

FORM FOUR AGRICULTURE NOTES

LIVESTOCK PRODUCTION V (POULTRY PRODUCTION)

Introduction

The term *poultry* refers to all kinds of domestic birds kept for meat or eggs production. They include turkeys, ducks, geese, guinea fowls, chicken, ostriches and pigeons. The management of poultry aims at production of high quality eggs and meat to meet the ever increasing market demand.

Selection and Breeding

Small scale farmers increase their flock by keeping breeds that go broody. However commercial poultry farmers buy day old chicks from recognized hatcheries such as Kenchic and Muguku. Hybrids are not recommended for breeding as their hybrid vigour would decline in their offspring and many do not go broody. Broodiness is the desire to sit on the eggs.

The birds selected should have the following characteristics.

- Young
- Healthy
- Able to go broody
- Prolific
- Good mothering ability.

Commercial farmers should also consider the following.

- Whether the enterprise is for meat or egg production
- Age, that is either day-old or at point of laying.
- Breed of birds in respect to egg colour and size of birds.
- Production, which is percentage laying or growth rate.

NB/. After the selection of the breeding stock, cocks are allowed to run with hens daily to ensure that all the eggs are fertilised

Composition of an Egg

The parts of an egg include the following.

- The shell

- The shell membrane
- Air space
- Egg white (albumen)
- Chalazae
- Yolk.

The shell

It forms about 10-12% of the total egg content and is largely made up of calcium and phosphorous compounds which make it hard. It gives the egg its shape and provides protection to the inner contents of the egg. The egg shell is porous and allows gaseous exchange to take place. This makes it possible for the embryo to develop.

Shell membrane

This forms the inner lining of the shell and makes about 1% of the egg content. It is formed of two separate membranes which closely adhere to each other. The two membranes separate at the broad end to form an air space/air cell.

The inner membrane is about 0.015mm thick and the outer one is about 0.05mm thick.

The air in the air space is used by the developing embryo during incubation.

Albumen/Egg white

The albumen forms about 55-60% of the total egg content. It is a jelly like colourless fluid when fresh and turns white when cooked. It is divided into four major parts: chalazae and chalaziferous albumen, thin inner albumen, thick albumen and outer thin albumen. The albumen surrounds the yolk and serves as a food reserve to the developing embryo. It is mainly protein.

Chalazae

This forms about 3% of the albumen and it's a dense white mass floating all over the place within an egg. It has two twisted cords which hold the yolk in place at the centre of the egg. The two chalazae hold the yolk from both ends of the egg thus allowing the yolk to move the germinal disc always to the top position. This is important during incubation for the purpose of heat transfer

to the developing embryo. If the chalazae are broken the yolk is displaced from its normal position.

The Yolk

It is divided into three major parts and forms about 33% of the total egg content. It is yellow in colour and spherical. Its main function is to supply for all the embryo requirements since it contains food reserves for the developing chick. The yolk is rich in vitamins, fats, minerals and proteins.

The three parts are:

- Germinal disc
- Pigments
- Vitelline membrane.

The germinal disc: this is formed from the ovary after fertilization and is always found at the top of the yolk as a small spot regardless of what position an egg is resting. The disc is joined to the centre of the yolk by a funnel shaped structure called the streak/lutebra. This allows maximum heat transfer to the developing embryo within the yolk.

The egg pigments: The pigment contained in the yolk always comes from the food the bird eats and also from its body. This pigment is known as Xanthophylls and is responsible for the colour of the shell and that of the yolk (yellow)

The vitelline membrane: the vitelline membrane surrounds the yolk and therefore gives the yolk its shape. If the egg is not properly stored, this membrane may break up causing the yolk to come out of it.

Incubation of eggs

This refers to the embryonic development of a fertilized into a chick under correct conditions which will ensure that a chick is hatched from the egg. In chicken these conditions must be provided for 21 days while in turkeys and ducks this takes 28 days.

Selection and Care of Eggs for Incubation

Eggs for incubation should have the following characteristics.

- Should be fertilized
- Medium sized-55-60gm in weight. Lighter or heavier weight lowers hatchability.
- Have smooth shell
- Oval in shape
- Free of any cracks in the shell
- Clean to ensure that the pores are open
- Not have abnormalities such as blood spots, meat spots or double yolk
- Should be fresh – collected within one week and not more than 10 days.

NB/. The internal condition of the egg is examined through egg candling.

Egg Candling

This is the method used to check the freshness of an egg for physical abnormalities or likelihood of being hatched. It is done by passing a strong light through the egg in a dark room. The source of light may either be a torch, candle or electric bulb.

Procedure of candling

The egg is placed over a hole made on a card board box. A light under the box is then put on. The observer then looks at the egg against the light below.

The following can be observed through egg candling.

- The size of the air space
- If the egg is fertilised (the germinal disc will be seen as a black spot).
- Whether the yolk has blood spots.
- Whether the shell has cracks
- Whether the egg shell is broken
- Whether the shell is very porous.

Incubated eggs are candled two or more times.

First candling is done between the 5th and 7th to check for fertility. If they are fertile, blood veins are seen. If they are not they appear clear.

The second candling is done on the 18th day to confirm the presence of the chick. An egg with a living embryo clearly shows a large section containing the embryo and a smaller section which is clear containing the air space.

Methods of Incubation

1. Natural incubation

This method involves the use of a broody hen to sit on the eggs. The hen provides the necessary conditions for incubation e.g. warmth, turning the eggs etc. the hen must sit on the eggs for 21 days for successful embryonic development. A hen normally shows some signs when it is about to go broody.

Signs of Broodiness in Poultry

- i) Prolonged moulting
- ii) Tendency to sit on the eggs after laying
- iii) Number of eggs laid are few
- iv) Plucking of feathers from the abdomen/breast region
- v) Produces a characteristic sound and becomes aggressive.

Preparation and Management of Natural Incubation

- i) Ensure the hen is completely broody. i.e. shows the ability to sit on the eggs for long hours. The broodiness can also be induced by use of China clays.
- ii) Prepare the nest in a secluded place of the poultry house. The nest can be a wooden box, karai, a woven basket or a carton box. The nesting box should be spacious to allow movement of the hen. The nest should be lined with some nesting materials such as dry grass, sawdust or wood shavings to maintain warmth in the nest.
- iii) Give an adequate number of eggs to the broody hen i.e. 10-15 eggs. A hen may not cover more than 15 eggs hence low hatchability.
- iv) Set the eggs in the evening or night but not in the morning so that the chicks will start emerging on the evening or night of the 21st day. When the chicks start emerging in the morning,

the hen will walk out with a few chicks and leave the unhatched ones to die.

- v) Regularly dust the hen with appropriate pesticides so as to control external parasites such as fleas, mites etc.
- vi) Allow the bird to occasionally move out to scratch and exercise.
- vii) Feed the brooding hen daily and provide adequate clean water.

NB/. The hen should not be disturbed at all.

Advantages of Natural Incubation

- i) Less skill is required
- ii) It is not labour intensive as there is no turning of the eggs and checking of temperatures.
- iii) It's a cheap way of multiplying birds i.e. small scale farmers who cannot afford incubators can multiply their flocks using this method.
- iv) Hatchability is very high compared to artificial incubation therefore reducing the risk margin.

Disadvantages

- i) Only few chicks can be hatched at a time by one hen
- ii) Egg production is reduced when the birds go broody.
- iii) It's only possible with breeds that go broody.
- iv) The farmer cannot plan when to incubate.
- v) Diseases and parasites can easily be transmitted to the chicks from the hen if it is infected.

2. Artificial Incubation

Under this method all the conditions necessary for the hatching of the eggs are provided artificially by equipment called an incubator.

Conditions Necessary for Artificial Incubation

1. *Temperature:* Temperature should be maintained at 37.5°C – 39.4°C. Lower or higher temperature would kill the developing embryo.
2. *Fresh Air /Ventilation:* There should be adequate fresh air circulating in the incubator. The fresh air is required by the

- developing embryos. Ventilation facilitates gaseous exchange and helps to control humidity.
3. *Relative Humidity*: It should be about 60%. If it is too low, the embryos may lose moisture and die. Water is placed in a tray within the incubator to maintain the humidity. The damp cloth also assists in maintaining the relative humidity. High humidity lowers hatchability and leads to production of large chicks which look abnormal. It also results into dampness which predisposes the eggs to infections.
 4. *Egg Turning*: This is quite important in the management of an artificial incubator. This helps to avoid the germinal disc sticking onto the egg shell leading to the death of the embryo. Wrong turning of the egg may lead to breaking of the blood vessels. Turning should always be done along the axis of the eggs and each time in a different direction. Some incubators have automatic turning devices.

Management of the Incubator

The following should be observed for artificial incubation.

- i) The incubator should be cleaned and disinfected or fumigated before putting in the eggs.
- ii) Eggs should be turned every 6-8 hours each day. However in the first 24 hours and the last three days they should not be turned. These are the critical stages of embryonic development. They should be turned around 180°C.
- iii) Any egg found to be infertile on the 5th day should be removed.
- iv) Remove any broken eggs.
- v) Maintain temperature within the set range
- vi) Add water as necessary to maintain the correct humidity.

Advantages of Artificial Incubation

- i) It's possible to plan when to have the chicks.
- ii) Many chicks are hatched at once
- iii) If management is good, there is no danger of infecting the chicks with diseases and parasites.
- iv) The incubator is usually ready when required.

- v) Egg production is not affected by incubation as the hens do not go broody.

Disadvantages

- i) Incubator is expensive to buy hence has high capital investment.
- ii) More labour intensive.
- iii) More skills required
- iv) Have high risks of damaging all the eggs if the requirements such as temperature or relative humidity are not strictly observed and controlled.
- v) Only viable in large scale hatcheries.

Sources of Chicks

For success in the poultry enterprise, the following factors should be put into consideration.

- i) Reputation of the supplier
- ii) The type of chicks required in relation to size, breed, sex etc
- iii) Time factor i.e. how long the chicks will take in transit from the hatchery to the farm. Very long hours of transportation cause stress to the chicks. Arrangement should be made to feed the chicks on transit if the source is very far.

The most reputable sources of chicks in Kenya are;

- i) *Muguku Poultry Farm- Kikuyu.*
- ii) *Lake Chicks Hatcheries – Kisumu*
- iii) *Kenchic Hatcheries – Athi river*
- iv) *Stockplan Hatcheries – Mombasa*
- v) *Sigma Supplies – Nairobi*
- vi) *Ken Bird – Nairobi*

Brooding and Rearing of Chicks

Brooding is the rearing of chicks from one day old to the time they are taken to the main house. Brooding is a very critical and difficult period in the management of birds. There are two methods used in brooding the chicks.

- i) Natural Brooding
- ii) Artificial Brooding.

Natural Brooding

This follows natural incubation. The hen is allowed to provide warmth and other requirements to the chicks. Feed and water should be provided for both the hen and the chicks. The hen stays with the chicks until they are old enough to feed themselves.

Advantages

- i) It is cheap
- ii) It is suitable for most small poultry farmers.
- iii) It is less labour intensive

Disadvantages

- i) Only possible where the hens go broody
- ii) It is not suitable for large scale production of birds.
- iii) Lowers the egg production during the brooding period.

Artificial Brooding

This refers to keeping of the chicks in a structure called a Brooder where food and other requirements are provided. Chicks remain in the brooder for 6-8 weeks.

Requirements in an Artificial Brooder

1. *Litter*: this should be in the form of wood shavings. This should be on the floor. It maintains warmth and absorbs moisture.
2. *Fresh air*: holes for ventilation should be made on the walls of the brooder for gaseous exchange. The holes however should not allow draught into the brooder.
3. *Heat source*: there should a wire guard round the heat source to prevent the chicks from being burnt. Correct temperature should be maintained at 32-35°C in the first week, 29-33°C in the second week and 26-30°C in the third week. The heat sources include electric bulbs, charcoal burners, lantern, kerosene and gas burners. The heat source should be withdrawn gradually to avoid stress. If it were withdrawn at once, the chicks would overcrowd at one point of the brooder resulting in deaths. A thermometer should be used to check the temperature.

The behaviour of the chicks can also be used to tell whether the temperature is correct. When the chicks move away from the heat source then the temperature is too high, while overcrowding around the heat source means the temperature is too low. When the temperature is optimum the chicks are found evenly spread all over the brooder floor. The brooder should have sufficient lighting to allow the chicks to see water and food. Very bright light makes the chicks toes to shine hen toe pecking and also makes the chicks blind. Dim light is therefore recommended.

4. *Shape of the brooder.* There should be no sharp corners in the brooder. Such corners would encourage overcrowding hence suffocation of the chicks.

5. *Equipment*

a) *Feeder:* There should be sufficient feeders for the chicks. If the chicks overcrowd during feeding then more feeders should be made available. The feeders should be kept clean. During feeding the chicks should be given a feeding allowance of 1 inch per chick during week 1-2 and 2 inches per chick from weeks 3-6. The feeders should have a rotating bar to avoid the chicks contaminating the feed by stepping or defecating on the feed.

b) *Waterers:* The waterers should also be made in such a way that the chicks do not defaecate or step into the water. They should be pointed at the top so that the chicks cannot perch. They should always be kept clean. During the first to second week the appropriate spacing for the waterers should be 0.2 inches per chick and 0.4 inches per chick from week 3 to week 8.

Brooder and Brooder Management

a) *Preparation before the chicks arrives.*

- i) The brooder should be made ready 2-3 days before arrival of the chicks. The brooder house should be washed and disinfected. Spread litter then cover it with newspapers. Newspapers help to prevent the chicks from eating the litter.

- ii) Place water and feed equipment in the brooder house. Ensure they are clean. Place food in the feeders and water in the waterers.
- iii) Provide heat source in the brooder. Check to ensure the heat source is functional. Turn on the heat source on the day of chicks' arrival.

b) Day of arrival of chicks.

Vaccinate them if they were not vaccinated in the hatchery. Remove any dead chicks and dispose off properly.

c) Feeding

- i) Remove the newspapers after the chicks have learnt to eat from the feed troughs.
- ii) Provide chick mash till the eighth week. Chick mash has 20-22% DCP and vitamins A and D. it is highly digestible. Ensure the chicks are given adequate amounts of feeds at all times.
- iii) In the sixth week introduce grit or sand to help in digestion. Also introduce roosts for the chicks to perch.
- iv) In the seventh week, introduce growers mash. Start with growers mash mixed with chick mash at a ratio of 3:1 respectively. Gradually reduce the amount of chick mash as the amount of growers mash is increased. When the chicks are 8 weeks old, they are removed from the brooder.
- v) At the ninth week, chicks are fed on growers mash only and are now taken to the main poultry house.
- vi) Clean the troughs and waterers daily.
- vii) Provide adequate clean water daily.

NB/. On average a chick uses 1.5-2.2 kg of chick mash during the brooding period of 8 weeks.

d) Parasite and disease control

- i) Vaccinate chicks against Gumboro after 2 weeks, Newcastle, 3-4 weeks and fowl typhoid at 7 weeks of age.
- ii) Dust chicks with appropriate pesticides such as pyrethrins to control external parasites e.g. mites, lice etc.

- iii) Provide antibiotics mixed in chick mash or drinking water to protect against disease attacks e.g. coccidiostats are incorporated in drinking water to control coccidiosis.
- iv) Isolate and treat sick chicks
- v) Dispose off dead chicks properly
- vi) Disinfect the feeders and waterers. Provide a footbath at the entrance of the poultry house.

e) Other management practices.

- i) Debeaking should be done 8-10 days towards the end of the brooding period.
- ii) Keep proper records of the feeding programme, treatment and the number of deaths of the chicks.

Management of Growers (9th week-20th week i.e. point of lay)

From the 9th week the birds are referred to as *growers* or *pullets*.

a) Feeding

- 1) Feed the growers on 115 grams of growers mash per bird per day. Growers mash contains 16-17% crude protein, vitamins and mineral salts.
- 2) Supplement the growers mash with grains and greens. Hang the greens to provide exercise for the birds.
- 3) Introduce layers mash from the 16th week and increase gradually.
- 4) At the 12th week onwards soluble grit should be provided. This provides enough calcium which is necessary for hard egg shell formation.
- 5) Provide clean water *ad libitum*.

b) Parasite and disease control.

- i) At the 18th week vaccinate against fowl pox. Give a booster vaccine against Newcastle disease at 20 weeks of age.
- ii) Drench the birds regularly against internal parasites.
- iii) Dust the birds with appropriate pesticides against pests such as fleas, mites and lice.
- iv) Control predators

v) Clean and disinfect waterers and feeders daily.

c) Other management practices.

- i) Provide more floor space for the birds as compared to when they were in the brooder.
- ii) Keep litter as dry as possible by turning it regularly or scattering grains on it to facilitate turning of the litter by the birds.

