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Agricultural Sciences
STUDY GUIDE

12

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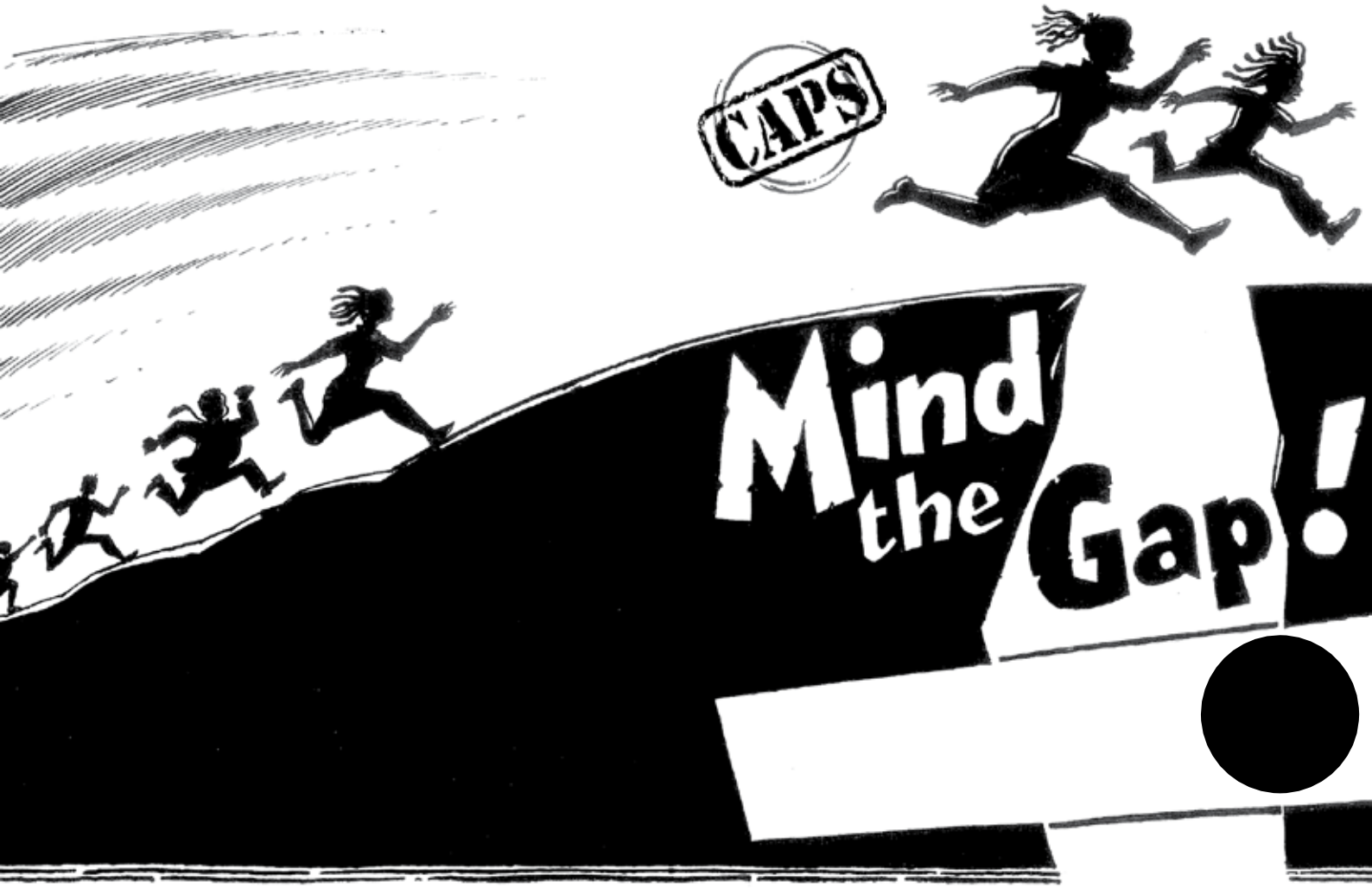

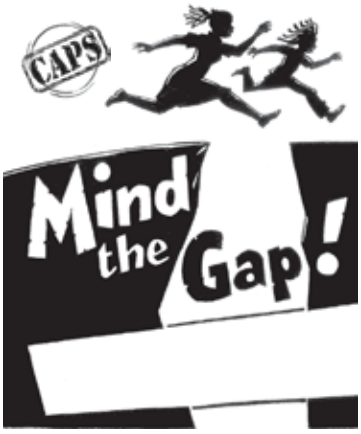

Curriculum and Assessment Policy Statement (CAPS) Mind the Gap Grade 12

Study Guide Agricultural Sciences

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Ministerial foreword

Matsie Angelina Motshekga, MP

Minister of Basic Education

The Department of Basic Education has pleasure in releasing the second edition of Mind the Gap study guides for Grade 12 learners. These study guides continue the innovative and committed attempt by the Department of Basic Education to improve the academic performance of Grade 12 candidates in the National Senior Certificate (NSC) examination.

The study guides have been written by subject expert teams comprised of teachers, examiners, moderators, subject advisors and subject co- ordinators. Research started in 2012 shows that the Mind the Gap series has, without doubt, had a positive impact in improving grades. It is my fervent wish that the Mind the Gap study guides take us all closer towards ensuring that no learner is left behind, especially as we move forward in our celebration of 20 years of democracy.

The second edition of Mind the Gap is aligned to the 2014 Curriculum and Assessment Policy Statement (CAPS). This means that the writers have considered the National Policy pertaining to the programme, promotion requirements and protocol for assessment of the National Curriculum Statement for Grade 12 in 2014.

The Mind the Gap CAPS study guides take their brief in part from the 2013

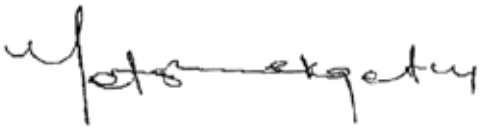
National Diagnostic report on learner performance and draws on the

2014 Grade 12 Examination Guidelines. Each of the Mind the Gap study guides provides explanations of key terminology, simple explanations and examples of the types of questions that learners can expect to be asked in an exam. Marking memoranda are included to assist learners in building their understanding. Learners are also referred to specific questions in past national exam papers and examination memos that are available on the Department's website – www.education.gov.za.

The CAPS edition include Accounting, Economics, Geography, Life Sciences, Mathematics, Mathematical Literacy and Physical Sciences. The series is produced in both English and Afrikaans. There are also nine English First Additional Language study guides. They include EFAL Paper 1 (Language); EFAL Paper 3 (Writing); and a study guide for each of the Grade 12 prescribed literature set works.

The study guides have been designed to assist those learners who have been underperforming due to a lack of exposure to the content requirements of the curriculum and aims to mind-the-gap between failing and passing, by bridging the gap in learners' understanding of commonly tested concepts so candidates can pass.

All that is now required is for our Grade 12 learners to put in the hours preparing for the examinations. Learners make us proud – study hard. We wish each and every one of you good luck for your Grade 12 examinations.



Matsie Angelina Motshekga, MP

Minister of Basic Education

May 2014

Chapter 1

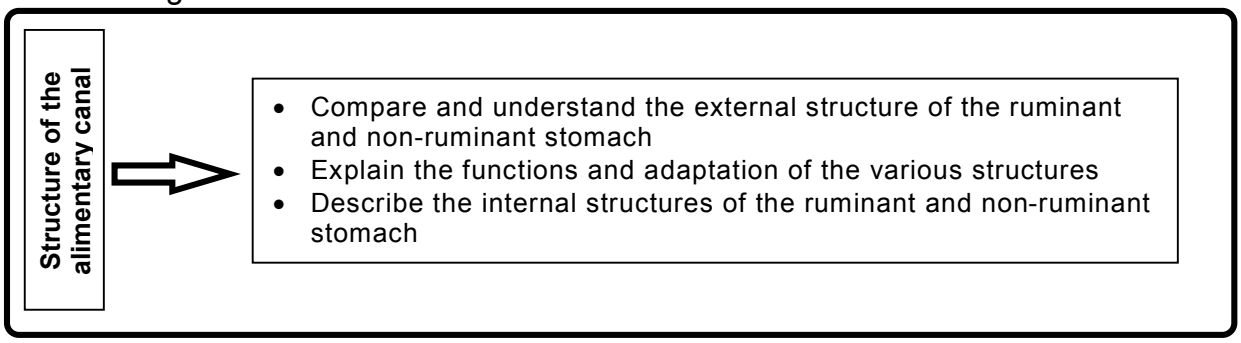
Paper 1

ANIMAL NUTRITION

1.1 The structure of alimentary canals

Learning objective

At the end of this unit the learners should be able to demonstrate the knowledge of the following content.



1.1.1 **Terminology**

Terminology ~~is~~ are special words/concepts or expressions used in relation to a particular subject or activity. The following list of terms is used in the structure of the alimentary canal. Study these terms that focus on the structure and functions of the parts of the alimentary canals of the three farm animals discussed in your textbook and in the diagrams.

TERM	DEFINITION
Abomasum	- True/milk stomach of a ruminant
Anus	- End of digestive system
Cardiac sphincter	- Ring muscle controlling movement of food into the stomach
Cecum	- Formed where small intestine mouths into the large intestine
Cloaca	- Excretion of faeces and urine (urogenital opening and eggs)
Crop	- Soft bag-like enlargement in the oesophagus of a fowl.
Four/Complex stomachs	- Rumen, reticulum and omasum of the ruminants.
Gizzard / Ventriculus	- Muscle stomach. - Small stones to help indigestion. - Grinding of ingested foodstuff

Non-ruminants/monogastric animals	-animals that have a simple stomach.
Oesophagus (gullet)	- Tube-like structure that leads from the back of the throat (pharynx) to the stomach.
Omasum(Leaf stomach)	- Leaf shaped folds inside, - Third and smallest stomach of the ruminant
Proventriculus	- True or glandular stomach
Pyloric sphincter	- Ring muscle that control digested food in to the Small intestines
Reticulum	- Honeycomb-shaped second stomach of the ruminant.
Rumen	- Largest compartment of the ruminant stomach.
Ruminants	- Animals that have a complex stomach (divided into four chambers) and chew the cud.
Small intestines	Duodenum – 1st section of small intestines Jejunum – 2nd section of small intestines Ileum – 3rd section of small intestine
Villi(Singular for villus)	- Tiny finger- like projection found on the wall of the Small intestines that increase the surface area

1.1.2 Feed intake and alimentary canal comparison

The structure of the alimentary canals of farm animals:

Mammals, being the most developed organisms, possess different digestive systems to feed on a variety of food types available in the world.

Monogastric (simple stomach animals) and ruminants are the two main types of mammals based on their types of digestive systems. There are more monogastric/simple stomach animals, yet the ruminants are very important in the entire biosphere. Ruminants are the reason you don't have to eat grass.

Anatomy, fermentation, and the diet are the main differences between the two types of organisms and those will be discussed in this chapter.

Main differences between Monogastric/Simple stomach and Ruminants?

Pay special attention

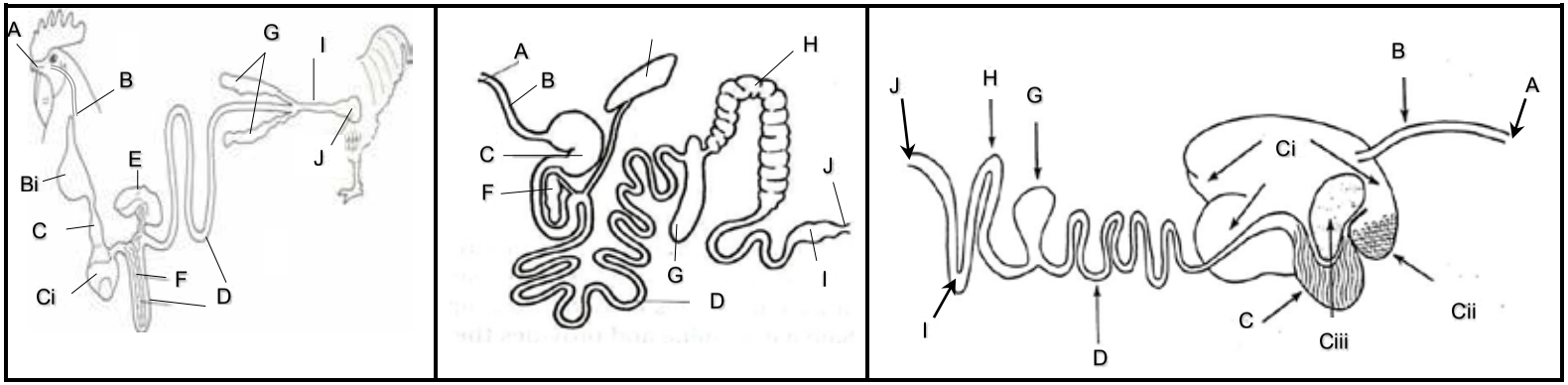
• Monogastrics have a single-chambered stomach, but ruminants have a four-chambered stomach.

• Ruminants are always herbivores while monogastrics show all types of food habits.

• The digestive system of ruminants is more efficient than the monogastric system in breaking down food and absorbing nutrients.

• Ruminants regurgitate the ingested food during digestion, but monogastrics do not.

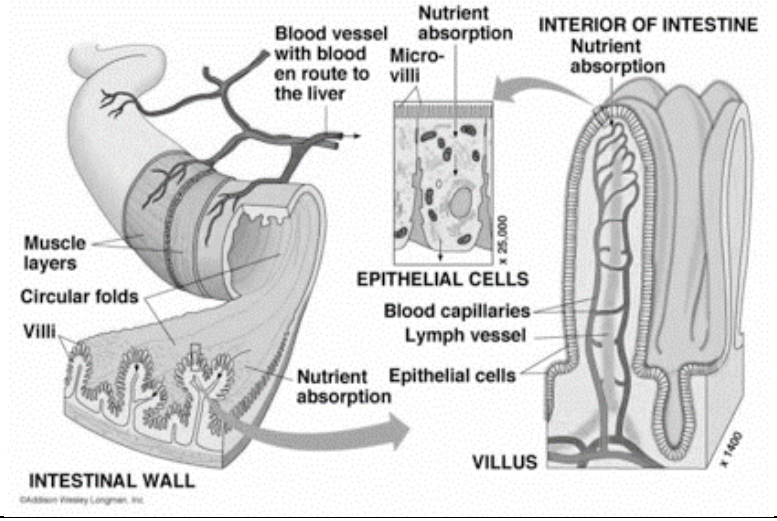
• Ruminants are foregut fermenters while **monogastric herbivores** are hindgut fermenters.



Fowl/Chicken **Monogastric** **Ruminant/Complex stomach/polygastric**

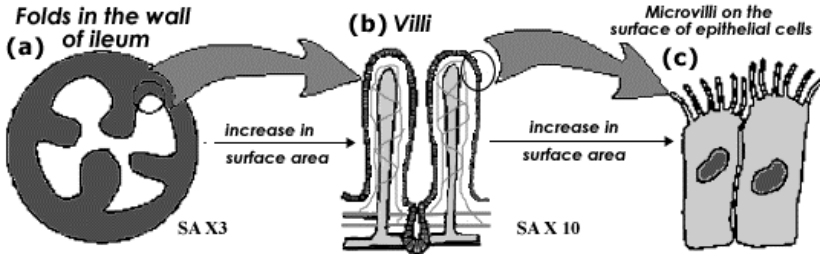
Table of the differences between the three digestive systems:

Component	Fowl/ Chicken	Monogastric animals (Pigs and Horses)	Ruminant animal: (Sheep and cattle)
A – Mouth/Beak - Teeth	No Amylase No teeth	Secrete salivary Amylase Teeth	No Amylase Teeth
Legend for teeth I - Incisors C - Canines PM - Premolars M - Molars		Teeth: Top – 3,1,4,3 Bottom - 3,1,4,3. (For enrichment, only)	Teeth: Top – 0,0,3,3 Bottom – 4,0,3,3 (For enrichment, only)
B – Oesophagus Bi Crop 	Transport food to stomach -Bag like enlargement of the oesophagus store food	Circular and longitudinal muscles which contract result in peristalsis for food movement	Circular and longitudinal muscles which contract result in peristalsis and retro - peristalsis for rechewing the cud
C - Stomach	Consists of two completely separate parts, namely:	• Has a capacity of 8 litres. • Consists of three separate parts, viz.	**Ci. The rumen** • Largest part of the complex stomach. • Occupies 80 % of total volume.

	C. Proventriculus • true or glandular stomach Ci Ventriculus/ Gizzard/muscle stomach • Muscle stomach. • Small stones to help indigestion. • Grinding of ingested foodstuff.	○ **Cardiac. (Top part)** ○ **Fundus.** ○ **Pyloric (bottom part)** • Both a digestive and a storage organ. • Contraction of stomach wall, food is mixed with saliva. • Stomach wall secretes **gastric juices** and **hydrochloric acid**. • Both the entrance and exit from the stomach are controlled by circular muscles known as sphincters.	**Cii. Reticulum (Net/honeycomb stomach)** • Occupies 5 % of total volume. • Smallest of all stomach compartments. **Ciii. Omasum / Leaf stomach** (primary, secondary, tertiary leaves) • Comprises 7 % of total volume. • Appears as ball-shaped. **C. Abomasum** • Also called true stomach. • Comprises 8 % of total volume.
D - Small intestines	• Divided into **duodenum, jejunum** and the **ileum** • Region for digestion and absorption in the animal body • Bile and pancreatic ducts open separately into the duodenum and secrete **bile** and **pancreatic** juice respectively. • Duodenal glands secrete duodenal juice. • Glands of Lieberkühn (indentation between villi) secrete **succus entericus**.(intestine juice) • Small intestine opens into large intestine. • The wall of small intestine(inner surface) is covered in villi which increase the absorption surface area.		

<table>
<tr>
<td>Pay special attention</td>
<td>
Internal structure of the intestinal villi.

Villi are small, finger-like growths or extensions of mucous membrane of the small intestine.
Each villus consists of connective tissue which is surrounded by a layer of epithelial cells.
A small lymphatic vessel is responsible for the absorption
Each villus has a few involuntary muscles which keep it in constant movement.

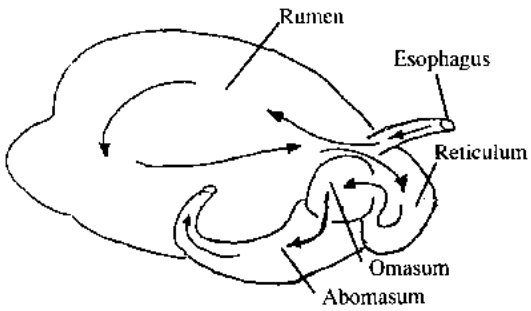
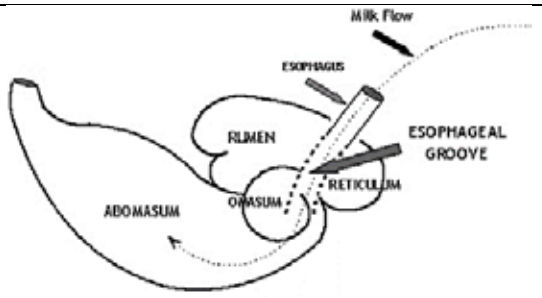


Distinction between intestinal folds and Villi
<table>
<tr><th>Intestinal folds</th><th>Villi</th></tr>
<tr><td>Bigger extensions of the intestinal mucous membrane.
Comparable smaller surface area for absorption.
Supplied with veins and arteries.</td><td>Smaller extensions of the mucus membrane on the folds.
Comparable bigger surface area for absorption.
Supplied with venous and arterial capillaries.</td></tr>
</table>
Take this table out
Adaptation of small intestine to the absorption of the most digested food.

Long enough to provide sufficient absorption area.
Many folds increase surface area for absorption.
Villi also increase surface area for absorption.
Involuntary muscles provide constant movement or peristalsis.

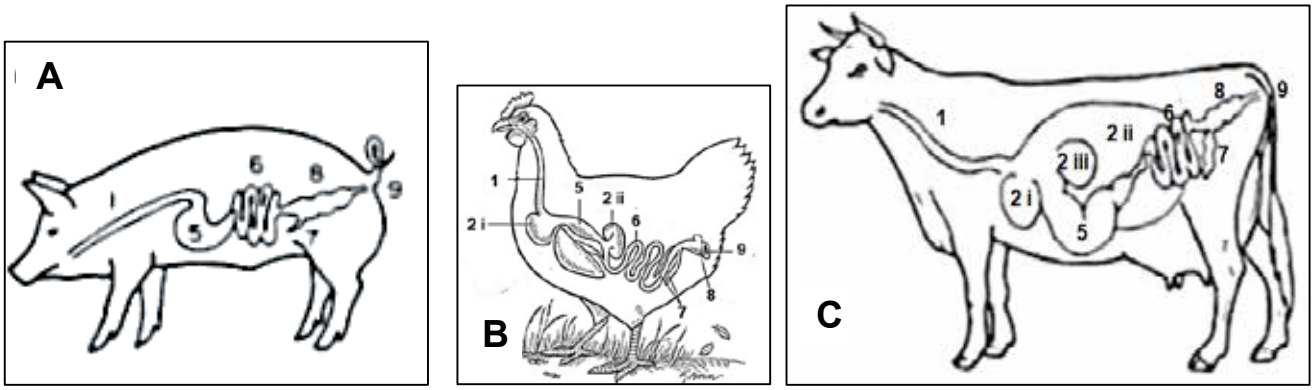
</td>
</tr>
<tr><td>E - Liver</td><td>Production of bile.</td></tr>
<tr><td>F – Pancreas</td><td>Production Pancreatic juice -</td></tr>
<tr><td>Large intestine
G- Caecum
I – Colon
H – Rectum</td><td>Large intestines consist of three parts, namely the caecum (G) (blind gut), the colon (H), the (I) - rectum.
Slime glands produce no enzymes
Caecum is formed where small intestine mouths into the large intestine.</td></tr>
<tr><td></td><td>J – Vent/Cloaca(Birds)
Excretion of faeces and urine (urogenital opening).</td><td>J – Anus (Mammals),
Alimentary canal ends in the anus, which is opened and closed by a sphincter</td></tr>
</table>

Adult ruminant versus new-born calf

	
<u>Rumen</u>: large enough to accommodate or store food.	• During suckling, the oesophageal groove is closed and the milk bypasses the rumen and reticulum and passes through the omasal groove directly to the abomasum or true stomach. • Poorly developed since little grazing
<u>Reticulum</u>: • Well developed as part of complex fermentation organ. • Regulates the movement of food particles from rumen to the lower alimentary canal.	• Poorly developed in size as no or little fermentation of food occurs. • No regulation of food particles.
<u>Omasum</u>: Well developed as necessary for grinding of food and absorption of water.	• Underdeveloped since no grinding and absorption of water.
<u>Abomasum</u>: Well developed and enzymic digestion of food occurs here.	• Well developed and the only properly functioning stomach in digestion of food.

1.1.3 Activity

1. Complete the following questions based on the diagrams by identifying the parts of the digestive systems in the following farm animals.



Name the digestive system of

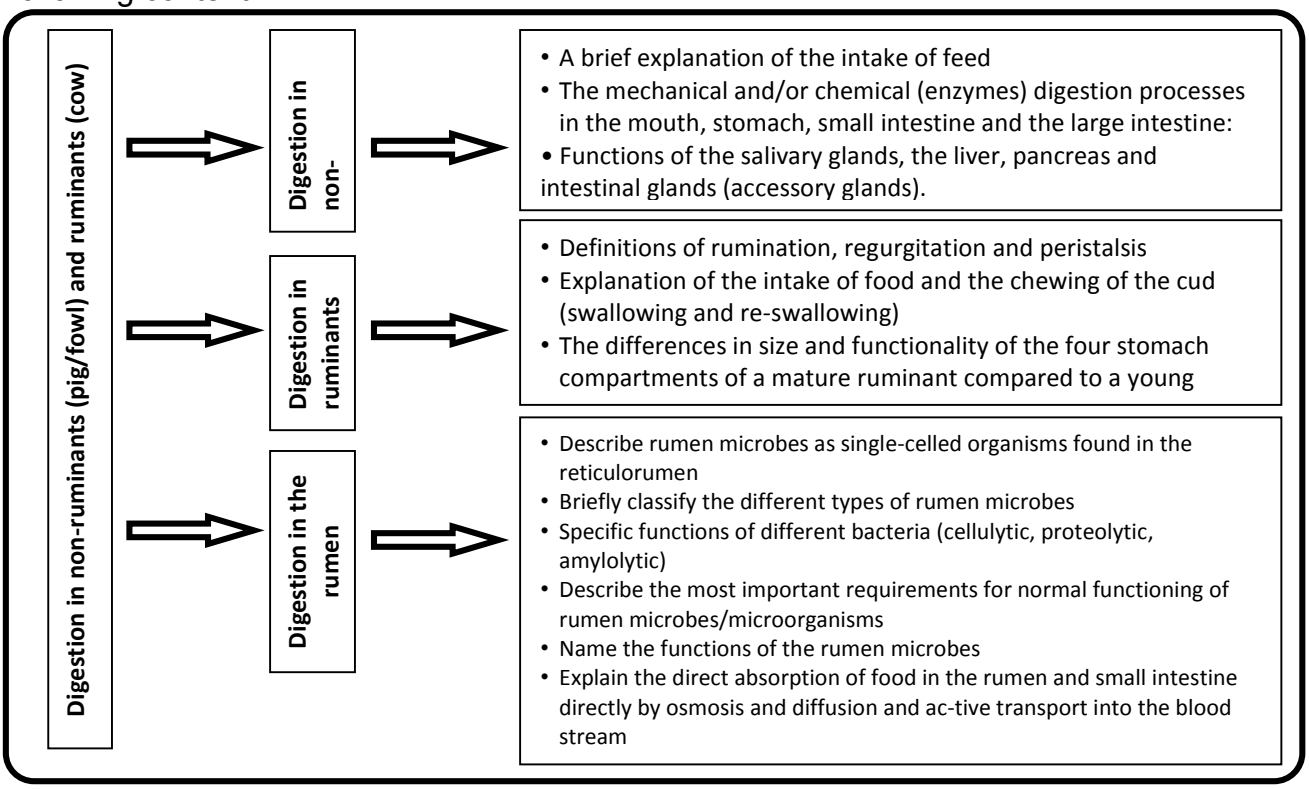
A. _____ (2)
B. _____ (1)
C. _____ (2)

Identify the parts of the digestive systems as indicated by the numbers in each diagram.

No.	Diagram A	Diagram B	Diagram C	
1				(3)
2 i				(2)
2 ii				(2)
2 iii				(1)
5				(3)
6				(3)
7				(3)
8				(3)
9				(3)

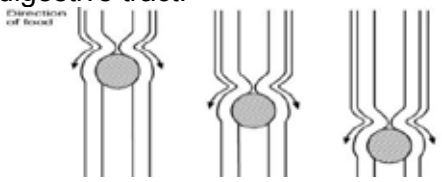
1.2 Digestion – Non ruminants vs Ruminants

At the end of this unit the learners should be able to demonstrate the knowledge of the following content.



1.2.1 Terminology

TERM	DEFINITION
Absorption	-is the movement of dissolved food into the cells of the body.
Amylase	-the enzyme that converts starch to maltose.
Amylolitic	-effecting the conversion of starch into soluble dextrin and sugar
Bile	-a yellowish, bitter, alkaline liquid made in the liver and emulsifies fats.
Bolus	The chewed rounded food , mixed with saliva that get transported via peristalsis to the rumen
Cellulytic	-Bacteria or enzymes capable of hydrolyzing cellulose
Chemical digestion	-this involves chemical reactions by digestive enzymes in the alimentary canal.
Cud	Partly digested food from the first stomach of ruminant back to the mouth for further chewing.
Diffusion	Nutrients in digestive system migrate, or *diffuse,* from a place of high concentration to a place of low concentration
Digestion	- the mechanical and chemical breaking down of food into smaller components that can be absorbed into a blood stream.
Fermentation	Chemical breakdown of substances by micro- organisms, involving the release of heat.
Emulsification	-fats broken down into small droplets
Enterokinase	-enzyme that converts trypsinogen to trypsin.

Islets of Langerhans	- Irregular clusters of endocrine cells in the pancreas that secretes insulin and glycerol
Lipase	-the enzyme involved in fat digestion(breaks fats into fatty acids and glycerol).
Mechanical/Physically digestion	- this is a physical breakdown of food into smaller pièces (chewing food)
Osmosis	Dilutes the high-concentration side and increases the concentration of the low-concentration side until the two sides are balanced.
Pepsin and Trypsin	-enzymes that breaks proteins to peptides
Peristalsis	-the wave-like contractions that move food down/along the digestive tract. 
Proteolytic	-the breaking down of proteins into simpler compounds, during digestion.
Rennin	-enzyme that changes soluble caseinogen of milk to insoluble casein.
Retro – peristalses/ Regurgitation	the wave-like contractions that move food upwards in the digestive tract for rumination
Swallowing	process in animal body that makes something pass from the mouth, to the pharynx, and into the esophagus

1.2.2 Digestion and Nutrient Absorption

Mammals are either or meat eaters (carnivores), plant eaters .(herbivores), or mixed-food eaters (omnivores). The main phases of digestion are *alike* in these groups. The *mouth* and *teeth* serve to some extent to tear the food to pieces. When animals eat, food are collected in various ways, chewed(mechanically/physically broken down) to increase the surface area for the rest of your digestive system to act on. Carnivores frequently masticate the food less thoroughly than do herbivores. This is related to the greater ease with which animal foods are attacked by the enzymes of digestion. Dry food cannot be easily swallowed unless it has been mixed with *saliva,* which is secreted by the salivary glands. The saliva contains water, a small amount of salts and protein, and a digestive enzyme, *amylase,* which acts on starch. The pH optimum of amylase is neutral or slightly alkaline, which is *also* the normal pH range of saliva.

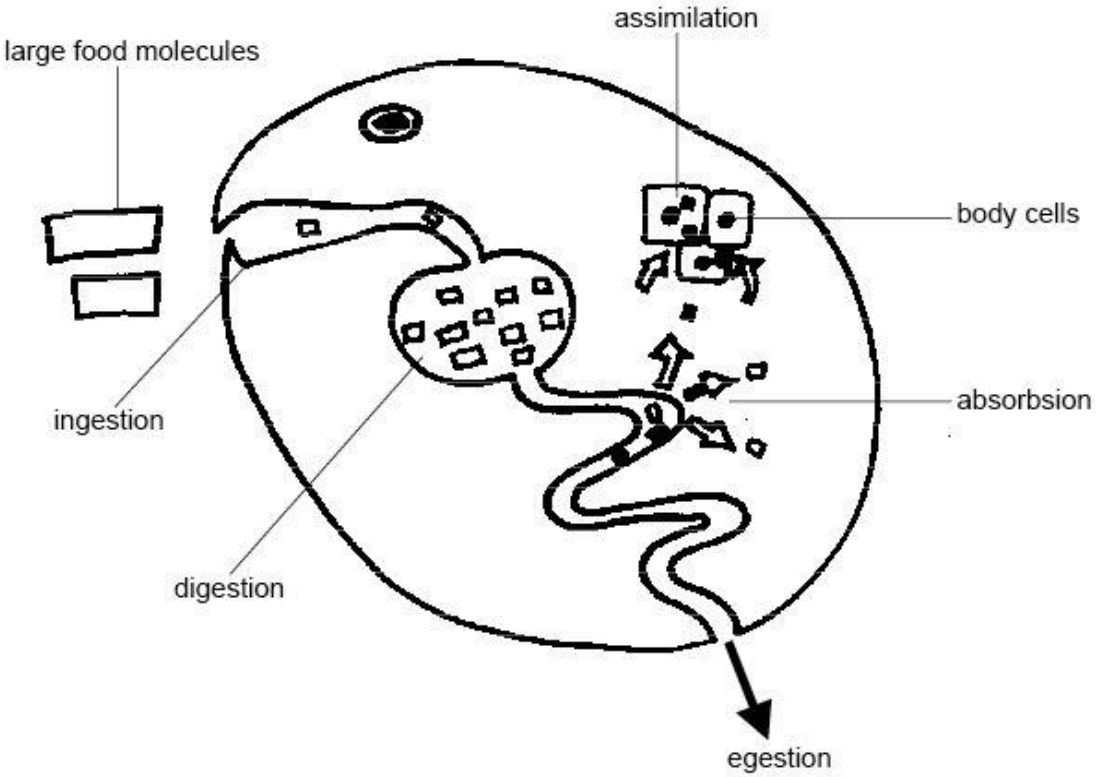
The *stomach* serves as a *reservoir* for food as well as for digestion. Digestion is started in the stomach and intestines and the nutrients are broken down to their final form by enzymes embedded at the site of absorption in the intestinal wall. Most nutrients are absorbed through the microvilli in the small intestine, small protrusions on the finger-like villi that line the intestinal wall. Any foodstuff not digested is excreted.

Glands in the stomach wall secrete protein-splitting enzyme *pepsin* and hydrochloric acid in a concentration of about 0.5 percent. The pH optimum of pepsin is about 2, and the enzyme therefore works well in the acid stomach juice. When the food comes into contact with the acid, the salivary amylase is inactivated, and starch digestion is stopped; thus the only major digestion in the stomach is proteolytic. The strong acid also inhibits bacterial growth, which otherwise would be excessive during the several

hours the food stays in the stomach.

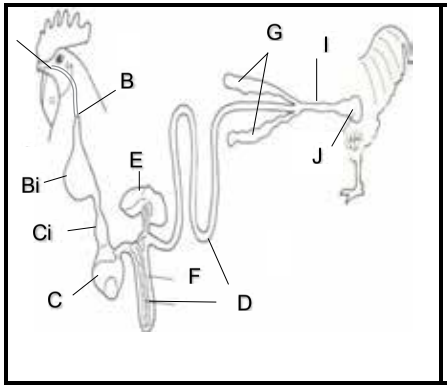
The passage of food from the stomach is controlled by a sphincter between the stomach and the upper intestine. When the sphincter relaxes, a small portion of highly acidic semi-digested food enters the upper intestine. As the acid comes into contact with the intestinal walls, the pylorus sphincter closes firmly so that no more material leaves the stomach.

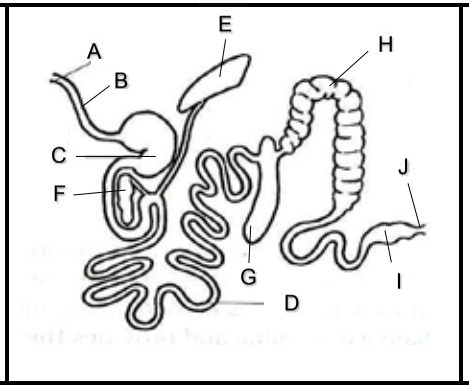
After initial digestion, enzymes chemical breakdown of feedstuff in the digestive system break down complex molecules in to smaller metabolites.

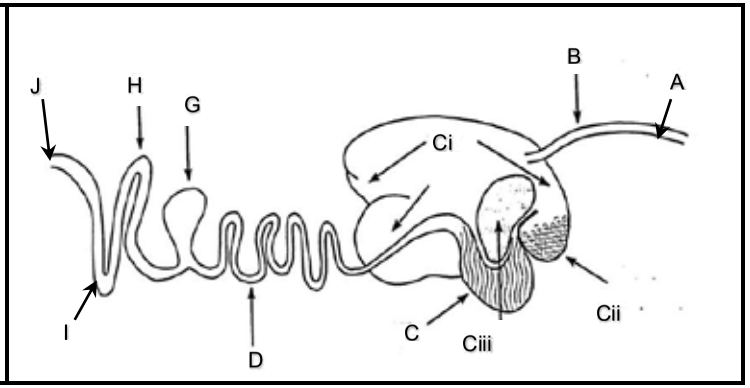


Simplified illustration of the digestion process.

Digestion in farm animals (Ruminant vs Non Ruminant)

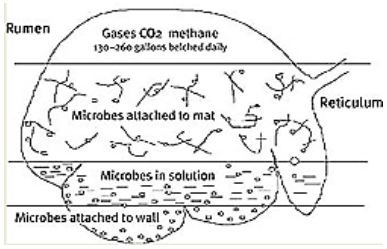


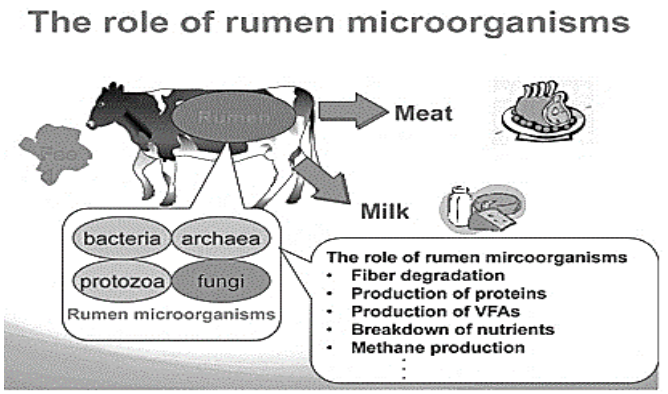




	Fowl	Pig	Ruminant
Mouth/Beak	**Beak** • No lips, no teeth, and no chewing. **Tongue** •Helps in swallowing	**Functions of the tongue** • Acts as a taste organ. • Helps in chewing process. • Helps in swallowing. • Assists in mixing of food. • Detects foreign bodies in the food. • Plays part in intake of food. **a. Function of saliva** • Moistens and lubricates food. • Serves as a solvent of food. • alkaline medium for enzymes reaction • alkalinity acts as antiseptic • Contains enzymes ptyalin which changes starch to maltose.	**Tongue** • Plays part in intake of food • Acts as a taste organ. • Helps in chewing process. • Helps in swallowing. • Assists in mixing of food. • Detects foreign bodies in the food. **Saliva functions** • Binding agent in the formation of bolus. • Absence of enzymes salivary amylase in the saliva of ruminant.

	Intake of food and storage **Crop** • Enlargement of the oesophagus provides storage for consumed food. • Moistened and softened foodstuffs	**Intake of food and storage** • In the oesophagus, the food moves in the form of peristalsis which is the alternating contraction and relaxation of the circular muscles by which the circular muscles by which the circumference of the gullet is enlarged at one place and narrowed at another.	**Intake of food and storage, regurgitation and chewing the cud** • When the cow eats, food is not properly chewed, but swallowed and stored in the rumen, This enables the cow to take in large quantities of food quickly and then later chew it finer, i.e. chewing the cud.  • In resting animals the food is transported back to the mouth by means of reverse peristalsis. This proses is called rumination Process of rumination 1. regurgitate bolus from rumen 2. chew 3. reswallow and falls/taken to reticulum 4. repeat with another bolus • The function of chewing the cud is that food is physically refined and the flow of saliva is stimulated. • The swallowed food falls into the reticulum from where it is passed to the omasum. • Swallowed foreign objects such as nails, glass, wire or plastic collect in the reticulum - Mixing is accomplished by rhythmic contractions of the walls of rumen and reticulum, co-ordinated with movement of other parts of the digestive tract (gastric movements).
Digestion in the stomach	**Proventriculus** • Glandular stomach where the first significant amount of digestive juices are added.(True stomach)	**Digestion in the simple stomach** • The stomach of a pig is lined with thick membrane which contains a large number of glands which secrete gastric juice. • Gastric juice consists of ***water, mucus, salts, hydrochloric acid***	**Digestion in the Reticula-rumen** • The stomach compartments, rumen and reticulum serve as fermenting and mixing vats (tanks). • No enzymes are secreted by rumen. • Digestion takes place with the aid of **micro-organisms** which live in symbiosis with the host.

	Gizzard/Ventriculus • A muscular organ used to grind and break up food. • May contain grit (small stones) picked by animal.	(HCl) and two enzymes ***rennin*** and ***pesinogen***. • Mucus, secreted by the ***cardiac glands***, protects the stomach lining against ***hydrochloric acid***. **a. Function of hydrochloric acid (HCl)** • Creates a desirable pH for enzyme reaction. • Neutralises alkaline reaction of the saliva. • Supplies acid medium for enzymes rennin and pesinogen. • Activates pesinogen which is changed to form pepsin. • HCl changes ***sucrose*** to ***glucose*** and fructose. • HCl is antiseptic – destroys bacteria and prevents rotting • Lubricates the stomach.	**<u>Microbe requirements and importance</u>** • **Roles of different microbes** Three different types of microbes are produced in the rumen namely: i Fungi ii. Bacteria iii. Protozoa  **<u>Rumen flora</u>** • **Bacteria:** ○ Bacterial populations: 109 to 1011/mL – highly specialized bacterial community, all are anaerobes, specific groups specialize in the degradation of cellulose, starch, hemicellulose, sugar, fatty acids, proteins, fats, some autotrophically produce *methane and acetate.* • **Protozoa**  ○ They are primarily ciliates, anaerobes (105 to 106 / ml), some degrade cellulose, starch, carbohydrates *(but compared to bacteria, not quantitatively as important, others are predators.* ○ Ruminants digests protozoa – *thus, some protein contribution to the ruminant's diet is probably easier for ruminant to digest than bacteria.* **<u>Microbe functions</u>** **The importance of rumen microbes** • Increased number of microbes in the rumen is the key to animal production as microbes break down feed to produce volatile fatty acids, which are used as energy for maintenance and production.

			• Rumen microbes are also digested and absorbed in the small intestine of the animal as the main protein source for production, providing up to 70%-90% of a cow's protein requirements.  **Requirements for microbe-activity** • Sufficient mineral nutrients. • Easily digestible carbohydrates.(roughage) • Sufficient nitrogen. • Slightly and medium (pH 6.5 – 7.0). • Favourable temperature of 37 to 40 ° C. **<u>Microbe and host(ruminant) symbiosis)</u>** Cows and microbes actually have a mutual beneficial relationship. Microbes give the cow: • labour to digest feed; • a source of protein; • a source of volatile fatty acids; • the ability to digest forage. Cows provide microbes with: • water; • warmth; • grinding (cut chewing) of feed; • anaerobic (no oxygen) conditions

			Essential nutrients for the microbes
			• **Water**
			  ○ Cows require up to 100 L of drinking water/cow/day. Water maintains the rumen liquid environment, supports microbe metabolism, and dilutes acids in the rumen.
			• **Energy**
			  ○ Most energy for microbes to grow and multiply is sourced from:
			  ○ starches (e.g. cereal grains)
			  ○ sugars (e.g. lush forages, molasses and citrus pulp)
			  ○ Digestible fibre (e.g. forages, cottonseed hulls, palm kernel extract and brewer's grain).
			• **Protein**
			  ○ Microbes use both true protein (e.g. animal protein and plant) and non-protein nitrogen (e.g. urea) for growth and reproduction. Rumen microbes in turn become the largest source (greater than 70%) of dietary protein for the cow.
			• **Minerals**
			  ○ Calcium, phosphorus, sulphur and magnesium are essential for microbes to grow and multiply.
			Influence of feed on digestion
			Feed influences microbe type, digestion and intake
			• The type of feed - especially its fibre content - influences:
			  ○ the type of microbe in the rumen
			  ○ the speed of digestion
			• the total intake of dry matter and nutrients
			  ○ Concentrates and lush forage, contain lower amounts of fibre, build up the quick-working 'floating' microbe population and cause feed to move more quickly through the rumen and digestive system. The cow wants more food, and intake increased.
			• Mature forages contain higher fibre and lower soluble nutrients, which build up the slow-working, fibre-

			digesting microbes and cause feed to move more slowly through the system. The cow feels less hungry, and intake is reduced.
			• **Omasum**
			  o Grinds food between horny, muscular leaves.
			  o Food is dried out; coarse particles are prevented from moving into abomasum.

			Absorption in the reticulo – rumen of the ruminant • Volatile fatty acids, and • Ammonia and carbon dioxide is absorbed directly from the walls of reticulo-rumen and the omasum. • Water and mineral salts (Na, Ca, Mg) are absorbed directly from the rumen.
Liver	**Bile**, which is secreted by the liver, gets into the duodenum via the bile duct		
Pancreas	**Secrete pancreatic juice** through the pancreatic duct into the duodenum.		
Small intestine digestion	Region for digestion and absorption in the animal body The acid chyme, let through in small quantities into the duodenum by the pyloric sphincter, stimulates the mucous membrane of the duodenum to **secrete the hormone secretin**. The **secretin is transported to the pancreas** by the blood where it stimulates the **pancreas to secrete pancreatic juice** through the pancreatic duct into the duodenum. Pancreatic juice contains inorganic salts (mainly sodium carbonate) and the enzymes trypsinogen, chymotrypsinogen, amylase and lipase. The inactive trypsinogen is changed into. active trypsin by the enzyme enterokinase and autocatalytic. The chymotrypsinogen is activated to chymotrypsin by trypsin. The enzymes bring about the following changes: • Trypsin changes proteins and peptones to amino acids. • Chymotrypsin changes proteins and peptones to amino acids. • Amylase hydrolyses starch to maltose. • Lipase hydrolyses emulsified fats to glycerol and fatty acids. Succus entericus (intestinal juice) contains the following enzymes: • Enterokinase which activates trypsinogen to trypsin. • Erepsin hydrolyses peptones to amino acids. • Lipase hydrolyses emulsified fats to glycerol and fatty acids. • Sucrase hydrolyses sucrose to glucose and fructose. • Maltase hydrolyses maltose to glucose. • Lactase hydrolyses lactose to glucose and galactose.		

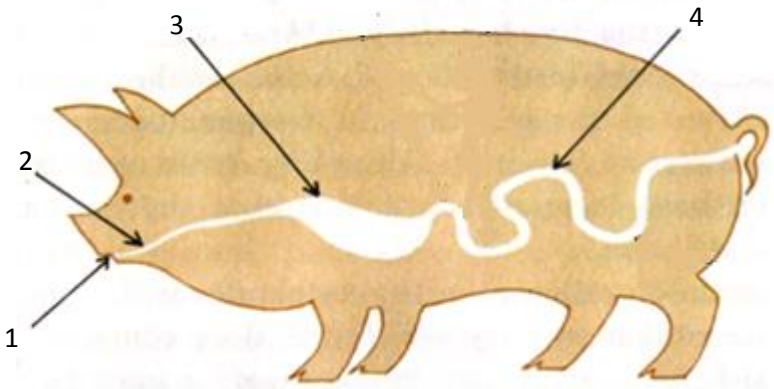
Intestinal absorption	Bile is the third liquid which takes part in the digestion of food in the small intestine. Bile, which is secreted by the liver, gets into the duodenum via the bile duct. It does not contain any enzymes, but sodium and potassium salts of bile acids and residues of red blood corpuscles. • Bile is alkaline and neutralises the acid of the chyme to get the pH right (+8) for the action of the enzymes in the small intestine. • The bile salts emulsify the fats so that the surface is enlarged for the action of enzymes. • The bile salts activate the lipase in the succus entericus and the pancreatic juice. • Bile makes the chyme less liquid so that it moves slower through the small intestine and consequently digestion and absorption are improved. • Bile assists with the absorption of fats from the alimentary canal. The water-insoluble fatty acids combine with the bile salts to form a soluble compound. • Bile is essential for the absorption of vitamins A, D, E and K from the alimentary canal. • Bile is antiseptic, and therefore counteracts putrefaction in the small intestine. • Bile promotes peristaltic movements in the small intestine. **Absorption in the small intestines** • Water, vitamins, amino acids, glucose and mineral salts are absorbed through capillary blood vessels in the villi. • The fatty acids and glycerol are absorbed through the lymph or lacteal in the villi. **Passive vs Active adsorption of Nutrients (Two Mechanisms (diffusion and osmosis) are known as passive transport and the last is known as active transport.)** 1. **Diffusion:** The natural tendency for dissolved substances (compounds of digestion-for example, glucose (the simple sugar formed in starch digestion), (end products of fat digestion, including glycerols, monoglycerides, and fatty acids) are formed in the intestine, they are absorbed / migrate, or *diffuse,* from a place of high concentration to a place of low concentration. When the concentration of glucose in the intestine is high, it may enter the blood by such passive diffusion. 2. **Osmosis** Osmosis dilutes the high-concentration side and increases the concentration of the low-concentration side until the two sides are balanced. Osmosis allows your body to absorb these nutrients into the intestines and individual cells. The process of active transport through the blood then distributes the nutrients to the locations where they are needed. 3. **Active transport**

	Absorption/movement of substances against the direction in which they tend to diffuse passively (that is, movement against the concentration gradient) requires energy and is called *active transport.* Energy is used because substances must be moved against their natural tendency to diffuse in the opposite direction.
Digestion in Large intestines	• Caecum and rectum are involved in reabsorption of water, and the formation of faeces. • Bacterial digestion (fermentation) takes place in the caecum especially in the horse. • The food material reaching the colon consists mainly of cellulose, hemicellulose, lignin and possibly proteins and carbohydrates which are retained by the lignin and are protected against the action of enzymes. The glands in the large intestine **secrete no** enzymes. Therefore digestion is brought about in the large intestine by the enzymes transported with the food and by microbial action. • The **faeces** which are excreted consist of water, undigested food residue, digestive secretions, epithelial cells of the canal, bacteria, inorganic salts and bacterial catabolystic products

1.2.3 Activity

Study the diagram of a pig/ monogastric animal below and provide the following information

1. Identify and describe the following at each of the identified numbers

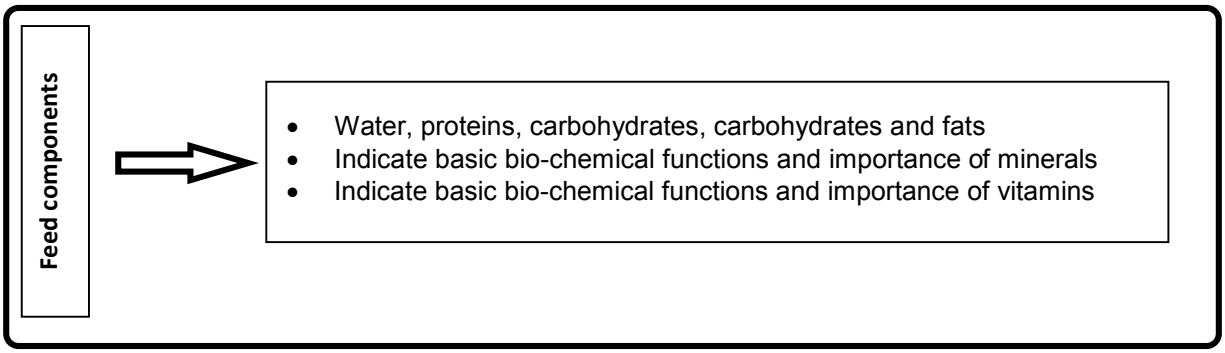


1. Identify the Digestive processes involved in the above illustration (2)
2. Tabulate/List the enzymes, hormones and gastric juices involved in the digestive processes at each location
   (20)
3. Nutrients absorbed at each site (10)

(You can do this activity for each of the three farm animals)

1.3 Components of feeds

At the end of this unit the learners should be able to demonstrate the knowledge of the following content.

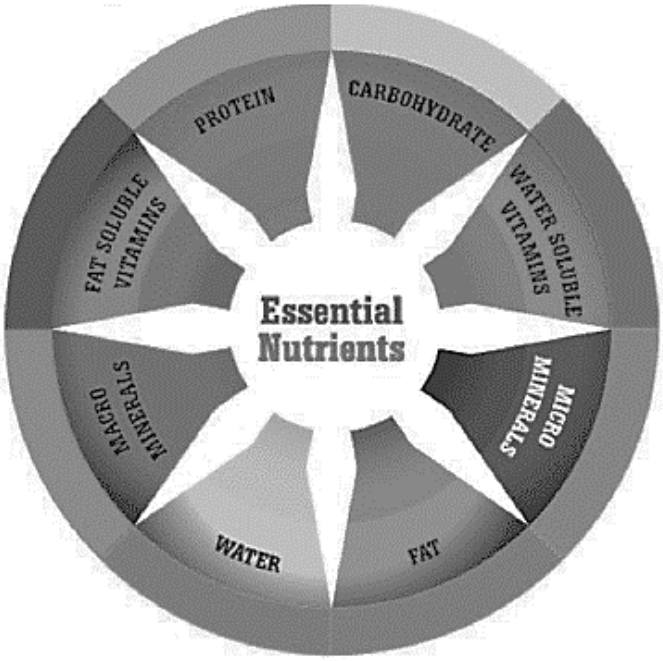


1.3.1 Terminology

TERM	DEFINITION
Amino Acids	-building blocks(monomers) of protein
Concentrates	-feeds that have high percentage of TDN (> 60%) in small volume
Crude fiber	-consists of cellulose and lignin, which are extremely difficult to digest.
Digestibility	-portion food that is absorbed by the body and not excreted
Digestible Nutrient	-The portion of the nutrient which may be broken down (digested) and absorbed and used by the body
Dry matter	-all the constituents of feed except water.
Feed	- a substance, which is eaten by a farm animal and which, after physical and chemical digestion, provides the basic nutrients which the animal needs, for maintenance growth, reproduction and production.
Maintenance ration	-amount of feed needed simply to maintain the body mass and composition of an animal (i.e. support life).
Minerals	-inorganic elements needed in small quantities in an animal's body
Nitrogen free extract	-consists of easily digestible carbohydrates like sugars and starch
Osteomalacia	-the disease found in fully grown animals when too much calcium has been removed from their skeletons.
Nutrition	Nutrition is the science of dealing with the utilization of food by the body processes which transforms food into body tissues, and energy.
Nutrient	A Nutrient is a single class of food or group of foods that aids in the support of life and makes it possible for animals to grow or provide energy for physiological processes.
Production Ration	amount of feed that is over and above the maintenance ration which provides energy for production such as milk, eggs and meat.
Urea	-is a cheap NPN source that can be used by ruminants to synthesize proteins.
Vitamins	-organic compounds needed in small quantities in animal body

1.3.2 Components of feed, sources, compositions and functions.

Nutrients becomes indispensable for life. Carbohydrates, fats, minerals, proteins, vitamins and water as major nutrients are required for the regular functioning of animal system while anti-oxidants and phytochemicals becomes the micro nutrients which will involve in the protection and functioning of some body systems.

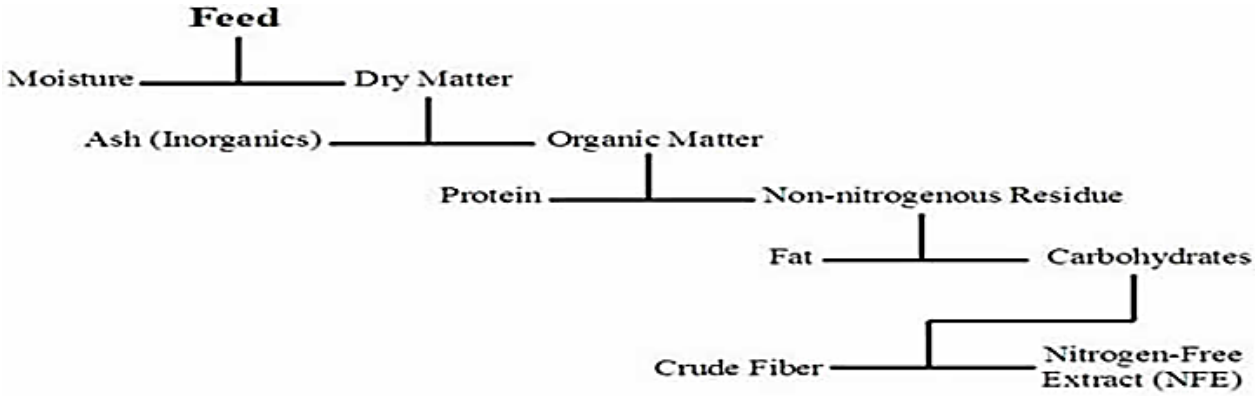


The profitability of farm animals depends on their health and yield, as well as the quality of the produce. A high-quality feed that meets the animals' nutritional needs "at point," reduce feed costs in terms of the amount of feed consumed per unit of produce.

