases.
- When administering any form of treatment such as drenching, injection and mastitis control.
- When spraying or hand dressing the animal with chemicals to control external parasites.
- When milking the animal.
- When performing some of the management practices such as dehorning, disbudding, castration, hoof trimming .

*When carrying out these activities animals should be restrained in a **crush** or with **halters**.*

Other methods of restraining animals include the use of;

- halters,
- ropes,
- bull ring
- lead stick.
- Use of a head yoke.

Activities that necessitate handling of the animal

- ✓ Drenching-oral administration of drugs to the animal. Its dine using a drenching gun. Animal is restrained.the hed is held close to the stocksman under the left hand arm pit. Mouth is opened with the left hand.mouth is opened with the left hand and drugs pushed in.
- ✓ Injection-intra-muscular injection done into the muscles or intra venous into veins.
- ✓ Mastitis control- restrain animal in the crush. Complete milking and then infuse antibiotis into the teats.
- ✓ Hand spaying-animal is restrained in a crush. Use a stir up pump or knapsack sprayer. Spray all sides preferred by ticks.

Livestock Health II *(Parasites)*

Introduction

- A parasite is an organism which obtains its livelihood from another organism (host) which suffers damage.
- Parasitism is the association between a parasite and a host.
-

The effects of parasite on the host animal are:

- Depriving the host of its food- internal parasites compete with the host for nutrient leading to loss of wt, emaciation and low production.
- Sucking blood hence causing anaemic condition that might result in death.
- Damaging the organs and tissues of the host- internal parasites i.e round worms, liverflukes migrate from place to place injuring tissues.
- Cause irritation on the skin of the host- parasites biting effect makes the animal to rub itself against solid objects destroying skin, fur or wool.
- Destruction of hides and skins.
- Transmission of diseases.
- Cause obstruction in body passages leading to malfunctioning of affected organs.

General Symptoms of Parasites Infestation:

- Emaciation.
- Pot bellied condition.
- Swellings in the jaw or other areas.
- Rough hair or rough coat.
- Anaemia.
- Diarrhoea.
- Presence of worm segments and blood stains in the defecation.

Types of Parasites

There are two types of parasites:

- External (ecto-parasites)
- Internal (endo-parasites)

External parasites are;

- ticks,
- tsetse flies,
- mites,
- lice,
- fleas
- keds

- They found outside of the body of the host organism. They attack the skin of livestock.

  They live on or under the skin.

  They belong to phylum athropoda

Classes of parasites

- **Class insect-** flies, keds, mosquitoes, flies, lice, and fleas.
    - Tsetsefly (*Glossina spp)*

      It's a large fly that bites during the day. Has many species in different habitats. Feeds on wild and domestic animals blood. It undergoes complete metamorphosis(develops from eggs-larvae-puparium and adult stage)

Harmful effects of tsetseflies

- ✓ Transmits trypanosomiasis through trypanosome protozoan parasite in the saliva.
- ✓ Sucks large volumes of blood from the animal causing anaemia in small animals.
- ✓ Damages the skinsnand hides of animals the wounds formed act as routes for secondary infection by pathogens.

Control of tsetseflies

- ✓ Bush clearing to destroy breeding places of the flies.
- ✓ Spraying breeding places with suitable insecticides regularly to kill adult flies.
- ✓ Use fly traps with impregnated nets.
- ✓ Use of sterilizing agents ie radio isotopes on male flies and releasing them.
    - Keds (*melophagus ovinus)*

Commonly known as sheep ticks. Are hairy and wingless blood sucking flies that attack sheep.

Harmful effects

- ✓ Retardation of growth in lambs.
- ✓ Animals become anaemic
- ✓ Irritation, animals scratches and bites itself hence damaging the wool.
- ✓ Considerable when infection is heavy.

- **Arachnida –**consists of ticks, mites and spiders

Life Cycle of ticks

- Eggs are laid in cracks on the ground.
- They hatch in 4-6 weeks into larvae which climb on the grass waiting for a passing animal.

One-Host Tick

- This requires one host to complete its life cycle.
- *Example:* blue tick ***(Boophilus decoloratus)***.
- *Preferred sites:* face, neck, dewlap and side of the body.
- *Disease transmitted:* Redwater and anaplasmosis.

Two-Host Tick

- This requires two different hosts to complete its life cycle.
- ***Example****:* The red legged tick ***(Rhipicephalus everts)***
- *Preferred sites:* Ears, anus, udder and the tail.

- *Disease transmitted:* Redwater and east coast fever.
- *Example:* Bont legged tick ***(amblyomma spp.)***
- *Preferred sites:* Udder, scrotum and tail switch.
- *Disease transmitted:* Sweating sickness.

Three-Host Tick

- This requires three hosts to complete its life cycle.
- *Example:* The brown ear tick *(**Rhipicephalus appendiculatus)***
- *Preferred sites:* Ears, tail switch and around the eyes.
- *Disease transmitted:* East coast fever and redwater.
- Bont tick transmit heartwater *(**amblyomma spp.)***

Control of Ticks

- Dipping/spraying/hand dressing with acaricides.
- Rotational grazing.
- Ploughing the land to break the life cycle.
- Hand picking and killing.
- Fencing of the grazing fields to keep off other animals including wild game.
- Burning of grass to kill them in various stages.

Endo-parasites (internal Parasites)

- Endoparasites are helminths.

They can be divided into:

- Platyhelminthes/flatworms which include;
  - Trematodes (flukes)
  - Cestodes (tapeworms).
- Nemato-helminthes/nematodes. E.g Roundworms.

General Symptoms of Helminthiasis

- Diarrhoea which foul the anal and tail region.
- Dullness.
- Anaemia.
- Big stomach (pot bellied condition).
- Presence of worm segments in faeces.
- Coughing.

Trematodes (Liver Fluke)

- There are two species of flukes:
  - ***Fasciola gigantica***
  - ***Fasciola hepatica***.
- *Fasciola hepatica* is more common.
- It is commonly found in the liver and bile duct of cattle, sheep and goats.
- Liver fluke is a problem in marshy and low lying wet areas.

Life Cycle of the Liver Fluke

- Adult fluke in the liver of the primary host lays eggs.
- Eggs pass through the bile duct into the small intestines and are passed out in faeces onto the pasture.
- Under moist conditions, they hatch into a **miracidium larva** which swims about in

search of a secondary host (fresh **water snails**).
- In the snail, it develops through **sporocyst, redia and cercaria**.
- When it leaves the snail, the cercaria gets encysted on vegetation and becomes **metacercaria.**
- This is swallowed by the primary host with grass.
- The young fluke migrates into the liver through blood vessels when it matures.

Control of Liver Fluke

- Keep livestock off marshy areas near the rivers/streams/lakes and dams.
- Drench affected animals.
- Drainage of swampy areas.
- Eradicate the intermediate host by use of molluscicides.
- Provide water to livestock in elevated troughs.

Tapeworms

- There are many species of tapeworms

Eexample;

- ***Taenia solium***
- ***Taenia saginata.***

The adults live in the small intestines of man (the primary host).

- The intermediate host of ***Taenia solium*** is pig .
- The intermediate host of ***Taenia saginata*** is cattle.

Life Cycle of Tapeworm

- Adult tapeworms live in man's intestines where it lays eggs.
- Eggs are passed out with faeces,
- Then they develop an outer covering known as **onchosphere.**
- The eggs are swallowed by intermediate host.
- The outer covering is digested and the young worm emerges.
- This bores into the blood vessels and is carried to specific muscles such as the tongue, heart, thigh muscles.
- It develops into an encysted form called **bladder-worm.**
- When the animal is killed and meat is eaten raw or in an inadequately cooked form, man gets infected by the bladder¬-worm.
- In man, the bladder-worm evaginates and attaches itself onto the intestinal wall where it develops into an adult.

Control of Tapeworms

- Meat should be well cooked before eating.
- Use of drugs in primary host.
- Meat inspection by meat inspectors/ veterinary officers.
- Use of pit latrines by man.

Nematodes (Roundworms)

Common ones are;

- ***Ascaris suum*** (pig roundworms),
- ***Ascaris lumbricoides*** found in man and sheep
- ***Haemonchus contortus*** found in sheep, cattle and goats.
- Roundworms are common in warm areas especially in areas where the standards of hygiene and sanitation are low.

Nature of Damage

- Damage is done to the liver and lung tissues as they migrate in the body.
- Suck out blood.
- Deprive the host of food.

Control of Roundworms

- Use of drugs.
- Rotational grazing.
- Use of proper stocking rates to avoid overgrazing.
- Practicing high standards of cleanliness and hygiene such as use of latrines.

Livestock Production II *(Nutrition)*

Introduction

- Animals are fed for the purpose of production and body maintenance.
- The edible material given to animals is called food.
- It is digested, absorbed and utilized in the body.
- Nutrients are organic and inorganic substances contained in the food materials.

Components of Food material

- water,
- protein,
- carbohydrates,
- fats and oils,
- vitamins
- mineral salts.

Water

Sources

- Free water (through drinking)
- Bound water (contained in feeds).
- Metabolic water (obtained from oxidation of food).

Functions

- Regulates body temperature.
- Transport agent in the body.
- Universal solvent in the body.
- Gives shape to the cells (turgidity).
- Acts as a lubricant.
- Acts as constituent of body fluids.

Factors Determining the Requirements of Water by Livestock

- Production level.
- Amount of dry matter eaten.

- Temperature of the surrounding area.
- Type of animal.
- Type of food eaten.

Protein

Sources:

- Groundnut cakes,
- cotton seed cakes,
- fish meal,
- meat meal.

Functions:

- Growth of new tissues.
- Repair of worn out tissues (body building).
- Synthesis of antibodies.
- Synthesis of hormones and enzymes.
- Production of energy during starvation.

Digestion of Proteins

In non-ruminants, protein digestion takes placed in the stomach.

- Food is subjected to mechanical breakdown through chewing into small particles.
- Protein is acted on by enzymes to turn into amino acid which is assimilated into the bloodstream.

In ruminants, protein digestion initially takes place in the rumen.

- Food is acted on by micro-organisms into microbial protein.
- Later, enzymatic action takes place in the "true stomach" or abomasum where proteins are broken down into amino acids which are then assimilated into the bloodstream.

Carbohydrates

Sources:

- Cereals,
- tubers
- commercially mixed feeds.

Functions:

- Supply energy and heat to the body.
- Excess is stored in form of fat for insulation of the body.

Digestion of Carbohydrates

- In non-ruminants;
  - carbohydrate feeds are broken down by chewing into small particles.
  - Then enzymatic action further breaks down carbohydrates into glucose, fructose and galactose which are then assimilated into the bloodstream.
- In ruminants;
  - mechanical breakdown of carbohydrate feeds is followed by microbial activities which break down cellulose into **volatile fatty acids.**
  - These are absorbed through the rumen walls.
  - Some carbohydrates are broken down by enzymatic action in the "true stomach" or

abomasum.

Fats and Oils

Sources:

- Cotton seeds,
- soya beans
- groundnuts.

Functions:

- Supply energy and heat to the body.
- Excess is stored as fat adipose tissues.
- Source of metabolic water in the body.
- Required for the development of neural system.
- Insulator in the body.

Digestion of lipids in Ruminants

- Fats are hydrolysed in the rumen into fatty acids and glycerol.
- Others are fermented into propionic acid,
- The shorter chains are passed to the true stomach where enzymatic action takes place.

Vitamins

Sources:

- Green materials,
- dried grass
- fish liver oil.

Functions:

- Protects the body against diseases.
- Regulate the functions of all parts of the body.
- It acts as a co-enzyme in the body.

Examples:

- Vitamin A,
- vitamin B2
- vitamin C,
- vitamin E
- vitamin K.

Minerals

Sources:

- Salt licks,
- bone meal,
- legumes
- cereals.

Functions:

- Form part of the tissues such as bones and teeth.
- Work together with the enzymes.
- Act as acid -base balances.
- Act as electrolyte in the body.

- Regulate osmotic balance in the body.

Examples:

- Calcium,
- phosphorus,
- magnesium,
- iron,
- iodine,
- sodium
- chlorine.

➢ ***Calcium and phosphorus -***
- Needed for teeth and bone formation.
- Lack of these minerals leads to **rickets, osteomalacia**.

➢ Lack of iron leads to **anaemia.**

Classification of Animal Feeds

This is based on nutrient composition:

- Roughages.
- Concentrates.
- Feed additives.

Roughages

- Are feeds of low available nutrients per unit weight and high fibre content.

Examples:

- Dry roughages,
- succulent roughages,
- residues from agricultural by products and conserved materials.

Characteristics

- Low level of available nutrients.
- Have high level of calcium especially legumes.
- Good source of vitamin A.
- Have high fibre content.

Concentrates

- Are feeds of high available nutrients per unit weight.

Examples:

- Maize germ and bran,
- malt extract,
- milk products,
- soyabeans,
- oil seed cakes,
- meat meal,
- bonemeal
- bloodmeal.

Characteristics

- Low fibre content.
- Feed content is consistently high.
- High digestibility of the feed.
- High in nutrient content.

Feed Additives

These are substances added to the feed to increase;

- palatability,
- medication
- or hormones to make animals produce more.

There are two types:

- Nutritive additives, such as mineral licks (maclick).
- Non-nutritive additives, such as;
  - medicants (coccidiostats),
  - Stilboestrol (used in beef animals)
  - oxytocin (to increase milk let down).

Functions

- Stimulate growth and production.
- Improve feed efficiency.
- Prevent disease causing organisms.

Compounded Feeds

- These are the feeds prepared and mixed by use of machines.
- These feeds can be round, pelleted, pencils, cubes or mash.

Poultry feeds can be categorized as:

- Chick mash having 20% D.C.P. given to chicks.
- Growers mash having 16% D.C.P. given to growers.
- Layers mash having 12-15% D.C.P. given to layers.

Meaning of terms used to express feed values

- Nutritive ratio (NR):
  - Is the proportion of protein to carbohydrates and fats.
  - In young animals 1:3:6
  - In old animals 1:8.
- **Crude protein (C.P):** Is the total amount of protein contained in a feed.
- **Digestible Crude Protein (D.C.P):** Is the portion of crude protein which an animal is capable of digesting.
- **Crude Fibre (C.F.):**
  - Is the total amount of fibre contained in a feed.
  - It is mainly lignin and cellulose.
- **Digestible Fibre (D.F.)**: Is the portion of the total fibre contained in a feed which an animal is capable of digesting.
- **Dry Matter (D.M.):** Is the material left in a feed after water has been removed.
- **Starch equivalent (S.E.):** Is the amount of pure starch which has the same energy as 100kg of that feed.
- **Total Digestible Nutrients (T.D.N.):** Is the sum of all the digestible organic nutrients such as fats, proteins, carbohydrates and fibre.

Computation of Livestock Rations

- ***Ration:***
  - Is the amount of food that will provide essential nutrients to an animal in a 24 hour period
  - to enable that animal to meet its maintenance and production requirements.
- ***Balanced ration:***

- Is the ration that contains all the essential nutrients in required amounts and in the right proportion.

- ***Maintenance ration:***
  - is the portion of a feed required by an animal to continue with the vital body processes with no loss or gain in weight.
- ***Production ration:***
  - Is the feed required by animals over and above maintenance ration to enable the animal to produce;
  - for example; milk, eggs, wool, grow in size, perform work, reproduce and fatten.

Steps in ration formulation

- Finding out the animal's feed requirement based on body weight.
- List all the available feeds, with their nutrient composition and their prices.
- Calculate the amount of ingredients required in the ration to meet the animals needs.

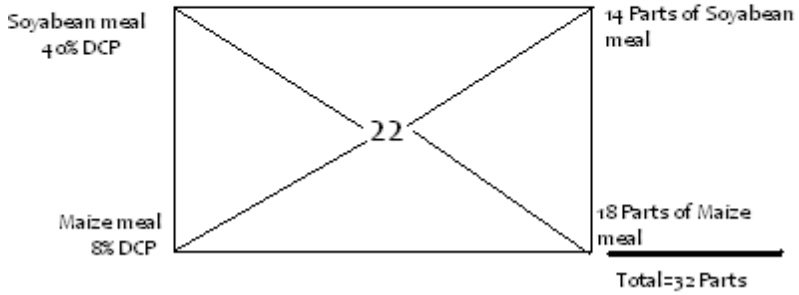
Methods used in ration formulation

- Trial and error method
- Pearson's square method
- Graphical method
- Linear programming(use of computers)

Examples;

Mix a Pigs ration 22% protein using soya bean meal 40% DCP and maize meal containing 8%DCP.

Pearson's square method



Soya bean meal (14 *100)=43.75kg
32

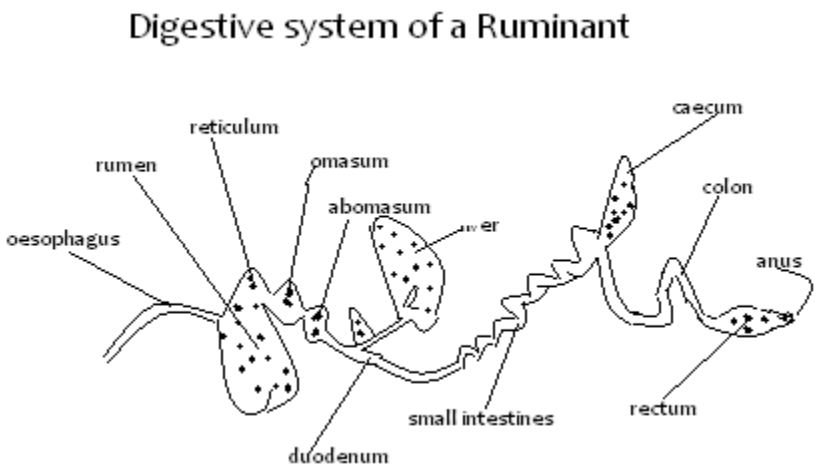
Maize meal (18*100=56.25kg
32

Digestion and digestive systems

- Digestion is the process through which food is broken down into small particles in the alimentary canal ready for absorption into the blood stream.

Digestion of food in livestock takes place in three stages;

- Mechanical breakdown and chewing
- Microbial breakdown by bacteria and protozoa in the rumen of ruminants
- Chemical breakdown by enzymes.



Rumen-

- Breakdown of food by micro-organisms and also stores food.
- Synthesis of vitamin B-complex.
- Synthesis of amino acids from ammonia gas.
- Proteins are broken to peptides and amino acids.
- Carbohydrates are broken to volatile fatty acids.

Reticulum:

- Separates large food particles from the small particles.
- Retains foreign materials such as stones, hard wood and sand.

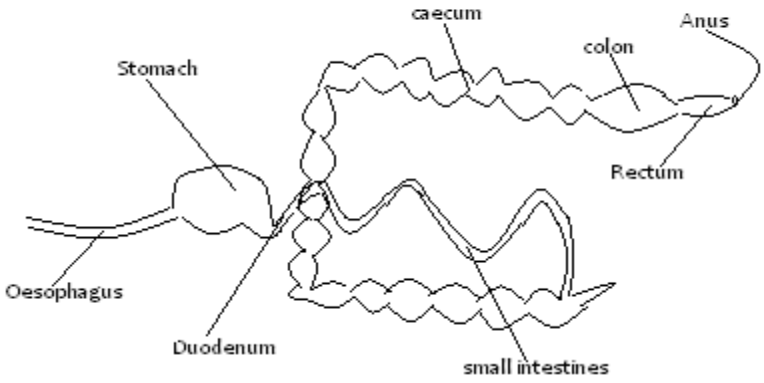
Omasum:

- Breaks up food by grinding.
- Reduction of water content from the feed stuff.

Abomasum:

- Enzymatic digestion takes place here ..
- Contains some microbes which digest cellulose.
- Breaks up food by grinding.
- It is also found in non¬-ruminants.

Digestive system of a non-ruminant e.g pig

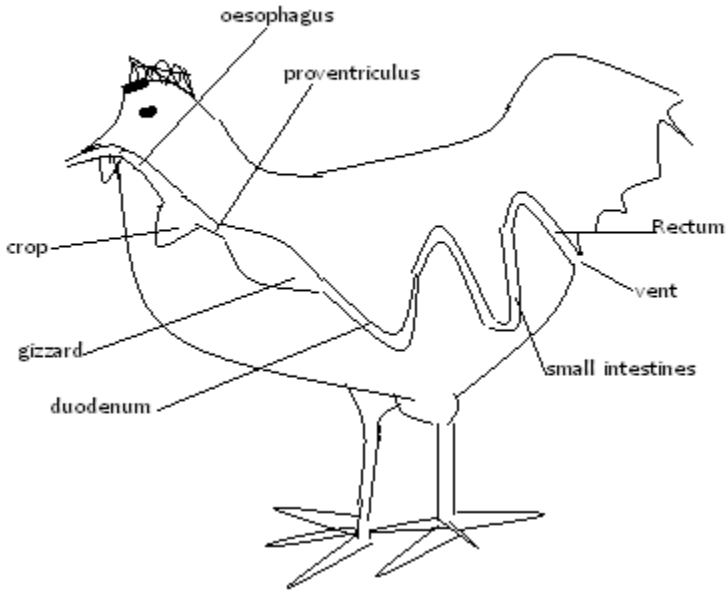


Comparison Between Digestion in Ruminant and Non-ruminants

- ***Differences***

Ruminants	*Non -ruminants*
• Chew the cud. • Have four stomach chambers-thus polygastric. • Regurgitate food. • Can digest cellulose. Have micro-organisms in the rumen that digest cellulose. 5. Have no Ptyalin in saliva hence no enzymatic digestion in the • Most digestion and absorption takes place in the rumen. • Have alkaline saliva due to presence of ammonia.	• Do not chew the cud. • Have one stomach chamber - thus monogastric. • Cannot regurgitate food once swallowed. • Have no micro-organisms in the stomach hence cannot digest cellulose except those animals with micro-organisms in the caecum. • Have Ptyalin in the saliva hence enzymatic digestion starts in the • Most digestion and absorption in the small intestines. • The saliva is neutral pH.

Digestion system of poultry



Functions of the Parts of Poultry

- **Crop:**
  - Storage of food.
  - Softening of food by secretions from small glands in the walls.
- **Proventriculus:** Enzymes start the breakdown of food.
- **Gizzard**:-Crushes and grinds the coarse food (has small grit and gravel).

Comparison Between Digestion In Ruminants and Non-Ruminants

Similarities Between Digestion In Ruminants and Non-Ruminants

- Digestion in young ruminants is similar to that in non-ruminants as they do not have a developed rumen-reticulum complex.
- Final protein digestion takes place in the small intestines in both cases.
- Water absorption takes place in the colon in both ruminants and non¬ ruminants

Livestock Production III…
(Selection and Breeding)

Introduction

- The breeding of animals is under human control, and the breeders decide which individuals shall produce the next generation.
- The breeder makes a choice.
- The breeding of animals is based upon the fact that certain qualities are genetic

,hence valuable qualities are passed on from parents to off -springs.

- The qualities can be maintained or improved in the next generation.

The performance of an animal is influenced by two major factors;

- Genetic potential
- The environment, which includes:
  - Feeding,
  - Health,
  - Care
  - The ecological conditions.
- The genetic potential of an animal is inherited from its parents.
- In selection and breeding animals with superior characteristics are selected and allowed to mate.
- In the process they transmit the superior characteristics to their offspring.
- When this is done over a long period of time, it results in livestock improvement.

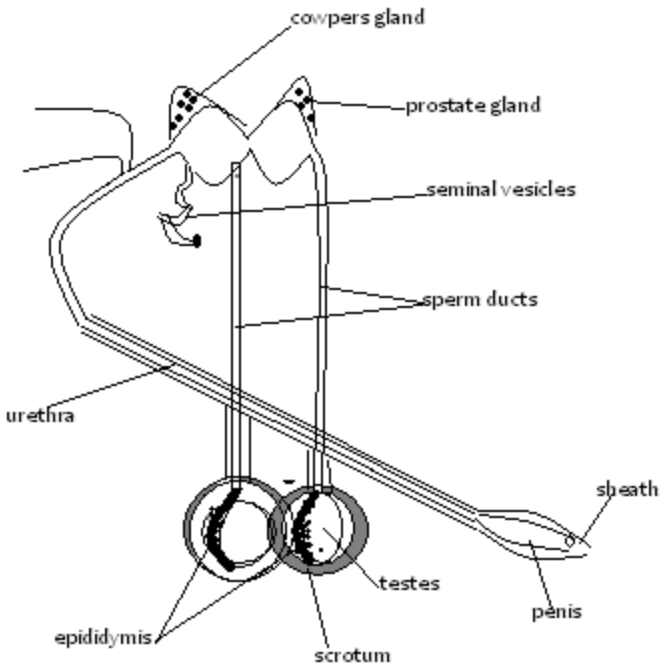
Reproduction and Reproductive Systems

- Reproduction is the process by which off-springs are produced.
- All farm animals multiply by means of sexual reproduction.
- It begins with fertilization which is the fusion of male and female gametes to form a zygote.
- Fertilization takes place internally in the body of the female.
- The embryo(zygote) formed develops inside body of mother, fed and protected until end of gestation period.
- In poultry, the process is different in that eggs are fertilized internally but laid and development of the chick takes place outside during incubation.
- In both male and female, certain organs are specialized for the process of reproduction.
- Some of these organs secret fluids which are necessary for the movement and survival of the gametes(reproductive cells.)

Reproduction in Cattle

- The male reproductive organs produce the male gametes,the spermatozoans.
- These are introduced into female reproductive system, where they fuse with the sperm to form zygote.

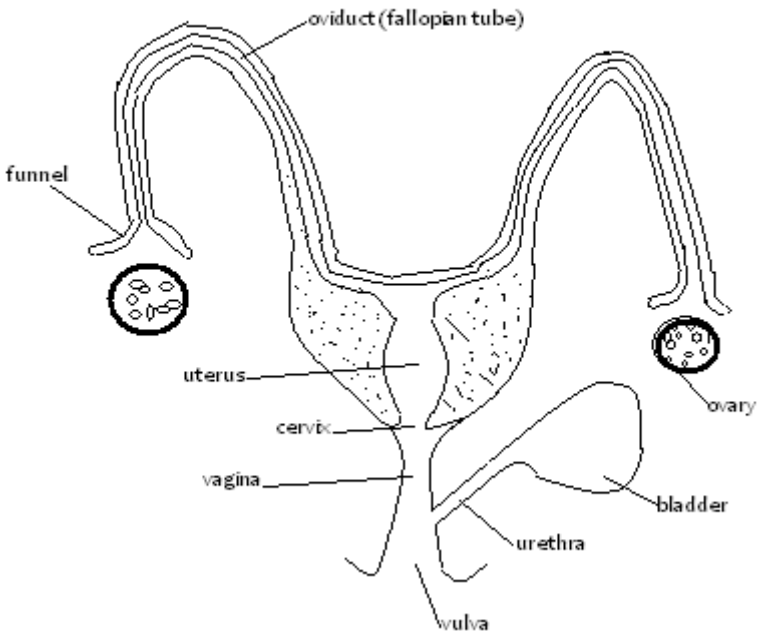
Reproductive system of a bull



- ***The testis:***
  - There are two testes hanging loosely between hind legs.
  - Enclosed by loose skin (scrotum)scrotum regulate temperature of testis for optimum production of sperms.
  - Produce spermatozoa(sperms)which are stored in coiled tube called epididymis.
- ***Epididymis:*** Storage of spermatozoa.
- ***Sperm ducts:***
  - Conveys sperm from the testis and urine through the penis.
  - sphincter muscles contract to allow each to pass separetly.
- ***Seminal vesicles produce fluid called semem.***
- semen carries sperms out of penis in fluid form.

- **Prostate gland** -produce fluid that neutralize the acidic effects of urine in the urethra preventing death of sperms.
- ***Accessory glands:*** Include seminal vesicles cowpers gland and prostate gland.
- ***Urethra****:* Conveys urine and semen.
- ***Penis:***
  - Surrounded by a sheath which is an extension of skin.
  - It introduces sperms into the vagina of a cow through the vulva during mating.
  - It is a copulatory organ, also used for urination.

Reproductive system of a cow



Ovaries and fallopian tubes(oviduct)

- Two ovaries located in abdomen, left and right.
- Produce ova/eggs and hormones which control sexual cycle.
- Oestrogen produced by graafian follicle inside ovary induces oestrus
- ie. Heat period so that the cow shows signs of heat
- After every 21 days the ovary releases a mature ovum and the cow comes on heat.
- The ovum travels through the fallopian tubes to the uterus.
- The release and movement of the ovum down to the uterus is called **ovulation.**
- If mating is done at this time, fertilization will take place.
- The fertilized egg implants itself onto the endometrium(walls of uterus)and develops into foetus.

Fallopian tubes:

- Fertilization takes place here.
- Also a passage for the egg from the ovary to the uterus.

The uterus:

- Embryo develops here.
- *The cervix:* Closes the uterus.

The vagina and Vulva:

- Vulva is the external opening of female reproductive system.
- It allows mating to take place so that sperms are deposited into the vagina.
- The foetus and urine are removed through the vulva.

Pregnancy

- Is period between fertilization of ova and the expulsion of the foetus through the vulva.
- Also called **gestation period.**
- In cattle gestation period is 270-285 days.
- Ends with the birth of a calf.
- The reproductive tract undergoes a period of rest during which it is repaired and returns to normal.
- During pregnancy, hormone called **progesterone** is produced by the placenta to maintain the foetus in the uterus.

Parturition(giving birth)

- Act of giving birth called parturition.
- This time the foetus expelled through the birth canal.

When an animal is about to give birth, it shows signs;-

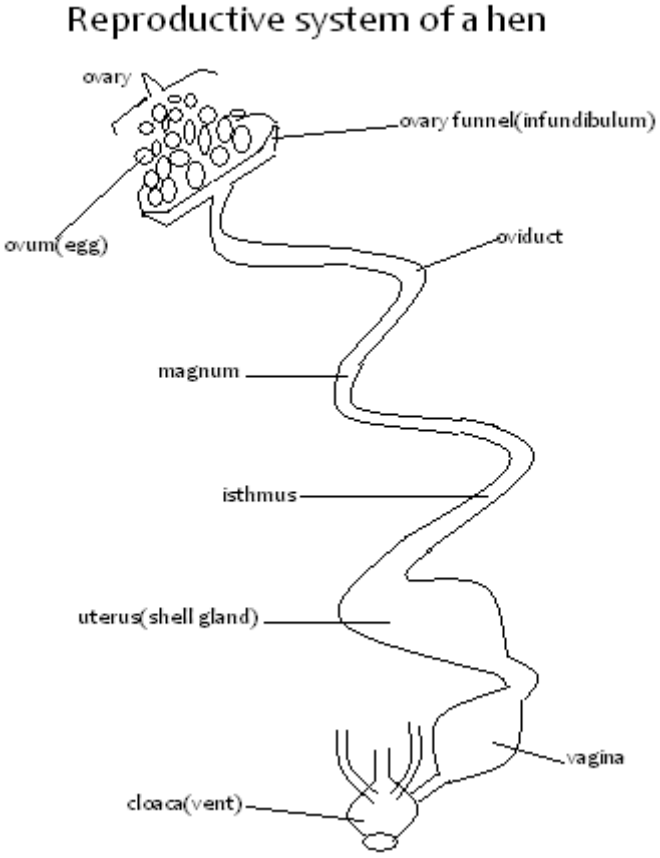
- Distended udder which produces thick milky fluid called colostrums.
- Swollen vulva producing thick mucus.
- Loose and slackened pelvic girdle.
- Visible pin bones.
- General restlessness.