NB. Birds start laying at 18-21 weeks of age depending on the breed. Light breeds begin to lay at 18-20 weeks, some hybrids start laying at 18 weeks while indigenous breeds begin to lay at 23-27 weeks.

Feeding and Rearing of Layers

- Provide enough floor space, roosts, feeders, and waterers
- Give each hen about 120 grams of layers mash per day. The layers mash contains 14-16% DCP, Vitamins A, B, C and minerals.
- Provide clean water always
- Vaccinate every 6 months against Newcastle and fowl typhoid
- Keep the litter as dry as possible.
- Provide enough laying nests in the poultry house.
- Collect eggs twice, noon and evening
- Hang green leaves to keep the birds busy preventing cannibalism
- Incorporate grains at the rate of 65 grams per bird per day.
- Cull non layers and cannibals
- Provide soluble grit or oyster shells all times to ensure strong shelled eggs and efficient digestion.

Feeding and Rearing of Broilers

Broilers are referred to as table birds. They are kept for meat production. They exhibit high growth rate and have a very high feed conversion ration. They usually achieve a weight of 2kg in about 60 days. The following practices are carried out.

a) Feeding

- i) Chicks kept for broiler production are fed on broiler starter mash. The feed contains 20-24%DCP, vitamins and minerals essential for rapid growth.
- ii) Provide adequate clean water always
- iii) From week 4-5 gradually introduce broiler follow on mash or pellets. It contains 18-20%DCP. It encourages development of lean meat i.e. discourages over fattening. The feed should be provided ad libitum.
- iv) From 8th week up to slaughter the birds are given broiler finisher pellets.

b) Parasite and disease control

- i) De-worm regularly
- ii) Dust the birds to control external parasites
- iii) Vaccinate against common disease e.g. Newcastle disease at 3rd-4th weeks
- iv) Incorporate coccidiostats in the broilers pellets.
- v) Dispose off dead birds properly.

c) Housing

Broilers are best managed under the deep litter system. Its floor space requirements are low, about one square foot per bird. The house should be well ventilated for efficient air circulation. Broilers should be kept in dimly lit houses to reduce their activity, ensuring that most of the feed taken in is used for growth.

Rearing Systems

The method of keeping poultry is referred to as rearing system. The choice of the system to use depends on the following factors.

- Land availability
- Labour availability
- Capital
- Security
- Market
- Availability of appropriate equipment
- Topography of the land to facilitate easy drainage

- Knowledge of the farmer.

There are four main rearing systems i.e.

- Free range
- Fold system
- Deep litter
- Battery cage system

1) Free Range/Extensive system

Birds are allowed to move freely in a fenced ground that has a house to provide shelter at night and during the rainy seasons. The laying nests are also put in the house. Feed and water troughs are placed outside but should be protected against rain.

Requirements

1. *Land.* Should be adequate, well drained and with trees for shade. It should be fenced. About 100 birds should be kept in 1 acre.
2. *Runs.* The land should be partitioned to allow rotation. This reduces diseases and parasite build up. The partitioned areas are called runs.
3. *House.* The house should be movable or at the centre of the runs.

Advantages

- i) Cannibalism and egg eating are reduced as the birds are not overcrowded.
- ii) Birds exercise hence good growth
- iii) No need to provide grit as the birds can pick it from the ground
- iv) Less feed is used as the birds supplement with insects and grass.
- v) Manure is evenly spread in the runs hence vegetation regeneration
- vi) It requires low capital investment
- vii) Low labour requirement.

Disadvantages

- i) A lot of land is needed for the birds
- ii) Birds can be eaten by predators or stolen
- iii) Eggs get lost in the runs
- iv) Dirty eggs
- v) Difficulty in close supervision of individual birds

- vi) Breeding programme not easily followed
- vii) If the perimeter fence is not adequate the birds can damage crops on the farm.
- viii) The range area may become contaminated with diseases and parasites

2) *Fold System /Semi Intensive System.*

This is a system where birds freely eat vegetation but are confined in small houses called folds or arks.

- A fold system measures 3.5m long, 1.5m wide and 1.5m high. Such a fold can accommodate 10-15 birds.
- 1/3 of the fold is roofed to provide shelter and the rest is open but enclosed by chicken wire mesh. The unroofed part allows sunlight and is used for exercise and feeding on the grass.
- The folds should be moved to a new ground daily. This reduces pest and disease build up, provides fresh grass to the birds and avoids accumulation of droppings.

Advantages

- i) Manure is uniformly spread in the field
- ii) Less feeding costs since the birds supplement the feed with insects and grass
- iii) There is no need of fencing
- iv) Reduced pest and disease build up.

Disadvantages

- i) Folds don't last long due to too much handling
- ii) Few birds are kept per fold
- iii) Very laborious
- iv) Egg production records per bird are difficult to keep
- v) The returns per unit land are relatively low.

3) *Deep Litter System.*

This is an intensive system. In this system, birds are confined within a big house.

Requirements of a deep litter system

i) Site

The land should be well drained.

ii) House

- Should be leak proof
- The leeward side should be open from 60-90cm above the ground. This area should be covered with a wire mesh. The floor should have litter.
- The litter keeps the floor warm and absorbs moisture. Litter materials include crushed maize combs, coffee husks, sawdust, wood shavings etc.
- The litter should be 15-30cm deep.
- Litter should be turned regularly to mix the droppings. Grains should be thrown regularly on the litter for the birds to scratch for the grains thus turning the litter.
- The floor space requirement should be 1m² per 2- 3 birds.

iii) Feeders and Waterers

They should be enough and should always be cleaned daily to avoid any infections.

iv) Roosts and Perches

Roosts are timber frames on which the birds perch for rest. They should be about 30cm per bird and should be about 1-1.2m. They should be movable for easy removal of droppings and for easy cleaning. *Diagrams*

v) Laying Nests

Provide laying nests in the poultry house.

Requirements for laying nests

- Should be dimly lit to discourage egg eating
- Large enough to accommodate the bird comfortably. Nests are of two types, individual type and communal type. Individual type should measure 25-30cm wide, 30-35cm high and 30-36cm long. Communal nests can accommodate 50-60 birds and they measure 1.35m – 1.5m long, 30cm wide and 35cm high on the front side

and 75cm on the back side. It should have a door measuring 20x20 cm wide.

- Place dry clean beddings

Advantages of the deep litter system

- i) High stocking rate
- ii) System can be used for rearing a breeding stock
- iii) Fast accumulation of manure
- iv) Birds are safe from predators and thieves
- v) Less loss of eggs
- vi) Low labour requirements once everything is in place.

Disadvantages

- i) There is a likelihood of pest and disease accumulation in the litter
- ii) Cannibalism, egg eating, feather plucking and toe pecking are common.
- iii) Individual egg production record is not possible
- iv) Litter may be difficult to find in some areas
- v) Feeders and waterers may be contaminated by litter if not properly placed
- vi) Eggs may become dirty if they are laid on the floor or if the laying nests are not clean.

MILK AND MILKING

Milk

White substance secreted in the mammary glands of female animals. It is secreted as food for their young ones.

It is also processed into products such as butter, cheese and ghee.

Composition of milk

The composition of milk varies from one animal to another as shown below. It contains proteins, carbohydrates (lactose) fats, minerals and water.

Animal	Protein %	Fat %	Lactose %	Ash%	Water %	Total solids %

Human	1.3	3.8	7.0	Trace	87.3	12.6
Sheep	5.4	6.2	4.3	0.95	78.9	21.1
Goat	3.3	4.1	4.7	0.79	87.9	12.0
Cow	3.3	3.7	7.3	0.72	86.0	13.0

Factors affecting the milk composition

- i) **Age of the animal**; young animals produce milk with high butter fat content than old animals.
- ii) **Physiological Condition of the animal**; under conditions such as extreme emaciation, the butter fat content significantly drops. Pregnant animals also produce milk low in butter fat content.
- iii) **Completeness of milking**; the last milk to be drawn has the highest butter fat content. Also the milk drawn from animal in the evening has higher butterfat content as compared to that obtained in the morning.
- iv) **Stage of lactation and pregnancy**; butterfat content, proteins and minerals in milk are usually higher at the middle of the lactation period and drop towards late gestation.
- v) **Type of food eaten by the animal**; animals eating a lot of roughages produce milk rich in fats, proteins and lactose than animals which is fed on a lot of grains. This is because roughages produce a lot of acetic acid (*a volatile fatty acid which is used as a source of energy in the mammary glands to synthesize milk*).
- vi) **Breed differences**; different breeds produce milk with different percentage composition as shown below.

<i>Animal breed</i>	<i>Protein %</i>	<i>Lactose %</i>	<i>Fat %</i>	<i>Cal/kg</i>	<i>Solids Not Fat (SNF) %</i>	<i>Ash/minerals %</i>
Jersey	4.0	4.8	5.2	880	9.3	0.75

Ayrshire	3.4	4.8	3.9	748	8.6	0.75
Friesian	3.2	4.7	3.8	704	8.5	0.70
Guernsey	3.7	4.8	4.8	745	9.0	-
East African Zebu	3.3	4.7	5.5	-	8.8	0.76

- vii) *Season of the year*; fats increase during the cold season. The **solids not fats** decrease during the hot season.
- viii) *Other factors* animals under treatment produce milk of variable composition depending on the drugs used. Animals suffering from mastitis have reduced lactose because the mastitis bacteria attack the milk sugars.

Milk Secretion and Let-down

The structure of the mammary gland

It is the organ responsible for milk production in mammalian animals.

It is composed of balloon shaped secretory cells called alveoli (alveolus).

The alveoli are surrounded by a dense network of blood capillaries. These alveoli are joined together by a capsule to form a lobule with a duct. The alveoli drain their content into the lobule. Several lobules are grouped together to form a lobe which is drained by the lactiferous duct.

Many lobes form one quarter of the udder. Several lactiferous ducts drain into the gland cistern of the quarter. The quarters of the udder are anatomically separated and drain into separate teat cisterns. Each teat has an opening called a teat orifice/canal whose opening and closing is controlled by the a sphincter muscle.

Milk secretion

Milk is made from products of digestion such as blood sugar, amino acids and fatty acids. These nutrients are carried by blood into the alveoli where they are manufactured into lactose, casein and butter. Other milk

components such as vitamins and minerals are also added to milk through filtration by the alveoli cells.

Milk synthesis or lactogenesis is controlled by the hormone prolactin. Low levels of oestrogen during late gestation period stimulate the secretion of the hormone prolactin by the pituitary gland. Prolactin activates milk secretion process in the mammary glands.

Milk secreted is stored in the hollow cavities of the alveoli and within the lactiferous ducts. Some milk however drains into the gland cistern where it is stored until milking.

Milk let down

This is the flow of milk from the upper region of the udder (alveolar region) to the lower part of the udder (gland cistern and teat cistern). This process of milk let down is caused by the hormone oxytocin released by the pituitary gland. Oxytocin causes contraction of the muscle fibres surrounding the alveoli. This contraction forces milk into the gland and teat cisterns.

However some external factors also influence the milk let down process.

These are:

- i) Taking the cow into the milking shed
- ii) Sight or smell of food in the feed trough
- iii) Rattling sound of the buckets
- iv) Sight of the milkman
- v) Massaging or washing the udder with warm water
- vi) Sight of the calf for cows used to suckling calves
- vii) Suckling by the calf

NB. Milk let down lasts for about seven to eight minutes hence the person milking must be very fast in order to remove as much milk as possible.

Proper stimulation of the udder when milking is therefore very necessary throughout the milking process.

The secretion of adrenaline from the adrenal glands suppresses the effects of oxytocin. Adrenaline inhibits the supply of blood to the alveolar region causing relaxation of the muscles fibres thus there is no milk let down.

Other factors that may contribute to inhibition of milk let down include;

- i) Excitement or frightening of the cow.
- ii) Hunger
- iii) Change of milkman
- iv) Change of the milking schedule
- v) Effects of the oestrus
- vi) Feeling of pain
- vii) Strange surroundings

Before milking the alveolar cells are turgid but after milking they appear long and thin.

Clean milk production

Characteristics of clean and high quality milk

- i. Free from disease causing organisms
- ii. Has no hair, dirt or dust
- iii. Has high keeping quality
- iv. Has a good flavour
- v. Its chemical composition is within the expected standards

Essentials of clean milk production

- *Avoid flavours in milk-* bad flavours in milk are caused by feedstuffs and oxidation. Silage and feedstuffs such as Mexican marigold, onions and other fruit wastes can cause bad flavours in milk. Such feedstuffs should be given to the animals after and not before or during milking. Oxidation of milk fats occurs when milk has been exposed to the sun for a long time or if put in containers with traces of copper or iron giving it a bad flavour. Milk should therefore be protected from sunlight and should be stored in containers which are free from traces of copper or iron.
- *Healthy milking herd.* Cows should be tested regularly for milk borne diseases such as tuberculosis and brucellosis. A strip cup should always be used to check for mastitis.
- *Clean milking cows.* The flanks, underline and the whole udder should be washed and dried thoroughly before each milking. Two towels should be used. One for cleaning the udder and the other

one for drying. Any long hair on the udder and flanks should be clipped.

- *Healthy and clean milkman.* Any milkman suffering from contagious diseases should not handle milk or do the milking. The milkman should keep his finger nails short and should have his hair covered. He should preferably wear an overall when milking.
- *Clean milking shed.* The milking parlour should be kept clean. It should have a good drainage and easy to clean. It should be cleaned after every milking.
- *Clean milking utensils.* The milking utensils and equipment should be seamless and smooth to facilitate thorough cleaning. They should be washed with hot water and detergent. Keeping them in the sun during the day sterilises them.
- *Milk filtration cooling and storage.* Milk should be filtered and cooled to 5°C after milking. Cooling slows down bacteria multiplication hence improved keeping quality. The milk should then be stored in a cool, dry and dust free room or delivered immediately to the market.

Milking materials and equipment

- *Udder clothes/towels.* Two towels should be provided for each cow, one for washing and the other for drying. If the animals are many the towels are dipped in hot water or disinfected before they are used on another animal.
 - *Filtering pads.* They are used for straining milk.
 - *Milking jelly.* It is smeared on the teats after milking to prevent cracking. It should not be applied before or during milking.
 - *Warm water.* For washing the udder before milking. It also stimulates the milk let down process.
 - *Milking pails/bucket.* Should be made of materials that are free of copper and iron traces.
- Strip cup.* For detecting mastitis.

- *Milk cans/churns.* Used to hold milk during storage and transportation. Should also be made of materials that are free of copper or iron on their surfaces.
- *Other equipment.* Cooling apparatus, milking stool and weighing scale.

The milking procedure

Milking can be done either by hand or machine depending on the scale of farming. The following are the stages in milking.

- *Pre-milking procedure.* Milking materials and equipment are made available and within reach of the milkman. The cow is restrained in the milking parlour and given food. The udder is washed, dried and mastitis is checked.
- *Milking technique.* The proper method or technique should be used to extract as much milk as possible.
- *Procedure of proper milking.* In hand milking the teat is grasped tightly at its base between the thumb and the forefinger and the other three fingers are closed in tightly applying the pressure from the top to the bottom forcing the milk to drain out.

When the force is applied rhythmically, on the teat muscles, the orifice opens and milk is released. The base of the teat is held firmly to prevent the backflow of milk into the gland cistern.

Teats should not be stripped or pulled with fingers.

The following rules should be observed.

1. *Milk quickly and evenly.* The effect of oxytocin lasts for 5-8 minutes hence milking should be quick and efficient.
2. *Milk at regular times.* Cows are usually milked twice a day at approximately 12 hours interval. Milking should be done the same time in the morning and evenings. High yielding cows may be milked thrice per day.
3. *Avoid use of wet hands.* The milkman should dry his hands after cleaning the udder.

4. *Complete milking*. All the milk should be removed during milking. Incomplete removal of milk leading to the cow drying off too soon and total milk yield per lactation is reduced.
- Post milking practices
These include weighing, recording, straining, cooling and storing it, cleaning the utensils and washing the milking parlour.

Dry Cow Therapy

This is the administration of antibiotics to an in-calf cow in its late gestation period to control mastitis during the drying off period. The antibiotic (penicillin) is infused into the udder through the teat canal using a syringe.