The quality of a feed can be expressed as a feed:yield ratio; yield may be considered in terms of quantity of milk produced (kg) or gain in body weight (BW) per animal per day (g). Animal feeds vary greatly in composition and water content, therefore animal nutrition societies prefer to use feed dry matter weights for comparison.

Why is Nutrition so important?

To obtain and utilize feed stuffs and convert them to desirable products such as meat, milk, eggs, fiber and work.



Components of feed

1.3.2.1 Water

Water is the cheapest nutrient. It provides the basis for all fluid in the animal's body.
Water can be obtained by either drinking it or through the feed it consumes. The dryer the feed the more water the animal needs. Water needs also increase due to higher temperature and also when they are lactating.

Importance

- Over 80% of the animal's body is composed of water.
- A loss of 20% will result in death of the animal.
- Animals generally need about 3 liter of water for every kg of solid feed they consume.
  - The average cow will consume 45 liter of water per day.
- Hard working animals need more water the harder they work.
- Lactating animals requires a lot more water to produce milk for its young

Composition

- H_20(2 hydrogen atoms and 1 oxygen atom)

Functions

- Water is used in the blood supply.
- Digestion requires moisture for the breakdown of nutrients.
- Water is needed in the movement of feed through the digestive tract and in flushing the animal's body of waste through urine.
- It helps regulate the animal's body temperature.
- Chemical reactions
- Shock absorber
- Body support

Sources

- Rivers
- Dams
- Some water comes in the feed itself, such as in succulent green pasture forages and silage.

1.3.2.2 Proteins

No other nutrient can replace protein in the diet. Needed to grow new tissues and to repair old tissues in animals. Every day, 3 to 5 percent of the body's proteins are rebuilt. The highest amounts of proteins can be found in the muscles of animals. The most common nutrient deficiency is that of proteins. Since most feedstuffs are low in proteins, protein supplements may be necessary. Proteins are made up of various combinations of up to 26 amino acids. Amino acids are the building blocks of proteins. Amino acids are classified as either essential or non-essential (Essential amino- acids are components without which the animal cannot survive.
Non – essential amino-acids are components without which the animals can survive)
Importance

- An essential part of all living tissue.
- Needed for maintenance, finishing, work, and wool production, the greatest need is for growth, reproduction and lactation.
- Depending upon the species, the minimum level of protein needed in the ration ranges from 8 to 21 percent.
- More protein is required for younger animals.
- Protein requirements are also higher during the gestation and lactation periods than at other times. Average percentage of nitrogen in a protein remains constant, namely, 16 %.

Composition

Long complex organic compounds that are formed when amino acids combined with each other into polymers.

- Proteins are organic compounds that contain carbon, hydrogen, oxygen, and nitrogen and sometimes iron, phosphorus, and sulphur

Proteins are divided into

CP Crude protein, Digestible protein and made from various amino acids

- **Crude protein(CP)**
  - All of the nitrogenous compounds found in a feed.
  - The nitrogen content of protein averages 16%.
  - Not all crude protein in a feed is digestible.
  - 60% of a roughage ration is digestible.
  - 75-85% of a high concentrate ration is digestible
  - Because ruminants can utilize both protein and NPN through microbial action in the rumen, the use of crude protein value is valid and realistic when balancing ruminant rations.
  - Non-ruminant animals cannot use the amides (NPN) as a substitute for the essential amino acids.
- **Digestible Protein (DP)**
  - A rations approximate amount of protein available for use by the animal.
  - Is the difference between the protein content of the feed and what is found in the faeces
- **Amino -acids**
  - Organic acids containing one or more alpha-amino groups that form the building blocks of proteins.
  - There are 20 to 22 amino acids commonly found in proteins.

Functions of proteins

- Protein provides amino acids to build new tissues (growth).
- Required for the production of enzymes and hormones.
- Excess proteins are de-aminated to serve as source of energy.
- Required for reproduction.
- Required for production of wool, meat, eggs and milk.
- Serve as building blocks of supportive structures in the body.
- Repair worn-out tissues.

Deficiency

Symptoms of a protein deficiency include anorexia, slow growth rate, decreased feed efficiency, low birth weight, and lower milk production. Young animals need diets higher in proteins than older animals. Animals in gestation or lactation stages also need higher levels of proteins in their diets

Protein deficiency

- A shortage of protein in the diet results in a variety of symptoms.
- Including depressed performance, higher production costs.
- Unthriftyness, poor hair coat.

Protein Sources

Types of proteins

- Plant proteins – these are of plant origin / the source is plants.
  - soybean meal, cottonseed meal, , and legume hay
- Animal proteins – they are of animal origin / the source is animal.
  - fish meal, carcass meal, blood meal, chicken manure etc
- Synthetic proteins – they are artificially produced. (NPN – Non-protein nitrogen (Urea))
  - A non-protein nitrogen compound that contains 45% nitrogen. Manufactured by combining atmospheric nitrogen with ammonia and carbon dioxide. Most common of the non-protein nitrogen sources used in ruminant rations.

1.3.2.3 Carbohydrates

Plants create carbohydrates via photosynthesis and supply carbohydrates and most of the energy needed by animals especially ruminants. Carbohydrates make up 65 to 75 percent of the dry weight of most grains, forages, and roughages. They include sugars, starch, cellulose, hemicellulose and lignin.

As crude fiber increases, digestible energy usually decreases. In most concentrate feeds, crude fiber is the less digestible portion and nitrogen-free extract (NFE). NFE the most digestible portion of the carbohydrates

Microorganisms in the rumen use fibrous materials such as cellulose and hemicellulose as energy sources. Because of bacterial fermentation of cellulose and hemicellulose to fatty acids, ruminants can utilize roughages and forages as sources of energy better than non-ruminants. Feeds high in cellulose can furnish most of the ruminant's energy needs when only small amounts of energy are needed above maintenance.

Importance

- Carbohydrate functions as a hormone - Many hormones like FSH (Follicular stimulating hormone which takes part in ovulation in females) and LH (Luteinizing hormone) are glycoprotein and help in reproductive processes.
- The microbes get ATP (energy) from reducing carbohydrates, and thus use the energy for their own actions
- As a side product, the rumen microbes create volatile fatty acids (VFA). VFAs are absorbed into the ruminant through the rumen wall, and they in turn become the major source of energy for the animal
- Crude fiber is needed for normal functioning of alimentary canal.

Composition

- Organic compounds made of carbon,(C), Hydrogen (H), & Oxygen (O).
- Each C_2H_2O molecule is made up of 40% C, 7% H and 53% O2.
- 75% of all the dry matter in plants is carbohydrates

Carbohydrates are divided into two groups:

- **Fiber (Crude Fibre)- insoluble carbohydrates**
  - lignin, cellulose and hemicellulose
  - Fiber less efficient feed than NFE because hemicellulose and cellulose require more energy, they are less efficient sources of energy for the animal.

- **Nitrogen-free extract (NFE) - soluble carbohydrate of the *feed***
  - The NFE includes sugar, starch and some hemicelluloses.
  - Sugars are the most easily digested while cellulose and lignin are more difficult.
    - Monosaccharide's/ simple sugars: glucose, fructose and galactose
    - Disaccharides / double sugars: maltose, sucrose and lactose
    - Polysaccharides / many sugar units joined together to make large carbohydrate molecules / macro-molecules: starch glycogen and crude fibre.
  - Glucose is the basic compound of all different carbohydrates that are synthesised.
    - e.g. glucose + glucose = maltose
    - glucose + fructose = sucrose
    - glucose + galactose = lactose

Functions of carbohydrates

- Carbohydrates are an important source of heat energy.
- Fattening of farm animals.
- Carbohydrates are stored as glycogen in the liver and muscles as glycogen (animal starch).
- Crude fiber provides bulkiness to ration.

Sources

- The most important source of carbohydrates for animals is grain.
- Grain is also known as concentrates because of the high concentration of carbohydrates which are high in energy.
- Forages fed to animals are called roughages because of the amount of fiber in the diet. Roughages are generally low in net energy.

Factors to consider when feeding carbohydrates

- Grains have a high feeding value because the starch is easily digested.
- Ruminant animals because of bacterial action in the Rumen can utilize large portions of coarse roughage.
- Non-ruminants have less ability to utilize energy from fiber.
- The young of all species require more easily digested feeds.

1.3.2.4 Fats and oils (lipids)

Fats are builds from fatty acids, much like carbohydrates are built from saccharides. Plant fat has usually more unsaturated fatty acids than animal fat. Fats in general belong to lipids, which include also phospholipids and steroids.

Importance

- Fats have twice as much energy as carbohydrates, approximately 39 MJ/kg.
  Fat for farm animals is important only when they are young, and receive most of their energy from the fat in their mother's milk.
- For ruminants, poultry and pigs, carbohydrates are more important.

Composition

Lipids are 77% C, 12% H & 11% O.

- Simple lipids are true fat and waxes. At room temperature fat are solids and oils are liquid
- Compound lipids are esters, which contain groups in addition to an alcohol and fatty acid. Cholesterol is included in this category of organic compounds.
- Fatty acids are either saturated or unsaturated
- Lipids are derived from simple or compound lipids, separated by hydrolysis (will not dissolve in water)
- Volatile fatty acids
  Ruminants bacteria in the rumen create volatile fatty acids (VFAs) with the energy they receive from reducing carbohydrates. The most important three volatile fatty acids for ruminants are acetic acid, propanoic acid and butyric acid. Acetic acid is used to synthetize 50 % of the fats in milk.

Functions

- Fats in the body are used in electron transfer,
- As a reaction medium,
- cell membranes and as stored energy.
- Plants have fats in their leaves and cell membranes, where they are stored as oils. Fats are used as fatty acids, of which three are necessary:

Functions of lipids

- Lipids build up all cell membranes.
- They form water repelling (hydrophobic) layers.

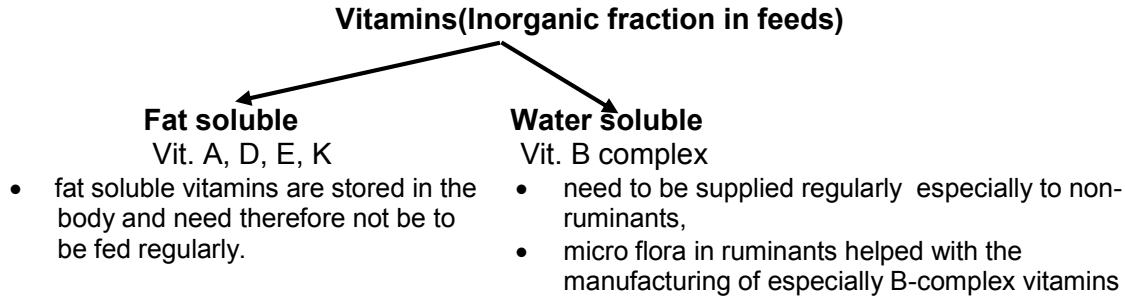
- Lipids are a concentrated source of energy.
- Carriers fat-soluble vitamins, Assist in the absorption of vitamins.
- They also provide
    - energy reserves,
    - Form a protective layer against shock (kidneys), protection for vital organs, and
    - Fatty layer under the skin serve as an effective insulator

Sources

- The most important sources of fats in feed for agriculture animals are the grains that contain oil such as corn and soybeans
- The most important sources are oil seeds and oil cakes.

1.3.2.5 Vitamins

Though vitamins, minerals and water do not provide energy, they are required for multi-various functions of the body.



Importance of vitamins

- Vitamins are essential organic nutrients, required in small amounts
- Required for growth, maintenance, reproduction and lactation.
- Helps regulate body functions

Sources:

- Naturally found in feed
- Feed additives made from animal by-products
- Must be obtained from sources like feed, rumen bacteria & sun.

Fat soluble vitamins(A, D, E and K)

Vitamin	Sources	Functions	Deficiency
Vitamin A Most important vitamin needed by all farm animals especially pregnant females. Important for vision, especially night vision, bone formation, renewal of epithelial tissue, fertility. Also an antioxidant.	Found in green plants (carotene) reserves are stored in the liver. (winter)	• Functions in eyesight and bone formation. • Aids in building up resistance to infection. • Normal reproduction. • Development healthy skin and nerve tissue.	• Night blindness • Lowered resistance to disease, • Lower fertility and slow growth. • Rough hair coat, swollen legs in cattle,
Vitamin D Sunlight converts pro-vitamin D to vitamin D. Vitamin D is needed by all farm animals and the reserve is stored in the liver.	Sun-dried hay is a good source Sunlight: - The precursor for vitamin D exists in the skin. It turns into D-vitamin in sunlight or UV-light, and absorbs	• Improves the absorption and metabolism of Ca and P. • Improves growth and immune system of animals.	• Rickets in young animals causes weak bones. • Osteomalacia in adult animals causes brittle bones. • Reduced growth and food intake drops.

	them into the body.	• Plays a role in DNA synthesis and genetic expression.	
Vitamin E is an important antioxidant that interacts with selenium to provide protection to cells and tissues and is involved with immune function and muscle development.	Germ or germ oils of plant seeds and green plants, plant feeds, especially vegetable oils and whole grain products Oil seeds Cereal grains	• Aids in the prevention of muscular dystrophy in young calves. • Acts as an antioxidant, protecting the unsaturated fatty acids in cell membranes from oxidization. • Supports blood circulation, immunology and fatty acid synthesis is required for animal growth,	• Stiff lamb disease in sheep./muscular dystrophy • Reproductive disorders in mature animals • Embryo failures in fowls
Vitamin K Required vitamin K produced in the digestive system of animal by synthesis of bacteria. The synthetic vitamin K is water-soluble, but in the liver it is transformed into a fat-soluble form	Green leafy plant are good source of vitamin K Fish meal	• Essential for clotting of blood (prothrombin).	• Anaemia can hinder blood clotting in farm animals that leads to bleeding.

Water Soluble Vitamins(C and B complex)

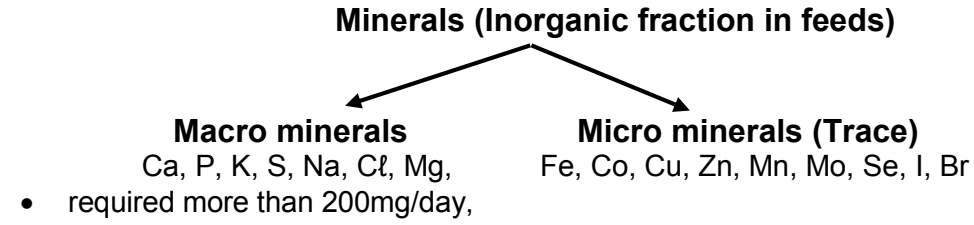
These are vitamins dissolved by water. As water passes through the body, it carries out water-soluble vitamins. Thus, these vitamins need to be consumed every day by monogastric animals. Water-soluble vitamins are made by microorganisms in the rumen of a ruminant animal and by fermentation in the caecum of the horse

Vitamin	Source	Functions	Deficiency
Vitamin B Complex Classified into two groups. **Group I B** vitamins include thiamine, riboflavin - **Group I B** vitamins are involved in the release of energy from feed nutrients. **Group II B** vitamins include folic acid and vitamin B12 - Group II B vitamins	Vitamin B are often bound to proteins, so they are metabolized as proteins.	• Coenzyme in energy-releasing reactions, coenzyme in RNA and DNA formation, , niacin), • Control the formation of red blood cells	Symptoms depend on which vitamin B the animal is lacking. There can be e.g. weight loss, neurological dysfunction, convulsions, skin infections, hypertension, diarrhea, lesions and anemia.
Vitamin B_1 (thiamine) Soluble in water and known as anti-neurotic vitamin	Cereals, beans, peas and green leafy fodders	• Neurological functions (thiamine), • Maintains muscle tone in the stomach & intestines, preventing constipation/ bloating	• Loss of appetite and mass. • Polyneuritis could lead to paralysis of hind legs. • Lowered fertility. • 'Star gazer' position in chickens. • Lactation decreases

		• Provides nourishment of digestive organs • Supports healthy mucus membranes	
Vitamin B_2 (Riboflavin)	Yeast, milk and leafy green fodders	• redox-reactions (riboflavin • Normal growth • Support the development of anti- bodies	• Dermatitis (skin rash in pigs. • Curled toe paralysis in chickens. • Lowered resistance against diseases.
Vitamin B_{12} B_{12} is an exception, it can be stored to some extent it is also closely associated with Cobalt for synthesis	B-vitamins are synthesized in the rumen and large intestine.	• **B_{12}** concern metabolism of nucleic acids and proteins, • it also functions in metabolism of fats and carbohydrates.	• Retarded / slow growth. • Poor hatching of eggs. • Staggering and wasting disease. • Curled toe paralysis in chickens.

1.3.2.6 Minerals (Inorganic Fraction)

Supplementation of minerals are important in livestock production to maintain high levels of production.



- required more than 200mg/day,

Minerals are broadly classified as macro minerals which are micro minerals or trace minerals should be differentiated from another group of minerals, “toxic minerals”.

Entry into the body:

Minerals in soil gets absorbed by the plants/grass and most chemical elements will be in simple form and larger chemical compound elements need to be broken down for absorption and so the type of soil and the feed plays a vital role in determining the mineral supplementation of any livestock in that particular area.

In ruminants, the gut bacteria provides Vitamin B12 which is very helpful in the consumption of cobalt and these type of minerals are even called as bio minerals.

Trace minerals & toxic minerals becomes the usual keys to be manipulated with an animal which is non-productive.

Macro Minerals			
Mineral	**Source**	**Function**	**Deficiency**
Calcium**(Ca)**	Most grasses are adequate in calcium	• Formation of bone and teeth. • Blood clotting. • Maintains acid-base equilibrium	• Pica, Rachitis, Rickets, Osteomalacia
Phosphorus**(P)**	Forages are low in phosphorus, particularly late in the	• Bone ad teeth formation.	• Pica, Rachitis, Rickets, Osteomalacia.

	growing season need to supplemented with phosphorus concentrates	• Important part of cell membrane. • Metabolism of carbohydrates. • Components of proteins and phospho-lipids.	
Sodium**(Na)** and Chlorine**(Cl)**	Ordinary salt	• regulate body pH and the amount of water retained in the body. (Osmotic pressure in body) • Important for normal kidney function	• Loss of appetite and inefficient weight gains or body weight loss
Potassium**(K)**	Grasses, particularly early spring growth, contains adequate amounts of potassium and supplementation is rarely needed.	• Maintains acid-based equilibrium. • Regulates osmotic pressure in body – water balance in body	• affects intake, • productivity, • heart function, • muscle function.
Magnesium**(Mg)**	Magnesium oxide	• Activates enzymes in nerve impulses. • Efficient carbohydrate metabolism • Essential part of bone structure.	• grass tetany or hypomagnesaemia • Weakening of bones
Sulphur**(S)**	Sulphur : Need only supplementation when high levels of NPN is used	• Activates enzymes innerve impulses. • Part of the hormone insulin. • Rumen microbes require sulphur for protein synthesis. • part of the essential amino acids	Normally no deficiency

Micro Minerals(Trace)			
Mineral	**Source/Supplement**	**Function**	**Deficiency**
Iron**(Fe)**	Green leafy plants and legumes	• Needed for haemoglobin formation of red blood corpuscles. • Part of enzymes that transport oxygen	• Anaemia - reduce oxygen carrying (haemoglobin) content of the blood
Copper**(Cu)**	Seeds and by-products are rich in copper	• Copper fixes iron in haemoglobin. • Formation of wool and hair. • Normal calcification of bones. • Maintenance of fertility	• Swayback • Wool loses crimp and hair discolouration • Lower fertility • Reduced growth rates, • decreased feed conversion, • lameness, • poor immune function, • impaired reproductive function
Cobalt**(Co)**	Most forages sufficient or added in the mineral mix	• Needed to synthesise vitamin B12 by rumen bacteria	• Loss of appetite and poor growth -Wasting disease.

Selenium**(Se)**	Sources rich in Vit E also prevents selenium deficiency	• maintaining a healthy immune system	• This disorder is called nutritional muscular dystrophy (NMD) or white muscle disease • retained foetal membranes (RFM) • premature, weak calves,
Zinc**(Z)**	Zinc methionine, an organic form of zinc	• Prevents parakeratosis. • Promotes the healing of wounds. • Promotes growth and feed utilization	• leads to depressed feed intake and growth • abnormal hair coat and skin lesions.
Iodine**(I)**	Iodine compounds	• Iodine makes up part of the thyroid hormones	• Goitre.
Manganese**(Mn)**		• part of several important enzyme systems	• Impaired reproductive performance in both cows and bulls and in the birth of deformed calves.

1.3.3 Activity

1. For each of the listed conditions regarding deficiency list the correct mineral/vitamin to each deficiency as mentioned

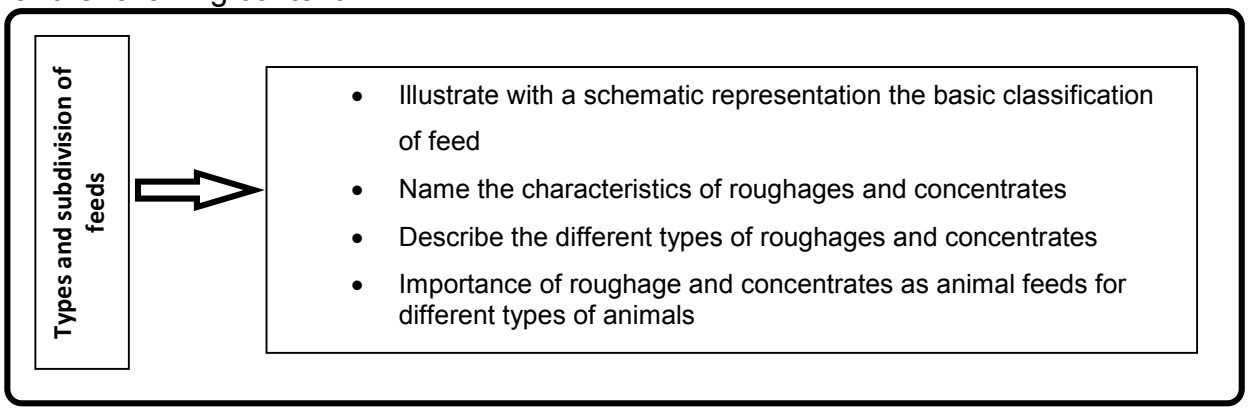
Mineral Deficiencies	Mineral		Vitamin Deficiencies	Vitamin	
Abnormal bone growth		(1)	Abnormal bone growth		(1)
Anemia		(1)	Paralysis		(1)
Decreased growth		(1)	Decreased appetite		(1)
Deformed bones		(1)	Impaired vision		(1)
Enlarged thyroid gland		(1)	Increased susceptibility		(1)
Lameness		(1)	to infections		(1)
Milk fever		(1)	Poor blood clotting		(1)
Paralysis		(1)	Unthrifty appearance		(1)
Poor feed efficiency		(1)	Loss of hair		(1)
Poor hair coat		(1)	Poor coordination		(1)
Reduced feed intake		(1)	Poor growth		(1)
Reproductive problems		(1)	Reproductive problems		(1)
Rickets		(1)	Rickets		(1)
Skin disorders		(1)	White Muscle disease		(1)
Stiffness in the joints		(1)			
Unthrifty appearance		(1)			
Weakening of the bones		(1)			
White Muscle disease		(1)			

2. Answer the following questions

1. Name the six classes of essential nutrients. (6)
2. Describe 4 functions of proteins. (4)
3. Name two sources of proteins. (2)
4. List two symptoms of protein deficiency. (2)
5. Name the seven macro-minerals. (7)
6. Describe the function of calcium and phosphorus. (2)
7. What is the typical source of sodium and chlorine? (2)
8. Name the 7 micro-minerals 1 source and 1 deficiency. (14)
9. Name the four fat-soluble vitamins. (4)
10. What is the function of vitamin D? (4)

1.4 Types and subdivision of feeds.

At the end of this unit the learners should be able to demonstrate the knowledge of the following content.

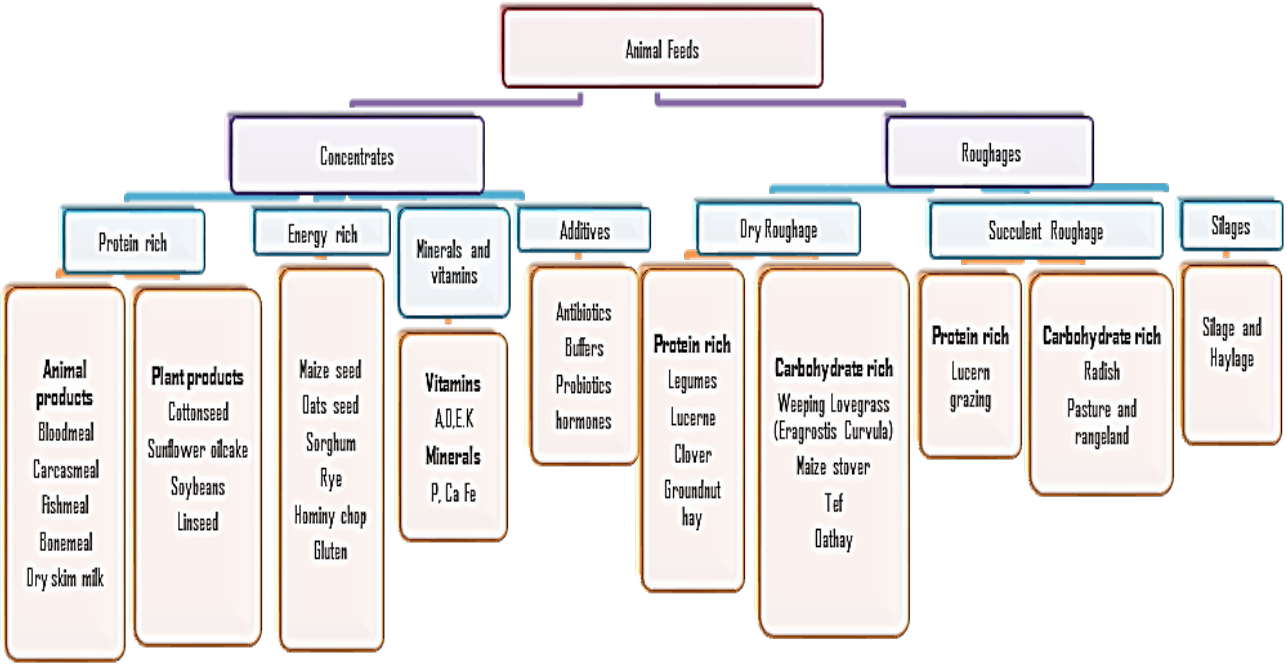


1.4.1 Terminology

TERM	DEFINITION
Balanced Rations	-feed that supply the needed nutritional requirements to farm animals
Bloating	- accumulation of gases in the rumen, causes excessive constipation which may be fatal to the animal.
Cafeteria style	– the type of mineral provision that depends on the animal to take in as much as it requires.
Concentrates	- feeds that have high percentage of TDN (> 60%) in small volume
Dry matter	- all the constituents of feed except water.
Forage	- is plant material eaten by grazing livestock
Fodder	- a type of animal feed, is any agricultural foodstuff used specifically to feed domesticated livestock,
Maintenance ration	-amount of feed needed simply to maintain the body mass and composition of an animal (i.e. support life).
Molasses	-a sugarcane by-product energy supplement added to a winter lick for ruminants.
Nitrogen free extract	-consists of easily digestible carbohydrates like sugars and starch
Production ration	-the additional amount of feed an animal needs on top of the maintenance ration in order to do work and for production
Roughages	- feeds that have small percentage of TDN (< 60%) in small volume
Silage	-is a fermented feed resulting from the storage of green forages under anaerobic conditions
Feed Supplements	Feed supplements are the compounds used to improve the nutritional value of the basal feeds so as to take care of any deficiency
Feed Additives	Feed additives are the non-nutritive substances usually added to basal feed in small quantity for the fortification in order to improve feed efficiency and productive performance of the animals. Some commonly used feed additives are as below

1.4.2 Classification of Animal feeds

Animal feeds are classified as either roughage or concentrates.



Roughage consists of grass (from pastures, meadows, or from cropping) or other fodder crops, (e.g., maize, legumes, cruciferous plants). Roughage is predominantly given to ruminants who digest fiber with the assistance of microbes in their forestomach (rumen), and may be supplied fresh (green) or preserved (ensiled, sun dried, or artificially dried).

The concentrates mainly consist of cereal and legume grain (generally below the quality required for human consumption) and residues of flour, starch and alcohol produced from cereal grains, i.e., bran-, corn-,or wheat-gluten feed, or of oil extraction, i.e., solvent extracted meals from soybean, rapeseed, sunflower, cottonseed, linseed, peanut and other oilseeds.

Farmers' choices of what to feed their livestock are determined by factors such as:
- the age and species of the animals concerned,
- their intended products (meat, milk or eggs),
- the price and availability of feed materials,
- their nutritive value and
- time of year and the geographical location (soil type and climate) of the farm

The energy and nutrients that feed provides occur in different proportions in different feeds and materials, and for many animals a typical diet will consist of a combination of feeds to provide everything they need for their health, welfare and production. Ruminants (cattle, sheep and goats) are an exception to this because grass may be the only ingredient in their diet for much of the year and some supplements in certain regions.

1.4.2.1 Concentrates

- Concentrates are either protein-rich or carbohydrate (energy)- rich.
- They are not bulky, contain less than 18 percent crude fibre
- Have a high nutritive value (a high percentage of digestible nutrients)., i.e. >60 % TDN.
- Are more expensive.
- Mainly for production of milk, eggs, energy and fat
- Concentrates are further classified as:
  - Energy Rich Concentrates – e.g. Cereal grains, cereal grain byproducts,
  - Protein Rich Concentrates – Plant origin e.g. Oilseed cake, Brewer's grains and yeast. - Animal origin e.g. Fish meal, Meat meal, Blood meal

Functions of concentrates

- Pigs and fowls feed on concentrates, because they cannot digest roughages.
- Protein- or carbohydrate-rich concentrates balance roughages according to the needs of the ruminant.
- Used for increased milk and meat production.
- Necessary for reproduction.

Protein-rich concentrates	**Characteristics of fish meal**	**Suitability of fish meal**	**Suitability for supplying energy**
Examples - fish meal, oil cakemeal's, and lupin seed.	• The valuable high protein content makes it expensive. • Has high BV due to the presence of amino acids. • A good source of vitamins A, D and B12. • Excellent protein supplement for young growing animals and high producing single stomach animals e.g. pigs.	• Growth – suitable for growing young animals. • Fattening – not suitable too expensive to be used for fattening. • Production – very suitable in rations of cattle, sheep and pigs. • Energy – not suitable must be used in small quantities – very expensive	• Must be used in small quantities, as it is very expensive
Energy rich concentrates	**Characteristics of maize meal**	**Suitability of maize as a concentrate**	**Suitability for supplying energy**
Examples are Maize meal and Oatmeal	• Very tasty and the best fed for all farm animals. • Forms the bases for production rations (meat and milk) • Contains a high percentage of carbohydrates and fat. • Highly digestible in all types of animals. • Cannot feed large quantities to pigs	• Growth – not suited for young growing animals. • Fattening – very suitable. • Production – unsuitable for protein-rich products e.g. eggs. • Energy – very suitable.	• Very suitable • Balances roughage. • Ideal for pigs and fowls. • Increase milk and meat production. Fattening

1.4.2.2. Roughages

Roughages are the feed stuffs which contain more than 18 percent crude fibre and less than 60 percent Total Digestible Nutrients

Examples of roughage

- Silage
- Grazing
- Hay

Characteristics of roughage

- Roughage is bulky.
- Contains little digestible nutrients, i.e. < 60 % TDN.
- Has a high crude fibre content.
- Dry roughage is divided into protein-rich and carbohydrate rich.
- Divided into **dry roughage** (contain about 10-15 percent moisture) or **succulent (green fodder,) roughage** –containing about 60-90 percent moisture. eg. Pastures, cultivated fodders, tree leaves, root crops and silages.

Function of dry roughages

- Ruminants are dependent on roughage.
- Cheapest source of feed.
- Provides bulkiness to the ration.
- Roughage enhances rumen development in young ruminants.
- Dry roughage prevents bloating in ruminants

Protein-rich roughage	**Characteristics of Lucerne Hay**	**Suitability of Lucerne hay**	**Suitability for supplying protein**
Examples: Lucerne hay, Cowpea / Peanut Hay	• Most nutritious of all hays. • Extremely rich in calcium. • Relatively rich in proteins. • Lucerne is palatable. • Green Lucerne tends to cause frothy bloat in ruminants	• Growth – suitable for growth purposes.. • Production – extremely suitable especially with ruminants. Energy – excellent for horses, but must be supplemented with mealie meal Fattening – unsuitable, needs a supplement of maize	**Good**
Carbohydrate-rich roughage (Protein poor	**Characteristics of oat hay / straw**	**Suitability of oat hay**	**Suitability for supplying protein**
Examples: Mealie plants, oat hay, straw from cereals, grasses	• Poor in protein. • Very tasty. • Low digestibility. • Cheap roughage. • Poor in vitamins and minerals. • Supplies the bulk to the ration.	• Growth – unsuitable for growing animals. • Fattening – suitable, if supplemented with carbohydrate-rich concentrate. • Production – must be supplemented with protein-rich concentrate. Energy – poor if not supplemented	**Low**

1.4.2.3 Balancing a ration.

To achieve the best production from your farm animals you must provide them with optimum nutrition throughout the production cycle. A ***ration*** is the amount of feed an animal receives in a 24-hour. ***Rations*** must be properly ***balanced*** for farm animals to use feeds most efficiently. ***Ration balancing*** is another management tool the efficient producer can use to maximize profits.

An easy way to balance a ration is the use of the **Pearson Square. The Pearson square** can be used for balancing protein feeds and energy feeds

Step by Step

Step 1.

Draw a square and write the percentage of the required nutrient number in the middle of the square. That number represents the nutritional requirement of the animal. E.g. CP – Crude Protein

Step 2. Write the CP of the available feeds to use in the ration on the left of the square at each corner. NB select the feeds so that the number in the middle of the square fall between the numbers on the left.

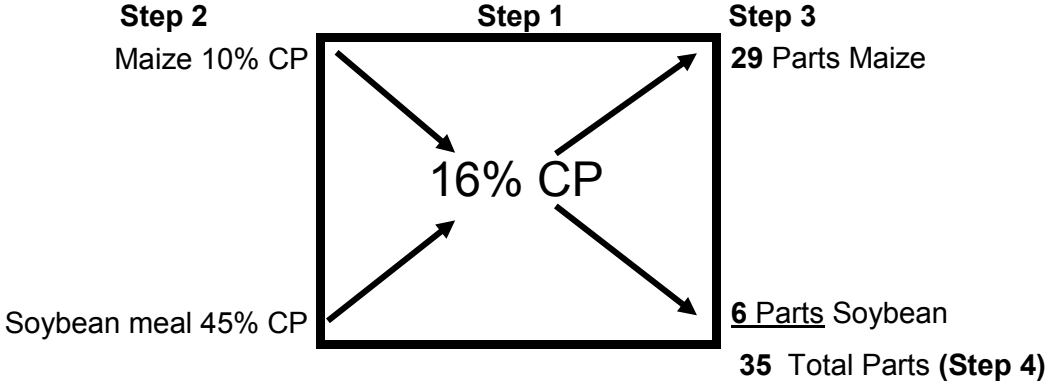
Step 3. Subtract the nutrient values on the left from the nutritional requirement in the middle disregarding any negative as follows. The subtracted value from the top left corner is written at the bottom right corner and visu versa.

Step 4. Add the subtracted values of the feedstuff parts together to determine the total.

Step 5. Divide the ingredient for which you want to know the ration by the total parts. Multiply by 100 to determine the percentage. Round if necessary.

Step 6. To determine the amount of each feed ingredient, multiply the percentage of each ingredient by the total amount of feed desired.

Eg. Mix a ration with 16% CP nutrient requirement for cattle using Soybean meal and Corn as feedstuffs. Calculate the percentage of feed used in the ration. Also the kg of each feed needed in a 500 kg mixture.



Ratio of maize to Soya (29:6)

Step 5

To determine the percentage of Maize to use in the ration 29/35 * 100 = 83%
Determine the % of Soybean meal to use in the ration 6/35*100= 17%

To determine the kg of maize meal to use in a 500kg ration ∴ 500 x .83 = 415kg
Determine kg of soybean meal to use in 500kg ration ∴ 500 X .17 = 85 Kg
500 kg

Thus in a 500kg feed mixture you will the mix 415 g maize meal and 85 kg soybean meal to get a 500kg ration with 16% CP to feed to cattle.

1.4.2.4 Feed supplementation –

The provisioning of additional feedstuffs to the animal to improve the growth and production of the animal.

Methods of supplementation

- Mineral supplementation options include
    - purchasing a commercial supplement to add to feed or water
    - using a home-mix or Non-Protein Nitrogen N.P.N (e.g. Urea and Biuret)
    - having the mineral supplement custom-mixed,
- Injection
    - mineral options – Mineral mixtures, Iron for pigs etc.
    - Vitamins – Vitamin mixtures (A and D)
    - Growth hormones in the ear
- Feed additives – antibiotics and amino-acids (methionine, lysine)
- Dosing (cobalt)
- Soil sods (iron supplementation for piglets)- Indigenous method
- Drinking troughs (mono-sodium phosphate)

Feeding Mineral supplements/mixes

- Mineral feeders – protected from rain to avoid wastage and poisoning
- Cafeteria-style mineral provisioning animals choose based on palatability of supplement controlled by the addition of SALT

1.4.3 Activity

Complete the following

1. ...1) are the feedstuff which contain more than 18 per cent crude fibre. ...2) are the feedstuff which contain less than 18 per cent crude fibre. ...3) are the compounds used to improve the nutritional value of feeds. Dry roughages contain ...5) percent moisture.

2. Analyse the nutritional information on the label below.
   a) Divide the list of ingredients into the six classes of essential nutrients? At least 2 ingredients per nutrient. (12)
   b) What is the percent protein? (5)
   c) Which minerals does the food contain? (6)
   d) Which vitamins does the food contain? (3)
   e) Calculate the kg protein in a bag if the bag weighs 50 kg (2)
   f) Name one amino acid used in the feed

FEED LABEL

Guaranteed Analysis

Protein, min.	12.00%	Copper, min.	65.00 ppm
Fat, min.	5.50%	Selenium, min.	0.60 ppm
Fiber, max.	23.00%	Selenium, max.	0.61 ppm
Lysine, min.	0.70%	Vitamin E, min.	225.00 IU/lb
Calcium, min.	0.80%	Vitamin A, min.	3500.00 IU/lb
Calcium, max.	1.00%	Biotin, min.	3.6 mg/lb
Phosphorus, min.	0.50%	Starch, max	7.0%
Magnesium, min.	0.50%	Sugars, max.	4.0%
Zinc, min.	220.00 ppm		

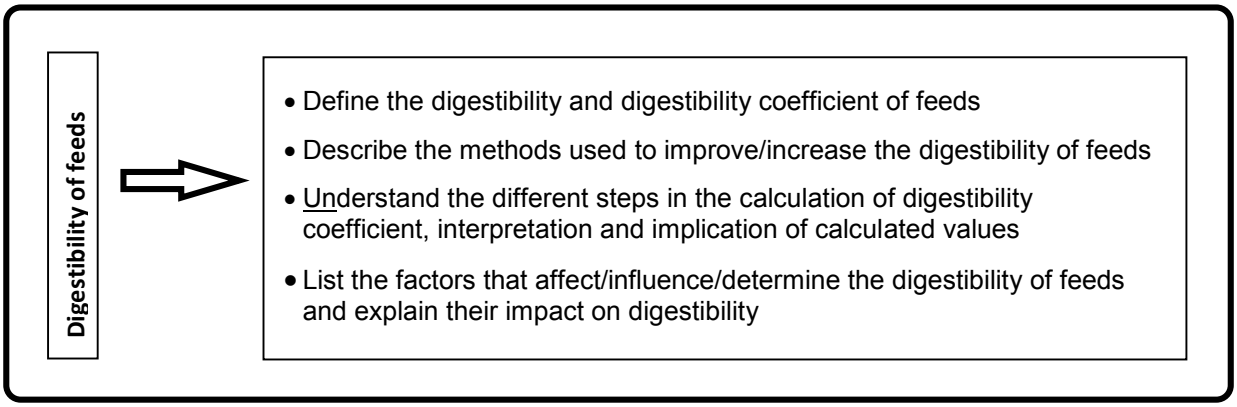
Ingredients

Alfalfa, Shredded Beet Pulp, Wheat Middlings, Ground Oat Hulls, Ground Soy Hulls, Ground Flaxseed, Soy Oil, Calcium Lignin Sulfonate, Calcium Carbonate, Mono-dicalcium Phosphate, Salt, Vitamin A, Natural Flavor, Vitamin C, Biotin, B12 Concentrate, Calcium Pantothenate, Choline Chloride, Natural Vitamin E, Tocopherols, Vitamin D, L-Lysine, Magnesium Oxide, DL-Methionine, Niacin, Riboflavin, Selenium, Thiamine, Cobalt Carbonate, Copper Sulfate, Ferrous Carbonate, Manganous Oxide, Calcium Iodate, Zinc Oxide.

A popular feed illustrating iron (Ferrous Carbonate) and manganese (Manganous Oxide) shown in Ingredients but not represented in the Guaranteed Analysis.

1.5 Digestibility of feeds – Calculations in Animal nutrition

At the end of this unit the learners should be able to demonstrate the knowledge of the following content.



1.5.1 Terminology

TERM	DEFINITION
Biological Value (BV)	-is an index of the quality of the protein in a feed
Co-efficient of digestibility	-is a measure of the digestibility of a feed expressed as a percentage in terms of dry matter (DM).
Digestibility	-the portion of the feed that is absorbed and not excreted by the body.
Digestibility - coefficient	the proportion of a nutrient taken into the digestive tract that is actually digested
Digestible energy	-Gross energy value of a feed minus energy lost in faeces.
Gross energy	-the energy that is released as heat when a feed is completely oxidized to carbon dioxide, water and gases.
Maintenance ration	-amount of feed needed simply to maintain the body mass and composition of an animal (i.e. support life).
Metabolic energy	-gross energy value of a feed minus energy lost in faeces, urine and gaseous end-products of digestion.
Nett energy	-gross energy minus energy lost through faeces, urine, digestive gases and lost as heat.
Nutritive ratio (NR)	-ratio between digestible protein (DP) and digestible non-nitrogen compounds
Production ration	-the additional amount of feed an animal needs on top of the maintenance ration in order to do work and for production

1.5.2 Digestibility of Feed

Digestibility. The *digestibility* of a *feed* determines the amount of feed that is taken in and actually absorbed by an animal and therefore the availability of nutrients for growth.

1.5.2.1 Factors determining the digestibility of feeds

- **Composition of feed**
  - The greater the percentage of crude fibre, the lower the digestibility.
- **Composition of the ration**
  - Composition of other feed consumed with it, determines the digestibility of feed. This is known as associative effect.
- **Preparation of feed**
  - For maximum digestibility, certain feeds should be especially prepared, e.g.
  - Crushed maize is more digestible than whole maize for cattle; maize-meal is more digestible for pigs.
- **Type of animal / Animal factor**
  - Feeds high in crude fibre are better digested by ruminants than by non-ruminants.
- **Quantity of feed taken in / level of feeding**
  - Increased feed intake results in faster movement of food through the alimentary canal and lower digestibility
- **Age of the plant**
  - Hay made from younger plants is more digestible than from older plants.
- **Individuality**
  - Animals differ with respect to individual ability to digest feed.
- **Nutritive ration**
  - Feeds with a wide nutritive ration are less digestible.

1.5.2.2 How to increase/improve digestibility of feeds

- Type of crop used
- Stage at which the plant was cut for making hay.
- Method of making hay.
- Preparation of hay and method of feeding.
- Supplementing the ration with molasses.
- Supplementing a ration with proteins.
- Supplementing a ration with non-protein Nitrogen (NPN)
- Boiling of grains and cereals
- Grinding and milling grain
- Soaking the grain
- Pelleting.

1.5.2.3 Determining digestibility coefficient

If 100 kg feed is taken in and only 30 kg were excreted, one must assume that 70 kg were digested and absorbed. The excrete is expressed in terms of dry material and as a percentage, known as digestibility coefficient. The digestibility indicates the nutritional value of the feed. The higher the digestibility the more nutrients is available for growth and production. An indication of nutritive value of a feed is its digestibility of dry matter(%). Feeds and fodders can be classified as shown below based on their digestibility.

- Above 70% = good
- 60-70% = moderate
- 40-60% = low
- Less than 40% = very low

Eg. Calculate the digestibility co-efficient of the following ration fed to a mature dairy cow.

- Dry matter content of the ration 85 %
- Feed intake by the cow 10 kg
- Faeces excreted 4 kg
- Dry matter content of faeces 75 %

$$\textbf{Digestibility \%} = \frac{\textbf{DM intake (kg) - DM excreted (kg) } \times \textbf{100}}{\textbf{DM intake (kg)}}$$

Understand the logic by following these steps: -

Step 1: Find out the actual amount (in kg) of dry matter (DM) of the given feed in KG

Dry matter content of the feed is $\frac{\text{10Kg(feed intake) x 85\%}}{100}$ *= 8.5 Kg feed*

Step 2: Find out the actual amount (in kg) of excrement (DM) of the given feed in KG

Dry matter content of the feed is $\frac{\text{4Kg(excrement) x 75\%}}{100}$ *= 3 Kg faeces*

Step 3: Subtract the (DM) quantity of excretion from the (DM) quantity of feed taken by the animal.

8.5 kg(DM feed eaten) – 3.0 kg (DM faeces excreted) = 5.5 Kg

Step 4: Express the difference as a percentage of the dry matter quantity taken in by the animal.

$$\frac{5.5 \times 100}{8.5}$$

64.7% or 65% digestibility

Step 5: This percentage indicates how much feed has been digested and absorbed by the body of the animal

This sample of feed is therefore 65 % digestible

Feeds digestibility can be changed to improve the nutrient availability to the animal that consumes it.

1.5.3 Activity

1. Determine the digestibility of a feed. The information are as follows
   - Feed ingested: 7kg with a 92% dry matter
   - Faeces excreted: 4kg with a 96% dry matter

   Using the following formula:

   Digestibility % = <u>DM intake (kg) - DM excreted (kg) × 100</u>
   DM intake (kg)

   <u>DM = Dry material</u> <u>intake</u>… **thus you must get rid of the moisture**.
   Decide with which **figures** you want to work and take care **not to get confused**

Step 1 Feed intake using moisture%(If the feed is 92% dry then there is ….% moisture in the feed)
……..%moisture of …..kg = …../…… × …… = ……kg
Thus : Total feed intake = ... kg – **moisture** which is **..... %**
...../..... × .....kg = ...kg
....kg-.....kg =**..... kg**

Step 2 Moisture in manure(if the manure is 96% dry there is ....%moisture in the manure)
Mass of manure excreted = ...kg – moisture (.....%)
...../..... × .....kg = ...kg
.....kg-.....kg = **.....kg**

Or

Feed intake using dry matter of feed
…..% of ….. kg = …../100 ×….. = …… kg and
……% of ……kg = ……/100 × …. = ……. kg
Note: In this case it is always important to **subtract the moisture content** (get rid of **the influence of moisture on the mass**)

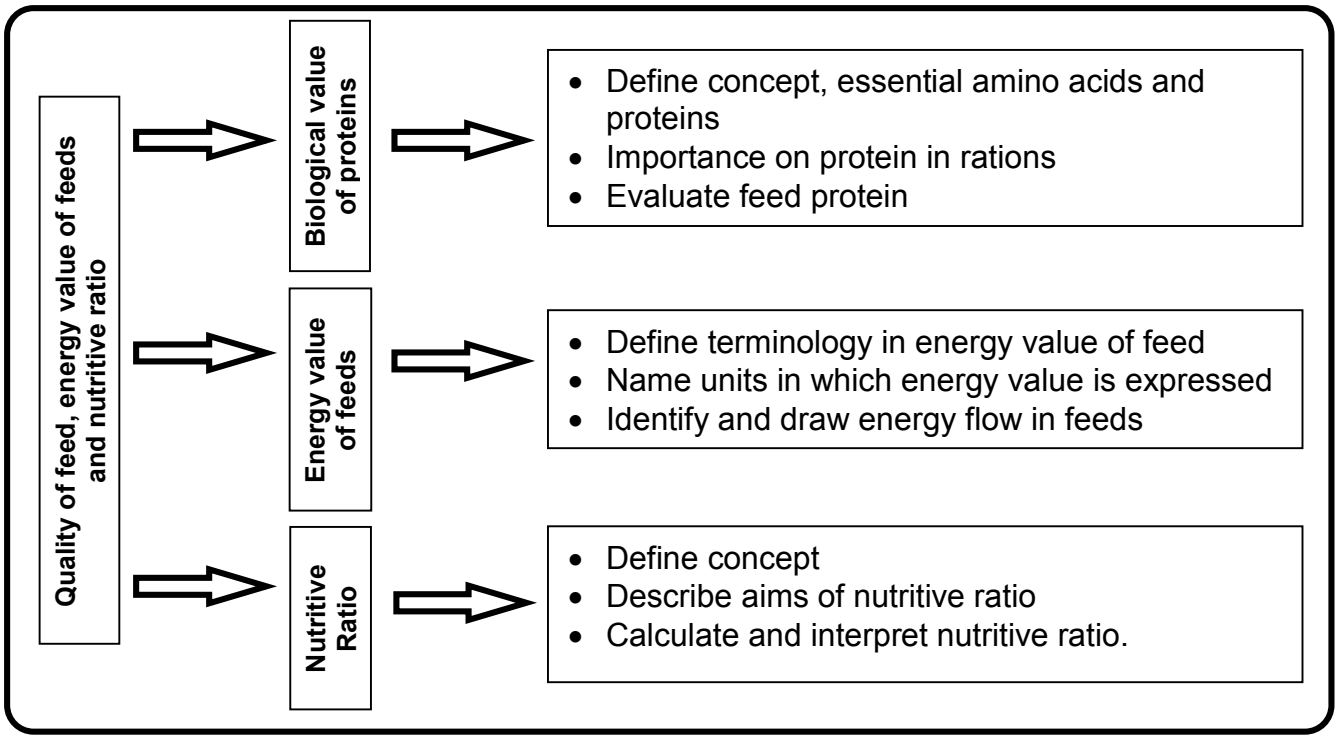
Step 3 and Step 4 Thus: **Digestibility % = <u>DM intake (kg) - DM excreted (kg) × 100</u>**
DM intake (kg)
= <u>..... – .....</u> × .....
.....
= <u>.....x.....</u> ✓= **.....% ✓✓**

……

Step 5 Comments on the digestibility

1.6 Quality of feeds

At the end of this unit the learners should be able to demonstrate the knowledge of the following content.



1.6.1 Terminology

TERM	DEFINITION
Biological Value (BV)	-is an index of the quality of the protein in a feed
Co-efficient of digestibility	-is a measure of the digestibility of a feed expressed as a percentage in terms of dry matter (DM).
Digestible energy	-gross energy value of a feed minus energy lost in faeces.
Gross energy	-the energy that is released as heat when a feed is completely oxidized to carbon dioxide, water and gases.
Metabolic energy	-gross energy value of a feed minus energy lost in faeces, urine and gaseous end-products of digestion.
Net energy	-gross energy minus energy lost through faeces, urine, digestive gases and lost as heat.
Nitrogen free extract	-consists of easily digestible carbohydrates like sugars and starch
Nutritive ratio (NR)	-ratio between digestible protein (DP) and digestible non nitrogen compounds
Production ration	-the additional amount of feed an animal needs on top of the maintenance ration in order to do work and for production

1.6.2 Quality of feeds

Feeds are complex materials; different foodstuffs have quite specific physical and chemical characteristics that affect the results of the animal nutrition process. Knowledge of the type of feed eaten by the animal is important when calculating their rations and in determining how to best meet the amount of nutrients required for animal maintenance and production.

1.6.2.1 Biological value (BV) of Proteins

a) The quality of a protein is described as "Biological Value". This is the efficiency with which a protein supplies the nitrogen requirement of an animal. It is an index of the quality of a protein.

1.6.2.2 Essential amino acids and ideal proteins

b) Certain amino acids can be synthesised by the animal and are **non-essential** amino acids.
c) Amino acids that cannot be synthesised and need to be taken in are **essential** amino acids.

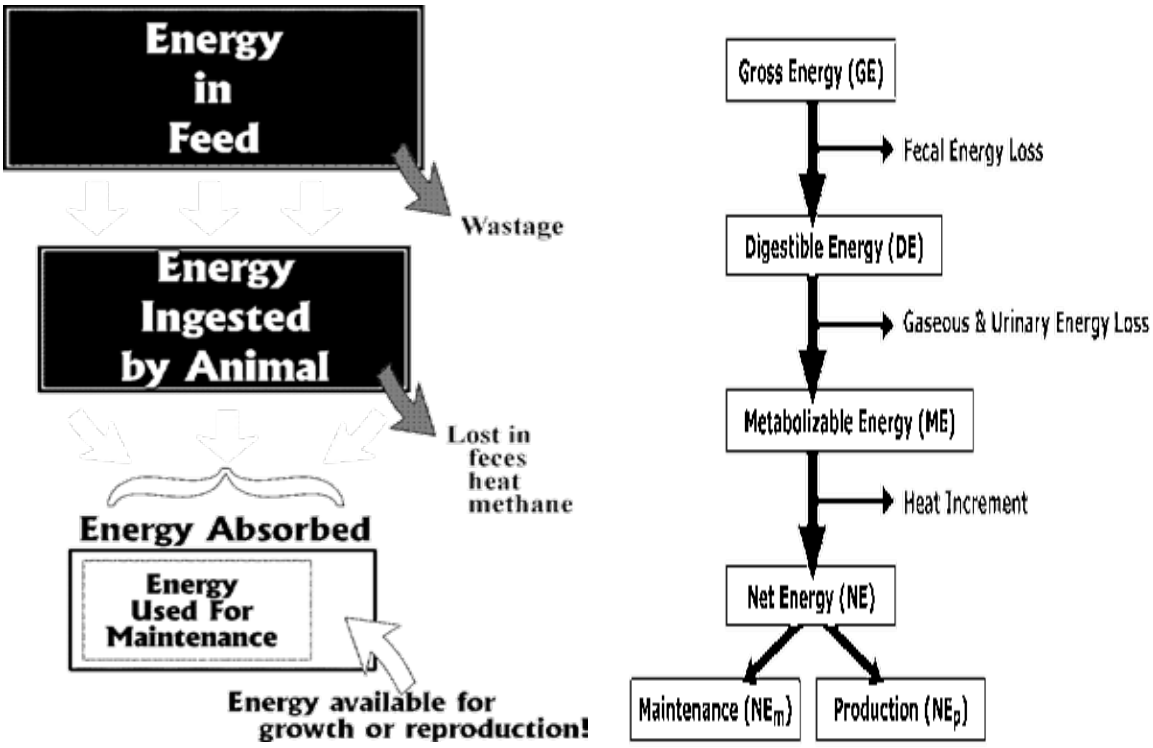
1.6.2.3 Nutritive value of protein

- This refers to the quantity and quality of protein in the feed.