- Animal parturates within 2-3 hours after this signs.
- The correct presentation is with the front feet first ,and the head outstretched and resting in between the fee.
- Any other presentation called **mal-presentation or breech presentation** and requires assistance.

Reproduction in Poultry

- The cock has no penis but a small opening near the vent through which sperms are emitted.
- Cock has testes within the body.
- The hen has elongated oviduct for formation of an egg.
- Fertilization occurs internally.
- During mating the cloaca of the hen and the vent of the cock fit into each other and then semen is poured into the cloaca ,then sucked to the oviducts.

The Reproductive System of a Hen



Ovary

- Hen has two ovaries but one functional.
- Ova formed in ovaries.
- 3500-4000 ova present inside ovary held by follicle.
- Mature ovum released via rapture of follicle.
- It moves into oviduct received by the funnel.

Funnel(infundibulum)
- Fertilization occurs here.
- Chalazae also added to yolk.
- Time here is 15 minutes.
- It is 11.6cm long.

Magnum
- Thick albumen is added.
- Stays for 3hrs.its 33cm long.

Isthmus
- Its 10.6cm long.
- Shell membranes added.
- Determines shape of egg.
- Water, mineral salts and vitamins added.
- Takes 15 minutes.

Uterus(shell gland)
- Calcium deposited 9ie.shell added around the egg.
- Pigments added.
- Addition of albumin finished.
- Stays here for 18-22hours.

Vagina
- Short, 6.9cm long.
- For temporal storage of egg before laying

Cloaca
- Egg moves out of cloaca through the vent.
- The cloaca extents out to prevent the egg from breaking.

NB;
- Egg formation not depended on fertilization.
- Egg formation takes 24-26hours.
- The components of egg are obtained from body reserves of the hens body.

Selection of a Breeding Stock
- Selection is used as a tool for livestock improvement.
- A breeding stock is a group of males and females which act as parents of future generations.
- Selection is the process of allowing certain animals to be parents of future generations while culling others.
- Culling is the removal of animals which do not perform to the desired level, from the herd.
- The animals retained have certain desirable characteristics which make them produce more.
- Selected animals make up the breeding stock.
- The breeding stock should pass the good qualities to their offsprings for better performance, to improve the livestock.
- Selection process repeated for many generations increases chances of formation of desirable qualities in an animal.
- Genetically termed as gene frequency(occurrence of the genes that carry desirable characteristics.)
- Selection increases occurrence of desirable genes and decreases occurance of undesirable genes.

- During selection, the characteristics to be selected for are first studied closely to ascertain that it is not influenced by the environment, but mainly by the genetic make-up.
- Selection helps improve characteristics which are highly heritable.
- Heritability means the likelihood of a particular trait to be transmitted to the offspring and they are strongly inherited.
- A character like milk yield is lowly heritable, i.e. it is weakly inherited and a bigger percentage of the character is affected by the environment.

The degree to which selection affects a character depends on the following factors;

- The heritability of the character
- The intensity with which the selection is done
- The interval between generations and kind of selection being practiced.

Factors To Consider When Selecting A Breeding Stock.

- Age
- Level of performance
- Physical Fitness
- Health
- Body Conformation
- Temperament or Behaviour
- Quality of products
- Mothering Ability
- Adaptability
- Proliferation

- **Age**
  - Young animals,
  - Those that have not parturated for more than 3-times, should be selected.
  - They have a longer productive life.
  - Old animals are poor breeders and low producers.
  - Production and breeding efficiency decline with age.
- **Level of performance**
  - Animals with highest production level selected.
  - Performance best indicated by records.

Good performance of animal indicated by;

  - High milk, wool and egg production,
  - Good mothering ability
  - High prepotency which is the ability of a parent to pass good qualities to their offsprings.
  - The animals with poor performance should be culled.
  - Good records kept and used by the farmer for this purpose.
- **Physical Fitness**

Animals selected should be free from any physical defect

e.g.

  - mono-eyed,
  - limping,
  - irregular number of teats,
  - scrotal hernia,
  - defective and weak backline

- **Health**
  - Sick animals do not breed well and are expensive to keep.
  - Animals that are resistant to diseases pass these characteristics to their offsprings

- **Body Conformation**

  - Animals for breeding to be selected according to proper body conformation.
  - A dairy cow should be wedge-shaped with a large udder, thin legs, long neck.
- **Temperament or Behaviour**
  - Animals with bad behaviors should be culled.eg
  - Cannibalism, egg eating, aggressiveness, kicking

- **Quality of products**
  - Select animals that give products of high quality.
- **Mothering Ability**
  - Animals selected should have a good mothering ability,
  - That is animals with good natural instinct towards their young ones.
  - This will enable them to rear the young ones up to weaning.

- **Adaptability**
  - Animals selected should be well adapted to the prevailing climatic condition in the area.
- **Prolificacy**
  - Animals selected should be highly prolific.
  - That is, animals with the ability to give birth to many offsprings at a time(larger litter).
  - This is a quality that should be considered when selecting pigs and rabbits.

Selection in cattle, and sheep,

Selection in cattle
Consider the following;
- Level Of Performance Which Include;
  - Milk Yield Buter Content.
  - Length Of Lactation Period.
  - Calving Intervals.
- Age Of The Animal,
- Fertility,
- Physical Fitness,
- Health Of The Animal,
- Body Conformation,
- Suitability Of The Enterprise-Milk Or Beef

Selection in sheep
Consider the following;
- Level of performance which includes;
  - Mothering ability
  - Growth rate

  - Wool quality
  - Carcass quality
  - Twining rate
- Age
- Suitability to the enterprise-wool or mutton
- Flocking instinct
- Health of the animal
- Physical fitness
- Inheritable defects
- Fertility
- Inheritable defects.
- Fertility.

Selection in Goats

Consider the following:

- Fertility.
- Mothering ability.
- Growth rate.
- Twining rate
- Carcass quality/dressing percentage.
- Growth rate.
- Suitability to the enterprise - milk or mutton.
- Health of the animal.
- Age.

Selection in Pigs

- Consider the following:
- Carcass quality/dressing percentage.
- Suitability to the enterprise (bacon or pork)
- Growth rate.
- Health of the animal.
- Mothering ability.
- Prolificacy.
- Number of teats.
- Temperament.
- Body formation.
- Age.
- Heredity defects

Selection in Camels

- Health of the animal.

- Age.
- Temperament.
- Foraging ability.
- Fertility.
- Level of performance-milk, meat, fur and transport.

Method of Selection

These include:

- **Mass selection** - Animals with superior characteristics are selected from a herd and

then allowed to mate among each other.
- **Progeny testing** - assessing on the breeding value of an animal on the basis of performance of its offsprings.
- **Contemporary comparison** ¬-comparison of performance between heifers of the same age and sexual maturity.

Breeding

- Process of mating selected males and females to produce offspring with the desired characteristics.

Reasons:

- To expand the inherited potential of the animal.
- To improve production.
- To overcome production problems created by the environment.
- To satisfy consumers taste.
- For economic reasons.

Terms Used in Breeding

Inheritance

- Genetic transmission of characteristics from parents to offsprings.
- The mechanism of inheritance is carried by the sex cells (gametes) and is controlled by genes found in the chromosomes.
- Genes are very tiny units of inheritance carrying particular characteristics, such as colour, body shape and amount of milk production.
- Chromosomes are genetic materials which carry genes.
- They exist in pairs paternal and maternal) in the nucleus f the body cells.
- They are always constant in number.

Dominant and Recessive Characteristics

- A dominant gene is one that suppresses the other.
- It produces a dominant characteristic.
- *A recessive gene* is one that is suppressed by the other.
- It produces a recessive characteristic.

Hybrid and Hybrid Vigour

- **A hybrid** is an animal which is the product of crossing animals of two different breeds.
- **Hybrid vigour or heterosis** is increased vigour and performance resulting from crossing two superior breeds.

Epistasis

- This is the masking of the effect of one gene by another gene which is non-allelic, that is situated on different locus.

Breeding Systems

Inbreeding

- Mating of animals which are related. *Reasons:*
- To increase genetic uniformity in a herd.
- Used to fix the required characteristics in new breeds.
- To increase phenotypic uniformity.

- To get proven sires.

Limitations

- It can bring about loss of hybrid vigour.
- It may lead to decline in fertility.
- It may lead to high rate of pre-natal mortality.

Systems of Inbreeding

- **Close Breeding**: mating between very closely related animals, for example sib-mating and parents sib-mating.
- **Line Breeding:** mating of distantly related animals that had a common ancestor for example cousins.

Outbreeding

- Mating of animals which are not related.

Reasons:

- To introduce new genes in an existing breeding herd.
- To exploit heterosis resulting from a cross between two breeds.
- To develop a new breed or a grade animal.

Limitations

- Lack of uniformity in animals that result from outbreeding.
- Desirable characteristics may be lost due to variation.

Systems of Outbreeding

- *Cross-breeding*

  Mating of animals from two different pure breeds.

- *Out-Crossing*

  Mating of unrelated animals from the same breed.

- *Upgrading/Grading up*

  Mating where the female of a cow grade stock (locals) is mated with a pure breed sire.

  The resultant animal is referred to as a high grade.

Mating in Livestock

Mating in Cattle

- Heat signs occur every 21 days.
- The heat period last for 18-30 hours¬ on average 24 hours.
- Cow should be served 12-18 hours after showing the first heat signs.

Heat Signs

- Restlessness.
- Mounting on others and when mounted on she stands still.
- Rise in body temperature.
- Drop in milk production in lactating cows.
- Vulva swells and becomes reddish.
- Clear or slimy mucus from the vulva.
- Bellowing or mooing frequently.

Mating in Pigs

- Heat signs in pigs occur after every 21 days.
- The heat lasts about 72 hours.
- Sows or gilts should be served in 18- 36 hours of the heat period.

Signs of Heat

- Restlessness.
- Frequent urination.
- Swelling and reddening of the vulva.
- Clear or slimy discharge from the vulva.
- Frequent mounting on others.
- It responds very well to the 'riding test'.

Mating in Rabbits

- Does are ready for mating 6-7 months of age.
- Heat signs occur every 14 days.
- The doe should be taken to the buck and not vice versa.

Signs of Heat

- Restlessness.
- Frequent urination.
- Swollen vulva.
- The doe throws herself on the side.
- The doe rubs herself against the wall or any other solid object.
- The doe tries to contact other rabbits in the next hutch by peeping.

Methods of Service in Livestock

Natural Mating

Advantages:

- It is more accurate.
- It is less laborious.
- Useful when heat signs of females cannot be easily detected.

Disadvantages

- Inbreeding is not easily controlled.
- Transmission of breeding diseases.
- Extra feed for the male is required.
- Large males can injure small females.
- Wastage of semen.
- It is cumbersome and expensive to transport a bull to remote areas.

Artificial insemination

- Introduction of semen into the female reproductive tract by artificial means.

Advantages

- There is economical use of semen.
- It controls transmission of breeding diseases.
- Sires that are unable to serve cows due to heavy weight or injury can produce semen

to serve cows.
- It prevents large bulls from injuring small cows.
- It reduces the expenses of keeping a male animal.
- A small scale farmer who cannot afford to buy a superior bull can have the cows served at a low cost.
- Semen can be stored for long.
- It helps to control inbreeding.
- It eliminates the threat of keeping dangerous bulls from the farm.
- It makes research work easier.

Disadvantages

- Harmful characteristics can be spread quickly by one bull to the offsprings.
- It requires skilled labour.
- Low chance of conception due to death of semen during storage.
- It is laborious:

Embryo Transplant

- It is the implantation of an embryo (fertilized ova) from a high quality female (donor) in the uterus of a low grade female (recipient).

Advantages

- Faster multiplication of an animal with superior characteristics .
- It is easier to transport embryos than the whole animal.
- Embryos can be stored for a long period awaiting the availability by recipient females.
- It stimulates milk production in a female (recipient) that was not ready to produce milk.
- Low grade animals can be used in production and rearing of high quality animals.
- Offsprings of a superior female can spread quickly in an area.

Disadvantages

- It is expensive.
- It requires skilled personnel.
- It requires special equipment for fertilization and storage of embryos.

Signs of Parturition in Livestock

- Parturition is the act of giving birth in female animals.

Parturition in Cattle

- The gestation period in cattle is 270-285 days averaging 280days.

Signs of Parturition

- Restlessness
- Enlarged or swollen vulva.
- Clear mucus discharge from the vulva.
- Slackening of the pelvic muscles.
- Full and distended udder.
- Thick milky fluid from the teats.
- A water bag appears and bursts just before calving.

Parturition in Pigs

- The gestation period in pigs is about 4 months or 3 months, 3 weeks and 3 days.

Signs of Parturition

- Restlessness.
- The vulva turns red and swells.
- The udder becomes full with a milky fluid the sow starts to prepare a nest by

collecting some beddings at one comer of the pen.

Parturition in Rabbits

- The gestation period in rabbits is 28-32 days.

Signs of Parturition

- Preparing a nest by plucking off hair from her belly.
- Goes off feeding
- Restlessness.
- The udder distends.

Livestock Production IV

(Livestock Rearing Practice)

Introduction

- In the management of livestock there are many activities that are carried out on animals to enhance production.
- They require care in feeding, health, breeding.
- Specific management also important in bee and fish farming.

Routing livestock rearing practices.

- A routine is a fixed/regular way of doing something.
- done repeatedly after a certain period of time

Feeding Practice

- Animals are fed to cater for both maintenance and production requirements.
- These are special types of feeding carried out on certain animals to cater for specific needs.

These include:

Flushing

- The practice of giving extra quality feed to an animal around service time.
- In sheep it is done 2-3 weeks before tupping and 3 weeks after tupping.
- In pigs it is done 3-4 weeks before service.

Importance of Flushing

- It increases conception rates.
- It enhances implantation of the zygote.
- In sheep it increases twinning percentage by 15-20%.

Steaming Up

- Giving extra quality feed to an animal during the last weeks of gestation.
- In cattle it is done 6-8 weeks before calving.

Importance Steaming Up

- It provides nutrients for maximum foetal growth.
- It helps in the build up of energy for parturition.

- It ensures the birth of a healthy animal.
- It promotes good health of the mother.
- It increases and maintains high milk yield after birth.

Creep Feeding

- Feeding of young animals from birth to weaning.

Piglets

- 10 days old - introduced to creep pellets.
- 5 weeks old - creep pellets mixed with sow and weaner meals.
- 8 weeks old - weaning.

Lambs

- Run with their mothers for natural suckling.
- Bucks - introduced to succulent feeds and concentrates.

Kids

- Meat goats kids suckle naturally.
- Dairy goats, fed on milk artificially,
- Given 0.5-1.25 litres up to the third week.
- Introduced to concentrates at 3-4 months.
- Weaned at 6-8 weeks of age.

Parasite and Disease Control Practices

Vaccination

- Introducing active disease organsms which are reduced in strength or virulent into the animals' body to induce immunity.

Administration of *Vaccination* done through:

- By injection.
- Orally through the mouth.
- By inhalation through the nose.
- Eye drops.

Deworming

- Practice of killing/removing internal parasites by administering drugs known as dewormers / antihelmitics.

Hoof Trimming

- Cutting back overgrown hooves with the help of a hoof trimming knife, a hoof cutter or a hoof rasp.

Importance

- Facilitate easy movement.
- Control of foot rot disease.
- Facilitate mating - prevent the ram from injuring the ewe during tupping.

Docking /tailing

- This is the removal (cutting oft) of tails in sheep during the first week after birth.

Importance

- Even distribution of body fat.
- Facilitate easy mating in adult life.
- Minimise fouling of the wool with faeces.
- Reduce incidences of blowfly infestation.

Methods of Docking /tailing

- Cutting with sharp knife or scalpel.
- Use of elastrator and rubber ring.

Dipping and Spraying

- These are methods of applying acaricides on the animals to control external parasites.

Dusting

- It is the application of chemical powders on the animal body or on the walls of the animal house to control external parasites.
- It is used to control stick-fast parasites and fleas in poultry.

Breeding Practices

These are practices carried out to enhance successful breeding.

- ***Crutching and Ringing***
  - Crutching - cutting of wool around the external reproductive organs of female sheep.
  - Ringing - trimming wool around the sheath of the penis of the rams to facilitate mating.
- ***Tupping and Serving***
  - Tupping refers to mating in sheep and goats.
  - Serving refers to mating in cattle and pigs.
- ***Raddling***
  - This is the practice of fitting the rams with breeding chutes which are painted in different colours during mating
  - to identify mated ewes and to indicate the active rams hence help in culling of the weak rams.

Identification

The practice of putting identification marks on animal.

- **Branding** - burning marks on the animals skin.
- **Ear tagging** - placing marked plastic or metallic tags on the animals ears.
- **Ear notching** - cutting different shapes bearing different values on the ear lobes.
- **Tattooing** - use of permanent ink or dye to mark animals with light skin.
- **Neck strap or chain** - Fixing of tags round the animals neck with a chain or a strap.

Importance/ purpose of Identification

- record keeping
- Setting disputes in case animals get mixed up in the pasture.

Debeaking

- Cutting about 1/3 of the upper beak with a knife, scissors or hot iron.

- ***Importance***
- Control egg eating.
- Control cannibalism.

Tooth Clipping

- The removal (clipping) of the needle (canine) teeth in piglets 24 hours after birth.

Culling

- Removal of undesirable animals from a herd.

Dehorning

- Removal of horns or horn buds from an animal.

Importance

- It prevents animals from injuring each other.
- It makes the animal docile and therefore easy to handle.
- For easy transportation and feeding.
- Prevents destruction of farm structures.

Shearing

- The practice of cutting wool from all over the body of a sheep.
- It starts at the age of 8 months and then done once a year.
- Should be done during the dry season.
- Tools used: wool shears.
- Care must be taken not to cut the skin, testicles, udder, vulva and penis.

Castration

- It is the rendering unserviceable the testicles of a male animal.

Importance

- To control breeding diseases.
- To control breeding.
- For faster growth rates.
- Increase quality of meat by removing unpleasant smell especially in goats.

Methods Used:

- *Closed/bloodless method*
  - involves use of burdizzo or rubber ring and elastrator.
  - Animals do not bleed but may not be 100% effective.
- *Open method*
  - A surgical method used for castrating cocks, piglets and rabbits whose testes are internal.
  - Also used for lambs, kids and calves.
  - Animals bleed a lot.
  - However, it is 100% effective.
  - It is not recommended for mature adults.
- *Caponisation*
  - It is the practice of making male birds lose their male characteristics by use of hormones.
  - Hormones used include stilboestrol which is injected into the birds when they are one day old and female hormones implanted beneath the skin at the neck.
  - Birds which have lost their male characteristics in this way are referred to as capons.

Management During Parturition

- Parturition is the act of giving birth to fully grown foetus.

Parturition in Cattle

- It is referred to as calving.
- Gestation period lasts 270-285 days after conception.
- When the signs of parturition are observed the cow should be separated from the rest of the herd.
- Normal calving should take 2 hours and the normal presentation is the muzzle, face or fore head on top of the forelegs first.
- In case of other presentations the mother should be assisted.
- Provide the mother with plenty of water and feed after parturition.
- If the after birth does not come out within 48 hours a veterinarian should be called to remove it.

Parturition in Sheep

- It is referred to as lambing.
- Gestation lasts 21 weeks (150 days) after conception.
- The ewe lamb naturally without any problem.
- If complications arise the ewes should be assisted.

Signs of Parturition in Sheep

- Udder becomes full.
- Teats are bright red in colour.
- Restlessness and bleating.
- Slackening of the hip muscles.

After these signs are seen the ewes should be separated from the others.

- The normal presentation is forelegs and head first.
- After birth the mother should be allowed to lick the lamb to ensure the coat is dry.

Parturition in Goats

- It is referred to as kidding.
- It takes place 150 days after conception.
- Nannies carrying twins, kid a few days earlier.
- Kidding nannies should be kept in a clean dry place which should be well sheltered.
- Signs of parturition are similar to those of ewes.
- Kidding nannies should be kept with another female for company.

Parturition in Pigs

- It is referred to as farrowing.
- Gestation period 113-117 days (4 months).

Signs of Farrowing

- The sow becomes restless.
- There is enlargement of the vulva .
- Muscles on each side of the tail slacken.
- There is loss of appetite.
- The udder and the teats become enlarged.
- The sow collects bedding material in one comer to build a nest.
- Milk present in the teats 24 hours before farrowing.

After the signs are seen;

- Farrowing takes about 2-6 hours under normal condition.
- An attendant should be there to assist the mother and piglets.
- Ensure the removal of the after birth to prevent the sow from eating it.
- The sow should be fed well and given plenty of clean water.

Parturition in Rabbits

- It is referred to as kindling.
- It takes place 28-32 days after conception.
- Provide a nesting box and plenty of dry soft beddings in the hutch towards the fourth week of gestation .

Signs of Parturition

- The doe plucks off the fur from her body.
- Uses the fur to build a nest about 3-10 days earlier.

Bee Keeping (Apiculture)

- Bees are insects which live in very well organised colonies.

Each colony consists of:

- Queens - fertile females that breed to ensure the continuity of the species.
- Drones - fertile males that mate with the queen for reproduction process.
- Workers - non-fertile or sterile females that maintain the colony.

Duties of Workers

- They rear and nurse the brood (eggs, larvae and pupae), queen and drones.
- They collect nectar and make honey.
- They make the honey combs.
- They protect the hives.
- They clean the hive.

Importance of Bees

- Collect nectar from flowers.
- Make honey - a nutritious product used by man as food.
- Helps in crops pollination of plants.
- Bees produce wax used to make candles.
- They make propolis - a bee product which is medicinal.

Routine Management

Siting/locating of an Apiary

Factors to consider;

- Nearness or accessibility to nectar or flower-producing vegetation.
- Areas with shade. Bees are sensitive to the sun's heat and require some shade to protect them.
- Safe distance from human residence and other livestock.
- Bees are stinging insects and can be a hazard to humans or other animals.
- Nearness to a source of water for use in their nutrition.
- A good distance from source of noise and other disturbances.
- Safety from predators for example honey badgers, ants (safari ants), birds and other parasites such as wax moths.

Feeding

- Normally bees are self-sufficient in providing their food from the honey they make.
- However, during the dry season, their feeding should be supplemented by providing a solution (syrup) of sugar water or giving molasses.
- This should be placed strategically so that it is easily accessible to the bees.

Parasites

- Ants
- Wax moths
- Bee louse
- Honey badger

Control of Parasites

- Use of physical barriers such as Vaseline/grease to control ants.
- Smoke the hive to control bee louse.
- Suspend the hive to control honey badgers.
- Burn infected combs to control wax moths.

Diseases and Control

- African bees are seldom attacked by diseases.

Harvesting Honey

Factors to consider;

- **Stage of ripening**: Honey must be harvested when it is fully mature.
- **Season of the year**: Harvested at the end of the rainy season.

Procedure

- Blow light smoke through the hole.
- This makes bees suck honey and become engorged and docile.
- Lower the hive to the ground.
- Open the hive to expose honey combs.
- Brush the bees off the honey combs.
- Cut the honey combs, leaving a small margin on the bars and keep them in a closed container.

Honey Processing

- Using heat in a water bath to melt the honey.
- Crushing and straining.
- Using a centrifugal extractor.

Precautions When Handling Bees

- Avoid excessive smoking.
- This kills the brood and lowers quality of the honey.
- Use protective clothing to avoid sting.
- Protect the hive from rain water.
- Use clean equipment and containers to avoid contamination of the honey.
- Use recommended method of extracting honey.
- Use recommended type of hive such as Kenya top bar hive.

Fish Keeping (Aquaculture)

Introduction

- The rearing or keeping of fish is called fish farming and is normally carried out in specially prepared ponds.

A good fish-pond should have the following features:

- Site should be on a fairly level ground with a permanent supply or source of water.
- The area should have clayey soil to avoid loss of water through seepage.
- Water must be free from any pollutants such as chemicals and other wastes.

Construction should provide for:

- an inlet for fresh supply of water,
- a spill ¬way channel to take off overflow or excess water,

- an outlet to drain off the water when it is necessary to replace pond water,
- a fence to keep off predators and other intruders.

Feeding Fish

- Fish naturally feed on worms, insects and algae in the ponds.

These sources of food must be supplemented by throwing in the pond ;

- kitchen wastes,
- chopped vegetable materials such as cabbage leaves,
- cereal brans
- brewers' grain .

Management Practices to Ensure Maximum Harvest of Fish

- Control of stocking rate, that is to, have the recommended population of fish in a pond at anyone time.
- Harvest at the correct maturity stage.
- This is done by using the fishing net with correct mesh sizes to avoid catching the fingerlings.
- Avoid water pollution in the ponds which may poison fish.
- Ensure adequate supply of food in the pond.
- Water in the ponds should be kept in motion to facilitate aeration.
- Maintain appropriate depth (level) of water.
- Control predators and/or thieves.
- Drain and refill ponds with fresh water as necessary.

Harvesting Fish

- Harvesting or extracting fish from the fish¬ ponds for consumption

Two main methods:

- *Hook-and-line method:*
  - This is slow, injures small fish and is inefficient.
  - It is only suitable for small-scale fishing.
- *Use of fishing nets:*
  - This is the most efficient method as long as a net with the correct mesh sizes is used.
  - Harvesting may be done 6-8 months after the introduction of fingerlings into the fish pond.

Maintenance of the Fish Pond

- Repairing the dyke or any structure on it.
- Cleaning the pond and removing foreign materials.
- Planting grass where necessary.
- Removing un desirable vegetation.
- Removing the silt.

Fish Preservation

Practices before preservation:

- Clean the fish to remove mud and any worms.
- Removing scales and slime.
- Opening the fish on the side to remove the gut and the intestines referred to as gutting.
- Cleaning the abdominal cavity thoroughly.
- Keeping fish in open containers.

Methods of Preservation

- Freezing
- Salting
- Sun drying
- Smoking

Appropriate Handling of Livestock During Management

- Physical beating should be avoided.
- Structures which help in restraining animals should be used whenever applicable.
- The correct methods of securing and casting animals should be used.
- Use as little force as possible.
- Equipment such as ropes, halters, lead stick and bull rings are used to handle animals appropriately.

Farm Structures

Introduction

- Farm structures are physical constructions on the farm used to increase efficiency in production.

Construction of Farm Structures

Involves:

Planning for farm structures ;

Consider;

- Farm activities.
- Size of the enterprise.
- Future of the enterprise.
- Accessibility.
- Soil type.

Siting farm structures;

Consider:

- The location of the homestead.
- Accessibility.
- Security.
- Drainage/topography.
- Wind direction.
- Relationship between the structures.
- Proximity to social amenities.
- Farmer's taste and preference.

Materials for Construction

Structural Materials and Use

Factors which determine the type of materials to use are;

- durability,
- strength,
- labour,

- availability,
- workability,
- serviceability,
- cost
- sanitation.

Stones and Bricks

Advantages

- Stones and bricks are durable, easy to disinfect, resistant to weather and insects decay and are easily available.

Disadvantages

- They are bulky and require skilled labour to make them.

Plastic and Synthetic Materials

These include;

- glass,
- asbestos fibre
- polythene materials.

Advantages

- Light,
- cheep depending on quality,
- easy to disinfect,
- can be moulded into any shape,
- are durable,
- cannot be destroyed by insects and fungus
- are water-proof.

Disadvantages

- Are easily destroyed,
- fragile,
- very expensive
- require skilled labour.

Wood (Timber)

Advantages

- They are workable,
- cheap,
- can be re-used
- are fairly strong.

Disadvantages

- They can catch fire easily,
- decay if exposed to water

- are affected by fungus and insects.

Concrete

- Is a mixture of cement, sand, aggregate and water
- e.g. in making blocks the ratio is 1:2:3; one part cement, two parts sand and three parts aggregate.

Uses

- Making posts for fencing.
- Making walls and floor of buildings.
- Making gabions and water channels to prevent erosion.
- Making water troughs.

Advantages

These materials are;

- durable, workable,
- easy to disinfect,
- cheap to maintain,
- fire resistant

Disadvantages

- These materials are ;
- expensive,
- require skilled labour,
- bulky,
- cannot be reused

Animal handling structures

- The crush –used when doing following activities;
  - Spraying livestock to control ticks,
  - milking,
  - examining sick animals,
  - artificial insemination,
  - treating animals, eg drenching, vaccination,
  - dong routine jobs such as dehorning, identification marks,
- The spray race-used in the control of ticks by spraying livestock with acaricides
- The dip- machakos type, and the pludge dip. This is used in the control of ticks by dipping livestock

Farm Buildings

Factors to be considered in site selection;

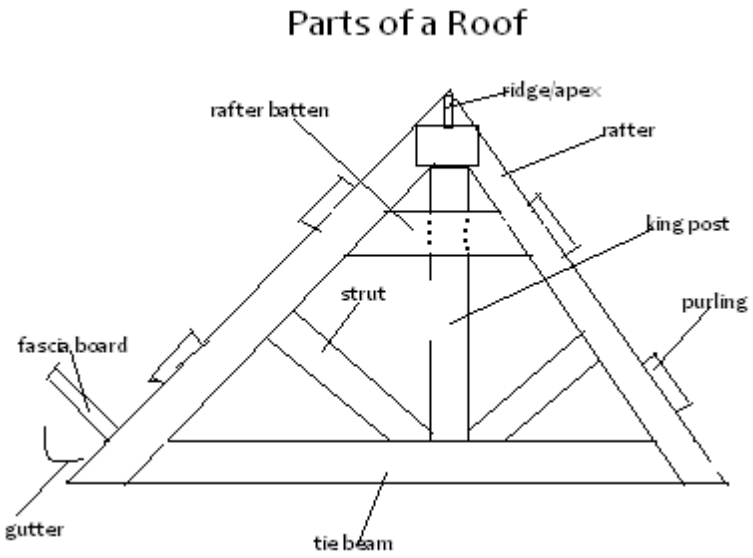
- Security
- Nearness to a source of water
- Topography
- Direction of the prevailing wind
- Direction of the sun
- Personal whims/tastes and preference
- Nearness to means of communication.

Types of farm buildings

- Houses for farm animals.
- Stores for farm produce.
- Stores for equipment, tools and supplies.
- Buildings for growing crops e.g green house.
- Building for processing plant e.g milk plant.