MILK PRODUCTS

They include the following;

1. ***Homogenized and pasteurized milk***. Homogenization is the process by which the fat globules in milk are broken down into smaller particles and are distributed evenly in the milk. Pasteurization involves heating the milk and then cooling it suddenly. This destroys most of the harmful bacteria in the milk. Homogenized and pasteurized milk is prepared and packed by KCC, Brookside, Tuzo, Delamere Dairies and Egerton Dairies etc. this milk is marketed as whole milk.
2. ***Ultra Heat Treated (UHT) Milk***. This is milk which has been treated at a temperature between 130 and 135⁰C for one second and then immediately packed and cooled. This milk has a long shelf life without refrigeration. It is marketed as whole milk.
3. ***Cream***. This is the layer of fat on the surface of the milk. It is separated from the raw milk either mechanically by use of machine separator or by hands. The machine separator spins the milk rapidly so that the centrifugal force that is created separates the fat globules from the rest of the milk.
4. ***Skim milk***. This is milk without cream. It is used in the manufacture of fat free milk powder.

5. **Butter.** Butter is milk fat lacking non-fat solids and is obtained by churning cream in a churn. Butter contains 80% fat, 16-20% water and 1-1.5% non fat solids.
6. **Ghee.** It's prepared by either heating cream or butter in order to remove moisture and non fat solids. Ghee contains 100% fat and is mainly used for cooking.
7. **Curd.** It is prepared by leaving whole or skim milk unprotected to coagulate as a result of bacteria in the environment.
8. **Cheese.** Cheese is consolidated curd. It obtained by compressing milk curd until the moisture is drained out. Cheese has an elastic texture. Acids, enzymes and salts are added to it.
9. **Powdered milk.** This is milk prepared by drying the whole milk or skimmed milk and converting it into powder.
10. **Yoghurt.** This is thickened flavoured milk. It is slightly acidic. The thickening is done by adding certain bacteria and food flavours to the milk. Other milk products include ice-cream and condensed milk.

Marketing of Milk

Milk in Kenya is mainly carried out through cooperative societies e.g. KCC, Tuzo, Brookside etc.

The sale of milk in Kenya is regulated by the Kenya Dairy Board. Pricing is based on the quantity processed.

Farmers also sell their fresh milk directly to consumers and other middlemen.

Problems facing Dairy Farmers in Marketing Milk

1. Milk is highly perishable and so needs cold storage facilities which most farmers cannot afford.
2. Transportation problems. Certain milk producing areas are in accessible due to poor road network. This may delay milk delivery hence milk spoilage.
3. Special containers are required for handling of milk some of which are expensive.

4. Lack of market information on milk price and other existing marketing opportunities.
5. Price fluctuations
6. Delayed payments to farmers

Marketing of Beef Cattle

In Kenya there are three channels through which Kenyan beef farmers can market their products.

a) Kenya Meat Commission (KMC)

This is a statutory body mandated by the parliament to buy animals from the farmers, process and sell the meat products. The slaughter houses for KMC are located in Athi River, Ngong and Mombasa.

b) Livestock Marketing Division. (LMD)

This is a division in the Ministry of Livestock Development that is involved with the marketing of livestock especially those from arid and semi arid areas. The livestock division has built holding yards for the farmers to bring their animals for auction.

c) Local Slaughter Houses

These are specially constructed houses with all the slaughter facilities. Butchers buy animals either directly from farmers or from Livestock Marketing Division and take them to the slaughter houses for slaughter after which they sell meat to consumers through their butcheries. Price of meat is majorly dependent on market situations.

PRODUCTION ECONOMICS

The country's income can be expressed through the following ways.

- Gross Domestic Product
- Gross National Income
- Per Capita Income

Gross Domestic Product (GNP)

- This is the sum total of all the goods and the services produced by the residents of a country within a period of one year.
- The residents are either citizens or foreigners who have invested in that country.
- The foreigners however remit their income to their home countries hence there is income *outflow*.

Gross National Income. (GNI)

- This is the sum total of all goods and services (*in monetary terms*) produced by the nationals of a given country within a year regardless of their country of operation.
- The nationals of a given country may invest or seek employment in foreign countries. These nationals remit their interests, profits and income to their home countries.
- There is therefore income *inflow* to their country.
- The difference between income inflow and income outflow added to the GDP gives the GNI

$$(\text{Income inflow} - \text{income outflow}) + \text{GDP} = \text{GNI}$$

Per Capita Income

- This is the average per head in a country. It is obtained by dividing the gross national income of a country by the country's total population.

$$\text{Per Capita Income} = \frac{\text{GNI}}{\text{Total population}}$$

Per capita income is not a good measure of the economic well being of the people in a country due to the uneven distribution of the income.

Contribution of Agriculture to National Development

- Food supply
- Source of income and capital
- Source of raw materials to industries
- Market for industrial goods
- Creation of employment
- Source of revenue to government
- Foreign exchange earner.

Factors of Production

1. Land

Solid part of the earth where capital can be placed. Land is scarce and is valued depending on the following

- *The ability to produce crops and livestock.* This is based on land productivity and not size. Land productivity is determined by the soil fertility and climatic conditions of an area. Land productivity can be improved by fertilizer application, irrigation, proper tillage, soil and water conservation etc.
- *The space for construction of the farm buildings, agro-industries, urban centres and infrastructure.* All these structures are important in agricultural production.

Farmers can acquire land through the following methods.

- Inheritance
- Buying
- Leasing from landlords
- Allocation by the government through settlement schemes.

2. Labour.

- This refers to the human physical and mental services employed in the production process.
- Labour is considered on the basis of the output of an individual and not on the number of people employed.
- The work output of labour is expressed in terms of the amount of the work done within a specified period e.g. man hours or man days.

Types of labour

Family labour

It consists of the farmer and members of his family. The tasks are assigned according to the age and ability of the family members.

Hired labour.

Its labour employed outside the family. It can be permanent or casual.

Casual labour is normally engaged at labour peaks e.g. during harvesting, planting weeding etc.

Permanent labour is normally hired on monthly basis.

How to Improve labour Productivity

- *Training.* Done formally through schools and colleges or informally through field days, agricultural shows, demonstration farms, workshops etc.
- *Farm mechanization.* Mechanization makes farm operations to be faster and efficient.
- *Giving incentives and improving the terms and conditions of service.* They include provision of housing, medical facilities, rewarding good workers and better remuneration. All these motivate labour to work hard and efficiently.
- *Labour supervision.* This improves efficiency and productivity of labour.
- *Assigning tasks based on abilities and promoting specialization.* This helps workers to know clearly their duties and responsibilities making them more efficient and accountable.

3. Capital

These are the assets that are essential in the production process. In agricultural production, capital includes tools and equipment, farm inputs, farm machines and money. Without capital all other factors of production will be of no importance.

Types of Capital

- *Liquid capital.* This is money and can be easily converted into other forms of capital
- *Working capital.* These are raw materials used for production. They are normally consumed completely in the production process e.g. Fertilizers, pesticides, fuel, feedstuffs etc.
- *Fixed or durable capital.* These are assets employed in the production process but are not used up completely in the process. Fixed assets only depreciate in value due to wear and tear and age. They include farm buildings, farm machinery, permanent crops etc.

Sources of Capital

- *Credit facilities.* Credit may be obtained from commercial banks, cooperatives, statutory boards eg. AFC, private organisations etc.
- *Self savings*
- *Free grants*
- *Inheritance*

NB/ the higher the quality of the capital, the more the production. E.g. 10kg of hybrid seeds produce more yield than 10kg of ordinary seeds.

4. Management.

It's the process of planning and decision making in the organization of the other factors of production to minimize costs and maximize profit/output.

Functions of a manager

- Short term planning
- Long term planning
- Information gathering
- Keeping farm records
- Implementing farm management decisions
- Finding ways of overcoming constraints
- Determining the production efficiency of his enterprise.

Managerial Guideline Questions

- *What to produce.* This is determined by factors such as market demands, cultural values of the people, ecological factors and government policy.
- *How much to produce.* Determined by factors such as land, capital, labour force etc.
- *How to produce.* Determined by available techniques of production acquired through training and experience.
- *When to produce.* Determined by the season when the crops or livestock perform well or when the market is available.
- *For whom to produce.* Determined by the demand and the price of the product.

Qualities of a Good Farm Manager

1. Flexible in his decisions to adjust to the dynamic economic trends.
2. Hardworking and time conscious
3. Knowledgeable about agricultural principles such as practical farming skills, marketing and accounting.
4. Responsible, dynamic, competent, ambitious and focused.

Ways of Promoting Farm Management Skills

- Training managers
- Carrying out research on farm management
- Teaching agriculture in schools and forming 4k and YFC

The production Function

This is the physical relationship between inputs and products. It shows the quantity of output that may be expected from a give combination of inputs.

Types of Inputs

- Variable inputs
- Fixed inputs.

Variable Inputs

They vary with the level of production. They include labour force, fertilizers, seeds, feeds, fuel, pesticides, livestock, drugs etc.

Characteristics of variable inputs

1. They change in quantity required with the level of production.
2. Are added to fixed inputs for production
3. Their cost value depends on the kind and quantity used.
4. Are usually allocated to specific enterprises
5. Their cost Value is used to calculate the gross margins of various farm inputs.

Fixed Inputs

These do not vary with the level of production. They include farm machinery, permanent labour etc.

Characteristics of Fixed Inputs

1. They have fixed cost i.e. are constant
2. They do not vary with the level of production.

3. Their costs are not normally allocated to specific enterprises or product.

Input Output Relationships

Example 1

A farmer has a land fixed at one hectare

Suppose the maize seed is varied from 0kg to 25kg

The maize yield will therefore vary with the respective seed rates as shown below

Land (ha)	Input (kg of seed)	Output (90kg Bags)
1	0	0
1	5	10
1	10	20
1	15	35
1	20	45
1	25	60

Example 2

Suppose land and maize seed rate inputs are fixed at 1 ha and 25 kg respectively.

The nitrogen fertilizer is applied at different rates. The following relationship is realized.

Hectare	Seed rate (kg)	CAN fertiliser (kg)	Marginal input (kg)	Total Product (90 kg bags)	Marginal product (90 kg bags)
1		0	0	6	6
1	25	20	20	12	6
1	25	40	20	19	7
1	25	60	20	29	10

1	25	80	20	36	7
1	25	100	20	42	6
1	25	120	20	48	6
1	25	140	20	53	5
1	25	160	20	57	4
1	25	180	20	59	2
1	25	200	20	60	1

Plot the a line graph of CAN input against Maize output

- Land and seed rate are fixed at 1 hectare and 25 kg respectively.
- CAN fertiliser is varied at 20 kg units
- Maize yield increases as shown by the total product curve
- Marginal product is the additional return realised above the previous total product as a result of the marginal input. *E.g. when 100kg of CAN fertiliser are used, the marginal product is 6 bags.*
i.e. 42-36 = 6
- Marginal inputs are additional inputs above the previous input.

Types of production functions

- Increasing returns production function
- Constant returns production function
- Decreasing returns production function

1. ***Increasing Returns Production Function***

In this type of a function, each additional unit of input results in a larger increase in output than the preceding unit of input. This is a rare production in agriculture.

It is usually experienced in the initial low levels of inputs application as in fertilizers, seedrate, and animal concentrates etc.

Example

Egg production from individual birds with varying amounts of layers mash.

Layers	Layers mash (kg/week)	Total egg production per week	Marginal product per week
--------	--------------------------	-------------------------------------	------------------------------

100	0	140	0
100	10	155	15
100	20	180	25
100	30	240	60
100	40	340	100
100	50	470	130

Draw a graph of amount of layers mash (input) against total egg production (output)

2. Constant Returns Production Function

In this case, the output increases at the same rate for each additional unit of input. The returns are constant to the input factor.

This function is very rare in agriculture due to presence of other factors that influence agriculture such as climate, human factors, pests and diseases.

It is only common in industries.

E.g. Production of loaves

Labour (man days)	Wheat flour (kg)	Total number of loaves	Marginal product
5	10	25	0
5	20	50	25
5	30	75	25
5	40	100	25
5	50	125	25
5	60	150	25

Draw a graph of input against output.

- *The PF curve is a straight line*
- *The slope of the curve remains the same*
- *The marginal product is constant at 25*

3. *Decreasing Returns Production Function*

Each additional unit of input results into a smaller increase in output than the preceding unit of input.

It is the commonest type of production function in agriculture.

It is common in areas like feeding livestock in order to increase their output, fertilizer application in crop production, feeding layers for egg production etc.

Example

Maize production in 90kg bags from varying amounts of NPK fertilizer application

Land (1ha)	NPK fertilizer input (kg)	Total maize production (in 90 kg bags)	Marginal production (in 90kg bags)
1	0	5	5
1	30	12	7
1	60	28	16
1	90	47	19
1	120	59	12
1	150	65	6
1	180	68	3
1	210	70	2
1	240	70	0
1	270	68	-2

Draw a graph of input against output

NB/

- Initially each additional unit of inputs leads to a larger increase in output than the preceding one. (i.e.0-90 kg of NPK)
- Thereafter, the increase is at a decreasing rate i.e. between 90-210kg of NPK input. At this point the law of diminishing returns starts to operate.

- Any further application of the NPK fertilizer results in a decline in output.

Economic Laws and Principles

They include:

- The law of diminishing returns
- The principle of substitution
- The principal of equi-marginal returns
- The principle of profit maximization

1. The Law of Diminishing Returns

It states that *if successive units of one input are added to fixed quantities of other inputs, a point is eventually reached when the additional (marginal) and average product (output) per additional unit of input will decline.*

Land (1 ha)	Variable input (NPK in kg)	Total product (maize in 90 kg bags)	Marginal product (90 kg bags)	Average product (90 kg bags)
1	30	10	0	10
1	60	27	17	13.5
1	90	42	15	14
1	120	56	14	14
1	150	63	7	12.6
1	180	65	3	10.8
1	210	65	0	9.3
1	240	60	-5	7.5
1	270	52	-8	5.8
1	300	42	-10	4.2

NB/ NPK fertilizer is applied in units of 30 kg each. Therefore the average product is obtained by dividing the total product by the units of fertilizer used.

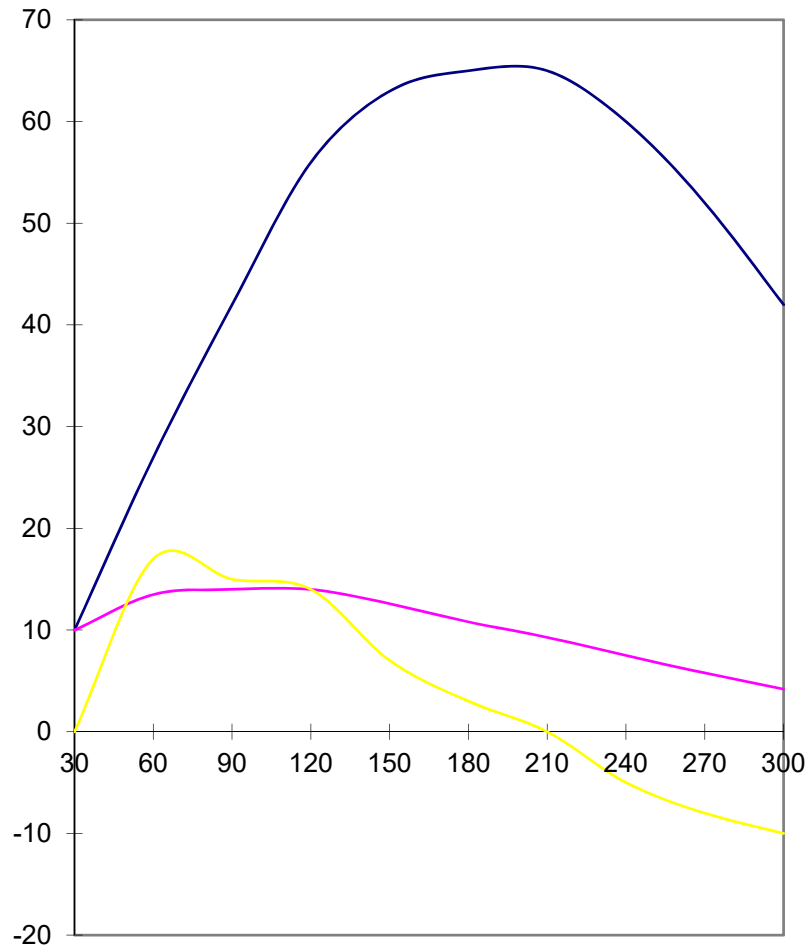
Plot graphs of total product marginal product and average product on the same axis

Zones of a Production Function Curve

The law of diminishing returns helps the farmer to identify the most profitable point at which to produce. If perpendicular lines are drawn through the point where average product equals average product (point where the two intersect), and through the point where the marginal curve intersects the horizontal axis ($MP=0$), the graph is divided into three zones.