1.6.2.4 Energy Value of Feeds

Units for expressing energy value

- The greatest part of feed is used for the production of energy
- This amount of energy in feed is expressed as joules or calories.



Energy value of feeds

Gross energy (combustion heat or potential energy)

- Gross energy is the total energy provided by a feed when it is completely burnt (oxidised)
- The energy released is measured in a bomb calorie meter.

Digestible energy

- Digestible energy is the gross energy minus energy lost through faeces.

Metabolic energy

- This is the gross energy value minus energy lost in faces, urine and fermentation faeces (gaseous end products)
- It is the energy lost through work and production.
- Portion of gross energy used for work, growth, fattening, milk and heat production.

Net energy

- The gross energy value minus energy loss in faeces (manure), urine, digestive gases and energy lost as heat (body heat)

1.6.2.5 Nutritive ratio (NR.)

Gives an indication of the protein content of the feed. It is the ratio of the digestible protein *to* the sum of digestible non-protein (carbohydrates and fat). It is computed in recognition of the fact that protein serves some special functions in the animal body, which cannot be performed by the digestible non-protein nutrients present in the TDN.

Calculating the NR of the following feed:

- Feed has a 82% TDN(Total digestible Nutrient's) and 7% DCP(Digestible crude protein)

Calculation: $NR = \frac{TDN - DCP}{DCP}$ $\frac{\text{Total Digestible Nutrients – Digestible Crude Protein}}{\text{Digestible Crude Protein}}$

$= \frac{82-7}{7}$

$= \frac{75}{7}$

$= 10.7$

Answer is expressed as a Ratio 1:10.7	meaning for every one part of digestible protein there is 10.7 parts other digestible nutrients

The feed has a wide nutritive of 1:10.7 It means that for each kg of DCP, the feed contains 1.07 kg digestible non-protein nutrients

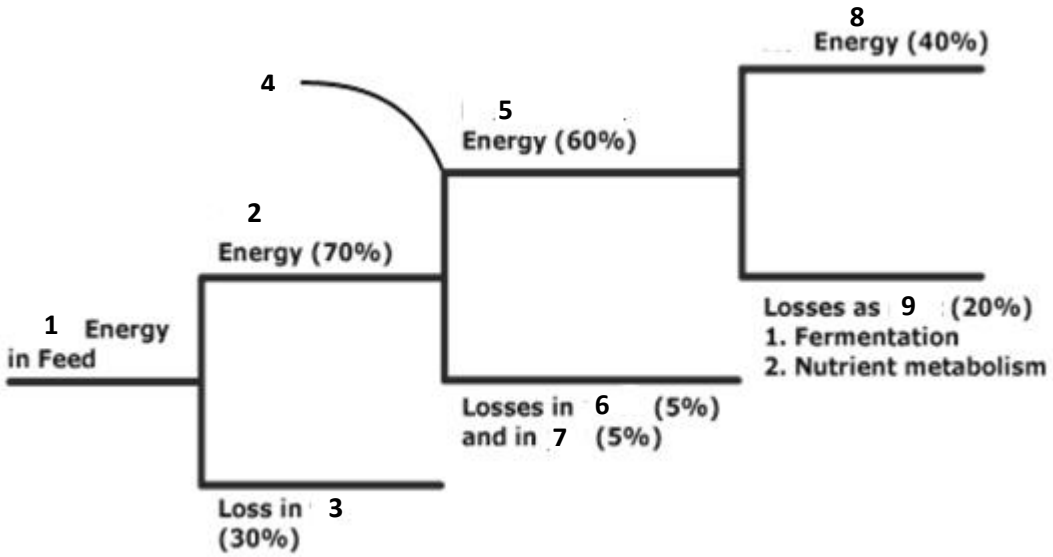
Feeds richer in protein have narrow nutritive ratios while feeds poor in protein content have wide nutritive ratio. It is usual *to* consider that rations with wide nutritive ratio (1:9) are suitable for idle horses and cattle; a medium ratio (1:6) for early fattening, lactation, working animals, etc. and a narrow ratio (1:0.7) for young stock.

Interpretation of feeds regarding NR

For maintenance	For growth	Milk production	For reproduction	For fattening
NR between1:6 and 1:8	NR 1:5 or less	NR 1:5 or less	NR less than 1:5	NR 1:9- 1:10
Protein needed for the replacement of tissue	Lots of protein needed of high biological value	Lots of protein needed of high biological value	Lots of protein needed of high biological value	Protein only for maintenance
Carbohydrates, fats and vitamins only for maintenance	Carbohydrates, fats and vitamins only for maintenance	Sufficient carbohydrates and fats for maintenance and production	Carbohydrates, fats and vitamins for maintenance. An increase needed to support last third of pregnancy	Carbohydrates and fats needed in large quantities
Minerals only for the replacement of losses	Sufficient minerals and vitamins	Sufficient minerals and vitamins	Sufficient minerals and vitamins	Minerals and vitamins for maintenance

1.6.3 Activity

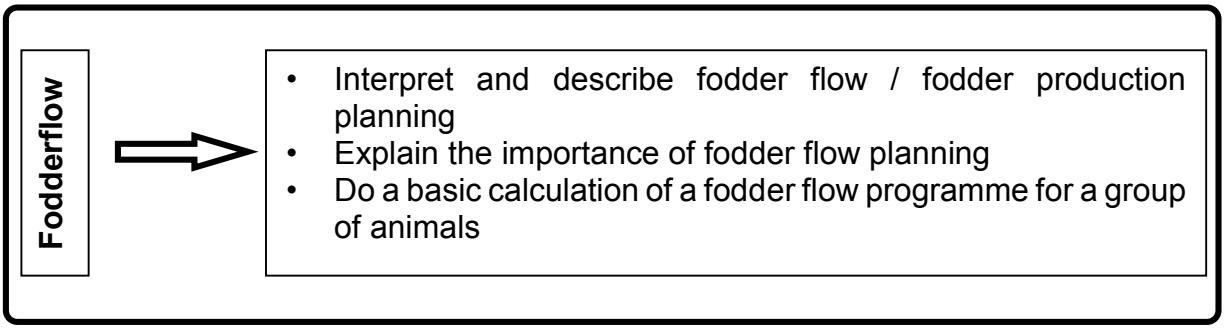
1. Complete the diagram by completing the missing terms indicated by the respective numbers.



(9)

1.7 Fodder flow/ Feed flow programming

At the end of this unit the learners should be able to demonstrate the knowledge of the following content.



1.7.1 Terminology

At the end of this unit the learners should be able to demonstrate the knowledge for understanding and describe the components below in the following contexts

TERM	DEFINITION
Animal unit equivalents (AUE)	Standardising grazing demand among different herbivore species. An AUE expresses the quantitative **forage** demand of a particular kind and class of animal relative to that of an **animal unit**, based primarily on metabolic bodyweight

Type of Herbivore	Animal Unit Equivalents
Mature Cow, Non-Lactating	1.0
Mature Cow, Lactating	1.2
Mature Bull	1.2
Sheep, Mature, Non-Lactating	0.2

Carrying Capacity	Number of grazing animals a management unit is able to support without depleting rangeland vegetation or soil resources.
Fodder flow programme	Enough feed for all the animals through(all year round) the year
Fodder	Includes all grazing, hay, silage, and roots available on the farm
Feed/fodder Intake	Amount of feed voluntarily consumed by an animal
Stocking rate	Actual number of animals on a management unit throughout the time period of grazing.

1.7.2.1 Feed Intake

Intake is the amount of feed voluntarily consumed by an animal. It is determined by:

- the availability, and digestibility of feed
- the nutrient content of the feed
  - feed intake is depressed when a diet contains inadequate amounts of minerals, vitamins and various sources of nitrogen or when it is poorly digestible.
- bite size and frequency which, in turn, is influenced by plant structure and feed availability
  - the amount consumed per bite tends to increase with the amount of green leafy material
- the physiological status of an animal
  - pregnant animals have different intake requirements according to litter size and stage of gestation.
- environmental conditions

- the availability of water will affect the amount of feed an animal consumes, as will temperature and humidity.
- infectious, parasitic and metabolic diseases, which may depress intake.

1.7.2.2 Fodder flow

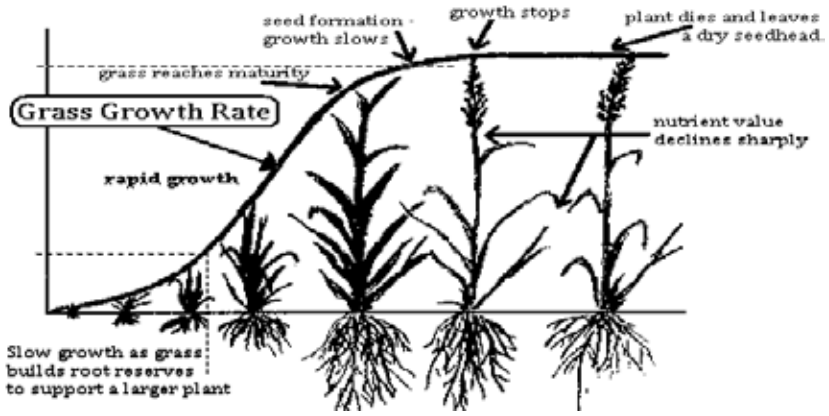
Supply of feed is a key factor on any livestock farm. Fodder available on the farm includes grazing, hay, silage, and roots. A constant supply of good quality roughage is the solid foundation of profitable farming. Concentrates are supplementary feeds and not a staple food.

"The objective of fodder production planning is to match the production capabilities of the farm to the animals' requirements to obtain the greatest margin on feed costs, within safe limits of natural resource utilisation." Or simply put "enough feed for all the animals through(all year round) the year"

How do you do it.

1. The first step is to draw up a stock flow programme to plan your fodder flow.
2. Determine the potential of the pasture before stocking it with a certain number of animals. This assessment will ensure that the correct number of animals is kept to utilize the veld and/or pasture in such a way that both the pasture and animal remain or increase in production and quality.

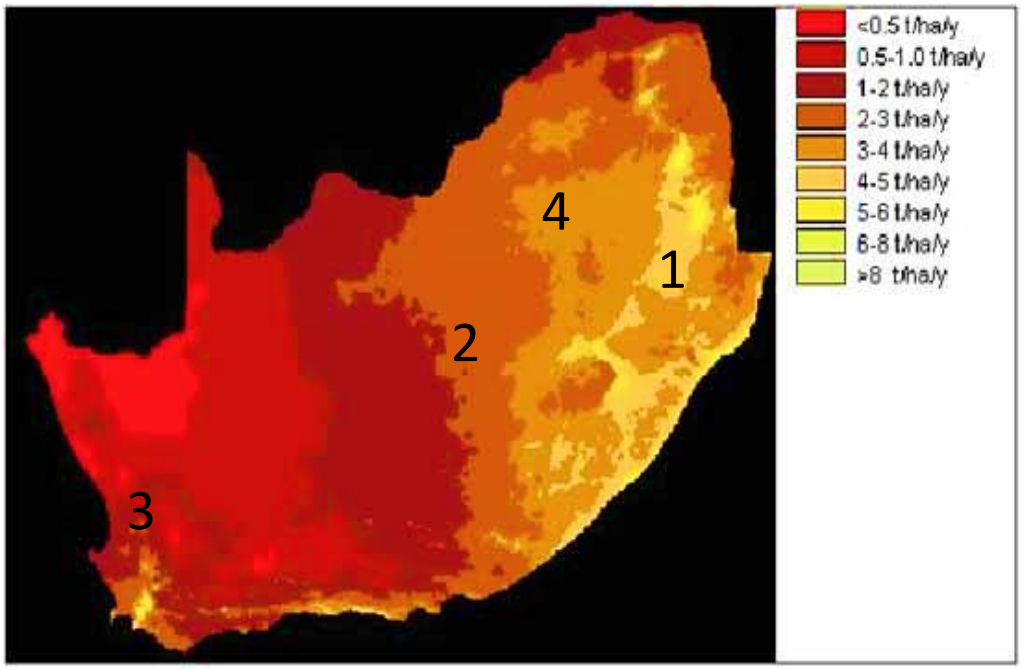
Understanding grass growth



Grass follow a sigmoid growth cure until it reaches maturity. Nutrients are sent to the roots until it can support biomass or leaf production. If we continue to graze camps and not leaving leaves to produce nutrients for growth, the root system will not develop to support leave production. When plants reach maturity, the nutritional value start declining going into the winter.

3. "The carrying capacity of the property, not the owner's target income, should determine the number of animals to keep,"
    a. Pasture quality depends on the type of grasses available and the vigorous growth of the plant during the season. Growth is normally influenced by the timing and amount of rainfall it will receive in a year.

4. To determine the carrying capacity of the veld the production per Ha is needed as shown in the diagram below.



Production of veld in t/ha in South Africa

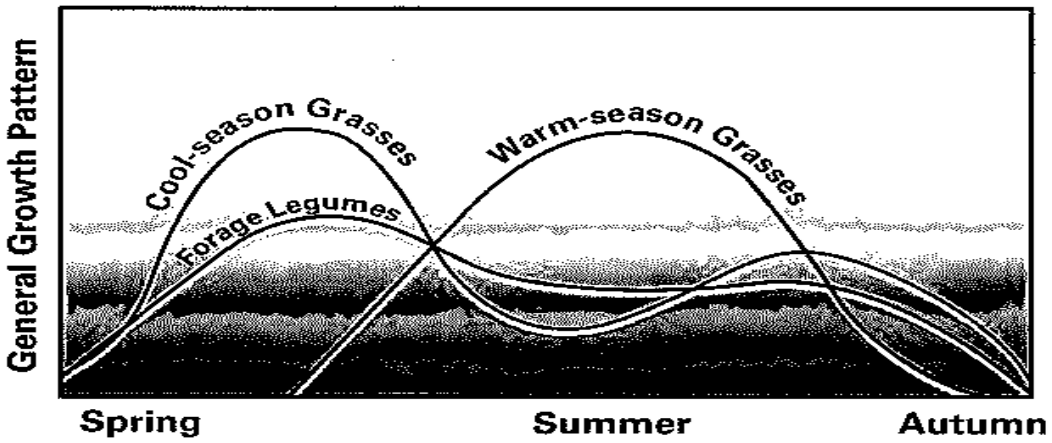
Pay special attention

A cow weighing 500 kg eats about 2.1% of its body weight per day.
Thus 500 kg x 2.1% = 10.5 kg per day
In a year a cow will need 365 days x 10.5kg = 3833 kg food/year
= 3,8 Tons of feed per year/ large stock unit

In the map above area 2 produce 2 tons / ha / year. The farmer can only utilise 50 % of the grazing because of trampling and 50% must be left behind for good growth after grazing.

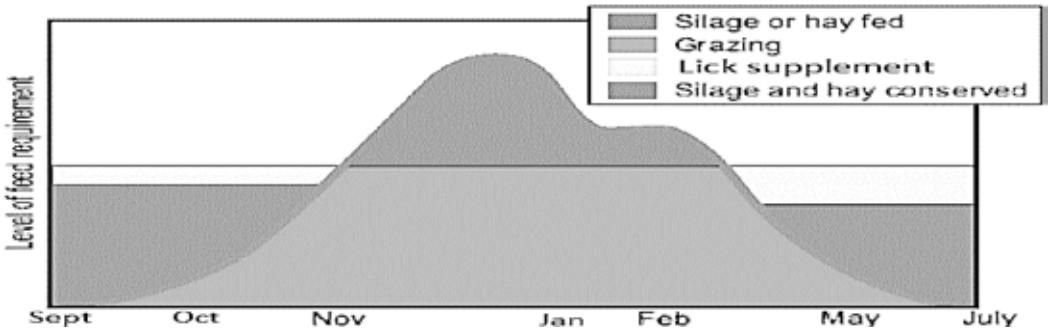
For Area number 2, 4 ha are thus needed to sustain one LSU (an animal weighing 500 kg) in a year. A Farm of 500 ha can thus sustain 125 animals weighing 500 kg.

5. The fodder flow is a sum of fodder and its availability from each source of forage. Eg. veld (warm season grasses), pastures(cool season grasses and legumes), Stover(crop residue left eg. maizestover for grazing) etc.) Month by month.



Availability of feed sources during a year

6. Ideally, it would match the required feed flow. If not matched it must be forced by:
   (a) purposely altering the stock flow, e.g. by strategic culling and calving, and/or
   (b) producing more food at particular times, and/or
   (c) transferring excess fodder from one time of the year to another as hay, silage, or standing forage.



Let look at the following steps to determine the fodder flow programme

Step 1: Calculate the annual feed available on the farm

Fodder production from resources per year																
					Esimated DM production in TON / month											
					JAN	FEBR	MRT	APR	MEI	JUN	JUL	AUG	SEPT	OKT	NOV	DES	TOTAAL
Feed Sourc	Ha available				0,2	0,2	0,1	0,1	0,1	0,0	0,0	0,0	0,0	0,1	0,1	0,1	1,0
	Allocated	0,0	Production/ha														
Veld 1	50,0	50,0	5,6	T/HA	42,2	43,8	34,2	20,1	20,7	0,3	0,3	0,8	1,9	35,3	37,8	40,5	277,8
Veld 2	50,0	50,0	1,5	T/HA	25,9	27,0	21,0	12,4	12,7	0,2	0,2	0,5	1,2	21,7	23,2	24,9	170,9
Veld 3	46,0	46,0	1,0	T/HA	12,6	13,1	10,2	6,0	6,2	0,1	0,1	0,2	0,6	10,5	11,3	12,1	82,8
SmutsW	0,0	0,0	3,5	T/HA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
EragrHW	22,1	22,1	4,0	T/HA	13,5	14,1	11,0	6,5	6,6					11,3	12,1	13,0	88,0
Hawer	25,0	25,0	5,0	T/HA				12,5	25,0	25,0	25,0	15,0	10,0	10,0			122,5
Oesrest/ou la	20,0	20,0	6,0	T/HA						30,0	30,0	30,0	30,0				120,0
SmutsSH			3,5	T/HA								0,0	0,0	0,0	0,0		0,0
VeldSH			1,2	T/HA							0,0		0,0				0,0
TOTAAL	213,1	213,1		T/HA	94,2	97,9	76,3	57,4	71,2	55,5	55,5	46,6	43,7	88,8	84,3	90,5	862,0

Step 2: Stock flow programme:
Determine the amount of animals you will have on the farm for each month.
Eg. A cow herd of 50 and mated in January will give the following stock on the farm. The calving % is 85%.
Eg. Stock flow programme

Group	Jan	Febr	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Cows	50	50	50	50	50	43	43	43	43	43	43	43
Calves										30	43	43
Bulls	2	2	2	2	2	2	2	2	2	2	2	2
Selling culls(Cows)						7						
Total	52	52	52	52	52	45	45	45	45	75	88	88

Step 3: Calculate the annual intake for all animals during the year based on the stock flow
To calculate the daily intake required per animal use the following information

Animals eat approximately 10% of their metabolic mass and it can be calculated as follows:

- Mass of the animal x 2.1%**(dry cow)** → 500 kg x 2.1% = 10,5 kg/day or
- Mass of the animal x 2.3% **(lactating cow)** → 500 kg x 2.3% = 11,5 kg/day
- Mass of a bull x 2.1% **(Bull)** → 900 kg x 2.1% = 18,90 kg/day

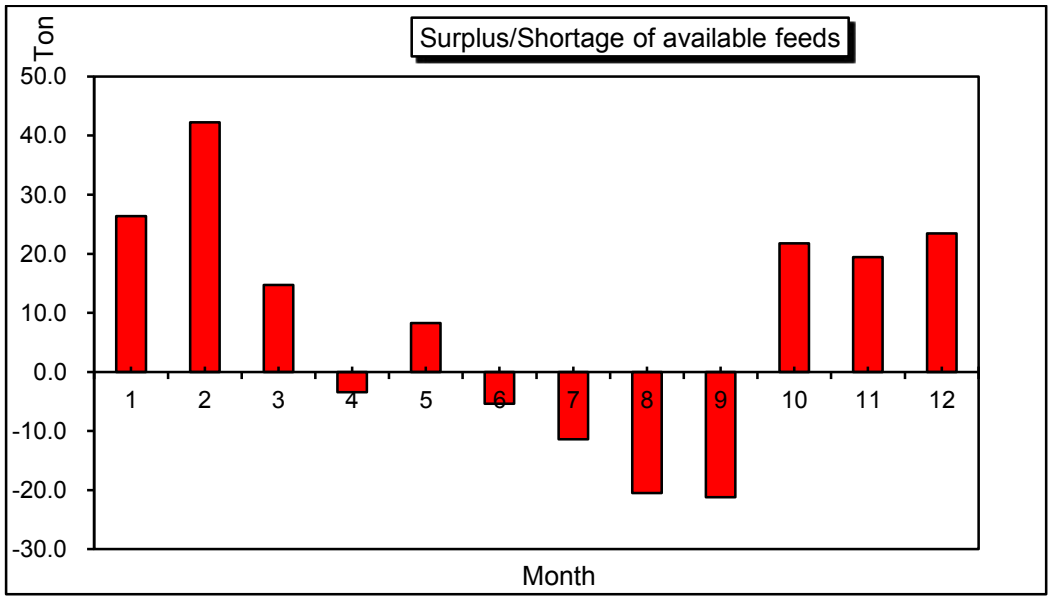
The table provide the number of animals that need to be fed per month

Group	Jan	Febr	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Cows	50	50	50	50	50	43	43	43	43	43	43	43
Calves										30	43	43
Bulls	2	2	2	2	2	2	2	2	2	2	2	2
Selling culls						7						
Dry animals	52	52	52	52	52	45	45	45	45	15	0	0
Lactating cows										30	43	43
Dry	546	546	546	546	546	452	452	452	452	157,5	157,5	157,5
Lactating										345	345	345
Bulls	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8
Total feed/day	546	546	546	546	546	452	452	452	452	502,5	502,5	502,5
Days	31	29	31	30	31	30	31	30	30	31	30	31
Total feed/Month	16926	15834	16926	16380	16926	13560	14012	13560	13560	15578	15075	15578

Total kg needed to feed the animals in a year = 183 914 kg or 184 Tons of fodder

Step 5: Determine surplus / shortage

From the table in Step 3 and the table in step 4 the shortage and surplus of food is determined



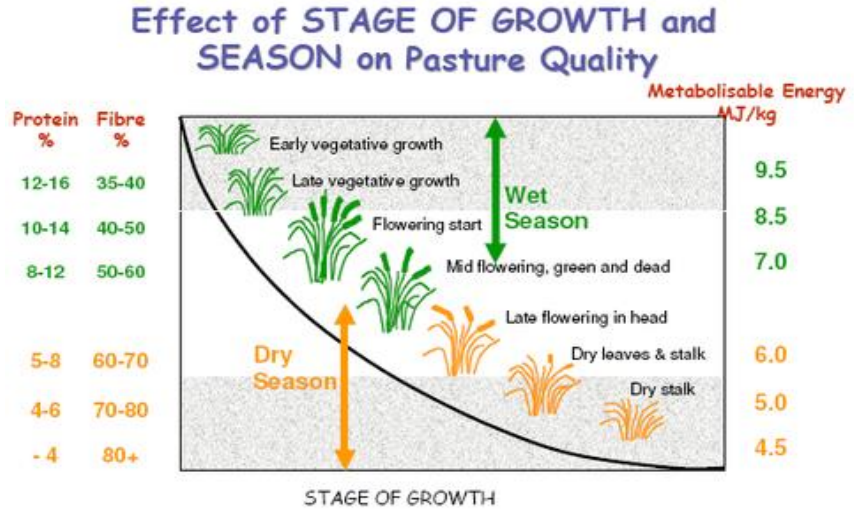
The above graph clearly indicate that Month 4, 6, 7, 8 and 9 show shortages and the farmer need to make use some of the surpluses like cutting hay for the months where there are shortages. If he cant cut hay he needs to plant some pastures that he can use during those months of shortages. If hê cannot do any of the above the he need to reduce animals to balance his number of animals and fodder produced on his farm.

1.7.3 Activity

1. A Farmer wants to purchase a 650ha farm situated in an area that produce 3 t/ha/year. It is situated in the summer rainfall area with cold winters. Advice the farmer on:
   - How many dry cows (500 kg) can he keep on the farm and how many lactating cows(500kg). (12)
   - Different pastures he can use to ensure that there is food al year round available for the animals to utilize. (4)
   - How he can approach his grazing strategy in the winter. Give a reason for your answer. (4)

   (20)

Use the diagram below to assist you in your decision making.

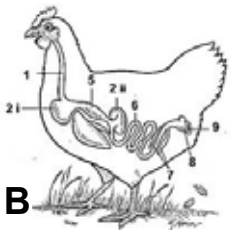


Memos

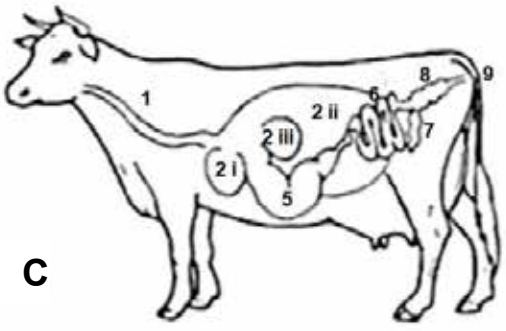
Activity 1.1.3

Complete the following diagrams by identifying the parts of the digestive systems in the following farm animals.

A



B



C

2. Name the digestive system of

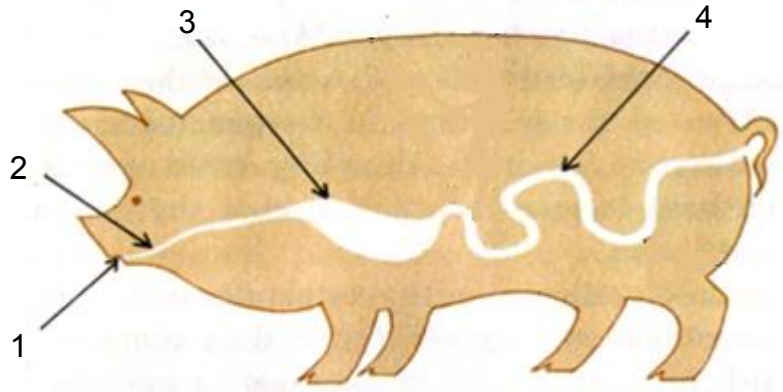
   a. Simple stomach✓/ Mono-gastric✓ (2)
   b. Fowl ✓ (1)
   c. Complex✓/ Ruminant✓/poly gastric✓ (3)

3. Identify the parts of the digestive systems as indicated by the numbers in each diagram.

	Diagram A	Diagram B	Diagram C	
1	Oesophagus✓	Oesophagus✓	Oesophagus✓	(3)
2 i		Crop✓	Reticulum✓	(2)
2 ii		Gizzard/Ventriculus✓	Rumen✓	(2)
2 iii			Omasum✓	(1)
5	Simple Stomach✓	Proventiculus✓	Abomasum✓	(3)
6	Small intestines✓	Small intestines✓	Small intestines✓	(3)
7	Cecum✓	Cecum✓	Cecum✓	(3)
8	Rectum✓	Rectum✓	Rectum✓	(3)
9	Anus✓	Vent✓	Anus✓	(3)

Activity 1.2.3

1. Identify and describe the following at each of the identified numbers



1. Digestive processes involved in the digestive system
   1.1 Mechanical /Physical✓
   1.2 Chemical ✓ (2)
2. Enzymes and digestive juices involved in the digestive proses at each location
   2.1 Mouth - Ptyalin✓
   2.2 Esophagus - none✓
   2.3 Stomach – Gastric juice✓ containing water, mucus, salts and hydrochloric acid
   - Enzymes rennin✓ and pepsinogen✓

   2.4 Small intestine – Hormone secretin✓ result in secretion of
   - Pancreatic juice✓ contain Trypsin✓, chymotrypsin✓, Amylase✓, Lipase✓
   - Intestinal juice (succus entericus) ✓ contain the following enzymes
     - Lipase✓, Erepsin✓, Sucrase✓, Maltase✓, Lactase✓, Enterokinase✓
   - Bile✓ activate lipase✓ (20)

3. Nutrients absorbed at each site
   3.1 Mouth - none✓
   3.2 Oesophagus - none✓
   2.3 Stomach - none✓
   3.3 Small intestine - Absorption of Amino Acid✓, Monosaccharide's✓, glycerol✓, fatty acids, ✓vitamins ✓and minerals✓
   3.4 Large intestine – water reabsorption ✓ (10)

Activity 1.3.3

For each of the listed conditions regarding deficiency list the correct mineral/vitamin to each deficiency as mentioned

Mineral Deficiencies	Mineral	Vitamin Deficiencies	Vitamin
Abnormal bone growth	Calcium/Phosphorus✓	Abnormal bone growth	D✓
Anemia	Iron✓	Paralysis	B_{12}✓
Decreased growth	Cobalt/Zinc✓	Decreased appetite	B_1✓
Deformed bones	Phosphorus✓	Impaired vision	A✓
Enlarged thyroid gland	Iodine✓	Increased susceptibility to infections	B_2✓
Lameness	Copper✓		
Milk fever	Calcium✓	Poor blood clotting	K✓
Paralysis	Potassium✓	Unthrifty appearance	A✓
Poor feed efficiency	Sodium/Chlorine✓	Loss of hair	D✓
Poor hair coat	Zinc✓	Poor coordination	B_{12}✓
Reduced feed intake	Zinc/Cobalt✓	Poor growth	D✓
Reproductive problems	Manganese✓	Reproductive problems	E✓
Rickets	Calcium/Phosphorus✓	Rickets	D✓
Skin disorders	Zinc✓	White Muscle Disease	E✓
Stiffness in the joints	Calcium✓		
Unthrifty appearance	Zinc✓		
Weakening of the bones	Magnesium✓		
White Muscle disease	Selenium✓		

(31)

Answer the following questions

1. Name the six classes of essential nutrients.
    d) Protein✓
    e) Carbohydrates✓
    f) Water✓
    g) Fats✓
    h) Vitamins✓
    i) Minerals✓ (6)
2. Describe the function of proteins.
    - Muscle growth✓
    - Required for production of enzymes and hormones✓ (2)
3. Name two sources of proteins(One plant origin and one animal origin).
    - Cotton seed cake✓
    - Fishmeal✓ (2)
4. List two symptoms of protein deficiency.
    - Depressed performance✓
    - Unthrifty hair coat✓ (2)
5. Name the seven macro-minerals with a deficiency of each.
    - Calcium – Rickets/Osteomalacia/Ragitis✓
    - Phosphorus – Rickets/Osteomalacia/Ragitis ✓
    - Sodium – Loss of appetite/ poor growth✓
    - Chlorine - Loss of appetite/ poor growth ✓
    - Potassium -✓
    - Magnesium -
    - Sulphur - ✓ (14)
6. Describe the function of calcium and phosphorus.
    - Bone forming and ✓ (4)

7. What is the typical source of sodium and chlorine?
    - NaCl SALT ✓ (1)
8. Name the 7 micro-minerals.
    - Iodine ✓
    - Cobalt✓
    - Iron✓
    - Copper✓
    - Selenium✓
    - Zinc✓
    - Manganese✓ (7)
9. Name the four fat-soluble vitamins.
    - A, ✓D, ✓ E ✓and K✓ (4)
10. What is the function of vitamin D?
    - Improves adsorption✓ and metabolism of Ca and P✓
    - Improve immunology✓ and growth ✓
    - Plays role in DNA synthesis ✓ (5)

Activity 1.4.3

Complete the following

1. ...1) are the feedstuff which contain more than 18 per cent crude fibre. ...2) are the feedstuff which contain less than 18 per cent crude fibre. ...3) are the compounds used to improve the nutritional value of feeds. Dry roughages contain ...4) percent moisture.

   1) Roughage✓
   2} Concentrates✓
   3) Supplements✓
   4) 10-15% moisture✓ (4)

2. Analyse the nutritional information on the label below.
   a) Divide the list of ingredients into the six classes of essential nutrients? Identify at least one ingredient used in the feed for each nutrient.
      Protein ✓ - Alfalfa, ✓
      Carbohydrates✓ - Groundnut hulls, Ground oats hulls (any)✓
      Energy✓ – Flax seed, ✓
      Fats✓ – Soy Oil✓
      Minerals✓ – Magnesium oxide, Calcium Carbonate, Chlorine, Chloride etc. (any)✓
      Vitamins✓ – Vit. D, Biotin, B_{12} (any) ✓ (12)

   b) What is the percent protein?
      - 12% ✓ (1)

   c) Which minerals does the food contain,?
      - Calcium✓, Phosphorus✓, Magnesium, ✓ Zinc✓, Copper✓, Selenium✓ (6)

   d) Which vitamins does the food contain,?
      - Vit E✓, Vit A✓, Biotin✓ (3)

   e) Calculate the kg protein in a bag if the bag weighs 50 kg
      - 50Kg X 12%✓ = 6kg✓ (2)

   f) Name one amino acid used in the feed.
      - Lysine ✓ (1)

   (25)

Activity 1.5.3

1. Determine the digestibility of a feed. The information are as follows
   - Feed ingested: 7kg with a 92% dry matter
   - Faeces excreted: 4kg with a 96% dry matter

Feed intake
Using moisture:
Thus : Total feed intake = 7 kg – **moisture** which is **8 %**
8/100 × 7kg = 0.56kg ✓
7kg-0,56kg =**6,44 kg**✓

Mass of manure excreted = 4kg – moisture (4%)✓
4/100 × 4kg = 0.16kg✓
4kg-0.16kg = **3.84kg**✓

Or using dry matter:
92% of 7 kg✓ = 92/100 ×7✓ = **6.44** kg✓ and 96% of 4✓ = 96/100 × 4✓ = **3.84** kg✓
Note: In this case it is always important to **subtract the moisture content** (get rid of **the influence of moisture on the mass**)

Thus: **Digestibility % = $\frac{\text{DM intake (kg) - DM excreted (kg) × 100}}{\text{DM intake (kg)}}$**

$= \frac{6.44 - 3.84}{6.44} \times 100$ ✓

$= \frac{2.6 \times 100}{6,44}$ ✓= 40% ✓

This means that 40% of the feed is digested or absorbed by the animal which indicates that this is a feed with a low digestibility content and thus of poor value.
This feed will be used as a maintenance feed and animals need some other supplementation.

Activity 1.6.3

Missing terms on Energy flow diagram.

1 Gross✓
3 Digestible✓
4 TDN – Total Digestible Nutrients✓
5 Faeces✓
6 Metabolisable✓
7 urine✓
8 gas✓
9 Net energy✓

Activity 1.7.3

1 A Farmer wants to purchase a 650ha farm situated in an area that produce 3 t/ha/year. It is situated in the summer rainfall area with cold winters. Advice the farmer on:

a) How many dry cows (500 kg) can he keep on the farm and how many lactating cows(500kg).

Determine need per cow

- A cow weighing 500 kg eats about 2.1% of its body weight per day.
  Thus 500 kg x 2.1% = 10.5 kg per day
  In a year a cow will need 365 days x 10.5kg = 3833 kg food/year ✓
  = 3,8 Tons of feed per year/ large stock unit✓
- A lactating cow weighing 500 kg eats about 2.3% of its body weight per day.
  Thus 500 kg x 2.3% = 11.5 kg per day✓
  In a year a cow will need 365 days x 11.5kg = 4198 kg food/year ✓
  = 4,2 Tons of feed per year/ large stock unit✓

Farms production 650 x 3t/ha = 1950 t/year✓
Only 50 % can be used = 1950/2 or 1950 x 50%✓
= 975 tons available for grazing✓

1 - Number of dry cows - 975/3.8 t/y✓ = 256 dry cows✓
2- Lactating cows - 975/42✓ = 232 Lactating cows✓ (12)

b) Different pastures he can use to ensure that there is food al year round available for the animals to utilize.
a) he can plant cool season grasses to graze during ✓
b) Some pastures can be cut for silage✓ of hay ✓and those could be fed during the dry winter season✓ (4)

b) How he can approach his grazing strategy in the winter. Give reasons for your answer.
a) some pastures could be rested✓ and a protein lick been✓ fed to stimulate intake✓ of dry material and to aid in the digestion of fodder by the micro-organisms. ✓ (4)
(20)

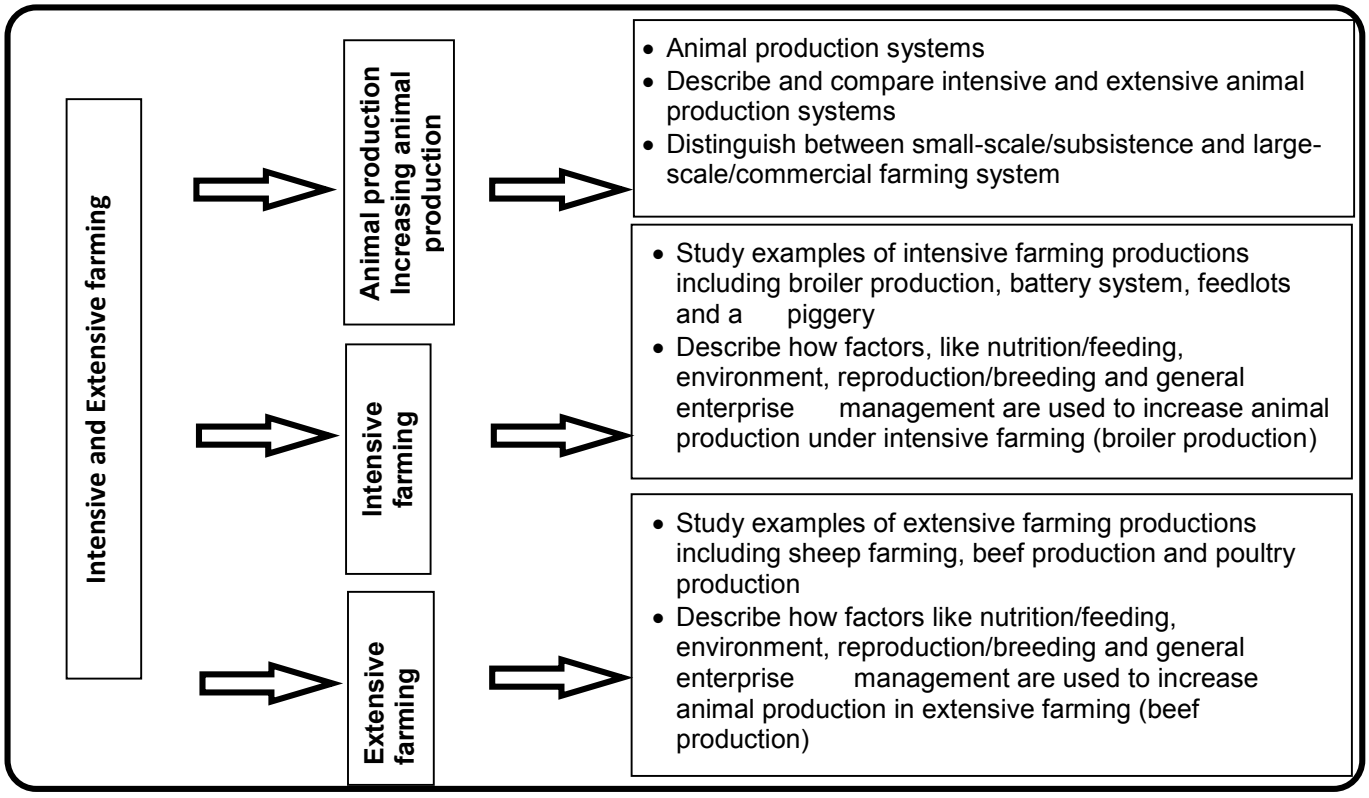
Chapter 2

Paper 1

ANIMAL PRODUCTION

2.1 Intensive and Extensive Farming

By the end of this unit the learner should be able to demonstrate knowledge of the following content:



Terminology

Term	Definition
Breeding	the mating and production of offspring by animals.
Carrying capacity	is the maximum stocking rate possible while maintaining or improving vegetation
Environment	the surroundings including all external factors where the animal lives and operates.
Intensive animal farming	is a system where large numbers of animals are concentrated in a small area.
Large-scale or commercial farming	is a farming system which usually involves large numbers of animals
Nutrition	the process of taking food into the body and absorbing it for maintenance, growth, reproduction, repair of worn tissues.
Stock density	is the number of animals on a specific area of the pasture for a specific period of time **or** Is the number of animals on a given piece of land over a particular period of time
Stocking rate	Is the number of animals on a given piece of land over a particular period of time **or** is the number of animals on a specific area of the pasture for a specific period of time

2.1.1 Intensive animal farming

This is a farming system where livestock are raised at high stocking density. Intensive farming has high input with high output. The environment for the animals is modified to suit all specialised breeds and production systems. Examples of intensive farming: Pig production, Broiler production, Cattle in feedlot.

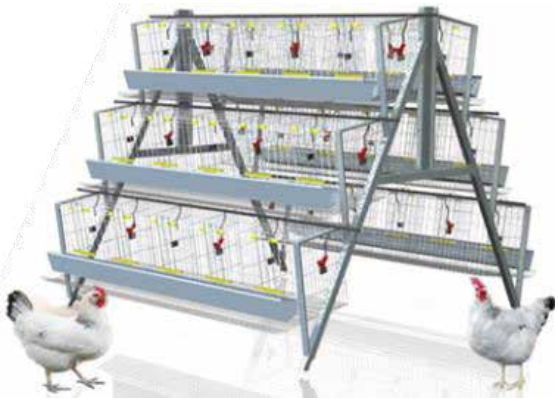
Meat, milk and eggs are the main products of intensive farming.

Pigs: Pigs are kept for their meat. They are kept and fed in pig styles. Pregnant sows are kept in gestation cages.

Gestation cage

Poultry: Broilers are kept for meat. These birds grow very fast. They are slaughtered at six to eight weeks. Birds are kept in a run and fed intensively to make them grow faster.

Egg Layers produce eggs. These birds are kept mostly in battery cages.



Battery cage

Cattle: These are kept for both meat and milk. Dairy cows are kept in sheds where they receive feed. Beef cattle are kept in feedlots. They are fed concentrates which make them grow faster prior to slaughter.

Feedlot pen

Sheep: These are mainly kept for meat but also for wool. Sheep are kept in sheds and fed balanced meals to grow faster.

Goats: These animals are kept for both meat and milk.

2.1.1.1 Factors to increase animal production under intensive farming

The following factors refer to broiler production.

Feeding: The broiler feed must contain correct quantities of different kinds of nutrients. The amount of nutrients change with age and size of the broiler.

Environment: This includes the insulation, ventilation, heating and stock density of broilers per shelter.

Breeding / Reproduction: Animals that are resistant to various diseases and pests, adaptable and produce high quality products are used by farmers. Most broiler farmers do not reproduce their own birds but obtain them from specialised breeders. Characteristics

such as growth rate, feed conversion rate are considered for reproducing broiler chickens.

General enterprise management: Management determines financial and sustainability of production enterprise. Management of natural and human resources is important in intensive farming system.

2.1.2 Extensive farming

Animal farming system where animals are kept at low density on large areas of land. The output is moderate and the input is low in extensive farming. Land with limited agricultural potential is mainly used for extensive beef production. In the Karoo sheep production is under extensive system of farming. Example for extensive farming: Sheep production in the Karoo.

2.1.2.1 Factors to increase animal production in extensive farming

The following factors are with reference to beef production

Feeding: Natural vegetation is used for animal nutrition. Feed supplements may be necessary during periods of drought since natural grazing supply is seasonal.

Environment: Animals need to be adapted to local climate and environment. Indigenous breeds are better adapted to local environment which includes climate, vegetation and diseases.

Breeding: Breeding and calving season should be planned to start when there is enough grazing of high nutritional value.

Reproduction: Reproductive performance in animals is influenced by breeding management, genetic merit, nutritional status and health status.

General production enterprise management: Animals must be adapted to local environment (natural resources and diseases). Human activity (record-keeping, marketing and health management) in beef production must be minimal.

Comparison between Intensive and Extensive farming systems

Intensive Farming	Extensive Farming
High labour and capital use	Less input of labour and capital
High animal population density compare to land	Low animal population density to area/land available
Large output per land size	Small output per land size
Generally closer to the market area	Largely distant from market areas

Subsistence Farming

This is the production of animals and crops by a farmer to feed their family rather than take to market. This is practised extensively in the rural and semi-rural areas of South Africa to feed families. There is a developing trend in towns and cities for subsistence farming through urban Agriculture. Subsistence farming is also known as small-scale farming.

Commercial Farming

The production of crops and animals to sell at market for profit is called commercial farming. Modern technology is used extensively in commercial farming. Commercial farming generally contributes to environment pollution.

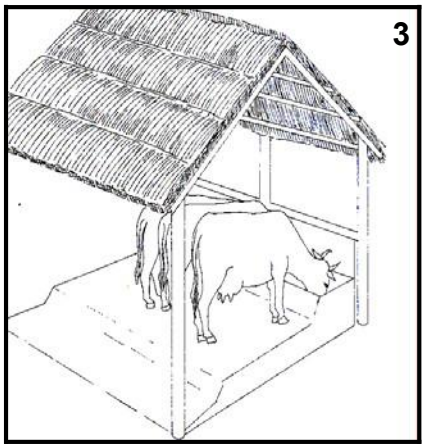
Differences between subsistence farming and commercial farming

The following are some of the differences between subsistence farming and commercial farming:

Subsistence farming	Commercial farming
Farms are small	Farms are bigger
System is simple with low productivity	System is complex with high productivity
Traditional farming techniques are used	Modern and sophisticated techniques are used
Variety of livestock is selected	One or two livestock types are selected
Output is targeted for family use	Output is targeted for profit making in the open market
Little environment pollution	High pollution levels to the environment

2.1.3 Activities

1. The diagrams below illustrate different systems of production.



1.1 From the diagrams marked **1** to **3**, select the shelters which are the most suitable for the following systems for production:

(a) Extensive farming (1)

(b) Indigenous system of farming (1)

1.2 Name TWO characteristics that are normally associated with the production system marked **2**. (2)

1.3 Compare, in table format, the production system marked 2 and 3 with regard to the following aspects:

(a) Environment control (2)

(b) Drought risk (2)

(c) Production output (2)

2. The farmers below are involved in two different production systems.

FARMER A	FARMER B
Farming in a 4 800 ha semi-arid area with 2 workers. The farm has 1 farm shed, 8 wind pumps, 1 cattle-handling facility, 1 dipping station and 400 cattle kept on natural pasture.	Farming in a 400 ha wet area with 20 workers. The farm has 6 farm sheds, 25 feedlot camps, 3 cattle-handling facilities, 3 dipping stations and 3 500 cattle.

2.1 Identify the farming system practiced by FARMER A. (1)

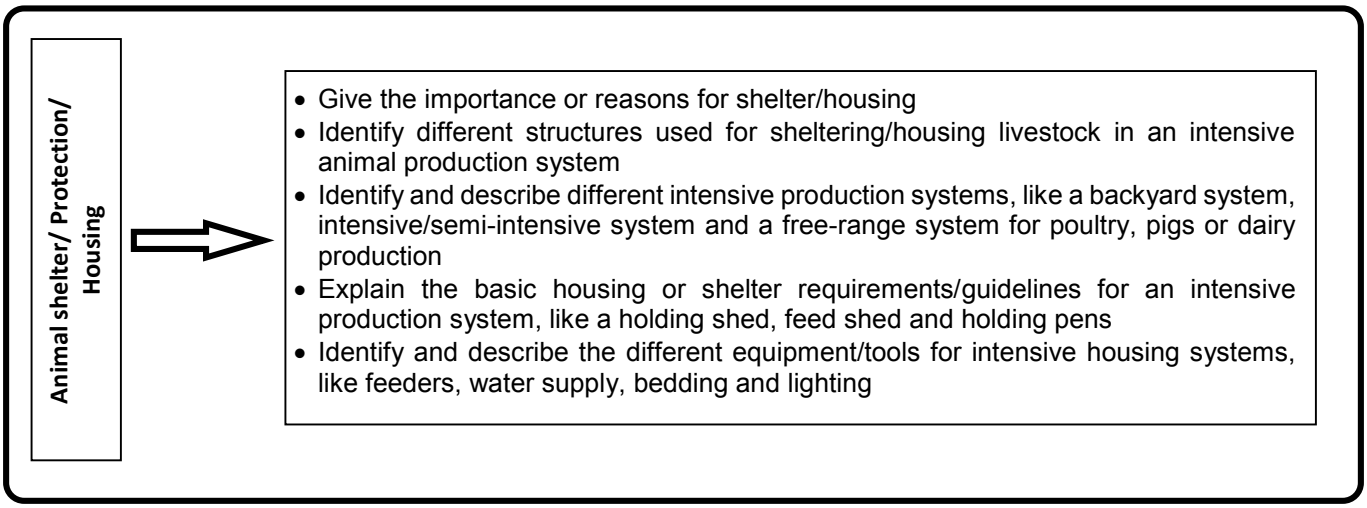
2.2 Give TWO reasons from the table that support the answer to QUESTION 3.4.1 (2)

2.3 Briefly distinguish between the feeding strategies followed by FARMER A and FARMER B. (2)

2.4 State TWO measures that FARMER A can take to increase production. (2)

2.2 Animal shelter, protection and housing

By the end of this unit the learner should be able to demonstrate knowledge of the following content:



Terminology

Term	Definition
Backyard system	the system of using part of the homestead as mini farm for growing crops and raising animals
Feedlots	a plot of ground/building where livestock are fattened for the market.
Feed shed	it is a building that is used to keep animal feed
Free range	a system of animal management where animals are not confined and can roam and forage over an area of open land.
Holding shed	it is a building that is used to shelter animals for a limited period of time
Hoppers	containers for grain which narrow near the bottom and release grain from this end.
Hyperthermia	condition in which the body temperature is much higher than normal.
Hypothermia	condition in which the body temperature is much lower than normal.
Shelter	is a place giving temporary protection from bad weather or predators, includes, simple shelters, open and closed housing, sheds, holding pens and crushes.
Thermoregulate	control the body temperature to its optimum level.
Ventilation	the entry and circulation of air freely.
Watering points	is the place where livestock receive their water.

2.2.1 Importance of shelter and housing

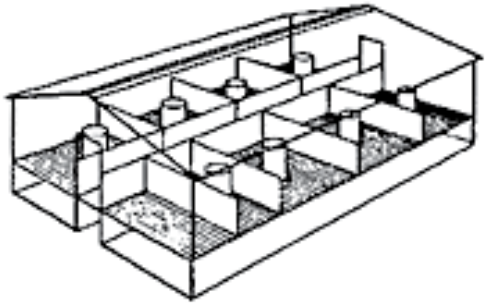
Shelter and housing protect animals against:

- Extreme heat
- Severe cold
- Wetting by rain
- Strong sun

Protecting animals from all these conditions help improve desired production enterprise.

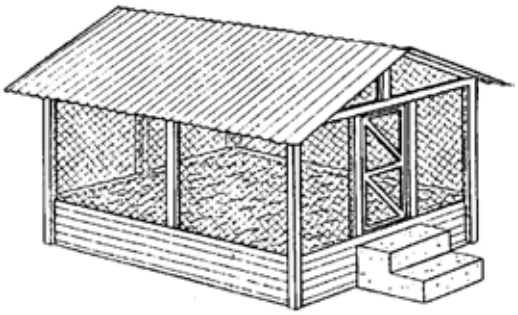
2.2.2 Different structures used for sheltering

Pigs: Pigsties are made from bricks, cemented floors and poles. In intensive pig production system, the pigsties have furrowing pens, rearing pens and fattening pens.



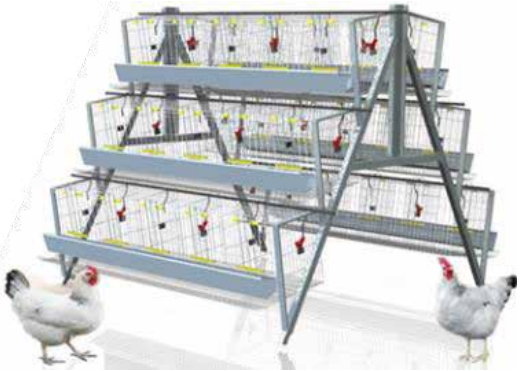
Pigsty

Chickens: Intensive chicken production system uses deep-litter and battery cages to house the birds. The deep-litter system is made from permanent materials that are easy to clean.



Deep-litter house

The battery cages are made from wire. These cages are placed in the fowl run.



Battery cage

Dairy cows: Structure used for milking cows must be easy to clean. A large number of dairy cows needs a milking shed with buildings such as milking parlour, milk room, feed shed and holding pen.

Milking parlour

Feed shed

Different housing is provided for backyard systems, intensive systems, free range systems and semi-intensive systems of animal production. All these animal production systems relate to pigs, poultry, sheep, goats and cattle. These are general and common livestock in South Africa.

Backyard System: animal production system where animals are kept in backyards of homesteads for personal use.

Intensive system: animal are produced on large scale for commercial use. Animals are kept in large housing or sheds.

Free range: animal production system where animals are left to run, roam, feed and graze freely without any artificial restrictions.

Semi-intensive system: animal production system with characterises of both backyard and intensive systems. Animals are produced for personal consumption but surplus can be sold for income.

2.2.3 Basic housing requirements for intensive production system

Shelter is critical in intensive production systems. The following are basic shelters found in intensive production systems:

INCLUDE: FACTORS THAT EFFECT HOUSING REQUIREMENTS (not in the CAPS)

- **Holding sheds**: used to keep a lot of animals and protect them from elements. Water and food are provided especially when the animals are kept for extended periods.
- **Holding pens**: these are used to keep animals before handling them. These are

generally in the open without overheard covers. Water and food are provided.

- **Feed sheds**: some animal feeds including supplements are not available on the farm. The feed is brought to the farm and stored in the shed. The feed sheds protect animal feed from spoilage due to rain, rodents and insects.
- **Handling facilities**: these are used to handle animals for a number of reasons.

2.2.4 Equipment/tools for intensive housing systems

Feeders: Tube and pan feeders are used in feeding. Strong feed troughs are used so that pigs do not turn them over. Common cattle feeders are bunk feeders, creep feeders, bale feeders.

Water supply: There are different types of drinkers. Automatic bell drinkers, fount drinkers and nipple drinkers are mainly used for chicken production. Water bowls with nipples are used in pig production. Big water troughs are used in cattle production.

Bedding: Animals need a bedding that is safe, absorbent and provide insulation. Straw, sawdust, wood shavings are common bedding materials for livestock.

Lighting: Fluorescent and infrared lights are used for chickens, pigs and cattle production.