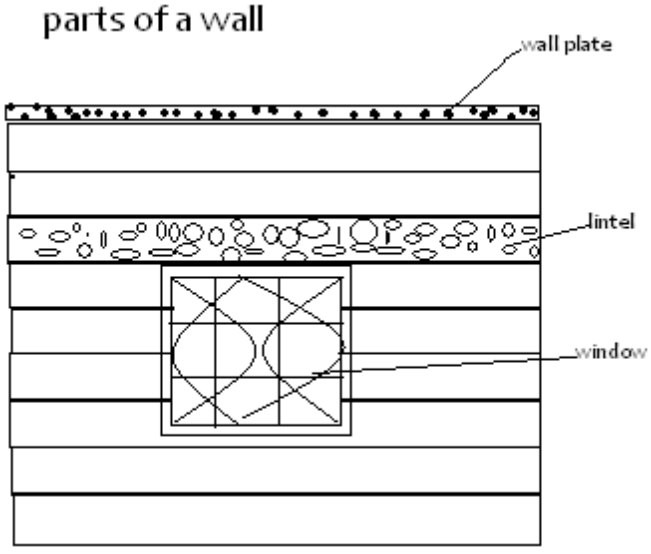
Parts of a building

- The foundation,
- The walls,
- The roof

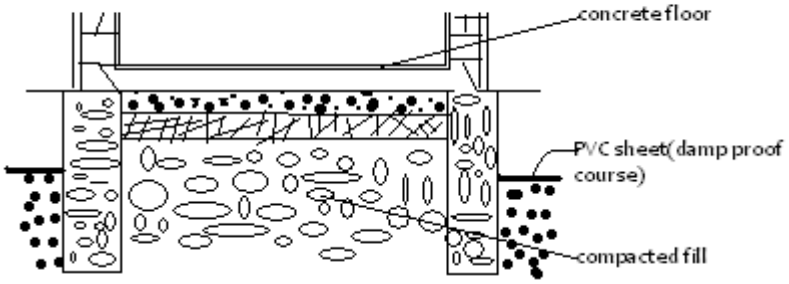


Include;

- kingpost,
- rafters,
- struts,
- tie beam,
- rafter batten



Parts of the foundation



Include;

- concrete floor,
- foundation wall,
- PVC sheet (damp-proof course)
- the compacted fill (hard core).

Fences

- Importance of Fence in a Farm
- Keep out intruders to the farm,
- Define the boundary lines of the farm.
- Paddocking of fields to make rotational grazing possible.
- Live fences serve as windbreaks.
- Fences are used in mixed farming to protect crops from damage by livestock.
- Fences add aesthetic values to the farm.
- It is easy to control breeding.
- It is easy to isolate sick animals from the rest of the herd.

Types of Fences

- Dead fences.
- Barbed wire fences.
- Electric fence.
- Concrete fence.
- Chicken wire fence (mesh wire fence).
- Woven wire fence (chain link).
- Wooden fence.

Fencing Practice

- Materials include;
  - wires,
  - staples,
  - nails,
  - posts,
  - droppers
  - concrete materials.
- Size of posts:
  - General purpose 2.5m by 25cm in diameter
  - Strainer units and corner posts 3m by 30cm in diameter:
- Distance between the posts:
  - 3m between posts, 10m if droppers are to be used.
  - 200m between strainer units.

- Depth of holes - 60cm.

Gate Posts, Gates and Strainer Units

- Gates should be hung on posts separate from the fence.
- Mechanical implements for example tractors require 4.0-4.5m width of gate.
- Entrance gates for pedestrians can be accommodated within the fence.

Steps in Fencing

- Locate the corners
- Clear the fencing area.
- Mark gates, strainers, pass places and standards by pegging.
- Dig holes to proper depths.
- Fix the standard posts.
- Firm around posts or apply concrete.
- Fix wires on posts.
- Fix the droppers.

Agricultural Economics II
(Land Tenure and Land Reforms)

Introduction

- Land is an important factor of production.
- Without land it is impossible to practice the agricultural business.
- However the efficiency of utilization of land is influenced to a large extent by the condition of holding the land.

Land Tenure

- Land tenure is defined as the possession of the legal rights to the use of land.
- Various kinds of rights to the use of land give rise to different tenure systems.

Land Tenure System

- All land tenure systems fall into two major classes, namely:

Collective Tenure Systems

This includes:

Communal Tenure Systems

- This involves the possession of rights over land by the whole community.
- It works quite well under conditions of unlimited land resources.

Advantages of Communal Tenure

- Landless problem does not exist.
- Land is not fragmented.
- Allows for free movement of animals in search of better pastures and water.
- Promotes community spirit among the members.

Disadvantages of Communal Tenure

- No incentive among the users to conserve the land resources.
- Everybody strives to maximize returns from the land without the drive to invest, for example, in terms of soil conservation and maintenance of soil fertility.
- There is a tendency of overstocking and continuous cropping; which leads to soil erosion and loss of land productivity.
- As a result of communal grazing of livestock, it is impossible to improve livestock through;
    - controlled breeding,

- proper feeding,
- disease and parasite control.

- Since there is no title deed, (certificate of ownership) it is virtually impossible to secure loans to develop the land.

Co-operative Tenure System

- This category includes various collective arrangements under the government or other authorities.
- Farmers voluntarily group together and buy land which they subsequently operate on co-operative basis.
- Examples are co-operative ranches.

Advantages of Co-operative Tenure

- No land disputes.
- Labour is well utilized.
- Profit is distributed according to the number of shares.
- Resource use is enhanced for high production.

Disadvantages of co-operative tenure.

- Incase of poor management everybody will loose.
- No individual title deed hence cannot secure loans.

State ownership

- Land is owned by the whole state and is refered to as government land.

Examples in Kenya;

- Areas not allocated to individuals
- Land under local county councils/cities and towns
- Land under forest, game reserve and parks, land for infra-structure and public utility

Advantages of state ownership

- Generation of income for the state
- All the citizens benefit from whatever comes out of the land.

Disadvantages

- Non-competitive in terms of production
- No individual motivation when working on the land.

Individual Tenure system

The various forms of individual land tenure are;

- **Owner operator,**
- **Plantation and Concestion,**
- **Land-lordism/Tenancy**

Owner operator

- **This category includes all persons who operate on land to which they have absolute individual rights.**

- **Examples are the majority of individual land owners in areas where demarcation and registration of land has taken place and title deeds issued.**

Advantages

- The owner is free to make permanent production plans.
- The owner can pledge the land title deed to secure loans(credit) from lending agencies for further development
- An individual is motivated to work harder than when under communal arrangement
- Managerial failures usually affect small units of production and are therefore negligible.
- It is easy for the owner to get agricultural advice.

Disadvantages

- Cost such as machinery for processing may be too high for the individual owner
- Innovation may be inadequate due to low levels of education.
- Lack of capital to invest.

Plantation and concession

- In this form of land tenure, the individual is usually a company or a corporation.
- Most of them engage in the production of only one commodity
- They are rigid in their production plans and in most cases labour is hired on wage basis.
- Example are coffee, tea, sugarcane, sisal estates in Kenya.

Advantages

- High production from the land hence high economic gains
- Allows foreigners to use and develop land
- No land disputes
- Create employment for the local people
- Generate government revenue through taxation.

Disadvantages

- Individuals own large pieces of land while others are landless
- Large areas of land may be left underdeveloped.
- Foreigners may repatriate profit to their countries.
-

Landlordism and tenancy

- The arrangement here involves the ownership of land by one individual or group of individuals (landlord) who lease it to another individual (tenant).
- A legal lease specifies the length of time during which the tenure is operative; and that serves as a security of tenure to the tenant.
- The efficiency of production in this arrangement is greatly affected by the length of lease, its legal backing and rent payable.

Advantages

- A person without land can get a chance to use land.
- A landlord who cannot operate the land, for any reason, can still earn income by leasing it to a needy tenant.
- It is a flexible arrangement; that is, it allows room for change of production plans

should need arise.
- Security of tenure gives the tenant incentive to invest depending on the length of tenure.

Disadvantages

- Poor land use and low production if the tenant does not have enough funds to improve on land.
- Tenants cannot produce long term crops,
- Landlords can exploit the tenants by overcharging.
- Lack of incentives to improve land by the tenants since it does not belong to them.

Land Reforms

Definition

- Land reform is any organized action designed to improve the structure of land tenure and land use.

Forms of Land Reform

Land Consolidation

- This means bringing or putting together, into one piece; fragmented parcels or pieces of land scattered over a large area.

The objective of land consolidation are :

- To save on time spent while moving from one piece of land to another.
- To facilitate effective and efficient farm planning.
- To create an incentive among land operators to invest on and develop land.
- To facilitate mechanization and improve production through efficiency.
- To improve level of production through effective supervision of the labour force and sound farming methods,

Land Fragmentation and Sub-division

- This is the subdividing of a (large) piece of land into smaller portions.

- Sometimes it becomes necessary to sub-divide land for the following reasons:
  - To sell part of the land.
  - The parent may wish to subdivide and distribute his land among the sons, daughters and other dependants.
  - The government may decide to subdivide large farms in order to settle landless citizens.

Land Adjudication and Registration

- Land adjudication involves;

  - Establishing the legitimate ownership,

  - Measurements (to make permanent boundaries)

- Recording of land details.

- Once land has been adjudicated, and any disputes concerning the same land are settled,
- It is then registered in the "***Register of Land".***
- And the owner is issued with a land title deed or certificate of legal ownership.

Importance of land title deed

- The legal owner of the land has security of tenure and hence an incentive to invest and improve productivity.
- A farmer can mortgage the land by offering land title certificate as a security to loaning agencies to secure capital to finance development projects.
- If a farmer who cannot operate the farm, he can still earn income from it by leasing it.
- Disputes concerning land boundaries and/or land ownership no longer arise.

Land Settlement and Resettlement

Definition

- Land settlement means the occupation of land which was previously uninhabited.
- Land resettlement, on the other hand, is the transfer of people from an already densely populated area to a sparsely populated one.

Objectives

- To settle the landless citizens.
- To relieve population pressure in densely populated areas.
- To increase or promote agricultural productivity by farming on land that was previously unused or lying idle.
- To create self-employment thus improving the living standards.
- Land reclamation, especially by creating tsetse fly-barriers.

Soil and Water Conservation

Introduction

- Soil and water are two very important natural resources in farming.
- They should therefore be well maintained and used without wastage to sustain continuous production.
- Water loss during the rainy season should be prevented and excess water conserved for use during scarcity.
- Soil erosion must be controlled at whatever cost if soil is to be conserved.

Soil Erosion

- It is the removal and carrying away of the top soil by the action of water or wind.

Factors Influencing Soil Erosion

- ***Amount and intensity of rainfall.***
  - The steeper the land the higher the velocity of surface runoff.
  - The higher the velocity of surface runoff the greater is its erosive power/effect.
- ***Type of soil*** for example sandy soils are more easily detached and carried away than clayey soils.
- ***Soil depth***;

- The deeper the soil, the longer it takes to be saturated with water.

- ***Land use:***
  - ***Overstocking*** leads to bareness of the land and looseness of the soil.
  - ***Deforestation*** - indiscriminate removal of trees leads to exposure of soil to heavy rainfall and high temperatures.
  - ***Indiscriminate burning of vegetation*** exposes the soil to erosive agents.
  - ***Clean weeding*** leaves the soil bare.
  - ***Ploughing along the slope.***
  - ***Monoculture*** or continuous cultivation.
- ***Ground cover***
  - Trees act as windbreakers.
  - Roots of vegetation cover hold the soil particles together.
  - Leaf fall act as mulch which reduces erosion.
  - Leaves of vegetation cover intercepts raindrops reducing their erosive power.

Agents of Erosion

- ***Water*** - moving water has erosive power.
- ***Wind*** - wind carries away soil.
- ***Human beings*** - through man's activities such as cultivation and mining.
- ***Animals*** - through overgrazing and creating footpaths where soil erosion takes place.

Types of Erosion

- ***Raindrop (splash)*** - displacement of the soil caused by raindrops.
- ***Sheet*** - uniform removal of soil in thin layers from flat or gently sloping areas.
- ***Rill -*** removal of soil from small bur well defined channels or rills.
- ***Gulley*** - removal of soil from channels which become progressively deeper and wider.
- ***Riverbank Erosion*** - removal of soil along river banks by the river water.
- ***Solifluction*** - gravitational flow of soil saturated with water.
- ***Land slides*** - mass movement of rock debris and soil down a slope,

  For example;
  - Slip movement of earth or rock masses for a short distance.
  - Debris slide - materials move at a greater speed.
  - Debris fall - movement of materials/debris along vertical cliff.
  - Rock fall - movement of rock down a very steep slope.
  - Rock slides - mass of rock materials that slide along a bedding plate, a joint or a fault face.

Soil Erosion Control Measures

Soil conservation measures can be classified into:

- Biological or cultural control
- Physical or structural control

Biological or Cultural Control Measures

These measures are applicable where land slope is between 2-12%.

- ***Grass strips/filter strips***;
  - These are narrow uncultivated strips along the contour left between cultivated strips.
- ***Cover cropping*** ;
  - The establishment of a crop that spreads out over the surface of the soil to provide it with a cover.
- ***Contour farming*** ;
  - Carrying out all land operations along the contour.

- ***Mulching*** ;
  - Covering of the soil with either organic or synthetic materials.
- ***Proper cropping systems*** such as:
  - Crop rotation
  - Correct spacing
  - Inter-cropping
  - Ridging/furrowing
  - Strip cropping
- ***Controlled grazing***;
  - Proper stocking rate, rotational grazing.
- ***Strip cropping***;
  - Growing crops which give little ground cover in alternate strips with crops such as beans which have a good ground cover.
- ***Afforestation/re-afforestation***.
  - ***Afforestation*** - growing of trees where non-existed.
  - ***Re-afforestation*** - growing of trees where they have been cut down.
  - ***Agroforestry*** - land use that involves the growing of trees in combination with crops and pastures on the same piece of land.

Physical or Structural Control Measures

- These are soil and water conservation measures which involve mechanical constructions on the earth.
- They are used in areas of moderate slope between 13-55%.

They include:

- ***Trash or stone lines***;
  - These are rows of heaped crop' residues or stones made along the contours.
- ***Filter strips***;
  - It involves the growing of an open crop in the upper side of the slope followed by a dense crop to reduce speed of water.
  - This increases infiltration.
- ***Terraces;***
  - Are structures constructed across a slope to reduce the length of a slope thus reducing run-off.
- ***Bench terraces;***
  - Are constructed where the slope is 35-55%.
  - Tree crops are suitable for such areas.

Importance of a Bench Terrace: -

  - Reduces slope of the land.
  - Conserves soil moisture.
  - Better retention of soil fertility.
- ***Narrow based terraces –***Cannot allow cultivation by machines.
- ***Broad based terraces*** - Is wide enough to allow cultivation by machines.
- **Graded terraces:**
  - Have a drainage channel to lead off excess water to a vegetated place.
  - They should be about 100m in length.
- ***Level terraces:***
  - Have no outlet channels,
  - The aim is to have water infiltrating,
  - Hence no water can flow from the ends of the terrace.
- ***Fanya juu:***
  - A ridge made by digging a channel and throwing the soil uphill.

- ***Fanya chini:***
  - In this case the soil is heaped on the lower side of the channel.
- ***Bunds:*** heaps of soil (earth) made along the contour.
- **Cutoff drains:**
  - An open trench with an embankment on the lower side into which water from the farm drains.

Water from the trench should be discharged into;

  - Natural waterways,
  - Artificial waterways,
  - Rocky ground
  - Grassland
- ***Gabion/Porous dams***:
  - Galvanized wire mesh boxes filled with stones which are built across slopes and gullies.
- ***Dams and reservoirs ;***
  - Dams - barriers built across a river/waterway to hold and store water. It reduces speed of runoff.
  - Reservoirs - these are large storage tanks.
- ***Ridging -*** heaps of soil to reduce the speed of water,
  They retain the water for some time.

Water Harvesting Methods

- Water harvesting and storage should be done during the rainy seasons to avoid wastage.

This should be done using the following methods:

- ***Roof catchment*** - trapping and collection of rain water from roof tops.
- ***Rock catchment*** - water is harvested by constructing a barrier on the lower side of a large impervious rock to trap surface runoff from the rock.
- ***Weirs and dams.***
  - ***Dam*** - a barrier constructed across a river or a dry valley so that it can hold water.
  - ***Weirs*** - barriers constructed across a river or a stream to raise the water level and still allow water to flow over it.
- ***Ponds -*** water retention excavations made to hold excess surface water.
- ***Retention ditches/level terraces***.-These are terraces constructed with blocked ends to retain water.

Micro-Catchments

- A system of harvesting limited rainfall and storing the water in the ground for use by the planted crops.

Types of Microcatchments;

- ***Triangular/V-shaped/Negarims***;
  - V¬-shaped bunds measuring 25cm
  - Are built with soil from the excavated planting holes to direct runoff water towards the basin area around the base of each plant
- ***Semi-circular bunds***;
  - Formed around the growing plant to hold water around the plant.
- ***Trapezoidal bunds***;
  - Trapezoidal shaped bunds, which enclose a large area where the crops are grown.
- ***Contour bunds/furrows*** ;
  - These are furrows made along the contours between the rows of crops where agro¬forestry trees are intercropped with annual crops.
- ***Planting holes/pits*** ;

- These are extra large planting holes made and filled with dry plant materials before filling in with soil.

Use of Micro-Catchments

- Slow down the speed of surface runoff.
- Used during landscaping of the compound, parks and roadside nest areas.
- Reclamation of land for food crop in dry areas.
- Water collected and stored can be used for irrigation
- Afforestation in dry areas.

Weeds and Weed Control

Introduction

- Weeds cause heavy crop losses if not controlled.
- Their control is important so as to maintain high quality and quantity produce.

Definition:

- A weed is any plant growing where it is not required.
- And whose economic disadvantages outweigh the advantages.

Harmful Effects of Weeds

- Weeds compete with crops for nutrients, space, light and soil moisture.
- Some weeds, for example, *Striga spp* are parasitic to cultivated crops such as maize.
- Some weeds lower the quality of agricultural produce for example:
  - Mexican marigold gives undesirable flavour to milk if dairy cows feed on it.
  - Devils horsewhip, black jack, bristly fox-tail and others get attached to sheep wool thus lowering its quality.
- Some weeds are poisonous to human beings and livestock for example:
  - Thorn apple *(Datura stramonium)*
  - Sodom apple *(Solanum incanum)*
- Some weeds have allelopathic effects to cultivated crops.
- Water weeds block irrigation channels.
- Aquatic weeds such as Salvinia in Lake Naivasha and water hyacinth in Lake Victoria affect fishing.
- Some weeds are alternate hosts for insects, pests and disease causing organisms for example:
  - Wild oat *(avena fatua)* is an alternate host for rusts.
  - Mallow *(malva verticillata)* is an alternate host for cotton stainers.
- Weeds lower the quality of pasture for example:
  - Tickberry *(Lantana camara)*
  - Nut grass *(Cyperus rotundus),*
  - Manyatta grass *(Eleusine jaegeri)*
- Some weeds irritate workers thus reducing the efficiency in which they are controlled for example:
  - Double thorn *(Oxygonum sinuatum),*
  - Stinging nettle *(Urtica massaica)* ,
  - Devil's horse whip *(Achyranthes aspera).*

Factors Contributing to the Competitive Ability of Weeds

- They produce large quantities of seeds for example pigweed and black jack.
- Their seeds remain viable in the soil for a long time awaiting conducive germination

conditions.
- They have effective seed dispersal mechanisms.
- Some weeds propagate by means of elaborate underground storage structures.
- They are efficient in utilizing little moisture, nutrients and sunlight.
- Some have short life cycles.
- They have elaborate root systems for supporting the plant and absorbing nutrients and water.

Weed Classification

It is based on:

- ***Life cycles*** for example:
  - ***Annuals*** - complete their life cycle in only one season.
  - ***Biennuals -*** complete their life cycles in two seasons only.
  - ***Perennials*** - complete their life cycle in more than two seasons.
- **Morphology** - leaf formation such as size, shape and venation.
  - ***Broad leaved weeds*** for example black jack, lantana, pig weed, oxalis and others.
  - ***Narrow leaved weeds*** for example couch grass, setaria, nut-grass, manyatta grass and others.
- **Habitat -** some weeds are terrestrial (grow on land) while others are aquatic (grow on aquatic/marine conditions).

Weed Identification

- Weeds are identified by their common (individual) names and botanical names.
- They are named according to specific features or according to person who identified them.

Common Name **Botanical Name**

- Black Jack ……*Bidens pilosa*
- Mexican marigold ……*Tagetes minuta*
- 0xalislsorrel ……..*Oxalis spp.*
- Double thorn ……*Oxygonum sinuatum*
- Thorn apple ……..*Datura stramonium*
- Couch grass ……..*Digitaria scalarum*
- Nut grass ……..*Cyperus rotundus*
- Wandering Jew ……*Commelina bengalensis*
- Sow thistle ……*Sonchus ole race us*
- Devil's horsewhip ……..*Achyranthes aspera*
- Macdonald's eye/ Gallant soldier. *Gallinsoga parviflora*
- Sodom apple ……..*Solanum incanum*
- Black night shade ……..*Solanum nigrum*
- Chinese lantern…… *Nicandra physalodes*
- Bracken fern ……..*Pteridium aquillium*
- Love grass/ Bristly foxtail …….*Setaria verticillata*
- Cleavers ……*Gallium spurium*
- Stinging Nettle ……..*Urtica massaica*
- Fat hen/Goose foot ……..*Chenopodium spp.*
- Rape weed ……*Brassica nap us*
- Wild oats ……..*Avena fatua*
- Lantana/Tick berry ……*Lantana camara*
- Water hyacinth ……*Eichhornia crassipes*
- Striga/Witch weed ……*Striga hermontheca*

- Creeping indigo ……*Indigofera spicata*

Weed Control Methods

The methods of weed control determined by:

- The weed being controlled.
- Weather conditions.
- Capital availability.
- Effect on environment.

METHODS OF WEED CONTROL INCLUDE:

Chemical Weed Control –

- The use of chemicals known as herbicides to control weeds.

Classification of Herbicides

Based on:

- ***Formulation -*** the physical form of the herbicides for example:
  - Liquids
  - Wettable powders
  - Emulsion
  - Dust
- *Time of Application*
  - Pre-emergence - applied before the planted crop germinates.
  - Post emergence - applied after the planted crop germinates.
- *Selectivity*
  - Selective.
  - Non selective.
- *Mode of Action*
  - Contact - herbicides that kill only the parts of the plant which it comes into contact.
  - Translocated systemic herbicides that will kill the whole plant even if it comes into contact with only a small part of it.

Methods of Herbicide Application

- Spraying - application of solutions.
- Dusting - application of dusts.
- Fumigation - application of fumigants into the soil.

Safety Measures in the Use of Chemicals

- Read manufacturer's instructions and follow them.
- Wear protective clothing such as overalls, breathing mask, gloves and boots.
- Avoid inhaling the herbicides.
- Wash thoroughly after handling chemicals.
- Do not blow or such blocked nozzles.
- Avoid herbicide drift to unintended crops and other plants.
- Avoid herbicide drift to livestock feed and water.
- Avoid spilling herbicides in pastures and fodder crops.
- Dispose off the empty containers properly for example burying them in the soil.
- Do not wash spraying equipment in water sources used by animals and human beings.

- Store chemicals in a safe place.
- Wash the spraying equipment thoroughly.
- Sink left over chemicals into the soil after the day's work.

Advantages of Chemical Weed Control

- It is less laborious.
- Effective in the control of difficult weeds such as couch grass and sedges.
- It does not disturb crop roots and other underground structures.
- It makes the control of weeds in certain crop easier.
- It is efficient in both wet and dry conditions.
- It does not destroy soil structure.
- Cheaper in large scale production than the use of manual or mechanical cultivation.

Disadvantages of Chemical Weed Control

- It requires skilled labour in mixing and application.
- Cause environmental pollution.
- Herbicides have long residual effects which may interfere with future crops.
- It is very expensive.

Mechanical Weed Control

- It involves the following operations:

Tillage/Cultivation

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

Advantages

- Cheap in small scale production.
- Increases water and air infiltration into the soil.
- Incorporates crops residues into the soil.
- The earthing-up done during tillage encourages root growth.

Disadvantages

- If done repeatedly it destroys soil structure.
- It is laborious and expensive in large scale production.
- It may not effectively control weeds.
- It may lead to soil erosion and loss of soil moisture.
- Damage crop roots.

Slashing/Mowing –

- Mechanical removal of shoots from weeds.
- It is effective in the control of annual weeds.

Uprooting

- It is done when the crops are too close
- To allow mechanical cultivation or where weeds are scattered.

Cultural Weed Control

It involves the following practices:

- Mulching.
- Cover cropping.

- Crop rotation.
- Timely planting.
- Use of clean seed/planting materials.
- Proper spacing.
- Proper seedbed preparation.
- Flooding.

Biological Weed Control

- The use of living organisms to control weeds.

Examples are:

- Use of livestock to graze and control growth of weeds especially in plantations.
- Use of weed eating fish to control aquatic weeds.
- Use of moths to control cactus.
- ***Limitations:*** the method is not reliable.

Legislative Weed Control/ Quarantine

- It involves government laws and regulations which prevent the introduction and spread of foreign weeds in a country or an area. Done by KEPHIS.
- ***Limitations:*** Only samples are checked while the bulk of the materials may have some weed seeds.

Crop Pests and Diseases

Introduction

- Crop pests and diseases lead to high losses in crop production hence efficient control measures are needed.
- Proper control measures require the farmers to be able to;
  - Identify these organisms,
  - Know their life cycles, feeding habits
  - The damage they cause to crops.

Crop Pests

Definition of a Pest:

- It is a living organism that destroys crops/ trees either directly or indirectly by introducing pathogens (disease causing germs).

Classification of Pests

Pests are classified according to the following:

- ***Mode of Feeding***
  - Pests with biting and chewing mouth parts - they cause physical damage and reduce the photosynthetic area of the plant.
  - Pests with piercing and sucking mouth parts - they suck out the nutritious plant

sap and in the process may introduce disease causing organisms.

- ***Crops Attacked***
  - Some crop pests attack specific crops for example, stem borers prefer cereal crops.
- ***Stage of Growth of Crops Attacked***
  - There are pests of seedlings attack when the crop is young, for example cutworms.
  - Pests of fruits - attack the crops at fruiting stage.
  - Pests of grains attack the crops when the grains are formed.
- ***Field and Storage Pests***
  - Some pests attack the crops while in the field.
  - Other pests attack the produce after it has been harvested and stored.

Identification of Common Pests

Name of Pest	*Crop Attacked*	*Damage Done*	*Control Measures*
Armyworms *(Spodoptera exempta)*	(i) Cereal (ii) Sugar cane (iii) Grasses	Defoliate the whole plant	(i) Early planting (ii) Use of effective insecticides
Cut worms *(Agrotis Spp.)*	Young	Cut the seedlings at the stem base	(i) Early planting (ii) Use of soil applied (fumigants) (iii) Flood/irrigation
Boll worms *(Heliathis migera)*	Cotton, citrus, maize, beans, millet, legumes	Eat and destroy the fruits and seeds	(i) Crop rotation (ii) Field hygiene (iii) Spraying with (iv) early planting
Maize stalk borer *(Busseola fusca)* and *(Chilo partellus)*	Maize sorghum	Destruction of the stem and young growing tissues	(i) Early planting (ii) Field hygiene (iii) Crop rotation (iv) Use of stalk borer dust.
Loopers *(Ascotis selena*	Coffee	Make windows in crop leaves	(i) Use of effective (ii) Use of parasitic wasps, and chameleons
Leaf Miner *(Leucoptera meyricki and L. caffeina)*	Coffee	Make mines in the leaves reducing photosynthetic area.	(Use of parasitic wasps enemies) (ii) Use of effective
Stainers *(Dysdercus spp.)*	Cotton	Stain the cotton lint reducing quality	(Use of parasitic tachinid (Spraying with insecticides. (Control alternate hosts. (Crop rotation
Aphids *(Aphis spp.)*	Several crops as citrus, cotton, beans. cabbages and others	(i) Transmit viral diseases. (ii) Suck out sap leading to stunted growth.	(Natural enemies for lady birds (ii) Overhead irrigation (iii) Use of insecticides

Other Crop Pests Include:

- Mealy bugs - coffee
- Thrips - coffee
- Beetles - field and storage pests.
- Birds - field pests - cereals and fruits.
- Rodents - field and storage pests ,cereals and tubers.
- Nematodes - soil borne pests - tomatoes, potatoes, sunflower, beans.

Harmful Effects of Crop Pests

- Pests such as squirrels and rodents, unearth planted seeds, resulting in poor germination.
- Some pests like nematodes, termites and moles damage crop roots causing wilting and death of the crops.
- They lower the quality and quantity of farm produce.
- They increase the cost of production since farmers will incur expenses in purchasing chemicals to control them.
- They transmit diseases to crops for example, aphids transmit streak virus disease in maize.
- Chemicals used to control the pests cause pollution to the environment.
- They exterminate the crop by feeding on them for example eating embryo of the seed.

Control of Pests

- If pest population causes damage beyond tolerance then it is said to have reached economic injury level (EIL) hence control measures should be effected before this level.

Before any control measure is effected ,the following should be considered:

- Know the life cycle of the pest.
- Correct identification of the pest.
- Correct assessment of the damage.
- The weather conditions.
- The value of the crop in question.
- The cost factor of the control method.

Methods of Controlling the Pests

- Cultural methods.
- Physical/mechanical measures
- Biological methods.
- Chemical methods.
- Integrated pest management.

Cultural Methods:

- These are farming practices which aim at reducing the pest population by destroying the life cycle of the pests either by exposing them to adverse conditions or denying them food.

These include:

- **Timely planting** to escape pest attack.
- **Timely harvesting.**
- **Proper tillage.**
- **Close season**: this is the period when a susceptible crop is not grown in order to control a certain pest.

- **Trap cropping**: These are crops which attract pests diverting them from the main crop. The trap crop is grown together with the main crop.
- **Crop rotation**: It breaks the life cycle of the pest.
- **Planting resistant varieties**: These are plants with natural protective mechanisms against pest for example hairy cotton against jassid bugs, goose necked sorghum against birds, high tillering in sorghum against shoot fly.
- **Field hygiene:** This includes rogueing and removal of crop residues which harbour pests from field.
- **Alterations of environmental conditions**, such as, creating a micro¬climate which is not conducive to pests for example open pruning in coffee.
- **Crop nutrition:** application of fertilizers and manures to make the crop strong and able to escape pest attacks.
- **Destruction of alternate hosts,** for example, weeds like mallow which harbour cotton stainers.
- **Use of clean planting materials**. This helps to prevent introduction of crop pests.
- **Proper spacing**: if well spaced some pests find it difficult to move from one plant to another.
- **Use of organic manure**, for example, farmyard manure discourages eel worms (nematodes).

Chemical Control

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

Classification of Pesticides:

Pesticides are classified on the basis of:

Mode of Entry

- Stomach - ingested by the pest together with the crop materials.
- Contact - absorbed through the body tissues.
- Fumigants - through the breathing mechanism.
- Systemic - translocated to all parts.

Mode of Action

- Respiratory poisons - interfere with breathing mechanisms.
- Coagulants - cause the blood of the pest to coagulate.
- Neurotoxins - act on the nervous system.
- Protoplasmic poisons - cause the cells to disintegrate.

Target Pests

- Insecticides - kill insect pests
- Molluscicides - kill snails and slugs.
- Rodenticides - kill rodents.
- Nematocides - kill nematodes.

Formulation .

- Dusts, granules and powders
- Emulsifiable concentrates.
- Miscible liquids.
- Wettable powders.
- Fumigants.

Factors That Affect the Efficiency of Pesticides

- Concentration of the pesticides.