Zone I

- In this zone the producer under utilizes the land resource and NPK fertilizer.
- Total product increases at an increasing rate until MP reaches the peak.
- It is not ideal for the farmer to limit production in this zone as the resources can still yield more.
- The zone is referred to as an irrational zone of production



Zone II

- The producer uses the resources to the maximum
- Total product increase at a decreasing rate
- Zone starts where MP starts to decline and ends where MP = 0. At this point the AP is at its maximum.
- Therefore AP reaches its maximum when it is equal to the MP
- It is economical to produce in this zone.
- The zone is referred to as rational zone of production.

Zone III

- More application of NPK fertilizer results in the total product declining.
- Marginal product becomes negative
- It's uneconomical to operate in this zone.

- The zone is called irrational zone of production.

2. The Principle of Substitution

- The principle of substitution state that, *if the output is constant, it's profitable to substitute one input factor for another as long it is cheaper than the one being substituted.*
- E.g. Milk production can be maintained constant by substituting dairy meal (less expensive) for dairy cube which are more expensive.
- This principle is based on the concepts of input-input relationships and the product – product relationship
- These concepts enable the producer to substitute a less profitable enterprise with one which is more profitable.

Input-input Relationship

This is the way inputs are combined in production to maximize profit.

Inputs may be combined as follows

1. *Fixed proportions.* In this method of combination there is no substitution. Both inputs must be present in the same proportions.
2. *Constant rate of substitution.* Input factors substitute one another at a constant rate for each level of output regardless of the ratio of the two factors used. This is called perfect substitution. E.g. maize and sorghum as livestock feeds.
3. *Varying rate of substitution.* The factors substitute each other at varying rates. It is the commonest form of substitution in agriculture e.g.
 - i. Hay and grain in feeding livestock
 - ii. Poultry manure and nitrogenous fertilizers
 - iii. Homemade feed rations against commercial livestock feeds.

Product- product Relationship

This is the combination of enterprises with the aim of maximizing the revenue. The following are examples of product – product relationships.

A) Joint Products

This is a situation where a farmer ends up getting other products in the process of producing another product. For example;

- Wool and mutton
- Cotton lint and cotton seed
- Beef and hides
- Mutton and skin
- Milk and butter
- Honey and wax

B) Competitive products

In this case when the production of one product is increased, the production of another is reduced. This occurs where the available resources are limited. e.g.

- Wheat and maize – if wheat acreage is increased, the maize acreage is reduced.
- Dairy and beef cattle – if the number of beef cattle is increased that of the dairy animals is considerably reduced.

C) Supplementary products

This is a situation whereby one product may be increased without decreasing the other. It occurs where the available resources are not fully utilized.

Examples

- Introducing a poultry enterprise to supplement other enterprises
- Growing an intercrop between the rows of main crop such as beans in maize plantation

D) Complementary products

This is where an increase in the production of one product increases the production of another simultaneously. E.g. a farmer can introduce a pig enterprise which will be maintained by by-products of grain.

3. The Principle of Equi-marginal Returns

It states, the limited resources should be allocated in such a way that the marginal return to those resources is the same in all the alternative uses to which they are put.

This principle is used along with the principle of opportunity cost in the process of maximizing profits.

4. The Principle of Profit Maximization

This is based on the concepts of cost and revenue.

i) The concept of cost

Cost is the price paid for goods used and services rendered in a production process.

The cost of production is quantity input factor used multiplied by the price of each unit of input factor.

$$\text{Production cost} = Q_x \times P_x$$

Where Q = Quantity

P= Price

X= Input factor

The role of cost in production

1. They are used to calculate the gross margins
2. They help to establish the most profitable level of production once they are expressed in monetary terms.
3. Cost influences the quantity of a particular product being produced i.e. the costs incurred during the production period influence the quantity of the product obtained.

Types of cost

1. *Fixed cost (FC)*. These are input costs that do not vary with the level of production. They include rent, salaries of permanent labour, depreciation of farm machinery, buildings etc.
2. *Variable costs (VC)*. These vary with the level of production. They include costs of feeds, fertilizer, fuel and wages of casual labour.
3. *Total cost (TC)*. This is the sum of the FC and VC. $TC = FC + VC$
4. *Average cost (AV)*. This is the total cost divided by the number of units of inputs. $AC = TC/Y$ where Y is the number of units of input.
5. *Average Variable Cost (AVC)*. This is the total variable cost divided by the total output. $AVC = VC/Y$
6. *Average fixed cost (AFC)*. This is the total fixed cost divided by the total output. $AFC = FC/Y$
7. *Average total cost (ATC)*. This is the sum of average variable cost and average fixed costs. $ATC = AFC + AVC$

8. *Marginal cost (MC)*. This is the extra cost incurred in the production of an additional unit of output.

$$MC = \frac{\Delta VC}{\Delta Y}$$

Where Δ = change

VC= variable cost

Y= output

NB/ All the costs are defined in terms of units of output and not in terms of units of inputs.

ii) The concept of Revenue.

Revenue is the amount of money realized after the sale of the produce.

Types of Revenue

1. *Total Revenue (TR)*. This is the total physical product multiplied by the unit price of the product.

$R = Q_y \times P_y$ where Q = quantity, P = price and y = output factor.

A farmer harvested 1000 90kg bags of wheat, if the price of a 90kg bag of wheat is Ksh 1500,

Calculate his total revenue.

2. *Net Revenue (NR)*. This is the difference between total revenue and the total costs of production. This is the profit. $NR = TR - TC$.

3. *Marginal Revenue (MR)*. This is the extra income obtained from the sale of the additional unit of output.

Concept of Profit Maximization

Where the maximum revenue is obtained, then the profit is maximum at that point. In production the maximum profit is obtained where marginal revenue (MR) is equal to the marginal cost (MC). At this point the net revenue is also at its maximum.

Example

In a maize production project carried out over a period of eight seasons, a farmer used one hectare of land each time and applied various quantities of DSP fertilizer as shown in the table below

DSP fertilizer cost 280/- per 50kg bag.

A 90kg bag of maize was selling at 200/-

DSP fertiliser (in 50 kg bags)	Maize yield (in 90kg bag)	Total revenue (Ksh)	Total cost (Ksh)	Marginal revenue (Ksh)	Marginal cost (Ksh)	Net revenue (Ksh)
0	15.5	3,100	0	0	0	3,100
1	35.6	7,120	280	4,020	280	6,840
2	52.7	10,540	560	3,420	280	9,980
3	68.5	13,700	840	3,160	280	12,860
4	70.0	14,000	1,120	300	280	12,880
5	70.5	14,100	1,400	100	280	12,700
6	70.5	14,100	1,680	0	280	12,420
7	68.5	13,700	1,960	-400	280	11,740

. From the table it is evident that,

- As more units of fertilizer are applied, the net revenue increases to reach the maximum of Ksh. 12,880 at 4 bags of fertilizer.
- At the level of 4 bags of fertilizer per hectare, the marginal revenue is almost equal to the marginal cost. This is the point of maximum profit.

Farm planning

This involves setting objectives or goals and clearly stating and defining how to achieve them on the farm.

The farm manager has to devise a working programme that uses the limited resources in the most prudent way in order to maximize profit.

Factors to consider in Drawing a Farm Plan

1. *Size of the farm.* A large farm can hold many enterprises while on a small piece of land only few enterprises can be accommodated.

2. *Environmental factors.* The climate, soil type and topography should be considered when making a farm plan. These determine the specific enterprise to be established on the farm. Topography determines where various enterprises should be located depending on the required drainage.
3. *The current trends in the labour market.* This determines the availability of labour. The cost and requirement of the labour should be put into consideration.
4. *Farmer's objectives and preferences.* The interests of the farmer should be put into consideration. A farmer may decide on what enterprises to keep.
5. *Possible production enterprises.* Enterprises to be established are determined by environmental factors, size of the farm, market and price trends in the market.
6. *Existing market conditions and price trends.* If there are no markets for a particular commodity, the farmer's will not produce it. Most farmers try to time their crops to mature when the prices are high.
7. *Availability and cost of farm inputs.* Farmers prefer enterprises which are easily affordable and whose inputs are readily available.
8. *Government regulations and policy.* There are certain government regulations which control the establishment of some enterprises. It is also prohibited to cultivate near the river banks.
9. *Security.* Certain enterprises must be established near the homestead for security reasons.
10. *Communication and transport facilities.* Some enterprises require good communication network.

Steps in Making a Farm Plan

1. Determining the farm size by surveying and calculating out the acreage.
2. Determining the environmental situation, i.e. Climate, soils and vegetation. This is done to ascertain the possible enterprise on that farm.
3. Determining the farmer's objectives and preferences in order to eliminate undesired production possibilities.

4. Developing a provisional/tentative schedule by listing the selected enterprises and analyzing the types and costs of physical resources required. One enterprise or a combination of enterprises should be selected.
 5. Determining the technical feasibility (*practical/able to be done*) of the farm to make it realistic taking into consideration other influences such as government policy.
 6. Determining the expected yields and returns of various enterprises.
 7. Determining the budget by translating the physical plan into monetary value.
 8. Developing a financial flow in order to ensure that it is consistent, workable and desirable.
 9. Implementing it.
 10. Observe and evaluate the plan in the course of implementation.
- NB/. After planning is completed, all the factors of production are organized in such a way that the expected results are achieved.

Farm Budgeting

A farm budget is an estimate of the future expenses and income of a proposed farm plan.

Budgeting is the process of estimating the results of a proposed farm plan. It is the translation of a physical plan into financial terms.

Importance of Budgeting

1. Enables the farmer to predict future returns hence helping him to plan ahead.
2. Helps the farmer in decision making whereby a good budget helps the farmer to avoid over expenditure and impulse buying.
3. Helps the farmer to avoid incurring losses by investing in less profitable enterprises.
4. It ensures periodic analysis of the farm business.
5. Acts as a record and can be used for future reference.
6. It enables the farmers to secure loans from financial institutions such as A.F.C. and commercial banks.
7. It highlights efficiency or weakness in the farm business.

Types of Farm Budgets

- Partial Budget
- Complete Budget

1. Partial Budget

It is the simplest and shows the financial implications of proposed minor changes in the farm. For example, change in the size of dairy herd, change of size of land under a crop and change of production technique.

A partial budget tries to address the following questions.

- What would happen if a farmer expanded an enterprise
- What would happen if a farmer replaced one enterprise with another
- What would happen if a new technique is introduced on the farm such as changing from hand milking to dairy milking or rotational grazing to zero grazing?

In partial budgeting one asks four guiding questions.

1. What extra cost is the farmer going to incur as a result of the proposed change.
2. What revenue is to be foregone as a result of the proposed change?
3. What extra revenue is to be earned from the proposed change?
4. What costs are to be saved if the change is effected?

After getting the answers to these questions, the farmer is able to establish whether the proposed change will result in a gain or a loss.

If the farmer is to gain the change is worthwhile but if he is to lose, the proposed change is discarded and other options are sought.

Example

Mr/Mrs X has 4 hectares of arable land,

- 1.5 ha is under wheat
- 0.5ha under maize
- 0.3ha under fodder crop
- The rest is either under improved grass ley or natural grass

The farmer wishes to know whether replacing 0.3 ha of maize with Irish potatoes the following season will be worthwhile.

- The fertilizer rate would have to be increased from 2 bags per ha for maize to 2.5 bags per ha for potatoes and an extra 40 man days of casual labour per ha.
- Average yields of maize and potatoes are 56 and 90 bags respectively.
- The prices are Ksh 1200 per a bag of maize and Ksh 300 per bag of potatoes.
- Seeds costs are Ksh 1350 per 10kg of maize seeds and Ksh 200 per 50 kg of potato seeds.
- D.A.P. fertilizer cost Ksh 1400 per 50 kg bag.
- Labour is paid at Ksh 150 per man day.
- He would require 10 bags of potato seeds and 1 bag of maize seeds to cover 0.3 of a hectare.

Draw up the partial budget and indicate whether the proposed change is worthwhile.

Partial Budget for Mr/Mrs X's Farm

Debit (-)	Ksh	cts	Credit (+)	Ksh	Cts
1. Extra costs on Potatoes			1. Extra revenue on Potatoes		
i) Fertilizer $2\frac{1}{2} \times 0.3 \times 1400/=$	1,050	=	Yield $90 \times 0.3 \times 300/=$	8,100	=
ii) Labour $40 \times 0.3 \times 150/-$	1,800	=			
iii) Seed 200×10	2,000	=			
SUB-TOTAL	4,850	=	SUB-TOTAL	8,100	=
2. Revenue foregone			2. Costs saved Maize		

Maize yield	13,440	=	i) Seeds	1,350	=
56 X 0.3 X 1200			1 X 1350		
	18,290	=	ii) Fertiliser	850	=
			2 X 0.3 X	10290	=
			1,400		
TOTAL			TOTAL		

Therefore (extra revenue + costs saved) – (extra cost + revenue foregone) is
 $10,290 - 18,290 = -8,000/=$

-8,000 indicate a loss and therefore the proposed change is not worthwhile.

2. Complete Budget

When proposed changes in the farm are major, or a new farm is being planned for, a complete budget is mandatory. Unlike the partial budget which only deals with variable inputs, a complete budget considers both variable and fixed costs.

Guidelines to follow when carrying out complete Budgeting

1. *Formulation of the farming goals.* The farmer states the reasons for setting up the farm business.
2. *Taking the farm inventory.* Farm buildings, breeding stock, human labour, sources of power machinery and farm equipment are some of the things to include in the inventory i.e. all the assets in the farm.
3. *Planning for resources.* This shows how the resources such as the land, labour and capital are utilized.
4. *Estimating production.* From such enterprises such as crops, animals and other activities.
5. *Estimating the income and expenditure.*

6. *analyzing the input-output relationships that exist on the farm*
7. *Analyzing existing production weaknesses in the farm.*
8. *Making a number of alternative farm plans and choosing one for adoption.*
9. *Putting the best chosen plan into operation and supervising its implementation.*

An example of complete Budget for two hectares mixed farm.

Enterprise	Acreage	Gross margins in Ksh.
i) Maize	0.5 ha	3,000
ii) Irish potatoes	0.5 ha	2,500
iii) Beans	0.5 ha	4,500
iv) Onions	0.25 ha	2,800
v) 100 laying hens	0.25 ha	15,000
		27,800

Gross margins are obtained by deducting the total variable costs from the total revenue of each enterprise.

I.e. Gross Margin = Total Revenue – Total Variable cost

Fixed costs

- Labour - one regular hired worker p.a. 4,800.00
- Depreciation of poultry house built at 28,000 over 15 years
150.00
- Cost of hand tools and equipment 1,000.00
- Total fixed cost **5,950.00**

Farm profit = Total Gross Margin – total Fixed Cost
= 27,800.00 – 5,950.00
= 21,850.00

Agricultural Support Services Available to the Farmer

1. Extension and Training.

This involves giving informal education to the farmers on production techniques. The Ministries of Agriculture and Livestock Development have extension officers who give these services to the farmers through seminars, short courses, field days, training and visits, demonstrations, chief's *barazas* etc. BAT Kenya Limited, Kenya Breweries Ltd, Church organizations and other N.G.O's also provide extension services.

2. *Artificial Insemination (A.I) Services*
3. *Veterinary services.* Veterinary officers help the farmers in treating and controlling livestock diseases and parasites.
4. *Farm input supplies.* Some cooperatives and private companies supply farm inputs to the farmers. Kenya Farmers Association is an organisation involved in such activities.
5. *Banking.* A farmer requires banking services. Farmers can open a *current account* or a *savings account* with banks.

Current Account

It's a bank account from which cheques are paid. Money in such an account does not earn interest.

A Savings Account

This account earns interest but cheques cannot be drawn on it.

Advantages of using banking services

- a) The farmer's money is safer in the bank.
- b) Cheques can be used as evidence of payment in case of a dispute.
- c) Writing a cheque is easier than counting huge sums of money.
- d) Farmers with bank accounts can get overdrafts where current account holders are allowed to withdraw more money than what is in the account or loans.
- e) The bank gives advice to farmers on how to use the credit given for maximum results.
- f) A banker's statement acts as an evidence of a farmer's financial worthiness when he wants to acquire or lease some property.

6. *Credit.*

Since capital is a limited resource, farmers can overcome this limitation by borrowing capital. Borrowed capital is called credit or loan. The

farmers pay it back with an interest. The loan is given against such collateral as land title deed, buildings and machinery.

Types of Credit

- Short term Credit. Given as working capital such as seeds, fertilizer and feeds. It's repayable within one year. AFC gives farmers short term credit.
- Medium term Credit. Repayable within 5 years and is used for farm development projects such as fencing, buying machinery, soil and water conservation and buying livestock.
- Long term credit. Repayable within a period of 15 years. It's used for improvement of projects such as soil conservation, building and construction, establishing permanent crops etc.

Credit can be termed as *soft or hard*. Hard loan is given against security such as machinery and land while soft is given with little or no security.