2.2.5 Activities

Production Systems: Various production systems are used to raise farm animals

Production System A	Production System B
	

1.1 Identify the two production systems above. (2)

1.2 Name and discuss TWO factors which allow an increase in production in system B. (4)

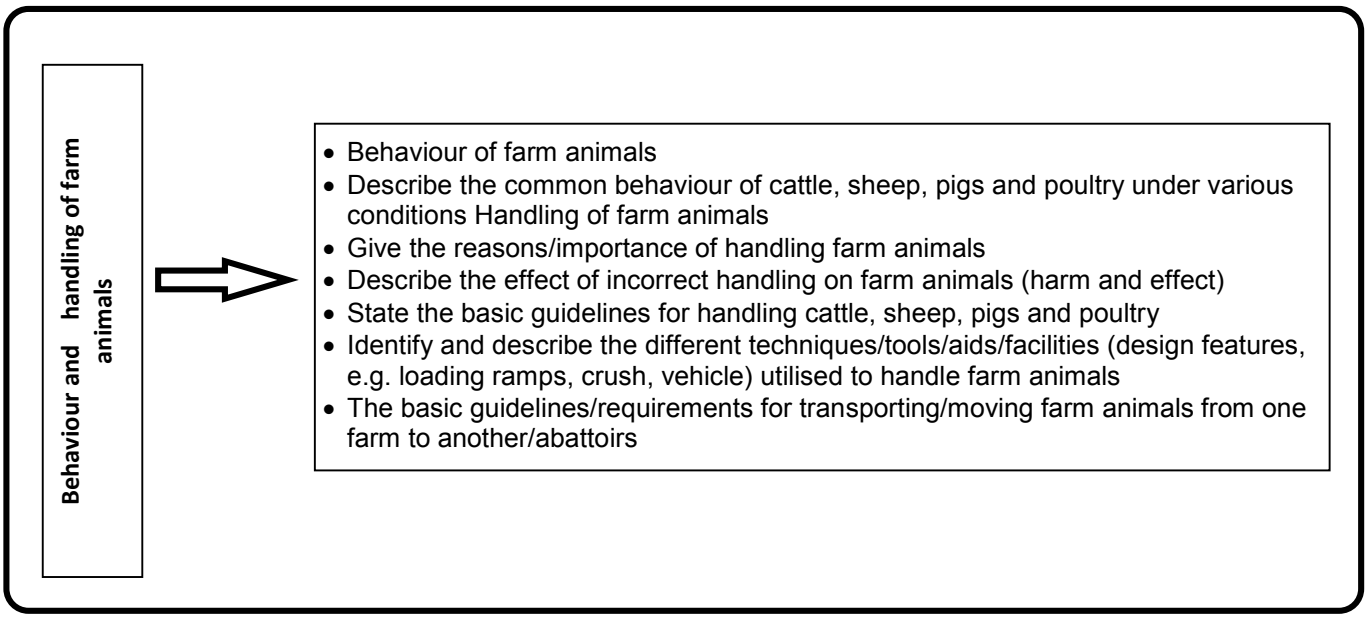
1.3 Farm animals are warm blooded which means that their bodies are able to maintain a constant body temperature.

1.3.1 Supply another term for 'warm blooded'. (1)

1.3.2 It is cruel to subject animals to severe weather conditions. Name TWO conditions that animals should be protected from. (2)

2.3 Behaviour and handling of farm animals

By the end of this unit the learner should be able to demonstrate knowledge of the following content:



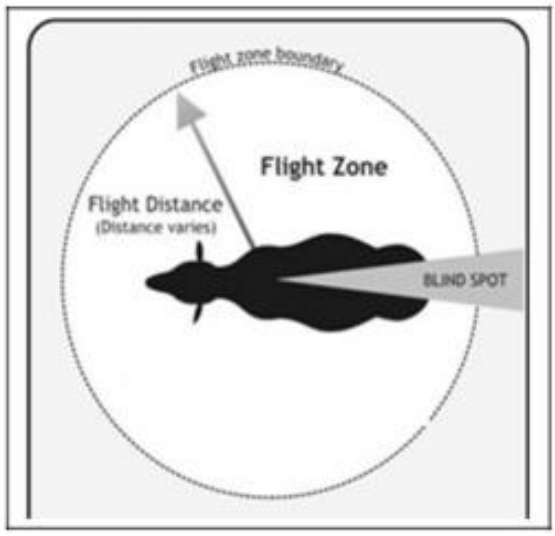
Terminology

Term	Definition
Broodiness	the tendency of a hen to sit on eggs.
Feedlots	a plot of ground/building where livestock are fattened for the market.
Flight zone	is a distance that agricultural and wild animals like to keep between themselves and a threat of danger.
Handling	to touch or hold or move animals from one place to another.
Hoppers	containers for grain which narrow near the bottom and release grain from this end.
Panoramic vision	some animals can see all around e.g. cattle
Roost	is when chickens settle for rest especially when they have laid eggs.
Rotational grazing	involves moving animals between different grazing camps so as to achieve veld management objectives.
Rounding off	fattening or growing animals for market readiness
Watering points	is the place where livestock receive their water.

2.3.1 Animal behaviour

Animal behaviour is the way in which an animal reacts and interacts with other animals, human beings and the environment.

Cattle, Sheep, Pigs and Poultry: These animals will behave differently under various conditions such as mating, grazing, treatment for health reasons, giving birth, transportation, milking, artificial insemination. Generally animals are more difficult to handle under these conditions. Flight zone and blind spot are very important areas that influence animal behaviour. **Flight zone** is the distance that animals like to keep between themselves and a threat of danger. **Blind spot** is the spot out of animal's front line of vision.



Flight zone and Blind spot

2.3.2 Handling of farm animals

Reasons for handling livestock (cattle, pigs, sheep and poultry) include:

- Artificial insemination
- Health reasons (vaccination, dosing, cleaning of sheds etc)
- Feeding
- Parturition (giving birth) and egg laying
- Marketing
- Slaughtering

2.3.3 Effect of incorrect handling of farm animals

The following are some of the incorrect ways of handling farm animals:

- Aggressive handling
- Plucking feathers from poultry that is not calm
- Moving cattle and pigs in large groups
- Moving animals across the road without proper warning to traffic is dangerous
- Kicking and beating animals when moving is harmful

2.3.4 Guidelines for handling livestock (cattle, sheep and poultry)

The following must be considered when handling farm animals:

- Handler should not yell at livestock
- Be cautious to animals that are blind to one eye
- Never approach animal from the back
- Talk softly to animal when approaching it
- Do not work with big and small animals in the same crush
- Crush should be wide without sharp objects

2.3.5 General techniques used when animals need to move

- Use spotlight when loading animals on a ramp to increase visibility
- Reduce noise on gates by installing rubber bumpers
- Walking and working surfaces should be free of hazards
- Electric fencing can be erected to keep animals grazing in one pasture for a short time

2.3.6 Tools that are used to handle livestock

Animal	Tools for handling
Cattle	Halters, Head rails, Cradles, Crushes, Portable pens, Loading ramp, Prodders, Spotlight, Ropes, Chains, Electric fencing
Pigs	Plywood boards, Nose ropes, Crushes, Prodders, Plastic shakers, Slappers, Boxes
Sheep	Crushes, Gates, Plastic shakers, Slappers, Guiding animals, Nylon flags

2.3.7 Basic requirements for transporting farm animals

Transport	Treatment
Before transport	• Transport permit must be completed before transporting animals • Keep farm animals together for two to three days before transporting them • Dehorn animals before transporting them • Group animals of the same size for transportation
Loading and unloading	• Loading ramp must be properly designed • Crush for unloading should be wide and straight • Crush for loading should have high solid sides • Steps must be part of the design for loading and unloading crushes for cattle and pigs

2.3.8 General guidelines for transporting

- Animals must not be transported when roads are busy
- Familiarise animals with loading area
- Truck floor must not be slippery
- Do not transport cattle, sheep, goats and pigs together
- Truck must be ventilated
- Clean the back of the truck before loading animals
- Do not load animals too long before departure

2.3.9 Activities

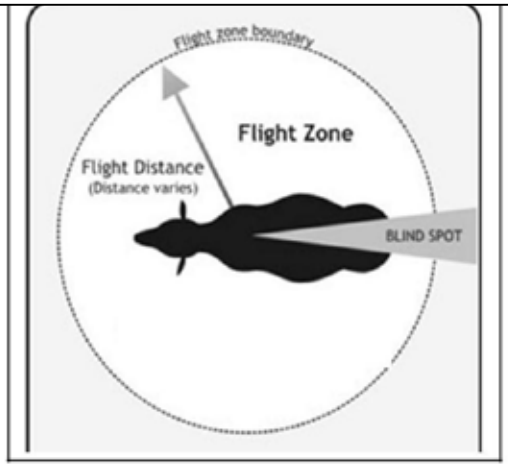
Animal handling

Read the following extract and answer questions

Win all the way with proper equipment

The correct equipment can make the life of a livestock farmer easier and at the same increase their profits. Cattle handling must be efficient, because time is money and money means profitability. The biggest improvement in that case can be achieved by holding pen design, especially the crush.

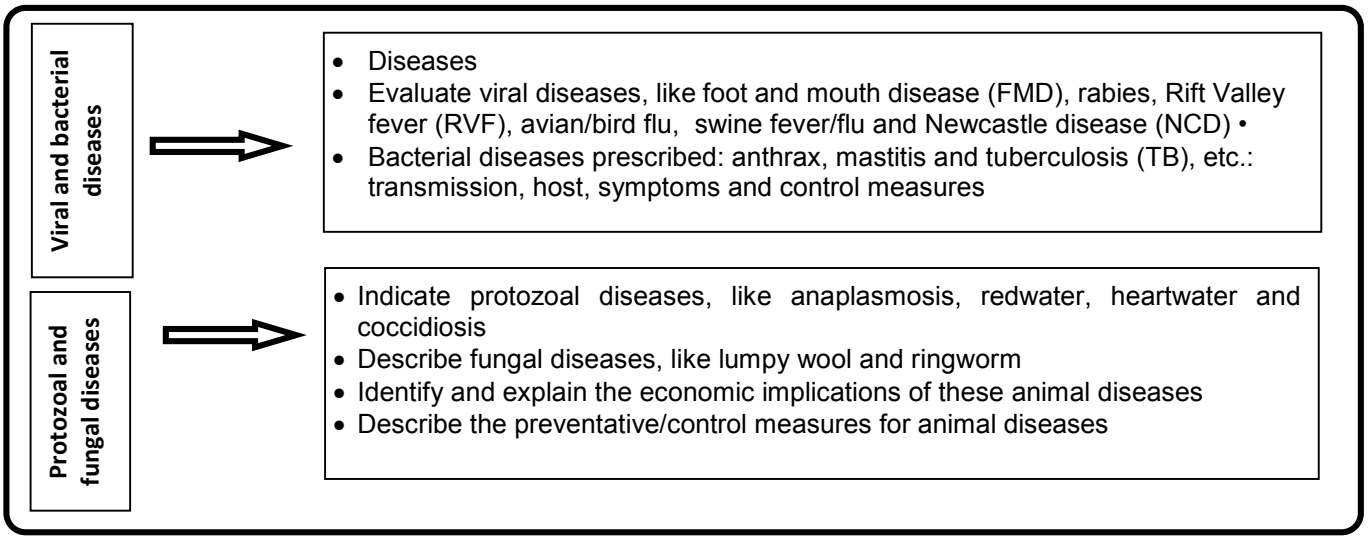
Adapted from Landbouweekblad



1 Suggest THREE reasons why it may be necessary to handle cattle. (3)
2 Explain TWO basic requirements of crushes. (3)
3 Name the type of vision that occurs in cattle. (1)

2.4 Animal diseases: Viral, bacterial, protozoan & fungal

By the end of this unit the learner should be able to demonstrate knowledge of the following content:



Terminology

Term	Definition
Antibiotics	are chemical compounds used to kill bacterial and fungal infections.
Antibodies	protein substances produced by white blood cells in response to specific foreign antigens.
Bacteria	are microscopically small, single celled organisms.
Biopsy	is an examination, under a microscope of a tissue from a living body to determine the cause or extent of disease.
Clinical examination	is when you examine animals for signs of disease.
Contagious	means an ability to infect other animals.
Diagnosis	is the identification of a disease from the examination of symptoms.
Endemic	is when a disease occurs in a population regularly and can be predicted.
Epidemic	is a widespread occurrence of a disease that spread rapidly through an area.
Fungi	are single –celled or multicellular organisms.
Pathogens	are disease –causing organisms.
Post mortem	takes place when one cuts open the carcass of dead animal to determine the cause of death.
Protozoa	are single celled organisms that live within the animal or on the animal.

Quarantine	means keeping animals in isolation for a fixed period of time to enable officials from the Department of Veterinary Services to test for and detect diseases.
Vaccination	is the injection of a single substance into an animal to prevent a specific disease.
Vectors	are insects or ticks, that carry the disease organism from infected to healthy animals.
Viruses	are very small acellular structures, only visible with a powerful electron microscope, they multiply only within a living cell and can be transmitted from one organism to another.

2.4.1 Viral diseases

Disease	Transmission	Host	Symptoms	Treatment
Foot-and-mouth diseases	• Transmitted by means of secretions and excretions from infected animals • Ingestion of contaminated feed • Entry through skin abrasion or mucous membrane	• Farm livestock except horses • Hooved animals	• High fever • Nasal discharge • Lesions on the tongue, mouth, nose, around hooves and in between toes • Sticky foamy salivation	• Quarantine infected animals • Vaccinate animals • Slaughter and burn infected animals • Cleanse and disinfected equipment and vehicles
Rabies	• Saliva through bite of infected animal	• Livestock like cattle, goats and sheep • Domestic cats and dogs	• Aggression • Excessive salivation • Paralysis of lower jaw and tongue • Changes in normal behaviour	• Immunisation and vaccination • Destroy infected animals and burn carcases
Rift valley fever	• Bites of mosquitoes and other biting insects • Handling of infected meat or blood of infected animals	• Cattle, sheep and goats • Humans	• High fever • Abortion • Death of young animals • Anorexia	• Annual vaccination • Spray with insecticides to control vectors • Slaughter and dispose of infected animals

Avian influenza (bird flu)	• Spread directly by movement of infected birds • Contaminated clothes, vehicles	• Ducks, turkey, geese, chickens, ostriches and other birds	• Death • Nasal discharge • Diarrhoea • Swelling of combs and wattles • Loss of weight and appetite	• Mass slaughter of infected birds • Vaccinate poultry
Swine flu/fever	• Contact with infected pigs • Infected tick vectors • Blood or respiratory excretion of infected pigs	• Domestic and wild pigs	• High fever • Loss of appetite • Bleeding and vomiting • Diarrhoea • Muscular weakness	• Infected pigs should be kept away from swine-free areas • Slaughter and dispose of all infected animals
Newcastle diseases	• Secretions from nose, mouth and eyes of infected animals • Chicken eating contaminated feed and drinking water	• Poultry of all ages and types	• Loss of appetite • Nasal discharge • Yellow/green watery diarrhoea • Paralysis of wings and legs	• Vaccination • Cull infected birds and burn the carcasses • Disinfect poultry house

2.4.2 Bacterial diseases

Disease	Transmission	Host	Symptoms	Treatment
Anthrax	• Transmitted through spores • Contaminated feed	Cattle, Sheep and Goats	• High fever • Swelling of neck and throat • Decrease in milk production • Rumination stops	• Quarantine infected animals • Vaccinate animals • Treat with antibiotics • Disinfect animal sheds, parlour and equipment
Mastitis	• Bacteria invade teat canal • Milker,	Dairy cattle, Sows, Dairy goats, pigs ,	• Swollen, hot and painful udder	• Clean and disinfect milking parlour and

	milking machines and flies transfer the bacteria	sheep, humans	• Lack of appetite • Decline in milk production • Milk may contain clots	equipment • Treat teats with germicide • Treat with antibiotics
Tuberculosis	• Through inhalation, saliva, ingestion, droppings	Cattle, pigs, sheep, humans	• Chronic coughs • Increased rate of respiration and breathing	• Vaccinate animals • Disinfect premises regularly • Quarantine affected animals

2.4.3 Protozoan diseases

Disease	Transmission	Host	Symptoms	Treatment
Anaplasmosis	• Ticks and biting flies	Cattle, Sheep, Goats	• Yellow and pale mucous membrane • High fever • Weight loss • Lack of appetite • Anaemia	• Treat with antibiotics • Dip and vaccinate young animals • Control ticks and flies
Redwater	• One-host blue tick	• Cattle, sheep and goats	• Rapid respiration rate • Lack of appetite • Anaemia • Jaundice	• Vaccination • Treat with antibiotics
Heartwater	• Bont tick (three-host ticks)	• Cattle, sheep and goats	• Uncoordinated movements • Diarrhoea • Nervousness • Listlessness • Difficulty breathing	• Immunisation and intravenous injection
Coccidiosis	• Eggs in the faeces of infected animals • Contaminated feed and grazing pastures	• Cattle, sheep, goats and poultry	• Loss of appetite • Diarrhoea • Muscle tremor and convulsion	• Isolation and sanitation • Prevent overcrowding • Use feeders and drinkers

2.4.4 Fungal diseases

Disease	Transmission	Host	Symptoms	Treatment
Lumpy wool	• Direct transmission of fungal spores to non-infected animals • Spores transmitted by contaminated equipment • Spores transmitted by biting insects	Cattle, Goats and Sheep	• Lumps and scabs on the fleece • Scabs on ears, lips, scrotum, face and shanks	• Use zinc sulphate to dip animals • Isolate infected sheep • Use antibiotics to treat badly affected animals
Ringworm	• Direct contact with infected animal • Hands of handlers • Flies	Cattle, Goats, Sheep, Pigs, Rabbits and Birds	• Hair loss • Crusty grey-white scabs • Scaly and itchy ring-like lesions	• Isolate infected animal • Wash skin with iodine • Disinfect shearing equipment with fungicide

2.4.5 Activities

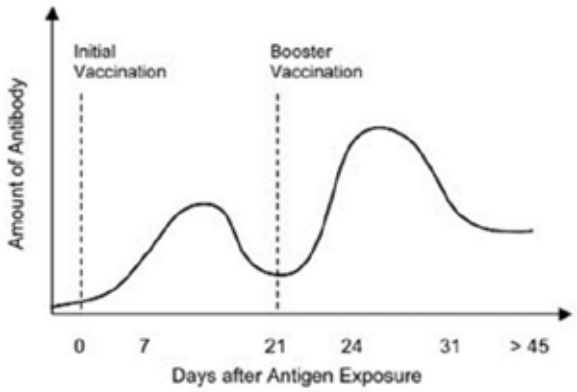
Animal Diseases

1. Foot and mouth disease affects the production of animals and it limits the export of agricultural products to other countries

1.1 State the type of organism that causes foot and mouth disease. (1)
1.2 Explain how this disease is transmitted. (2)
1.3 Indicate how this diseases is controlled by government (2)

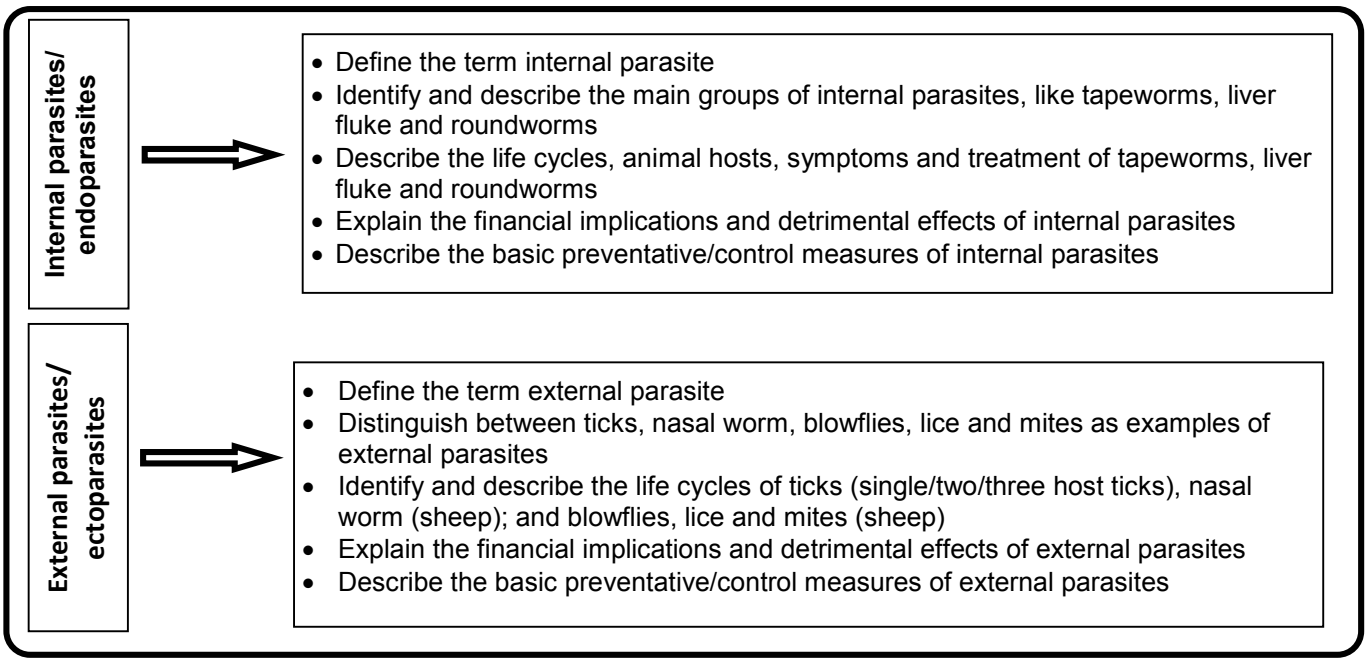
2. Prevention of diseases is better than cure

2.1 Explain the term *antibody*. (2)
2.2 Indicate what happed the levels of antibodies in the animal after second vaccination based on the graph above. (2)
2.3 How many weeks will it take the animal to have complete protection from the disease after vaccination? (1)



2.5 Parasites: External and Internal

By the end of this unit the learner should be able to demonstrate knowledge of the following content:



Terminology

Term	Definition
Animal pests	are organisms that live in or on the body of an animal or share the same environment as the farm animal.
External parasites(ectoparasites)	are parasites that attack the body tissues such as blood, skin and hair of animal.
Internal Parasites	are parasites that live inside the host and rob it of its food and blood

2.5.1 Internal Parasites

	Tapeworm Long narrow and flat organism that lives in intestines of hosts	**Liver fluke** Flat leaf-like flukes in the bile ducts in the liver	**Roundworm** Small, white thread-like and lives in the gut and lungs of hosts
Animal hosts	Cattle, Sheep and Goats	Cattle, Sheep and Goats	Cattle, Sheep and Goats
Symptoms	Diarrhoea, loss of condition	Diarrhoea, Anaemia	Anaemia, Diarrhoea
Treatment	Dosing with de-wormer	Dosing with de-wormer specific for liver fluke	Dosing with broad spectrum de-wormer

2.5.1.2 Life Cycles (simplified)

Tapeworm	Liver fluke	Roundworm
Eggs in faeces ↓ Embryo in intestine ↓ Scolex in intestines ↓ Adult tapeworm	Eggs hatch in water ↓ Larvae in snail ↓ Young flukes attach to grass ↓ Cattle eat grass with fluke ↓ Adult fluke in liver of cattle	Eggs in faeces ↓ Embryo in faeces ↓ Larvae on grass ↓ Adult roundworm in sheep

2.5.1.3 Financial implications and detrimental effects of internal parasites

- Loss of production and income
- High mortality rate
- Treatment cost is high
- Infested meat is dangerous to humans

2.5.1.4 Basic preventative and control measures

- Provide clean drinking water
- Deworm animals regularly
- Practice rotational grazing

2.5.2 External Parasites

	Animal host	Symptoms	Treatment
Ticks	Sheep, pigs, cattle	Anaemia, weight loss, reduced quality and quantity of meat	Remove ticks by shearing, dip animals with chemicals, vaccination
Nasal worm	Sheep	Irritation an infection in nasal cavity Loss of condition	Chemical de-wormer Dosing with medicine
Blowflies	Sheep	Skin breaks Soiled fleece Distress	Tail docking Chemical control
Lice	Sheep, cattle, pigs, chickens and goats	Restlessness Loss of appetite	Dipping with chemicals Quarantine
Mites	Sheep and cattle	Skin irritation Inflammation Loss of appetite	Dipping with chemicals

2.5.2.1 Life cycles (simplified)

One-host Ticks (Blue tick)	Two-host Ticks (Red-legged tick)	Three-host Ticks (Bont tick)
Eggs ↓ Larvae ↓ Nymphs ↓ Adults	Eggs ↓ Eggs hatch to six-legged larvae ↓ Larvae moults to nymph on first host ↓ Nymph moults into adult and attach to second host for feeding and mating	Eggs in winter ↓ Larvae in first host ↓ Larvae moults to nymph on second host ↓ Nymph moults in adult and leave second host ↓ Adult attach to third host for feeding and mating

Blowflies	Nasal worm
Eggs on sheep wool ↓ Eggs hatch to larvae ↓ Larvae drop off sheep ↓ Larvae turn into pupae ↓ Adult blowflies grow from pupae	Eggs on nostrils ↓ Larvae in sinuses ↓ Larvae turns pupae on ground ↓ Adult fly

2.5.2.2 Financial implications and detrimental effects of external parasites

- Decreased production results in money loss
- Dip and chemical treatments are expensive
- Labour costs are expensive
- Veterinary costs are expensive

2.5.2.3 Basic preventative and control measures

- Biological control
- Shearing around the tail of sheep
- Application of relevant chemicals

Economic Implication of animal diseases and parasites

- Banning of export of animals and animal products
- Negative financial impacts on farmers due to diseases and parasites
- International trade decreases and this affects economy of the country
- Disease and parasites outbreak impact on food security
- Disease and parasites outbreak impact on job security
- Costs of control, prevention and treatment are high

The basic principles of good health to control animal diseases and parasites or pests

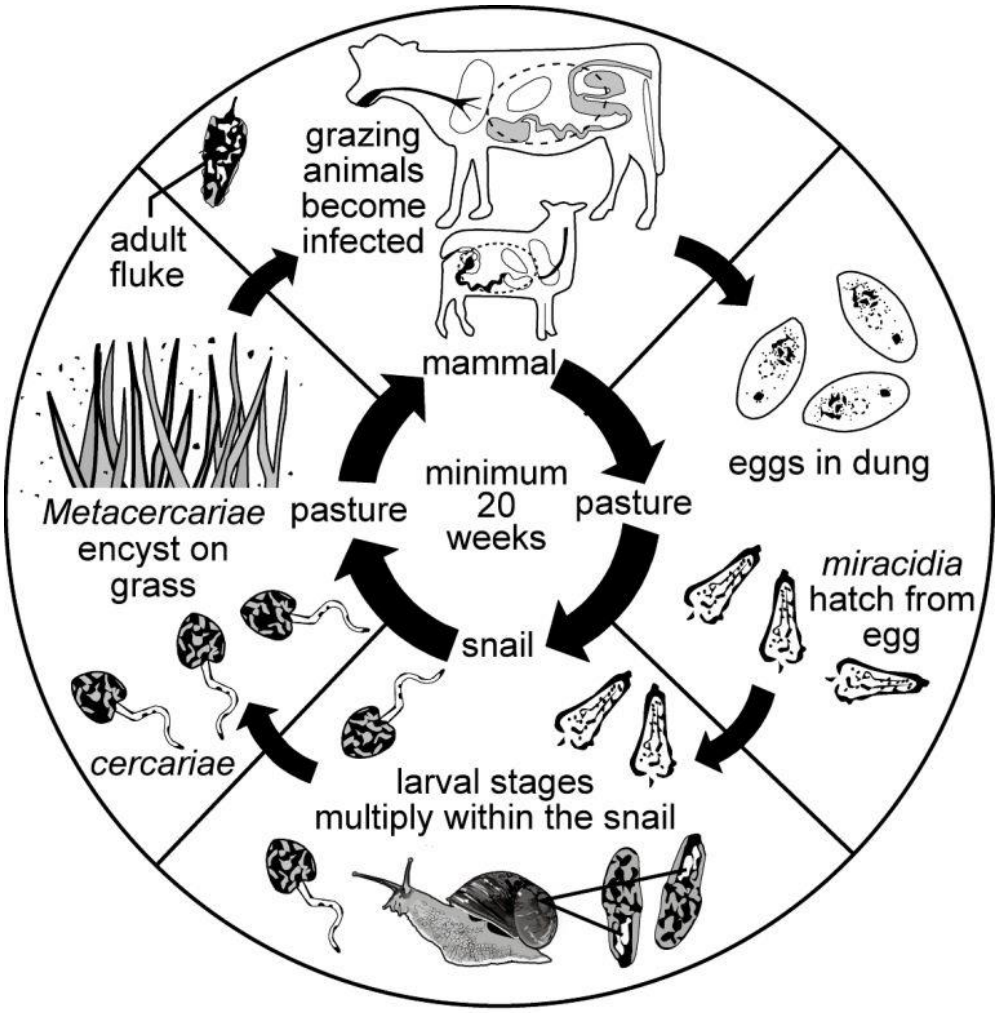
The following are some of the measures used to promote good animal health and control diseases, pests and parasites:

- Regular inspection of animals for early detection of diseases or infections
- Vaccination of animals to prevent diseases and parasites
- Correct application of medicine and treatment techniques
- Animal feed must be free from contamination
- Animals must have access to fresh clean drinking water
- Isolate affected and infested animals from the herd (quarantine)
- Practice controlled veld fires to encourage new vegetation and kill pests and parasites

2.5.3 Activities

QUESTION 2

Study the diagram of the life cycle of the liver fluke parasite and then answer the questions.



2.1 Name **ONE** negative effect that liver fluke has on farm animals. (2)

2.2 How long does it take to complete a life cycle? (1)

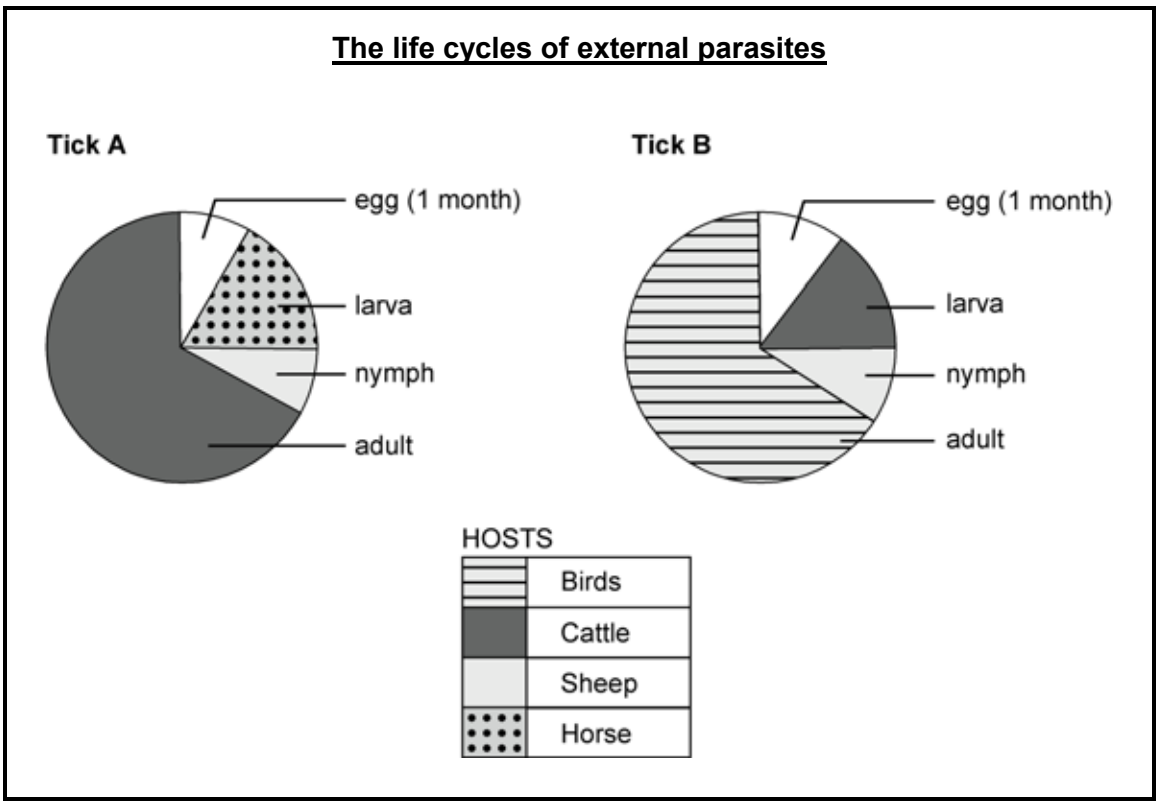
2.3 What is the secondary host of the liver fluke? (1)

2.4 What environment favours the infestation of farm animals? (1)

2.5 Where does the parasite grow? (1)

2.6 What can the farmer do to break the life cycle and so prevent infestation of his animals? (1) [7]

Question 3
Study the circle diagram carefully before answering the questions.



3.1 How long does it take for the eggs of tick A to hatch? (1)

3.2 Both tick species have long mouth parts. Why is this to the disadvantage of the hosts? (2)

3.3 Different animals become hosts at different developing stages. Name the host for each of the following stages in tick A:

(a) Nymph stage (1)

(b) Larva stage (1)

(c) Adult stage (1)

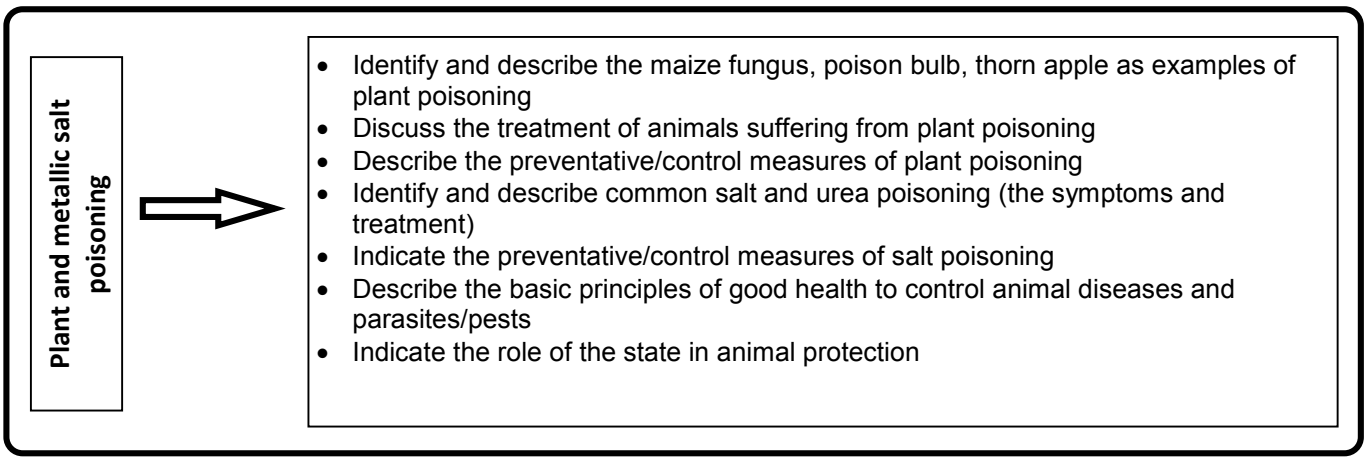
3.4 The best control method is to destroy the adult tick before the eggs are laid. Why is it difficult to control the numbers of tick B? (2)

3.5 Prevention is better than cure. Give **TWO** reasons why this is the case. (2)

3.6 What must a farmer do to prevent these parasites as much as possible? (2) **[12]**

2.6 Plant and other poisoning

By the end of this unit the learner should be able to demonstrate knowledge of the following content:



Terminology

Term	Definition
Aflatoxin	is a mould that is produced by maize fungus and is carcinogenic.
Alkalosis	excessive blood alkalinity that is caused by high levels of bicarbonate in the blood
Carcinogen	is any substance that promotes the formation of cancer.
Toxicity	level of being poisonous or toxic

2.6.1 Poisoning from Plants

This form of animal poisoning is not very common but does occur. It normally occur when the pastures are overgrazed and only poisonous plants remain.

Indigenous and non-indigenous plants in South Africa can be poisonous to animals. The most common and important plant poisoning are:

Maize fungus

Maize fungus grows on maize cobs. This fungus produces threads of filaments called hyphae. Maize fungus leads to aflatoxin in animals. It is prevalent in North West, Free State, Mpumalanga and KwaZulu-Natal.

Treatment includes:

- Keeping affected animals calm to reduce further infections
- Increasing the supply of proteins and vitamins A, D, E, K and B

Poisoning from maize fungus can be prevented or controlled through:

- Removing infected feed from animals
- Removing source of poisoning

Poison bulb

This type of poisoning is mainly caused by bulbs. The most common is one-leaf Cape tulip. The whole plant is poisonous. It grows mainly in Free State, North West, Northern Cape, and Eastern Cape.

Treatment includes:

- Administer charcoal into the rumen of the affected animal.

Prevention and control can be achieved through:

- Keeping new animals from the infested grazing land

Thorn apple

This is a weed that produces thorny seed capsules. It often grows between cultivated crops. The whole plant contains high levels of toxins.

Treatment includes:

- Treating the affected animal with charcoal

Prevention and control can be achieved through:

- Removing the source of poisoning

2.6.2 Salt poisoning

The intake of less water and more salts by farm animals results in salt poisoning. Salt poisoning is related to the quantity and quality of water intake by animals. Animals that are mainly affected are poultry, cattle and pigs.

Symptoms of salt poisoning

- Cattle: loss of appetite, dehydration, partial paralysis
- Pigs: stop eating and drinking, become deaf and blind
- Poultry: leg paralysis, diarrhoea, increased thirst

Treatment of salt poisoning

- Fresh quality water must be provided to animals
- Remove source of poisoning

Prevention of salt poisoning

- Supply sufficient clean fresh water to animals.
- Ensure that there is water supply closer to the salt licks in the camps

Poison by metallic salts

When metallic salts and inorganic substance mix with animal feed, animals are poisoned.

2.6.3 Urea poisoning

Urea is a non-protein source of nitrogen for ruminants. Urea poisoning in animals occurs when it is not properly mixed in the ration.

Symptoms of Urea poisoning

- Bloating
- Painful muscular cramps (tetany)
- Breathing with difficulty
- Frequent defecation and urination

Treatment of Urea poisoning

- Administer vinegar to reduce the effect of alkalosis.

Prevention of Urea poisoning

- Gradual increase in urea supplement to animal ration.
- Limit access to licks containing urea to animals that show salt deficiency.

2.6.4 Activities

1. Name TWO plants that are commonly found on natural pastures and could be poisonous to animals (2)
2. Indicate THREE measures a farmer can take to prevent plant poisoning. (3)

2.7 The role of the state in animal protection

The state plays important role in regulating farming practices. The following are some of the roles that the state implement:

- Implementing and enforcing legislation such as Animal Health Acts, Animal Diseases Act
- The state also render the following services towards animal protection:
    - Quarantine services
    - Control measures
    - Animal health schemes
    - Duties of owners of animals
    - Import bans
    - Exports of animals and animal products
    - Importation of vaccines
    - Movement permits
    - Veterinary services
    - Research

2.6.3 Activities

The South African government plays an important role in the regulation of farming practices. It ensures quarantine services and control measures regarding the import and export of animals. They also conduct research and provide veterinary services.

1

1.1 Indicate THREE types of animal health research done at the Veterinary Institute (3)

1.2 What is the purpose of a quarantine station? (2)

1.3 Besides the roles mentioned in the above extract, name TWO other roles performed by the state to protect the South African animal industry. (2)

Chapter 2 Activities
Memorandum

2.1 Intensive and Extensive Farming

1. **Enterprise systems**

1.1 Structure (a) – 2 ✓ (1)

(b) – 1 ✓ (1)

1.2 **Characteristics of production systems marked 2**

- Animals graze freely in camps✓
- Less capital intensive✓
- Few labourers needed✓
- Little human interference✓
- Free animal movement✓
- Minimal control and supervision of animals✓
- Animals kept in low density✓
- Large area utilised for production purposes✓ (any 2) (2)

1.3 **Comparison of production systems A and B**

Aspect	Production System 1	Production System 3
(a) Environmental control	Minimal or no control of the environment ✓	Environmental conditions controlled to suit the animals ✓
(b) Drought risk	High drought risk/animals travel long distances in search for fodder and water ✓	No drought risk/water is supplied/provided all the times ✓
(c) Production output	Relatively low production output/dependent on availability of natural grazing/dependent on environmental conditions/rainfall ✓	High animal production output/ optimal/maximum production output/not dependent on environmental conditions/environ-mental control ✓

(6)

2. **Production Systems**

2.1 **Farming system A**

Extensive system ✓ (1)

2.2 **Two reasons**

- Fewer workers / 2 workers✓
- Limited facilities / 1 cattle handling facility / 1 farm shed ✓
- Fewer / smaller number of animals over large area✓
- Cattel kept on natural pasture✓ (any 2) (2)

2.3 **Difference in feeding strategies**

- Farmer A is feeding livestock on natural pasture✓
- Farmer B is feeding livestock through feedlot ✓ (2)

2.4 **Two measures to increase production for Farmer A**

- Supplementary feeding ✓
- Control adverse environmental conditions through shelter✓
- Control of pests and diseases ✓
- Correct breeding methods✓
- More effective grazing system / rotational grazing ✓ (any 2) (2)

2.2 Animal Shelter, Protection and Housing

1.1 - Backyard systems✓ (1)
- Intensive system ✓ (1)

1.2 - Nutrition✓: broilers are sensitive to sudden change in their feed✓
- Environment✓: proper insulation with good ventilation, lighting and heating✓
- Breeding✓: cost of feed, conversion ratio for feed and sale price of broilers are key to improved production
- General management✓: proper sanitation with good floor space in the broiler house✓
(any 2) (4)

1.3.1 Homeothermic / homeothermy✓ (1)

1.3.2 - Extreme heat✓ (1)
- Severe cold✓ (1)
- Wetting by rain✓ (1)
- Strong sun✓ (1)

2.3 Behaviour and Handling of Farm Animals

1. **THREE Reasons for handling animals**
   - Artificial insemination✓
   - Health reasons (vaccination, dosing) ✓
   - Feeding✓
   - Parturition✓
   - Marketing✓
   - Slaughtering ✓

   (any 3) (3)

2. **TWO basic requirements for crushes**
   - Strong enough to hold animal✓
   - Animal must fit with comfort✓
   - Animals must be able to see each other in a crush✓
   - A handler must be able to work with animal in a crush✓

   (any 3) (2)

3. **Vision in cattle**
   - Blind spot✓ (1)

2.4 **Animal Diseases**

1. **Animal diseases**

1.1 **Organism causing foot and mouth disease**
- Virus✓ (1)

1.2 **Transmission of foot and mouth disease**
- Secretion and excretion from infected animals✓
- Ingestion of contaminated feed✓
- Virus entering through abrasion or mucous membrane✓

(any 2) (2)

1.3 **Control of foot and mouth by government**
- Quarantine of animals✓
- Vaccination✓
- Animal health education✓

(any 2) (2)

2.5 Animal Parasites

Question 1

1.1 Production and growth decreases✓✓ / animal becomes anaemic ✓✓ (2)

1.2 20 weeks✓

1.3 Snail✓ (1)

1.4 Wet grass land / pastures✓ (1)

1.5 Liver✓ (1)

1.6 – Keep animals away from wet grass lands or pastures✓

- Control snails✓
- Throw salt around through✓ (any 1) (1)

Question 2

2.1 One month✓ (1)

2.2 - Wounds form through which blowflies attack✓✓
- This can cause diseases such as sweat disease / heart water✓✓ (any 1) (2)

2.3 a) Sheep / goat✓
b) Horse✓
c) Cattle✓

2.4 The adult silage is only found on birds✓ which is difficult organism to catch and treat✓ (2)

2.5 - Loss of production✓ (1)
- Medication is expensive✓ (1)

2.6 - Dip (1)
- Get rid of blowflies (1)

2.6 **Plant Poisoning**

1. **Two poisonous plants**
   - Poison bulb/leaf✓
   - Thorn apple✓
   - *Lantana camara*✓
   - Drimia species✓
   - Lupins✓
   - Buffalo grass✓
   - Devil's thorn✓ (any 2) (2)
   -

2. **THREE measures of preventing plant poisoning**
   - Remove poisonous plants from pastures/burn the infested areas/application of herbicides/chemicals ✓
   - Remove animals from camps infested with poisonous plants ✓
   - Feed/water animals well/provide proper nutrition ✓
   - Avoid overgrazing ✓
   - Practice rotational grazing ✓
   - Inspect hay kept in stables ✓
   - Knowledge on poisonous plants ✓
   - Do not feed animals moulded hay/cut from areas with poisonous plants ✓

   (any 3) (3)

2.7 Role of state

1.1 **Type of research done by state Veterinary Institute**
   - Veterinary research to improve vaccines / source new products✓
   - Surveillance / control / preventing diseases✓
   - Producing new vaccines ✓ (3)

1.2 **Purpose of quarantine**
   - To isolate animals and ✓
   - To prevent diseases from spreading in the country✓ (2)

1.3 **Other roles the state play to protect animal industry**
   - Animal health schemes✓
   - Duties of owners of animals✓
   - Import bans✓
   - Importation of vaccines✓
   - Movement permits✓ (any 2) (2)

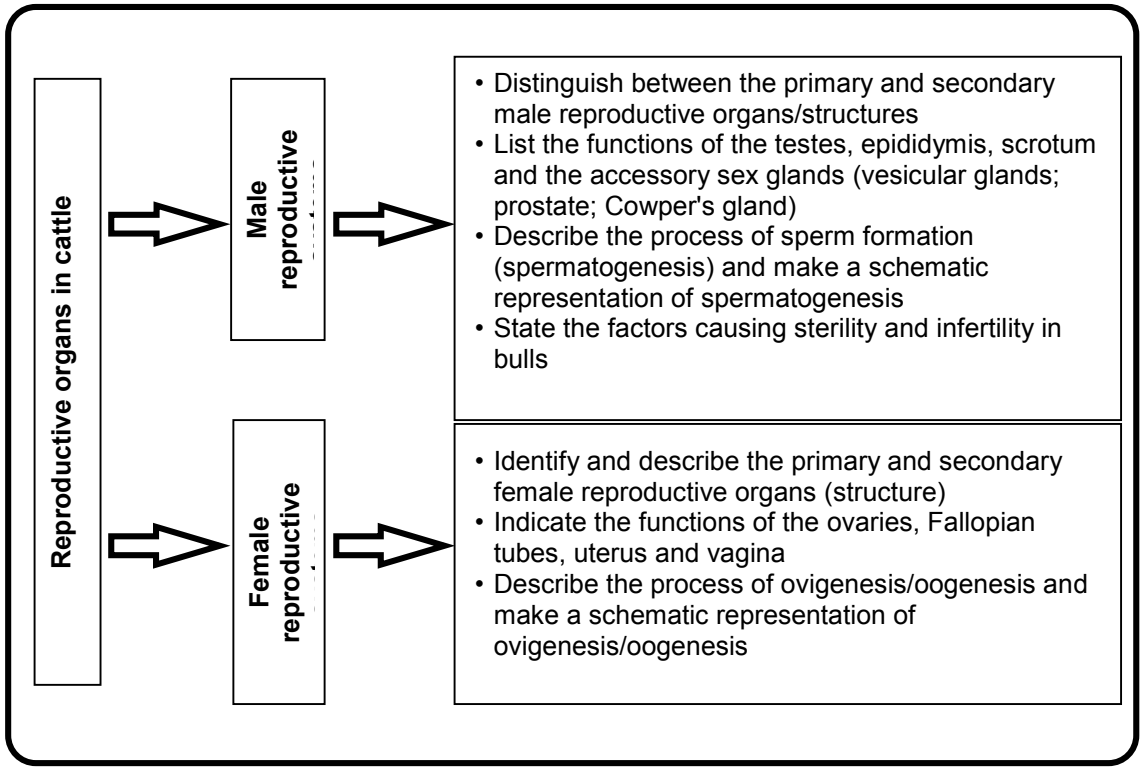
Chapter 3

Paper 1

ANIMAL REPRODUCTION

3.1. Reproductive organs

At the end of this unit the learner should be able to demonstrate knowledge of the following content.



3.1.1 Terminology:

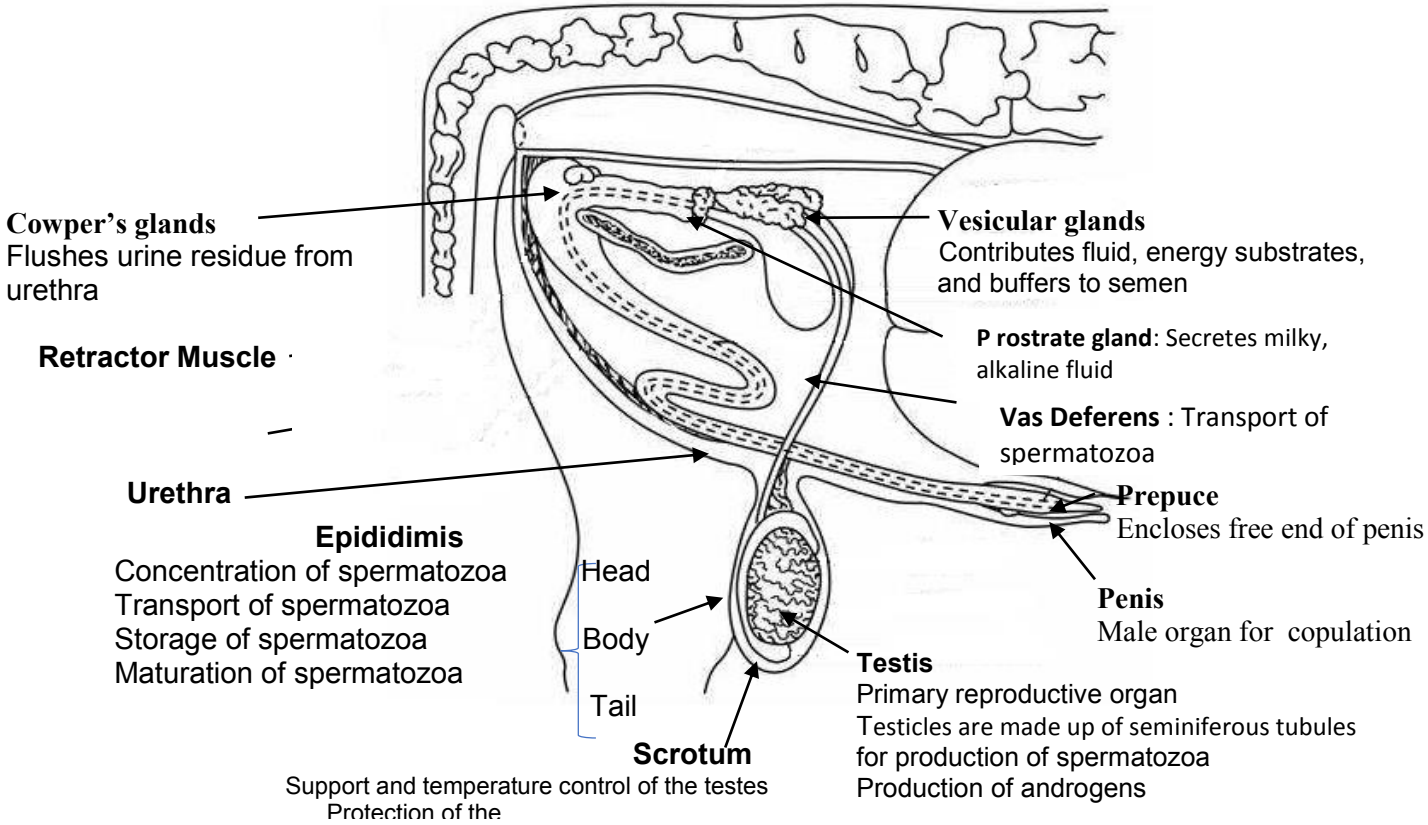
TERM	DEFINITION
Ampulla	Site for fertilisation
Cervix	A firm tube-like structure found between the uterus and the vagina
Clitoris	Small elongated erectile organ at the anterior part of the vulva
Ejaculation	Release of semen into the vagina during copulation/mating
Epididymis	A single, narrow, coiled tube that transports sperm from testes to the vas deferens
Fallopian tubes/ oviducts	A pair of coiled tubes that extend from the ovaries to the uterus
Gametogenesis ▪ **Oogenesis/ovigenesis** ▪ **Spermatogenesis**	Formation of gametes Formation of a mature ovum from a primary oocyte Formation of spermatozoa in the testes
Oocyte	An immature ovum that into a follicle
Ovary	Primary sex organ of a female
Ovulation	A release of a ripe ovum from an ovary

Ovum	Female gamete
Penis	A male organ of copulation
Primary reproductive organs	produce gametes or sperm/ova,
Prostate gland	A gland that lies in the form of a ring around the urethra in males
Reproduction	Production of offspring
Scrotum	A sac that houses and protects the testes
Secondary reproductive organs	The duct system transporting the gamets and associated organs
Semen	A mixture of sperm & fluids from the seminal vescicle, prostate gland & Cowper's gland
Sperm	Male gamete
Testis	Primary sex organ of a male animal
Testosterone	A male hormone responsible for male characteristics
Uterus	An organ where a developing embryo is implanted
Vagina	A female mating organ/ a birth canal
Vulva	External opening of the vagina

For a species to thrive, it must be able to reproduce itself. Producing offspring requires the proper functioning of both the male and female reproductive systems, each of which consists of several parts that have specific purposes in the reproductive system. Reproduction in farm animals ensure an income for the farmer.

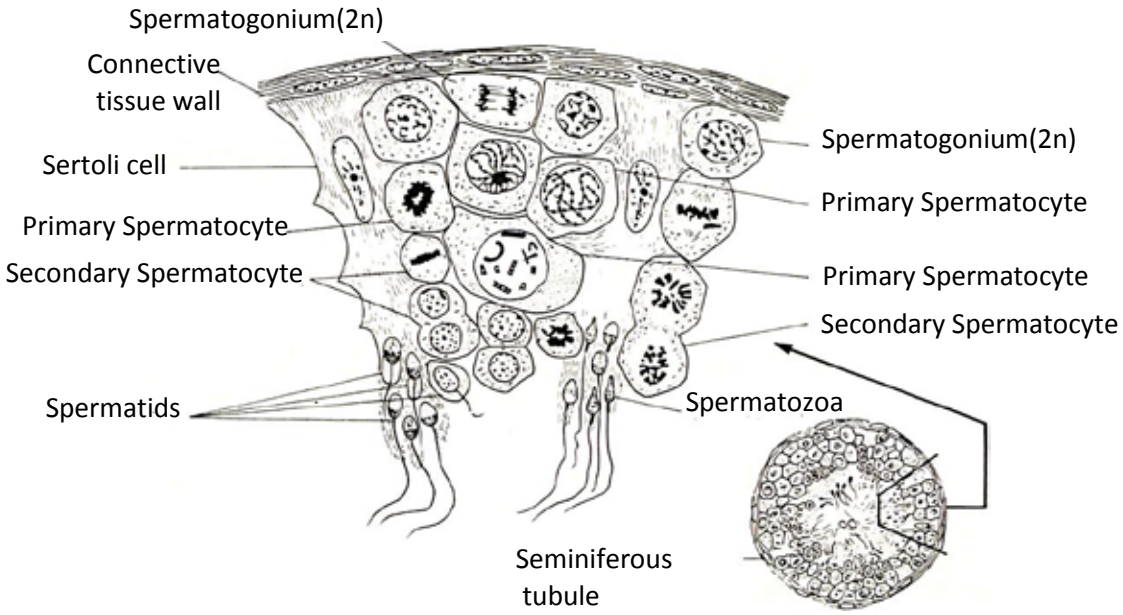
3.1.2 Male reproductive organs

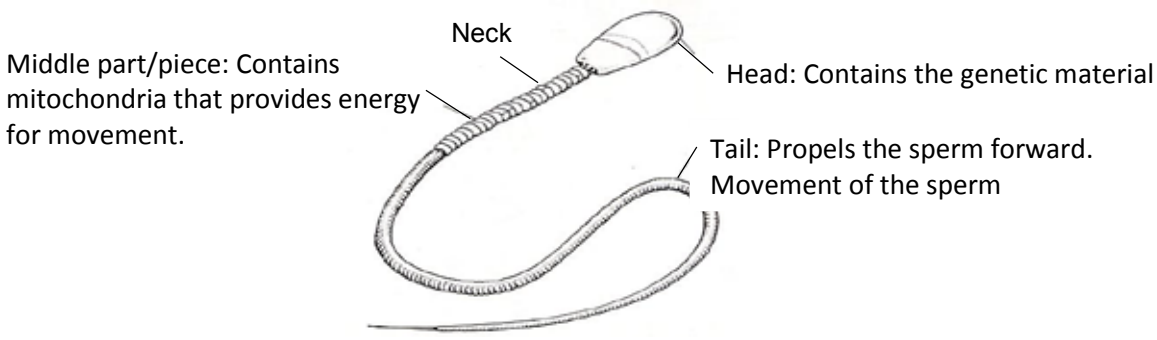
These organs are similar in all male mammals. The bull's reproductive is used to illustrate the male mammalian reproductive system.
The male reproductive organs consist out of two parts – primary reproductive organs,
The primary organs consists of the testis, which is responsible for the production of the sperm and the secretion of testosterone, and the storage of the semen.
Secondary reproductive organs consist mainly of the parts and ducts transporting semen to be transferred and associated organs. This comprises of the Vesicular glands, Vas differens, Prostate,Cowpers gland and the Penis



Sperm formation(spermatogenesis)
Spermatogenesis is the process during which the primary male sex cells undergo metamorphosis in the tubules of the testes and develop into spermatozoa. The process starts when the animal reaches puberty.