- Weather conditions at the time of application.
- Timing of application - efficiency is high if applied when the pest is most susceptible.
- Persistence of the pesticide having long residual effect in the soil.
- Resistance of the pests.

Advantages of Chemical Pest Control

- Faster
- Immediate results are achieved.
- Low labour requirements.

Disadvantages of Chemical Pest Control

- Expensive to buy.
- Cause pollution to the environment.
- Require skilled labour to apply.
- Some pesticides may kill beneficial organisms and predators.
- Some target pests may build up resistance.

Mechanical Pest Control/Physical

- This involves the killing of the pests using physical methods.
- Or creating physical barriers to prevent pests from getting into contact with the crops .

Example:

- Flooding/irrigation; for example, moles are suffocated through flooding.
- Use of lethal temperatures: either too cold or too hot.
- Suffocation; commonly used in grain storage bins by being made air tight.
- Trapping and killing, for example, rats.
- Creation of physical barriers, such as, rat bafflers, sticky materials on tree trunks.
- Proper drying: this makes them too hard to be destroyed by pests.
- Scaring devices especially in rice plantations to control birds.
- Use of explosives thrown at breeding places of birds to kill or scare them away.

Biological Pest Control

- It involves the use of living organisms to reduce the pest population.

Predator ***Target Pest***

- Parasitic wasp----------White fly in citrus, boll worms, stalk borers
- Birds---------- Crickets, locusts, caterpillar llars.
- **Lady Bird ----------Aphids**
- **Trachnid flies ----------cotton stainer**
- **Praying mantis----------giant loppers**
- **Majimoto ants ----------scales**
- **Cats ----------moles,rats,mice**
- **Brachonid wasps----------mealy bugs**
- **Chicken ----------cotton stainer, larvae of beetles, grasshoppers, crickets**

Advantages

- Cheap
- No environmental pollution
- Saves on labour.

Disadvantages

- Takes too long to get the correct agent
- Difficult to control the pest effectively.

Integrated Pest Management

- It is a new method which involves the combination of the methods mentioned above.
- The aim is to have least hazards to the user and to the environment.
- Example, attractant-pheromones are used to attract pests to one place where they are sprayed and eradicated.

Legislative Method/Quarantine

- Legislative mearsures of pest control are effected by the Kenya Plant Health Inspectorate Service(KEPHIS) through seed inspection.

Crop Disease And Their Control

- A disease is any deviation from the normal performance or functions.
- A plant disease is any harmful physiological disorder in a plant caused by pathogenic agents such as virus, bacteria, fungi.
- The study of plant disease is called plant pathology.

Economic importance of crop diseases

- They lower crop yield
- They reduce the quality of the produce thus reducing their market value
- They cause food poisoning. E.g ergot in wheat, afflatoxin in grain crops by fungus.
- They reduce photosynthetic area of the plant.

Classification and identification of plant disease

- Plant disease are classified according to their causal agents;

Fungal diseases;

- Fungi are non-green plant-like.
- Some are parasitic and others are saprophytic.

Parasitic fungi divided into;

- ***Obligate parasites-*** those that depend on other living organisms for food.
- ***Falcultative parasites***-those that are able to live on both the living and dead tissues.

Examples of fungal disease

- ***Panama disease***(Fusarium oxysperium—bananas)
- ***Cigar-end rot***(Verticilium theobromae)-bananas
- ***Die back*** –attack the tips of shoots and roots
- ***Mildews***-foliar disease of several crops
- ***Armillaria root rot***(Armillaria mellea)-coffee and tea
- ***Damping off-disease*** of seedlings in the nursery
- ***Anthracnose*** (Colletotrichum spp)-coffee,beans,tomatoes.

- Fungus also cause damage to stored grains which are not properly dried or if the store is damp.
- Fungus cause food poisoning and lower seed viability for example ***Aspergillus flavus*** which produces a highly toxic compound called ***afflatoxin.***

Examples of fungal disease

Disease/cause	Crops attacked	Symptoms of attack	***Control measures***
Late blight (*Phytopthora infestans)*	Members of Solanaceae family (potatoes, tomatos)	Dry patches on the leaves and fruits (necrotic lesions)	-Crop rotation -effective fungicides -treated seeds -resistant varieties
Rusts (*Pucinia spp)*	Rice, wheat , sorghum, maize	Red and brown pistules on the leaves, shriveled grains	-resistant varieties -Recommended fungicides -Early planting
Smuts(*Ustilago spp)*	Wheat, maize , sugarcane	Black powder mass on the spikes and the ear	-Field hygiene, -certified seeds, -resistant varieties, -crop rotation
Blasts*(Piricularia oryzae)*	Rice	-Small blue sports on leaves with grey centre.	-Seed dressing -Resistant varieties eg sindano

		-Attack inflorescence to cause "empty heads"	-Destruction of affected plants -fungicides
Coffee Berry Disease(CBD) *(Colletotrichum coffeanum*)	Coffee	-Dark blotches spots on the flowers -Brown concentric rings on the leaves -Dark sunken wounds on the berries.	-Resistant varieties eg Ruiru 11 -Proper pruning -Effective fungicides -strippung

Bacterial Diseases

- Bacteria are microscopic single-celled organisms which reproduce by binary fission
- ***Transmission;*** Through irrigation water, seeds, fertilizers, manures, wind ,
- raindrop splash, insects, soil and mechanical means.

Symptoms of Bacterial Diseases

- Wilting
- Cankers(necrotic tissues)localized necrosis
- Gall formation in infected tissues.

Examples of bacterial diseases

Disease/Cause	*Crops Attacked*	*Symptoms of Attack*	*Control Measures*
Halo blight *(Pseudomon phaseolicola)*	Beans	i. Irregular dark lesions on leaves and pods. ii. Yellow band round the lesions called "halo". iii. Water soaked lesions	1 Use of resistant [illegible] for example Wairimu. , ii. Effective fungicide. iii. Crop rotation
Fusarium wilt *(Fusarium oxysporum)*	Tomatoes	i. Stunted growth. ii. Yellowing and shedding of leaves. iii. Wilting of the plant.	i. Use of resistant varieties.
Black arm *(Anthomonas malvacearum*	Cotton	i. Small round spots on the cotyledons of young seedlings. ii. The spots elongate to form black lesions on the stem.	i. Field hygiene. ii. Use of certified seeds.
Bacterial wilt *(Pseudomon solanacearu*	Tomatoes potatoes	Uniform. wilting of the whole plant even with enough water.	i. Use of certified seeds. ii. Crop rotation.

Viral Diseases

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

Symptoms of Viral Infection

- Leaf chlorosis.
- Leaf curling.
- Mosaic(light green or yellow patches).
- Malformation(distortion)of plant parts.
- Rosettes; Development of abnormally short internode.

Transmission

- Through the use of infected vegetative materials and insect vectors like aphids, mealybugs and leafhoppers.

Viral diseases

Disease/Cause	*crops Attacked*	*Symptoms of Attack*	*Control Measures*
Ratton	Sugar cane	Red discoloration on the bundles.	I Use of clean materials. 1 Treatment of seed canes.
Maize streak	Maize	Yellow stripes alternating with green, parallel to the midrib.	i Control leaf hopper. ii. Use if certified seeds. iii. Field sanitation.
Greening disease	Citrus	i. Yellow mottling of the leaves. i Die back. iii. Premature leaf fall.	i, Use of clean tools when budding. 1 Control of insect
Leaf mosaic	Suzgar cane, cassava. potatoes.	i. Yellow mottling. I Necrosis of stem.	i Control of aphids. ii. Use of clean materials. i Seed treatment.
Tristeza	Citrus	I Dwarfing of i Die back.	i. Stripping affected fruits. ii. Use of clean equipment of budding.

Other Causes of Crop Diseases

- Flooding forming ammonia which is poisonous to the crops causing a burning effect on leaves.
- Chemicals: some may be toxic.
- Poor weather: Extremes of day and night temperatures.
- Stress: such as irregular watering as in tomato blossom end rot.

Control of Crop Diseases

- Cultural method: This involves use of
- Healthy planting materials.
- Practicing field hygiene.
- Proper seedbed preparation.
- Proper spacing.
- Heat treatment of the planting materials for example sugar cane.
- Proper drying of cereals and pulses to 13%M.C.
- Growing disease resistant varieties.

Legislative Method

- Involves the imposing of regulations and laws especially in case of disease outbreaks to prevent the introduction and spread of diseases.

Chemical Control

- Used as a last resort.

Chemical control measures include:

- Seed dressing before planting.
- Soil fumigation to control soil borne diseases.
- Spraying: application of fungicides.

Crop Production VI

(Field Practices II)

Introduction

- There are many crops cultivated in Kenya.
- These crops are grown for various uses and require different ecological conditions.

Definitions:

- ***Hybrids -*** These are crop varieties developed by crossing two pure lines.
- ***Composites*** - These are crop varieties developed through repeated mass selection.
- ***Cultivars*** - these are varieties of crops which are cultivated in a given area.

Maize

- *Main growing areas:* Trans-Nzoia, Nakuru, Uasin Gishu, Laikipia districts and others.
- ***Ecological Requirements***
  - *Altitude:* Upto 2000m above sea level.
  - *Temperature:* About 25°C
  - *Soils:* Freely draining, fertile loam soils.
  - *Rainfall:* 750-12S0rnm critical at silking and pollination stage.
- ***Varieties***
  - High altitude areas: Hybrids 611, 613 and 614C.
  - Medium altitude areas: 511,512,622 and 632.
  - Marginal rainfall areas: Katumani composite and Makueni composite.
  - Coast regions: Coast composite and Katumani composite.

Seedbed Preparation

- Ploughing should be deep and done during the dry season to eradicate weeds.
- Require medium tilth.
- Plant spacing 75-90cm x 20-30cm.
- Planting done at the onset of the rains. This helps to reduce pest attack.
- Dry planting in areas with inadequate rainfall is necessary.

Field Maintenance:

- Apply phosphatic fertilizer during planting at a rate of 120kg/ha P2O5
- Also nitrogenous fertilizers as top dress at the rate of 200kg of ASN or CAN.
- Control weeds by cultivation, use of appropriate herbicides, uprooting, slashing and mulching.

Pest Control

- **Maize Stalk Borer:**
  - Nature of damage: Boring the leaves causing windowing effect, boring the stems and cobs.

- Control: Destruction of previous years crop residue, closed season and apply chemicals
- ***Maize* Weevils**:
  - it is a storage pest.
  - *Damage:* Bores holes into the maize grains, eating the contents.
  - *Control:* Proper hygiene and sanitation in the stores.
  - Use of chemicals such as Actellic Super.

Disease Control:

- ***Rust***
  - *Cause:* Fungus.
  - *Symptoms:* Red or brown pustules on the. leaves.
  - *Control:* Plant resistant varieties and crop rotation.
- ***Smuts***
  - *Cause:* Fungus
  - *Symptoms:* Black sooty mass of spores on maize heads or cobs(ear).
  - *Control:* Crop rotation, growing resistant varieties and destruction of affected plant parts.
- ***Maize Streak Virus***
  - *Cause:* Virus
  - *Symptoms:* Yellow longitudinal stripes parallel to the midrib.
  - *Control:* Certified seed, early planting and rogueing.

Harvesting

- Harvest the crop 3-9 months after planting depending on variety.
- Maize stalks are cut and stocked in the field.
- Cobs removed by hand.
- For large scale harvesting, combined harvesters are used.
- Yields about 3,OOOkg and *4500kg/ha.*

Bulrush Millet

Areas where grown:

- Lower areas of Kirinyaga,
- Embu,
- Meru,
- Parts of Machakos
- Kerio Valley.

Ecological Requirements

- ***Altitude:*** Does well in areas below 1200m.
- ***Rainfall:*** 500-600mrn per annum.
- ***Soils:*** Light sandy soils.
- ***Varieties:*** Serere 2A, 3A, 6A, 17, *16/9*

Seed Bed Preparations

- Ploughing of land during the dry season.
- Soil should be of fine tilth since the seeds are small.

Planting:

- Done at the onset of the rains.
- Planted by broadcasting and row planting at a spacing of 60cm x 15cm.

Field Maintenance:

- Weeding is done until tillering.
- Top-dressing is done by use of sulphate of ammonia.

Pest Control

Birds

- ***Nature of Damage**:* Eats the seeds at milky stage.
- ***Control:*** Bird scaring devices.

Disease Control

Ergot

- ***Cause:*** Fungus.
- ***Symptoms**:* Heads become sticky.
- ***Control:*** Use of certified seeds, crop rotation and destruction of affected crops.

Downy Mildew

- ***Cause:*** Fungus.
- ***Symptoms:*** Long, whitish lines on the leaves.
- ***Control:*** Crop rotation and field hygiene.

Harvesting

- Done by cutting off the heads.
- Drying of the heads.
- Threshing and winnowing of the grains.
- Stored under well ventilated dry conditions.
- Yields about 1000kg/ha with good management.

Finger Millet

- ***Areas where grown**:* Western Kenya and Uganda.

Ecological Requirements

- ***Altitude:*** 0-2400m above sea level.
- ***Rainfall:*** 900mm, drought resistant in the early stages.
- ***Soils:*** Free draining fertile soils.

Varieties:

- Serere varieties developed at Serere in Uganda.
- Ultra lupin
- 5.18 oats.

Land Preparations

- The seedbed should be thoroughly prepared to a fine tilth due to the small size of the seeds.
- It also helps to control weeds.

Field Operations

Planting

- Finger millet should be planted as early as possible in the season.

- It is usually broadcasted by hand.
- If planted in rows, the furrows should be 30-33cm apart and the plants should be thinned to 5cm apart within the rows.

Fertilizer Application

- Sulphate of ammonia at the rate of 125kg/ha is recommended for topdressing finger millet.

Weed Control

- Clean seedbed preparation
- Uprooting

Pest Control:

- *Birds are controlled through scaring.*

Disease Control

Head blast:

- *Cause:* Fungus
- *Symptoms:* Brown spots with grey centres on the leaves and stems below the inflorescence.
- *Control:* Use of resistant varieties.

Harvesting

- Individual heads are cut with knives.
- Heads are dried, threshed and winnowed.
- Yields 1650kg/ha with good management.

Sorghum

- It is grown in Western, northern, Rift Valley, Eastern and some parts of Central Province.

Ecological Requirements

- *Altitude:* 0-1500m above sea level.
- *Rainfall:* 420-630mm. It is drought resistant.
- *Soils:* Fairly fertile and well drained soils.

Varieties

- Dobbs variety.
- Serena variety.

Field Operations

Planting

- Broadcasting the seeds on the firmly prepared seedbed.
- Intercropped with other crops especially maize and beans.
- Can be planted in pure stands at a spacing of 60cm **x** *15cm*

Fertilizer Application

- Responds well to farmyard manure (FYM).

- Inorganic fertilizers are not commonly used in growing sorghum.

Pest Control

- ***Bird pests: They are the most common sorghum pests.***
- ***They include***
    - ***quelea,***
    - ***aethiopica (Sudan Dioch),***
    - ***weaver birds,***
    - ***starling bird***
    - ***bishop's bird.***
- ***They are controlled through;***
    - killing them using explosives,
    - poison spraying in their breeding places
    - use of flame throwers.
- Sorghum shoot-fly controlled by early planting, closed season and application of insecticides.
- Stem borer - control by use of insecticides and field hygiene.

Disease Control

Common sorghum diseases include:

- Leaf blight
- Anthracnose.
- Sooty stripe.
- Loose smut
- Head smut

Smuts are controlled by seed dressing-while the other diseases are controlled by growing resistant varieties.

Harvesting

- Sorghum is ready for harvesting 3-4 months after planting.
- Heads are cut off using a sharp knife after which they are sun-dried, threshed, winnowed and stored.
- Up to 3000kg/hectare can be obtained with good management.

Beans

- Grown in all provinces where maize is grown.

Ecological Requirements

- ***Altitude:*** 10.00-2100 metres above sea level.
- ***Rainfall****:* Average of *62Smm* per annum.
- ***Soils****:* Well drained loamy soils rich in organic matter.

Varieties

Varieties for dry beans:

- Rose Coco,
- Mwezi Moja,

- Canadian Wonder,
- Wairimu,
- Haricot,
- Mwitemania.

Variety for canning: Mexican 142.

Varieties for French Beans:

- Primeur,
- Long Tom,
- Saza,
- Master Piece
- Monel.

Seedbed Preparation

- Land should be prepared early.
- Primary and secondary cultivation done to control perennial weeds.

Seed Selection and Treatment

- Select wholesome seeds free from damage and wrinkles.
- Seeds are dressed against bean fly.
- Seeds should be inoculated with appropriate bacteria (none dressed seeds)

Planting

- Planted at the onset of the rains.
- Spacing *30-45cm* x *15cm.*
- Apply phosphatic fertilizer during planting time.
- Plant 2-4 seeds per hole.

Field Maintenance

- Provide sticks for the climbing varieties.
- Control of weeds through shallow cultivation.
- Top-dress with nitrogenous fertilizer for example CAN.

PestControl

- ***Bean-Fly***
  - *Nature of damage:* Feeds on the stems causing swelling at the roots.
  - This results in wilting and death.
  - *Control:* Dressing of seeds, early planting and spraying with insecticides.
- ***Bean Bruchid (Storage Pest)***
  - *Nature of damage:* Make dark circular windows on the grains.
  - *Control:* Clean stores, fumigation, and seed dressing.

Diseases Control

- ***Bean Anthracnose***
  - *Cause'* Fungus
  - *Symptoms:* Brown or black lesions on the underside of the leaves, pods and stems.
  - *Control:* Growing resistant varieties, crop rotation, destruction of crop residues and spraying with fungicides.
- ***Bean Rust***

- *Cause:* Fungus
- *Symptoms:* Red brown pustules on the leaves.
- *Control:* Planting resistant varieties and spraying copper fungicides.

Harvesting

- Done during the dry season for dry beans and when the pods are dry.
- Threshing and winnowing done.
- Sorting of rotten, off types and damaged ones.
- Sold to National Cereals and Produce Board when dry.
- For French beans, pick the pods when soft and green.
- Market immediately to avoid shrivelling.

Rice Production

Areas where grown;

- Mwea Tabere Irrigation Scheme
- Ahero Pilot Scheme in Kano plains.
- Bunyala in Busia.
- Bura in Tana River.

Land Preparation

- Plots of 0.4 hectare are made with bunds constructed around them.
- Plots are flooded for four days.
- Rotavators/jembes are used to work the flooded fields on the fifth day.
- The land is then levelled and allowed to drain.

Water Control

- During land preparation, water level should be about 7.5-10cm.
- During levelling water level should be 5cm
- Water is drained off completely for direct sowing.
- For transplanted rice, water level should be 5cm at transplanting.
- Water level should be maintained at 1/3 the height of plant until maturity.
- Water should be allowed to flow slowly through the fields.
- Old water should be changed every 2- 3 weeks if the flow of water is not possible.
- Water introduced should always be warm to ensure pollination.

Fertilizer Application

- S.A applied in the nursery.
- Rate of 25kg SA for every nursery unit of 18.5m x 18.5m.
- Phosphatic fertilizers broadcasted in the field.
- Rate of 120kg ha DSP before planting.
- S.A applied in the field in two splits before and after transplanting at a rate of 250kg/ha

Flooding in Rice

Flood water in rice production is important for the following reasons;

- It provides good conditions for growth such as high humidity.
- Kills soil organisms.
- Prevents denitrification.

Weed Control

- Controlled through flooding.
- Appropriate herbicides such as propanil and butachlor are also used.

Harvesting of Industrial Crops

- cotton, pyrethrum, sugarcane, coffee and tea.

Harvesting of Cotton

Stage of harvesting

- Takes 4 months to mature.
- Harvest when bolls are dry and fully opened.

Method and Procedure

- In Kenya cotton is picked manually.
- Sort out grade AR (safi) from grade BR
- (fifi) into separate containers.

Precautions

- Harvest during dry conditions to prevent dirtifying the lint.
- Avoid use of gunny bags to prevent contamination.
- Avoid picking leaves.
- Harvest on weekly basis.

Harvesting of Pyrethrum

Stage of harvesting

- Takes 3-4 months to mature.
- Harvest the flowers with disc florets which have assumed a horizontal position.

Methods and Procedure

- Pyrethrum is picked manually.
- Flowers are picked by twisting the heads so that no stem is attached.

Precaution

- Clean harvesting should be done.
- Avoid picking leaves.
- Flowers are placed in woven baskets.
- Overblown flowers are picked and thrown off.
- Pick the flowers when the dew is dry.
- Harvested flowers should be taken to the factory the same day.
- Avoid compaction of flowers in the basket.
- Harvesting interval, once in two weeks during the wet season and once in a month during the dry season.

Harvesting Sugarcane

Stage of harvesting;

- Take 14-20 months for the plant crop to mature and 12-16 months for the ratoon crop.
- Sampling of cane is done before harvesting to ascertain the correct sugar content.

Methods and Procedures

- Cut the cane at the ground level to avoid yield loss.
- The green tops are removed from the canes.
- Harvesting matchet is used for cutting the cane.

Precaution

- Cane should be harvested immediately at maturity to avoid lowering quality.

- The green tops should be removed immediately after cutting to avoid reduction of sugar content by enzyme invertase.
- Burnt cane should be harvested immediately after burning to prevent rapid inversion to monosaccharides.
- The cane should be processed within 48 hours.

Harvesting of Coffee

Stage of harvesting;

- Takes 2-4 years depending on the pruning system.
- Harvest only ripe berries.

Methods and Procedures;

- Hand picking is done so that ripe berries can be selected.
- During picking hooked sticks can be used to bend the tall trees.

Precautions

- Only the uniformly ripe berries should be picked.
- Over-ripe and under-ripe berries should be dried and sold as buni.
- Ripe cherries should be processed on the same day they are picked.

Harvesting Tea

Stage of harvesting

- It takes 2-4 years for tea to mature depending on the method of bringing young tea into bearing.

Method and Procedures

- Tea harvesting is known as plucking.
- Fine plucking - 2 leaves and a bud are removed.
- Coarse plucking - 3 leaves and a bud are removed.
- A straight fitto(straight stick) is used to guide the plucker on the plucking table.
- Tipping is done by cutting off shoots that appear above the fitto.

Precautions

- Plucked tea is placed in woven (well ventilated) baskets to prevent fermenting before it reaches the factory.
- The plucked tea should be kept in a cool place awaiting transport.
- It should be processed within the same day of harvesting.
- Harvesting is done on a weekly basis under wet conditions and once after every two weeks under dry conditions.

Forage Crops

Introduction

- These are plants which either grow naturally or are cultivated by man to be used for feeding livestock.
- The term forage crops include pasture and fodder crops.
- Fodder crops are purposely grown for feeding livestock.
- They are cut or uprooted when ready
- Pasture is a ground cover of grass or a mixture of grass and legumes grazed directly or cut and fed to livestock.

Classification of Pastures

- **According to type of stand**.

  - Either pure
  - Mixed stands.
- **According to ecological zones .**
  - Low altitude,
  - Medium altitude,
  - High altitude pastures
- **According to the establishment** .
  - Natural
  - Artificial pastures.

Examples of grasses

- Napier,
- Rhodes,
- Setaria,
- Molasses,
- Congo signal,
- kikuyu,
- star,
- Guatemala,
- Sudan
- Guinea.

Examples of legumes;

- Lucern,
- Clover,
- Desmodium,
- Glycine,
- Stylo,
- Centrio,

Pasture Establishment

Seedbed Preparation

- This involves clearing the land, primary and secondary cultivation to a fine tilth because the seeds are small.
- This is done during the dry season.

Selection of planting materials

- Select seeds of high germination percentage,
- Free from impurities or buy certified seeds.
- If vegetative materials are used, select from high yielding, vigorous-growing and healthy plants.

Treatment of legume seeds

- Legume seeds are inoculated with the correct strain of bacteria which fix nitrogen for the crop.

Planting

- This is done at the beginning of the rains

Methods of sowing are;

- ***Direct sowing,***
- ***Under sowing,***
- ***Over-sowing***

Oversowing

This is introduction of a pasture legume in an existing grass pasture.

Undersowing

The establishment of a pasture in an already existing crop which acts as a cover crop.

Seeds rate depend;

- On purity of seeds,
- Pasture species
- Whether pure or mixed stand.

Apply phosphatic fertilizer when planting and later top-dress with nitrogenous fertilizer.

Pasture management

- **Re-seeding or gapping;** Re-seeding is done if the grass is completely denudated.

- But if partially, gapping can be done
- **Control of weeds** by slashing, uprooting and mowing
- **Fertilization of pastures**-done by use of manures and nitrogenous fertilizer.
- **Topping**;This is the removal of stemmy fibrous material left behind after grazing.It allows new growth after the rains
- **Control of pests**-done by trapping of moles, use of pesticides and biological means.

Pasture Utilization

- Pastures should be utilized at maturity when nutritive value is high.

It is utilized through the following methods:

- **Direct grazing** - this can be done through rotational grazing or herding.
- **Zero grazing** - this is where the pasture is cut and fed to the animals in the stalls.

Common fodder Crops

Edible Cana

- ***Altitude:*** 1500 - 2000m above sea level.
- ***Establishment:*** Young tubers or bulbs are used.
- ***Spacing:*** 1m x 1m.
- ***Management:*** Does well with application of farmyard manure and requires fertile land.
- ***Utilization:*** Tops and tubers are sliced and fed to livestock.
- ***Conservation:*** Bulbs or tubers are sliced and stored.

Napier Grass

- ***Altitude:*** 0 - 2000m above sea level.
- ***Establishment:*** Stem cuttings or splits.
- ***Spacing:*** 1 m x 50cm.

Management:

- Apply phosphatic fertilizers during planting time.
- Top-dress with nitrogenous fertilizers in split application.
- Clean weeding when young.
- Cut when 6-8 weeks or 1m-1.5m in height.
- ***Utilization:*** Cut stem is fed to livestock.
- ***Conservation:*** Ensiled when in plenty.

Types of Napier Grass:

- **Bana grass (**broad-leaved with hairy leaves)
- **Clone** (thin-stemmed and hairless)
- **French Cameroon** (thin-stemmed and not hairy).
- **Pakistan hybrid** (thin-leaved with hairy leaves).
- Used for silage making.

Lucerne

- ***Altitude:*** 1500 - 2500m above sea level.
- **Soil:** Deep red soil are ideal.
- ***Establishment:*** Inoculated seeds are planted 30-50cm apart in the rows.
- ***Management:*** Weeding and fertilizer application.
- ***Utilization:*** Cut wilted and fed to livestock before flowering stage.
- ***Conservation:*** Hay, silage, dried materials such as cubes or pencils.

Mangolds

- Is a root crop.
- Root is utilized as livestock feed.
- Ripe ones are used.

Kales

- Leaves used as livestock feeds.

Guatemala Grass

- Leaves and stems used as livestock feed.

Sorghum Grass

Two varieties:

- Columbus grass
- Sudan grass.
- Established from seeds which are drilled or broadcasted.
- Columbus grass should be dried before feeding to animals to avoid hydrocyanic and prussic acid poisoning.

Desmodium (Desmodium spp)

Two varieties ;

- Green leaf
- Silver leaf.
- Established from seeds on thoroughly prepared clean beds.
- Can also be inter-planted with Napier grass.
- Cut and wilted before feeding to livestock.

Agroforestry, trees used as fodder crops include:

- Leucaenia
- Calliandra
- Atriplex
- Sesbania.

Forage Conservation

Forage can be conserved as;

- Hay,
- Silage
- Standing forage.

Importance of forage conservation:

- To reserve excess forage for use during time of shortage.
- To avoid unnecessary wastage of forage.
- Conserved forage can be sold.
- To have sustained supply of feed for livestock throughout the year.

Methods

Hay Making

- This is the dehydration of green pastures to a moisture content of 16-20 per cent

Steps in hay making:

- Cut the crop when the sun is shining.
- Dry the materials for 1-2 days.
- Windrow the dry material to allow for further drying.
- Bale the dry materials for storage.
- Store under shed or shelter.

Factors Determining Quality of Hay

- Stage of growth at which forage is harvested.
- Leaf content of the forage material.
- Method of handling and curing the hay.

- Form in which material is fed to livestock.
- Species of forage used.
- Amount of foreign materials in forage.

Silage Making

- This is a feed produced by conserving forage in succulent form through the process of fermentation by anaerobic bacteria.

Steps in silage making:

- Cut the crop and transport it to the silo,
- Material with a high moisture content is wilted in the sun for 4-48 hours before ensiling .
- Material is chopped to reasonable size pieces before filling in the silo.
- Spread the chopped material evenly.
- Check temperature if below 31°C, needs further filling; if above 31 °C compaction is necessary.
- Filling should be complete by the end of the third or fourth day.
- The silo is covered with 15cm of straw, sawdust then 15cm of soil to make it air and water tight.
- A trench is dug round the silo to keep off surface water.

Factors Affecting the Quality of Silage

- Maturity stage of the crop when cut.
- Type of crop.
- Moisture content of the material
- Additives such as molasses.
- Degree of compaction.
- Size of pieces ensiled.
- Amount of foreign materials included in the silage.
- Amount of leaf of the ensiled material.

Standing Forage

- This is forage left in the field to be used during the dry season.

Livestock Health III: (Diseases)

Introduction

Livestock diseases are classified according to causative agents as follows:

- Protozoan diseases -caused by protozoans.
- Bacterial diseases - caused by bacteria:
- VIral diseases - cause by virus.
- Nutritional diseases - brought about by nutritional disorders.

Protozoan Diseases

- East coast Fever (ECF).
- Anaplasmosis (gall sickness)
- Coccidiosis
- Trypanosomiasis (Nagana)

East coast Fever

- *Animals attacked:* Cattle
- *Cause:* Protozoan. *(Theileria parva)*
- It is a tick-borne disease transmitted by red-¬legged tick and brown ear tick.

Symptoms

- Rise in body temperature.
- Swelling of lymph glands below the ear.
- Difficulties in breathing.
- Dullness.

Control and Prevention

- Control of vectors through dipping and fencing.
- Treatment by use of clexon in the early stages.

Anaplasmosis (gall sickness)

Animals attacked:

- Cattle between 2 months and 2 years.
- Poultry.
- Lambs and kids.
- Rabbits.

Cause: Protozoan *(Anaplasma marginale)*

- Transmitted by the blue tick
- contaminated surgical instruments and hypodermic needles.

Symptoms

- Fever/rise in body temperature.
- Constipation or hard dung.
- Paleness in the gums, eyes and lips.
- Drop in milk production.

Control

- Tick control.
- Intramuscular injection of antibiotics and iron giving injections.
- Coccidiosis

Coccidiosis of Poultry

- *Cause:* Protozoan *(Eimeria spp.)*

Symptoms

- Sudden death of chicks.
- Whitish, yellow and blood stained diarrhoea.
- Ruffled feathers.
- Chicks become paralysed before dying.
- Chicks become anaemic and dull.

Control

- Disinfection of chick house.
- Prevention of contamination of food and water with droppings.
- Use of prophylatic drugs for example, Coccidiostats.

Trypanosomiasis (Nagana)

- *Animals attacked:* cattle, sheep and goats.
- *Cause:* Protozoan of the trypanosome species,
- *Vector*-tsetse flies.