Sources of Agricultural credit

- *Cooperative societies*. They give credit to farmers. Their interest rate is lower than that of commercial banks.
- *Crop boards*. Some crop boards give credit to farmers and recover their money through deduction made on farmers pay out. E.g. Pyrethrum Board of Kenya and the National Irrigation Board.
- *Commercial banks*. They advance short term to medium term loans to farmers which are paid back with an interest that is slightly higher.
- *Agricultural Finance Corporation*. They give short term to long term credit to farmers. Their interest rates are low.
- *Settlement Fund Trustees*. They lend short term to long term credit to new settlers in settlement schemes.
- *Others*. Hire purchase companies, individuals, insurance companies and traders.

7. Agricultural Research.

- The main objectives of agricultural research are;
 - i) Improve crop and livestock production techniques.

- ii) Develop improved varieties of crops and livestock.
- iii) Improve pastures and fodder quality.
- iv) Develop techniques of controlling diseases and parasites.
- v) Determine suitable ecological zones for various crops.
- vi) Coordinate research work being done throughout the country to avoid any duplication.
- Examples of agricultural research stations in Kenya.
 - i) Coffee Research Station in Ruiru. - *Coffee*
 - ii) Kenya Agricultural Research Institute (KARI) at Muguga - *Agronomy, plant pathology, entomology, forestry etc.*
 - iii) Kenya Agricultural Research Institute (KARI) at Kitale. – *Maize and pasture crops.*
 - iv) National Plant Breeding Station at Njoro. – *Wheat, barley, sunflower etc.*
 - v) Pyrethrum Research Station at Molo. – *pyrethrum*
 - vi) Horticultural Research Station at Thika. – *fruits, cut flowers, pulses etc*
 - vii) National Sugar Research Station at Kibos.
 - viii) Tea Research Foundation at Kericho.
 - ix) Dryland farming Research Station at Katumani in Machakos. – *plant breeding pest management, animal nutrition.*
 - x) National Agricultural Laboratories at Kabete – *entomology and soil testing.*
 - xi) Sunflower Research Station at Wanguru near Embu.
 - xii) International Centre for Insect Physiology and Ecology (ICIPE) at Nairobi and Mbita.
 - xiii) Western Agricultural Research Station in Kakamega which deals *with research of on sweet potatoes, cassava and small ruminants.*
 - xiv) National Animal Husbandry Research station at Naivasha. - *Livestock breeding and management*
 - xv) Veterinary Research Station at kabete.
 - xvi) Coast Agricultural Research Station at Mtwapa which conducts *research on maize and sugarcane.*
 - xvii) Cotton Research Station at Kibos Kisumu.

xviii) Embu Research Station. – *Medium altitude maize varieties.*

xix) International livestock Research Institute (ILRI) in Nairobi.

8. Marketing.

- The following are some organizations that market farmers produce.

i) National Cereal and Produce Board.(NCPB) – *maize, wheat and pulses e.g groundnuts, beans, green grams etc.*

ii) Kenya Cooperative Creameries.(KCC) – *milk*

iii) Kenya Planters Cooperative Union (KPCU) - *Coffee*

iv) Pyrethrum Board of Kenya. – *pyrethrum*

9. Tractor Hire Service.

This involves hiring of tractors and implements by farmers who don't have them. The following offer these services.

1. *Government Tractor Hire Service.* This is under the Ministry of Agriculture. Farmers hire implements and tractor if they do not have them. These services are available in almost all districts. The service is relatively cheap but farmers rarely get the services when they need them because of high demand.
2. *Private Contractors.* These are either individual contractors or companies who offer these services to farmers. They move from one part of the country to another in search of farmers who would need their services. For example in December to March, there are many contractors in Rift Valley. In August and September, they move to short rain areas. These contractors however charge more than the government but they are more readily available.
3. *Individual Farmers.* Some farmers have tractors for their own personal use. When they have finished ploughing their own land, they let them out for hire. Their charges are negotiable.
4. *Others.* Some cooperative societies own tractors, which they let out for hire to their members. Cooperatives are cheaper than other hire services.

Advantages of Tractor Hire Services.

- Farmers who can't afford to buy a tractor can get access to tractor services.

- Farmers don't incur the costs of servicing and maintenance of the tractor and implements.
- The services are more efficient than hand tools, which is the other alternative.

Disadvantages of Tractor Hire Services.

- They are not available to most farmers when they need it.
- Private contractors and individual farmers may overcharge farmers.

Risks and Uncertainties in Framing

Uncertainty. It is the imperfect knowledge about future events or outcome due to the uncontrollable variables such as weather changes, pest and disease outbreaks and fluctuations in commodity prices.

Risk. This is the divergence between the expected and actual outcome.

There is always a difference between what a farmer would predict and the actual outcome.

Types of risks and Uncertainties

- i.) *Fluctuation in commodity prices.*
- ii.) *Physical yield uncertainty.* The farmer is unsure of what to actually expect.
- iii.) *Ownership uncertainty.* Farmer may lose the produce through theft, change in government policy, fire, death etc.
- iv.) *Disease and pest outbreaks.*
- v.) *Sickness and injury uncertainty.* The farmer or member of his family or employee is affected and loses the ability to work due to sickness or injury.
- vi.) *New production technique uncertainty.* The farmer may be uncertain whether new technique is as effective as the previous one.
- vii.) *Obsolescence.* A farmer may invest in machinery, which may become outdated (obsolete) within a short time.
- viii.) *Natural catastrophies.* Things like earthquakes, floods, drought, storms and strong winds may destroy crops and kill animals.

Ways of Adjusting To Uncertainty.

- i.) *Diversification*. This involves having several and different enterprises on the farm so that should one fail, the farmer does not suffer total loss.
- ii.) *Flexibility in production methods*. Farmers may design their enterprises in such a way that, should there be a need to change from one enterprise to another, they can do so with minimal expenses. For example livestock buildings should be designed in such a way that they can be modified to accommodate any type of animal as need arise.
- iii.) *Input rationing*. Farmers may apply fewer inputs than the optimum required for an enterprise to reduce more losses in case of any unexpected variable. Additional inputs can be used in enterprises with better chances of giving more returns.
- iv.) *Insurance*. Insuring the enterprises guarantees farmers compensation in the event of loss. This covers losses due to crop failure, death of livestock, theft, fire, and accidents in farm machinery.
- v.) *Contracting*. Farmers may enter into contracts with consumers to supply specified goods for a certain period of time at an agreed price. E.g Tobacco farmers with BAT Kenya Ltd., barley farmers with EABL. Pig farmers with Farmers Choice etc.

Advantages

This ensures a constant, fixed market for their produce.

- Should prices fall, the farmer gains as he continues to supply the produce at the contracted price.

Disadvantages

- Contract prices are usually lower than the average market prices hence farmers get lower incomes in the long run.
 - Should market prices rise, the farmer would not benefit as their price is already agreed on.
- vi.) *Selecting more certain enterprises*. A farmer should try to select an enterprise that earns a steady income though less profitable than choosing one that has a high variation income realization.

- vii.) *Adopting modern production methods.* They include, irrigation, spraying crops against pests and diseases, vaccinating animals against diseases etc.

Government role in minimizing risks and Uncertainty

- *Weather forecasting.* This helps farmers to prepare land and plant at the right time.
- *Research and extension.*
- *Subsidizing of input prices.*
- *Market regulation.* This protects the farmer from exploitation.

AGRICULTURAL MARKETING AND ORGANISATIONS

Market and Marketing

Market:

- Is an institution for exchange of goods and services.
- Is a place where buyers and sellers carry out business transactions or
- Is a group of buyers and sellers in sufficiently close contact with one another for exchange to take place between them.

Perfect market	Imperfect market
Any buyer can purchase from any seller	Some buyers or sellers or both are not aware of the prices offered by others.

Types of market structure

- i) **Monopoly;** A single seller may dominate the market but many consumers or buyers in the market.
- ii) **Oligopoly:** few sellers or firms with mutual interdependence.
- iii) **Monopsony:** one buyer and many sellers of a specific commodity.
A sole buyer exists in the market.
Sellers may lower the price below the expected fair price.

Marketing/ Marketing functions:

-Are all the activities and services which are associated with the flow of goods and services from production to consumption.
A service is a function which alters a commodity in form, place, time or possession to increase the value of a product.

Marketing Functions and Services

Describe the marketing functions of agricultural commodities. (10 mks)

a) Buying and Assembling

Buying: Is the acquisition of goods from the farmers on payment of cash.

Assembling: Collecting of produce from the farms and concentrating at stores by private traders or marketing boards.

b) Transporting and distribution: Through air, water, rail, or road by middle men.

c) Storage: storage varies with the product and the climatic environment e.g. meat is stored in cold stores, eggs under oil or water glass coatings which seal the shell to prevent deterioration. Storage makes goods available throughout the year.

d) Packing: Materials include; baskets, sacks, milking cans and churns, cardboard box, containers etc. prevents the produce against damage, theft and adulteration on its way to the market. It also facilitates measurement.

e) Processing: Changes the original forms of goods e.g. meat animals—slaughtered, dressed and chopped. Milk—pasteurized, bottled, buttered, cheesed.

f) Grading and Standardization: Grading: Sorting out of produce into different lots considering market quality, bearing label and name e.g. on size, shape, colour, ripeness flavor, length and other measurable features that affect value. Purpose: --Is to select desirable quality produce and avoid time wastage at inspection.

Standardization: Establishing uniformity in quality and quantity of products. Purpose: increase buyers' satisfaction, establish criteria for inspection, ensure safety and avoid exploitation of consumers.

g) Packaging: comes after processing.

Purposes:

- Enables handling of produce.
- Makes marketing more efficient.
- Prevent physical deterioration, theft, tampering, adulteration and substitution.
- Offer easy labeling.

- Measurement.
 - Attachment of sales description and instructions.
 - Promote sales or advertise.
- h) Collecting market information or market research:**
- Provide knowledge of supply and demand.
 - Determine where and when to sell.
 - Determine quality of commodity needed
 - Determine prices in alternative markets.
- i) Selling:** Presentation of produce to consumers. Involves advertising, displaying of the produce in the market and bargaining for fair prices. Do not overcharge or under charge.
- j) Financing:** Capital is required from buying raw produce to final sale of finished goods.
- k) Bearing of risks/uncertainties:** Include destruction by fire, theft, physical deterioration in quality, fluctuation of prices and change in tastes e.g. by transferring them to insurance companies.

Marketing Organizations and Agencies

Describe various agents and organizations that are involved in the marketing of coffee (10 mks)

These are bodies which facilitate the marketing process. Include:

- 1) **Wholesalers;** Buy goods from producers , processors or manufacturers in bulk and sell to retailers and other merchants and consumers in relatively large or small lots.
Have transport facilities. Have large storage depots. Bear marketing risks. Speculate on goods moved to the market. Arbitrage:- Buy when and where prices are low and sell when/where prices are high.
- 2) **Retailers:** Buy in bulk from wholesalers or processors and sell to consumers in small quantities.
- 3) **Itinerant traders/ middlemen:** Are middlemen who buy in small bits, assemble, transport and sell to town markets.
- 4) **Packers and Processors:** Are industries which change the form of produce e.g. Unga limited, B.A.T, Delmonte and sugar companies.
- 5) **Commission Agents:** Are middlemen who act on behalf of the other businessmen for a fee or a commission. Do not own any commodity.

- 6) **Broker Agents:** act on behalf of the sellers or do not actually handle the goods but have a good knowledge supplies of the same i.e. requirements and prices.
- 7) **Co-operative societies and unions:** Help farmers to market their produce locally and internationally e.g. k.c.c. reduce market costs for small scale farmers.
- 8) **Marketing Boards:** Assists in the production of agricultural commodities. Also store, sell, buy, and collect agricultural commodities.
- 9) **Auctioneers:** Concentrate buyers and sellers at a particular place and time where they negotiate on purchases and sales. Take a % commission on sales.

Special Characteristics of Agricultural Products

- **Bulky:** Occupy large weight and volume.
- **Perishable:** Cannot stay long without suffering loss and deterioration in quality

Problems in marketing agricultural products

Describe the problems encountered by farmers when marketing agricultural produce e.g. tomatoes (10 mks)

- a) **Perishability:** e.g. fruits, vegetables, milk, meat etc go bad very quickly.

Prevention

- Store under refrigeration.
 - Sell immediately.
 - Process into other forms.
 - Can or dehydrate e.g. fruits, vegetables. Prevention is expensive hence increase marketing costs.
- b) **Seasonality:** Products are only available in plenty at harvest periods.
 - This affects market prices and creates storage problems.
 - Supply is inelastic due to long waiting periods.
 - There is uncertainty on price expectation.
 - c) **Bulkiness:** Products weigh heavily, occupy large space and have low value per unit weight. This poses problems on storage, transportation and increases price of produce beyond buyers ability.

- d) **Storage:** Construction of storage facilities is expensive thus increasing the cost of marketing.
- e) **Poor transport system:** poor roads in rural areas and inadequate means of transport. Farmers fail to take produce to the market. Perishable products get spoiled.
- f) **Change in market demand:** The long time lag between the decision to produce and the actual availability of the product changes the consumers taste and preferences affecting demand and price.
- g) **Limited elasticity of demand/Inelastic demand:** Sometimes there is more quantity supplied which may lead to low demand and therefore low price for the produce i.e. excess supply that leads to low demand and low price.
- h) **Lack of market information:** This is due to low state of knowledge. This makes the production not to be in close conformity with market demand. Middlemen exploit them by buying produce at very low prices and sell at high profit margin.
- i) **Changes of supply /Inelastic supply:** Sometimes there is overproduction or under production of goods. This leads to fluctuation of market prices.

Efficiency in marketing/How to increase profits

- a) Minimize total costs of the whole process.
- b) Timeliness of the product assembly and delivery.
- c) Maintenance of the product quality.

Price theory

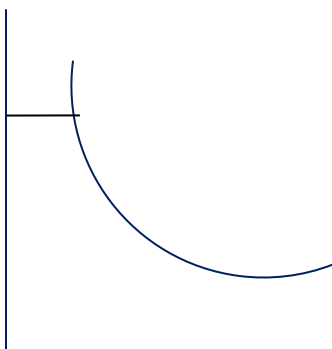
Price: Is the amount of money paid in exchange of good or service.
 -Is affected by demand, supply and the quality of good or service.

The law of demand and supply:

Demand: Quantity of goods or services consumers are willing and able to buy at each specific price in a given market at a given time.

Demand is low when the price of goods is high and vice versa.

Relationship between demand and price



Terms used in demand

- Want- Desire to have a good.
- Demand- Ability to purchase that good at a given price.
- Utility- Property of a product that makes it satisfies a want (desire).
- Effective demand: type of demand which involves payment for the required goods and is determined by one's income.
- Law of demand: The quantity of a good or service demanded varies inversely with the price, or the higher the price, the less the quantity demanded and the lower the price, the more the quantity demanded.
- Demand schedule: List of quantities a given population will buy at different prices.
- Individual demand: A list of quantities or products that a person will purchase at various prices.
- Total demand: total of individual demands of a product.
- Demand is mainly determined by price but sometimes it can change if the price is constant due to other factors.

Change of demand at a constant price.

Factors influencing demand for a commodity

- a) Population:** A change in the number of consumers in a market influences the total demand for goods and services. If population increases, the demand for a given good or service at a given price increases and vice versa.
- b) Income:** Consumers with a higher income buy more than those with low. As income rise, demand for some foods like meat, butter, rice, grape fruit etc rise.
- c) Preference and taste:** Demand changes with changes in tastes and preferences by consumers.
- d) Prices of related goods:** Demand of a commodity increases if there is an increase in the price of a substitute e.g. Margarine demand increases if the price of butter increases.

- e) **Advertisement:** Promotes the sale of a commodity thereby increasing its demand because customers become aware of the existence of the commodity.
- f) **Beliefs, customs and taboo:** Influence total demand for a given good or service e.g. pork among Muslims.
- g) **Price expectation:** If in future the prices of a certain commodity are likely to go up, then the demand of that commodity increases currently or vice versa.
- h) **Level of taxation:** Increase in taxes increases the prices of certain goods and fewer people can afford them. This reduces demand.
- i) **Perishability:** when goods like milk, eggs, meat, tomatoes and fruits deteriorate in quality, demand falls due to loss of freshness.
- j) **Future expectations or uncertainty;** Fear of shortage of a commodity in future, consumers buy more for stocking thus increasing demand.

Elasticity of demand (ED)

Ed- Is the degree of responsiveness of demand to change in price or the amount of change in the quantity of a product that the consumers will buy in response to a given change in price.