Spermatogenesis in the testis
Sections through testicular tissue to illustrate the process of spermatogenesis and the role of the Sertoli cells in supporting the germ cells. The interstitial tissue lies between individual seminiferous tubules.





Schematic representation of spermatozoan

STERILITY AND INFERTILITY:
Sterility- The male shows interest in a female and is able to serve the female but fertilization does not occur. It is permanent in nature.

Infertility – The failure of animals to produce gametes, to mate or for fertilization to occur. Infertility is temporary in nature and can be caused by various factors>

FACTORS CAUSING INFERTILITY IN BULLS
Infertility in bulls can be classified into three main groups e.g.

ABSENCE OF SEX URGE/LACK OF LIBIDO

Although the bull may be healthy and normal it does not show an interest in cows. This may be due to the following factors.

:

Immaturity.	Spermatozoa are produced as early as 8-9 months of age the various sex organs are fully developed only at an age of 2 years.
Lack of experience	Young bulls growing up on their own sometimes display no interest in cows due to a lack of experience and ignorance.
Exhaustion	Physical and sexual overstrain bulls display a lack of sex urge. Moderate exercise is essential for health and fertility. Correct ratio1bull:20-25 cows is important.
Malnutrition	Underfeeding and feeding an unbalanced ration a deficiency of constituents such as vitamins, minerals and proteins occurs and consequently the bull will not display sex urge. Overfeeding causes obesity and the animal is not inclined to copulate.
Diseases	Diseases coupled with fever and anaemia and which cause weakening and exhaustion, lower the sex urge.
Temperament & Environment	Each bull has its own temperament and a change in care, treatment and environment often cause a lack of sex urge.

INABILITY TO COPULATE /IMPOTENCE

Bulls may display sex urge but cannot serve a cow owing to various abnormalities.

Abnormalities in conformation	Weaknesses of the back or hind legs make serving of the cow difficult or impossible. Corpulence aggravates the problem.
Diseases.	Pain and infections of joints and feet prevent bulls from serving cows.
Injuries	The penis may break during copulation. The anterior part of the penis becomes paralysed and a bloody swelling forms. Tick bites cause festering which leads to outgrowths between the penis and the sheath
Congenital deformities	The penis may be too small or too short. The two muscles on the ventral side of the S-shaped curve may be too short so that the penis cannot be extruded properly. A constriction of the prepuce will also prevent the penis from being extruded.

INABILITY TO FERTILISE

Usually the sex urge is very good but the bull cannot fertilise cows because the spermatozoa have been damaged after they were produced or no spermatozoa were produced.

Exhaustion and malnutrition	No spermatozoa are produced or they are ejaculated before they are mature. Immature spermatozoa are usually deformed and infertile
Diseases	Spermatozoa formed after animals have recovered from diseases such as gallsickness or redwater are abnormal. Lumpyskin disease suppresses sperm formation for up to one year
Infection of the sex **organs**	The testes may be infected by germs either through the blood or the lymph stream or the vasa deferentia or they can penetrate from the outside through wounds.
Congenital deformities. e.g Hypoplacia & Criptorchidism	Underdeveloped testes are or when both testes remain in the abdominal cavity, bulls are infertile. Navel hernias may prevent the bull to serve. Scrotum hernias cause the intestines to slip down into the scrotum and the animal becomes infertile. Abnormalities of the structure of the acrosome impede the secretion of the enzyme hialuronidasis which is responsible for the dissolving of the membrane of the ovum and fertilisation cannot take place. The head and tail of a spermatozoan may be torn apart and the animal is infertile

3.1.3 Female reproductive organs

Cervix: Prevents microbial contamination of the uterus. Reservoir for semen. Site of semen deposit during natural mating

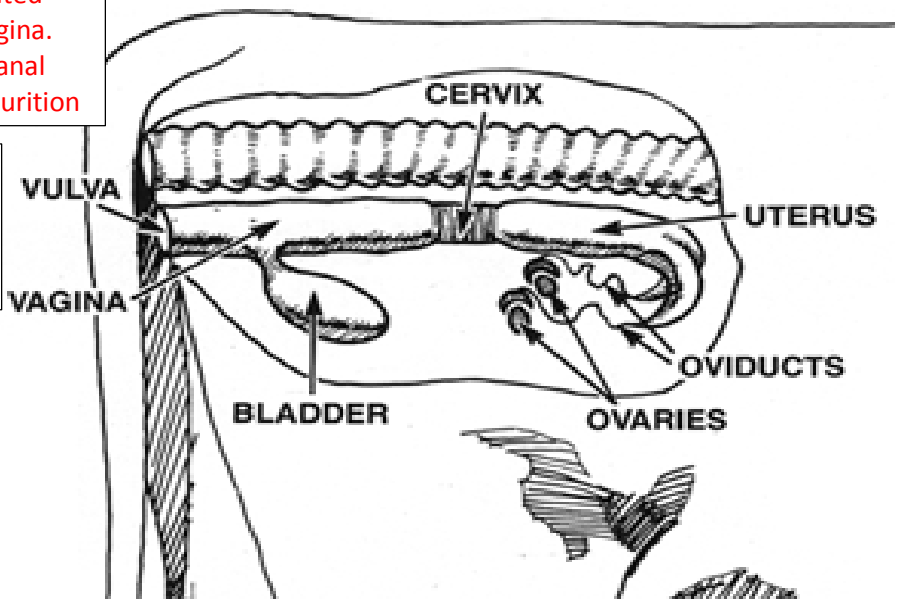
Vagina: Sperm gets deposited into the vagina. The birth canal during parturition

Uterus: Retains and nourishes the embryo and the foetus

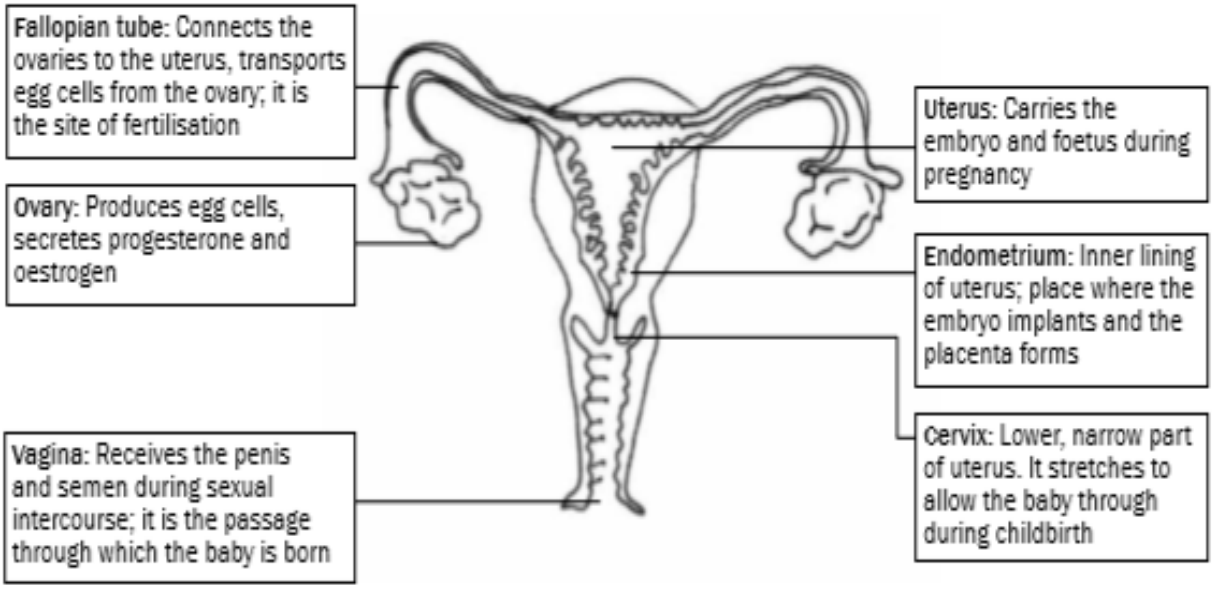
Vulva: Opening of the vagina

Oviduct: Gamete transport (Sperms & Ova) & Site of fertilization.

Ovaries: Produce and release eggs (Ovulation)



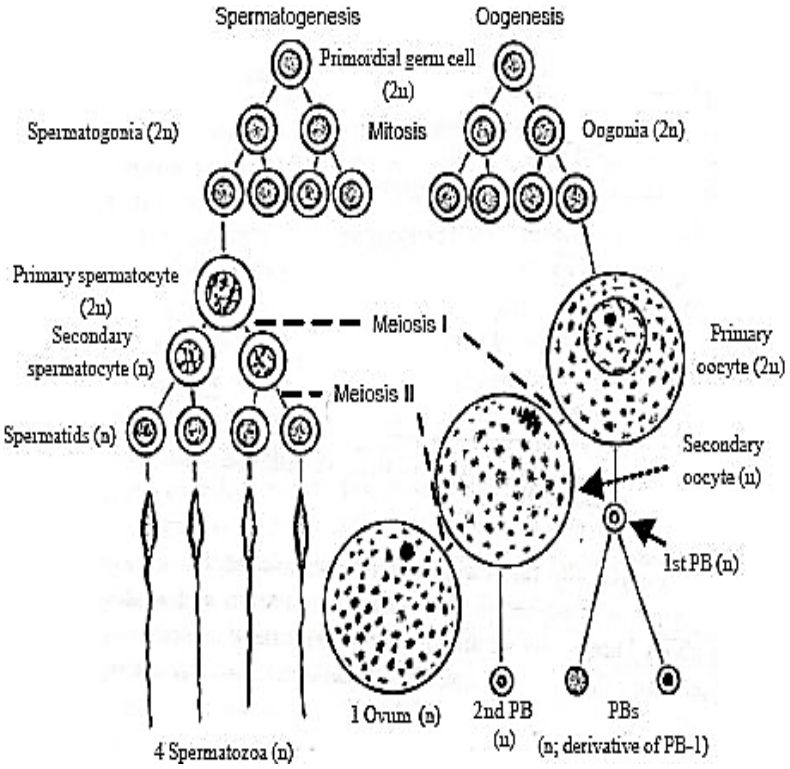
The structure of the female reproductive system



Spermatogenesis and Ovigenesis/oogenesis

Formation and maturation of the gametes must be completed for both the male and female before the reproductive processes can be initiated. The process starts when the animal reaches puberty.

Ovigenesis (or oogenesis) - is the formation and maturation of the female gamete. (one ovum and polar bodies)



Spermatogenesis:

STEP 1
A mitotic division of a spermatogonium forming a *dormant* and an *active spermatogonium.* The dormant spermatogonium remains in the germinal epithelium near the basement membrane to repeat the process later. The active spermatogonium will undergo four mitotic divisions, eventually forming 16 *primary spermatocytes*

STEP 2
Each primary spermatocyte will under a meiotic division forming two *secondary spermatocytes* . With this division, the chromosome complement in the nucleus is reduced by half so that nuclei in secondary spermatocytes contain unpaired (n) chromosomes.
Each spermatid develops a tail and forms a motile spermatozoa.

Oogenesis:

- The primordial germ cells differentiate into oogonia (2n – diploid)
- The oogonium divides by the process of mitosis and develops into two primary oocytes (2n- diploid)
- During meiosis I the primary oocytes divide and from secondary oocytes (n- haploid)and a polar body under the influence of the follicle- stimulating hormone.
- During meiosis II the secondary oocytes form ootids and three polar bodies
- The ootid differentiates and matures and an ovum is formed

Activity 3.1.4 : The male reproductive system

The diagrams below represent the reproductive organs of a bull, the processes of sperm formation and the development in the sex cells.

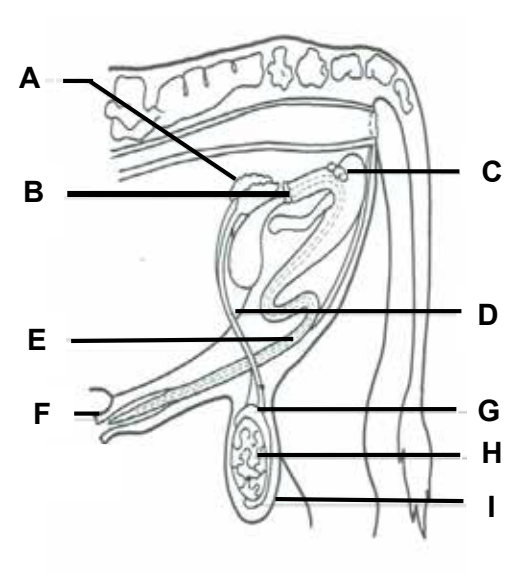


DIAGRAM 1

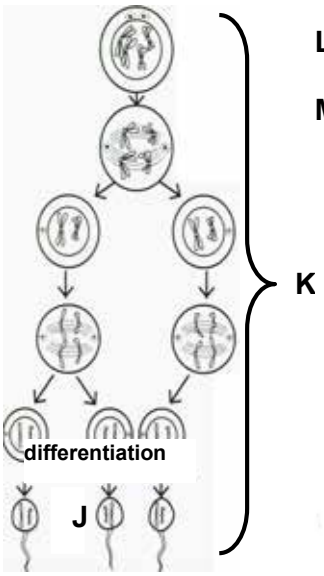


DIAGRAM 2

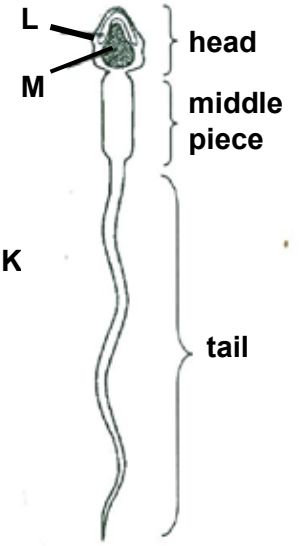
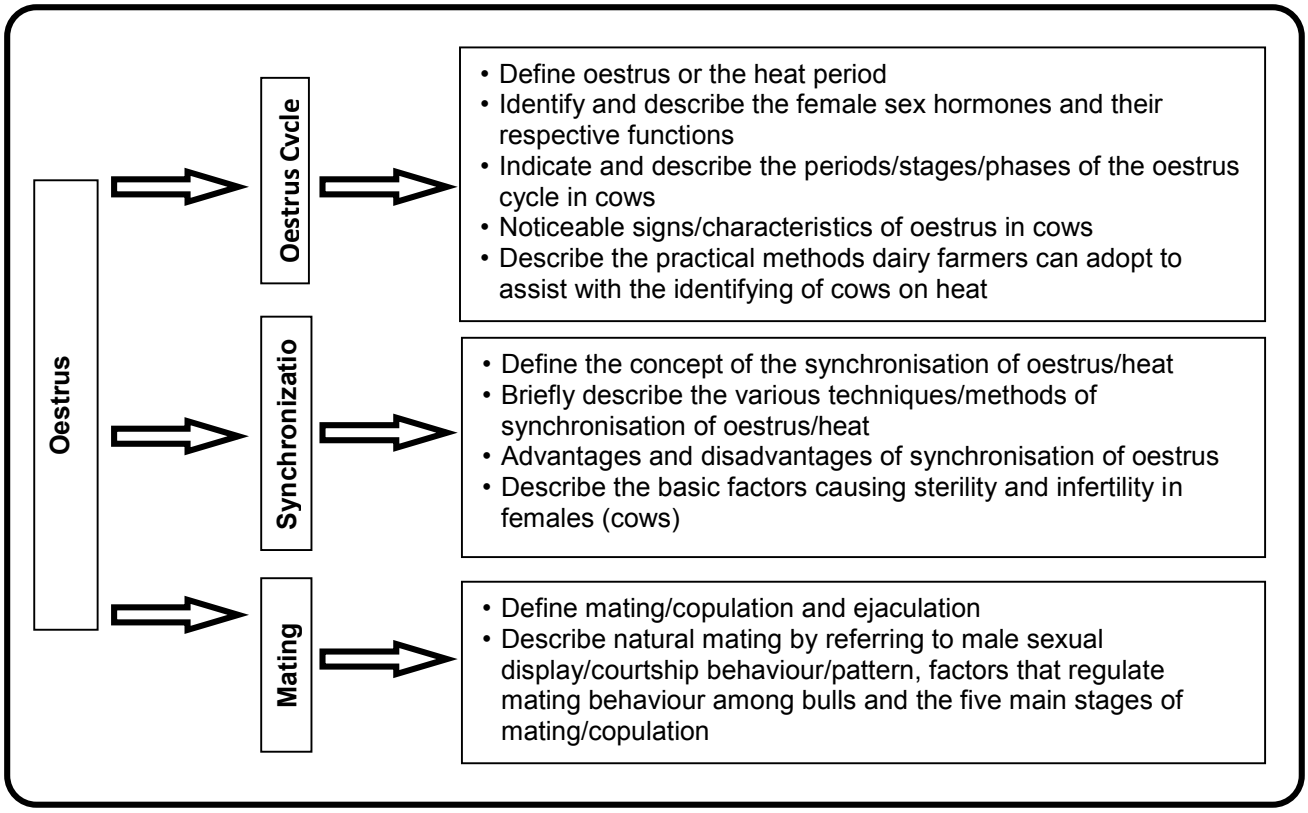


DIAGRAM 3

1. Name parts **A**, **B**, **C** and **H**. (4)
2. Identify process **K**. (1)
3. State ONE function each of parts **D** and **L**. (2)
4. Describe how congenital defects can influence the process in DIAGRAM 2. (2)
5. Give a reason why part **H** in DIAGRAM 1 is situated outside the abdominal cavity of a male animal. (1)

3.2. Oestrus, Oestrus Cycle, Synchronisation and Mating

At the end of this unit the learner should be able to demonstrate knowledge of the following content.



3.2.1 Terminology:

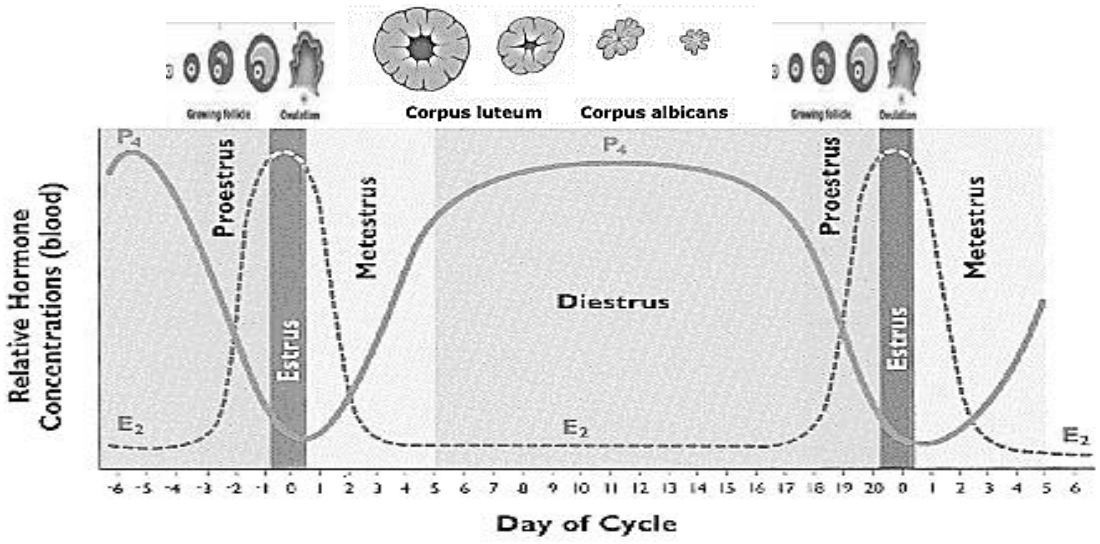
TERM	DEFINITION
Anoestrus	• A sexually mature, non-pregnant cow shows no signs of oestrus
Oestrogen	• A female hormone responsible for onset of behavioural oestrus
Oestrus	• A period when a female is receptive of a male & allows mating
Oestrus cycle	• A 21 day period which a follicle develops into a mature ovum
Oocyte	• An immature ovum that develops into a follicle
Ovulation	• A release of a ripe ovum from an ovary
Ovum	• Female gamete
Prolactin	• A female hormone responsible for production of milk
Prostate gland	• A gland that lies in the form of a ring around the urethra in males
Reproduction	• Production of offspring
Superovulation	• Treating a female with hormones in order to produce many ova at the same time
Synchronisation of oestrus	• A treatment of a large number of animals with hormones so that they all reach oestrus at the same period
Ovary	• Primary sex organ of a female

3.2.2 Oestrus

Oestrus or being on heat is a brief period of intensive sexual activity and the only time the female will allow mating. Oestrus is caused by hormones of the hypophysis and ovaries.

Phases of the oestrus cycle

The oestrous cycle is the rhythmical change and regular periods of oestrus which a normal, mature, non-pregnant cow displays. It starts at puberty and is repeated every 21 days unless it is interrupted by pregnancy, diseases or other factors and extends up to the end of the life-time of a healthy cow.



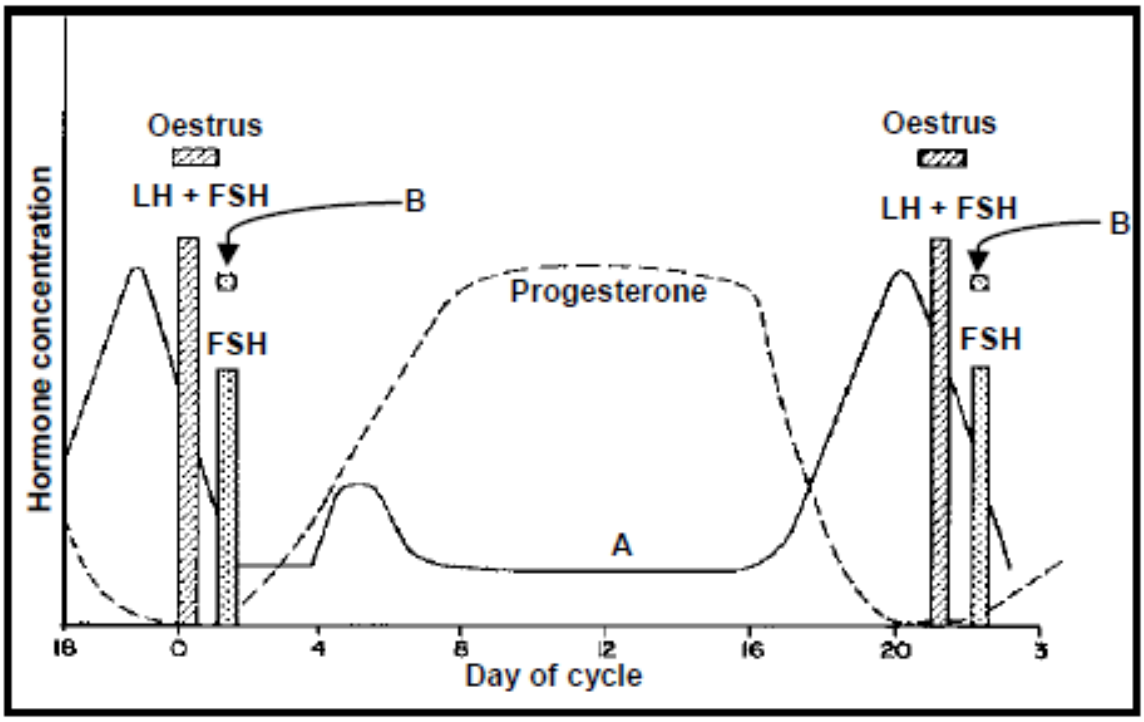
Pro-Oestrus	Oestrus (in heat).	Met Oestrus Post estrus	Di estrus FINAL phase
• 2 to 3 days • primary follicles are stimulated by FSH (follicle stimulating hormone) the • oocyte develops into an ovum • follicles are now called Graafian follicles • Graafian follicles function as endocrine glands and secrete the oestrogen • Oestrogen is responsible for symptoms of oestrus • Muscles of the cervix relax to allow spermatozoa to move from the vagina to the body of the uterus	• about 16 hours-18 • phase of sexual desire • characterised by changes in behaviour of the cow, the vulva becomes more swollen, the genital organs are redder and large quantities of mucus are secreted. • follicles grow to the size of a pigeon's egg. • Ovulation only occurs 6 to 14 hours after the period of oestrus. • The cow will allow mating only during this period	• 3 days. • sudden cessation of heat • hypophysis secretes lutilizing hormone (LH). • FSH and LH stimulates the Graafian follicle to ripen • LH and oestrogen are responsible for rupture of the ripe Graafian follicle. • Ripe ovum is released(ovulated) • After ovulation LH stimulates the ruptured Graafian follicle to form the *corpus luteum* •	• about 15 days • sexual inactivity. • cow is calm and restful and displays no sexual desire. • corpus luteum secretes pro-gesterone which, together with oestrogen, is responsible for final preparation of the uterine wall. • The corpus luteum decreases in size during the last few days of the phase • If fertilisation has taken place the corpus luteum will persist for the whole pregnancy period.

Hormones involved in the oestrus cycle

Hormones	Organ	Functions
Gonadotrophic releasing hormone	Hypothalamus	• Releasing FSH and LH release
Follicle stimulating hormone (FSH)	Pituitary gland	• Follicle growth • Estrogen release •
Luteinizing hormone (LH)	Pituitary gland	• Ovulation • Corpus luteum formation and function •
Oestrogen (Estradol)	Ovary	• Delays FSH • Mating behavior • Secondary sex characteristics • Maintenance of female duct system • Mammary growth
Progesesterone (Progestins)	Corpus Luteum	• Maintenance of pregnancy • Mammary growth • Delays secretion of FSH • Preparing the uterus to receive the fertilised egg

Activity:3.2.4 Hormones during the oestrus cycle

The graph below represents the levels of hormones at different stages in the oestrus cycle of a cow



1	Indicate the length, in days, of this oestrus cycle.	(1)
2	Name the structure that secretes progesterone during this oestrus cycle.	(1)
3	Name the hormone indicated by A in the graph above. Give a reason from the data above to support your answer.	(2)
4	Name the process represented by B in the graph above.	(1)
5	Name TWO visible signs that will be observed from this cow on day 0 or on day 21.	(2)

Oestrus in cows is identified by the following signs:

Behaviour of cow in heat.	Behaviour of other cows.	Visible changes of sex organs
• The cow is restless, usually seeks company, often bellows, • arches her back and mounts other cows. • The cow goes to the bull and allows serving. • When grazing, the cow not in heat will peacefully chew the cud while the cow in heat will isolate herself, remain standing or wander about. • mucus is suspended like ropes from the vulva, polluting the tail and thighs. • The hair on the rump of the cow in heat will be in disorder or soiled with mud or manure.	• Other cows mount the cow in heat.	• High concentration of oestrogen results in the following visible signs: • lips of the vulva become redder and more moist than usual.

The synchronising of oestrus is the treatment of cows with hormones to change their oestrus cycle in order that they all reach oestrus within a period of 4 to 5 days.

Bennefit:

- When cows on pasture are articially inseminated.
- Makes management easier

How it works - Progesterone inhibits the maturation of the Graafian follicles and so prevents oestrus. Cows in different phases of the oestrous cycle are treated over a period of 14 days. As soon as the progesterone injections are discontinued, the Graafian follicles begin to develop rapidly. The cows show signs of oestrus almost simultaneously within 2 to 5 days and artificial insemination can be applied.

Various artificial control and synchronization of estrus

Artificial control of oestrus are induced by:

Injecting gonadotrophic hormones	Follicle development is stimulated by these hormones to induce oestrus
Injecting oestrogen hormones	Synthetically manufactured oestrogen, generally known as stilboestrol, is used to induce oestrus.
Injecting progesterone	This hormone prevents oestrus and the animals will show signs of oestrus a few days after injections are discontinued
Squeezing out of the corpus luteum	As a rule the cow shows signs of oestrus four days after the corpus luteum has been squeezed out because the source of progesterone, which suppresses the development of follicles, has been removed

Advantages and Disadvantages of estrus synchronization

Advantages of Oestrus Synchronization	Disadvantages of Oestrus Synchronization
• Earlier and more concentrated calving • Uniformity of calves at weaning • Use of improved genetics for producing a value-added product • Less time for oestrus (heat) detection	• Drug expense and labour intensive • An existing high level of management is required • Good handling facilities are required • Cows must be cycling and in good body condition • You can only synchronize the number of cows you can inseminate at one time

FACTORS CAUSING INFERTILITY AMONG COWS
PATHOLOGICAL CAUSES

Organic diseases	Normally caused by inflammation of or around the sex organs. Inflammation in the Fallopian tubes prevents the downward movement of the ovum and the upward movement of spermatozoa that prevents fertilisation. Eg. Lowered fertility and inflammation of the cervix are the results of various forms of inflammation.
Contagious infertility	• Contagious infertility affects a large number of cows in a herd and causes low fertility or complete sterility. It is caused by venereal diseases such as trichomoniasis, vibriosis and vaginitis and is transmitted during copulation. • Brucellosis is not a copulation disease, but is transmitted through contact. The disease causes abortions and may lead to infertility.
Common contagious diseases	These diseases may cause lowered fertility to a certain extent because fever, emaciation or a weakened constitution disturbs the normal sex cycle. Some of these diseases may also give rise to secondary scars in the genital organs which prevent the development of the ovum, ferti-lisation and adhesion.

Physiological Causes
This is the direct consequence of a disturbance in the balance between the various sex hormones which control the functioning of the ovaries.

An-oestrus (absence of oestrus).	The sexually mature, non-pregnant cow shows no signs of oestrus caused by various physiological factors.
Infantilism.	Partly underdeveloped ovaries and other genital organs no follicles develop
Static ovaries	Ovaries appear normal but show no signs of activity.
Sub-oestrus.	The oestrous cycle is normal but the cow shows no signs of oestrus. Bull cannot detect that the cow is in oestrus. The quantity of oestrogen secreted is insufficient to cause oestrus.
Faulty ovulation	Cows with no visible pathological or other abnormalities of the genital organs fail to become pregnant after repeated copulation or insemintion. a) Delayed ovulation. Ovulation occurs only 24-28 hours instead of] 4 hours after oestrus. Spermatozoa can survive only for 24-28 hours in the female reproductive canal and are are already dead when ovulation occurs. b) Anovulation. Ripe Graafian follicle does not burst but continues to exist for a few days after oestrus after which it either degenerates (regression) or forms a cyst. With regression the follicle remains

	unchanged for a few days before it becomes rapidly smaller and disappears before the next oestrous cycle. c) Lutinised cysts yellow luteinising tissue is deposited on the inner wall of the follicle. This condition is rare and occurs when cows develop fever during the oestrous cycle. Removal of the cyst is followed by normal oestrus and fertilisation. d) Luteal cyst develops after normal ovulation. The small cavity in the corpus luteum contains more fluid than normal. Removal of the cyst is followed by normal oestrus and fertilisation.
Fixation of the corpus luteum	The corpus luteum does not degenerate after the fifteenth day and continues to produce progesterone. Progesterone retards growth and development of another follicle preventing the cow from coming in heat.

HEREDITARY CAUSES

Heredity influences reproduction in various ways by deviation in anatomical and physiological development of the reproductive organs, abnormal conditions in the uterus and disturbances in hormonal control.

Underdevelopment of the reproductive organs	One or both ovaries are very small, thin and hard and inactive. Other organs may also be underdeveloped, When a pair of reproductive organs is underdeveloped the cow is sterile and when only one of a pair of organs is underdeveloped the fertility of the animal is low.
Double cervix canal	Two canals run side by side in the cervix to the uterus but **one is blind-ending.**
Prolapse of the vagina	Vagina drops out during pregnancy especially when the cow is lying down. The mucous membrane makes contact with the ground and this may cause inflammation.
Hermaphrodite	The animal is neither male nor female and the male and female reproductive organs are underdeveloped.

ENVIRONMENT

The cow performs best with regard to breeding in the environment where she was born and reared. Transferring a cow from one region to another is followed by long periods of anoestrus

MILK PRODUCTION

The balance of hormones is disturbed if the demand on the sex hormones concerned with the composition and secretion of milk is increased. Cystic ovaria are common in high producing cows that decrease fertility..

POOR MANAGEMENT

The fertility of a female animal which is not well treated and cared for during the first year of her life will be low for the rest of her life. Infestation by internal parasites retards puberty and results in infantilism, an-oestrus, sub-oestrus and irregular oestrous cycles.

When a heifer becomes older than three years before being mated, she does not easily conceive and her fertility is affected. **I**f the normal oestrous cycle is not interrupted regularly by pregnancy it results in abnormalities of the ovaries and the cycle and it is characterised by cystic ovaries. Injudicious use of hormones causes permanent infertility. Ill-treatment of a cow results in disturbances of the rhythmic course of the oestrous cycle. Cows in heat which are driven very often show delayed ovulation or anovulation.

INCORRECT FEEDING

Overfeeding.	The ovaries of cows fattened for shows or stock sales are covered with an excessive layer of fat, have a scarcity of follicles and an absence of large growing follicles
Underfeeding.	The animal uses the reserves in its body to satisfy the requirements of various physiological functions at the expense of the reproductive system. The hypophysis loses mass and atrophies. In the hypophysis of small heifers cysts develop which retard puberty by 7 to 9 months. Deficiencies of vitamin A, proteins and phosphates in the pastures during the times of drought and the winter months cause long periods of anoestrus.
Unbalanced rations	Rations with a deficiency of minerals, especially phosphorus, and vitamins, such as A, D and E, will lower the fertility of cows.
Oestrogen in pastures	Lucerne and clover pastures contain oestrogen during certain stages of growth that it results in cystic ovaries in cows. As many as half of the cows on such pastures become infertile. A high percentage of pregnant cows show signs of heat and many abortions occur.

MATING

Defenition : Is the natural process whereby sperm gets deposited in the uterus of a female animal by the male animal through the process of copulation

The cow allows copulation during a very brief period prior to ovulation. A few thousand million spermatozoa are transferred from the bull by means of the penis to the anterior part of the vagina.

The spermatozoa move from the vagina, through the cervix, the body and horns of the uterus up to the infundibulum of the Fallopian tube close to the ovaria within 3-15 minutes.

The movement of the spermatozoa is caused by:

1. the propeller-like movements of the tail of the spermatozoa; and
2. the peristaltic movements of the walls of the uterus.

Copulation by the bull cause an increase of secretion of the hormone oxytocin by the hypophysis which stimulates the walls of the uterus.

To ensure fertilisation some spermatozoa remain in the cervix where conditions are favourable for survival. They move gradually forward from the cervix during the first 24-28 hours after copulation.

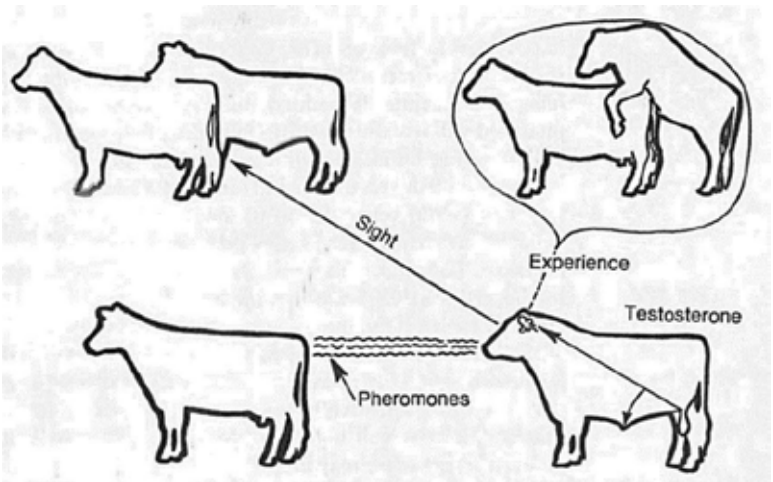
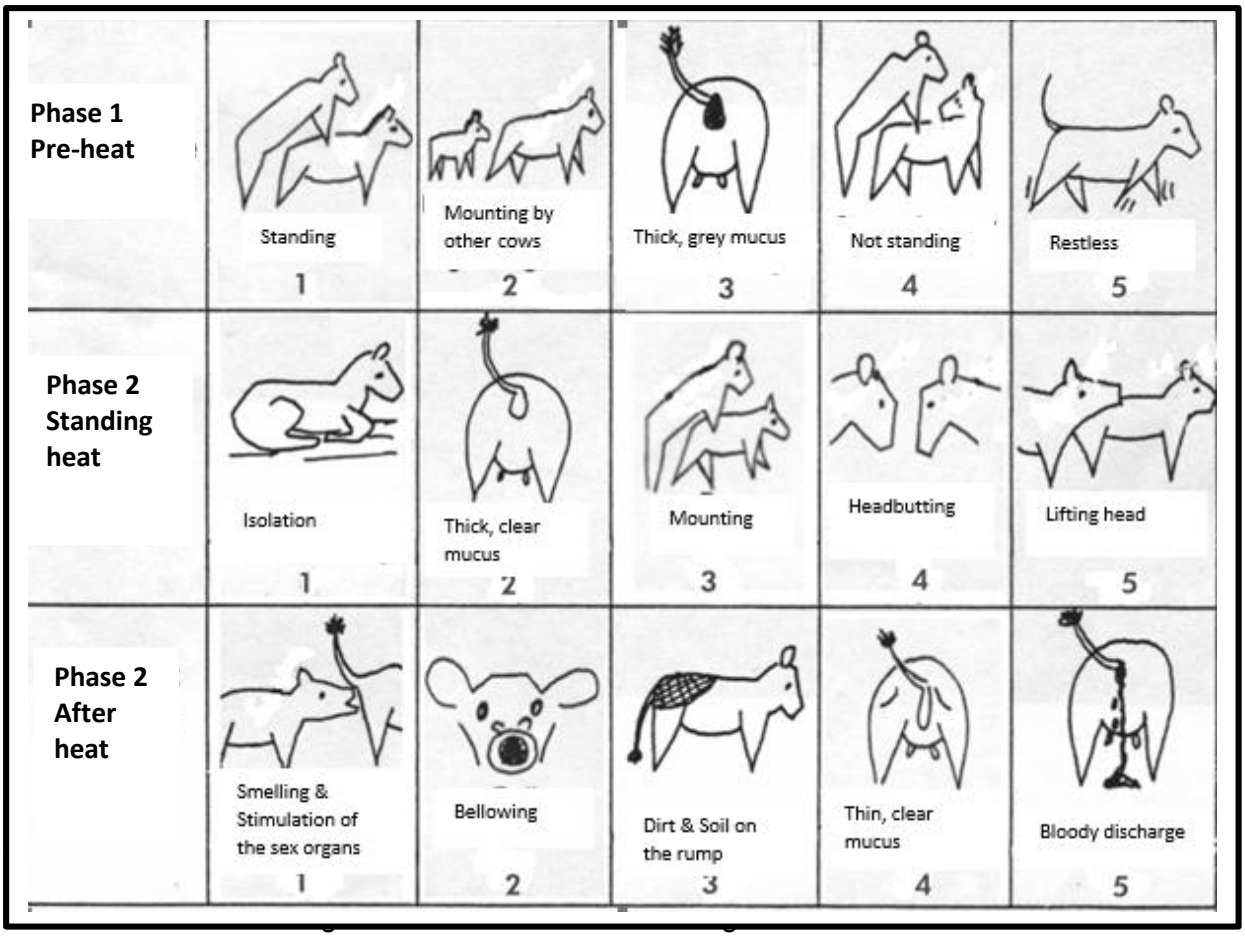


FIGURE 11-2. Interaction of factors that regulate sexual behavior in bulls and other species.

3.2.5 Activity: Heat detection (Oestrus) in animals

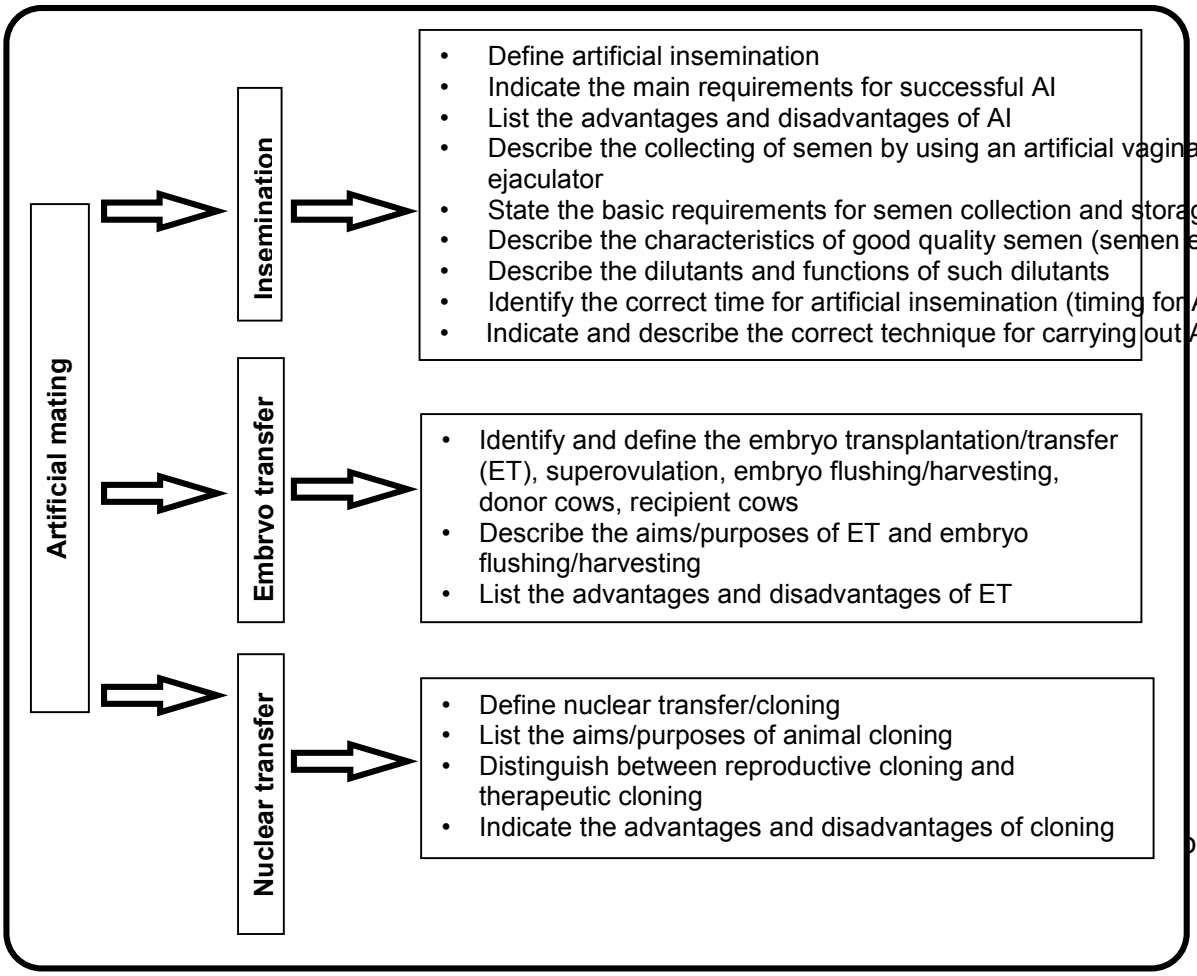


It is, however, not in the correct order. Complete the following diagram by placing the diagrams in the correct order

Phase 1. Pre-Heat					
Phase 2. Standing Heat					
Phase 3 Post Heat					

3.3. Artificial insemination

At the end of this unit the learner should be able to demonstrate knowledge of the following content.



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3.3.1 Terminology

TERM	DEFINITION
AI	• The process whereby sperm is placed into a female's uterus/ cervix by artificial means rather than natural mating
Embryonic transfer/transplant	• Removal of a fertilised ovum from the uterus of a superior cow & transferring it to the uterus of the inferior cow
Embryo	• A developing animal formed from a fertilised ovum
Nuclear transfer/ cloning	• A process that produces an identical copy of biological material
Superovulation	• Treating a female with hormones in order to produce many ova at the same time
Synchronisation of oestrus	• A treatment of a large number of animals with hormones so that they all reach oestrus at the same period

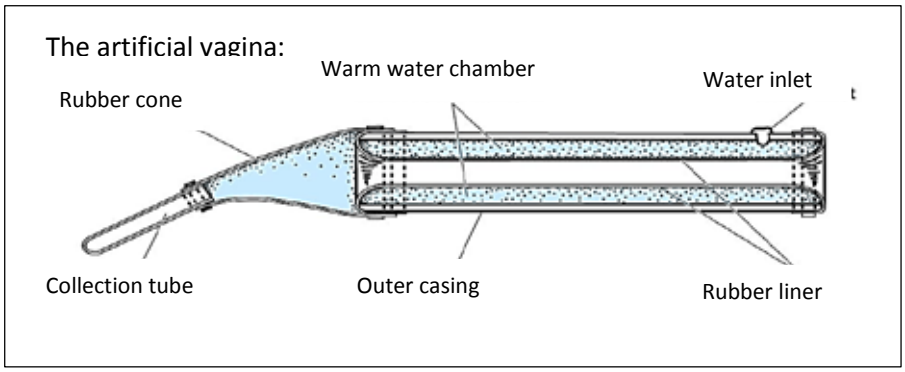
Artificial Insemination: Is the process of putting semen into the female uterus using methods that do not involve sexual activity between a male and a female.
The basic requirement for successful artificial insemination:

- The cow must be in oestrus
- The semen must be healthy and viable
- The inseminator must be familiar with the technique

Advantages of AI	Disadvantages of AI
• It reduces inbreeding • It is the most effective preventative measure against the spreading of venereal diseases, such as vibriosis and trichomoniasis, and organic diseases of the reproductive organs, such as inflammation of the uterus. • It is an economical method of breeding because one saves on the purchase price and the maintenance of a bull. • As the semen of the best available bulls are used the quality of the herd is improved. • A larger progeny is obtained because the semen of one bull is used to inseminate a few thousand cows per year as against 30-40 by natural copulation. • It is a rapid economic method if improving the quality of the herd. • Semen from outstanding bulls is obtainable. • The usable duration of a cow's life is pro-longed. • It enables the breeder to implement a planned breeding policy. • The breeding value of young bulls can be determined at an early stage. • The frozen semen of an outstanding bull can still be used after its death.	• The success is varied • Cows can be damaged or hurt by inexperienced technique • Heat detection must be done regularly. • It is expensive and specialized techniques is needed • Diseases spread rapidly. • There is always the possibility that a young bull which is well-bred according to its family tree will not transmit good characteristics to its progeny. • Cows may be **injured** if the insemination is carried out by an inexperienced or careless inseminator. • **Close inbreeding** may result if breeding records are not kept and semen of closely related bulls is used. • In the case of certain breeds only a **limited number** of bulls are available and breeding according to particular blood-lines is not always possible. • **Extra supervision and labour** are required and long distances have to be travelled to inseminate beef cattle under extensive conditions.

Methods of Semen collection

The Artificial Vagina: It uses thermal and mechanical stimulation to stimulate ejaculation. To collect semen, the male mounts the female but the penis is diverted into the artificial vagina and the semen is collected after ejaculation



- **Electro – ejaculation:** This techniques involves the application of a series of short, low voltage pulses of current into the rectum, where the pelvic nerves are involved in the ejaculatory response

Basic requirements for the treatment of semen:

Collected semen must be treated with a dilutant which contains egg yolk, milk, glycerol, buffers and antibiotics. The function of the dilutant**:**

- Increases the volume of the semen
- provides nutrients for the sperm cells
- provides protection against changes in pH
- prevents bacterial growth
- increases the viability of the sperm cells.

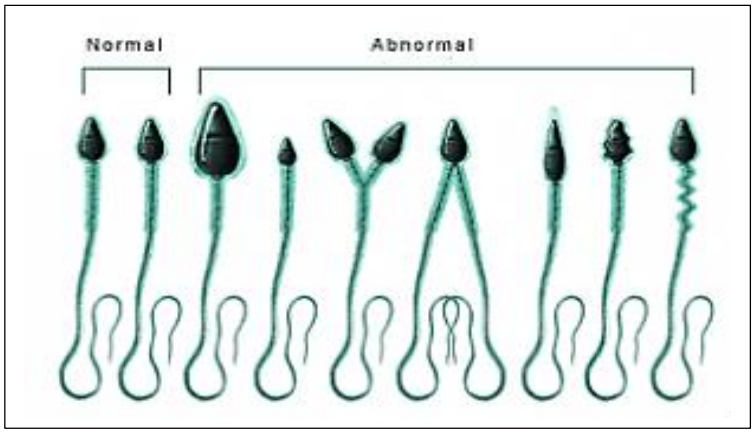
Basic requirements for the storage of semen:

- For shorter periods it can be stored at 5° C
- For longer times the sperm should be placed in 0,2ml or 0,5ml straws, and frozen in liquid nitrogen at -196 ° C.
- To thaw, the straws are placed in water between 32- 35 ° C for 15 seconds.

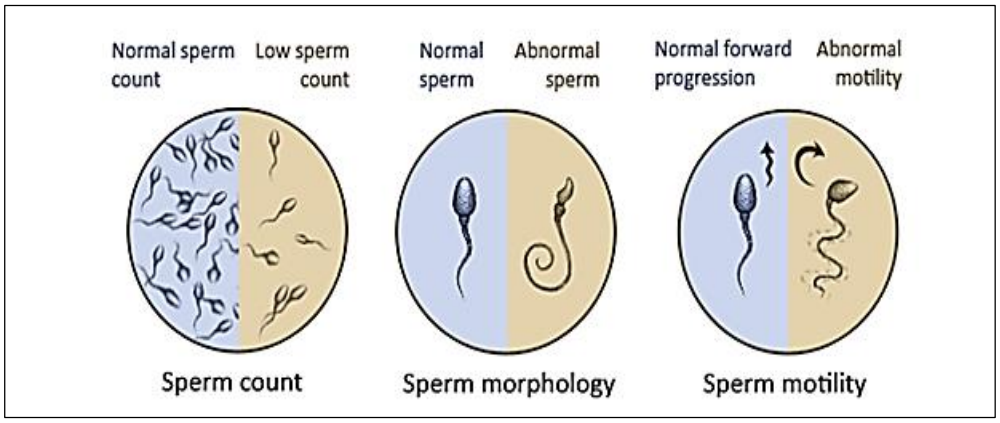
Quality of semen:

Good Quality	Poor quality
• It is opaque, milky white and sticky • At least 80% of the sperm should show forward sperm mobility. • Less than 20% of the sperm should show deviation in structure or abnormalities	• Grey semen, which indicates infection • Reddish semen indicates the presence of fresh blood • Dark brown semen contains old blood • Abnormal sperm count • Abnormal sperm morphology • Abnormal sperm movement

Abnormal sperm:



Good quality semen vs poor semen:



Semen dilution

Semen dilutant is a liquid dilutent which is added to semen to preserve its fertilizing ability.

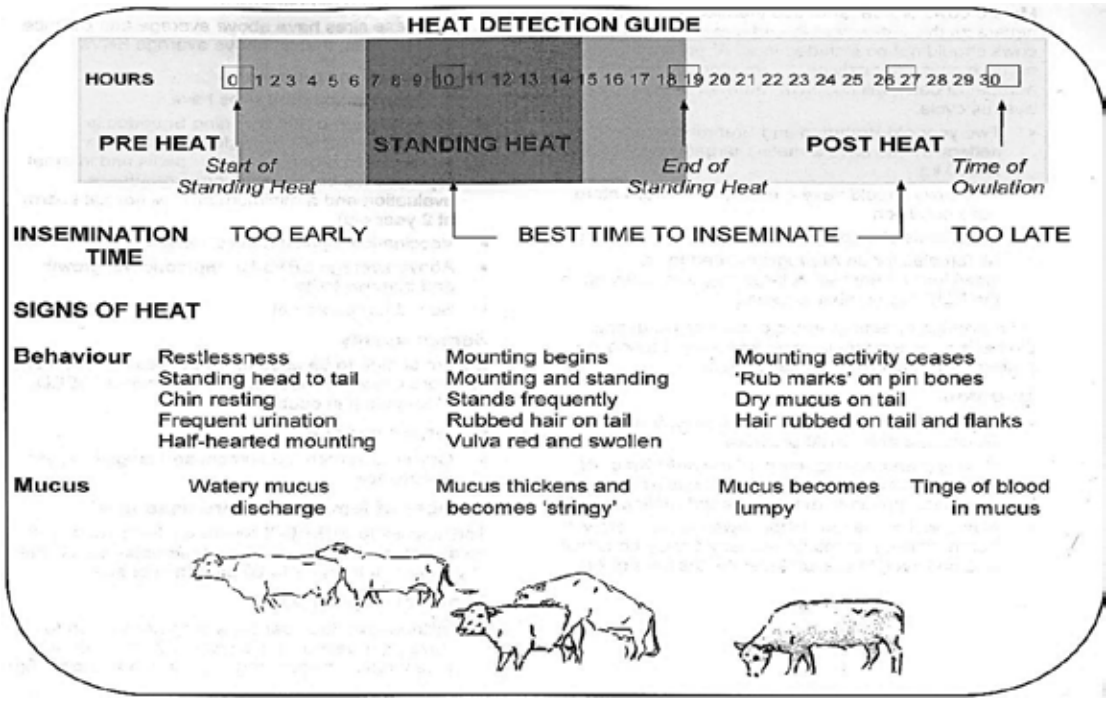
- It acts as a buffer to protect the sperm cells from their own toxic byproducts
- it protects the sperm cells from cold shock and osmotic shock during the chilling and shipping process (the sperm is chilled to reduce metabolism and allow it to live longer).

The extender allows the semen to be shipped to the female, rather than requiring the male and female to be near to each other.[1] Special freezing extender use also allows cryogenic preservation of sperm ("frozen semen"), which may be transported for use, or used on-site at a later date.[2] The addition of extender to semen protects the sperm against possible damage by toxic seminal plasma, as well as providing nutrients and cooling buffers if the semen is to be cooled also to protecting sperm from bacteria by adding antibiotics to it to prevent increase of bacteria. In the case of freezing extenders, one or more penetrating cryoprotectants will be added.

Diluents of many kinds have been used, including isotonic citrate or phosphate buffers, glucose containing media, and physiological saline. Egg yolk, which has cryoprotective properties, glycerol, fructose, antibiotics, penicillin and sterilized milk, is also a common component.