Symptoms

- Fever.
- Dullness.
- Anorexia/loss of appetite.
- Loss of body condition/emaciation.
- Swollen lymph nodes.
- Lachrimation which leads to blindness.
- Diarrhoea
- Rough coat and sometimes without hair and may be cracked.
- Swelling in parts of the belly.
- Drop in milk production in lactating cows.
- Loss of hair at tail end.
- Anaemia.
- Abortion may occur in pregnant females.

Control

- Treating animals with trypanocidal drugs.
- Effective vector (Tsetse flies)control
- Confinement of wild animals in game parks.

Bacterial Diseases

- Fowl typhoid
- Foot rot.
- Contagious abortion.
- Scours.
- Blackquarter.
- Mastitis.
- Anthrax.
- Pneumonia.

Fowl Typhoid

- *Animals attacked:* All domestic birds which include chicken, turkey and ducks.
- *Causes:* Bacteria *(**Salmonella gallinarum**)*

Symptoms

- Depression/appearing very sick.
- Respiratory distress.
- Dullness.
- Drooping wings.
- Sleepy eyes.
- Anaemia resulting in pale and shrunken
- combs and wattles.
- Greenish yellow diarrhoea.

Control

- Killing all affected birds and proper disposal of the carcasses.
- Maintaining hygiene in the poultry house.
- Ensuring that the house is dry and well ventilated.
- Obtaining chicks from reliable sources.
- Treatment using sulphur drugs which are mixed in drinking water or mash.

- For example: application of Furazolidone (Furazol) at the rate of 0.04% in mash for 10 continuous days treats the disease effectively.

Foot Rot

- It is also referred to as foul-in-the foot.
- ***Animals attacked****:* cattle, sheep and goats.
- However, it is most serious in sheep.
- *Cause:* Bacteria *(**Fusiformis necrophorus*** and ***Fusiformis nodosus**).*

Symptoms

- Animal's foot becomes swollen.
- Lameness is observed.
- Pus and rotten smell come out of the hoof.
- Sheep are found kneeling while grazing when the front feet are affected.
- Animals spend most of their time lying down when the hind feet are affected.
- Emaciation due to lack of feeding.

Control

- Hygiene in the living places.
- Regular foot examination and hoof trimming.
- Use of a foot bath of copper sulphate solution at 5-10% solution or formalin at 2-5% solution.
- Treating wounds on the feet with antiseptics.
- Affected animals should be given antibiotic injections.
- Isolation of sick animals from healthy ones.
- Avoid dampness and muddy conditions.

Contagious Abortion (Brucellosis/ Bang's Disease)

- *Animals attacked:* cattle, sheep, goats and pigs.
    - It also affects man.
- *Cause:* Bacteria
    - ***Brucella abortus*** in cattle,
    - ***Brucella suis*** in pigs
    - ***Brucella malitensis*** in goats and sheep.

Symptoms

- Spontaneous abortion or premature birth.
- Retained placenta if abortion occurs during the later stages of pregnancy.
- Infertility in cows while bulls have low libido and inflamed testis also known as orchitis.
- A yellowish brown, slimy, odourless discharge from the vulva may occur after the abortion.

Control

- Use of artificial insemination.
- Slaughtering affected animals followed by proper disposal of their carcasses.
- The attendant to the animals should avoid contact with the aborted foetus.
- A blood test should be carried out for all breeding animals to detect the infected ones.
- Hygiene in the animals' houses.

Scours (white Scours)

- *Animals atacked:* calves, piglets, lambs and kids.
- *Cause:* A bacterium which attacks young animals in the first week of life.

Symptoms

- White or yellowish diarrhoea.

- Pungent smelling faeces.
- Fever.
- Anorexia/loss of appetite.
- Listlessness.
- Sunken eyes.
- Undigested milk and mucus with blood spots observed in the faeces.
- Faecal matter sticks to the hind quarters.
- Sudden death if no treatment is given.

Control

- Maintaining hygiene in the young animal housing units.
- Avoiding dampness on the floor of the house.
- Fingers of the attendant training calves to drink milk from a bucket must be disinfected.
- Calving should be carried out in a clean area.
- Have separate attendants for the infected calves to prevent disease spread.
- Replacing milk with warm water mixture.
- Treating affected animals with antibiotics.

Black Quarter

- It is also known as black leg.
- *Animals attacked:* All ruminants aged between 8 - 18 months.
- *Cause:* Bacteria *(**Clostridium chauvei*** and ***Chauvei septicum**)*

Symptoms

- Lameness.
- Fever.
- Fast and heavy breathing.
- Cracking on the swollen parts if touched.
- Swelling of the affected parts usually the hindquarters, shoulders and chest or back.
- Dullness.
- Anorexia.
- Grunting and grinding of teeth.
- Animal stops chewing cud.

Control

- Treating with recommended antibiotics.
- Vaccinating using black quarter vaccine known as blanthax.
- Burying the carcass deep or burning it completely.

Mastitis

- Is an inflammation of the udder.
- *Animals attacked:* Goats, cows, pigs and human beings.
- *Cause:* Bacteria *(**Streptococcus spp.*** **or** ***Staphylococcus spp**.)*

Pre-disposing Factors:

- Incomplete milking.
- Injuries on the udder and teats.
- Weak sphincter muscles of the teats allowing free flow of milk.

Symptoms

- Milk is watery, blood stained or clotted.
- Swollen udder

Control

- Proper milking techniques.
- Treatment by use of antibiotics.
- Culling of animals which are often attacked.

Anthrax

- Attacks all domestic animals.
- Cause: Bacteria *(**Bacillus anthracis**)*

Symptoms

- Sudden death.
- High fever.
- Grinding of the teeth.

Pneumonia

- It is an inflammation of the lungs.
- *Animals attacked:* Calves, kids, lambs, piglets and poultry.

Cause:

- Bacteria (**Mycoplasma mycoides**)
- dust
- worms in the lungs.

Symptoms

- Dullness.
- Anorexia/loss of appetite.
- Staring coat.
- Emaciation.
- Breathing rapidly.
- Abnormal lung sounds when breathing.
- Coughing if the chest is pressed.
- Fluctuating body temperature.
- Nasal discharge.

Control

- Keeping young animals in warm pens.
- Proper sanitation.
- Isolation of the affected animals.
- Treating using antibiotics.

Viral Diseases

- Rinderpest.
- Foot and mouth disease (FMD).
- New Castle
- Fowl pox
- Gumboro
- African swine fever

Rinderpest

- *Animal attacked:* Cattle and wild game.
- *Cause:* virus.

Symptoms

- Harsh staring coat.

- Rise in temperature.
- Eye discharge (Lachrimation)
- Diarrhoea and dysentery.
- Ulcers in the mouth.

Foot and Mouth Disease

- *Animals attacked:* Cattle, sheep, goats and pigs.
- *Cause:* Virus .

Symptoms

- Sharp rise in temperature.
- Blisters in the mouth, hooves, udder and teats.
- Loss of appetite.

Control

- Vaccination.
- Quarantine
- nursing wounds with disinfectant.

New Castle

- *Animals attacked:* Poultry.
- *Cause:* Virus.

Symptoms

- Difficulties in breathing.
- Beaks remain wide open and necks are strained.
- Birds become dull.
- The birds stand with eyes closed all the time.
- Anorexia/loss of appetite.
- Nasal discharges which force the birds to shake their heads to clear it.
- Birds walk with a staggering motion.
- Paralysis of wings and legs may occur.
- Birds have their beaks and wings down.
- Birds produce watery greenish diarrhoea.
- Birds lay soft shelled eggs.

Control

- Killing all birds and burning them followed by cleaning and disinfecting the houses before bringing in new stock.

- Vaccination should be done during the first 6 weeks and then 2-3 months later.
- Quarantine.

FowlPox

- *Animals affected:* Poultry.
- *Cause:* A virus known as *avian fox.*

Symptoms

Two types of fowl pox with different symptoms.

- Cutaneous type
- Diptheritic type

The cutaneous type affects the skin and has the following signs:

- Injuries on the combs and wattles, legs, vent and under the wings.
- Loss appetite.

The diptheritic type affects internal membranes and has the following symptoms:

- Injuries in the inside of the throat and mouth membranes resulting in difficult breathing and swallowing.
- Eyes and nose produces a watery liquid.
- Loss of appetite.
- Dullness.
- Emaciation.

Control

- Killing all affected birds followed by proper disposal of their carcasses.
- Vaccinating remaining healthy birds.

Gumboro

- It is also referred to as poultry AIDS.
- *Animals attacked:* Poultry.
- *Cause:* A virus known as Birma virus.

Symptoms

- The glands above the vent (bursa) become swollen.
- Drop in egg production.
- Birds develop respiratory distress.
- Loss of appetite.
- Low water intake by birds.
- Loss of immunity making the birds more susceptible to opportunistic diseases.

Control

- Vaccination.
- Administering vitamins and especially B12.

African Swine Fever

- *Animals attacked:* All domesticated pigs.
- *Cause:* A virus known as Irido virus.

Symptoms

- Fever.
- Loss of appetite.
- Depression/dullness.
- Emaciation.
- Coughing.
- Nasal discharge.
- Diarrhoea in serious conditions.

Control

- Vaccination.
- Quarantine.
- Killing all affected animals and proper disposal of their carcasses.
- Double fencing to keep wild animals away.

Nutritional Diseases/Disorders

Milk Fever

- It is a non-infectious disease brought about by calcium deficiency in animals which have recently given birth.
- *Animals attacked:* Cows, goats and pigs that have recently given birth.

Causes:

- Due to low calcium levels in the blood.

- Which leads to an increase in the magnesium and sugar level in the blood.
- Mostly occurs in high producing cows in the first few months of lactation.
- This is because these animals loose more calcium through milk secretion than they are getting from the diet.

Symptoms

- Dullness.
- Muscular twitching causing the animal to tremble.
- Staggering as the animals move.
- Animal falls down ands becomes unconscious.
- The animal lies down on its side and the whole body stiffens.
- Body functions such as urination, defecation and milk secretion stops.
- Stomach contents are drawn into the mouth which later cause lung fever when breathing in.
- Loss of appetite.

Treatment

- Intravenous injection of soluble calcium salt in form of calcium boro-gluconate ,60gms dissolved in 500cc of water.
- Keeping the animal in a comfortable position on its sternum.
- Giving fresh water.

Note*:* The animals suffering from milk fever should not be given medicine orally for the following reasons:

- It will not be able to swallow medicine.
- The medicine may get into the lungs thereby promoting lung fever.

Control

- Partial milking for the first 10 days.
- High yielding cows should be given rations containing phosphorus and calcium.
- Giving high doses of Vitamin D.

Bloat

- *Animals attacked:* Cattle and sheep.
- *Cause:* Accumulation of gases as a result of fermentation in the rumen.

Symptoms

- The left side is blown up.
- Sudden death.

Control

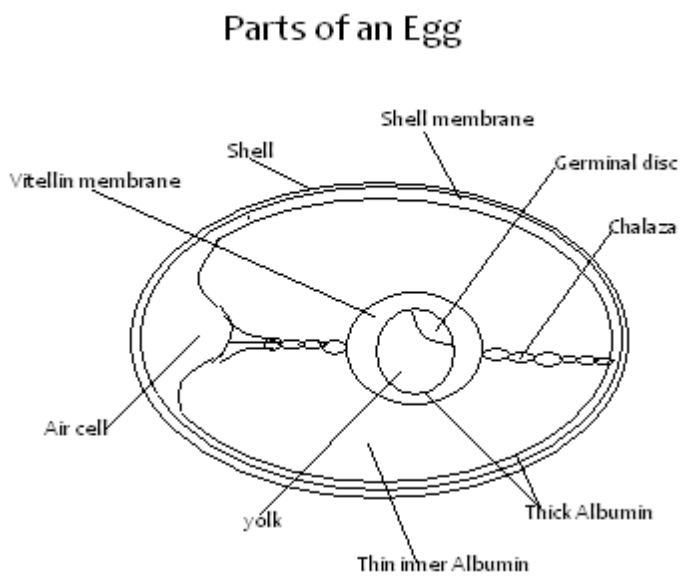
- Relieve by use of trocar and cannula.
- Chasing the animal around if noticed early.
- Drenching by use of stop bloat.
- Feeding ruminants with dry roughages during the wet season before grazing on lush pastures.

Livestock Production V (Poultry)

Introduction

- Poultry industry in Kenya has developed tremendously due to the use of artificial incubation and brooding and easy availability of hybrid birds, both eggers and broilers.
- Poultry production has become an easy source of income and food for the rural as well as the urban communities.
- The term poultry includes domestic birds such as turkeys, ducks, geese, pheasants, doves and pigeons.

- Of late ostrich farming has become a lucrative activity.
- Poultry production starts with incubation of eggs.



Parts of an Egg

- Shell
  - Forms 10-12% of the whole egg content.
  - Made of calcium and phosphorus.
  - Protects the inner egg contents.
- Shell membrane
  - Made of inner and outer *membranes.*
  - Lining of the egg shell.
  - Constitutes 1 % of the total egg content.
- Albumen (egg white)
  - About 55-60% of the total egg content.
  - It is divided into chalaza, thick and thin albumen.
  - Chalaza holds the egg yolk in position.
  - Albumen serves as food for the chick.
- Yolk
  - 30-33% of the total egg content.
  - Supply embryo with nutrients.
- Germinal disc -The embryo which develops into a chick if fertilized.
- Vitelline membrane - Gives the yolk its round shape.
- Air sac
  - Keeps the egg fresh by allowing gaseous exchange.
  - Provides oxygen for the embryo

Egg Candling:

- This is the practice of determining the internal qualities of an egg by examining it against a light source.

Procedure

- The egg is placed on a hole made on a cardboard box.
- This is called a candling box.
- A source of light is placed in the box directly under the egg.
- The observer then looks through the egg against the source of light below.

- Abnormalities on and within the egg can be seen through the translucent shell.

Incubation

- Involves the provision of fertile eggs with the proper condition for embryonic development.

Selection of Eggs for Incubation

- Should be fertile.
- Should be of medium size about 55- 60gms in weight.
- Should have smooth shell.
- Should be oval shaped.
- Should not be cracked.
- Eggs should be clean to ensure that pores are open.
- Should not have abnormalities such as blood spots, meat spots and double yolk. .
- Eggs should not be more than 5 days old.
- Eggs should be fresh that is collected within one week.

Internal egg qualities can be determined through the egg candling process.

Methods of Incubation

Natural Incubation

- This involves the use of a broody hen which sits on the eggs to provide them with conditions necessary for hatching.
- Takes 20-21 days.
- The hen is given about 10-15 eggs.

Signs of Broodiness in Poultry

- Tendency to sit on an egg after laying.
- Moulting of the hen.
- Making some noise at the laying nests.
- Feathers are raised.
- It becomes aggressive when disturbed.
- It stops laying.

Preparation and Management of Natural Incubation

- The hen is given "China eggs" to sit on to induce broodiness.
- When broody the hen should be provided with a nesting nest or a saucer¬shaped nest scooped on the ground.
- The nest shall be lined with soft bedding and fertile eggs provided.
- The eggs are set in the evening or night.
- The bird is dusted to control external parasites.
- The hen is allowed t hour outside to feed and exercise everyday.
- Broken eggs should be removed immediately.
- The hen should not be disturbed.

Advantages of Natural Incubation

- It is cheap.
- High hatchability.
- Low risk involved.
- Useful in small scale production.
- Less skill is required.
- Less laborious.

Disadvantages of Natural Incubation

- Egg production is low because the hen will not lay eggs during incubation.

- It is not possible to plan when to incubate.
- If the hen dies the eggs will be destroyed.
- If the hen deserts the eggs or refuses to sit on them the farmer will incur losses.
- Only few chicks can be hatched at a time by one hen.
- Diseases and parasites could easily be transmitted to the chicks.

Artificial Incubation

- This is the use of artificial device known as an incubator for hatching eggs.

Conditions Necessary for Artificial Hatching of Eggs

- Temperature - maintain at 37.5°C-39.4 °C throughout to control the rate of embryonic development of the chick. High or low temperatures are lethal.
- Ventilation - Good air circulation.
- Carbon dioxide: oxygen ratio maintained at 0.03%:21 %.
- Relative humidity - Maintained at 60%.
  - High humidity leads to marshy chicks
  - low humidity the chick may stick to the shell.
- Turning of Eggs –
  - Done 3-4 times a day to facilitate uniform distribution of heat for uniform development of chick.
  - Turn slowly 180 ° clockwise along the axis to avoid breaking the blood vessels.
  - Some incubators have automatic turning mechanism.
- Cleanliness - cleaning and disinfecting the incubator with formaldehyde solution.

Advantages of Artificial Incubation

- It facilitates large scale production of chicks.
- Incubators are always ready when needed.
- Artificial incubation leads to higher egg production because broodiness in the hens is not required, so there is more time for laying eggs.

Disadvantages of Artificial Incubation

- High initial capital in buying an incubator.
- High level of management and attention is required.
- It is not economical for only a small number of eggs.
- High risks involved in turning the eggs.

Brooding and Rearing of Chicks

- Brooding is the rearing of day old chicks upto 8 weeks old for the layer chicks and 2 weeks for the broiler chicks.
- For successful brooding the source of the chicks should be considered.

Sources of Chicks

The following factors should be considered:

- The reputation of the supplier (hatchery).
- Time taken by the chicks in transit.
- Proper sexing and breed identification.

Brooding

Natural Brooding

- A hen is allowed to take care of the chicks.
- She provides them with warmth and security.
- She stays with the chicks for 8 weeks and then rejects them.

Advantages

- It is cheap.
- Less labour is needed.

- Suitable for small scale.

Disadvantages of Natural Brooding

- Not possible to produce large numbers of chicks.
- The hen goes off laying during brooding time.
- Only possible when a broody hen is available.

Artificial Brooding

- The chicks are raised artificially in a structure known as a brooder until they are 8 weeks old.

Brooder Requirements

- Temperature - should be about 35°C in the 15th week and reduced to 21°C by the 8th week.
- Litter - wood shavings which are capable of absorbing 60% moisture without showing wetness should be used.
- Space confinement - Done by use of hardboards which are about 25cm high and form a circular space. A space of 1m^2 for 25 chicks is required.
- Feeders and waterers - should be enough for the chicks and evenly distributed in the brooder.
- Ventilators - windows should be enough to allow proper air circulation but direct draught should be avoided.

Types of Heaters in the Brooder

- Electric heaters - one ordinary bulb 100 watts can raise 30 chicks.
- One infra¬red bulb 240 watts can raise 100 chicks.
- Kerosene burners - Hurricane lamps can raise 100 chicks.
- Charcoal burners - these are specially made jikos with heat deflectors.

Brooder Management

Preparation Before Chicks Arrive

- Start 2-3 days before arrival.
- The brooder house should be cleaned to remove old litter and then disinfected.
- New litters 5-10cm high should be put in and covered with absorbent materials/news papers.
- Equipment should be cleaned, disinfected and tested to make sure that they are working.
- The brooder is lit about 6 hours before the chicks arrive.
- Feed and water should be placed into shallow containers.
- Brooder space should be confined with a hard board to prevent chicks straying far from the source of heat.

Management After Arrival of the Chicks

- Chicks are placed in the brooder during the day to familiarize with the brooder.
- If chicks arrive stressed and weak they should be given glucose solution in the waterers.
- In case the heat source is charcoal burners they should be covered with wire mesh.
- Feed chicks with chick mash which is later mixed with growers mash as the chicks grow.
- Clean water should be provided and changed regularly.

- Constant attention should be given to the chicks for the first 2 weeks.
- Any vices should be checked and controlled.
- Any dead chicks should be removed as soon as seen.
- Ventilation should be used to control the temperature and humidity in the brooder.
- Constant disinfection is required at the entrance to avoid diseases.

- Brooder space should be increased as the chicks grow.
- Debeaking should be done at 10 days old.
- Vaccination against diseases such as Gumboro after 2 weeks, New Castle at 3-4 weeks and fowl typhoid at 7 weeks.
- Dusting to control external parasites.
- Growers' mash should be introduced gradually at 7 weeks old.
- Chicks are removed from the brooder when they are 8 weeks old.
- On average the chick uses about 1.5kg - 2.2kg of chick mash by the time it is 8 weeks old.

Temperature Control in the Brooder

If the brooder temperatures are low the following should be done:

- Brooder space is reduced.
- Heaters are increased.
- Ventilators are closed.

If the brooder temperatures are too high the following should be done:

- Brooder space is increased.
- Heaters should be reduced.
- Ventilators should be opened.

Management of the Growers

- The growers are birds at the age of 9 weeks to the point of lay that is at 18 weeks.
- Growers should be fed on growers' mash.
- By this time the growers should be occupying the main poultry house.
- Sick birds should be isolated and treated.
- A foot bath for constant disinfection should be placed at the entrance.
- Each bird is fed 115 gms per day of growers' mash.
- Greens and soluble grit should also be provided.
- Clean water should be provided all the time (adilibitum).
- Drenching against internal parasites should be done by adding a dewormer into the water.
- Vermins should be controlled.
- Litter should be kept dry by turning.
- Vaccination should be done as required.
- Layer pullets require dimly lit house.

Management of the Layers

- Layers' mash should be introduced at 18 weeks and increased gradually.
- The birds start laying at 18-21 weeks.
- The birds should be vaccinated against New Castle and fowl typhoid.
- Enough floor space roosts, feeders and waterers should be provided.
- Each hen should be given 120gms per day of layers' mash.
- Clean water should be provided adlibitum.
- Eggs should be collected twice a day at noon and in the evening.
- Green leaves should be provided to keep the birds busy thus preventing cannibalism and improve the yellow colour of the yolk.
- Grains should be given in addition to the layers' mash at the rate of 65gms per bird per day.
- Soluble grit or oyster shells should be provided at all times for efficient digestion and strong shelled eggs.
- Layers should be fed according to their body weight and the rate of egg production for example a 70kg bag should feed 100 layers for 4-5 days.
- Enough laying nests should be provided at least 1 per 5 layers.
- The laying boxes should be dimly lit to reduce egg eating.

- Debeaking should be done when necessary.
- Broken eggs and dead birds should be disposed off properly.
- The non-layers and cannibals should be culled.

Management of Broilers

- Broilers are table birds kept for meat production.
- They have high growth rates or high feed conversion ratio.
- The objective is to produce a kilogram of quality poultry meat from less than two kg of broiler feed.
- The broiler chick requires special broiler feed from day old to 4 weeks of age.
- Broiler starters' mash or crumbs should be fed.
- This contains coccidiostat, high level of protein, vitamins and trace elements for early growth.
- From 4 weeks to 8 weeks they are given broiler follow-on mash or pellets.
- This feed contains high level of metabolisable energy to ensure a good cover of subcutaneous fat in the finished broiler.
- From 8 weeks until slaughter finisher pellets should be given to increase the size.
- Adequate clean water should be provided at all times (adlibitum).
- High level of hygiene should be maintained to reduce mortality rate.
- Birds should be dusted with appropriate pesticides to control external parasites.
- Deworming should be done routinely.
- Vaccination against common diseases should be done.
- Dead birds should be disposed off properly.
- Broilers should be kept under deep litter system, the house should be well ventilated and well lit.

Poultry Rearing Systems

- extensive,
- semi intensive
- intensive systems.

The Extensive Systems

Free Range

- Birds are set free throughout the day to fend for themselves.
- Birds are confined in night shelters for the night.
- There is no supplementation.

Advantages

- Birds eat insects and green leaves therefore less feed is required.
- Cheap method.
- Cannibalism and egg eating are reduced since the birds are not crowded.
- Manure is evenly spread in the runs.
- Low labour requirement.
- Birds get plenty of exercises thus helping to keep in good health.
- No need to provide grit as birds pick it from the soil.

Disadvantages

- More land is required if a farmer wants to rear many birds.
- Birds can be stolen or eaten by predators.
- Eggs get lost in the vegetation or stolen.
- Eggs get dirty.
- Difficult to determine layers from non-¬layers.
- Birds get easily infected with diseases and parasites of the area.
- Breeding programme is not easy to follow.

- Birds can destroy crops where perimeter fencing is not constructed.
- Low productivity per unit area.

Semi-Intensive

Fold System

- Birds are confined in small portable structures called folds.
- A fold measures 3.5m long, 1.5m wide and 1.5m height.
- 1/3 of the fold is roofed while the rest is enclosed with wire mesh.
- Birds get plenty of sunlight.
- Birds get fresh grass as the fold is moved to new grounds.

Advantages

- Manure is evenly spread in the field.
- Less feed is used because birds eat grass.
- Reduces build up of parasites and diseases since the fold is moved often.
- Birds are protected from predators.

Disadvantages

- Few birds are kept per fold.
- It is laborious since the folds are moved from one place to the other.
- Individual egg production record is difficult to keep.
- The fold does not last long because of
- high frequency of handling.
- The return per unit area of land is low.

Intensive System

Deep Litter System

- Birds are confined in a house throughout their life.
- The floor of the house is made up of litter which accumulates over time.
- Enough feeders, waterers and laying boxes are provided depending on the number of birds and space available.
- Movable roosts and perches made of timber frames should be provided in the house.
- Stress and vices should be watched closely and controlled.
- Eggs should be collected as frequently as possible to prevent dirt and egg eating.
- The house should be dimly lit.
- The floor space requirement should be *$1m^2$ per 2-3* birds.

Advantages

- High stocking rate per unit area of land.
- Low labour requirement.
- Fast accumulation of manure.
- There is control of feeding, egg production and movement of birds.
- Safety of the birds is guaranteed from predators.
- No loss of eggs.
- Useful method when rearing breeding stock.
- Regular cleaning of the house is not necessary since the litter absorbs the droppings.
- Easy collection of eggs.

Disadvantages

- High incidence of cannibalism like egg eating, feather plucking and toe pecking.
- Pests and disease causing organisms accumulate in the litter.
- Individual records of the birds are not possible.
- May be difficult to find litter.
- Eggs become dirty if laid on the floor.
- Feeders and waterers may be contaminated by the litter.

- The system encourages broodiness in hens.
- High infestation of diseases if the management is below standard.
- If there is a disease outbreak, it can spread very quickly throughout the house due to the communal housing.
- High cost of building deep litter house.

Battery Cage System

- Birds are confined in cages which are placed in the poultry house.
- The cages are made of wire mesh
- Each cage contains 1-3 birds.
- Water and feed troughs together with eggs trays are fitted along the front side of the cages.
- The floor of the cages should be slanting to allow the eggs to roll out of the cages.
- Droppings from the cages fall from behind for easy cleaning.

Advantages

- Records are easily kept therefore culling is easy.
- Birds do not become broody.
- More eggs are collected due to restricted movement of the hens and complete control of egg eating.
- Tender meat is obtained from the culls because the muscles have not been toughened much.
- Handling is easier than in the other systems and individual attention to hens is given.
- Stocking rate is very high.
- Vices are greatly reduced.
- Eggs are clean because hens do not step on them.
- The system can easily be mechanised.
- Birds do not contaminate the food and water.
- Sick birds can be detected easily and isolated for treatment.
- Wire floors prevent re-infestation of parasitic worms and coccidiosis.
- No bullying during feeding.
- Low labour requirement.

Disadvantages

- Initial costs for cages, equipment and house are excessively high.
- Requires high level of management.
- Higher maintenance costs where automation is used.
- Birds may get fatigue due to lack of exercises thus lowering productivity.
- In case of disease outbreak, spreading is very fast.
- Birds develop bruises on combs, breasts and toes as they stick their necks out-to feed and walk in the cages.
- Not useful when rearing breeding stock and the rearing of broilers.
- Cannot be used for brooding young chicks.

Stress and Vices in Chicken

- Stress is a condition imposed on the birds making them disturbed and uncomfortable.
- Stress reduces production and brings about poor performance.
- Vices are habits developed by animals.
- These affect production and health of the birds.
- Usually they are bad habits.

Cause of Stress in Poultry

- Sudden changes in routine management.

- Presence of strangers in the poultry house.
- Presence of animals and vermins.
- Too much noise.
- Constant and poor handling.
- Sudden weather changes.
- Disturbance of the pecking order.
- Overcrowding
- Poor hygiene.
- Disease and pest attack.
- Lack of food and water.

Control of Stress

- Poultry house should be kept quiet and constructed away from noise.
- Poultry house should be insulated to maintain constant temperatures.
- Parasites and diseases should be controlled.
- Change in routine management should be gradual.
- Enough feed and water should be provided.

Vices

- Feather pecking.
- Cannibalism (toe and vent pecking).
- Egg eating.

Pecking and Cannibalism

- Situation where birds peck at each other resulting in death or injury.

Effects:

- Feather and body growth rate IS reduced.
- Loss of birds due to death may result from cannibalism.
- Culling rate is increased (economic loss).
- The appearance of the carcass is spoiled thereby reducing its market value.

Causes of Cannibalism

- Overcrowding in the house.
- High temperatures in the poultry house making the birds uncomfortable.
- Too bright light.
- External parasite infestation.
- Inadequate and incorrect feeding.
- Idleness of the birds.
- Greediness of the birds.
- Disturbances of the pecking order.
- Prolapses of the rectum which occurs once in a while.
- Bright light in the lying boxes.

Preventive Measures

- Ample spacing should be provided on the floor, feeders, waterers and laying boxes.
- Overheating should be avoided during brooding.
- The house should be dimly lit for the layers.
- Laying nests should be darkened and above the ground.
- Dusting should be done to control external parasites.
- Provide enough balanced ration.
- Birds should be kept busy.
- New/strange birds should not be allowed in the house.

Egg Eating

A vice influenced by the following:

- Presence of broken or soft shelled eggs.

- Idleness of the birds.
- Inadequate laying nests.
- Mineral deficiencies.
- Bright light in the laying nests.
- Greediness of the birds.

Preventive Measures

- Eggs should be collected regularly.
- Laying boxes raised above the ground.
- Laying boxes should be darkened.
- Birds should be given balanced ration.
- Debeaking should be done as need be.
- Birds should be kept busy with greens.
- Birds should be kept according to age groups.
- Injured birds should be isolated and treated.

Marketing of Poultry Products

- Poultry products include eggs and meat.

Marketing of Eggs

- Eggs are delicate and perishable foods and have the highest value when fresh.

The factors considered when sorting out and grading eggs for the market include:

- Size/weight of the egg - large eggs fetch high prices than small ones. The average weight should be about 57gms.
- Shape of the egg - The normal egg shape is oval, with a broad end and a narrow end.
- Cleanliness - Consumers prefer clean eggs.
- Colour of the shell - Brown eggs are popular with the consumers.
- Candling qualities - candling is done to determine freshness of the eggs and presence of any other egg abnormalities.
- Shell texture - should be smooth and without cracks.

Poultry Meat

- Broilers are slaughtered at the age of 1-2.5months old with a life weight of 1.5-2kgs.
- The birds are killed and dressed in a clean way before being wrapped in clean bags ready for sale.
- The meat is sold in hotels and restaurants.
- Whole birds can be sold live in local markets.

Livestock Production VI (Cattle)

Introduction

- Cattle production is a widely distributed enterprise in Kenya.
- Most farming communities choose between the exotic and the' local breeds or their crosses depending on the environmental conditions.
- Whereas the backbone of beef industry in Kenya is made up of the indigenous animals and their crosses, and based in the somewhat drier areas, the-dairy industry is mainly based on the exotic breeds and their crosses and common in the wetter regions of Kenya.
- Whatever production undertaken, the returns depend mostly on the management

levels provided to these animals.