Calculation of Ed

Ed = % change in quantity demanded / % change in price

Example

The elasticity of demand when 1000 loaves of bread are demanded at a price of ksh. 20 per loaf while only 600 loaves were demanded at ksh. 23 per loaf is:

$$\begin{aligned}
 \text{Ed} &= \% \text{ change in quantity} / \text{original quantity} \times 100 \\
 &= (1000 - 600) \times 100 / 600 \\
 &= 400 \times 100 / 600 \\
 &= 66.6\%
 \end{aligned}$$

$$\begin{aligned}
 \text{Ed} &= \% \text{ change in price} / \text{original price} \times 100 \\
 &= (20 - 23) \times 100 / 23 \\
 &= -3 / 23 \times 100 \\
 &= -13.04\%
 \end{aligned}$$

$$\begin{aligned}
 \text{Ed} &= \% \text{ change in quantity} / \% \text{ change in price} \\
 &= 66.6 / -13.04 \\
 &= 5.11
 \end{aligned}$$

N.B the –ve and +ve sign of E_d is ignored.
The figure obtained gives the type of E_d e.g.

- a) Elastic if more than 1.
- b) Unitary if equal to 1.
- c) Inelastic if less than 1.

- 1. Elastic demand
- 2. Inelastic demand
- 3. Unitary elasticity

Factors that determine the elasticity of demand

- a) The availability of substitutes;** Commodities with many substitutes have an elastic demand although salt with no substitute has an inelastic demand and therefore has to be bought at any price.
- b) Degree of necessity:** Salt or food of great necessity have inelastic demand and have to be bought at any price. Luxury commodities have to be forgone in case of increase in price.
- c) The number of uses a product can be put to:** Commodities with several uses have elastic demand.
- d) Time lag:** If the use of a commodity can be postponed to another day the it has elastic demand e.g. cement for construction.
- e) Time span:** There is greater E_d in the long run because adjustments can be made while a smaller E_d in the short run since it is difficult to vary some factors.
- f) Proportion:** Commodities with large proportions of total expenditures e.g. animal feeds and fertilizers have elastic demand while those with very small proportion have inelastic demand.

Supply

Is the quantity of goods or services which producers or sellers are willing to sell at each specified price in a given market and time.

Law of supply: As the price of goods and services increase, the corresponding quantity of goods and services offered for sale increases and vice versa.

The relationship between price and supply

Change of supply at constant prices

Supply schedule: --Is a list of quantities of an item that will be produced or sold at all probable prices.

A supply schedule for meat:

Price of meat per month (ksh.)	Quantity of meat supplied in kg.
25	80
20	70
15	50
10	20
5	10

Factors influencing supply of a commodity

1. **Number of sellers in the market:** Many sellers increase the supply of goods and services.
2. **Prices of related goods:** Supply is low if the price of a related good is higher e.g. If the bread price increases its supply is higher but supply of cakes decreases.
3. **Price expectation:** supply is low now if in future the supply is expected to rise.
4. **Technology:** Lead to increase of production of goods.
5. **Weather:** Increase in production of goods when the weather is favorable.
6. **Government policy (taxation):** Increases in tax of inputs, increase price of commodities produced, thus the farmers drop the production of the produce.
7. **Change in prices:** Increase in price lead to increase in supply of the good because of the high profit earned.
8. **Cost of production:** If the cost of fertilizers and seeds is low, farmers supply more of this, in turn increase the yields.
9. **Increase in supply of associated goods:** increase the supply of the other good e.g. increase in meat supply increase in hides and skins.
10. **Transportation system:** Improved and efficient transport system, increase delivery and supply of farm produce.

Elasticity of supply (E.S)

Is the degree of responsiveness of supply to changes in price.

$ES = \frac{\% \text{ change in quantity supplied}}{\% \text{ change in price}}$

Example: If the price of millet changes from ksh. 10 to ksh. 12 per kg. Resulting to a change of supply from 400kg to 600 kg, calculate the elasticity of supply.

$$\begin{aligned}\% \text{ change in supply} &= \frac{600-400}{400} \times 100 \\ &= \frac{200}{400} \times 100 \\ &= 50\%\end{aligned}$$

$$\begin{aligned}\% \text{ change in price} &= \frac{12-10}{10} \times 100 \\ &= \frac{2}{10} \times 100 \\ &= 20\%\end{aligned}$$

$$\begin{aligned}\text{E.S} &= \frac{\% \text{ change in quantity supplied}}{\% \text{ change in price}} \\ &= \frac{50}{20} \\ &= 2.5\end{aligned}$$

Types of E.S

1. Elastic if more than 1
2. Inelastic if less than 1
3. Unitary if equal to 1

Determination of market price

When price is high P2, supply is high Q4 but demand is low Q2.

When price is too low P1, the supply is also low Q1, but the demand is high Q3.

P1 has to be raised for the suppliers to sell more goods and P2 has to lower to satisfy the demand.

The resultant price P, where quantity of goods supplied is equal to the quantity of goods demanded is known as **equilibrium or market price**.

No competition of suppliers and consumers. Both parties are satisfied. This situation only exists in a free market.

Price control:

1. Government gives subsidies by reducing the cost of production of inputs.
2. Government fixes the prices of related goods.

Agricultural Organisations

Agricultural organization is any body which promotes agricultural activities.

Include:

- 1. Co-operative societies:** Is an organization of people who have joined together voluntarily with a common purpose for a mutual economic benefit.

Types of co-operative societies

- i) Farmers or producer:** Formed by farmers with limited capital to viably stand by their own. They buy large lands and each farmer is paid dividends per his shares.
- ii) Consumer:** sell farm inputs to farmers. Buy inputs in bulk and sell at lower prices to farmers.
- iii) Marketing;** Formed by small scale farmers to market their produce collectively. This reduces costs.
- iv) Savings and credit:** Give loans to farmers.

a) Formation of co-operatives:

Steps followed:

- A minimum of 10 adults are required.
- Interested people form an interim committee.
- Name is decided.
- Members draw up a constitution.
- They work with the local co-operative officer.
- Seek for registration with the commissioner for co-operatives.

b) Principles of co-operatives:

- i) Open membership:** Joining is voluntary after paying membership fee regardless of race, religion, sex, education and political inclination so long as are adults with a sound mind.
- ii) Equal rights:** one man one vote operates.
- iii) Principle of share limit;** Members buy shares up to a specific maximum limit to avoid domination by one member.
- iv) Interest on shares:** Money accruing capital provides dividends on basis of share contribution.
- v) Withdrawal from membership:** Members withdraw voluntarily.
- vi) Loyalty:** Members are faithful and loyal to their co-operative e.g. Members must sell their produce through their co-operative.
- vii) Education:** Members are educated to be knowledgeable on relevant skills and conversant with co-operative affairs.

- viii) **Co-operative principle**; the co-operatives should join co-operative movements at primary, district, national and international levels.
- ix) **Non-profit motive**: Co-operatives are essentially non profit making organizations. This objective improves the living standards of members.

c) Functions of co-operative societies:

- Marketing or selling farmers produce.
- Negotiate for fair prices for inputs and produce.
- Keep records of co-operative activities and inform members accordingly.
- Pay dividends to members.
- Give loans/credit in kind to members.
- Educate members on relevant co-operative matters.
- Provide/distribute inputs at subsidized prices.
- Some process inputs.
- Provide extension and machinery services.
- Some provide banking services to members.
- Some invest money on behalf of farmers.
- Advice members on new and better methods of production.

2. Agricultural parastatal bodies: Are bodies established by acts of parliament.

Include: boards, commissions, authorities and corporations.

a) National irrigation board. Develop and improve irrigation projects e.g. mwea tembere, Ahero, west kano, perkerra etc.

b) National Cereals and Produce Board:

Functions

- Regulate and control production and storage of cereals and pulses.
- Buy and store cereals.
- Advice the minister on production, importation and exportation of produce.

c) The Kenya sisal board

Functions

- Promote sisal production.

- Regulate production, grading and marketing.
- Register sisal producers.
- License sisal factories.
- Examine export to ensure and maintain high quality.
- Re-bale sisal.

d) Coffee Board of Kenya.

Functions

- License coffee producers and processors.
- Carry out research on production and processing.
- Negotiate for fair prices and quotas.
- Market parchment coffee.

e) Pyrethrum Board of Kenya

Functions

- Advise farmers.
- Manage pyrethrum nurseries.
- Process pyrethrum in factories.
- Market processed products.
- Buy pyrethrum from farmers.
- Research to obtain best cultivars through selection and breeding.

f) Cotton Board of Kenya.

Functions

- Plan, monitor, regulate cotton growing and ginning.
- License and control cotton ginneries.
- Regulate and control quality of raw cotton.
- Regulate export and import of cotton lint/seed.
- Regulate and control seed supply and quality.
- Promote research, production and processing.
- Provide and co-ordinate training for industry sectors.

g) Kenya Sugar Authority.

Functions

- Advise on development of sugarcane production for manufacture of white sugar.

- Advise on rules and regulations for development of sugarcane in industries.
- Formulate and advice on sugarcane prices.
- Advice on research.
- Develop and implement cane testing services and quality.
- Advise on processing.
- Register producers.
- Ensure availability of statistics.
- Advise on utilization of sugarcane produce.

h) Horticultural Crops Development Authority.

Functions

- Offer advisory services.
- Collect produce from farmers.
- Sort and grade produce.
- Market produce locally and abroad.

i) Agricultural Finance Corporation.

Functions

- Provide credit at reasonable interest rates.
- Provide technical services to farmers e.g. on borrowed capital.
- Ensure loan repayment.

j) Agricultural Development Corporation.

Functions

- Run and operate state farms..
- Raise high quality livestock which are sold as breeding stock.
- Bulk planting materials.
- Promote agricultural production.

K. Kenya meat Commission.

Functions

- Buy cattle from beef farms.
- Slaughter beef.
- Grade carcasses.
- Market beef locally and overseas.

Other Farmers organizations

1. Kenya National farmers Union

Functions:

- Bargain for fair prices of produce.
- Ensure supply of farm inputs.
- Bargain for reasonable and affordable prices of farm inputs.
- Provide better infrastructure.
- Provide loan.
- Control pests and diseases.
- Market produce locally and abroad.
- Offer technical services.
- Represent farmers in international federation of agricultural producers.
- Publish a monthly magazine—“Farmers Voice”.

2. Agricultural Society of Kenya.

Functions:

- Hold competitive agricultural shows and exhibitions.
- Encourage breeding and importation of pure breeds.
- Encourage and assists in official milk recording scheme.
- Organize the running of YFC.
- Organize national ploughing contest.
- Publish Kenya stud book.
- Publish monthly journal—Kenya Farmer.
- Award bursaries for local and overseas studies/tours for its members.

3. 4-k clubs; kuungana, kufanya, kusaidia, Kenya.

For primary school members.

Functions

- Carry out practical projects show agriculture is a profitable profession.
- Expose youth to existing improved agricultural technologies.
- Develop and enhance leadership qualities among youth.
- Take part in competitive shows.
- Involvement in field trips.

4. Young Farmers Club

Secondary school and tertiary education members.

Functions

- Participate in exhibitions and competitions at A.S.K shows.
- Involvement in agricultural projects at club levels.
- Participate in YFC annual rallies.
- Involvement in workshops and seminars.
- Participate in national tree planting activities.
- Participate in exchange programmes both locally and abroad.
- Participate in national ploughing contest.

AGRICULTURAL ECONOMICS IV (FARM ACCOUNTS)

Importance of Keeping Farm Accounts

- **They help the farmer to:**

- i). Secure loans.
- ii). Make sound management decisions.
- iii). Determine whether the farm is making profit or loss.
- iv). Evaluate assets and liabilities.
- v). Prepare farm budgets.
- vi). Assess the tax a farmer is to be charged.

FINANCIAL DOCUMENTS

- **They include the following;**

- i). *Invoice.*
 - It is commonly used in business when goods are delivered on credit.
 - It is issued to inform the buyer of the goods delivered and debits the buyer. It contains the following details.
 - ✓ Date of the transaction.
 - ✓ Type and quantities of goods delivered.
 - ✓ Price per unit of the goods.
 - ✓ Total amount of money involved.
 - ✓ Serial number of invoice.
 - ✓ Terms of payment.
- ii). *Statements.*

There are two types of statements, these are;

- **Statements of account.** This is a document sent to the buyer by the seller as a reminder to inform him what he owes the seller. Usually it is written at the end of the month.
- **Bank statements.** This is a financial document sent by the bank to the farmer on a monthly basis showing the position of the bank account by the end of the month.

iii). *Receipt.*

- This is issued when cash payment for goods delivered or services rendered is made. It is issued by the seller to the buyer.
- It contains the following details.
 - ✓ People involved in the transaction.
 - ✓ Date of payment.
 - ✓ Goods or services for which payment is made.
 - ✓ Amount of money involved.
 - ✓ Signature of person receiving the money.
 - ✓ Receipt serial number.

iv). *Delivery note.*

- This document accompanies goods on delivery. It is evidence that goods have been physically delivered from the supplier to the buyer after a credit transaction.
- It contains the following details.
 - ✓ Date of delivery.
 - ✓ Quantity of goods delivered.
 - ✓ Method of delivery.
 - ✓ Person who receives the goods.
 - ✓ Condition in which the goods are received.
 - ✓ Delivery note serial number.

v). *Purchase order.*

- This is a request to a trading business firm to supply specified goods. It may be accepted or rejected by the supplier of goods.
- Purchase order specifies the following;
 - ✓ Type of goods required.
 - ✓ Quantity of the goods.

- ✓ Date of order.
- ✓ Person who orders the goods.
- ✓ Person who authorizes the order.
- ✓ Date within which the order goods should be delivered.
- ✓ Serial number of purchase order.

BOOKS OF ACCOUNTS.

a) Ledger.

- ✓ This is the principal or main book used in keeping financial records.
- ✓ It contains the details of all the things in the business owned by the farmer.
- ✓ All accounts are kept in the ledger.
- ✓ An account is a page or a section in the ledger given to a person or a firm on which all the business transactions relating to that person/firm are entered.
- ✓ In the ledger page, the account is divided into two parts drawn in the shape of letter T.
- ✓ The name of the heading for the account is written on the top line (above the horizontal line).
- ✓ Left hand side of the account is the debit side (DR) where all the decreases (purchases and expenses) are recorded.
- ✓ The right hand side is the credit side (CR) where all the increases (Sales and receipts) are entered.

A Ledger Account page.

Dairy Cattle.							
DR				CR			
Date	Particulars	Folio	Amount	Date	Particulars	Folio	Amount
2013			Shs.	2013			Shs.
			cts				Cts.
Jan 1 st	Bought 3 bags of dairy meal	1	3,000. 00	Jan 6 th	Sold 3 heifers	1	30,000 00

Use of columns

- i). *Date columns.*
 - The date affecting the account is recorded here.

ii). *Particulars column.*

- This is a short description of the entry being made.

iii). *Folio column.*

- This is a page where a particular account appears in the ledger. Every page in the ledger is numbered and each account should appear on its own page (folio).

iv). *Debit side. The following details are entered here.*

- ✓ Date of the transaction in the date column.
- ✓ The item in the particulars side.
- ✓ The folio number of the item in the folio column.
- ✓ Amount of money involved in the amount of column.

v). *Credit side. The following details are entered here.*

- ✓ The date of the transaction in the date column.
- ✓ Cash at hand in the particulars column.
- ✓ Folio number of cash at hand in folio column
- ✓ Amount received in the amount column.

b) Inventory

- This is a book in which a record of all the assets owned by a business or an individual is kept.
- Inventory records are divided into two groups as follows
 - i) Consumable goods inventory e.g. seeds, feeds, fertilizers, pesticides, fuel etc.
 - ii) Permanent goods inventory e.g. tools and equipment, machineries, buildings etc.

c) Cash Book

- This is a book in which all the transactions involving the receiving and paying out of cash are recorded.
- It consists of the sales and receipts side, and purchases and expenditure side.
- The following details are entered in a cash book.
 - i) Date of payment.
 - ii) Receipt number.

- iii) Person/firm from whom money is received.
- iv) Total amount received.
- The balancing of the cash book is done at the end of the month.

Diagram of a Cash account

Sales and Receipts 2013				Purchase and Expenditure 2013			
Date	Particulars	Shs.	cts	Date	Particulars	Shs.	cts
Jan 1 st	Sale of 2 egg trays	600	00	Jan 2 nd	Bought 70kgs layers mash	2,800	00

d) Journal

- This is a book where all unclassified transactions are entered.
- Some of the information that may be recorded in journal include;
 - i) Purchase on credit of a capital equipment i.e. things bought to keep and use and not for resale.
 - ii) Sale on credit of capital equipment.
 - iii) Rectifications of errors for example if errors are made in other books, new entries, correcting or cancelling the old entries are made in the journal.
 - iv) Transfers from one account to another in the ledger.
 - v) Opening entries in new books, when new books have to be opened etc.
- The following details are recorded in the journal;
 - i) Date.
 - ii) Name of the account to be debited.
 - iii) Name of the account to be credited.
 - iv) Amount of money involved
 - v) A brief description of the transaction.