OPTIMUM TIME TO INSEMINATE

- Heifers of all breeds are inseminated between the age of 15 to 27 months so that their first calves are born before they are 3 years old.
- Cows must be inseminated within 2-4 months after calving because they reach maximum fertility during this period.
- Best results are obtained if insemination is carried out during the second half of oestrus, or within 5 hours after visible signs of oestrus.
- Normally ovulation occurs within 14 hours after oestrus.
    - Cows which show signs of oestrus before midday should be inseminated in the afternoon,
    - while the insemination of cows that show signs of oestrus in the afternoon may be delayed until the following morning.
    - A cow which is still in heat 15 hours after insemination may be inseminated for the second time about 24 hours later.



TECHNIQUE OF INSEMINATION

Insemination is carried out in a sheltered area to eliminate unfavorable conditions such as wind, dust and rain.

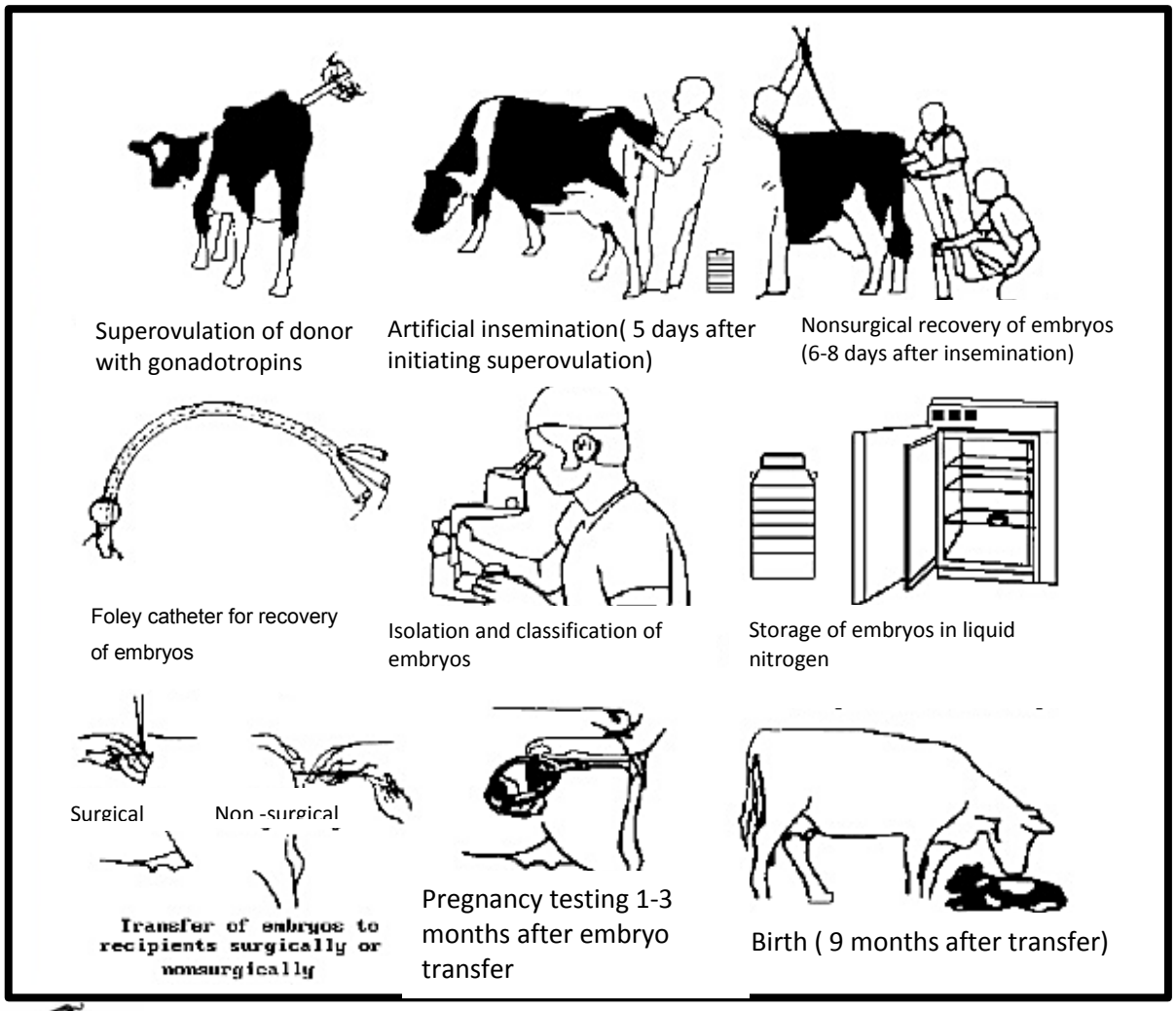
INSTRUMENTS MUST BE STERILE

- before insemination - bring cow to a stall so she is calm during insemination.
- A tube with semen is taken from the thermos flask, thawed, and inserted in pistolette and covered with sheath.
- The rectum is cleaned and the left hand is inserted into the rectum to remove faeces and the cervix is palpated.
- The hand is pushed in further to inspect the uterus and the horns of the uterus to ascertain to stimulate the secretion of oxytocin.
- The vulva is wiped clean, the inseminating tube(pistolet) inserted into the vulva and moved gently along the upper side of the vagina until it touches the little finger.
- Because the cervix is open during oestrus the inseminating tube enters the opening with ease.
- The semen is deposited either in the cervix or in the body of the uterus or in equal quantities in both these organs.

Embryo transplantation:

Definition: Embryonic transfer involves removing the fertilised ovum from the uterus of a genetically superior cow during an early stage of ovum development and transferring it to the uterus of a genetically inferior cow where the calf then develops until partuition (birth).

The process:



HEADING, TERMINOLOGY, PURPOSE

Step 1: The oestrus cycle of the donor and recipient cows are synchronised

Step 2 The donor female (a genetically superior female animal with desirable characteristics is treated with gonado trophic hormones to produce many mature ova at once (superovulation)

Step 3: The ova of the donor are fertilised with semen frim genetically superior males using artificial insemination

Step 4: About seven days after insemination the developing embryos are flushed out with a saline solution and collected.

Step 5 These embryos may be used immediately or frozen and stored in liquied nitrogen

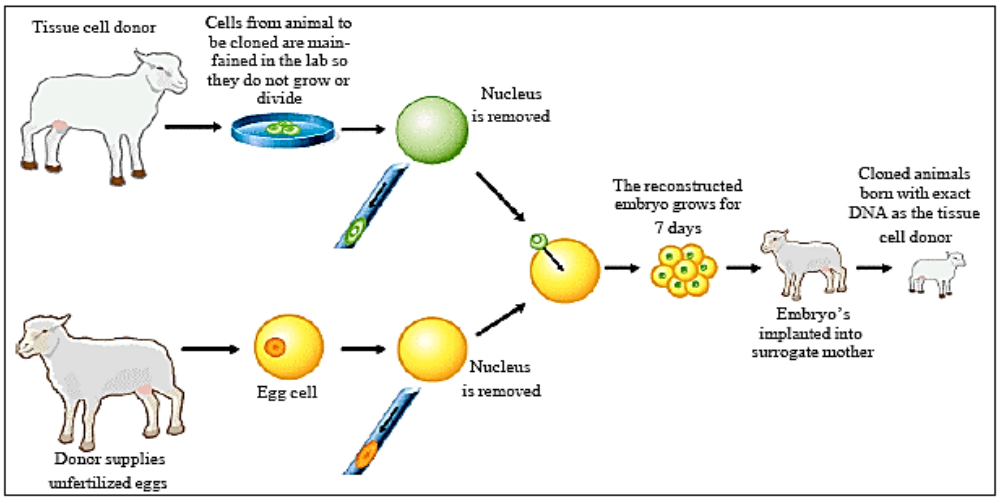
Step 6 The embryos are planted into the donor cows.

Step 7 The recipiants act as surrogate mothers, they carry the embryos while they develop, and give birth to them. They are not genetically related.

The advantages of Embryo transplantation	The disadvantages on Embryo transplantation
• More offspring per year can be produced form a superior animal than what is normally achieveble. • Profit is made from the increased sale of quality genetics. • The productive life of superior animals is extended. • The genetics in a herd are conserved through the use of embryo freezing. • Superior genetic material are introduced into a herd, rapidly and economically	• It is more expensive than conventional breeding. • Specialised skills and experience is required • Synchronisation of the recipeint and donor can be difficult. • Recipient cows may not have strong wnough heat cycle to accept the insemination • There is a danger that the recipient cows could abbort the eggs.

Nuclear transfer (Cloning):

Definition: Nucleur transfer (NT), also called cloning, is when the nucleus of a somatic cell is transferred to an unfertilised egg cell that has had its nucleus removed. The egg cell then divides until it becomes an embryo. The resultant embryo is then placed inside a surrogate mother where it develops



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Types of cloning:

Reproductive cloning: Is used to generate a cloned embryo, which is then implanted into the uterus of a recipient female to give rise to a cloned offspring that is genetically identical to the adult donor female. – Not always successfull and cloned animals commonly have abnormalities, regardless of the type of donor cell or species involved

Therapeutic cloning; Is performed with the aim of finding cures for diseases. The intention is not to create a cloned offspring but to derive embryonic stem cells that can be used for cell therapy

The aims of nuclear tranfer (cloning):

- To produce large numbers of genetically identical animals
- To produce offspring from high quality animals
- To preserve and extend proven, superior genetic
- To achive high quality meat and dairy products.

Advantages of cloning	Disadvantages of cloning
• It offers opportunities to select and multiply animals of specific merit with regards to porduction – eggs, milk & wool. • Allows to create large numbers of precise duplicates of an animal in a single generation • It is applied to increase the population sizes of indigenous species, or to restore them from extinction. • By reporoducing copies of desirable animals, farmers can farm with the best animals.	• It is new technology that requires specific skills • It is expensive and mainly used only for elite animals • Cloned animals seem to age prematurely • Dystocia problems can arise because clones can be very large at birth

3.4 Fertilization and pregnancy

Learning Outcomes:

At the end of this section the learner should be able to demonstrate knowledge of the following content.

Fertilisation and pregnancy ⇒

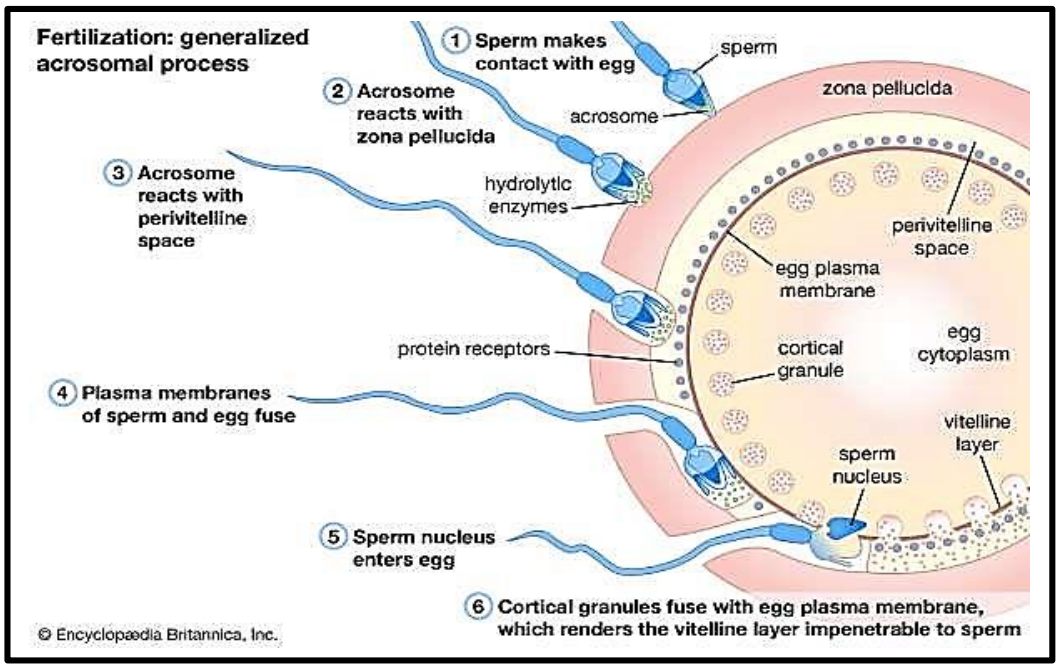
- Identify and define fertilization, pregnancy, gestation and placenta.
- Describe the fertilization process
- Differentiate between monozygotic twins and dizygotic twins
- Describe the formation of a freemartin
- Identify the stages of pregnancy
- State the reasons for abortions.

3.4.1 Terminology:

TERMS	DEFINITION
Pregnancy	Begins with a fertlised ovum and ends with birth
Gestation	The time from fertlilizationto birth,during which the foetus develops inside the mother
Fertlization	The joining of the nucleus of a male and female gamete, to form a zygote
Monozygotic twins	one of a pair of twins who develop from a single fertilized ovum and therefore have the same genotype, are of the same sex, and usually resemble each other closely.
Dizygotic twins	two offspring born of the same pregnancy and developed from two ova that were released from the ovary simultaneouslyand fertilized at the same time
Freemartin	The result of dizygotic twins where in the placenta male hormones affect the female calf, having an influence on the expression of female characteristics
Abortion	The termination of pregnancy before the foetus is viable:

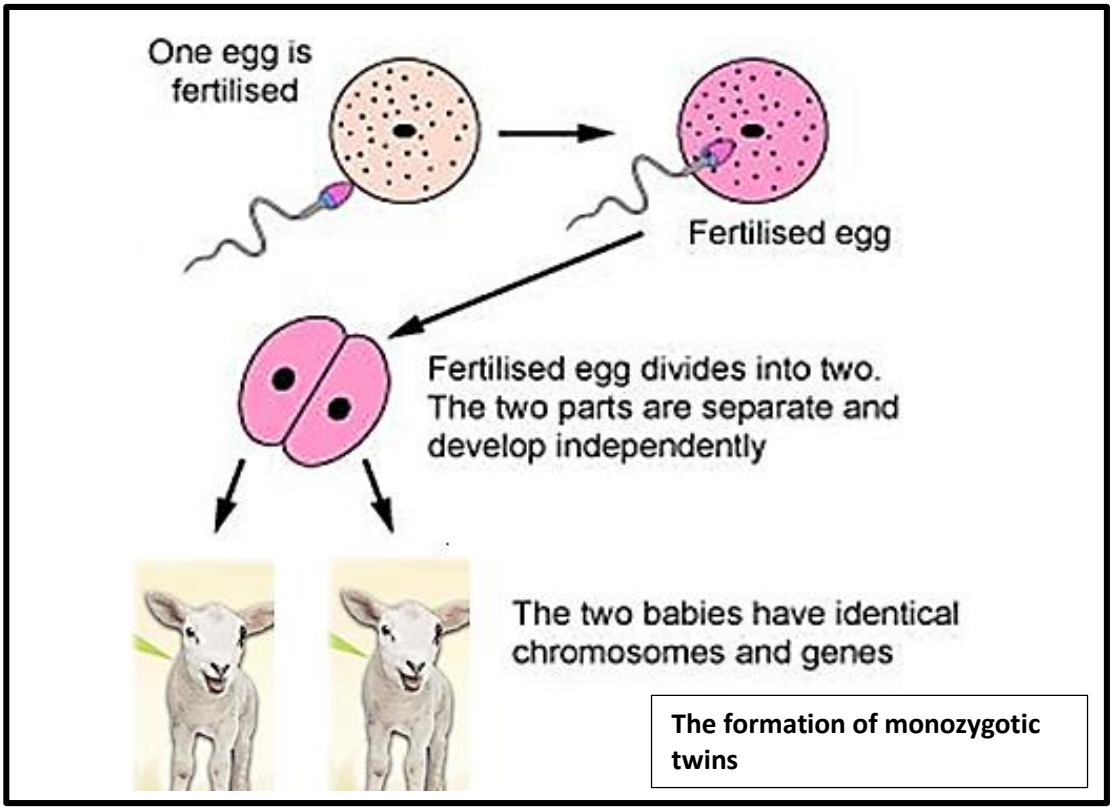
Foetus	An unborn animal in the later stages of development
Acrosome	An organelle covering the head of animal sperm and containin g enzymes that digest the egg cell coating,thus permitting the sperm to enter the egg.
Placenta	An organ that attaches an embryo to the uterine wall

The fertilization process



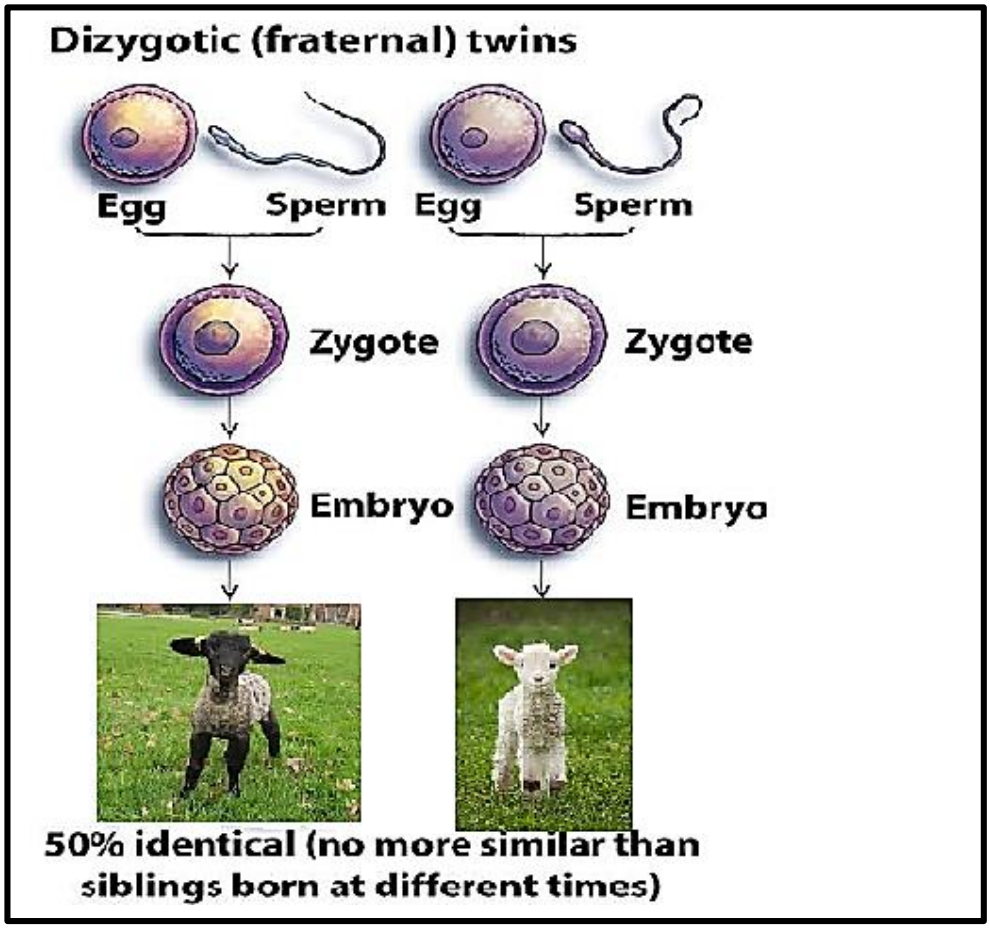
Multiple Births: - Monozygotic Twins, Dizygotic twins & Freemartins

Monozygotic twins result from a single fertilized egg (zygote) The zygote divides to from two separate daughter cells, each developing into an individual. Each individual is genetically and phenotypically identical.

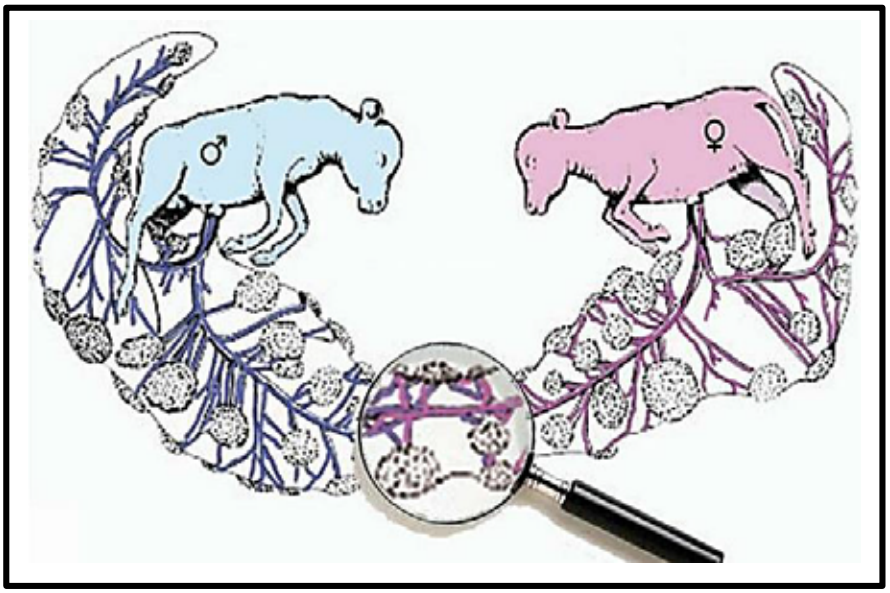


The formation of monozygotic twins

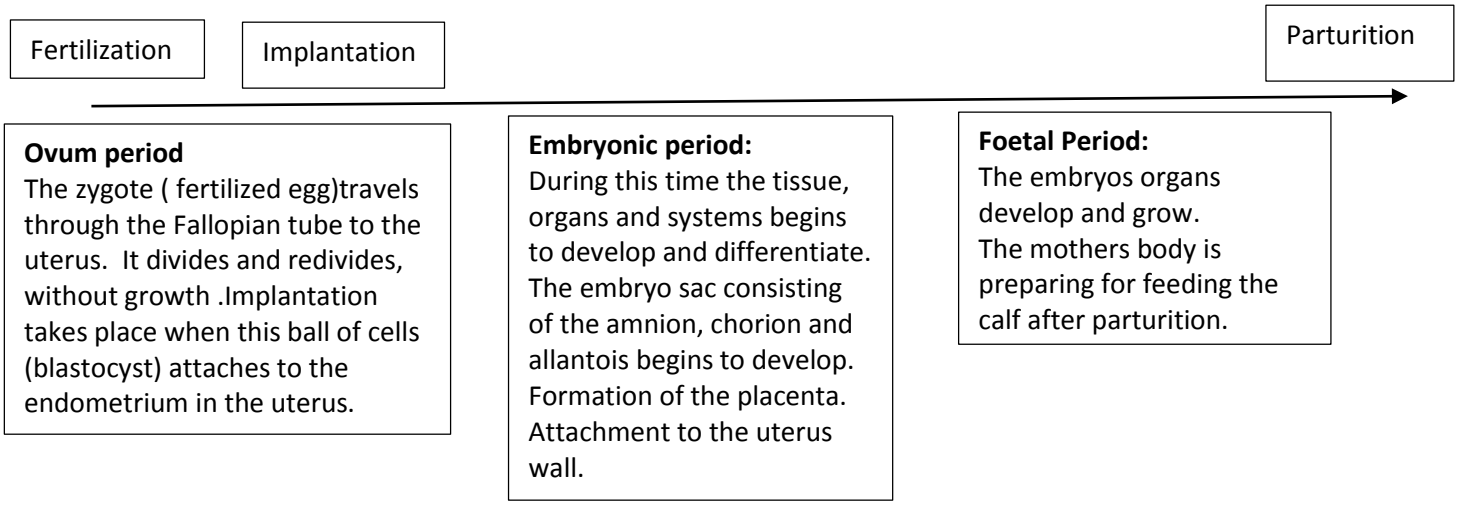
Dizygotic twins:
Dizygous twins from when two ova are released at the same time during ovulation. Each ovum is fertilized by different sperm. The sex of the twins can be the same or different.



Freemartin: The result of dizygotic twins where in the placenta male hormones affect the female calf, having an influence on the expression of female characteristics. This female calf is normally sterile and called a freemartin

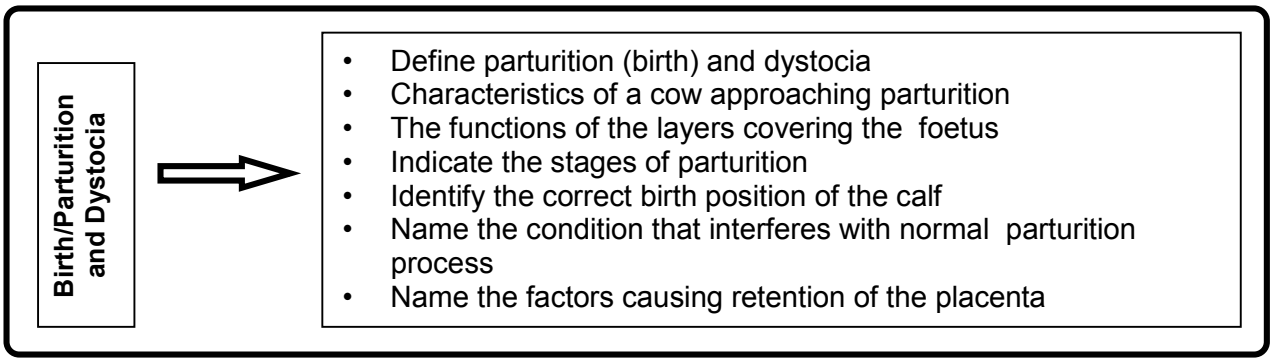


The stages of pregnancy(gestation):



3.5 Birth/Parturition and Dystocia

At the end of this section the learner should be able to demonstrate knowledge of the following content.

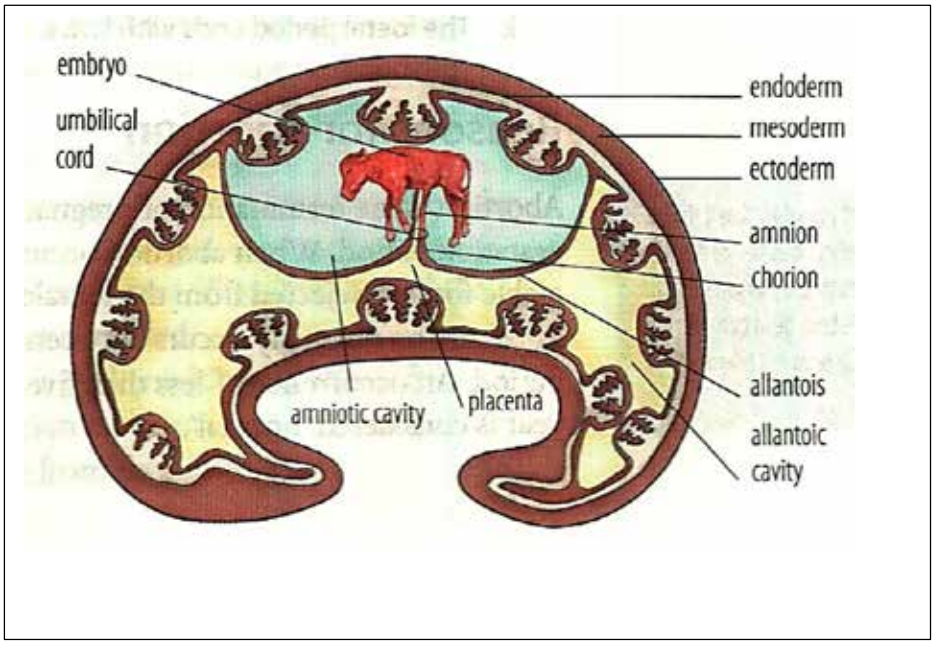


3.5.1 Terminology:

TERMS	DEFINITION
Parturition	The end of pregnancy - birth
Dystocia	Condition of prolinged and difficult partuirition, due to various reasons
Retention	Keeping back (the placenta) after birth
Placenta	a flattened circular organ in the uterus of pregnant mammals, nourishing and maintaining the fetus through the umbilical cord.

The membrane layers and their function:

Chorion	(Embryonic bag) The outer membrane that attaches to the uterus
Amnion	The inner membrane that contains the amnion fluid, that protects the embryo. The embryo is connected to the amnion by the umbilical cord
Allantois	To collect urine from the unborn calf



The formation of the placenta: The allantois and chorion develop around the embryo, forming the placenta. The placenta attaches the embryo to the uterus wall. It brings the blood vessels of the mother and the embryo close together. This allows nutrients, gasses, antibodies and wastes to be exchanged. No exchange or mixing of blood occurs

Birth (Parturition)
Parturition refers to the birth process, which starts with the contractions of the uterine wall and end when the foetus and after- birth are expelled

Signs of a cow about to give birth:

- Isolates herself from the group
- Urinates and defecates often
- The ligaments in the tail area, pelvis, vagina and cervix relaxes
- The vulva enlarges and becomes softer
- Mucus hangs from the vagina
- Teats are swollen and milk drops can be spotted

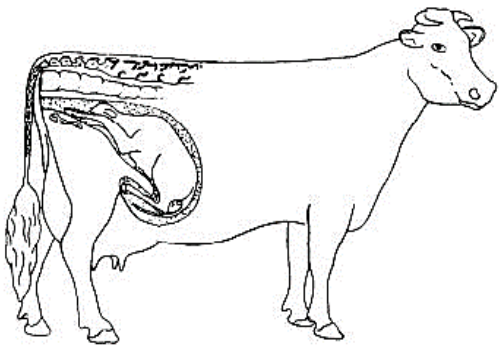
Stages(3) of normal parturition

Preparatory stage(1)
Contractions start and the foetus moves into the birth position.
- The vagina ,cervix and uterus enlarge to form a common canal.
- The membranes that covers the foetus

Ejection stage(2)
- More powerfull contractions
- The head and front legs of the foetus emerge from the vulva
- The mother lies down and tha calf is born

Expulsion of the placenta (3)
After a period of rest, the muscles of the uterus contract to expel the afterbirth. This includes the placenta, umbilical cord and foetal membranes

Retention of the placenta may occur due to:
- Vitamin A deficiency
- Sexually transmitted diseases
- Exhaustion
- General infections
- Mineral deficiency
- Sexually transmitted diseases



Normal birth position of calf

During the birth of a calf, the spine should be facing upwards. The head and legs must enter the birth canal first. The bottom of the hooves should face downwards. The correct posture is for the forelegs to stretch forwards towards the pelvis and the hindlegs towards the back

Abortion: The termination of pregnancy before the foetus is viable: (Reasons)

- Metabolic or hormone abnormalities
- Mal-nutrition
- Trauma or injuries
- Poisoning
- Infections

Mumification: When the foetus die after the skin and the skeleton has been formed.It forms an dried foetus that can stay in the uterus.
Maceration: The softer tissue decay, leaving behind the harder tissue

Conditions that may prevent the normal parturition process (dystocia)

- Abnormal birth position in calves

Fig. 1: Anterior presentation

Fig. 2: Posterior presentation

Fig. 3: Breech presentation

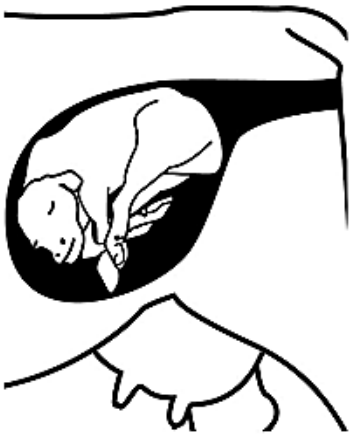


Fig. 4: Two front legs presenation

- Hydrocephalus
- Twins
- Congenital defects/ deformities

3.6 Milk production/Lactation

At the end of this unit the learner should be able to demonstrate knowledge of the following content.

Milk production/ Lactation

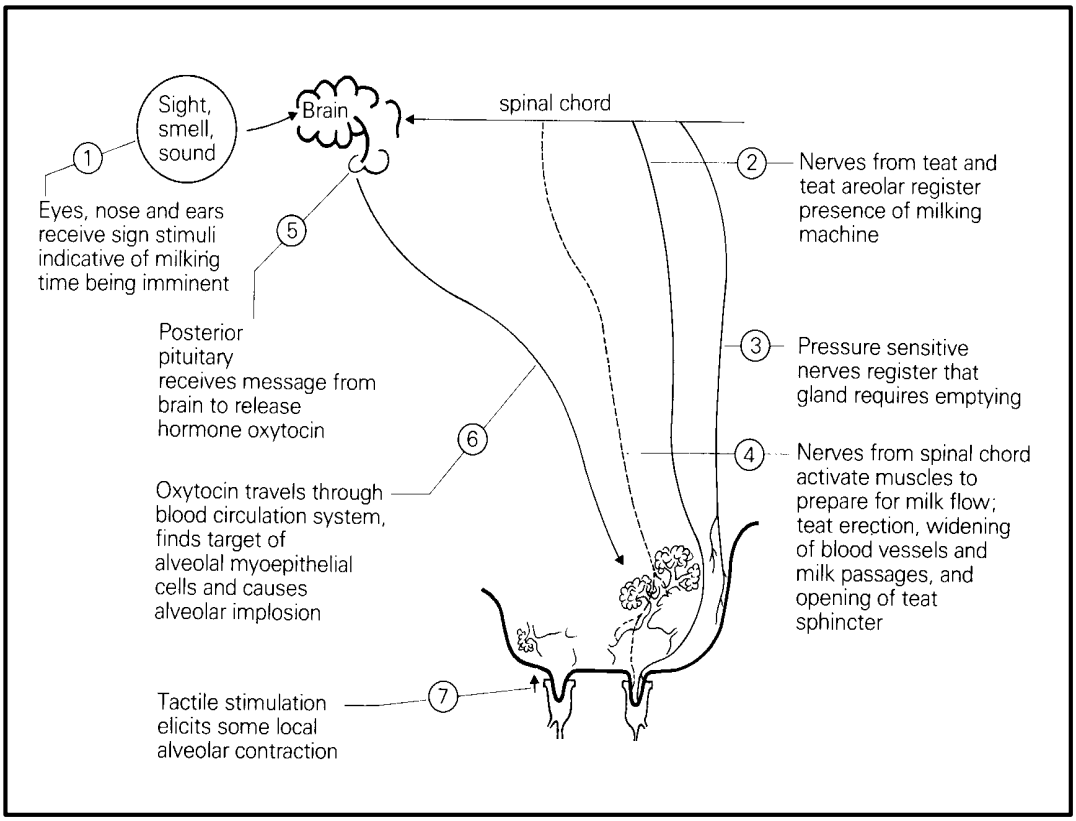
- Identify and define the lactation, dry period and milk ejection
- Identify and describe the structure of the udder of a cow (functions)
- Discuss the milk ejection/milk let down process and hormones involved
- Explain the importance and functions of colostrum for the new born calf
- Identify and describe the interpretation of the lactation curve and lactation cycle (period)

TERMS	DEFINITION
Colostrum	Yellow milk secreted during the first 3 days after calving
Lactation	The secretion of milk by the mammary glands. The action of suckling an infant.
Lactation period	The secretion of milk from the mammary glands and the period of time that a mother lactates to feed her young. The process can occur with all post-pregnancy female mammals
Dry period	Period from the end of lactation until the mother has another offspring

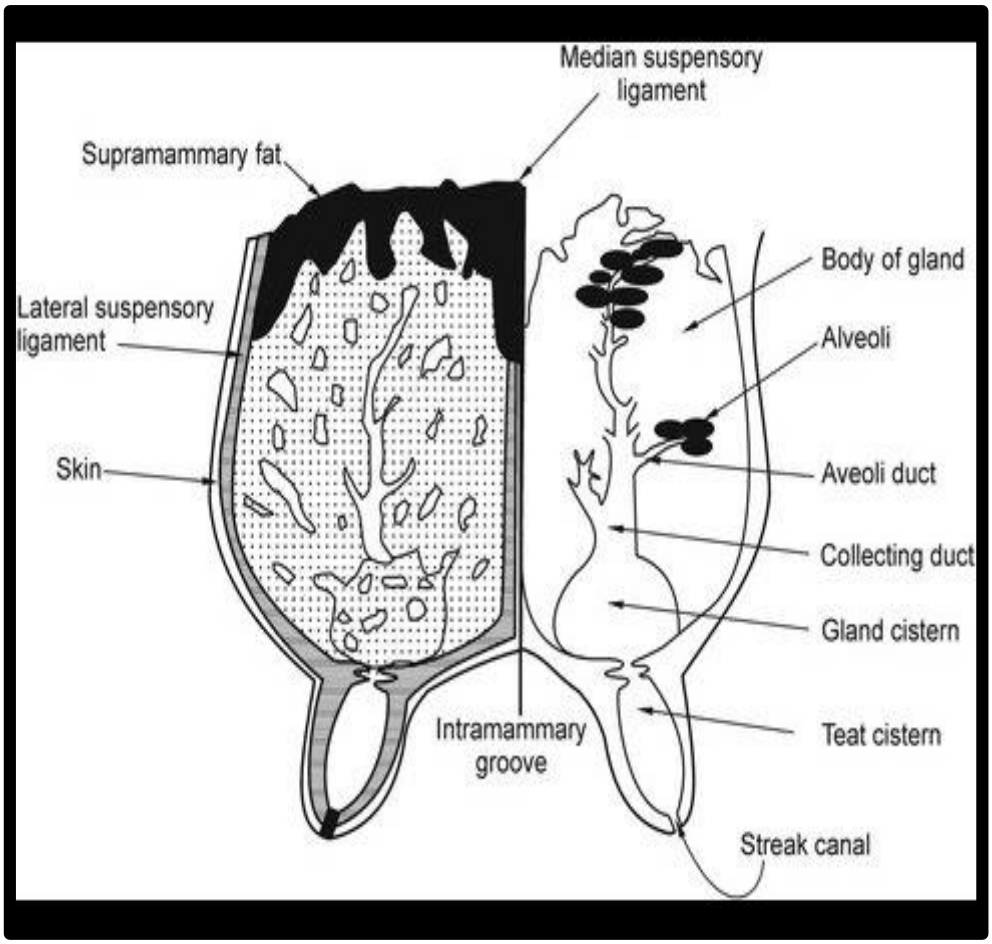
Milk production and lactation

Lactation is the period in which a female produces milk to feed their offspring. The milk releasing reflex is stimulated by the oxytocin hormone secreted by the hipotalamus.

The sequence of the milk releasing reflex is illustrated below:



The structure of the udder:



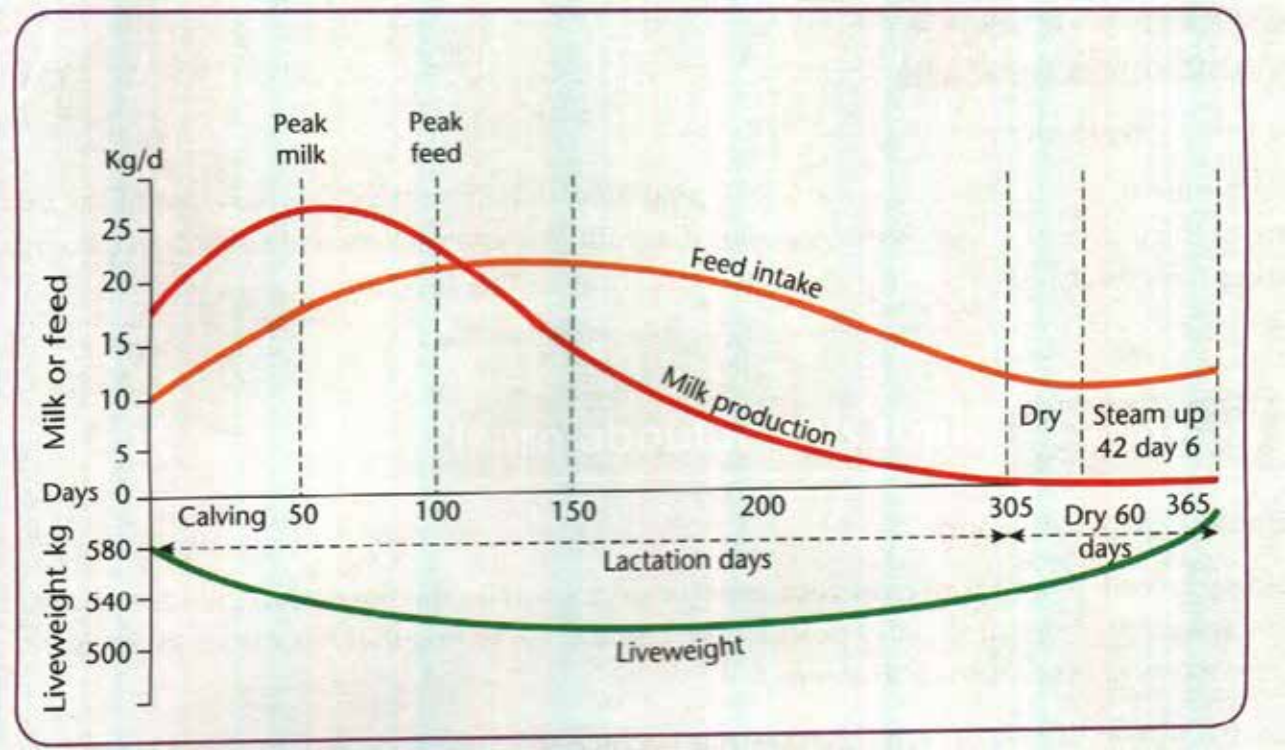
Colostrum:

The milk that is being produced for the first few days after birth.
It is more yellow than normal milk and contains extra nutrients, proteins, fats and lactose. It also contains antibodies that enhances the calf's resistance to diseases.

Lactation curve:

The lactation period stretches form parturition until the cow dries up. During this period there is an inverse relationship between amount of milk produced and the butterfat content . When the milk production is low the butterfat is high (normally early in the lactation period) and when the milk production is high the butterfat is low (later in the production period).

The normal lactation curve:

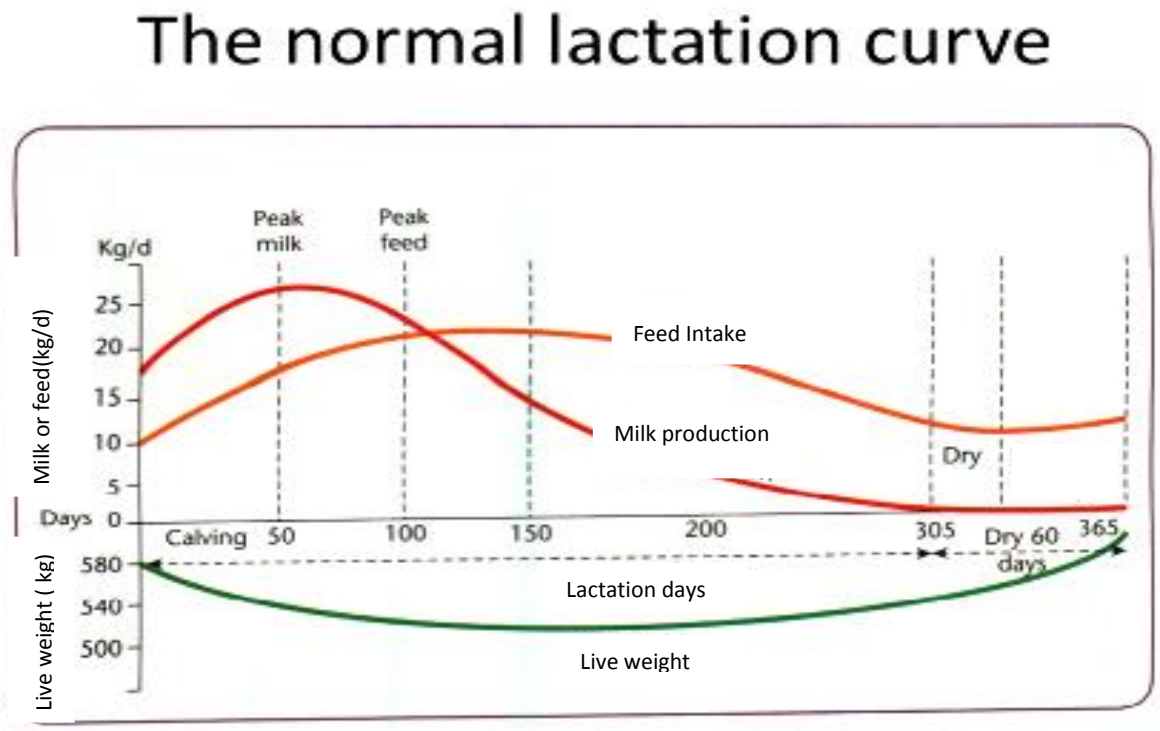


The cow starts to secrete normal milk 3 days after parturition. The lactation curve reaches maximum production eight weeks after calving. When milk production reaches its peak, the butterfat content is at it lowest. As milk production decreases the butterfat content increases.
The nutrition of the cow influences the butterfat content and cows that is fed more roughage will have a higher butterfat content in their milk.

Milk production in cows is influenced by the following:

- The age of the cow
- The nutrition of the cow
- Pregnancy inhibits milk yield, especially after the fifth month
- Temperature changes
- The number of times a cow is milked per day influences milk yield

Activity: 3.6.3 Lactation



1 Name the hormone that is responsible for the milk reflex. (1)

2 Explain the relationship between the feed intake, milk production and live weight of the cow as presented in the graph. (4)

3 Discuss TWO other factors that may influence milk production. (4)

Answers to activities:

Activity 2.1.4 : The male reproduction system

1 **Reproductive parts**
A – Seminal vesicle/vesicular gland✓
B – Prostate gland✓
C – Cowper/bulbo-urethral gland✓
H – Testis✓ (4)

2 **Process that occurs in K**
Spermatogenesis/ sperm formation/gametogenesis✓ (1)

3 **Functions**
D - Transports spermatozoa/enhances ejaculation✓
L - Facilitates penetration of ovum/releases an enzyme (hyaluronidase) that allows spermatozoa to penetrate the ovum/acrosome reaction✓ (2)

4 **Influence of congenital defects**
- Negatively affects sperm formation/spermatogenesis**/w**ill not allow optimum spermatogenesis to take place/sperm defects✓✓ (2)

5 **Reason for part H to be situated outside the abdominal cavity**
Sperm production occurs at the temperature slightly (1 to 3˚C) lower than that of the body/to regulate the temperature for more effective spermatogenesis✓ (1)

Activity 3.2.4: Hormones during the oestrus cycle

1 21 days✓ (1)

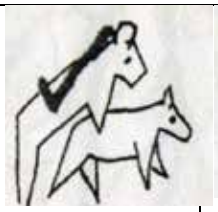
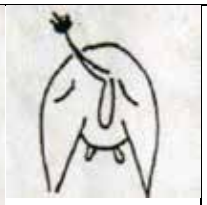
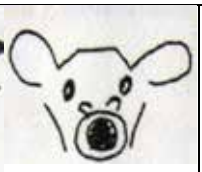
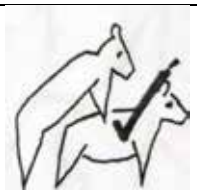
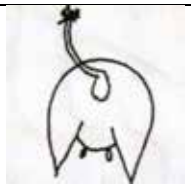
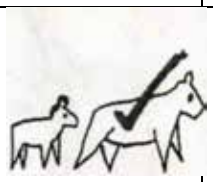
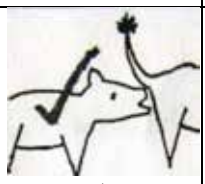
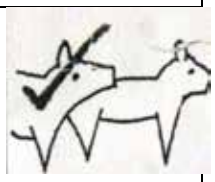
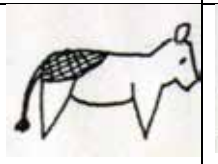
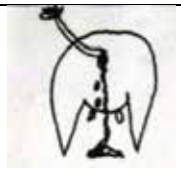
2 Corpus luteum✓ (1)

3 Oestrogen
The levels of this hormone are very high during oestrus/heat period (2)

4 Ovulation✓ (1)

5 • Vulva is swollen with reddish mucus membranes✓
• Mucus strings visible from the vulva/bull string✓
• Restless/bellowing✓
• Jumps on other cows and allows the cows to jump on her✓
• Scratch marks and dirt on the side and back✓
• Allows mating with the bull✓ (any) (2)

Activity 3.2.5 : Heat detection in Animals

Phase 1: pre-heat	 1 Riding Others√	 2 Thin clear buls string√	 3 butting heads√	 4 Bellowing √	 5 Restless√
Phase 2; Standing Heat	 1 Standing still √	 2 Thick, clear bul string √	 3 Bul calves trying to ride and follow her √	 4 Smell external sex organs √	 5 Throwing head backwards √
Phase 3: After Heat	 1 Don't stand anymore√	 2 Thick, grayish bul string√	 3 Riding and hoofmarks√	 4 Separate herself√	 5 Blood tainted secretions√

Activity 3.6.3: Lactation

1 Oxytoxin√

2 When milk production is high feed intake is also high✓ while body weight tends to drop. ✓
As milk production decreases, feed intake also decreases✓ but there is a slow increase in body weight. (4)

3 Extreme temperatures (hot or cold), ✓ In extreme cold energy are used by the cow to keep warm, which could have been converted to milk. ✓
In extreme hot weather cows tend to eat less, ✓ therefore having less energy to produce milk.✓
The age of the cow, ✓ Young cows and very old cows tend to produce less milk during their lactation cycle.✓
The health condition of the cow ✓ The amount of milk produced by an animal is directly related to the health of that animal. ✓ (4)
(any 2x2)

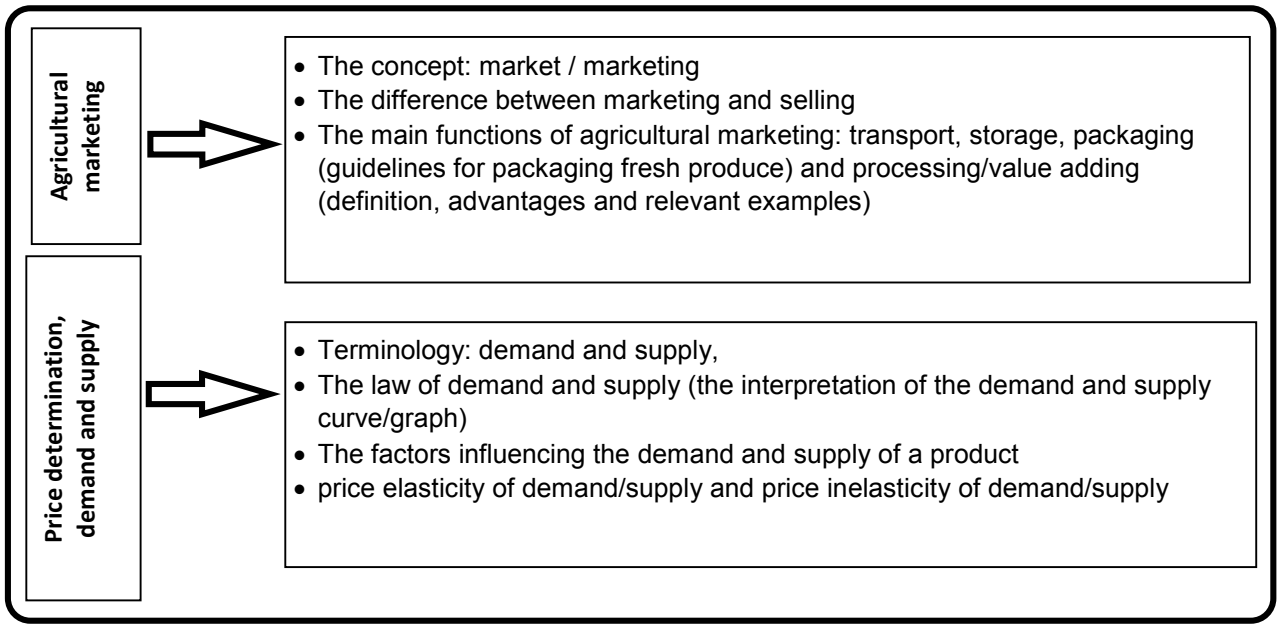
Chapter 4

Paper 2

AGRICULTURAL ECONOMICS: MANAGEMENT AND MARKETING

Learning objectives

At the end of this unit the learners should be able to demonstrate knowledge of the following content:



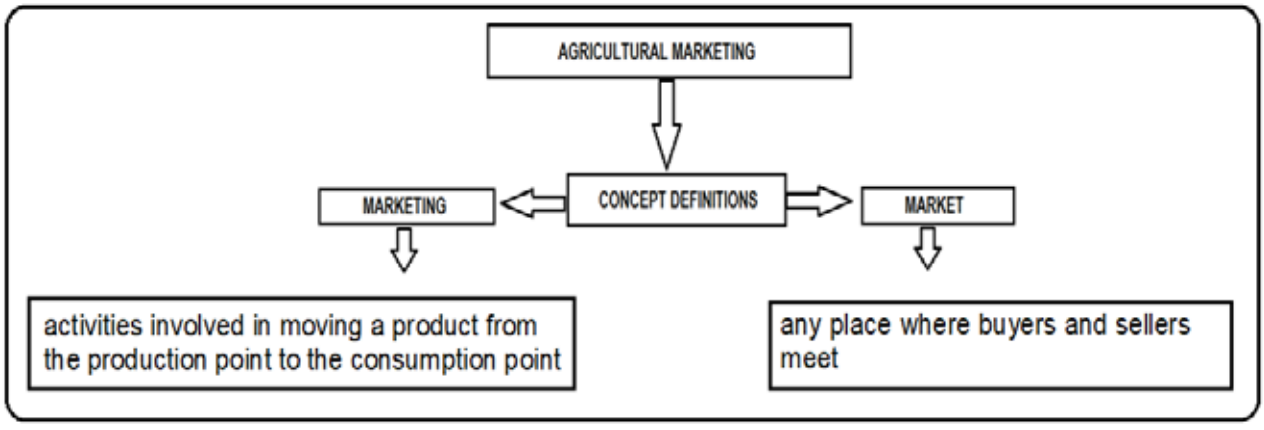
4.1 Terminology

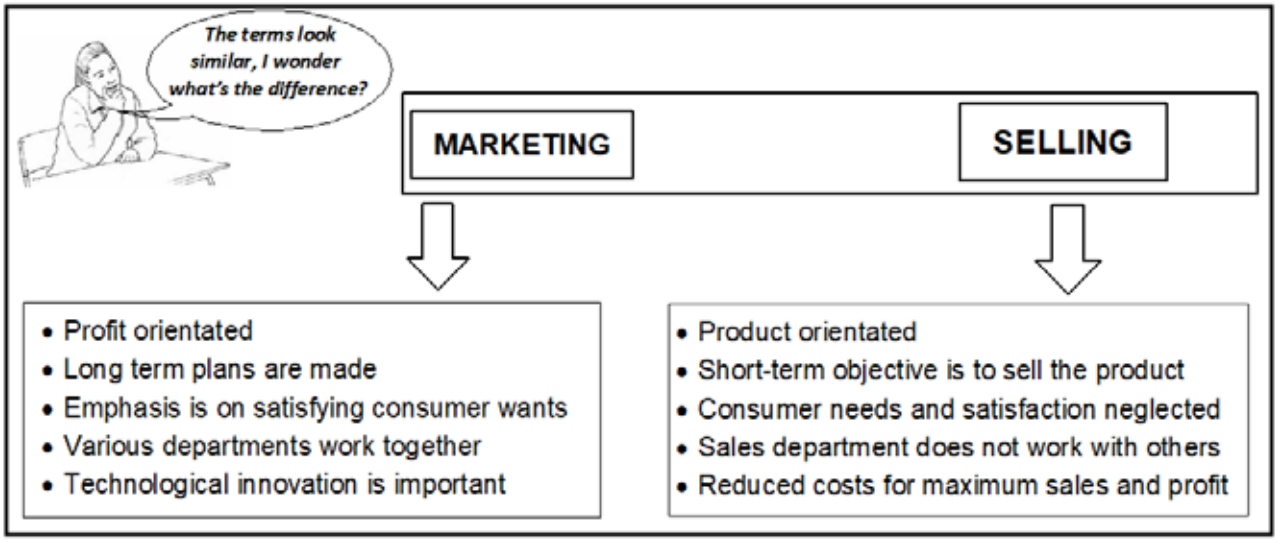
CONCEPT	DEFINITION
Market	any place where buyers and sellers meet or where supply and demand meets.
Marketing	activities involved in taking a product from the point of production to the consumption point
Selling	exchange of goods and services for money
Bartering	exchange of goods for other goods
Buying	obtain a product or service in exchange for payment
Processing	is the conversion and modification of a product in order to add value to it.