- A productive herd starts with good management of the young stock.

Raising of Young· Stock.

- The young one of cattle is known as a calf.

Feeding Dairy Calves

- Newborn calves should be given colostrums within the first 3-5 days of their life.
- Colostrum is important for the following reasons:
  - It is highly digestible.
  - It contains antibiotics.
  - It is highly nutritious.
  - It serves as a laxative.
  - It is highly palatable.
- Calves can be fed using natural method (direct suckling) or artificially/bucket feeding.

Natural Method

- In this method, calves suckle the mother directly.

Advantages

- The calf takes milk at body temperature.
- The milk is free from contaminants.
- Less problems of scouring.

Disadvantages

- Underfeeding of the calf may result.
- Cows may not let down milk in case the calf dies.
- Difficult to keep accurate production records.

Artificial/Bucket Feeding

- The calf is trained to feed from the bucket immediately after birth.

The calf is trained as follows:

- Well measured milk is put in a clean bucket.
- Index finger is inserted into the mouth of the calf.
- The head of the calf is lowered slowly into the bucket until the calf starts to drink the milk.
- The finger is withdrawn slowly as the calf continues to drink from the bucket.
- The procedure is repeated until the calf gets used to the process.

Advantages

- Easy to keep accurate production record/milk yields of the cow.
- Possible to regulate the amount of milk given to the calf
- The cow does not need the presence of the calf in order to let down milk
- Easy to maintain high hygiene standards.

Disadvantages

- Laborious
- Calf may be given cold milk
- Equipment used and the stockman may be dirty leading to scours

Preparation of artificial colostrums

Ingredients used

- A fresh egg whipped in 0.86 litres of warm water
- Litre of warm water
- One teaspoonful of cod liver oil
- One tablespoonful of castor oil
- Note; colostrums is fed to the calves three times a day for the first 4 days of life and thereafter twice a day.

Weaning of calves

Early weaning

- Calf is fed on whole milk up to the tenth week then it is weaned
- Calf is given milk equal to 10% of its body weight up to the 8th week
- After 8th week, milk is reduced gradually by 1 kg until weaning
- Calf is given early weaning concentrates and soft forage

Early Weaning Guide

Age in weeks	Whole milk(kg/day)	Concentrates(kg/ day)
1	Colostrums ad libitum	-
2-3	5	-
4-5	6	0.25kg/day
6-7	6	0.5kg/day
8-9	5	0.75kg/day
10-11	4	1.00kg/day
12-3	-	1.50kg/day
14-15	-	2.ookg/day
16	-	2.ookg/day

Late weaning

- Calf is fed on whole milk up to the 3rd week, when milk is replaced gradually with skim milk.
- At the age of 3weeks the calf is introduced to calf pellets or pencils and green fodder.
    - The calf is given plenty of clean water.
- The calf continues to be given additional skim milk up to the age of 14 weeks when maximum amount of milk is given.
- Skim milk is reduced from 14 weeks to 16 weeks when weaning is done.

Late weaning guide

Age in weeks	Whole milk (kg/day)	Concentrates (kg/day)	Skim milk (kg/day)
1	Colostrums ad libitum	-	-
2	3.5	-	-
3	4	-	-
4	4.5	0.25kg/day	1
5	4.0	0.5kg/day	3
6	3.0	0.75kg/day	5
7	-	1.00kg/day	7
8-14	-	2.00kg/day	8
15	-	2.00kg/day	4
16	-	2.00kg/day	4

Rearing of replacement stock

- The replacement stock includes young heifers and bulls which have been selected for breeding to replace the old stock.

Management Practice

- ***Parasite control***-Spraying against external parasites and deworming against internal parasites.
- ***Disease control***-Calves are vaccinated routinely against diseases such as;
    - Blackquater-at 4 months old.
    - Anthrax and Blackquater at 6 months old
    - Brucellosis - 3-8 months old (heifers).
- ***Castration*** - for male calves not selected for breeding.
- ***Identification*** - Suitable methods are used. It allows proper record keeping.
- ***Removal of Extra Teats*** ;
    - These teats are known as supernumerary teats which make milking of the animal difficult.
    - They are clipped off with teat clippers.
- ***Dehorning/Disbudding*** - The removal of horn buds using suitable methods.

Calf Housing

Requirement of a Calf Pen;

- Should be clean and easy to clean.
- Be warm and dry.
- Have adequate space to allow exercise and feeding.
- Should be properly lit and allow sunlight for Vitamin D.
- Have proper drainage to avoid dampness.
- Draught free to prevent chilling.
- Be well ventilated to allow fresh air.

Types of Pens

These can be;

- **permanent**
- **mobile/movable.**

Permanent Pens

- Have a solid floor raised above the ground.
- The floor should be slanted for drainage.
- Constructed near the milking parlour.

Mobile/Movable Pens

- Have an open floor to allow grass into the pen.
- Easily moved from one place to another to avoid soiling.
- Kept outdoors in the pastures to allow the calf to nibble on pastures.

Single Housing

- Calves should be housed singly up to the age of 3 weeks, when they are put in group pens.
- This is to avoid them licking each other and swallowing hairs which form indigestible balls.

Milk and Milking

- Milk is the white lacteal substance secreted by the mammary glands of the female mammals.

Composition of Milk

- Protein - Casein and whey.
- Fat - Butter fat.
- Carbohydrates - Lactose
- Minerals - mainly calcium and phosphorus.
- Water

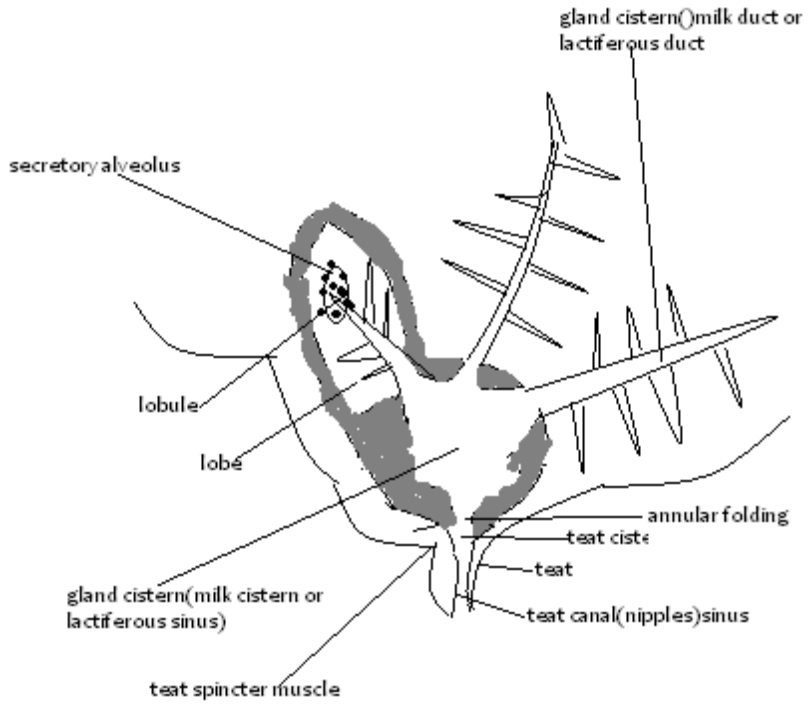
Factors Affecting Milk Composition

- Age of the animal.
- Conditions of the animal.
- Stage of lactation and pregnancy.
- Completeness of milking.
- Type of breed.
- Season of the year.
- Type of food eaten.
- Physiological conditions such as diseases.

Milk Secretion and Milk Let-down

- Milk is secreted by the mammary glands which is an accessory gland of the reproductive system.
- The mammary gland of a cow is known as an udder.

Structure of the udder



Structure of the Udder

The udder is composed of the following parts:

- Alveolus cells - synthesize and secrete milk.
- Lobule - a group of alveolus cells.
- Lobe - Several lobules grouped together and drained by lactiferous ducts.
- Gland cistern - space where milk collects from the lobes.
- Teat cistern - A space where milk collects before emission.
- Teat -An organ which drains each quarter of the udder.

Milk Secretion

- The process of milk secretion is known as **lactogenesis.**
- The digested food is taken to the udder via blood vessels.
- In the udder the nutrients are carried into the alveoli cells where metabolic reactions take place to build up these nutrients into milk.
- A hormone **prolactine** is secreted by pituitary gland which brings about lactogenesis.
- The milk secreted is then stored in the upper parts of the udder waiting to be released.

Milk Let-Down

- The process of milk let-down occurs naturally when the animal is stimulated.
- Milk secreted moves from alveolar region through the ducts to the gland cistern.
- **Oxytocin,** a hormone secreted by the pituitary gland causes the contraction of the udder muscles forcing the milk down the teats.
- Oxytocin hormone lasts 7 -10 minutes in the blood stream hence fast milking is important to withdraw the milk.
- Milk is withdrawn from the teats by gently squeezing them.

Factors Influencing Milk Let-Down

- Presence of the calf.
- Presence of the milkman/milker.
- Rattling of the milk equipment.

- Site of the food/feeding the animal.
- Massaging or washing the udder.
- Sight of the milk parlour.

Factors Inhibiting Milk Let-Down

- Beating the animal/inflicting pain to the animal.
- Presence of strangers and animals for example dogs.
- Poor milking techniques.
- Absence of the calf (in case the cow is used to it).

Clean Milk Production

The following factors are essential for clean milk production:

- A healthy lactating cow.
- A healthy and clean milker.
- Clean and properly constructed milking parlour.
- Clean and disinfected milking equipment.
- Proper handling of the milk after milking.

Milking Procedure

- The animals are brought near the milking parlour 15-20 minutes before milking to get into the mood of being milked.
- Milking materials such as equipment, feeds, ropes, stools and salve are collected and placed near the milking parlour.
- The animals are allowed into the milking stall one by one as the milking proceeds as follows:
  - The animal is restrained in the stall.
  - Feed is weighed and placed into the feed trough.
  - The udder is thoroughly washed, disinfected and dried with a clean cloth.
  - A strip cup is used to test for mastitis on each quarter.
  - Milking proceeds by squeezing the teats with the full hand. If machine milking the teat cups are placed on the teats.
  - For hand milking start with the hindquarters and finish with the forequarters.
  - Fast milking should take about 8 minutes then end with stripping the udder.
  - The milk is weighed and recorded.
  - The animal is then released.

Dry Cow Therapy

- This is the infusion of antibiotics into the teat canal of a cow that is preparing for drying off.
- It prevents bacterial infection which leads to mastitis.

Milk Products

- Pasteurized milk - milk that is heated and cooled immediately.
- Ultra Heat Treated (UHT) - milk heated to a temperature of 130-135C, packed and then cooled.
- Butter - Milk butter fat separated by a process known as churning.
- Cream *-A layer of is:* that collects at the top of the milk when left to stand.
- Cheese - Milk proteins which have been compressed.
- Ghee - Milk fat made from heating *cream or butter.*
- Skim milk - Milk without butter fat.

Marketing of Milk

- The Kenya Dairy Board regulates the production and sale of milk and milk products through various Dairy Co-operative Societies.

- Processors and distributors of milk and milk products include;
    - KCC,
    - Brookside Dairies,
    - Tuzo,
    - Delamere Dairies
    - Limuru Dairies.

Marketing of Beef

Done by the following:

- Individual fanners through the local slaughter house.
- Livestock marketing division.
- Kenya Meat Commission.
- Farmer's Choice.

Farm Power and Machinery

Introduction

- Farm power is any form of energy used in the farm to do work.

Sources of Farm Power

Human Power

- Performs light tasks.
- Quality of work produced is variable.
- Takes a long time to complete a task.

Animal Power

- Done by draught animals such as camels, donkeys, horses and elephants.
- Used in land preparation and transportation.

Disadvantages

- Slow.
- Animals are liable to sickness and get tired.
- Need enough food.

Wind Power

- To pump water from boreholes.
- To winnow crops such as beans, finger millet and rice.
- Generate electricity.

Disadvantages

- Not easy to control and may not be available when needed.

Water Power

- Irrigation.
- Grinding mills (to grind maize grains).

Disadvantages

- Difficult to use in the farm because it is not easy to control.

Biomas

This includes:

- wood or charcoal
- biogas power.

Charcoal/Wood Fuel Energy

Uses

- Provides heat for boiling water and cooking.
- Dehydrating of some crops.
- Curing of tobacco.

Disadvantages

- Exhaustible.
- It cannot be used directly in some farm operations.
- Large quantities are required.
- They are bulky hence difficult to transport.

Biogas

Uses

- Provides heat and light for cooking, boiling water and lighting.
- Produces electricity.

Disadvantages

- Only possible where there are animals under zero grazing unit.
- It is labour-consuming.
- Large quantities of dung are required.
- Cannot be used directly in some farm operations.

Fossil Fuels

These include:

- coal,
- petroleum oils
- natural gas.

Uses

- Petrol or diesel is burned in internal combustion engines to produce power.
- Kerosene is the main source of power to light rural homes.
- Natural gas is used for cooking, heating and lighting.

Electrical Power

It includes:

- hydro-electrical power (HEP),
- geothermal,
- nuclear
- power stored in batteries.
- Nuclear energy is a potential source of power which has not yet been used in the farms.

Uses of Electrical Power

- Runs stationary machines such as milling machines, grinding mills, cooling machines and water pumps.
- Supplies heat and light for operations of brooders.

Disadvantages

- Cannot be used directly in some farm operations.
- Lack of electricity in the rural areas.
- Power failures can lead to high losses.
- It is costly to install and maintain.

Solar Energy

Energy obtained from the sun.

Uses

- Provides heat and light.
- Used by all the plants in photosynthesis.
- Dehydrating crops such as vegetables, maize grains, beans and hay.
- Boils water which drives turbines to produce power for minor uses.

Disadvantage

- Low concentration of energy on cloudy days.
- Expensive In collecting and concentrating equipment.
- Cannot be used directly in some farm operations.
- Requires skilled labour to install and maintain.

Tractor

- The tractor has an internal combustion engine which burns petrol or diesel to produce power.
- This power is then passed to the gear box from where it is transmitted in various ways.
- The common tractor engine is a four stroke cycle engine.

The four strokes are:

- Induction stroke.
- Compression stroke.
- Power stroke.
- Exhaust stroke.

Induction Stroke

- Piston moves down.
- Inlet valve opens.
- Fuel and air get into the cylinder.

Compression Stroke

- Inlet valve is closed.
- Piston moves up the cylinder.
- Fuel-air mixture is compressed.

Power Stroke

- A spark is produced at spark plug, igniting the fuel-air mixture.
- The increased pressure forces the piston down the cylinder.

Exhaust Stroke –

- Exhaust valve opens.
- Piston moves up the cylinder.
- Burned fuel-air mixture expelled.

Advantages of the Four Stroke Engines

- Produce high power which can do heavy farm work.
- Have efficient fuel and oil utilization.
- Perform a wide range of farm operations.
- Are effectively cooled with water thus allowing the production of large engine size.
- Exhaust gasses are effectively expelled from the cylinders.

Disadvantages

- Are expensive to buy and maintain
- Their use is limited in some areas;
- Tractor can only be used on flat or gently sloping areas
- Require skilled personnel and support services

The Two Stroke Engines

- Found in small machines such as mowers, motor bikes, and water pumps which do light jobs in the farm.
- All the cycles are completed in two strokes of the piston.

These strokes are;

Induction and compression stroke

- The piston is at the bottom
- Piston moves up uncovering the inlet port
- Fuel-air mixure is drawn in
- Ignition occurs when the piston reaches the top
- Piston is forced downward compressing the mixture in the crank.

Power and exhaust stroke

- The piston is at the top
- Ignited gases produce pressure which force the piston downwards
- The piston covers the inlet port and traps fresh fuel-air mixture in the crank case
- Piston moves further down to uncover the exhaust port
- Fuel-air mixture transferred from the crankcase to the combustion chamber.

What Advantages of two stroke engine?

- Cheap to buy and easy to maintain
- Economical in fuel consumption
- Can be used in a wide range of farmland, including hilly areas
- Can do small tasks in the farm which would be un-economical to do using the four stroke engine.

What disadvantages of two stroke engine?

- They produce less power hence cannot be used for heavy duties.
- They are inefficient in burning fuel to produce power.
- They are air cooled thus limiting the size of the engine.

Systems of a Tractor

The modern tractor has the following systems:

- The fuel system.
- Electrical system
- Ignition system
- Cooling system
- Power transmission system.

The Fuel System

Supplies fuel to the engine.

Categorized into two types depending on the fuel used.

These are:

- The petrol fuel system.
- The diesel fuel system

The Petrol Fuel System

Consists of:

- **Fuel tank** - storage of fuel.
- **Fuel filter** - removes foreign particles from the fuel.
- **Carburettor** –
  - atomises fuel into spray.
  - introduces fuel-air mixture into the engines.
  - Regulates fuel-air into suitable proportions.
- **Fuel pump -** forces fuel into the carburettor.
- **Delivery pipe** - connects all the devices.

Maintenance

- Cleaning the carburettor regularly.
- Cleaning the fuel filter in petrol.
- Cleaning the hole in the fuel tank cap.

The Diesel Fuel System

Consists of:

- **Fuel tank** - storage of fuel.
- **Fuel injection pump** - pumps diesel through injection nozzles and breaks into fine spray.
- **Fuel filters** - remove foreign particles from the fuel.
- **Delivery pipes** - connect the various devices.

Maintenance

- Replacing the fuel filter.
- Bleeding in case air is trapped in the system.
- Cleaning the sediment bowl regularly.

Structural and Functional Differences Between Petrol and Diesel Engines

Petrol engine	Diesel Engine
• It has a carburettor	• It has an injection pump.
• Fuel and air are mixed in the carburettor	• The fuel and air are mixed within the

before it gets into the engine.	• cylinder.
• Fuel is ignited by an electric spark.	• Fuel is ignited by compression of air and fuel mixture in the cylinder.
• It produces little smoke because petrol is completely burnt.	• It produces a lot of smoke since the diesel is not completely burnt.
• Petrol engine is light in weight and suited for light duties.	• It is relatively heavy in weight and suited for heavy duties.

Electrical System

Consists of the following:

- **Battery**
  - Converts chemical energy into electrical energy.
  - Stores electrical energy produced by the running
- **Ignition circuit** - provide the electrical required by the spark plugs. current that produces a spark in the engine.
- **Generator circuit** - provide the electrical current that starts the engine.
- **Lighting circuit** - supply the electrical current required for the lighting system.
- **Starter motor circuit** - starts the engine.

Care and Maintenance of a Tractor Battery

- The level of electrolyte should be kept just above the plate by topping with distilled water.
- Corroded terminals should be scrapped clean and smeared with grease.
- The battery should be tightly fixed in a box to avoid spillage and damage.
- The battery should be fitted correctly on the tractor.
- The battery should be charged regularly and periodically.
- In case of long storage the battery contents should be kept upside down.
- The generator fan belt should always be functional to ensure the battery is always charged.

Ignition System

Consists of:

- **Ignition -** change the low voltage from the battery to high voltage current required by the spark plugs.
- **Condenser** - absorbs the self-induced current in the primary circuit.
  - stores current for a short time.
  - passes electric current to the distributor.
- **Distributor -** distributes the high voltage current to the spark plugs.
- **Contact breaker** - Interrupts the normal flow of current in the primary circuit.

State the Maintenance practices carried on the Ignition System

- The carbon deposits on the spark plug electrodes should be removed.
- The spark plugs whose electrodes are worn out should be replaced.
- The contact breaker points should be cleaned.
- The breaker points should be adjusted so that they lie between O.30mm and 0.50mm.
- The condenser should be replaced regularly.
- The ignition systems should always be kept dry.
- Ignition wires with poor insulation should be replaced.

Cooling System

- The cooling system aims at preventing the engine from overheating which would cause piston zeisure in the cylinder.

- Some tractor engines are cooled by air while others are cooled by water.

State the Characteristics of Air Cooled Engines

- They are simple in construction.
- They have fins and a fan blade which assists the circulation.
- They are light in weight for they have no radiators and water jackets.

Limitations

- They get hot quickly and use heavy lubricating oil.
- The cooling is not adequate under all conditions especially when carrying heavy loads.

Water Cooled Systems

- It consists of the radiator, water jackets, water hoses, water pump, thermostat and a fanning mechanism.
- Water is used to absorb heat from the engine block at a reasonable rate.

Care and Maintenance of Water Cooling system

- The water pumps should be lubricated regularly.
- Clean water should be used in the radiator and trash removed from the fins.
- All pipes should be fitted tightly to avoid blockage.
- The radiator should be filled with clean water before starting the day's work.
- Fan belt tension should be checked regularly and if too tight or too loose should be adjusted accordingly.

Lubrication System

- This system is aimed at supplying oil to all parts of the engine where friction is likely to occur.

Importance of Lubrication system

- It helps to increase the efficiency of the machine and reduces the rate of wear and tear of moving parts.
- It reduces the heat created by the rubbing surfaces and acts as a seal between them.
- It acts as a cleaning agent because it washes off all the dust, dirt, soot and metal chippings from the oil paths to the sump.

Types of Lubrication Systems;

- Splash feed type
- Force feed type
- Oil mist type

Types of Lubricants

- SAE 10 - This is thin engine oil which gives little protection when heated.

- SAE 50 - This is thicker engine oil which is recommended for protecting the bearings.
- SAE 90 - 100 - These are transmission oils which are recommended for clutch, gear box, wheel lubrication and ball bearings.

Note: SAE - Society of Automobile Engines.

Care and Maintenance of Lubrication Systems

- Old or contaminated oil should not be used for lubrication.
- Oil should be drained when still hot to avoid sticking on the walls of the sump.
- The oil filters should be replaced when necessary.

- The correct type of oil should be used as per the manufacturers' instructions.

Power Transmission System

- The function of this system is to transfer power from the tractor engine to the drive shaft, the wheel axle, the power take off shaft and the hydraulic system.
- The system consists of the clutch, gear box, differential and the final drive.

The power transmitted from the engine is made available for use through the following:

- **The propeller shaft** - it connects the gear box to the differential.
- **The power take off shaft (PTO shaft)¬** -It is located at the rear part of the tractor and rotates at the same speed as the crankshaft of the engine.
- **Hydraulic system** - it is operated by the use of a lever near the drivers seat.
- It is connected to the 3-point linkage and helps to lower or raise implements mounted on the 3-point linkages such as ploughs, mowers, planters and sprayers.
- **Draw bar –**
  - It is a one-point linkage at the rear part of the tractor.
  - It serves for the attachment of trailed implements that can be used during harrowing, transportation or rolling.

Tractor Servicing

- The aim of tractor servicing is to keep the tractor in good and efficient working conditions.
- Tractor servicing is either;
  - short
  - long term.

List the Short Term Tractor Servicing

It includes:

- Checking the engine oil daily by use of a dip stick.
- If the oil level is low, it should be added.
- The fuel level should be checked at the start of every day's work and added if necessary.
- Water level in the radiator should be checked and if possible topped up.
- The level of the electrolyte should be checked daily and topped up with distilled water accordingly.
- Nuts and bolts should be tightened every day.
- Lost nuts and bolts should be replaced before the day's work.
- Grease should be applied by use of grease gun through the nipples.
- Large sediments from the sediments bowl should be removed.
- The tyre pressure should be checked daily before the day's work.
- The fan belt tension should be checked to ensure that it deflects between 1.9cm and 2.5cm when pushed.
- The brake shaft bearing should be greased.
- The brake fluid level is maintained at the recommended level.

Long Term Services

- The engine oil should be drained completely from the oil sump and replaced with new oil.
- The gear box oil should be checked and refilled as recommended.
- The oil in the differential should be replaced as recommended.
- The linkage and the pulley attachment should be greased.
- The pulley oil level should be checked and added if need be.
- The dirty oil should be removed and replaced with clean one.

Farm Machinery

Tractor Drawn Implements

- These are implements which are attached to the tractor during operation.

State the two categories. Tractor Drawn Implements

- **One-point hitch implements** ;
  - Are attached to the tractor at only one point that is, the draw bar.
  - They include all trailed implements such as the trailers, heavy harrows, planters and rollers.
- **Three point hitch implements;**
  - Are implements attached to the tractor at three points that is, the top linkage point and two lower linkage points.
  - They are operated by the hydraulic system.
  - They include ploughs, most harrows, sub¬soiler, planters, mower, ridgers, sprayers and rotavators.

Trailers

- They are one-point hitch implements.
- They are used for transportation of goods.
- Small ones have two wheels while big ones have four wheels.

Maintenance

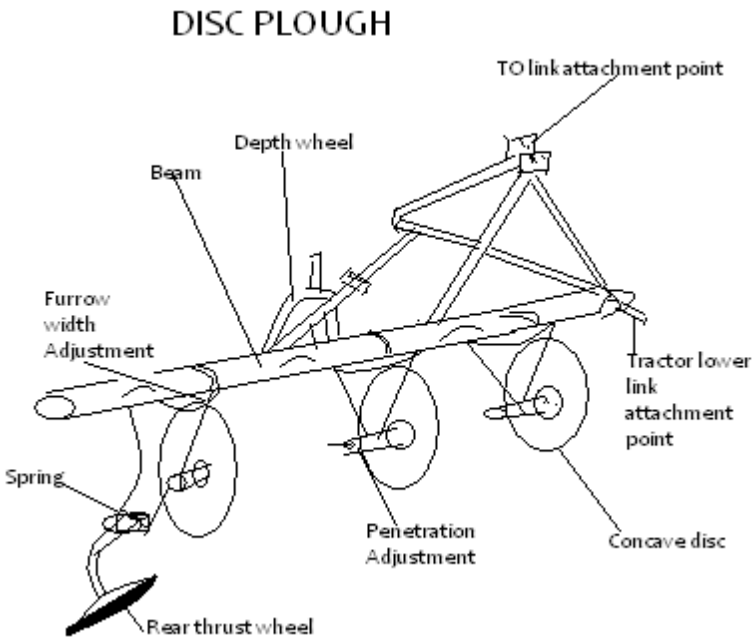
- All the moving parts should be lubricated.
- Tyre pressure should be adjusted to the correct pressure.
- Worn out tyres should be replaced.
- Loose nuts and bolts should be tightened, worn-out ones should be replaced.
- The implements should be kept under a shed during long storage.

Ploughs

- They are primary tillage implements.
- The common type of ploughs include:
  - Disc ploughs.
  - Mould board ploughs.

Disc ploughs

- It is made up of heavy steel concave discs of 60-70cm diameter.



Parts and Functions of a disc plough

- **The hitchmast:**
  - Is an attachment for the three point hitch.
  - Made up of two side links and a top link.
  - These are parts connected to hydraulic system of a tractor for lifting and pulling.
- The beam: Supports all other parts. It also adds weight for better penetration.
- Depth wheel:
  - Used when driving on highway,
  - it also controls the depth of ploughing.
  - May not be present in all disc ploughs.
- **The standard or leg**: Connects the discs to the beam.
- **The hub:** Allows the discs to rotate smoothly hence does the cutting of furrow slices.
- **The scrapers**: Remove the trash and mud or soil which cling to the discs,
- **Disc blades:** Cut and invert the furrow slices.
- **Rear furrow wheel:** Controls the depth of digging and stabilises the discs.

Adjustment

- The cutting angle should be adjusted at 35° - 50° from the l ine of travel.
  Achieved by pivoting the beam or the standard.

- Depth of digging: This is corrected by changing the height of depth wheel or adjusting hydraulic system and adding weights.

Care and Maintenance of Disc Plough

- Check for loose nuts and bolts and replace them.
- Sharpen the disc blades if blunt.
- Lubricate the rotating parts by use of oil/grease to reduce friction.
- Paint the exposed parts for example the beam/framework.
- Clean the implement at the end of each day's work before storage.
- Store the implements in a shed.
- The unpainted parts should be coated with old engine oil to prevent rust.

Uses of a Disc Plough

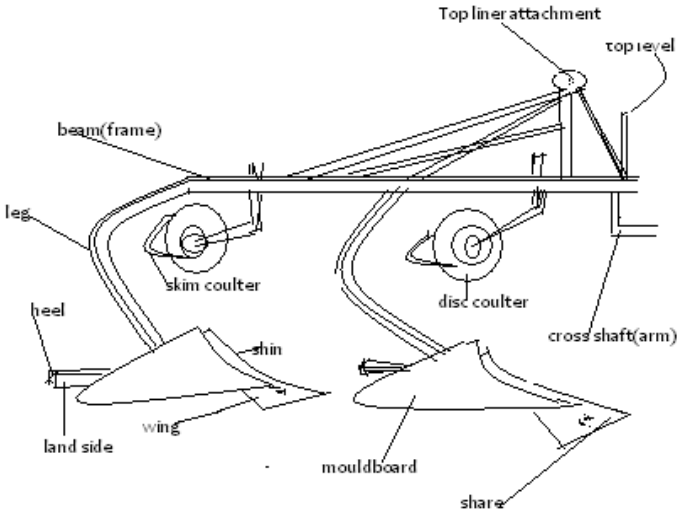
Used in areas with the following conditions:

- Virgin land with many obstacles.
- Land with too much trash or tall vegetation.
- Opening up pasture land.

Mouldboard ploughs

- This primary tillage implement is suited in areas without obstacles such as stones, tree stumps, and roots.
- It gives a uniform depth of ploughing.

MOULDBOARD PLOUGH



Parts and Functions Mouldboard ploughs

- **Share:** This makes the horizontal cut and starts the turning of the furrow slices.
- **Mouldboard:** Continues the turning of the furrow slices and pulverizes the soil.
- **Disc coulter:** Makes a vertical cut in the soil to separate the furrow slice from the un-ploughed land.
- **Skim coulter:** Removes any trash from between the furrow slices.
- **Frog:** It is the part where the share, mould board and the landside are attached.
- **Landside:** Stabilizes the plough and absorbs the side forces created when furrow is turned.
- **Shin:** Leading edge of a mouldboard.
- **Knife coulter**: Is a vertical knife which cuts trash and earth ahead of the share.

Care and Maintenance

- Lubricate the rolling parts for example wheel bearings and disc coulter bearings.
- Paint scratched parts of the plough.
- Sharpen the share or replace if worn out.
- Check all loose nuts and bolts and replace where necessary.
- Clean the implement after each day's work to remove soil, mud and trash.
- For long storage, keep under a shed and apply lubricants.

Adjustment

- **Depth:**
  - Controlled by raising or lowering the depth wheel.
  - Controlled by hydraulic control lever setting.
- **Pitch:** controlled by altering the length of the top link.
- **Front furrow width:** Controlled by cross shaft adjustment lever or by rotating the cross shaft crank.
- **Lateral levelling:** Controlled by tractor lift rod.

Operational differences between a disc and a mouldboard

Disc Plough	Mouldboard Plough
• Suitable on field with stones, roots and stumps.	• Cannot be used on fields with stone, roots or stumps.