Subsidiary Books of the Journal

a) Purchase Book

- All the details of items bought on credit are entered once.
- It is known as the creditors account. A creditor is someone to whom the farm (business) owes money.

b) Sales Book

- It is known as the debtor's account. A debtor is a person who owes money to the farm business.
- All details of goods sold from the farm for which payment has not been received are entered here.

FINANCIAL STATEMENTS

AIM:

- Determine profit or income.
- Evaluate the properties or assets in the farm.
- Determine the business liability.

INCLUDE:

- Balance sheet:** Is a financial statement drawn to show the financial position of a farm business as at a particular period of the year.

2 types;

- i)** Opening balance sheet: -Drawn at the beginning of an accounting period.
- ii)** Closing balance sheet: - Drawn at the end of an accounting period.

The closing B/s of an A/c period is the opening B/s of the next A/c period.

A B/s has 2 sides:

LHS: Shows liabilities.

RHS: Shows assets.

Liabilities: Are debts e.g.

- Loans and mortgages
- Bank overdrafts.
- Debts payable for goods and services received.
- Services paid to the business in advance.

2 types

- i)** Long term liabilities: Debts repaid in more than one year e.g loans from AFC.
- ii)** Current liabilities: Debts to be cleared or repaid within a period of one year e.g. rent, wages, electricity, water and telephone bills, bank overdrafts and debts payable.

Assets: owned property e.g.

- Cash at hand.
 - Value of farm items e.g. land, store produce, inputs, livestock, growing crops, farm buildings, machinery, equipment etc.
 - Debts receivable-for goods and services rendered.
- 2 types:
- i) Fixed Assets:- Durable properties held in the farm for a long time e.g. farm buildings, equipment, machinery, perennial crops and land.
 - ii) Current assets: - Held for a short period usually less than one year e.g. Cash at hand and in bank, debts receivable, farm produce to be sold, inputs in store etc

Orders used when drawing a balance sheet

Under assets:-

- i) Order of permanency; -Most permanent assets are written first and the least last.
- ii) Order of liquidity;- Most liquid assets are written first and most permanent last.

Under liabilities: -

- i) Permanent order: - Capital appears first followed by long term liabilities and lastly current liabilities.
- ii) Liquidity order:- Reverse is the case.

A format of a balance sheet

Balance sheet of X as at...Date

Liabilities	Shs. cts	Assets	Shs. cts
Current Liabilities.		Current Assets	
i) Short term debts		i) Cash at hand	
ii) Unpaid rent.		ii) Cash at bank.	
iii) Unpaid wages.		iii) Debts	
iv) Bank overdrafts.		receivable.	
		iv) Stock in store.	
		v) Livestock.	

Long term

Liabilities.

- i) Bank loan.
- ii) Interest on loan

Total Liabilities.

Capital/Net worth/Equity

Total

Fixed Assets.

- i) Machinery.
- ii) Perennial crops.
- iii) Buildings.
- iv) Land.

Total

- If the value of assets exceeds that of liabilities, the business is **solvent** i.e it can meet all its liabilities and a balance left.
- The balance left is called the net worth/ net capital /owner’s equity).
- If the value of liabilities exceeds that of assets, the business is **insolvent**; it cannot meet all what it owes other firms.

Examples

b) Profit and loss account: Is a financial statement showing whether a business made a profit or a loss. It has **2 sides**

i) Income side;

Details entered;

- Sales and receipts-produce sold and debts receivable
- Closing valuation-Value of assets in the farm by the end of the financial year.

ii) The expenditure side-

Details entered;

- Opening valuation-Are assets in the farm or business by the beginning of a financial year.
- Purchases and expenses: Items bought and debts payable.

A format of a profit and loss account:

Title-The profit and loss account of-----for the year.....

Expenditure		Income.	
	Shs Cts.		Shs Cts
Opening valuation	.	Sales and receipts	. .
i)		i)	
ii)		ii)	
iii)		iii)	
 Purchases and expenses		 Closing valuation.	
i)		i)	
ii)		ii)	
iii)		iii)	

Total Profit

Examples:

- If the value of expenditure is more than the value of income, the business has made a loss and if value of income is more than the value of expenditure, the business has made a profit.
- Thus (Closing valuation + sales and receipts) - (opening valuation + Purchases and expenses) = Net profit.

c) Cash Analysis: Is a financial statement drawn up to show the receipts and payment of cash in the business.

Format

Sales and receipts
and expenses

Purchases

Date	details	Total dairy maize vegetables poultry	date	details	total dairy maize vegetables poultry

Each sale or purchase is entered twice-once in the total column and once in analysis column-a column for specific enterprises that benefit from the sale or purchase of a particular enterprise.

The sum of entries in the total column is equal to the sum of all the entries in all the other columns (analysis column)

Importance:

- Shows money earned and spent on an enterprise.
- Shows total sales and receipts and purchases and expenses.
- Shows the net profit or loss.

AGROFORESTRY

- This is the growing of trees and crops and keeping of animals on the same piece of land.

Forms of Agroforestry

1. *Agrosilviculture*

- Combination of trees or shrubs and crops in agricultural production.
- It is common in high rainfall areas.

2. *Silvopastoral*

- Combination of growing trees or shrubs and keeping of livestock.
- It is common in the arid and semi arid areas.

3. *Agrosilvopastoral*

- Combination of growing trees/shrubs with pastures for livestock and crops.
- Practiced in the high potential areas.

Importance of agroforestry in Kenya

- i). Encourages afforestation/reafforestation
- ii). Source of wood fuel
- iii). Source of income
- iv). Raw material e.g. timber for construction
- v). Act as wind breakers
- vi). Aesthetic value/beauty
- vii). Control soil erosion
- viii). Act as livestock fodder.
- ix). Improves water catchment area
- x). Mark farm boundaries.

Characteristics of Good Agroforestry Trees and Shrubs

- i). **Fast growth** such as eucalyptus, *Grevillea robusta*, *Calliandra calothyrsus*, pines etc.
- ii). **Deep rooted** to ensure minimal competition for mineral nutrients and moisture with the crop plant. Examples include; *Eucalyptus spp*, *Grevillea robusta* etc.
- iii). **Nitrogen fixing** such as; *Calliandra calothyrsus*, *Leucaena spp*, *Cajanus cajan*, *Sesbania sesban* etc.
- iv). **Good in by product production** e.g. timber, fruits and poles. Examples include; *Croton macrostachyus*, *Grevillea robusta*, *Markhamia lutea* etc.

NB:

- i). *Trees such as the eucalyptus should not be planted near water sources because they would absorb the water and the source of water may end up drying.*
- ii). *Cypress and eucalyptus should not be planted in arable land as their leaves have allelopathic effects on crops i.e. they produce chemicals that inhibit the growth of some crop species.*

Types of Tree Nurseries

1. Direct Nurseries/Bareroot/Swaziland beds

- Seeds are planted directly on the ground without any containers.
- Seedlings here have low survival rate after transplanting due to root injury when uprooting.

2. Containerized nurseries

- Seeds are sown directly in containers such as pots, polythene bags, tins etc which are filled with soil mixtures.

Seed Collection and Preparation

Acquiring Seeds

- Good seeds should be whole, of good size, free from diseases and pests and should be fresh to ensure high viability.
- Seeds should be collected from mature trees, dried, and threshed before use.

Seed Treatment

This is done for two reasons.

- i) **To break seed dormancy hence rapid germination.**

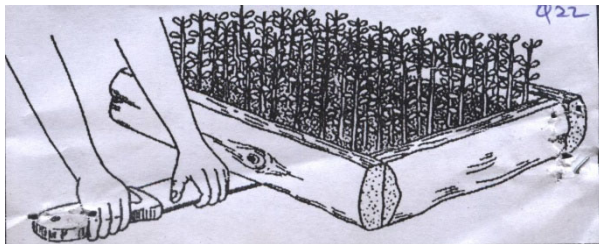
Methods of breaking dormancy include

- Hot water treatment e.g. in *Leucaena*, *Calliandra* and *Acacia*.
 - Mechanical breaking e.g. in seeds of the croton tree.
 - Light burning e.g. in wattle tree seeds.
- ii) Seed inoculation to promote nitrogen fixation in leguminous varieties**

Nursery Management

The following practices are carried in the nursery while seedlings are growing.

- Mulching.*
 - Watering.*
 - Weed control*
 - Pricking out.*
 - Shading.*
 - Pest and disease control.*
 - Root pruning.*
- This is the pruning of the tap root to encourage the development of a short, dense and strong rooting system.



viii) Hardening off.

Transplanting

- Holes for planting trees are dug long before transplanting day.
- Topsoil is kept separate and is used for refilling the hole halfway.
- Transplanting should be done at the onset of rains.
- Seedlings should be well watered a day before transplanting. This makes the soil stick onto the roots. It also eases the removal of the polythene sleeves for seedlings raised in sleeves.
- Seedlings are placed at the center of the hole.

- A sharp knife is used to cut and remove the polythene sleeve.
- More soil is added and firmed gently around the plant until the hole is completely full.
- Seedlings should be planted at the same depth as they were in the nursery.
- Watering should be done and mulch provided.
- A temporary shade may be established to conserve moisture.

Care and Management of Trees

i) Protection

- Young seedlings should be protected from damage by animals for about one year.
- This can be done for individual trees or for an entire field.

ii) Pruning and Training

- Pruning is the removal of extra or unwanted parts of a plant.
- Trees may be pruned for use as wood fuel or for fodder.
- Pruning can also be done to train trees to give the required shape or size.

iii) Grafting Old Trees

- When an agroforestry tree is old but has good characteristics, a scion can be taken from another tree that is compatible with it and grafted onto it.
- This is aimed at repairing such a tree.

Agroforestry Practices

i) Alley Cropping.

- This is the growing of trees and crops together. It is also known as hedgerow or intercropping.
- Trees are cut regularly and the leaves are used to mulch the crop.
- The trees used are leguminous so as to fix nitrogen e.g. Leucaena and Calliandra.
- Fruit trees can also be used.

ii) Multi-storey Cropping.

- In this case the trees are spaced widely and left to grow unchecked.
- Crops which can tolerate shading are planted.
- The trees and crops form different levels which look like storeys.

- Tree species for this system include; *Cardia*, *Casuarina equisetifolia* (Whistling pine), *African black wood*, *Muhugu* and *Acacia pp.*

iii) Woodlots in Farms.

- These are plots set aside for trees only.
- They are usually established on parts of the farm that are not productive.
- Such trees should be fast growing such as *Acacia* and *Eucalyptus spp.*

Sites for Agroforestry Trees

i) Boundaries.

Such trees help to:

- Protect the farm as fence.
- Mark the boundary.
- Form wind breaks.
- Provide timber and wood fuel.

Such trees include: Eucalyptus, Grevillea, and Jacaranda etc.

ii) River Banks.

- Such trees help to reduce the water velocity along the river banks, protecting exposed soil from erosive forces of the flowing water.

iii) Terraces.

- Roots of trees planted on terraces reduce the speed of water run-off and hold the soil particles together reducing soil erosion.
- Examples of trees here include, *Grevillea*, *Sesbania*, *Calliandra*, avocado, mango, pawpaw etc.

iv) Slopes.

- Trees planted on slopes control soil erosion.
- *Eucalyptus*, *Grevillea*, pines and croton trees are planted.

v) Homestead.

- Such trees are planted for beauty, fruits and shade. They should not be planted too close to the house.

Tree Harvesting Methods

i) Pruning

- This is the removal of the branches from the lower part of the tree crown.
- Pruning is done towards the end of the dry season to avoid damage to other crops.
- Branches obtained from pruning are used as fuel or wood fuel.

ii) *Lopping*

- This is the removal of branches from trees in haphazard manner.
- It is the most common harvesting technique for fodder trees.

iii) *Pollarding*

- This is the cutting of all the branches and top part of the tree.
- It is usually done to provide fuel wood and fodder.
- It is commonly is trees such as; Croton, Casuarina, Grevillea, Jacaranda, Ficus etc.

iv) *Coppicing*

- This is the cutting of the whole tree about 30cm above the ground.
- This is done to provide fodder, wood fuel and mulching material.
- The common coppiced tree species include; *Calliandra, Eucalyptus, Leucaena and Markhamia*.

v) *Thinning*

- This is the cutting down of some trees to avoid overcrowding.
- Thinning is done where trees have been established by direct seedling or planted very closely.

FARM POWER AND MACHINERY

FARM POWER---Is the amount of work done per unit time

USES OF FARM POWER

- Operate tools and equipment
- Slashing/ mowing
- Cutting trees
- Tilling of land
- Weeding
- Harvesting of crops

SOURCES OF POWER IN THE FARM

a) Human Power

Advantages

- i)Work in areas impossible for animals and tractor
- ii)Cheap
- iii) Available

Disadvantages

- i)Power is limited to very light tasks.
- ii) Quality of work produced is low / variable
- iii)Slow
- iv)Expensive in the long run.
- V) Health of workers influences the work done.

b) Animal Power

Donkeys, Oxen, Camel

Uses

-Cultivation, Transportation, Planting etc.

Advantages

- i) No skilled workers required.
- ii)Cheaper to buy and maintain.
- iii) Work output is higher than in human beings.
- iv) Can work in areas impossible for tractors/ sloppy areas.
- v) Work better on small holdings than tractors.

Disadvantages

- i) Need a big portion of land for grazing.
- ii)Slower than tractors.
- iii) Cannot work on large land.
- iv) Animals damage crops when used for weeding.
- v) Get sick reducing work output.

Animals are harnessed singly or in pairs using a **Yoke**.

b) Wind Power

Uses

- Dry grains and fodder.
- Winnowing crop yields.
- Pumping water/ drive wind mills.
- Generate electricity.

Disadvantages

- i) Unreliable e.g. direction.
- ii) Strength is unreliable.
- iii) Sometimes not available.
- iv) Not easy to control.
- v) Expensive to purchase a wind mill and its accessories.

d) Water Power

Source _ Running water.

Uses

- Ferrying logs in navigation rivers.
- Produce hydro-electric power.
- Operate different types of machines e.g. Maize grinding mills.
- Driving hydraulic pumps for pumping water for irrigation.

Disadvantages

- i) Some rivers are small and seasonal.
- ii) Expensive to harness the power.
- iii) Some farms are not accessible to moving water.
- iv) Difficult to use since not easy to control.

e) Biomass

Sources

-Biogas, Wood or charcoal.

F) Wood or charcoal

Sources ____ Trees in form of fire wood and charcoal

Uses

- Cooking
- Heating
- Dehydrating some crops
- Curing of tobacco

Disadvantages

- E) Exhaustible
- iii) Not used directly in some farm operations
- iv) Large quantities required
- Iv Bulky hence difficult to transport
- v) Pollute the environment

ii) Biogas

Sources

Is a product produced when animal dung is fermented in a **digester** thereby producing a flammable gas – **methane**.

Stages of methane production

Stage I: Animals digest insoluble organic substances by use of microbes to form waste (dung).

Stage II Microbes breakdown soluble substances in dung anaerobically in the digester.

Methane gas is produced.

Uses of Biogas

- Cooking
- Lighting
- Produce electricity
- Heating
- Boiling water
- Internal combustion engines

Biogas plant

Advantages of Biogas

- I) Economical for farmers with zero grazing units.
- ii) The effluent/ slurry provides fertilizer richer in Nitrogen than manure.
- iii) Flies cannot breed.
- iv) Unpleasant odours are removed.
- v) Minimal environmental pollution.
- VI) Reduced deforestation.

Disadvantages of Biogas

- i) Initial capital is high i.e. construction of Biogas digester is expensive.
- ii) Requires high management skills to produce the gas.
- iii) Requires a large number of animals to sustain gas production.
- iv) Only possible where animals are under zero grazing units.
- V) Labour consuming.

(f) Solar Radiation

Source: The Sun

Uses

- Photosynthesis
- Drying of crops prior to storage and processing.
- Provide electric power that is used for Lighting, pumping water, Cooking and heating.
- Distillation of clean drinking water.