Demand	quantities of a good that consumers are willing and able to buy or consume at different prices
Supply	quantities of a good that producers are willing and able to sell or produce at different prices
CONCEPT	**DEFINITION**
Law of demand	other factors kept equal, as the price of a good or service increases, demand for the good or service will decrease, and vice versa.
Law of supply	all else equal, an increase in price results in an increase in quantity supplied, and vice versa.
Price Elasticity	refers to a quantity response to price change or shows how sensitive quantity is to a change in price
Hedging	A strategy to eliminate financial risk by reducing impact of future changes in market price
Diversification	a farmer focuses in different enterprises and therefore spreading the risk.
Specialisation	is when a farmer concentrates on one product or form of enterprise
Marketing research	collection of information about consumers' needs, the market and competitors for effective marketing strategy.
Auction	a public sale in which goods or services are sold to the highest bidder.

4.2 Agricultural marketing

4.2.1 Difference between marketing, market and selling





4.2.2 Guidelines for packaging fresh produce

- Packaging should protect, contain, deliver, preserve, transport, inform, and sell the product in a way that appeals to the consumer

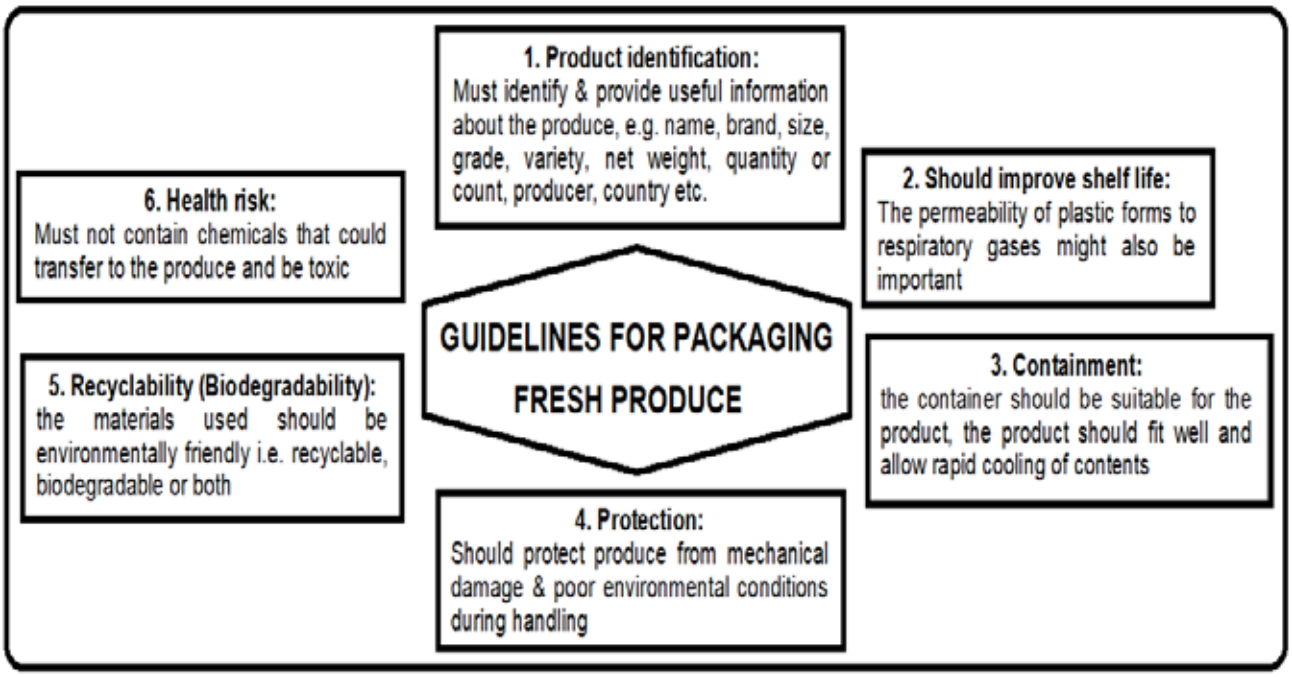
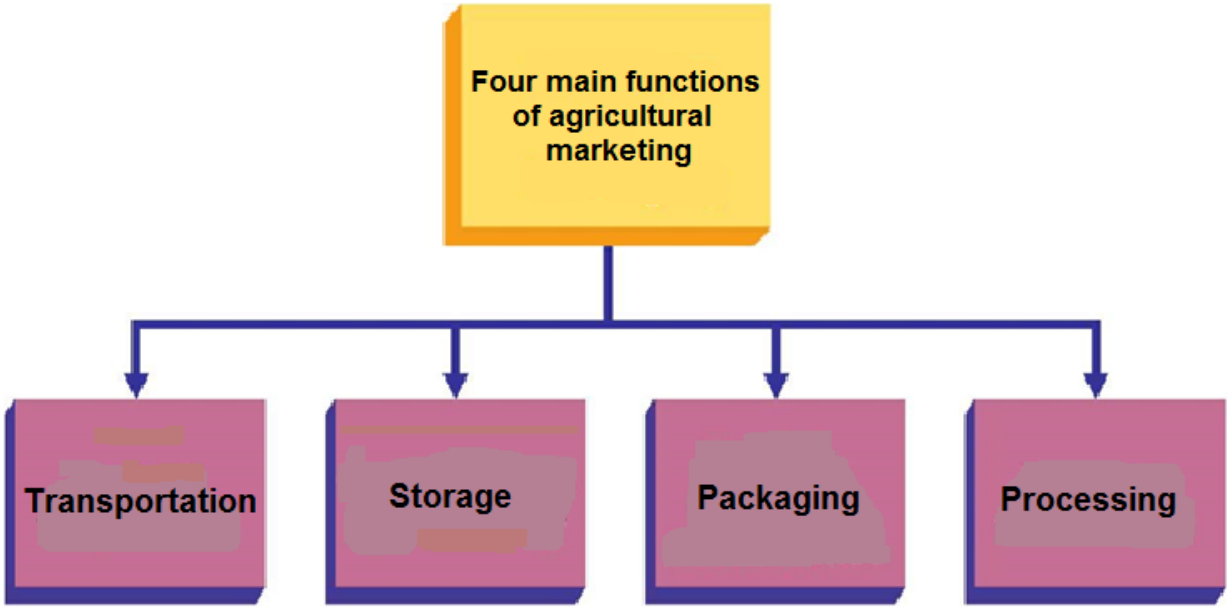


Figure 1: Guidelines for packaging fresh produce

4.2.3 The four main functions of agricultural marketing

Agricultural marketing plays a key role not only in stimulating production and consumption, but in accelerating the pace of economic development. Its dynamic functions are of primary importance in promoting economic development



Definition, advantages and examples of four main functions of agricultural marketing

Function	Definition	Advantages	Relevant examples
Transportation	• Means of conveying people or goods from place to place.	• Bridges the gap between producer and consumer. • Cost effective • Fast delivery • Quick movement of perishables to the market • Creates job opportunities • Bulky goods can easily be transported.	• Transporting apples from orchards to the cooler • Choice of transport is determined by the distance, costs, nature of the product and speed of delivery needed • Modes of transport: air transport, road transport and water transport
Storage	• Involves keeping and preserving goods until they are needed for consumption. **OR** • Post-harvest phase where products are kept for later use to guarantee food security.	• Ensure fresh products • Maintain products' quality • Bridge the time between production and purchasing • Ensure continuous supply of agricultural product • Ensure prices stay constant • Prevents an oversupply or shortage of goods.	• The storage function is performed: ○ Co-operative societies ○ Warehouse owners ○ Cold storage owners ○ Manufacturers ○ Wholesalers and retailers

Packaging	• Refers to the process of designing, evaluating, and producing packages. **OR** • The science, technology and art of enclosing products for distribution, storage, sell and use	• Improves shelf life • Gives the product appeal • Advertises the trademark • Makes it safer and less exposed to contamination • Food packaging accounts for a large amount of all • Convenience to the consumer • Creates job opportunities through waste recycling	Forms of packaging: • Primary: direct sale to consumer e.g. tomatoes packed in small pockets for sale. • Secondary: involves the packaging of sales units, e.g. pockets of tomatoes packed in cardboard boxes for transportation and handling. • Tertiary: involves the grouping of secondary packed units to further facilitate handling and transportation, e.g. boxes of tomatoes packed in a wooden pallet.
Processing/ Value adding	• Involves changing an agricultural product from its original form into a consumable commodity. • Processing is also called value adding.	• Reduces wastage of excess produce, especially lower grade fruit and vegetables. • Provides job opportunities. • Increases the quality of the product. • Way of overcoming over-supply of products. • Allows for easier packing and handling of products. • Increases share of the purchase price for a product • Longer shelf-life product, • Product availability in all seasons	• Indigenous processing: changes original product into a consumable one using indigenous traditional practices • E.g. drying up of meat, making of traditional beer and silage • Agro-processing: changes raw product to be more consumable and increase its value. • E.g. milling grain, meat dressing, cheese making, yoghurt blending, cutting, fermenting canning fruit and vegetables

4.2.4 Price determination, demand and supply

4.2.4.1 Price determination

- In a free market the interaction between the demand and supply is used to determine the costs for a good or service.

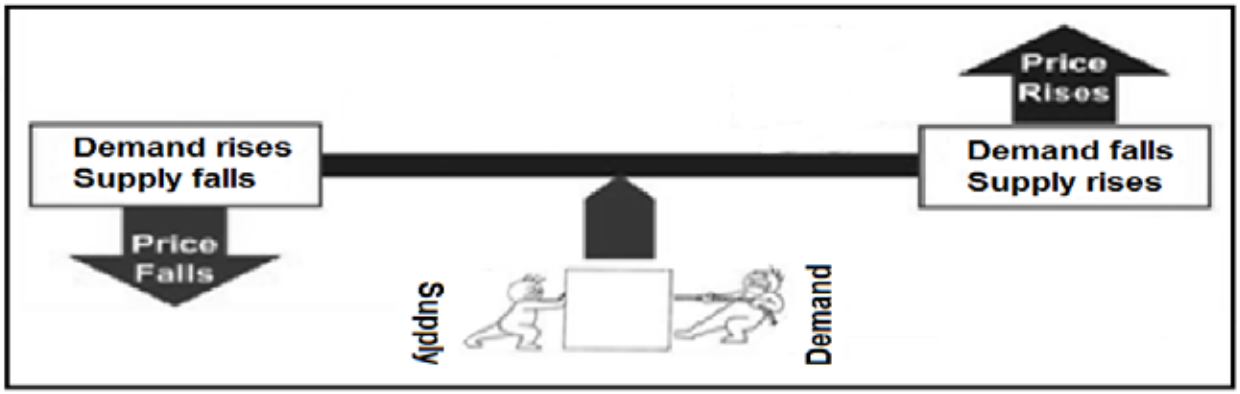


Figure 2: Supply and Demand principles

4.2.4.2 Demand

- **Demand**: quantities of a good that consumers are willing and able to buy at different prices.

- **Demand schedule**: is a table that shows the relationship between the price of a good and the quantity demanded

Demand schedule	
Price	**No. Of Apples**
5	30
10	25
15	22
20	18
25	15
30	12
35	10
40	5

Figure 3 (a): Demand schedule

- **Demand curve**: is a graph of the relationship between the price of a good and the quantity demanded

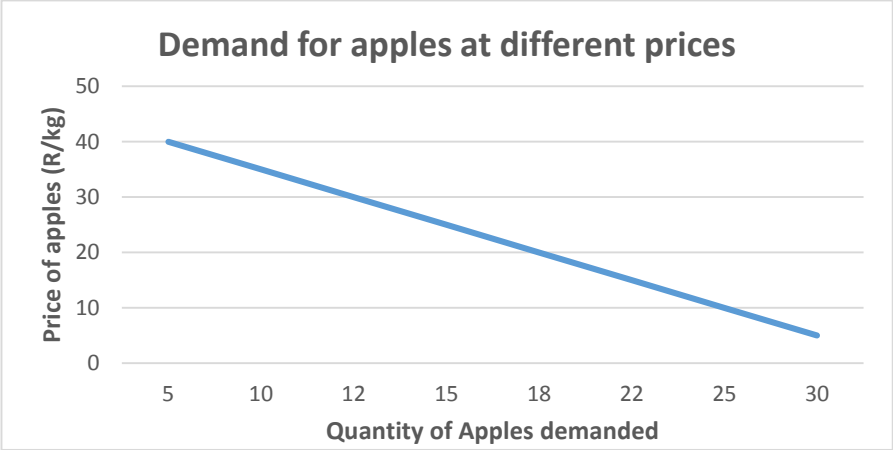


Figure 3 (b): Demand curve

- The demand curve is usually downward sloping, since consumers will want to buy more as the price decreases

4.2.4.3 Supply

- **Supply**: quantities of a good that producers are willing and able to sell or produce at different
- **Supply schedule**: is a table showing the relationship between price and quantity supply of commodity

Supply schedule	
Price	**Quantity of oranges supplied**
5	2
10	4
15	6
20	8
25	10
30	12
35	14
40	16

Figure 4 (a): Supply schedule

- **Supply curve**: is the graphical representation of the supply schedule or it shows how much of a good or service producer want to sell at any given time

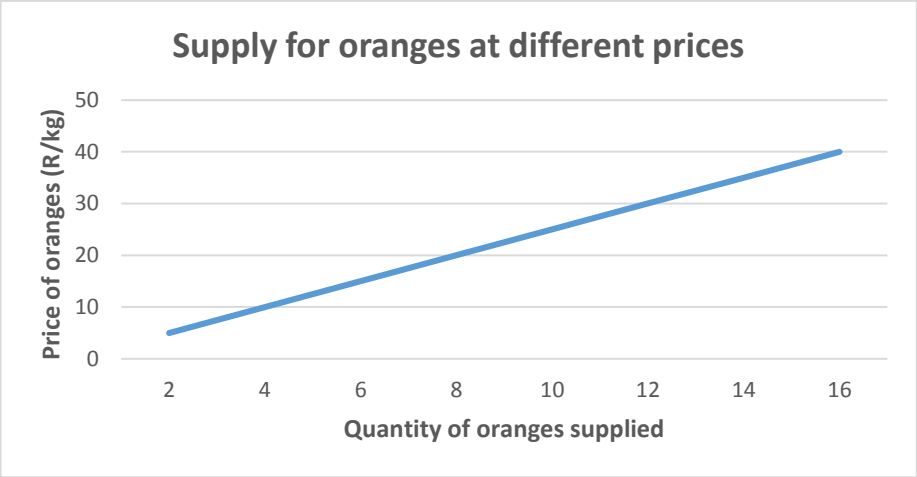


Figure 4 (b): Supply curve

- The supply curve shows the maximum quantities of a product that sellers would offer on a market at different prices per time unit.
- Usually the supply curve increases upward to the right, because a higher price will result in more of the product being offered on the market and more of the specific product will be produced

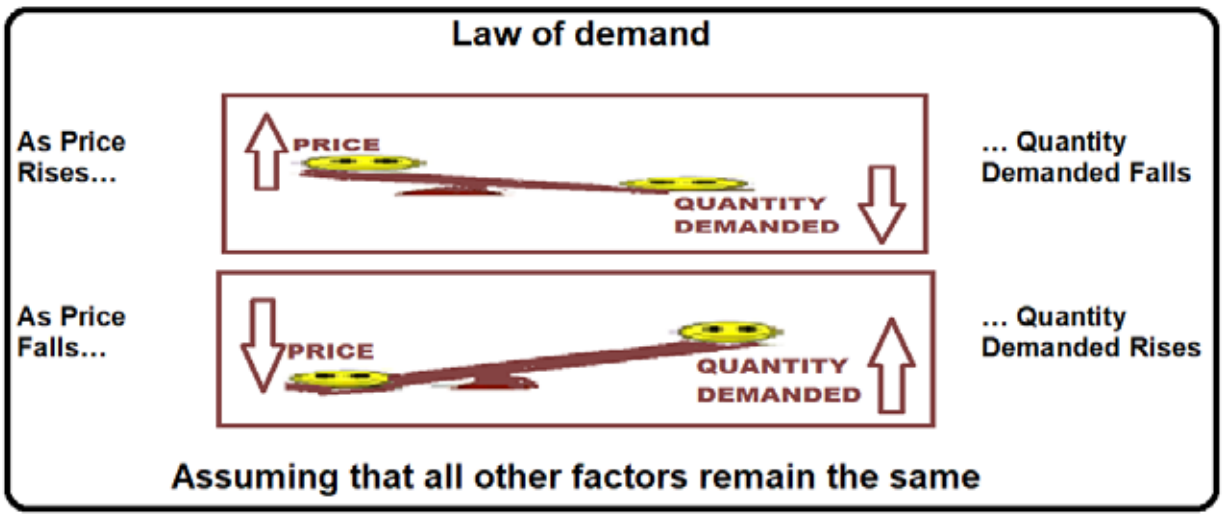
4.2.4.4 Explanation and interpretation of the law of supply and the interpretation of the supply and demand curve/graph

The law of supply and demand

- The law of supply and demand states that there is a higher demand for agricultural products when more customers buy a particular product. When there is a high demand, the price of the product will increase. On the other hand, the price will decrease when there is a low demand. This will result in many people buying the product which can lead to a product shortage. The price of the product will then increase. There is a stage in the market when supply and demand are equal and there is neither an oversupply nor a shortage. This is called market equilibrium. The price that consumers pay is determined by the market equilibrium.

The law of demand

- "If all other factors remain equal, the higher the price of a good or service, the less people will demand it, vice versa".



- There is an "*inverse*" relationship between Price and Quantity Demanded

Interpretation of the law of demand

- The lower the price of the product the more of the product will be bought by the consumer, provided that all the other factors that influence the demand remain equal or constant.

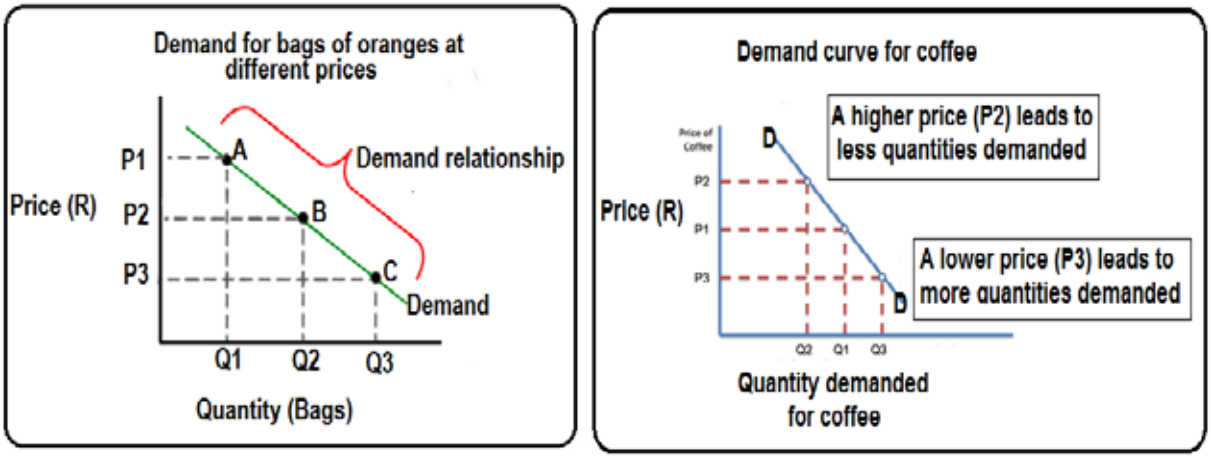
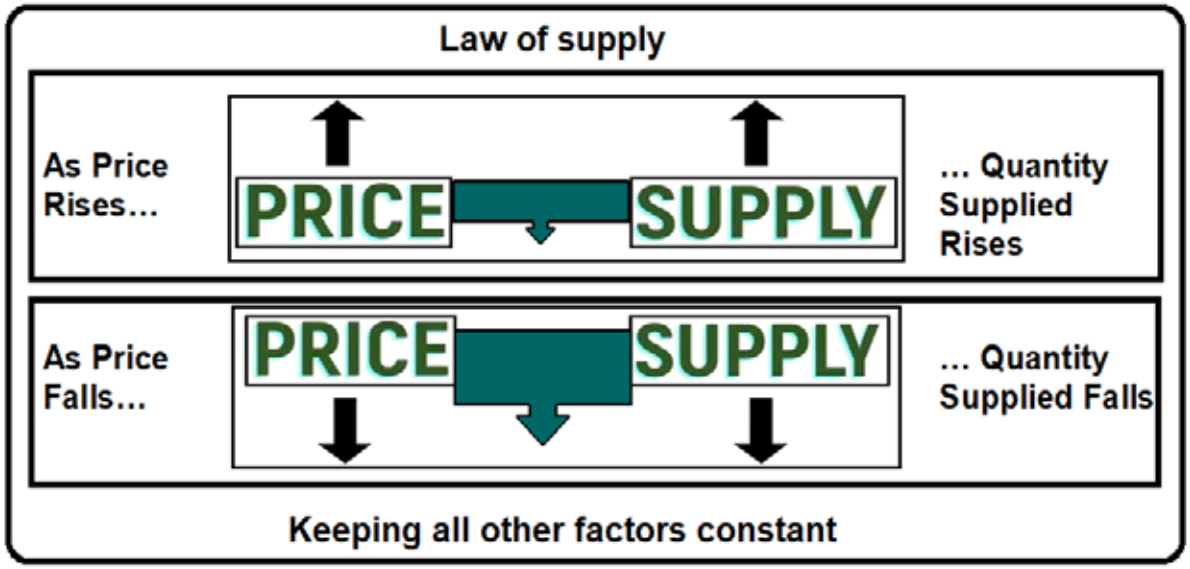


Figure 5: Graphical interpretation of law of demand

- Look at points A, B and C on the demand curve, each point on the curve reflects a direct correlation between quantity demanded (Q) and price (P).
- At point A, the quantity of oranges demanded will be Q1 and the price will be P1, and so on. The demand relationship curve illustrates the negative relationship between price and quantity demanded.
- At point A: The higher the price (P1) of oranges the lower the quantity demanded (Q1) and at point C: the lower the price (P3), the more bags of oranges will be in demand (point C)
- As mentioned above for oranges, the same is taking place in the graph representing demand for coffee, a higher price (P2) leads to less amount of coffee demanded, and at lower price (P3) more coffee is demanded.

The law of supply

- It demonstrates that the higher the price, the higher the quantity supplied vice versa, but unlike the law of demand, the supply relationship shows an upward slope.



- Producers supply more at a higher price because selling higher quantities at higher price increases profit. There is a directly proportional relationship between price and quantity supplied.

Interpretation of the law of supply

- The supply curve shows the maximum quantities of a product that sellers would offer on a market at different prices per time unit. Usually the supply curve increases upward to the right, because a higher price will result in more of the product being offered on the market and more of the specific product will be produced.

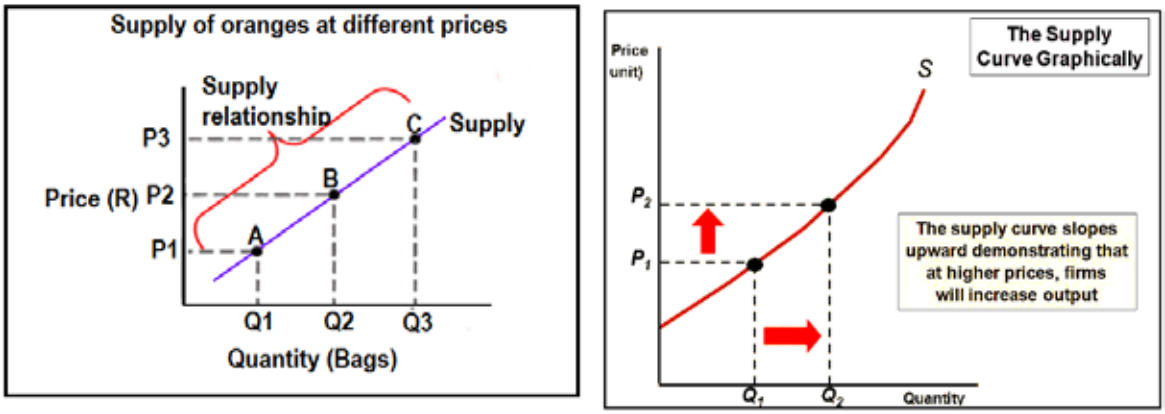


Figure 6: Interpretation of law of supply using graphs

- Look at points A, B and C on the supply curve, each point on the curve reflects a direct correlation between quantity supplied (Q) and price (P). At point B, the quantity supplied will be Q2 and the price will be P2, and so on.

- If the supply of a product decreases, the price goes up because there is greater demand for it. If the supply increases, the price should decrease as there is more of the product available to meet the same demand. If the demand decreases, the price also decreases as producers try to encourage consumers to buy the product.

Price determination using demand and supply

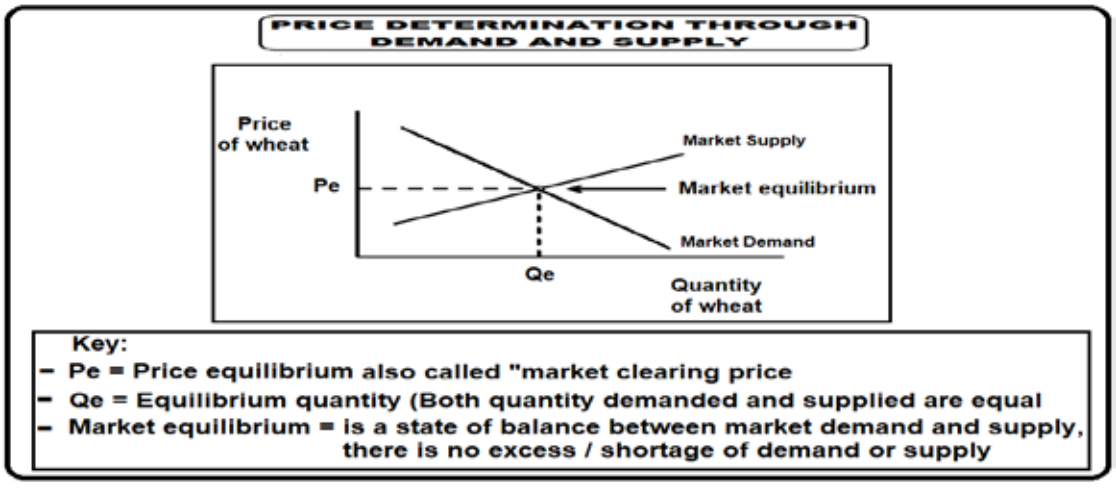


Figure 7: Graphical representation of price determination using demand and supply

- In a free market the interaction between demand and supply is used to determine the costs for a goods or service.

4.2.5 The factors influencing demand and supply of a product

Factors influencing demand	Factors influencing supply
• Price of the product • Price of competing/complementing/ supplementing products • Quality of the product • Consumer taste and preferences • Fashion / Advertising • Change in consumer income • Number of consumers • Price of substitutes or complements • Festive season • Research • Sociological factors • Legislation • Use of the product • Price expectation	• Price of the product • Production costs / Labour costs / Input costs • Change in technology • Environmental conditions / Nature • Government subsidy and taxation • Number of suppliers • Demand for the product • Expectations of future price change • Political instability • Legislation • Seasonality of the product • Changes in the price of similar goods • Use of the product. • Possibilities of increasing the supply of goods

Mnemonics:

A mnemonic code is a useful technique for learning information that is difficult to remember.

e.g. *Mnemonics used to easily remember the factors affecting demand and supply*

Five reasons for a change in demand

- Taste
- Income
- Market Size
- Expectations
- Related Goods

TIMER

Six reasons for a change in supply

- Subsidies and taxes
- Technology
- Other goods
- Number of sellers
- Expectations
- Resource costs

STONER

Different ways to avoid and overcome oversupply

- In agricultural economics overproduction or oversupply refers to excess of supply over demand of products being offered to the market. This can lead to lower prices and/or unsold goods along with the possibility of unemployment. Oversupply can also be defined as the accumulation of unsalable agricultural products that are in the hands of farmer.

- The illustration below shows methods that a farmer may use to avoid excess supply:

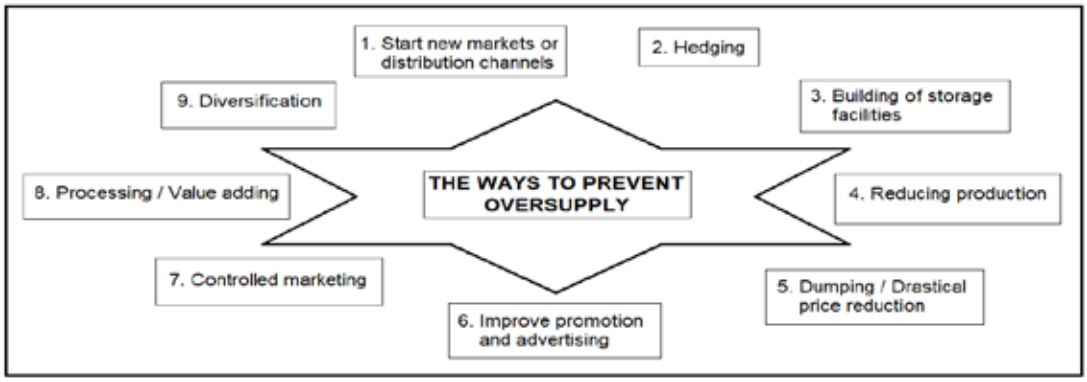


Figure 8: Ways to prevent oversupply

4.2.6 Price Elasticity / Inelasticity of Demand and Supply

Price elasticity shows how sensitive quantity is to a change in price

4.2.6.1 Price elasticity of demand

- Price elasticity of demand (PED or E_d) is a measure used in economics to show the responsiveness, of the quantity demanded of a good or service to a change in its price when nothing but the price changes. More precisely, it gives the percentage change in quantity demanded in response to a one percent change in price. When percent change in quantity demanded is greater than the percent change in price, demand is said to be elastic.

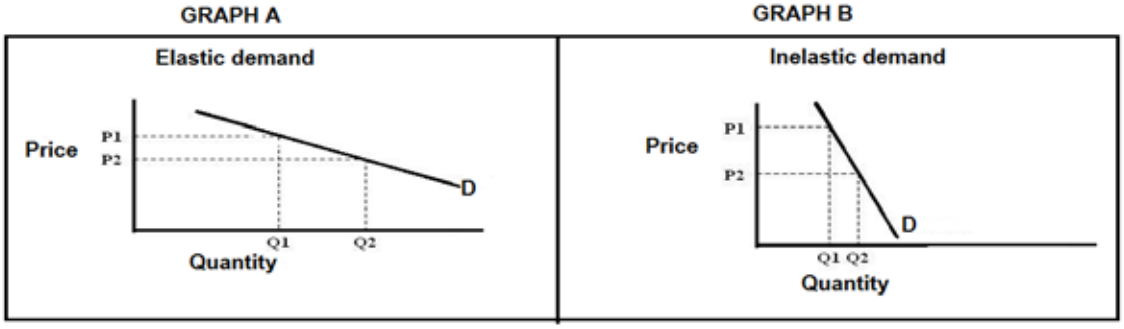


Figure 9: Elastic and inelastic demand

- Elasticity of demand is illustrated in figure 9 (graph A). Note that a small change in price results in a substantial change in quantity demanded. Consumer durables (farm items that are purchased infrequently) have elastic demand e.g. potato washing machine, if its price is increased buying can be postponed until the prices are better.
- It is common knowledge that when price increases less of that product will be bought. The concept of elasticity is concerned with how much less. Consumers will tend to avoid products they feel are overpriced and change to substitutes. Therefore, agricultural products that can be easily replaced by others have an elastic demand, when its price increases consumers stop buying it and buy more of the substitutes. For example, beef, pork and poultry are all meat products. The declining price of poultry caused its consumption to increase, at the expense of beef and pork.
- Figure 9 (graph B) illustrates an inelastic demand. A substantial change in price results only a slight change in quantity demanded. When percent change in quantity demanded is less than the percent change in price, demand is said to be inelastic. An example is when the price of salt decreases people will not increase the amount of salt consumed. Typically, businesses charge higher prices if demand for a product is price inelastic.

4.2.6.2 Price elasticity of supply

- Price elasticity of supply measures the responsiveness of quantity supplied to a change in price.
- The price elasticity of supply (E_s) is measured by % change in Q_s divided by % change in price.
- Generally, the supply for agricultural products is inelastic over a short term.

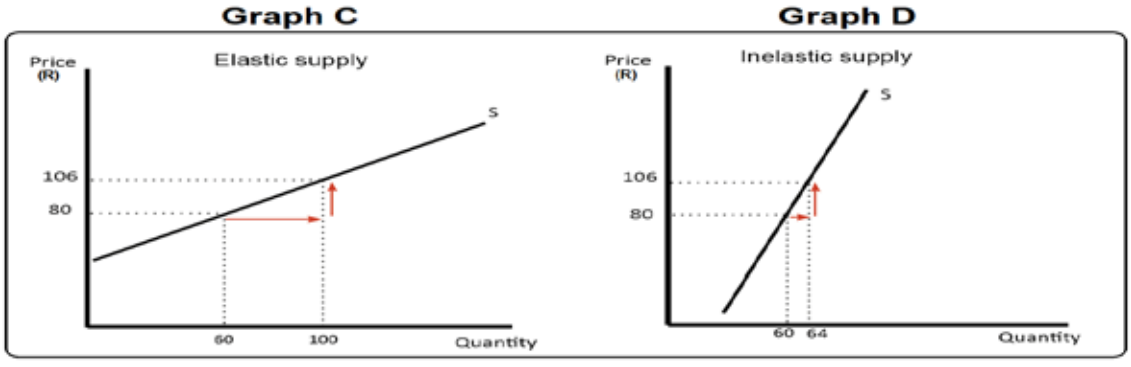


Figure 10: Elastic and inelastic supply

- This occurs when an increase in price leads to a bigger % increase in supply, therefore PES >1
- Figure 10 (graph C) shows elastic supply – a change in price causes a bigger proportional change in supply and in graph D supply is inelastic – a change in price causes a smaller proportional change in quantity supplied. An example is grapes, harvest is once a year, so in short-term, supply would be very inelastic. To supply grapes cannot occur overnight, it will take many months of until the next grapes season.

4.2.6.3 Graphical summary of elasticity / inelasticity of supply and demand

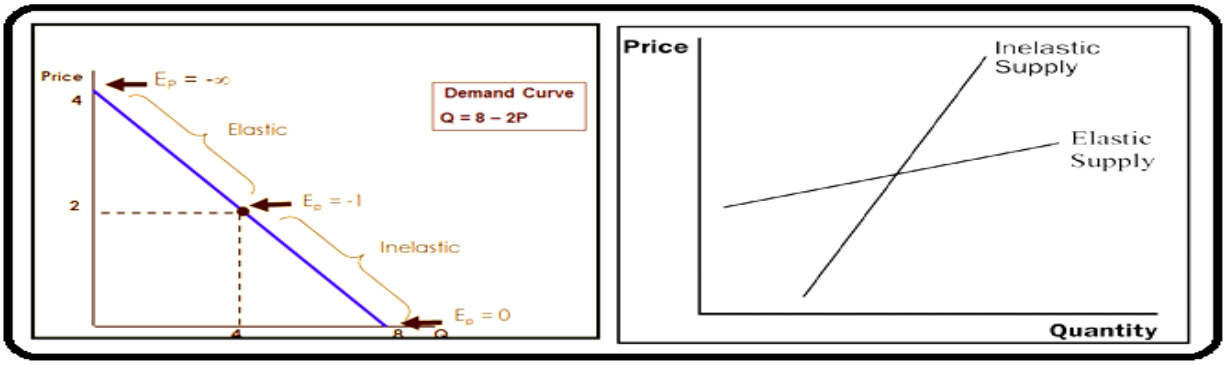


Figure 11: Elasticity of demand and supply

4.2.6.4 Determinants of Price Elasticity of Demand:

1. **Whether the product is a necessity or luxury** - consumption of necessities cannot be postponed, therefore the demand for necessities is inelastic. Luxuries tend to have elastic demand
2. **Few or many substitutes** – products with many substitutes tend to have an elastic demand
3. **Little or lots of time to compare** - in the long term, the demand for most goods is price elastic. This is because over time, consumers can find (cheaper) substitute goods and quit addictions - in the short time they cannot. Hence, in the short term, demand is rather price inelastic.
4. **Proportion of income** - the larger proportion of income a good constitutes, the more responsive its consumers will be to changes in price. If a good only constitutes a small proportion of a consumer's income, the demand for the good is likely to be price inelastic.
5. **Addictive or not** - much like necessity goods, if a good is addictive (e.g. cigarettes), consumers will continue to buy it despite changes in price - its demand is price inelastic.

4.2.6.5 The factors affecting elasticity of demand and supply

Factors affecting elasticity of demand and supply

Factors affecting elasticity of demand	Factors affecting elasticity of supply
1. Number of close substitutes	1. Nature / seasonality
2. Costs of switching between products	2. Stock of finished products
3. Product being a necessity or a luxury	3. Costs of attracting resources
4. Consumer income's proportion to the product	4. Time and production speed
5. Period after price change	5. Level of price
6. Peak and off-peak demand	6. Willingness of the farmer to take risk
7. Number of users	7. Nature of goods

ENRICHMENT (not for examination purpose)

Calculation of elasticity:

Price Elasticity Coefficient formula

Price elasticity of demand (E_d) = $\frac{\%\text{ change in Quantity demanded of a product}}{\%\text{ change in Price of a product}}$

$$E_d = \frac{\%\Delta Q_d}{\%\Delta P}$$

Demand is said to be **elastic** with respect to price if $E_D > 1$. $\%\Delta Q_d > \%\Delta P$

Demand is said to be **inelastic** with respect to price if $E_D < 1$. $\%\Delta Q_d < \%\Delta P$

Demand is said to be **unit elastic** with respect to price if $E_D = 1$. $\%\Delta Q_d = \%\Delta P$

Suppose that a 10% increase in price of bananas results in a 25% decrease in the quantity demanded

$$E_d = \frac{\%\Delta Q_d}{\%\Delta P} = \frac{25\ \%}{10\%} = 2{,}5 \text{ (Elastic demand)}$$

4.3 ACTIVITIES

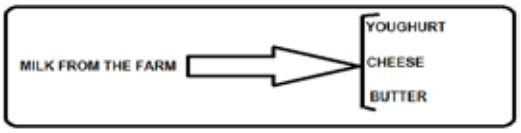
Agricultural marketing, price determination, demand and supply

1 Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number (1.1.1–1.1.10) in your ANSWER BOOK, for e.g. 1.1.11 D

1.1 ONE of the following factors DOES NOT influence the producer's decision and ability to supply a product to the market:

A. The state of technology
B. The buying power of consumers
C. Seasonal production
D. The profit margin of the product

1.2 The product function that is indicated by the diagram below is…



A. transport.
B. standardisation.
C. processing.
D. grading.

1.3 This is NOT the way to streamline and improve the agribusiness chain:

A. Improve roads to enable marketing
B. Cell phones and internet for easy access to marketing
C. Increasing transport costs by distributing the produce to nearby markets
D. Using cooling facilities to avoid oversupply to the markets

1.4 The following statement applies to eco-labelling:

A. It promotes product labelling as environmentally friendly
B. Sustainable labelling directed at the consumers only
C. It has components that have a negative impact on the environment
D. It does not take environmental concerns into account

1.6 The marketing function that bridges the gap between producer and consumer.

A. Storage
B. Processing
C. Packaging
D. Transportation

1.7 Generally, the supply for agricultural products is … over a short term.

A. Elastic
B. Inelastic
C. Equal
D. None of the above

1.8 The following statement is NOT part of a SWOT analysis:

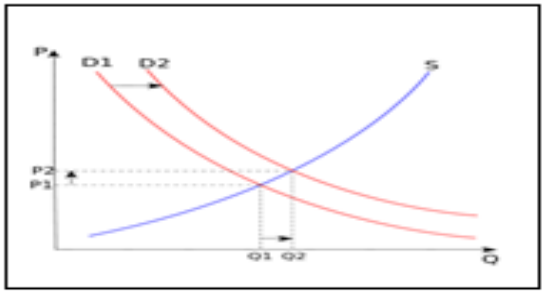
A. Involves identifying internal factors that are threats to the farming business
B. Strategic planning tool to evaluate a business
C. Identifying opportunities and taking advantage of them
D. Identifying strengths and weaknesses of a business

1.9 Some of the following statements are problems encountered when drawing up a business plan

(i)Being vague with too much information
(ii)Overambitious or unrealistic projections
(iii)Enough technical details
(iv)Not highlighting potential competition

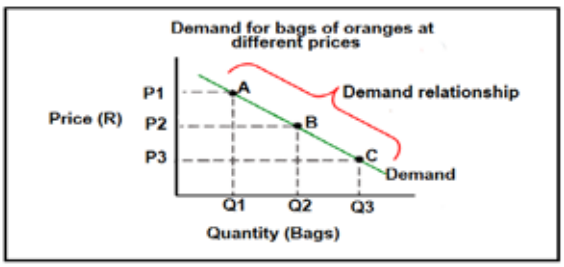
Choose the correct combination
A. (i), (ii) and (iii)
B. (ii), (iii) and (iv)
C. (i), (iii) and (iv)
D. ((i), (ii) and (iv)

1.5 The price of product is determined by the interaction of demand and supply. The letter **S** indicates …



A. surplus curve
B. equilibrium price
C. demand curve
D. supply curve

1.10 A, B and C are points on the demand curve. Each point on the curve reflects a direct correlation between quantity demanded (Q) and price (P).



The point on the graph reflecting that the highest price of oranges will result in the lowest quantities demanded.

A. At point B
B. At point C
C. At point A
D. None of the points

(10 x 2) (20)

2 Choose a description from COLUMN B that matches a term in COLUMN A. Write only the letter (A–J) next to the question number (1.2.1–1.2.10) in the ANSWER BOOK, for e.g. 1.2.6 K

	A	B
2.1	Selling	**A**. Exchange of goods for goods
2.2	Hedging	**B**. A series of activities involved in moving a product from the point of production to the point of consumption
2.3	Auction	**C**. All else equal, an increase in price results in an increase in quantity supplied.
2.4	Bartering	**D**. The process of collecting, interpreting and disseminating market information
2.5	Law of demand	**E**. A public place of sale or a situation where supply and demand meet.
2.6	Law of supply	**F**. Obtain in exchange for payment
2.7	Buying	**G**. A public sale in which goods or services are sold to the highest bidder.
2.8	Market	**H**. The higher the price, the less people will demand a certain product all other factors remaining the same
2.9	Marketing	**I**. Keeping the market price constant.
2.10	Market intelligence	**J**. Exchange of goods and services for money (10 X 1) (10)

3. Differentiate between marketing and selling in a tabular form (5)

4. The table below shows the supply and demand for 2kg pockets of apples at different prices:

PRICE/2kg (RAND)	SUPPLY PER WEEK	DEMAND PER WEEK
120	1200	0
100	1000	200
80	800	400
60	600	600
40	400	800
20	200	1000
0	0	1200

4.1 Use the information in the table above to draw a line graph of both the supply and demand on the same pair of axes. (6)

4.2 Deduce the market equilibrium price of apples from the graph drawn in QUESTION 4.1 (2)

4.3 Identify the price at which producers will be willing to supply 2 tons of apples per week. (2)

4.4 Deduce what will happen to the availability and price of apples at the price of R20,00 if the demand doubles and the supply increases by 45% only. Show ALL calculations to support your conclusion. (5)

4.5 Mention FOUR advantages of processing (4)

5. Read the scenario below and then answer the question that follow:

A group of sheep farmers in the Karoo wanted to increase their profit and have a sustainable market. They identified the following possible markets for their produce:

- Small butcheries
- Large supermarkets
- Local people who buy directly from the farm
- Auctions

5.1 Indicate the most sustainable market for mutton in the list above. (1)

5.2 Give TWO reasons to support your answer to QUESTION 5.1 (2)

5.3 Identify a market in the list above that has the highest security risk for a mutton producer. (1)

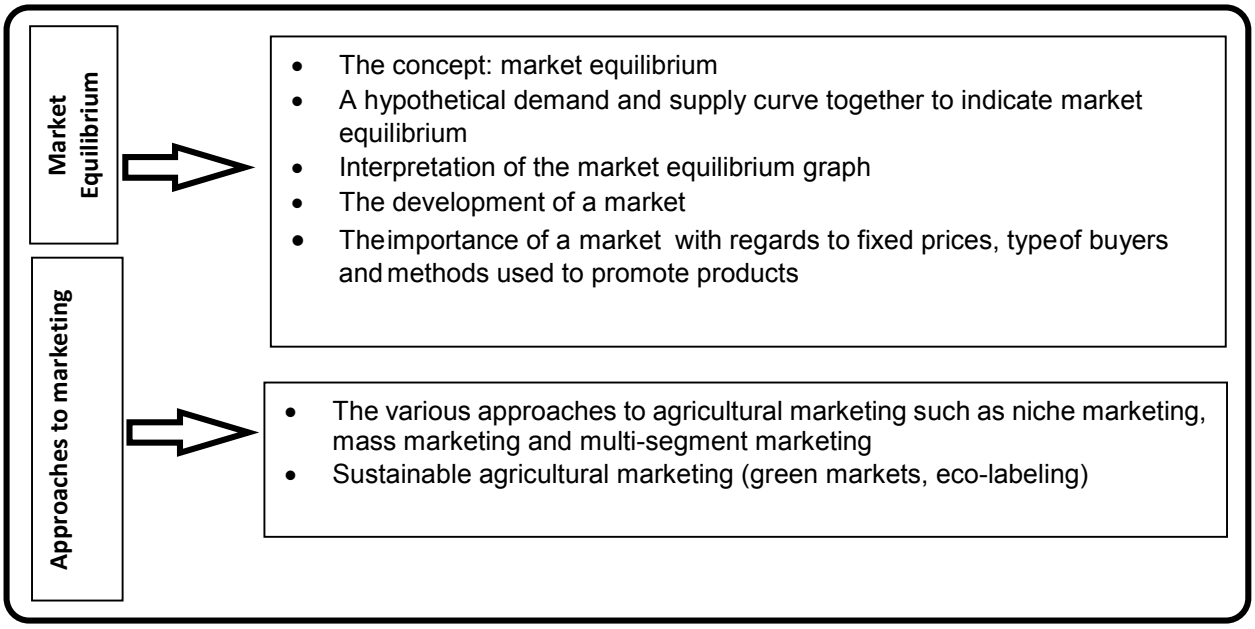
5.4 Justify your answer to QUESTION 5.3 (2)

TOTAL: 60 MARKS

4.4 Market equilibrium:

Learning objectives:

At the end of this unit the learners should be able to demonstrate knowledge of the following content:



4.4.1 Terminology

CONCEPT	DEFINITION
Market equilibrium	is a situation in the market where supply and demand are equal.
Ceiling price	is the highest price of a product in the market.
Niche marketing	involves selling to a small segment of the market
Mass marketing	is selling a product in different to different segments of the market.
Multi-segment marketing	involves choosing few segments of the market and developing a marketing strategy that suits it.
Monopoly	a market that has one seller and many buyers
monopsony	a market that has many sellers but only one buyer
Market intelligence	a process of collecting, interpreting and disseminating market information
A cartel	when a group of producers sell their produce as a unit resulting in price manipulation

4.4.2 The concept of market equilibrium

- It is a situation in the market where supply and demand are equal. The graph below represents a market equilibrium meaning that the quantity (Q) at which the demand and supply curves cross gives the price (P) that clears the market. If a market is at equilibrium, the price will not change unless an external factor changes the supply or demand, which results in a disruption of the equilibrium

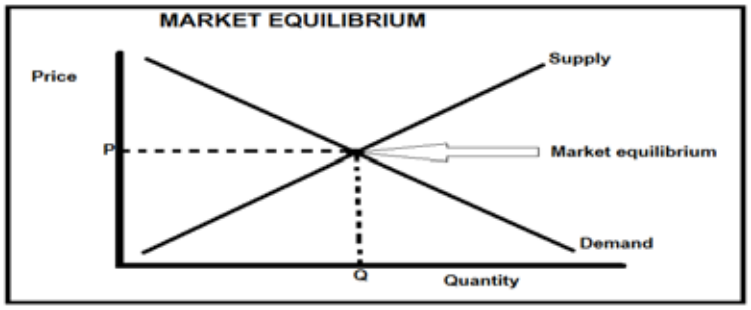


Figure 12: Market Equilibrium

4.4.2.1 The surplus and shortage

- Surplus:
  - A surplus occurs when production is above the equilibrium point
  - This often occurs if the floor price is set above equilibrium price

- Shortage:
  - A shortage occurs when production is below the equilibrium point
  - This often occurs if the ceiling price is set below the equilibrium price

Surplus and shortage represented in graphs

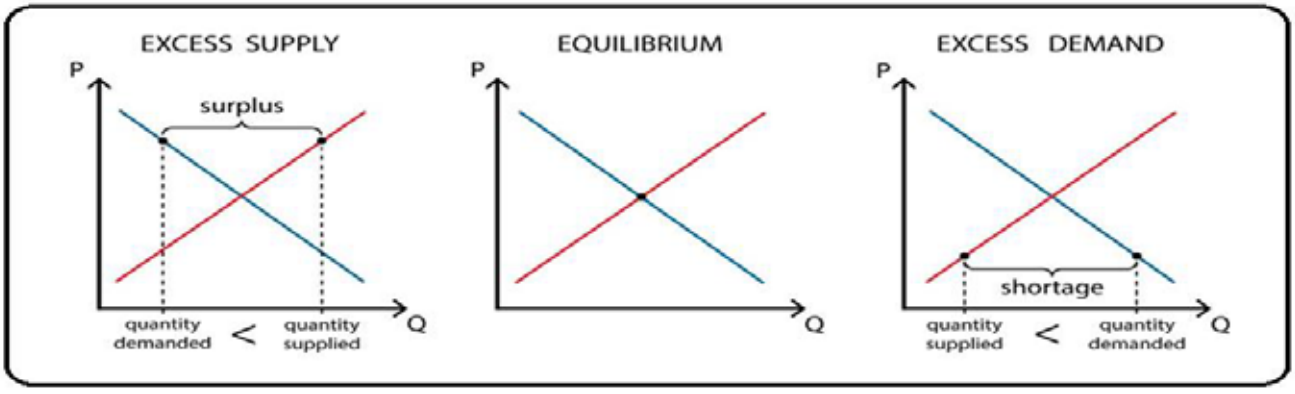


Figure 13: Surplus, equilibrium and shortage

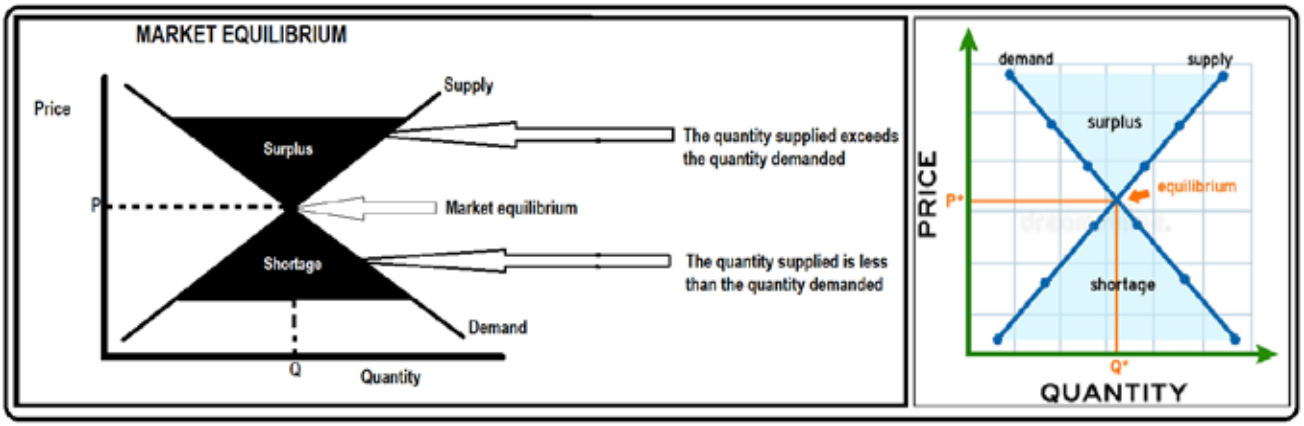


Figure 14: Surplus and shortage

4.4.2.2 Shifts in demand and supply

Shift in demand

- If one of the factors (other than price) influencing demand changes, the whole demand curve will shift. This will lead to a movement along the supply curve to a new intersection point. The equilibrium price changes if the demand for a product increase.

At Christmas time there is a greater demand for fresh cream. As the demand for ice cream increases and cream becomes scarce (perhaps demand even exceeds supply), the market sets a new price that is higher than the old equilibrium price. This means that sellers can charge more for cream without any changes in supply

Shift in demand graphs

- Graph A: Shows a decrease in demand from Q1 to Q2 (shift to the left - D1 to D2) causing a decrease in equilibrium price from P1 to P2. Market equilibrium shifts from E1 to E2
- Graph B: Shows an increase in demand from Q1 to Q2 (shift to the right - D1 to D2) resulting in an increase in equilibrium price from P1 to P2. Market equilibrium shifts from E1 to E2

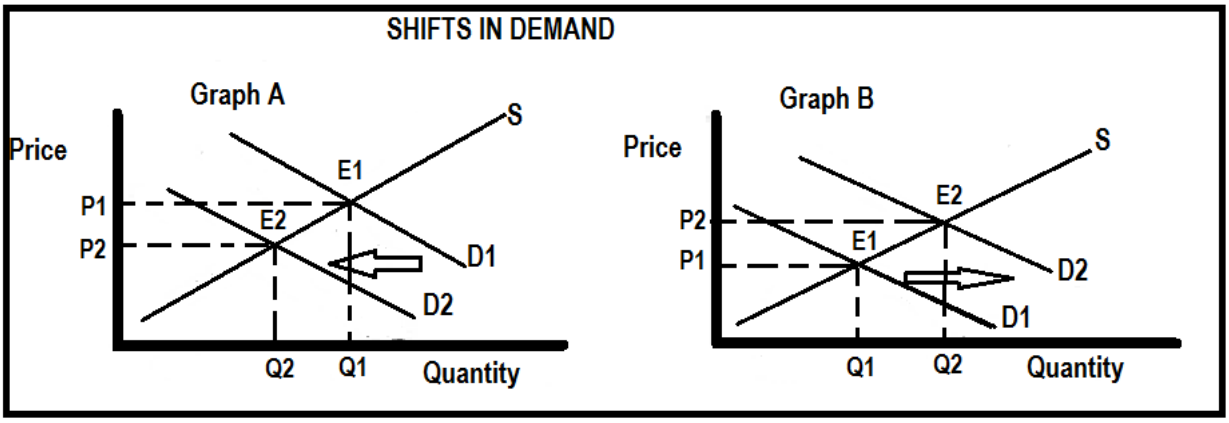


Figure 15: Shifts in demand

Shift in supply

- If one of the factors (other than price) influencing supply changes, the whole supply curve will shift. This will lead to a movement along the demand curve to a new intersection point. The equilibrium price changes as the level of supply changes.