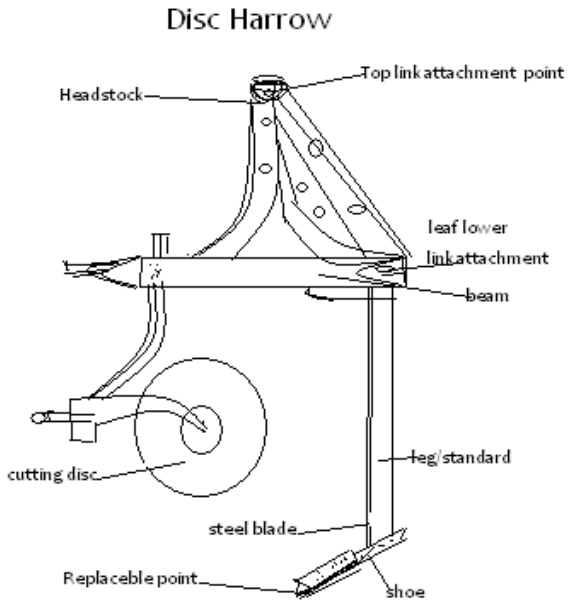
• Does not invert the furrow slices completely.	• Inverts the furrow slices completely.
• More secondary operations are necessary after it has been used.	• Fewer secondary operations are needed.
• Cuts at varying points.	• Operates at uniform depth.
• Not easily broken by obstacles.	• Can easily be broken by obstacles.
• Requires less power to operate.	• Requires more power to operate.

Harrows

- They are secondary cultivation implements.
- There are different types of harrows.
- The common ones are:
  - **disc, *Harrows***
  - **spring tine *Harrows***
  - **spike tooth harrows.**

Disc Harrows

- It comprises of a set of gangs with concave discs.



Uses

- Mixing the soil particles.
- Levelling the seedbed by breaking large
- lumps of soil.
- Killing weeds.

Disk harrows can be classified according to the arrangement of the gangs such a;

- ***s tandem,***
- ***double tandem***
- ***offset tandem***.

Depth Adjustment

- Adding weights on the harrows.
- Use of hydraulic force.
- Use of light or heavy harrows.
- Use of regulating wheels.

Care and Maintenance

- Check for loose nuts and bolts daily.
- Lubricate the shafts and bearings.
- Clean and oil before storage.

Spring Tine Harrow

- Is made up of flat and curved tines which act as springs.

Uses

- Levels and smoothens the seedbed.
- Breaks the soil clods.
- Mixes trash and soil thus preventing wind erosion.
- Aerates the soil.

Adjustments

- Depth is controlled by the horizontal connecting link and depth wheel.
- For individual tine, use crossbar and loosening the screws.

Care and Maintenance

- Check for loose nuts and bolts and tighten them if necessary.
- Clean after use.
- Oil the lever mechanism.

Spike Tooth Harrows

- Consists of a metal framework with rigid metal spikes which break up the soil by vigorously hitting large lumps of soils as it is pulled through the soil.

Uses

- It smoothens and compacts the soil.
- It breaks big lumps of soil into small particles.
- Can be used for cultivating small crops if well set.

Subsoilers

- Heavy and require high horse power to pull.
- Ploughing depth of 51-90cm.

Functions

- Break up compacted soil.
- Break up the hardpan.

Care and Maintenance

- Clean it after use
- Check the point and if worn out, replace it.
- Oil when not in use.

Ridger

- It is double mould board plough used to make ridges and furrows.
- It is used to prevent water logging and draining through furrows for easy harvesting of root crops.

Rollers

- This is an equipment used to compact the soil gently especially where tiny seeds are to be planted.

Rotavators: (Rotary cultivators)

- Work on the principles of high speed of revolving flail blades which beat and cut the soil together with trash.
- It is an equipment for both primary and secondary tillage operations.
- It is driven by the P.T.O. shaft of a tractor.

Uses

- Breaks up large soil particles into small ones.
- Mixes the vegetation and the soil.
- Achieves two operations in one pass.

Adjustments

- Forward speed of the tractor gives a fine tilth of the seedbed done through the gearbox.
- Depth of work done by control of depth wheel.
- Slip clutch may break in case the knives come across obstructions

Mowers

Uses

- Cutting grass for hay or silage making,
- cutting overgrown grass
- clearing the field.

Reciprocating Mower

Parts and Functions

- Swath stick: Keeps the cut crop falling correctly.
- Swath board: To remove the cut crop.
- Shoe: Has a runner to absorb the weight and wear.
- Cutter bar: Is a flat bar which guides the fingers.
- Wear plate: Counteracts downward force and holds the knives.

Adjustments

- To adjust knife register by moving the whole bar away or towards the yoke.
- Knife lead: The outer shoe should be adjusted to be outer than the inner shoe by 4cm.

Maintenance

- Check for loose nuts and bolts and tighten where necessary.
- Keep knife section sharp.
- Lubricate the knife parts.
- Check knife to ledger plate cup for best cutting.
- Keep all the parts tight.

Rotary Mowers

- Cutting edge consists of two blades fitted opposite to each other on horizontal disc.
- The cutting blades swing round at high speed horizontally to the ground hence cutting is effected.

Adjustment and Maintenance

- Blades should be sharp.
- Guards to be fitted around the blades to protect the operator from flying objects.
- Lubricate the P.T.O. shafts.
- Check the gear-box oil regularly and fill to the right level if necessary.

Planters

- They are machines used for sowing seeds.
- There are two types:
  - Row crop planters.
  - Seed drills.

Functions of the Planters

- Meter the seed and fertilizers from seed and fertilizer hopper.
- Open the seed furrow.
- Deposit the seed in the furrow through the delivery tubes.
- Cover the seed

Functions of Parts of a Seed Plate

- Filler plate: gives proper seed depth.
- False ring: allows the seed to fall from the seed plate into the boot.
- Knockout pawl: pushes the seeds out of the cell by the roller action.
- Cut-off pawl: prevents more than one seed remaining in a plate cell.
- Cells: shaped holes to hold the seed.

Adjustments

- Adjust the coulters depth for the right crop.
- Fix the right seed plate.
- Place the planter in the level position.
- All the shafts should be free to turn.

Care and Maintenance

- Check all loose nuts, bolts and tighten them.
- Clean and oil the planter after use.
- Grease the driv**e sprockets regularly.**

Seeders

- The grain drill sows grains of wheat, barley, oats, peas, beans and alfalfa seeds.

Parts that can be adjusted to change the sowing rate;

- Select the side of the feed wheel recommended on the drill charts for the seed-rate.
- Change the speed of the wheels by changing the gears or sprockets or both.
- Change the position of the feed gate in the cup.
- Use reducers below the feed wheel.

Care and Maintenance

- Keep seed and fertilizer hoppers dry and clean after each day's work.
- Check the drive shaft and lubricate them.
- Paint the parts for example fertilizer
- hopper to be shiny

Combine Harvester

Use

- Harvesting cereal crops for example maize, wheat and barley.

It is designed to do the following:

- Cutting
- Threshing.
- Winnowing
- Bagging

Parts of a Combine Harvester

- Cutter bar - cuts the grain head.
- Pick up reel- direct crop into the cutter bar,
- Elevator - channels the cut grain to the threshing drum.
- Winnowing ran - fans trash up onto a straw walker and directs it out of the combine harvester.
- Delivery tube - delivers the clean .grains into a collecting tank from where it is bagged.

Maintenance of a Combine Harvester

- Loose nuts and bolts should be tightened.
- Remove all foreign materials stuck in the machine at the end of the day's work.

Ridgers

- They are used for harvesting tuber crops and for making furrows or ridges.

Maintenance

- Lubricate the moving parts.
- Clean the implement after use.
- Store under a shed.
- Repair or replace worn-out or broken parts.
- Loose nuts and bolts should be tightened.
- Unpainted parts should be oiled during long storage.
- Shares should be sharpened if blunt.

Foragers

- They are tractor mounted and operated by power from the P.T.O. shaft .
- Used for harvesting forage crops such as Napier grass, sorghum and maize.

Maintenance

- Tighten loose nuts and bolts.
- Lubricate moving parts.
- Store in a shed.
- Clean after the day's work.
- Repair/replace worn out or broken parts.
- Unpainted parts should be oiled to prevent rust.

Maize Shellers

- These are stationary implements which are either hand or tractor driven.
- They consist of. a rotating disc which shell maize grains from cobs.

Maintenance

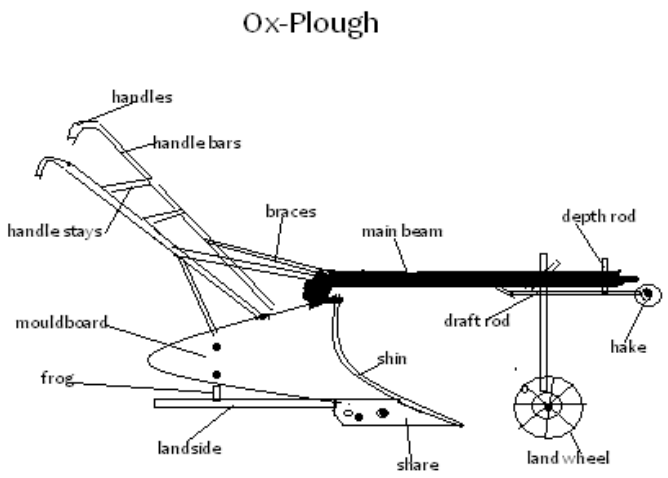
- Greasing moving parts.
- Removing any stuck maize cobs.

- Repair or replace worn out or broken parts.
- Store in a shed.

Animal Drawn Implements

Ox Plough

- Ox-plough is a simple type of a mouldboard plough which is pulled by a pair of oxen, donkeys or camels.



Explain the functions of the following parts of an ox-plough

- **Main beam** - It is the main component onto which all the other parts are attached.
- **Mouldboard** - It inverts the cut furrow slice upside down.
- **Plough share** -It cuts the furrow slices.
- **Land wheel-** It regulates the depth of plough.
- **Draft rod -** It is on this rod that a chain is connected on which a yoke is linked.
- It forms the draught mechanism of the plough.

What are the Advantages of an Ox-Plough Over Tractor¬ Drawn Plough ?

- Less skill is required to operate it.
- Useful where tractors cannot be used for example steep slopes.
- Cheap to buy and maintain.

What are the disadvantages of an Ox-Plough Over Tractor¬ Drawn Plough ?

- Much time is wasted in training oxen.
- Tedious and laborious to the driver of the animals and the controller of the implement.
- Animals can be sick or in poor physical state.
- Extra land is required as grazing fields for the oxen.

Adjustments

- Depth of plough is controlled by the land wheel and draft rod

Care and Maintenance

- Sharpen or replacing of the worn out share

- Replacement of worn out parts such as hooks and draw bar assembly.
- Oiling the shiny parts e.g mouldboard
- Wash off the soil after use.
- Paint the handles, beam and braces to prevent rusting.

Ox-Drawn Cart

- These are small carriages harnessed to the animals by a yoke
- The small carts have only two wheels bigger ones have four.
- They are pulled by animals in singles or in pairs
- Carts are used for transport.

Maintenance

- Moving parts should be oiled
- The yoke should be repaired when worn out or replaced if not repaired
- Tyre pressure should be checked and adjusted accordingly
- Repair other damages on the cart.

Agricultural Economics III:

(Production Economics)

Introduction

- The agricultural sector is a key player in the economy of our country.
- It is a major employer and brings a lot of national income through foreign exchange.

National Income

- These are the total earnings from goods and services produced by a country in a period of one year.

Relationship Between Firm and Household

- A household is considered to be a unit comprising a farmer and family members.
- It produces raw materials and consumes manufactured goods.
- A firm on the other hand, is any manufacturing or processing unit which consumes raw materials and produces manufactured goods.
- Both household and firm generate income, which in turn, is used to:
  - Improve the standard of living of the household members by paying for essential goods and services.
  - The firms build more industries to create more employment and revenue through

salaries and wages.
- Finance government projects through taxes and hence further national development.

Gross Domestic Product (G.D.P.)

- This is the sum total of all goods and services produced in a country in a period of one year.

Gross National Product (G.N.P.)

- Is the sum total of G.D.P. and the difference between income inflow (revenue coming into the country from outside) and income outflow (money going out of the country by foreign investors).
- It represents the total income earned within the country and from abroad.

Per Capita Income

- Is the Gross National Income (in terms of revenue) divided by the number of people living in the country.
- It is not a good measure of the economic well-being of the people because of the uneven distribution of income among them.

Contribution of Agriculture to National Development

- The interaction between household and the firm generate income which is used to finance further expansion of the firms.
- This creates more employment and revenue.
- The government taxes the income to finance **national development programmes such as;**
  - health,
  - education,
  - water, energy
  - communication.

Factors of Production

- A factor of production is anything that contributes directly to output, that is, it is a productive resource.

- Productive resources usually employed in the production of goods and services.

Incl ude:

- ***Land***
- ***Labour***
- ***Capital***
- ***Management***

Land

- As a factor of production, refers to the natural characteristics and properties of a given area of land.
- The key factor here is productivity for example soil fertility, presence of water and minerals and is always fixed and has no geographical mobility.

Labor

- Besides being a consumer, human beings are also a factor of production.
- They provide the labour force (human power) required in the production process.
- Labour is assessed in terms of productivity and not mere numbers of workers or labourers.
- Labour is measured in terms of man hours, man days or man months.

The labourer's productive capacity depends on such factors as;

- ***age,***
- health,
- state of nutrition
- level of education.

- The amount of work and the efficiency with which it is performed determines the quality of labour.

Capital

- Capital refers to all man-made assets that help land and labour to produce.
- It is categorized into:
  - ***Fixed/durable;***
  - ***Working capital***
  - ***Liquid capital***

Fixed/durable;

Capital for example

- machinery,
- buildings
- permanent improvements on land like fences,
- roads,
- irrigation facilities
- water¬ supply system.

Working capital;

Which include consumer goods such as;

- fertilizers,
- livestock feeds,
- fuel in store,
- pesticides.

Liquid capital;

For example;

- ready money,
- bank deposits,
- shares in financial institutions.

Management;

- *It* is a process of decision making in the farm.
- Managers use their knowledge and judgment to decide how to combine the other three productive resources in the best way possible.
- They make plans, execute them and bear the risks or consequences which such plans entail.

Production Function

Definition

- Production function is a physical relationship between inputs and outputs in a production process.
- It tells the quantity of output (product) that may be expected from a given combination of inputs.
- Production function may be expressed in table form or graphically as a curve.

Examples:

Feeding pigs for pork production at varying levels of concentrate feed.

1.

Unit of feed	Body wt. Gains (kg)	Marginal products (kg)
0	212	-
10	222	10
20	238	16
30	251	13
30	261	10
50	269	8
60	275	6
70	280	5
80	283	3
90	285	2
100	286	1

Types of Production Functions

- A production function assumes three forms which may be treated as different types*:*

- ***Increasing Returns***
- ***Constant Returns***
- ***Decreasing (Diminishing) Returns***

Increasing Returns

- In this type, each additional unit of input results in a larger increase in output than the preceding unit.
- This shows that resources are under utilized.

Constant Returns

- The amount of the product increases by the same amount for each additional input; that is constant returns to input factor.
- Again here resources are under utilized.

Decreasing (Diminishing) Returns

- Here, each additional unit of input results in a smaller increase in output than the preceding unit.
- Resource use is stretched to the maximum.
- It is the most commonly encountered form in agricultural enterprises;
- It gives rise to the law of Diminishing Returns.

Examples:

- Feeding dairy cows for milk production with varying amounts of feed.
- Crop responses to application of varying amounts of fertilizers.
- Use of varying units of labour on fixed unit of land.

Economic Laws and Principles

The Law of Diminishing Returns

- The law of diminishing returns states that;

"if successive units of one input are added to fixed quantities of other inputs a point is eventually reached where additional product (output) per additional unit of input declines."

- This law is encountered practically in all forms of agricultural production.
- It is useful in determining the most rational and profitable level of production.

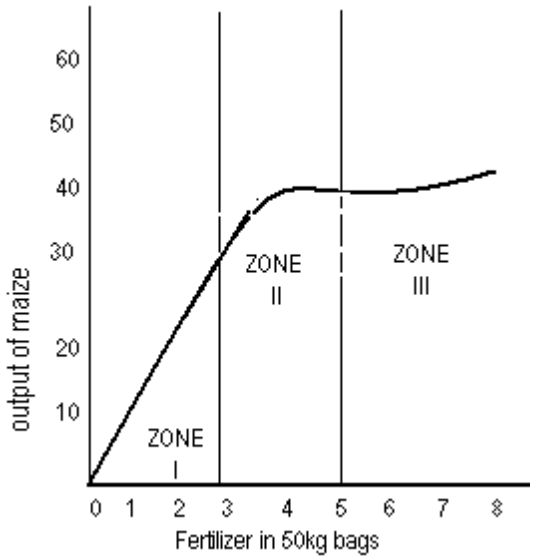
Example:

Production of maize at varying levels of N.P.K. fertilizer application on a fixed area of land.

Unit ofNPK Fertilizer (bags)	Total Yields	Marginal Products (bags)
30	10	-
60	27	17
90	42	15

120	56	14
150	63	7
180	65	3
210	65	0
240	60	-5
270	52	-8
300	42	-10

Zones of a production function curves



Zones of a production function curves these are:

- Irrational zone or Zone I.
- Rational zone or Zone II
- Irrational zone or Zone III.

- The three zones are arrived at by drawing two perpendicular lines through the production function curve, one at MP = AP and another at MP=0.
- In Zone I resources are not fully utilized while in Zone III, excessive application of resources leads to production decline or loss.
- It is not economical to produce at these levels.
- In Zone II resources are maximally utilized resulting in maximum production.
- It is therefore economical (or wise) to produce at this level.

Principle of Substitution

States-***"if the output in a production process is constant, it is profitable to substitute one input factor for another, as long as it is cheaper than its next alternative."***

- This principle is applicable in a situation where more than one variable input factors are used.

- For example feeding hay and concentrates for milk production, farmyard manure and phosphatic fertilizers in the production of maize.
- The basic problem that the producer wishes to solve when two input factors are used in combination is in what proportions must the variable inputs be combined in order to produce at a minimum cost and hence attain maximum profit.
- To solve the above problem, the producer must determine the least cost combination of inputs used.
- The least cost combination is attained at a point where the **Marginal Rate of Substitution (MRS)** equals the inverse of price ratio of the factors involved.

That is:

$\triangle x_2 = P X_1$

$\triangle X_1 = P X_2$

X_1 - first input factor
X_2- second input factor

$\triangle$ - change (increase or decrease)

P - price (cost of input fators)

Examples:

- Producing 20 bags of maize using varying combinations of farmyard manure and phosphate fertilizers.
- Price of farm yard manure (FYM) is KShs10/- per unit and that of phosphate fertilizer is Kshs 50/- per unit

X_1 (P-fert)	x_2 (N-fert)	$\frac{\triangle X_2}{\triangle X_1}$ (MRS)
100kg units	100kg	
I	9.00	-
2	4.00	5.1
3	2.80	1.20

4	2.40	0.40
5	2.00	0.40
6	1.80	0.20
7	1.65	015
8	155	0.10
9	1.45	0.10
10	1.45	*0.05*

In the above example, the following assumptions are made:

- A fixed quantity of output is to be produced.
- Input factors in combination substitute for one another at varying rates.
- Relative prices of input factors do not change drastically during the period of production.

NOTE: one input factor substitutes for the other at diminishing varying marginal rate of substitution.

Principle of Equimarginal Returns

- This principle states ;***" That the last unit of an input factor spent in one enterprise yields a marginal return exactly equal to the marginal return earned from the last unit invested in each of the other enterprises."***

Example

- If the last shs.100/- spent buying cattle feed will return more than shs. 100/= spent on buying fertilizer for growing maize, then it is advisable to purchase more feed up to a point where the last shs.lOO/- spent on it will return exactly the same as the last shs.100/- spent on fertilizers.
- This concept is only relevant in a situation where farmers do not have adequate capital to employ inputs up to the level where marginal revenue equals the marginal cost.

The principal of Profit Maximization

- The profit is defined as the difference, in monetary terms, between the total returns (income) and total costs (expenses) in a production process.
- Profit maximisation aims at obtaining the highest returns at a minimum cost per unit of input factor used.
- This can be done by considering two concepts.

Marginal Concept

- Profit is maximised when the marginal (additional or extra) revenue (MR) is equal to, or slightly higher than, the marginal cost (Mc).
- At this point every added input factor brings in higher returns than the expenses incurred in investing it.

Net Revenue Concepts

- Profit is said to be maximized in a production process when the Net Revenue (differences between total revenue and total costs) is the highest that is ;

  NR = TR - TC.
- This is arrived at by analyzing the total cost and total revenue earned from a particular enterprise and then subtracting the former from the latter.

When calculating the profit using whatever concept, the following assumptions are made:

- Cost of inputs (such as fertilizers, labour) remains constant during the period of production.
- Price of the produce (product) remains unchanged.
- Fixed costs are ignored that is only varying costs directly involved are considered.

Farm Planning

- Planning is the process of establishing the organizational objectives and defining the means of achieving them.

Factors to consider in drawing a farm plan.

- Size of the farm.
- Environmental factors.
- The current trends in labour markets.
- Farmer's objectives and preferences.
- Possible production enterprises.
- Existing market conditions and price trends.
- Availability and cost of farm inputs.
- Government regulations/policy.
- Security.
- Communication and transport facilities

Farm Budgeting

- Farm budgeting is the process of estimating the future outcomes of a proposed farm plan,
- That is; the future incomes and expenses of a farm plan.

Importance of Farm Budgeting

- It helps the farm in decision making.
- It helps the farmer to predict future
- returns that is planning ahead.
- It helps the farmer to avoid incurring losses by investing in less profitable enterprises.
- It helps the farmer to secure loans from financial institutions such as Agricultural Finance Corporation and commercial banks.
- It ensures a periodic analysis of the farm business.
- It acts as a record which can be used for future reference.
- It pinpoints strengths or weaknesses in farm operations.

Types of Budgets

Partial Budget

- It represents financial effects on minor changes in a farm organisation.
- It is necessary when a farmer wants to replace or reduce enterprise.

Complete Budget

- A complete budget is necessary when the farmer wants to start a new business where both the variable costs and the fixed costs are likely to be affected.
- It involves a major change or reorganization in the farm business.

Agricultural Services Available to the Farmer:

- Agricultural production efficiency is greatly increased by services rendered to the farming communities by;
  - Government institutions
  - Non-governmental organizations.

Some of these services are:

- ***Extension and Training:***
- ***Banking Services:***
- ***Credit:***

Extension and Training:

- In the field and in farmer's training centres.

Banking Services:

- These enables the farmers to save some of their farm income and invest them in future projects.

Credit:

- Credit is a financial assistance advanced to agricultural farmers to finance their farm projects and repay it with interest.
- It is a borrowed resource.

Types of Credit

- Credit is categorised according to;
  - Time of repayment
  - The types of projects to be financed.

Examples are:

Short-term Credit

- Repayable within one year and is advanced for the purchase of;
  - seeds,
  - fertilizers,
  - animal feeds .

Medium-term Credit

- ***Repayable w***ithin 2 - 5 years and is used to finance projects such as;
  - fencing materials,

- purchase of livestock,
- light farm equipment .

Long-term Credit

- Repayable period is up to 15 years and even more.
- It is given for the long-term or durable projects such as;
  - purchase of land,
  - construction of soil and water conservation structures,
  - farm buildings,
  - irrigation projects for perennial cash crops for example;
    - coffee,
    - farm machinery
    - implements.

Sources of Credit

- Co-operative societies and unions.
- Crop boards.
- Commercial banks.
- Agricultural Finance Corporation.
- Insurance companies.
- Individual money lenders.
- Settlement fund trustee.

Artificial Insemination Services:

- Provides farmers with semen from improved or superior bulls to improve their livestock herds through controlled breeding.

Agricultural Research Organization

- These develop and pass on to farmers, improved production techniques as well as crop and livestock species with better performance in different ecological zones.

Marketing Outlets

- These are agencies that ensure effective and efficient conveyance of farm produce to points of processing and consumption.
- They are largely crop marketing boards or corporations and cooperative societies.

Veterinary Services

- In the field are veterinary officers who help the farmer in treating and controlling livestock diseases and parasites.

Farm Input Supplies

- Farmers are able to obtain their farm inputs from organizations such as co-operatives and private companies.
- These organizations bring inputs closer to the farmers for example Kenya Farmers Association and private agro¬vets.

Tractor Hire Services

- This involves hiring of tractors and machinery at a cost by farmers who are not privileged to own their own.

Sources

- Ministry of Agriculture
- Private contractors.
- Individual farmers.
- Other service providers.

Risks and Uncertainties in Farming

- **Uncertainty-**is the state of not knowing about future events or outcomes.
- **Risks**-is the difference (divergence) between the expected and the actual outcome.

Types of Risks and Uncertainties

- Fluctuation of commodity prices.
- Physical yield uncertainty.
- Ownership uncertainty.
- Outbreak of pests and diseases.
- Sickness and injury.
- New production technique.
- Obsolescence for example machinery may become outdated or obsolete within a short time.
- Death of either farmer or livestock.
- Natural catastrophies such as;
  - floods,
  - drought,
  - earthquakes,
  - storm and strong winds which may destroy crops or kill the animals.

Ways in Which Farmers Adjust to Risks and Uncertainties

- Diversification.
- Selecting more certain enterprises.
- Contracting.
- Insurance.
- Input rationing.
- Flexibility in production methods.
- Adopting modern methods of production.

Agricultural Economics IV:

(Farm Accounts)

Introduction

- Farming is a business hence financial records are important.
- Financial and physical records if accurately kept in the farm serve as very important tools in decision-making.

Importance of keeping farm accounts:

i. To secure loans –financial records are considered by creditors to determine whether a

farm is credit worthy or not.

ii. To make sound management decisions- the records provide data that help the farm to plan and make decisions.

iii. To determine whether the farm is making profit – they indicate whether the farm is running at a profit or loss

iv. To prepare farm budgets- it helps the farmer to draw estimates for future income and expenditure (in preparing partial budget.

v. Evaluating assets and liabilities.-it helps in assessing the farms ability to pay what it owes others.

vi. Assessing the tax chargeable- it helps the farmer to estimate the amount of tax that can be charged for fair taxing.

- The financial records are kept in several books and statements as follows:

Financial Documents

They include:

- Invoices.
- Receipts.
- Delivery notes
- Purchase records.

1. An Invoice

- Commonly used when goods are delivered on credit.
- This is a document issued by the seller to the buyer for goods taken on credit, and payment to be done later.
- The original is given to the buyer and duplicate retained by seller for both parties to have details of the transactions.
- It specifies the period within which payment should be made and lists any trade discounts allowed.
- It's the first accounting document in a credit transaction.
- Invoices can be pre printed bound together to form a book

The invoice shows the following details:

- The buyer and seller (people involved in the transaction).
- Date of transaction.
- Amount involved (type and quantities of goods delivered.)
- Price per unit of the goods.
- Amount of money involved
- Invoice serial number.
- Terms of payments.

2.A Receipt

- This is a document issued by the seller to the buyer when cash payment for goods delivered is made.
- They are pre-printed and written in duplicate or triplicate. A receipt should be stamped with the official rubber stamp of the firm.

It shows the following:

- The buyer and the seller.
- Date of transaction.
- Amount involved.

- Serial number
- Goods or services being paid for
- Signature of the person accepting the receipt.
- The form in which payment is made ie cheque or cash.

3.Delivery Note

- It is a document which shows that the goods have been delivered.
- The receiver verifies the goods and then signs on the delivery note.
- Delivery notes may be pre-printed and written in duplicate or triplicate depending on the nature of the business.
- It serves as evidence that goods have been physically delivered.

Features:

The delivery note shows the following:

- Goods delivered as per order.
- Quality or condition in which the goods are received.
- People involved in the transaction.
- Date of delivery.
- Manner or method of delivery.
- Reference number of the purchase order
- Quantity and type of goods delivered.
- Signature of the person receiving

4. Purchase order

- It is a request to a trader or business firm to supply goods on credit. It may be accepted or rejected by the supplier.
- It's a binding contract document between buyer and supplier.
- It may be in pre-printed form or ordinary business letter.
- Commonly used purchase order is the LPO Local purchase order.
- Local purchase order number is quoted when preparing an invoice or may attach a copy of the LPO.

Features of a purchase order

- The firm or person requesting for goods
- The person or firm from where the goods are being requested
- Quantity, quality and type of goods being requested.
- The person who authorized the order to make it valid and to control expenditure.
- Purchase order serial number.

5.Statements

- Refers to a summary of all invoices of various customers sent to the customers for payment at the end of the month.
- It's a summary of transactions within a given period.
- There are two types of statements i) statement of account and ii) bank statement
- Bank statement if a financial document sent by the bank to the farmer on monthly basis to show the position of the bank account by the end of the month.
- Statement of account is a document sent to the buyer by the seller as a reminder to inform him/her what he/she owes the seller.

Features

- Date of the invoices

- The number of the voices
- The amount under the heading debit

If during the month any payment is made, its accounted for under heading credit. The difference between debit and credit is entered under heading balance.

Books of account

This are books that deal with specific areas of account. They include:

- Ledger
- Inventory
- Cash book
- Journal

Ledger:

- It's the main book used to keep financial records. It contains details of all the things in the business owned by the farmer.
- It is a principle book of accounts in which entries contained in all the other books are entered.
- Is a book which contains individual accounts. An account is a page or a section in the ledger given to a person/firm and on which all the business transactions relating to that person/firm are entered.
- It is a storehouse of all the transactions.
- A ledger indicates details of what the farmer or the business firm owns. It also indicates what the business has to pay out to other business establishments and the expected receipts to the business from other business establishments.
- A ledger indicates details of what the farmer or the business firm owns. It also indicates what the business has to pay out to other business establishments and the expected receipts to the business from other business establishments.
- Each page is numbered and vertically divided into two equal parts drawn in the shape of letter T: namely credit and debit. The title of the account is indicated at the top. Ie Poultry-Commercial layers. Debits are written on the left hand side while credit on the right hand side.
- Each part is further sub-divided into four sections. Date column, particulars column, folio column and amount received or spend out.

Ledger columns

Date column

It's where the date of the transaction is recorded. It contains two sub-columns. The first is for the month and the second for the date/day of the month. Accounting year is written at the top of the date column.

Particulars column

It contains the description of the transactions (what's purchased and what is sold) for both credit and debit columns. ie bought layers mash 5bags or sold 30 trays of eggs.

Folio column

A folio is a page in book keeping. Each page in the ledger is numbered, and so each account is on its own numbered page (folio). Enter the number of the page on the account in the folio column. Folio numbers helps in tracking the entries.

Entries in a folio.

Debit (DR) – the following details are entered in the debit column

- Date of transaction
- The item in the particulars
- Folio number in the account folio column.

- The amount of money in the amount column.

Credit (CR)-the following details are entered in the credit column

- Date of transaction
- The item in the particulars
- Folio number in the account folio column
- The amount of money received in the amounts column.
- Cash at hand in the particulars column.

NB: Balances of the debtor and creditors accounts can be used to determine how much the business owes to its creditors for good bought on credit. Accounting balance is the mathematical difference between the totals of the debit and credit sides of an account. If the debit side total is more than the credit side the total difference is known as **debit difference and credit difference if** credit side total exceeds debit totals.

To get accounting balance subtract the total of the smaller side from the total of the bigger side. Insert the figure on the side with the smaller total as a **balance carried down.** This makes the two sides equal. Below the totals write the account balance on the opposite side as balance brought down.