(g) Electrical Power

Source

- Geothermal Power
- Hydro_ Power station
- Nuclear Station/ Atomic energy
- Storage battery

Uses

- Run stationary machines e.g. milling, cooking, grinding and water pumps
- Supplies heat and light for operation of brooders
- Cooking
- Operate milking and welding machines
- Run water pumps

Disadvantages

- i) Cannot be used directly in some farm operations e.g. milking, welding etc.
- ii) Lacks in rural areas
- iii) Power failures lead to high losses
- iv) Costly to install and maintain

(h) Fossil Fuel

Naturally occurring sources

- Petroleum oils
- Coal
- Natural gas

Uses

- Petrol and diesel used in burning internal combustion engines
- Kerosene used in lighting rural homes

- Natural gas for cooking and heating in stoves and lighting.

Disadvantages e.g of coal

- i) Expensive to extract
- ii) Low energy value
- iii) Dirty/ a lot of smoke/soot/ pollution
- IV) Bulky hence high transport cost

(i) Tractor Power

Source

Tractor engine converts chemical energy (fuel) into mechanical energy that drives farm machinery.

The tractor engine is a four_ stroke cycle i.e. 4 movements of pistons.

Types of Engines

i) The Four_ stroke cycle engine

These cycles are completed in 4 strokes/ 4 movements of pistons.

The crank shaft makes 2 total revolutions.

The 4 cycles include:

- Induction
- Compression
- Power and
- Exhaust

a) Induction stroke/ Intake stroke

Steps

- i) Piston moves down the cylinder
- ii) Inlet valve open
- iii) Exhaust valve is closed
- iv) Fresh fuel and air gets into the cylinder.

b) Compression stroke

Steps

- i) Piston moves up the cylinder
- ii) Inlet and outlet/ exhaust valves are closed
- iii) Fresh fuel mixture is compressed into the combustion chamber.

c) The Power Stroke

Steps

- i) A spark is produced at the spark plug
- ii) The fuel mixture ignites and expands
- iv) The resultant pressure force the piston down the cylinder

d) The exhaust stroke

Steps

- i) Inlet valve closed
- ii) Exhaust valve open
- iii) Piston moves up the cylinder
- iv) Burned fuel mixture is eliminated through the open exhaust valve

Advantages of four stroke Engines

- i) Produce high power and can do heavy farm work.
- ii) Efficient fuel/ oil utilization.
- iii) Perform a wide range of farm operations.
- iv) Efficiently cooled by water thus allowing production of large engine sizes.
- v) Exhaust gases are effectively expelled from the cylinder.

Disadvantages

- i) Expensive to buy and maintain.
- ii) Their use is limited in areas/ sloppy areas
- iii) Require skilled personnel and support services.

Question a) Name the strokes in a four stroke engine and describe how each operates. (12 marks)

b) Describe the functions of a gear box in a tractor. (8 marks)

ii) The two stroke cycle engine

It is found in Mowers, Chain saws, Motor bikes and Water pumps.

The cycles are completed in 2 strokes of the piston.

There are no valves in the engine but three ports; Inlet, Transfer and Exhaust ports located in the cylinder wall.

a) Induction and Compression stroke

Steps

- i) The piston is at the bottom initially.
- ii) Upward movement of the piston opens the inlet port.

- iii) Air/ Fuel mixture is drawn in.
- iv) The piston reaches the top [Top Dead Centre -TDC] and ignition occurs.
- v) Piston is then forced downwards.
- vi) Piston compresses the fuel mixture in the crank case.

b) Power and Exhaust stroke

Steps

- i) Piston is at the top initially
- ii) Ignited gases cause a buildup of pressure in the combustion chamber forcing the piston downwards.
- iii) Piston covers the inlet port and traps fresh fuel mixture in the crank case.
- iv) Further movement of the piston downwards uncovers the exhaust port.
- v) Fuel mixture is transferred from the crank case into the combustion chamber through the open transfer port.

Advantages of 2 stroke cycle Engines

- i) Cheap to buy and easy to maintain.
- ii) Economical in fuel consumption/ consumes less fuel.
- iii) Can be used in a wide range of areas e.g hilly areas.
- iv) Do small works in the farm uneconomical with 4 stroke cycle engines.

Disadvantages

- i) Produce less power hence cannot be used for heavy duties.
- ii) Inefficient in burning fuel to produce power.
- iii) Air cooled hence limited engine sizes.

Structural and Functional differences between Petrol and Diesel Engines

Petrol Engine

Diesel Engine

<ul style="list-style-type: none"> 1. Has a carburetor. 2. Fuel air is mixed in carburetor before it gets into the engine. 3. Fuel is ignited by an electric spark. 4. Produces little smoke because petrol is completely burned. 5. Engine is light in weight and 	<ul style="list-style-type: none"> 1. Has an injection pump 2. Fuel _air mixed within the cylinder 3. Fuel is ignited by compression of air_ fuel mixture in the cylinder. 4. Produces a lot of smoke since diesel is not completely burned. 5. Diesel Engine is heavy in weight
---	---

<p>suited for light duties.</p> <p>6. Uses petrol as fuel.</p> <p>7. Uses more fuel per unit distance.</p> <p>8. No extra addition of air or fuel during the induction stroke thus air: fuel ratio is constant. (15:1).</p> <p>9. Has no sediment bowl.</p> <p>10. Operational cost is high because of high fuel consumption.</p>	<p>and suited for heavy duties.</p> <p>6. Uses diesel as fuel.</p> <p>7. Uses less fuel per unit distance.</p> <p>8. Air is taken in before induction stroke thus the ratio of Air: fuel is not constant.</p> <p>9. Has a sediment bowl..</p> <p>10. operational cost is low because of low fuel Consumption.</p>
---	---

Systems of the Tractor

a) Fuel System.

2 types

- i) Petrol fuel system
- ii) Diesel fuel system.

i) Petrol Fuel system

Petrol is put in a tank then passed to the carburetor through a pipe fitted with a filter.

It consists of:

i) **Fuel tank:** Storage of fuel.

ii) **Carburetor:**

- Atomizes fuel into spray (vapour).
- Introduces fuel air into the Engine.
- Regulates fuel air into suitable proportions/ mix fuel with definite amount of air.

iii) **Fuel pump:** Forces fuel into carburetor.

iv) **Delivery pipe:** connects all devices.

Maintenance

i) Clean the carburetor jets regularly to avoid blockage.

ii) Clean the fuel filter in petrol.

ii) Keep always clean the hole in the fuel tank cap.

ii) Diesel fuel system

Consists of:

- i) **Fuel tank:** Storage of fuel.
- ii) **Fuel injection (lift) pump:** Force diesel through injection nozzles and breaks into fine spray.
- iii) **Fuel filters:** Remove foreign particles from the fuel.
- iv) **Delivery pipe:** Connects the various devices.

Maintenance

- i) Replace the fuel filters.
- ii) Bleeding in case air is entrapped in the system.
- iii) Clean regularly the sediment bowl.

b) Electrical system

Consists of:

- i) Ignition/Generator/dynamo circuit: Provides electrical current that produces a spark in the Engine.
- ii) Starter Motor Circuit: Starts the engine/Rotates the fly wheel which rotates the crank shaft.
- iii) Lighting Circuit: supplies electrical current for the lighting system i.e of the head lamp, brake lights etc.
- iv) Tractor Battery: stores the electrical energy supplied by the running engine. Also converts the chemical energy into electrical energy. The electrical energy from the running engine driven by the generator, charges the battery.

Tractor battery contains 6 cells connected together to supply 12 volts. A battery has 2 sets of plates I.e +ve and – ve terminals.

Care and Maintenance of Tractor Battery

- i) Top with distilled water the level of electrolyte.
- ii) Scrap clean and smear with grease corroded terminals.
- iii) Fix tightly the battery in a box to avoid spillage and damage.
- iv) Fit correctly the battery in a tractor (right place).
- v) Charge the battery regularly and periodically.
- vi) Empty and keep the battery upside down in case of long storage.
- vii) The generator fan belt should be functional to ensure the battery is always charged.

c) Ignition system

Consists of:

- i) ignition coil: Converts or changes the battery voltage from 12v to 6000v required by the spark plugs.
 - Provides a spark at the sparking plugs located in the engine cylinder.
- ii) The Distributer: Distributes the spark or the high voltage current at each spark plug.
- iii) Condenser:
 - Absorbs the self induced current in the primary circuit.
 - Stores the current for a short time.
 - Passes the electric current to the distributor.
- iv) Contact Breaker: Interrupts the normal flow of the current in the primary circuit so as to generate high voltage from the coil.

Common Faults of the ignition system

1. Sudden stopping

Causes

- Poor terminal connections
- Faulty ignition system.

Correction

- Proper tightening of the terminals
- Proper cleaning and terminal readjustment.

3. Continuous engine running

Causes

- Broken leads
- Poor terminal connection.
- Faulty contact breaker

Correction

- Replace the broken leads.
- Clean and tighten regularly the broken leads.

Maintenance of the ignition system

- i) Remove carbon coatings on spark plug electrodes.
- ii) Replace spark plugs with worn out electrodes.
- Iii) Clean contact breaker points.
- iv) Adjust breaker points to lie between 0.30mm to 0.50mm.
- v) Replace the condenser regularly.

- vi) Keep the ignition system dry always.
- vii) Replace ignition wires with poor insulation.

d) The Cooling system

Importance

- Prevents the engine from overheating that causes expansion of engine components which would lead to: Leakage, valve burning, loss of engine power, cracking of the cylinder head and piston seizure in the cylinder.

Types of cooling systems

a) Air

b) Water

I) Air cooled system

-Used in light weight farm machines e.g mowers Motor bikes and Land masters.

Characteristics of air cooled Engines

- Simple in construction.
- Have fins and fan blade which assists in circulation.
- Light in weight since they no radiators or water jackets.

Limitations of Air cooled Engines

- Get hot quickly.
- Use heavy lubricating oils.
- Cooling is not adequate especially when carrying heavy loads.

ii) Water cooled systems

Water absorbs heat from the engine block at a reasonable rate.

Components:

Radiator, Water jackets, Water hoses, Water pump, Thermostat, Fanning mechanism etc.

Cooled water is sucked from the bottom part of the radiator with help of water pump.

It is pushed through water jackets and circulates within engine block and cylinder head.

A thermostat: Regulates the temperature of water in the engine at 80 to 90 degrees Celsius.

Hot water is forced back into the radiator for further cooling.

Care and maintenance of water cooling system

- i) Lubricate water pump regularly.
- ii) Use clean water in the radiator.
- iii) Remove trash from the fins.
- iv) Fit all the pipes tightly to avoid leakage.
- v) Fill the radiator with clean water before starting the days work.
- vi) Check regularly and adjust fan belt tension.

e) Lubrication system

Supplies oil to all parts of the engine where friction is likely to occur.

Importance of lubrication system in tractors

- i) Increase efficiency of the machine.
- ii) Reduces tear and wear rate of the machine.
- iii) Reduces the heat created by the rubbing surfaces I.e acts as a seal between them.
- iv) Acts as a cleaning agent ie washes off dust, dirt soot and metal chippings from oil paths to the sump.
- v) Oiling prevents rusting of stationary machines.

Types of lubrication system

- I) Splash feed type
- ii) Force feed type
- iii) Oil mist type.

Types of lubricants

Identified by their viscosity (thickness index) as indicated by (S.A. E)- Society of Automotive Engineers.

The lower the SAE number the thinner the oil.

- i) SAE 10—Thin oil . Gives little protection when heated.
- ii) SAE 50—Thicker oil . Protects bearings.
- iii) SAE 90—150. Transmission oils. Protects clutch, gear box, wheels, ball bearings.

Care and maintenance of lubrication system

- i) Do not use old and contaminated oil as a lubricant.
- ii) Drain oil while still hot to avoid sticking on sump walls.
- iii) Replace oil filters.
- iv) Use the correct oil type as per manufacturer's instructions.

f) Power transmission system.

Transfers power from tractor Engine to drive shaft, wheel axle P.T.O shaft and Hydraulic system.

Consists of:

1) The Clutch:

Functions

- i) Connects or disconnects the drive shaft to or from the engine.
- ii) Enables the tractor to take off gradually and smoothly.
- iii) Provides power from the engine to P.T.O shaft.

The clutch uses friction force to transmit power from the engine.

It has three parts: Crank shaft, friction disc and pressure plate.

2) Gear box

Functions

- Provides different forward speeds.
- Enables the driver to choose any forward or reverse gear to suit the operation.
- Allow change in speed ratio by altering the gears.
- Allows the driver to stop the tractor without suddenly stopping the engine or the foot keeping pressed on clutch.

3) The differential.

Functions

- Change the direction of drive to right angles so that power is transmitted to the rear wheels.
- Enables the rear wheels to travel faster or slower than others especially when negotiating corners.
- Differential lock avoids wheel slip or skidding.

4) Final Drive.

-Enables the wheels to propel the tractor machine either forward or backward.

Tires allow maximum grip (traction) i.e. where the wheels provide large surface area of contact between the tires and the ground.

Power transmission mechanism

Ways power is transmitted from the engine

i) Propeller Shaft

-Connects the gear box to the differential that has axles which drives the wheels. During forward movement, the tractor pulls or pushes attached implements.

ii) **The power Take off Shaft (P.T.O) Shaft**

-Located at the rear part of the tractor and rotates at the same speed as the crank shaft. It

-is connected to the mowers, planters, rotavators, shellers, sprayers and fertilizer spreaders.

iii) **Hydraulic system**

-Operated by a lever near the driver's seat .Attached to the 3 point linkage which lowers or raises attached implements e.g. mowers, planters, ploughs, and sprayers.

iv) **Draw bar**

-Is at the rear part of the tractor. Does not get power directly from the engine. Attaches trailed implements used for harrowing, transportation and rolling.

Tractor Servicing

Are practices or operations carried out to keep the tractor in good and efficient working condition thereby increasing its lifespan.

REVISION QUESTIONS

1. a) i) What is agricultural economics?

- The art and science of organizing limited resources to achieve maximum returns

ii) Explain the meaning of scarcity and choice

- Productive resources are scarce in relation to demand i.e goods and services produced are not enough to satisfy human wants
- Therefore, a choice has to be made on which goods and services should be produced using the limited resources.

b) Explain how the house hold and firm are both producers and consumers.

- The household demands goods and services and supplies labour and raw materials to firms
- Firms convert the raw materials and supplies finished goods to households.

- The relationship generates money to both sides therefore both are producers and consumers.

c) What do the following terms mean?

i) Gross domestic product (G.D.P)

- The sum total of goods and services produced by a country within one year.

ii) Gross national income (GNI)

- Total output from resources owned by the nationals of a country both within and outside the country within a year.

iii) Per capita income

- Gross national income divided by total population

d) i) What does the term opportunity cost in farming mean?

- Cost of the foregone alternative when we make a choice.
- Example is choosing to grow maize instead of wheat.
- Opportunity cost is the value of wheat
- Opportunity cost only exists where there are alternatives.

ii) State the main implications of opportunity cost in farming.

- Poor decision leads to losses
- Correct decision leads to good profits

iii) When is opportunity cost nil or zero?

- When supply is unlimited
- When goods are free
- When there are no alternatives

2. a) i) What is production?

- The process of transforming productive resources e.g land, labour and capital into consumption resources e.g potatoes, maize and milk over a period of time.

ii) State the factors of production.

- Land (provides space for production)
- Labour (human effort)
- Capital (man made to assist other factors)
- Management (organises other factors)

b) i) Name the sources of capital for farming.

- Credit facilities
- Personal savings and earnings
- Inherited property.
- Free grants

ii) How is labour classified?

- Family
- Hired (casual/permanent)

iii) State the functions of farm manager

- Planning i.e. short and long term
- Gathering information
- Comparing levels of production with those of neighbouring farms
- Detecting weaknesses and constraints and finding ways and means of overcoming them
- Keeping up to date farm records
- Implementing farm management decisions
- Taking responsibilities

c) i) State the law of diminishing returns

- In a production process, if variable additional units of an input are increased while all other factors are held constant, there will be an increase in additional output until a point is reached when the additional output per additional units of input declines.

ii) State agricultural examples of this law.

- Use of varying units of labour on a fixed unit of land
- Feeding dairy cattle with varying units of feed for milk production
- Using varying units of fertilizer in the production of a given crop

d) i) What is production function?

- The relationship between the units of input that a farmer employs in production and the corresponding units of output
- The output depends on inputs hence output is a function inputs.

ii) Name the types of production function?

- Increasing returns
- Constant returns
- Decreasing returns

iii) What is a decreasing returns production function?

- A production function where each additional unit of input results into a smaller increase in output than the proceeding unit of input.
- 3. Give 4 qualities desirable in a farm manager.**
- 4. State 4 ways of improving labour in the farm.**
- 5. State 4 management guideline questions which assist manager in decision making.**
- 6. State 4 characteristics of variable inputs.**
- 7. Give two examples of each of the following;**
 - **Variable inputs.**
 - **Fixed inputs.**