Cash Book:

- It is a book where transactions involving cash or cheque payments are recorded.
- Cash includes all forms of money, cheques, money orders, and bank drafts. It involves cash or Cheque payments and receipts.
- It is divided into two parts - debit and credit side.
- All the receipts of cash or Cheque are recorded on the debit (as sales and receipts) and all payments are recorded on the credit side (as purchases and expenses).
- Cashbook is a form of ledger account or a portion of ledger bound differently where all receipt and payments of money are recorded.
- The two major columns are further subdivided subcolumns; date of payment, particulars/details, amount (Shs/Cents or Cash/Bank).

Types of cash books

- Single column cashbook-it has only one column for amount. It has cash account and bank account on different pages.
- Two-column cashbook- has got two columns for the amounts side on both debit and credit. Column for cash and that of bank
- Three column cashbook –has got three columns for the amount on both debit and credit: discount received or allowed, cash and bank
- Petty cash book
- Analysis cashbook.

Example: Enter the following entries in the cash book.

- 1.7.05 -Received shs.2,000 from Ndete by cheque.
- 2.7.05-Bought D.A.P. fertilizer and paid cheque of shs. 5,000.
- 3.7.05-Received shs.5, 000 cash from Ngala.
- 4.7.05 -Paid water bill for Shs. 400 in cash.
- 9.7.05-Paid telephone bill of 1,500 by cheque.
- 11.7.05 -Deposited shs.2, 000 in the bank.
- 20.7.05 -Withdrew shs.2, 000 from the bank for home use.

Cash Book record

Sales And Receipts 2005				*Purchases ad and expense 2005*			
Date	Details	Cash	Bank	Date	Details	Cash	Bank
1.7.05	Received from Ndete		2,000	2.7.05	D.A.P		5,000
3.7.05	Received from Ngala	5,00		4.7.05	Water bill	400	
11.7.05	Cash	2,00		9.7.05	Telephone bill	500	
				20.7.0	Cash		2,000

Inventory

- It's a book which contains all the entries of what the business firm or the farm owns (assets).
- Assets quantities and conditions are recorded.
- Assets are valued at the beginning or at the end of the accounting period.
- Inventories are drawn at the end or at the beginning of the accounting period.
- It provides information used during valuation or drawing up of the balance sheet and profit and loss account.
- Assets either appreciate or depreciate in value therefore making information in the inventory to change.
- Appreciation is the increase in value due to birth of young stock, or purchase of new items
- Depreciation is the decrease in value due to plant death, animal loss or wear and tear of machineries and tools/equipment/farm buildings.
- Written off items are deleted in the inventory.
- Inputs stored are recorded in a store's inventory in order to control the issuing out of stock.
- There are different inventories ie crops, livestock. Farm machinery and equipment

Purposes of the inventory

- It helps in drawing up a balance sheet
- Helps in preparing a profit and loss account
- Provides information for valuation of the business

Categories of inventories

i. Consumables goods inventory- ie pesticides, animal feeds, fertilizers, drugs and construction materials. Have two main columns receipts and issues
ii. Permanent goods inventory- ie machinery, tools & equipment.

Information must be entered in an inventory book whenever items are received or issued.

Journals

- It's a book where all unclassified transactions are entered.
- It's also a diary/logbook that contains daily recording of all transactions in the farm.
- It also contains miscellaneous transactions that cannot be entered in books ie purchase books and return books considered to be subsidiary books.

Information recorded in the journal

- Purchase on credit of capital equipment-things bought for use not to resale
- The sale on credit of capital equipment
- Rectification of errors in books, new entries, correction or cancelling old entries made in journals.
- Transfers from one account to another in the ledger. Information on the purchases, sales returns, stocks and others in the journal is posted in the ledger and used to draw the trading account. Information on the depreciation of assets is transferred from the journal to the profit and loss account. These entries are known as closing entries.
- Opening entries in new books. Balances are journalized first, hence referred to as opening entries.
- Initial entry for the transaction involving the issues of shares in partnership, or joint stock ownership, or acceptance of new partners or the winding up of the

partnership.

Information on the journal page

- Date of transaction
- Name of the account to be debited
- Name of the account to be credited
- Amount of money transacted
- Details/a brief description of the transaction e.g. date and nature of transaction

Steps in entering the information in the journal

- Enter the account to debited, first
- Enter the information in the folio column after the transaction is posted to the journal e.g. 1.1 – the folio number relating to the posted entry. 1.2-folio number showing that the entry has been posted to avoid double posting.
- The columns (DR) and (CR) should be in the journal as a matter of procedure.
- The transactions should have vouchers or supporting documents.

Financial Statements

1. Cash Account Sheet /Analysis

- It's the procedure of keeping an account book in which all the individual transactions are recorded and analyzed.
- It involves the recording of sales and receipts, purchases and expense. Its has two columns: sales and receipts and purchases and expenses.
- It resembles cash book in terms of the entries of the receipts and payments however the difference is that in cash analysis the analysis columns are included.
- Each sale or purchase is entered twice, once in the total column and once in the analysis column.
- The sum of all the entries in the total column should always equal the sum of the entries in all the other columns.
- The cash analysis account sheet is given below.

2. The Balance Sheet

- It is a financial statement of assets and liabilities recorded on a given date.
- It shows the financial position of a farm business at a glance (snapshot). It's a statement showing what the farm business is worth. Its prepared at the end of the trading period or accounting period, normally one year.
- It contains two main columns: assets and liabilities. Assets are recorded on one side and liabilities on the other side.
- The totals of the two sides of the balance sheet must always be equal. Total of assets must be equal to the total of liabilities. The bottom line figures (grand total) must be on the same level and have a double underline.

A balance sheet should have the following details

- Name of the business ie Mukumu farm enterprise
- Name of the statement ie Balance sheet
- Date at which it is prepared ie 31st December 2004. Date is important because assets, capital and liabilities keep on changing as transactions take place and so a balance sheet can only be true at a specific time.

NB:

- ***A business is solvent when the assets are more than liabilities. Its insolvent when liabilities are more than assets.***
- ***Items of the balance sheet (assets and liabilities) are arranged starting with the most liquid (current) to the most permanent. (order of permanency vs order of***

liquidity)

Assets are items owned by the farmer,

These include:

- Property (money, goods and buildings).
- Debts receivable from other people.
- Goods and services paid for in advance.

Assets can be divided into two:

- **Fixed assets**: assets of permanent nature and not easily converted into cash. Ie land, buildings and machinery.
- **Current assets**: assets which can be easily converted into cash. They are less permanent property.ie crops in store and cash in bank.

- ***Liabilities are claims to the farmer's property such as bank overdraft and debts payable.***

They are divided into:

- Current liabilities - debts which must be paid within a short time.
- Long term liabilities - debts which are payable over many years or over a long period.

3.Profit and Loss Account /Trading account

- It's a financial statement showing whether the business made a profit or a loss.
- Prepared at the end of a calendar year.
- It has two main sides: income (sales made) and expenditure side (expenses incurred).
- It is a final account which summarizes the sale and receipts (income flowing in the business) and the purchases and expenses (flowing out of the business).
- It also shows the opening and closing valuations, debts payable and receivable.
    - **Income side**

- Contains the following details:
    - Closing valuation-all the assets in the farm/business by the end of the financial year, this gives the total value of the farm or the business.
    - Sales and receipts- all the produce items sold from the farm or business and any debts receivable by the end of the financial year.
    - **The expenditure side**
- It contains the following details
    - Opening valuation-all assets in the firm/business by the beginning of a financial year. It gives the value of the farm at the beginning of the year. It's the capital available for investment in the following year.
    - Purchases and expenses- include items bought and debts payable to the firm/business for the financial year.
- The expenses, purchase, debts payable and opening valuations are entered on the left hand side of the page of the account columns while all sales, receipts, closing valuations and debts receivable are entered on the right hand side of the page of the account columns.
- The closing valuation of the previous accounting period becomes the opening valuation for the current accounting period.
- When the totals of the opening valuation, purchases and expenses including debts payable is greater than the sum of the closing valuation, sales and receipts and debts

receivable then the business has made a **Loss.**

- If the totals of the, opening valuation, purchases, expenses, and debts payable is less than the closing valuation sales and receipts and debts receivable, the business has made a **Profit.**
- **Net profit =(closing valuation +sales and receipts)-(opening valuation + purchases and expenses)**
- To calculate profit or loss, account, valuation is done by having an inventory of all the assets.
- Valuation of the assets is determined by market price and cost of production for machinery and buildings as depreciation factor, is attached.

Format of a balance sheet
Balance sheet of Katilo school as 31-12-2009

Assets	Shs	Cts	Liabilities	Shs.	Cts.
Fixed Assets			Long-term Liabilities		
Land			Long-term loan for land		
Buildings			Loans payable over 15 years		
Fences and other structures					
Current Assets			Current Liabilities -		
Livestock			-Debts payable		
Debts receivable			-Credits from friends		
Cash in bank			-Short-term loans		
Cash in hand					
Sub-total			Sub-total		
Total			Total		

Format
Profit and Loss Account of Kitheko Farm at 31-12-2009

Sales and Receipts	Shs.	Cts.	Purchase & Expenses	Shs.	Cts.
I. Income during the			I. Opening valuation		
2. Debts receivable			2. Expenditure during the year		
3. Closing valuation			3. Debts payable Balance (being		
Balance (being a loss)			farm a profit or net income)		
TOTAL			TOTAL		

(Agricultural Marketing and Organizations)

Introduction

- Agricultural marketing is an economic activity which involves the distribution of farm produce from the farm to the consumer.

Market and Marketing

- Market is an institution for the exchange of goods and services or a place where selling and buying of goods takes place.
- Marketing refers to the flow of goods and services from the producer to the consumers.

Marketing Functions

- Transportation - Movement of goods from production centre's to the consumption centre's.
- Buying and selling - Purchase of goods from the producer to be sold to the consumer.
- Storage - Agricultural products are seasonal hence storage is necessary.
- Processing-Changing of raw form into utili sable form.
- Grading and standardization - Sorting into uniform lots of certain qualities.
- Assembling - Collecting the farm produce from the farm to the market centres.
- Collecting market information – To know the prices, supply and demand of certain commodities.
- Advertising - Making the consumers aware of the produce.
- Bearing of risks - Such as fire risk, price fluctuation.
- Financing or expenditure on other processes.
- Packaging or putting into small packs and labeling.
- Packing or putting produce In containers such as bags.

Marketing Agencies and Institutions

- Middlemen (itinerant trader) - are the people who buy from the producer and sell to other agencies.
- Wholesalers - Buy in bulk and sell to the retailers.
- Retailers - Buy from the wholesalers and sell in small units to the consumers.

Problems in Marketing Agricultural Produce

- Farm produce are bulky, that is weight and volume are high but low in monetary value thus difficult to transport.
- Most of the agricultural products are perishable for example milk, vegetables and fruits.
- Storage problems (since they are bulky they require a lot of space).
- Lack of proper transport system since agricultural products are in the rural areas and the market are situated in urban centres.
- Lack of market information hence farmers are exploited by middlemen.

Price Theory

- Price is the amount of money paid in exchange for goods or services.
- Price theory is concerned with the determination of price of any commodity.

- Price is determined where demand for and supply of any commodity are equal to each other.

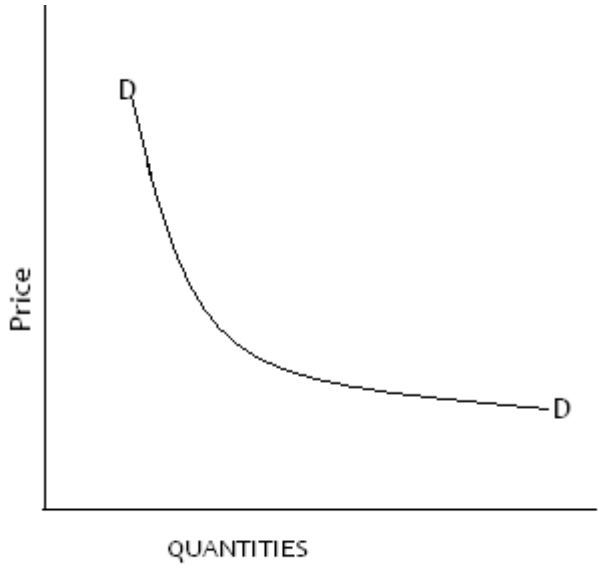
Demand

- It is the quantity of any commodity which is purchased at any price within a given time.
- The law of demand states that quantity demanded changes inversely with the price.

Demand Curve

- The curve slopes from left to right downwards.
- This means people buy more at lower prices and vice versa.

Demand Curve



DEMAND CURVE

Factors Affecting the Demand of a Commodity

- Population
- Income of the consumer.
- New inventions.
- Taste and preference of the individual.
- Price of the substitute commodities.
- Price expectations.
- Advertisement.
- Culture and social values *of* the consumers.
- Price of commodities having joint demand for example tractors and diesel.

Elasticity of Demand

- It is the responsiveness of demand to a change in price.
- Elasticity of demand = Percentage change in quantity demanded

Percentage change in price

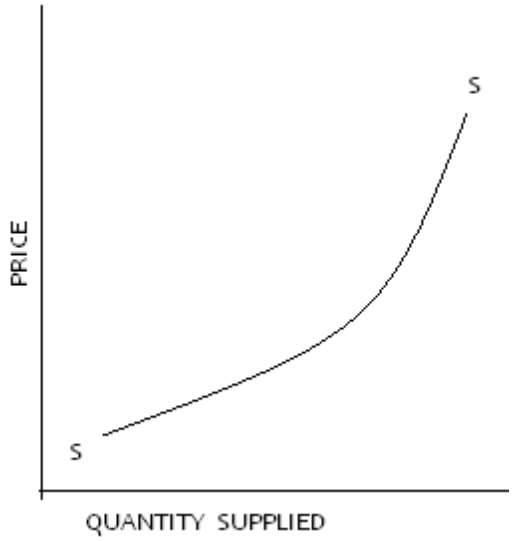
Types of Elasticity of Demand

- Elastic demand is one where the ratio is more than 1.
- Unitary elasticity is one where the ratio is equal to 1.
- Inelastic demand is one where the ratio is less than 1.

Supply

- Supply is the quantity of any commodity which is offered for sale at any price at a given time.
- The law of supply states that when price rises, quantity supplied increases and when price falls quantity supplied decreases (other factors held constant).
- The curve rises from left to right upwards.
- This means that people are willing to offer more for sale at higher prices.

SUPPLY CURVE



SUPPLY CURVE

Factors Affecting Supply of a Commodity

- Number of sellers
- Price of substitute commodities.
- New technology.
- Price expectation.
- Peace and security.
- Weather conditions.
- Policy of the government.
- Cost of production of the commodities.

Elasticity of Supply

This refers to the rate at which quantity supplied changes due to a change in price level.

$$\text{Elasticity of Supply} = \frac{\text{Percentage change in quantity supplied}}{\text{Percentage change in Price}}$$

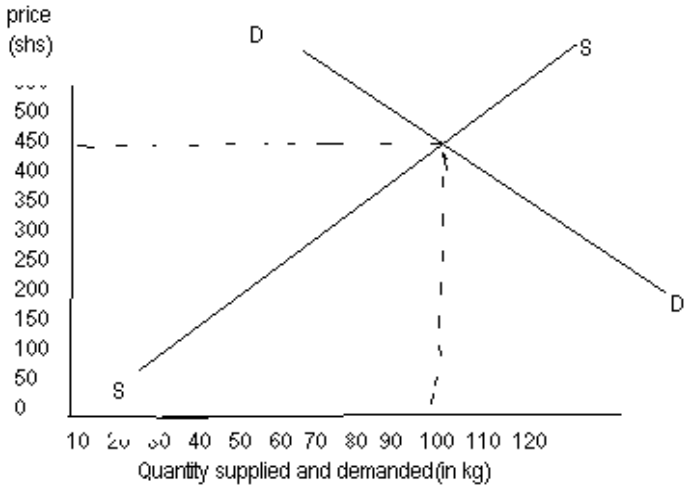
Type of Elasticity of Supply

- Elastic supply one where the ratio is more than 1.
- Unitary elasticity of supply is one where the ratio is equal to 1.
- In elastic supply is one where the ratio is less than 1.

➢ One of the problems of agricultural produce is that supply does not readily adjust to price changes.

Equilibrium Price

- Is the price at which demand and supply are equal.
- That means whatever is offered for sale at the market is bought.
- In the graph below, the quantity supplied and demanded are equal at a price of Shs.300 and quantity of 80kg.
- At this point the price is higher than shs.300 then the supply will be greater than demand and there will be surplus hence price will fall.
- If, on the other hand, the price is less than shs.300 demand will be greater than supply hence shortage and rise in price.



Agricultural Organization

- Agricultural organizations are agencies which, through their activities, promote agricultural development.
- These organizations are co-operatives and statutory boards.

Co-operatives

- A co-operative is an organisation of people with a common aim of pooling their resources to achieve their objectives.

Functions of Co-operatives

A co-operative society carries out the following functions:

- Collecting and assembling members' produce.
- Processing the farm produce after collection.
- Transportation of members' produce to market points.
- Negotiation of fair prices with the purchasing agencies for the members' produce.
- Purchase and distribution to members of farm inputs.
- Storage of members' produce before transmission to market points.
- Provision of credit facilities to members on easy terms.
- Training and education of members on improved farming techniques.
- Offering farm machinery services to their members on hire terms for farm operations.
- Co-operatives may invest in other viable ventures and the profits realised are shared among members in form of dividends or bonuses.

Formation and Structure of Co-operatives

The formation of a co-operative takes the following stages:

- Individuals with common interest collect together to form a primary co- operative society
- At least ten (10) members qualify for registration.
- Each primary co-operative society elect their office bearers consisting of chairman, secretary and treasurer.
- Several primary co-operative societies are usually amalgamated to form a district co-operative union.
- Tertiary co-operative unions are nation¬wide organizations to which the secondary co -operative unions are affiliated.
- Examples are Kenya Planters Co-operative Union, Kenya Farmers Union, Kenya Co-operative Creameries, Co-operative Bank of Kenya, etc.
- Apex organizations. This is represented in Kenya by Kenya National Federation of Co-operatives which is an affiliate of the International Co-operative Alliance.

Problems Facing Co-operatives

Co-operatives encounter the following problems in their operations:

- Managerial problems arising from:
- Financial mismanagement due to poor accounting.
  - Corruption and misappropriation of co¬operative resources by the personnel in the system.
  - Lack of advisory services on technical operations.
  - Inability to meet the set obligations of providing credit facilities due to malpractices.
- The nature of agricultural products and associated problems.
  - Bulkiness hence difficulties in transportation and storage.
  - Perishability of produce hence difficult to sustain quality.
- Inadequate capital to invest in the co¬operative undertakings.
- Transport problems due to poor roads.
  - This hampers the produce getting to the market points in time.

Statutory Boards

- A statutory board is an organization established by an Act of Parliament and charged with the running or managing of a certain industry within the government sector.

Marketing Boards

- Some of the statutory boards are charged with the marketing of certain farm produce and are thus called marketing boards.
- Examples are the Coffee Board, Pyrethrum Board, Cotton Seed and Lint Marketing Board, Tea Boards, National Cereals and Produce Board, Kenya Meat Commission, the Dairy Board of Kenya and others.
- Their marketing functions are to look for market and better prices.

Research Organization

- These are research centres which among other things, carry out research and trials on:
- Development of new varieties and cultivars of crops.
- Breeding disease and pest resistant varieties of crops and types of animals.
- Adaptations of crop and livestock species to ecological conditions of certain areas.
- Use of fertilizers and pesticides on crops in specific areas.
- Development of early maturing and high yielding species.
- Soil testing and crop analysis. Advisory services of agro-economic aspects.

Other Organizations

Kenya National Farmers' Union negotiates for:

- Reasonable and affordable prices of farm inputs.
- Better prices for farm produce.
- Better credit facilities.
- Better control of diseases and pest.

Agricultural Society of Kenya

- Organizes agricultural shows in the country.
- Encourages improvement of livestock through exhibitions and educating farmers
- Organizes the running of young farmers' clubs.
- Organizes and finances the ploughing contests during which farmers learn the modern techniques of seedbed preparation.
- Publish "Kenya Farmers" magazines.

Young Farmers and 4-K Clubs.

These are student organizations whose objectives are:

- To expose the young students and encourage them to appreciate agriculture as a profession in their career.
- To encourage the youth to develop leadership qualities through assignment of small farming projects.
- Organizing students exchange programmes with other club members both locally and abroad.
- To develop better farming skills through judging competitions, annual rallies and camps.

Agricultural Based Women Groups

- These are self-help groups whose objective is to uplift the economic status of their members by carrying out agricultural related activities.

Their success depends on the following factors:

- Commitment of their leaders.
- Motivation of the members.
- Sacrifice for each other.

Agroforestry

Introduction

- In Kenya land use is changing from extensive methods of farming to more productive and sustainable intensive methods.
- Agroforestry is a method of farming which has become increasingly important.

Definition

- This is the practice of integrating a variety of land use

- It combines tree growing, pasture and crop production practice on the same piece of land to improve the output of the land.

Forms of Agroforestry

- ***Agroforestry;***
  - It is a combination of trees/shrubs and crops in agricultural production.
- ***Silvopastoral:***
  - It is a combination of growing tree/shrubs, pastoral and keeping of livestock.
- ***Agrosilvopastoral:***
  - It is a combination of growing trees/shrubs, animals, pastures, and crops.

Importance of Agroforestry

- 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.

Important Trees and Shrubs for Particular Purposes

- ***Eucalyptus Spp;***
  - Timber,
  - Bee forage,
  - Fuel wood,
  - Medicinal,
  - Production of essential oils.
- ***Acacia Spp;***
  - Leaves and pods eaten by animals,
  - Provision of shade.
- ***Cajanus cajan (pigeon peas);***
  - Proteinous feed for human,
  - Used as fodder
  - Firewood.
- ***Croton megalocarpus(croton);***
  - Fuel wood timber for poles
  - Handles for hand tools.
- ***Erythrina abyssinica (flame tree);***
  - Wood carvings,
  - Bee forage,
  - Nitrogen fixation
  - Medicinal.
- ***Markhamia lutea (markhamia tree***)¬;
  - Timber for construction,
  - Shade,
  - Soil protection,
  - Bee forage.
- ***Grevillea robusta (silky oak.)***
  - Timber,
  - Fuel wood,
  - Fodder,
  - Bee forage,

- Soil protection,
- Wind breaker
- Shade.

- ***Sesbania sesban (sesbania);***
  - Fodder,
  - Nitrogen fixation,
  - Shade,
  - Fuel wood.
- ***Calliandra calothyrsus (calliandra)****;*
  - Fuel wood,
  - Fodder,
  - Nitrogen fixation,
  - Shade,
  - Bee forage.
- ***Persea american (avocado***) ;
  - Fodder,
  - Fruit production,
  - Shade,
  - Fuel wood.
- ***Mangifera indica (mango)***;
  - Fruit production,
  - Shade trees,
  - Wind break,
  - Soil protection,
  - Fuel wood.

Characteristics of Agroforestry Tree Species:

- Fast growth rate.
- Deep rooted.
- Nitrogen fixation ability.
- By-product production ability.
- Be multipurpose in nature.
- Should not possess competitive ability with main crop ..
- Have coppicing and lopping ability.
- Have appropriate canopy - should not shade others.
- Nutritious and palatable.

Trees and Shrubs to Avoid at Certain Sites and Reasons

- ***Eucalyptus Spp****.* -should not be planted near water sources because it would absorb the water.
- ***Eucalyptus Spp***. -should not be planted on the arable land as the roots have **allelophathic effects** on other vegetation including crops.
- ***Tall trees*** should not be planted near farm buildings because they may fall and damaging the buildings, their roots will break the building stones gradually.
- ***Bushy trees or shrubs*** should not be near farm buildings as they may harbour predators.
- ***Tall trees planted with main crop*** of a lower canopy intercept the rainfall, affecting the growth of the main crop.
- ***Cypress trees*** have leaves which produce acidity in the soil preventing undergrowth beneath the tree.
- These trees should not be planted within the farm but at the periphery.

Tree Nursery

- Tree nurseries are structures used to raise tree seedlings until they are ready for transplanting.
- There are 2 main types:

Bare root nurseries:

These are also known as *'Swaziland' beds* where the seedlings are raised directly into the soil.

Advantages

- Cheap and less time consuming.
- Require less labour
- Occupy a small space.
- Many seedlings are raised in a small space.
- Transportation of seedlings is easy.

Disadvantages

- Root damage when uprooting the seedlings.
- Difficult to transport.
- Lower survival rate after transplanting.

Containerized nursery:

- The seedlings in this type of nursery are raised in containers such as pots, polythene bags or tubes and tins.

Advantages

- Higher survival rate after transplanting.
- No root damage.
- Successful in arid areas.

Disadvantages

- Labour intensive.
- Difficult to get containers.
- Sometimes it may be difficult to get the right type of soil to use in the containers.

Seed Collection and Preparation

Seed Collection

Seeds should be collected from;

- Adaptable trees,
- High yielding,
- Healthy
- Resistant to pests /diseases.
- The mother plant should be identified first.

The following methods used to collect seeds.

- Shaking the tree.
- Gathering from under the tree.
- Lopping of the tree.
- Climbing on the trees.
- Hooking method.

Seed Preparation

- This done when seeds are collected from a fresh fruit, they should be soaked in water,

then washed and dried.
- ***Cleaning and sorting***: done to remove immature seeds, rotten seeds, broken or damaged seeds.
- ***Drying:*** Done by sun-drying or oven drying.
- ***Seed testing***: this determines;
  - Seed quality for percentage purity,
  - Seed weight,
  - Moisture content,
  - Germination percentage.
- Seeds should be stored in dry containers at room temperature.
- ***Seed treatment:*** seeds are treated first to break the seed dormancy and ensure rapid germination;
  - ***Hot water treatment***: used to soften the seed coat to make it more permeable to water.
  - Examples of seeds which require this treatment are ***leucaenia, calliandra*** and ***acacia.***
  - ***Mechanical breaking:*** done by nicking the seed coat with a knife for easy entrance of water for example seeds of ***croton*** trees.
  - ***Light burning:*** applied to the wattle tree seeds.

Nursery Management

The following are the practices carried out in the nursery when the seedlings are growing:

- ***Mulching:***
  - Aim is to reduce excessive evaporation,
  - Moderates the soil temperature,
  - When it decays it improves the soil structure,
  - Reduces the impact of the raindrops.
- ***Weeding:***
  - Done to reduce competition for growth factors by uprooting the weeds,
  - Use a sharp pointed stick.
- ***Watering:***
  - Done by use of a watering can
  - Done twice a day in the morning and in the evening.
- ***Pricking out***:
  - It is the removal of seedlings in an overcrowded area to another nursery bed,
  - This allows the seedlings to grow strong and healthy.
- ***Root pruning:***
  - It is the cutting of the roots longer than the pots.

  Root pruning is done for the following reasons;
  - Make lifting easier
  - Encourage fast establishment.
  - Reduce damage to the seedlings.
  - Encourage development of a short dense and strong rooting system.
- ***Shading:***
  - Done to reduce the intensity of sunlight .
  - Dark conditions should be avoided.
- ***Pest and disease control:***
  - Use of appropriate chemicals,
  - Sterilization of soil through heat treatment,
  - Fencing to protect seedlings against animal damage.
- ***Hardening off***:
  - It is the practice of preparing seedlings to adapt to the ecological conditions prevailing in the seedbed.

- It involves gradual reduction of shade and watering 1-2weeks before transplanting.

- ***Transplanting:***
  - The practice of transferring seedlings from the nursery bed to the main field where they grow to maturity.

Procedure of Transplanting

- Holes are dug early before transplanting.
- Topsoil is mixed with compost manure.
- The seedlings are watered well a day before transplanting.
- The seedlings are removed from the nurseries carefully with a ball of soil for the bare root seedlings and roots trimmed for the containerized seedlings.
- The seedling is placed in the hole at the same height it was in the nursery.
- The container is removed carefully.
- The soil is returned into the hole and firmed around the seedling.
- The seedling is watered and mulched.

Care and Management of Trees

- **Protection:**
  - From damage by animals such as goats and cattle by eating the leaves.
  - It is done by fencing the fields or using small poles around each seedling with or without wire nettings, can be done for individual trees or an entire field.
- **Pruning and trimming**:
  - Pruning is the removal of extra or unwanted parts of a plant.
  - The unwanted part may be due to breakage, overcrowding, pests or disease attacks and over production.
  - Pruning initiates growth of shoots and trains the tree to have the required shape.
  - Regular cutting back of the trees is known as coppicing,
  - It is done at the beginning of each cropping season to reduce competition for water, minerals, nutrients and sunlight with crops.
  - The materials pruned or coppiced are used as fuel wood or for fodder crops.
- **Grafting old trees**:
  - This is the practice of uniting two separate woody stems.
  - The part with the rooting system is known as root **stock (base)**
  - The part which is grafted onto the rootstock is called a **scion** which has buds that develop into the future plant.
  - The ability of the scion and the rootstock to form a successful union is known as **compatibility.**
  - Methods of grafting include whip or tongue grafting, side grafting and approach grafting.

Agroforestry Practices

- ***Alley Cropping/Hedgerow Inter¬cropping***:
  - The growing of multipurpose trees and shrubs together with crops.

Benefits

- Improve soil fertility through nitrogen fixation and organic matter.
- Provision of green manure.
- Used as fence and mark boundaries.
- Acts as windbreaks.
- Suppress weeds.
- Source of timber and fuel wood.

- ***Multi-storey cropping ;***

  - This is the growing together of trees of different heights.
  - The system is based on crops which can tolerate shading.
  - The trees and crops form different levels of canopy which look like storey.

  Benefits

  - Increases water conservation for pastures.
  - None of the crops or trees included will be shaded.
  - Act as windbreak for crops.
  - Creates suitable micro-climate in the area.
  - Trees are used for timber, fuel wood and forage.

- ***Woodlots (farm forests)***
  - These are plots of land set aside for trees only.
  - They are established in the hilly and less productive parts of the farm.
  - Fast growing tree species such as ***Eucalyptus spp***. should be grown.

Sites for Agroforestry:

- Farm boundaries - provide live fences.
- River banks - protect water catchment areas.
- Homesteads - provision of shade and windbreak
- Terraces - for soil conservation.
- Steep slopes - as contour hedges to encourage water seepage.

Tree Harvesting Methods

- ***Pollarding***;
  - This is the extensive cutting back of the crown of the tree about 2-3 meters above the ground level to harvest all the side branches.
  - It stimulates the development of a new crown and branches.
- ***Coppicing;***
  - Cutting the main stem of the tree completely at a height of 10 - 50 cm above the ground.
  - The tree should be cut in a slanting angle.
- ***Lopping or side pruning*** ;
  - The removal of selected branches of the tree
  - Done to produce fuel wood and fodder.
- ***Shaking of the tree*** ;
  - This is a method of harvesting pods and seeds from trees without cutting the tree.
- ***Cutting back;***
  - The tree is cut from the base to allow new growth as done in coffee when changing the cycle.
- ***Thinning;***
  - The removal of some of the trees growing in lines to give the remaining trees enough space to grow.