As summer arrives and fruit like peaches come into season, there is a greater supply. The market sets a new equilibrium price that is lower than the old price, and fruit sellers will shift their prices down to the new equilibrium price.

Shift in supply graphs

- Graph A: shows an increase in supply from Q1 to Q2 (shift to the right - S1 to S2) resulting in a decrease in equilibrium price from P1 to P2. Market equilibrium shifts from E1 to E2
- Graph B: shows a decrease in supply from Q1 to Q2 (shift to the left - S1 to S2) causing an increase in equilibrium price from P1 to P2. Market equilibrium shifts from E1 to E2

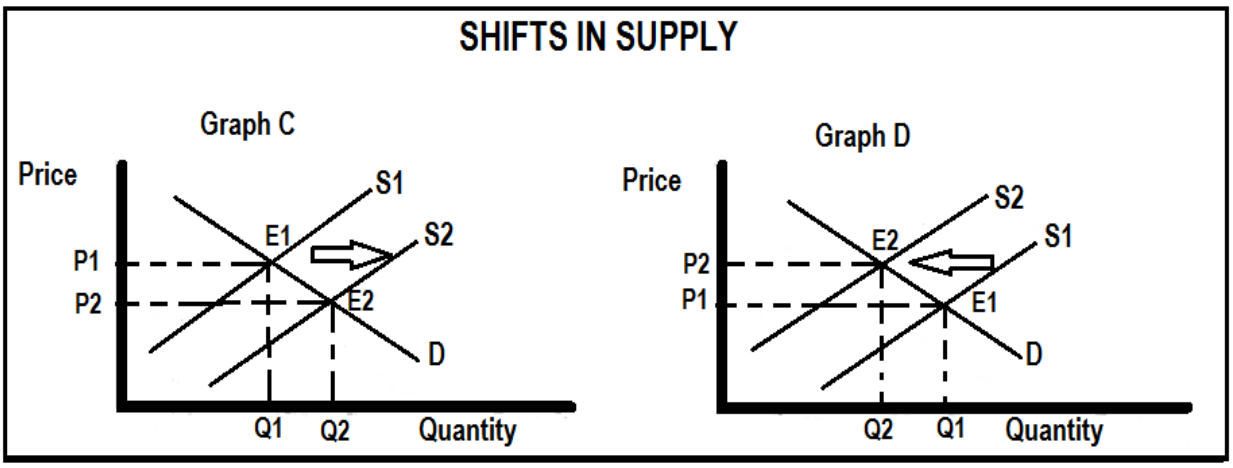


Figure 16: Shifts in supply

4.4.2.3 The development of markets:

- Market development is a strategic step taken by producers to develop the existing market rather than looking for a new market.
- The company looks for new buyers to pitch the product to a different segment of consumers in an effort to increase sales.
- The buyers compete to buy the best products for the lowest prices and the sellers compete to sell the biggest quantity of their products for the highest prices.

Types of buyers

- Retailers
- Food processing companies
- Exporters and importers
- Brokers
- Consumer

- Buyers can be categorized according to their reaction to a new product in the market
- Each group's reasons for buying are different, so you must modify your selling strategy appropriately for each group.
- Before starting a farming business, the farmer should identify and research a target market to find out its needs and wants, and how much it would be willing to pay to satisfy these. This will enable the farmer to produce appropriate products.

4.4.2.4 The importance of the market regarding the fixed prices

Fixed price

- Is an agreement between participants on the same side in a market to buy or sell a product, service, or commodity only at a fixed price, or maintain the market conditions such that the price is maintained at a given level by controlling supply and demand.

The intent of price fixing

- May be to push the price of a product as high as possible, generally leading to profits for all sellers but may also have the goal of fixing, pegging, discounting, or stabilizing prices. The defining

characteristic of price fixing is any agreement regarding price, whether expressed or implied.

- Government assists in controlling prices using the following methods:
  - Set floor prices for basic foodstuffs - This keeps the prices of basic foodstuffs as low as possible.
  - Set the ceiling prices for foodstuffs - This sets the maximum price for certain products.
  - Controls inflation

- When there is inflation, money loses buying power and this leads to an increase in prices. The average person will not be able to afford basic foodstuffs. So, the government should try to control inflation.

Advantages of fixed prices

- Increases sale volume,
- Saves time
- Sets the right price the first time.
- Buyers can determine an exact budget in advance
- Buyers become aware of the total cost before the project even begins

Difference between Monopoly and Monopsony

Monopoly

- A monopoly exists when a specific person or enterprise is the only supplier of a commodity.
- Buyers have no alternatives to buy from, so the seller can determine a fixed price.
- This price might be unreasonably high, as the seller does not need to worry about lower prices from competitors, and can supply the whole market

when a producer has a new kind of pear that has a lovely taste and a beautiful colour. As this producer is the only seller of this new pear and all the buyers want this new pear, the producer can decide on the fixed price at which it will be sold.

Monopsony

- Is a market that has many sellers but only one buyer.
- Here the sellers have no alternative buyers to sell to, so the buyer can determine a fixed price at which trade will take place.

This is when there is a company that wants to do studies on rotten apples, as there are no other buyers of rotten apples and there certainly are a lot of sellers of rotten apples, the company doing the study can determine the price which they want to pay.

4.4.2.5 Setting prices

- The producer of a product has to decide what price the product will be charged. The price of goods in any market depends on the interaction of three factors:
  - **Cost plus price**: the producer works out the cost of producing a product (that includes production, labour, materials, fixed costs, etc.)
  - **Market-orientated pricing / Demand and supply**: research is done to find out how much the consumer is willing to pay for the product and a price is set accordingly
  - **Competition-orientated pricing**: the producer finds out what prices are being charged for similar product or service in the market and set a price in those limits. The method does not pay too much attention to own production costs or demand for the product.

The marketing mix:

- Marketing mix is the combination of elements that are going to make the marketing strategy for a farming business
- Marketing mix helps in achieving the marketing objectives of the business
- Marketing mix needs to clearly differentiate your products from those of your competitors

Figure 17: Marketing mix (4 P's of marketing)

Market research

It is important that farmers do market research looking at each of the following:

Figure 18: Market research

The need and importance of market research

- Marketing research (MR) provides valuable data
- It studies consumer behaviour
- It helps to select suitable sales promotional techniques
- It supplies market related information
- It helps a company to evaluate its marketing performance
- It also has miscellaneous importance

Methods used to promote products

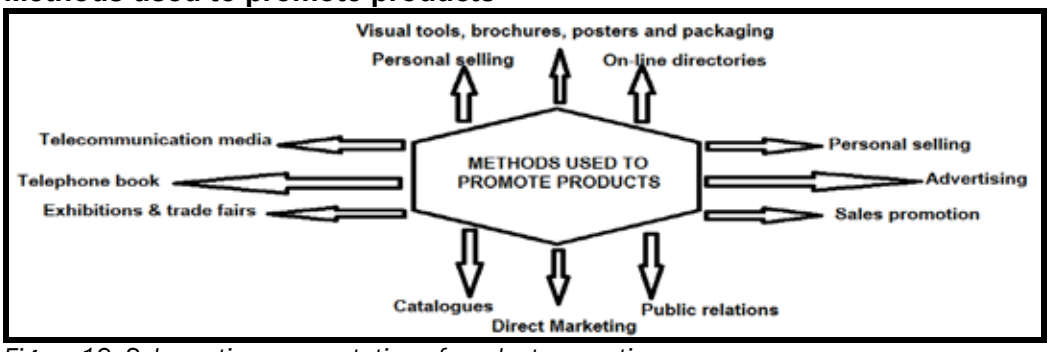


Figure 19: Schematic representation of product promotion

4.4.2.6 Approaches to marketing

Marketing Approaches		Advantages	disadvantages
1.	**Niche marketing** • Focuses on a specific group of consumers in a market place. • Is usually a small section of the market, comprising consumers who share a preference and who are willing to pay a premium for a product or service that satisfies that specific preference? There are three rules for niche marketing: • Meet the unique needs of the segment of the market • Focus on the interest and motivations for the segment when you develop promotional materials • Test the market by starting small, but with focus.	• Keep costs of small businesses low • Ignored by big businesses • The monopoly the first seller enjoys for a period.	• High costs to transport few products to the market • Include the high cost of developing a product for a niche • Other sellers can simply copy the idea and enter that market without having to invest in product or market development.
2.	**Mass marketing (undifferentiated marketing)** • In this form of marketing the farming business ignores market segment differences and addresses the whole market. • Mass marketing attempts to reach every consumer rather than targeting a particular market segment. • It targets the whole market with a single offer. • Such a strategy is effective only for products such as maize and fruit that appeal to a broad cross-section of consumers. • Traditionally, Mass marketing is done through radio. Television and newspaper	• Reaches lots of consumers • Effective only for products that appeal to a broad cross-section of consumers e.g. maize and fruit	• It cannot be used for products with limited appeal • Generally, more expensive than direct marketing
3.	**Multi-segment marketing**: • This type of marketing involves marketing to two or more segments of the market. • A unique marketing strategy is then developed to suit those segments. • Multi-segment marketing is when the same product is offered to different groups or segments in a market. • This is typically done by offering different levels of quality to different levels of income, for example offering Class 1 fruit to consumers with high income and Class 3 fruit to consumers with low income.	• Producers will have a market for all their produce.	• Consumers with higher income might opt to buy a lower quality of produce due to its lower price.

Sustainable agricultural marketing

Involves the application of an environmental educative approach to marketing

- Sustainability is about maintaining or even improving something over the long term
- This form of marketing ensures that with all the intensive production and marketing taking place, that the environment retains the potential to support future generations
- It entails adapting activities on every level of operation to be more ecologically friendly and safe, as well as socially acceptable and healthy,
- Examples:
- Developing a product that is naturally healthy, instead of genetically modified crops,
- Packaging: using recycled or recyclable materials in packaging instead of materials such as

plastic.

- Advertising: aiming to better communicate the sustainable agricultural 'practices employed in production is called eco-labelling.

Examples of sustainable marketing

Green markets	Eco-labelling
A green market distributes used, refurbished, reconditioned, repaired and recycled products that are in working condition through brokers and resellers	Eco-labelling is a method of labelling that communicates information, educates and increases consumer awareness on the impact of a product on the environment. It encourages consumers to buy products with a low environmental impact.

4.5 ACTIVITIES

Market equilibrium

1. Give one word or phrase for each of the following descriptions. Write only the word term/ phrase next to the question number (1.3.1 – 1.3.5) in the ANSWER BOOK.

1.1 When a group of producers sell their produce as a unit resulting in price manipulation

1.2 a market that has one seller and many buyers

1.3 is a situation where supply and demand are equal.

1.4 is the highest price of a product in the market.

1.5 involves selling to a small segment of the market

1.6 is selling a product in different to different segments of the market.

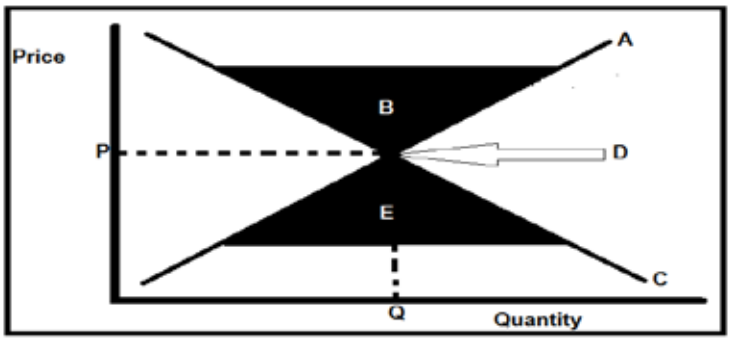
1.7 a market that has many sellers but only one buyer

1.8 involves choosing few segments of the market and developing a marketing strategy that suits it.

1.9 a process of collecting, interpreting and disseminating market information

1.10 Occurs when government put a legal limit on how low a possible price of a product can be. (10 X 2) (20)

2. The graph below represents demand and supply curves meeting at point **D**. Analyse
the graph and answer questions that follow:

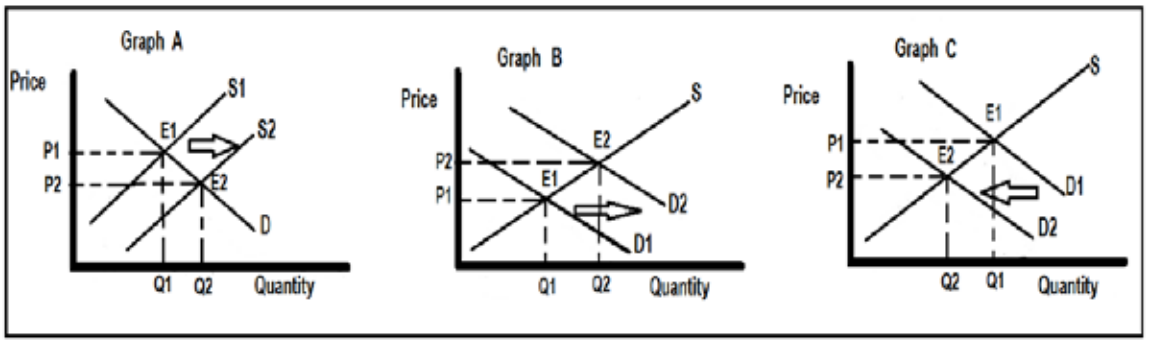


2.1 Suggest a suitable title for the graph above
(1)

2.2 Identify the most appropriate letters (**A**, **B**, **C**, **D** or **E**) from the graph above that represents each of the following:

(a) The quantity of goods offered for sale at a particular time and moment
(b) The situation where supply and demand are equal
(c) It occurs when production is below the equilibrium point
(d) The amount consumers are willing to buy at a given price
(e) Represents a situation when production is above the equilibrium point
(5)

3. The graphs (**A**, **B**, **C** and **D**) below represents shifts in demand and supply. Analyse the graphs and then answer the questions that follow:



3.1 Relate each of the following scenarios listed below to the graphs above:
(a) During summer peaches come into season as a result there is a greater supply, and fruit farmers will shift their prices down to the new equilibrium price.
(b) Health concerns cause more consumers to avoid eating red meat and shift to chicken. The demand for red meat over a long period will change as represented by one of the graphs above

. (c) At Christmas time there is a greater demand for fresh cream due to increased demand for ice cream resulting in markets setting a new higher price. (3)

3.2 There are different approaches to marketing. Match each of the following to different approaches of marketing.

(a) The security company decided to offer specialised services to farmers only in the form of farm protection services.

(b) A farmer who advertises on television the nutritional value of maize and its ability to feed many members of the family.

(c) A potato farmer sells the produce as fresh potatoes in small bags and some processed as fried chips and the smaller ones as baby potatoes (3)

4. Read the following and answer questions that follow:

> The condition where an agreement is reached between participants on the same side in a market to buy or sell a product, service, or commodity only at a particular price, or maintain the market conditions such that the price is maintained at a given level by controlling supply and demand.

(a) Suggest the name of the phenomenon above (2)

(b) Give FOUR advantages of the phenomenon named in QUESTION 4.3.3 (a) above (4)

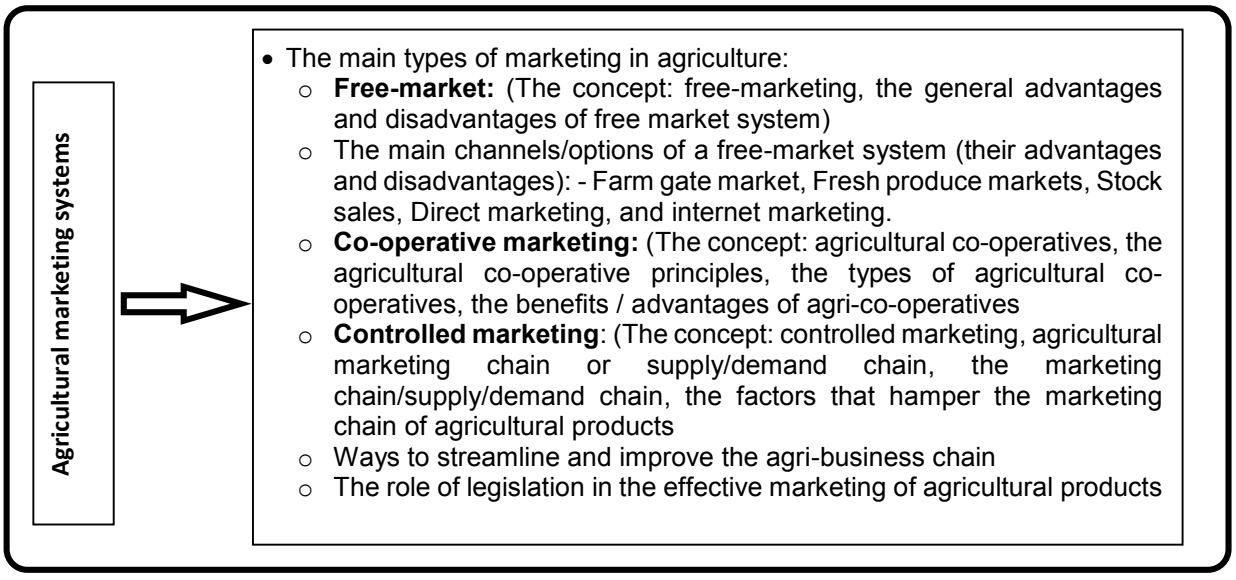
5. Define eco-labelling (2)

TOTAL: 40 MARKS

4.6 Agricultural marketing systems

Learning objectives:

At the end of this unit the learners should be able to demonstrate knowledge of the following content:



4.6.1 Terminology

CONCEPT	DEFINITION
Free marketing	is the form of marketing where producers market their products as they please.
Co-operative marketing	is when producers pool their products and market them through the co-operative society.
Controlled marketing	management of the distribution of goods and services by government or other entity
Agri-business chain	involves all the activities from production to the marketing of agricultural products
Marketing chain	describes the flow of products from production point (farm) to consumption point (consumer)
A cartel	group of producers sell their produce as a unit resulting in price manipulation
Price fixing	when group of producers collaborate and set prices artificially
Dumping	when great volumes of a particular product are imported at a very low price compared to local producers
Intermediary / Middlemen	a person or business that sells produce or service on behalf of producers to potential consumers

4.6.2 The main types of marketing in agriculture

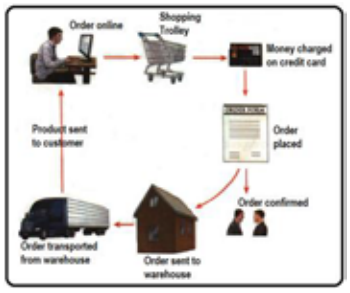
Farmers choose marketing methods based on the type of product that they need to sell.

	FREE MARKETING	CO-OPERATIVE	CONTROLLED
Definition	• Goods and services are exchanged freely without restrictions	• People working together to meet their common economic, social and cultural goal	• Buying and selling is controlled by boards
Advantages	• Sales for cash • Money received immediately • No middlemen / intermediaries • Profit can control how much profit they can make by analyzing the demand • Farmers are motivated to work harder • Farmers are encouraged to produce quality products because of competition • The producer can show initiative and drive • More farmers will be encouraged to enter as entrepreneurs as this form of marketing is cheaper	• Producer members are the owners of the co-op. • Risks are shared by all members. • Members enjoy economy-of-scale benefits in buying and selling. • Combining resources can give access to processing facilities and marketing expertise. • A co-op can extend credit to producers. • Costs can be distributed, such as equipment costs, processing costs, marketing costs, advertising costs and personnel costs. • Meet market requirements for volume and consistent supply. • Access to better infrastructure. • Eliminating the middleman. • Branding. • Access to funding	• Orderly marketing • Standardisation. • Stable prices. • Secure market outlets. • Larger enterprises are able to obtain international contracts. • Farmers can focus on their farming activities, rather than spending time on marketing their produce.
Disadvantages	• Farmers may lack necessary skills • Farmer bears all the risk alone, in	• Lack of Secrecy: Cooperative society must submit its annual	• Controlled marketing does not encourage

	times of disaster & for production • Prices will fluctuate because of the force of supply • A small-scale farmer will have less bargaining power • Production and marketing costs are high • Small-scale farmers struggle to keep up production and focus on marketing • Some farmers may form cartels to protect themselves from competition and consumers could be exploited • Marketing needs skilled expects	reports and accounts with the Registrar of Cooperative Societies. • Lack of Business Acumen: The member of cooperative societies generally lacks business acumen. • Lack of Interest: • Corruption: lack of profit motive breeds fraud and corruption in management • Lack of Mutual Interest:	entrepreneurship. • The establishment of centralised facilities such as abattoirs or grain storage facilities can be inefficient and increase transport costs. • Producers have fewer choices and cannot negotiate relationships and prices with potential buyers.
Examples / channels /Types	The main channels of a free-market • Farm-gate markets • Fresh produce markets. • Stock sales • Direct marketing • Internet marketing.	Agricultural co-operatives Commercial or consumer co-operatives	Controlled price of maize, wheat, red meat etc.

4.6.3 Advantages and disadvantages of the main marketing channels of free market system:

MARKETING CHANNELS	ADVANTAGES	DISADVANTAGES:
Farm gate marketing 	• Producer may be able to obtain a market price for the product without marketing costs. • Product will be fresh • Products are sold at a low price. • There are no transport costs. • Better suited to smaller scale farmer. • Farmer can sell produce him/herself, thus costs are reduced	• The farmer will have to accept the local price for his or her product. • The farmer will not, necessarily be wen located to reach customers.
Fresh produce markets 	• Farmers can take advantage of higher prices in times of short supply. • The market can sell large quantities of the farmers' produce. • The farmer can employ the services of an agent to perform the task of marketing.	• Availability of market information to make the right decisions. • Prices fluctuate. • Markets are often far from the point of production. • The time of harvesting is critical to the success of the crop • Produce must conform to accepted grade and packaging standards. • Farmer to be confident that he can cover the higher marketing costs
Stock sales 	• Promotion is done on behalf of the farmer. • Payment by the buyer is guaranteed. • The market is larger than the local market. • Small-scale farmers have access to these sales.	• The seller may not get the price he wants for the animal. • Prices may be lower than market price. • Small-scale farmers may not have the money or transport to take their animals to auction sales.

Direct marketing 	• Marketing margins could be reduced and thus the producer could obtain higher prices for the product, • The volume of sales is guaranteed to the farmer.	• The farmer must ensure that he or she has sufficient produce of acceptable quality to supply the customer or retailer at all times. • The quantity of produce must be high at all times. • If the farmer cannot meet the needs of the retailer, he will have to buy in produce to make up quantities required by the retailer.
Internet marketing 	• It can reach a global audience. • It is very fast. • The cost is relatively low • 24 hours a day, • Deliver is direct • This form of business is not capital intensive	• Attracting customers may not be easy. • Online marketing is not free. • Not all consumers shop online. • Many people prefer the live interaction • Many visitors will not want to use their credit card· • There is a lot of competition • The possibility of fraud is a risk.

4.6.4 The principles of Agricultural co-operatives:

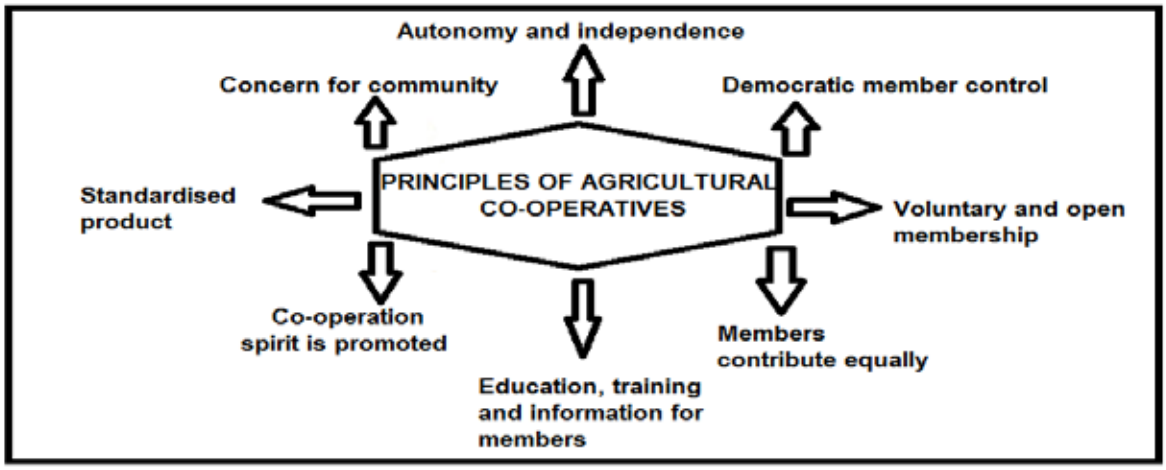


Figure 20: A Summary of principles of agricultural co-operatives

4.6.5 Agricultural marketing chain or supply/demand chain

- Marketing chain describes the flow of products from production point (farm) to consumption point (consumer)
- The agri-business chain has two parts:
  - The production (Supply) chain and
  - The marketing (Demand) chains.
- Before being harvested, the product goes through the production chain so that it is ready for harvesting and thereafter marketing.
- The marketing chain is also known as the supply/demand chain.
- It involves all the stages that a product passes through after being produced and harvested on a farm until it reaches the consumer:
- For example, → cleaning, drying, grading, processing, transporting, storage, packaging, labelling and branding.

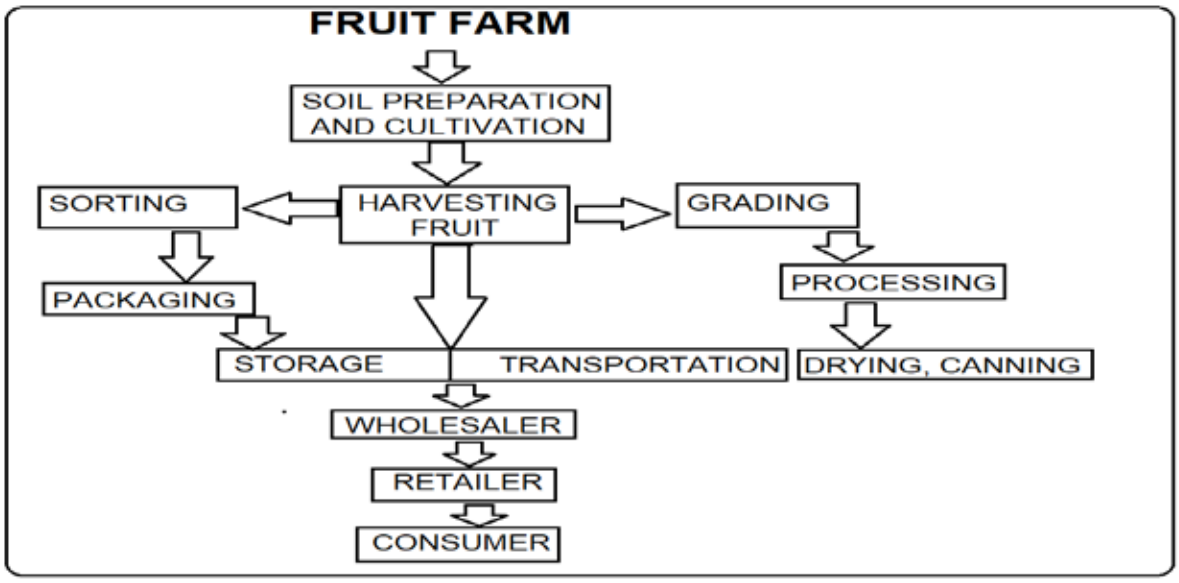


Figure 21: Marketing chain

4.6.5.1 Factors that hamper marketing of agricultural products

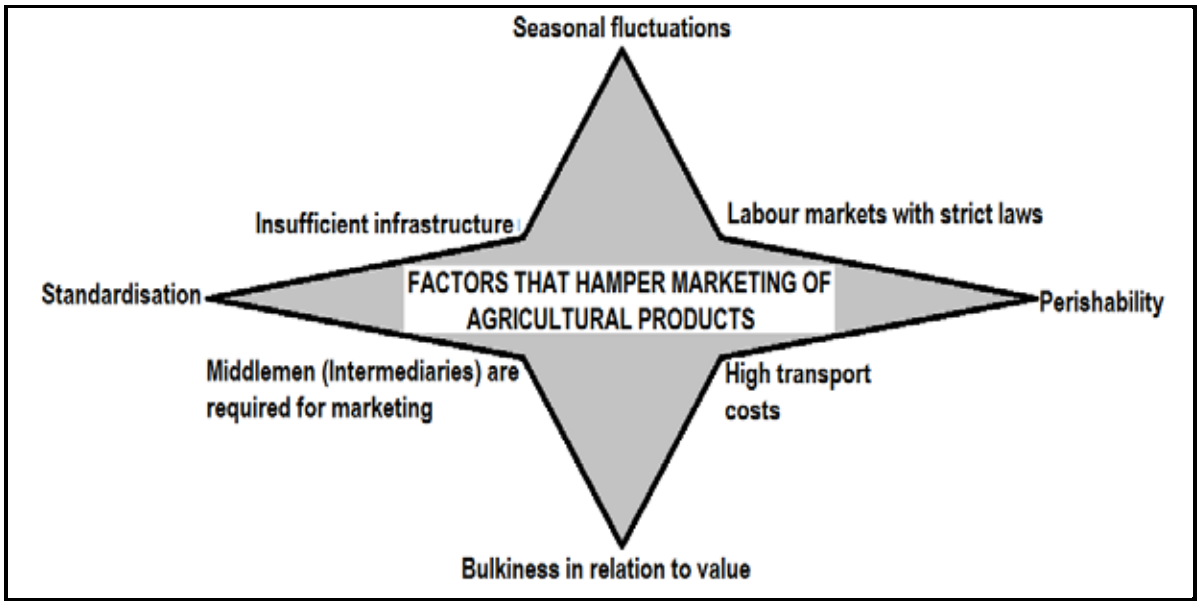


Figure 22: Summary of factors challenging marketing of agricultural products

The marketing of agricultural commodities is different from the marketing of manufactured commodities because of the special characteristics. The special characteristics which the agricultural sector possesses, and which are different from those of the manufactured sector, are:

- **Perishability of the Product**: Most farm products are perishable in nature; but the period of their perishability varies from a few hours to a few months.
- **Seasonality of Production**: Farm products are produced in a particular season; they cannot be produced throughout the year. In the harvest season, prices fall. But the supply of manufactured products can be adjusted or made uniform throughout the year. Their prices therefore remain almost the same throughout the year.
- **Bulkiness of Products**: The characteristic of bulkiness of most farm products makes their transportation and storage difficult and expensive. This fact also restricts the location of production

to somewhere near the place of consumption or processing. The price spread in bulky products is higher because of the higher costs of transportation and storage.

- **Variation in Quality of Products**: There is a large variation in the quality of agricultural products, which makes their grading and standardization somewhat difficult. There is no such problem in manufactured goods, for they are products of uniform quality.
- **Irregular Supply of Agricultural Products**: The supply of agricultural products is uncertain and irregular because of the dependence of agricultural production on natural conditions. With the varying supply, the demand remaining almost constant, the prices of agricultural products fluctuate substantially.
- **Small Size of Holdings and Scattered Production**: Farm products are produced throughout the length and breadth of the country and most of the producers are of small size. This makes the estimation of supply difficult and creates problems in marketing.
- **Processing**: Most of the farm products have to be processed before their consumption by the ultimate consumers. This processing function increases the price spread of agricultural commodities.

4.6.5.2 Ways to streamline and improve the agri-business chain

- Target correct harvest time: Fruit & vegetables at the correct stage of ripeness and grain at correct moisture content to increase their shelf life.
- Improve infrastructure: Improve infrastructure of the farm and its public roads.
- Cooling system for storage: Have cooling facilities on the farm to store fruit and vegetables during periods of over supply to market out of season.
- Have well trained graders and packers: Qualified packers with knowledge of how to handle fruit should be used in the grading process.
- Sophisticated grading machines of a high standard: to prevent damage to fruit.
- High quality packing material: prevents further damage and improves marketing price.
- Transport produce in cooler containers: to prevent spoilage.
- Marketing using internet and cell phone applications: as a marketing strategy.
- Reduce transport cost by combining loads: to meet market demand.
- Use transport companies with good track record: to prevent loss of produce because of accidents.

4.6.5.3 The role of legislation in the effective marketing of agricultural products

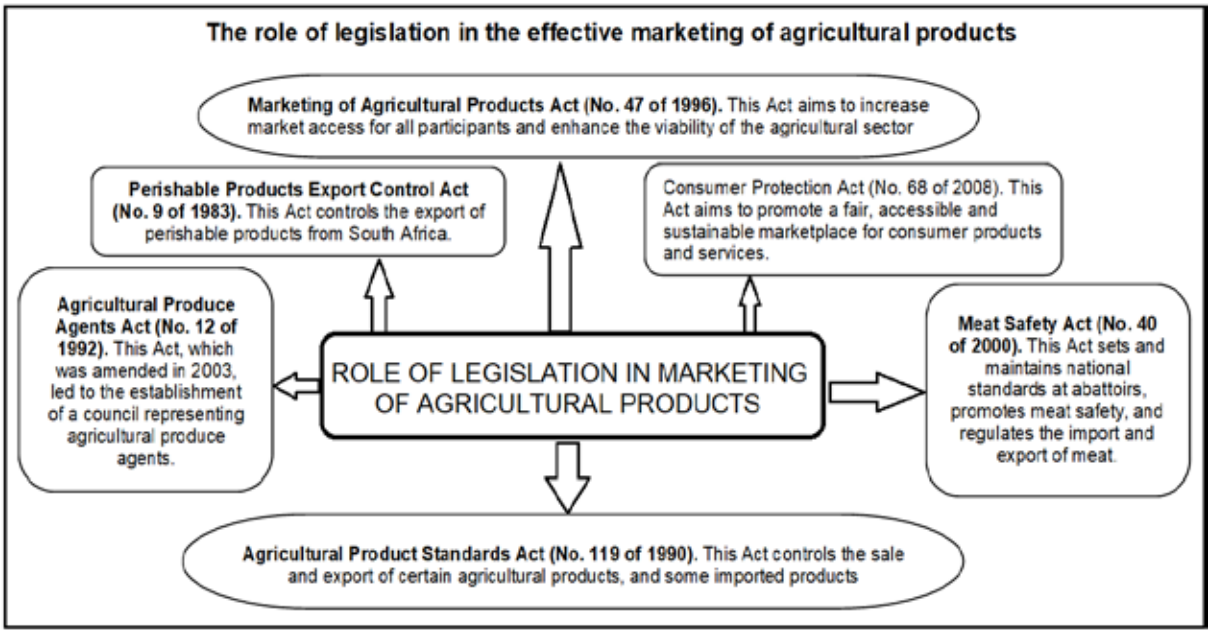


Figure 23: Legislation governing agricultural marketing

4.7 ACTIVITIES

Agricultural marketing systems

1 Various options are provided as possible answers to the following questions. Choose the most appropriate answer and write only the letter (A- D) next to the question number (1.1.1- 1.1.10) in the ANSWER BOOK. for example, 1.1.11 A

1.1 Demand is affected by …

A. weather conditions.
B. the price of the product.
C. the stability of the product.
D. the state of technology.

1.2 Free-marketing is a form of marketing in which the farmer markets his/her products …

A. as directed by control boards.
B. as he pleases.
C. with the aid of agents.
D. as per agreement by members of the society.

1.3 The form of marketing where a small segment of the market is targeted is called …

A. multi-segment marketing.
B. mass marketing.
C. niche marketing.
D. eco-labelling.

1.4 The channel of marketing in which a municipality builds a market and rents it out is called …

A. fresh produce markets.
B. farm gate sales.

1.5 C. a stock market.
D. internet marketing.

Which ONE of these is not an advantage of free-marketing?

A. Sales are for cash
B. No middlemen
C. Farmers receive payments immediately
D. Prices are controlled (5 × 2)
(10)

2. Change the underlined words in each of the following statements to make them TRUE. Write only the answer next to the question number (1.4.1-1.4.5) in the ANSWER BOOK

2.1 Packaging involves covering and labelling the product so that it appeals to the <u>marketer</u>.

2.2 The marketing chain starts after the product has been harvested and ends when the product reaches the <u>producer</u>.

2.3 Grading, packaging, cleaning and processing are part of the <u>agri-business chain</u>.

2.4 The <u>standardisation</u> of products means the sorting of products in terms of quality.

2.5 The <u>Marketing of Agricultural Product Act of 2001</u> increased the access to markets for all farmers.
(5 X 1) (5)

3.Choose a description from COLUMN B that matches the piece of legislation in COLUMN A. Write only the letter (A–H) next to the question number (6.2.1-6.2.7) in the ANSWER BOOK, for e.g. 1.2.6 K

	COLUMN A	COLUMN B
3.1	Marketing Act of 1996	A Formation of the National Agricultural Marketing Council
3.2	Advertising Standards	B Financial markets are fair and transparent
3.3	Consumer Protection Act of 2008	C Marketing license from the director of marketing
3.4	Marketing of Agricultural Products Act of 2001	D Fidelity Funds certificates
3.5	Security Services Act No 36 of 2004	E Dates and times for contacting clients
3.6	Agricultural Produce Agents Act of 1952	F Enhanced the jurisdiction of the agent's councils
3.7	Agricultural Produce Amendment Act of 2004	G Set up by the marketing communication industry
		H Proposed the introduction of inspectors (1 X 7) (7)

4. Give ONE word/term/phrase for each of the following descriptions. Write only the word/term/phrase next to the question number (1.3.1–1.3.5) in the ANSWER BOOK

4.1 A quantity of goods offered for sale at a particular price at a particular moment

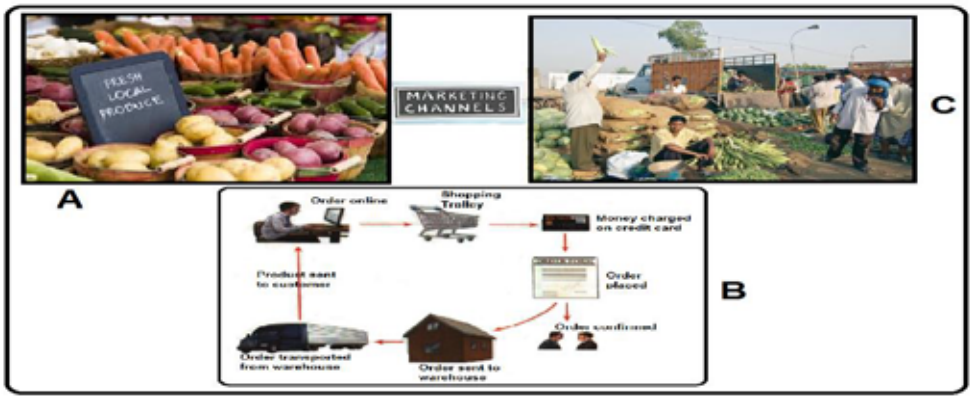
4.2 A situation in which the demand for a product is affected by price change.

4.3 Several activities that a product goes through after production until it reaches the consumer

4.4 The marketing act that protects consumers from exploitation

4.5 The form of market in which refurbished and reconditioned goods are sold. (5X2) (10)

5. The picture below represents marketing channels.



5.1 Identify the marketing channels represented by the pictures (**A**, **B** and **C**) above. (3)

5.2 Tabulate ONE advantage and ONE disadvantage for each channel identified in QUESTION 5.1 (6)

5.3 Name THREE factors that complicate the marketing of agricultural products (3)

6. Ongoing improvements to the agri-business chain are vital:

6.1 Explain how infrastructure development can improve the agri-business chain. (2)

6.2 Suggest THREE other ways to streamline and improve the agri-business chain. (3)

7. Read the passage below about co-operatives and then answer questions that follow.

Jabu Sithole wanted to establish a co-operative society. She made copies of the identity documents of her relatives and registered the co-operative society under the name Siyakhula. This society would concentrate on vegetable production and processing. She used all her money to finance the activities. Unfortunately, the business failed.

7.1 Give two reasons for the failure of Siyakhula Co-operative Society. (2)

7.2

7.3

7.4 Suggest THREE principles that should be applied in the functioning of a co-operative.(3)

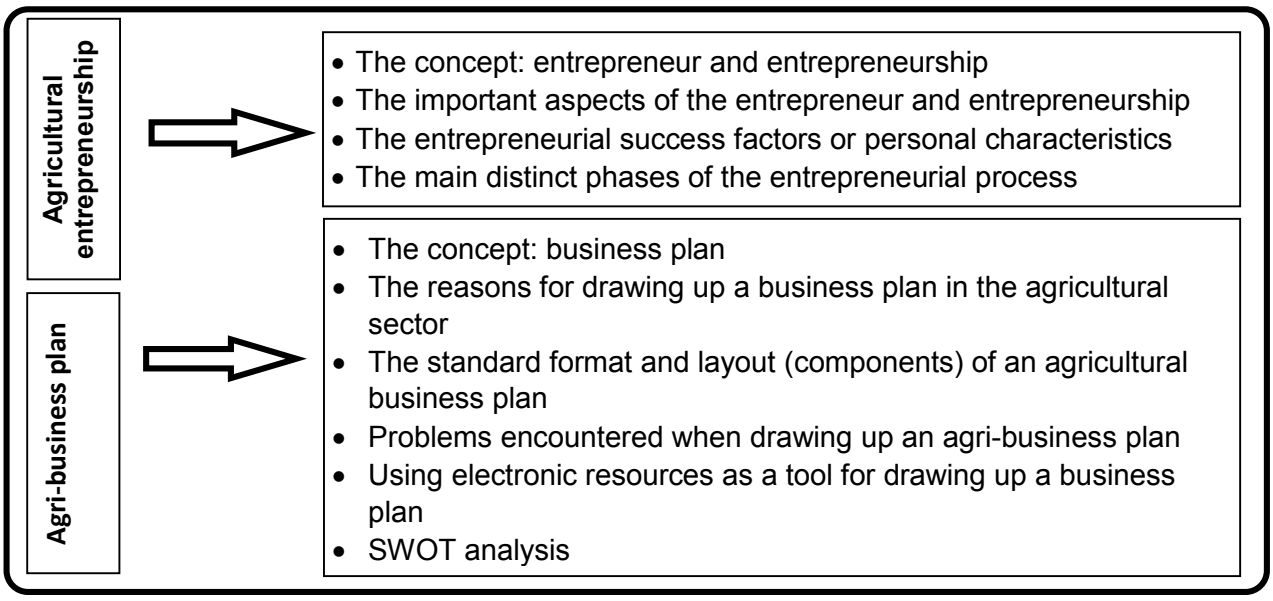
Describe how directors of a co-operative society are selected.
(1)

Give the term used to describe working together and sharing among co-operative society members.
(2)

TOTAL: 25 MARKS

4.8 Agricultural entrepreneurship

Learning objectives:
At the end of this unit the learners should be able to demonstrate knowledge of the following content:



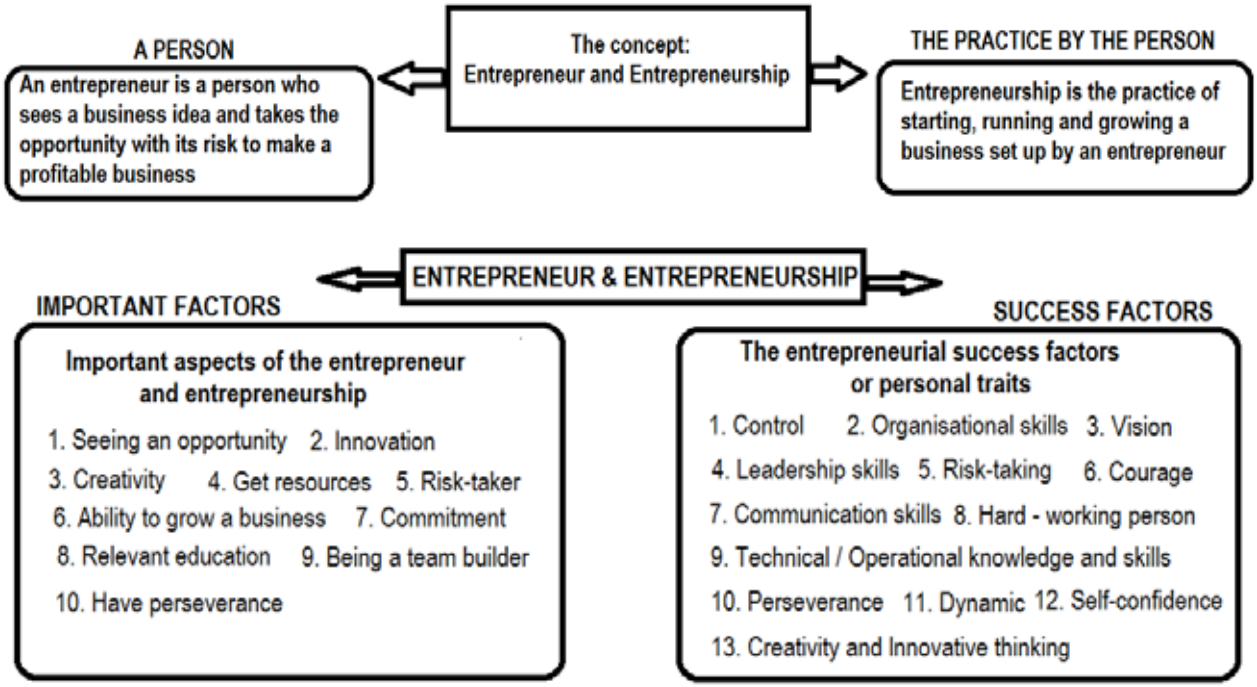
4.8.1 Terminology

CONCEPT	DEFINITION
Marketing research	involves the collection about the customers, the market and competitors in order to design an effective marketing strategy.
Standardization	standardization refers to the process of setting up basic measures or standards to which the products must conform
Grading	grading is the process of sorting individual units of a product into well-defined classes or grades of quality.
Branding	creating a name, symbol or design that identifies and differentiates a product from other products.
Business plan	is a written document that describes in detail how a business is going to achieve its goals and objectives.
Marketing research	involves the collection about the customers, the market and competitors in order to design an effective marketing strategy.

SWOT analysis	a study undertaken by an organization to identify its internal strengths and weaknesses, as well as its external opportunities and threats

4.8.2 Entrepreneurship and business planning:

4.8.2.1 Agricultural entrepreneurship



4.8.2.2 The main distinct phases of the entrepreneurial process

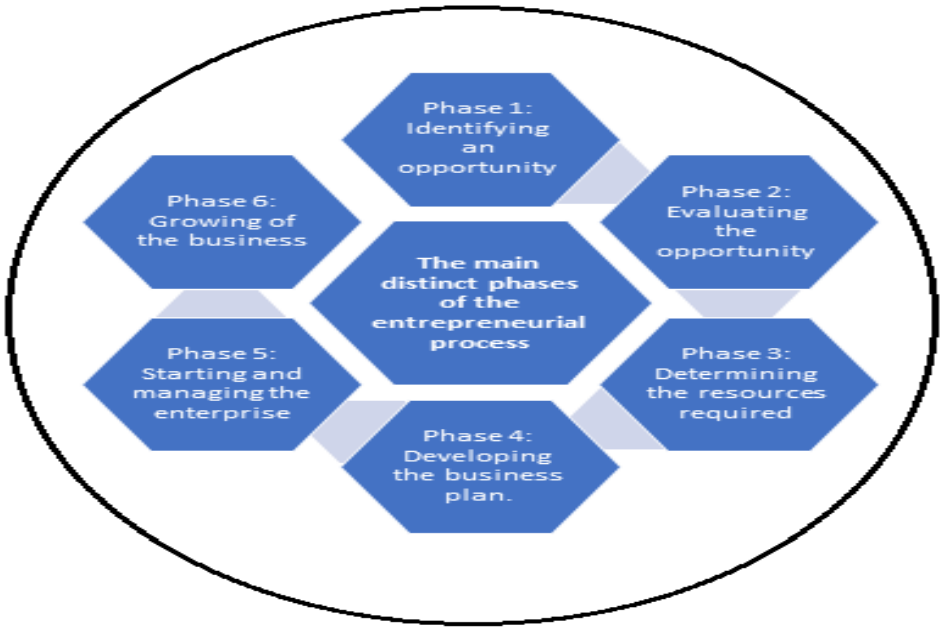


Figure 24: Summary of the phases of entrepreneurial process

4.8.3 Agri-business plan

The concept: business plan

- It is a document that describes how a business will operate. It also states the business goals, the reasons they can be achieved and the plan for how to achieve them.

Reasons for drawing up a business plan in agricultural sector:	
	1. To clearly document your business idea 2. To state your business vision and mission 3. To state the operational plan of the business 4. Financial details of the proposed farming business 5. Capital needs and funding strategy 6. Costs and income projections 7. Production information 8. Suitable marketing strategies 9. Helps the manager to identify opportunities 10. Provides information about internal and external environment

4.8.3.1 The standard format and layout (components) of an agricultural business plan

Title page	Includes business name, logo, period covered by the plan, date, contact people details,
Table of contents	List of what to find from each page
General overview of the business (executive summary)	• It briefly outlines each component of the plan in about two pages. • It must be interesting & well presented to catch the reader interest to read more about the business idea. • The type of business and form of ownership, including how it will be registered • Location of the business, mission statement, operational plan of the business, and how the business will grow and develop • Expertise required to run the business, and an analysis of the business strengths, weaknesses, opportunities and threats.
Marketing plan and production plan	• Market information, main target market for the product • Consider the needs of the main target market.

	• Describe how your product or service will meet their needs. • How will you tell them about your products (your marketing plan)? • How will you promote the products (your advertising plan)? • What market research have you done and what were the results? • Products to be produced, define your products or services and their position in the market. • You need to show that you know about industry trends and your market. • Show how your product matches or fits with the market definition. • What is the estimated price of the product? • Show your product development schedule and distribution • Indicate the sales channels for the distribution of the product. • Any partnership with the distributors should be indicated. • Competition, nature and the number of competitors should be mentioned. • Differentiate between your product and that of the competitors and how your product will have a competitive advantage.
Staff (human resources) details	• Management and staff details, management team, background and experience of management, composition of the Board of Directors • Labour force, number of workers employed, salaries and wages of workers, qualifications and skills required, the specialists in the farming business (but the workers can also be trained) • Operational or work plans with regard to labour (a list of activities with the time frames for each).
Financial details	• Valuation of present farming business • Current balance sheet, amount of capital required to start the business, how the available capital will be used • Projected profit and loss per year, projected cash flow, loan repayments per month • Equipment and materials, who will do stock control and how it will be kept • How investors will obtain high returns • How the product or service will be priced.

4.8.3.2 Problems encountered when drawing up an agri-business plan

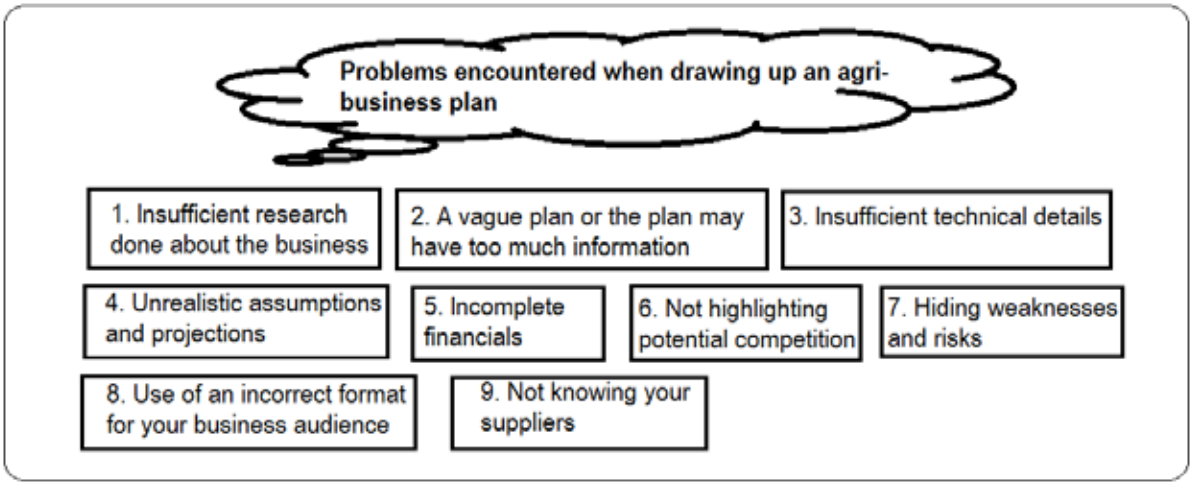


Figure 25: Summary of possible challenges when designing agri-business plan

Solutions when drawing up and implementing an agribusiness plan

- Using electronic resources as a tool for drawing up a business plan. It is important to complete the templates using correct data to produce a realistic business plan
  - One can download a template for a business plan from the Internet.
  - These are usually easy to use, and the entrepreneur just needs to fill in the blank space
  - The templates contain the key information needed in a business plan
  - This is convenient, and it saves the entrepreneur's time and money

4.9.4 SWOT analysis (also called situational analysis)

- SWOT analysis is a study undertaken by an organization to identify its internal strengths and

weaknesses, as well as its external opportunities and threats

- It is an acronym for **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats

INTERNAL FACTORS	**S (for Strengths of a business):** • The factors contributing to farming business' success. • internal factors which the entrepreneur can control • E.g. reputation, skills and labour experience, capital, machinery, equipment, credit, established marketing channels, modern technology, etc.	**O (for farm business Opportunities):** • External motivating factors that are needed for a farming business to prosper – its full potential to perform in the market • It is crucial to put a time-frame on the opportunity identified. • E.g. market growth, new trends, lifestyle changes, provision of supplies needed for various traditions.	**EXTERNAL FACTORS**
	W (for Weaknesses of the business): • Factors within the business preventing your success, but which you can improve for the benefit of the business. • Good entrepreneurs can change weaknesses to strengths for the business • E.g. lack of technology, poor location of the business, limited resources, lack of skills, undercapitalisation, etc.	**T (for Threats to the farming business):** • The external factors that can put your farming business at risk. • Contingency plans will be required to address all threats identified with timeframes. • E.g. price increases by suppliers, competition, a shift in consumer behaviour, economic down turns, introduction of more advanced technology	

4.10 ACTIVITIES

Agricultural entrepreneurship and business planning

1. Various options are provided as possible answers to the following questions. Choose the most appropriate answer and write only the letter (A- D) next to the question number (1.1.1- 1.1.10) in the ANSWER BOOK. for example, 1.1.11 A

1.1 A business plan is set up to provide all planning information needed for a specific farming operation. Which ONE of the following aspects is NOT normally part of a business plan?

A. Farm budget
B. Marketing plan
C. Soil survey detail
D. Details of employees.

1.2 In an agricultural business, a … is an entrepreneur.

A. production factor
B. capital
C. labourer
D. farmer

1.3 The characteristic of an entrepreneur that has a bearing on strategic management is:

A. team builder
B. visionary
C. technically knowledgeable
D. independent thinker.

1.4

The indicates a condition where the quantity of a product required by consumers, is exactly equal to the quantity which producers wish to sell.

A. market niche
B. market equilibrium
C. market penetration
D. market value

1.5 ONE of the following factors would influence the supply as well as the demand for a product:

A. The possibility of increasing the supply of products
B. The range of products available
C. The price of the products
D. The attitude and values of consumers (5 X 2) (10)

2. Choose a description from COLUMN B that matches the piece of legislation in COLUMN A. Write only the letter (A–H) next to the question number (6.2.1-6.2.7) in the ANSWER BOOK, for e.g. 1.2.6 K

Column A	Column B
2.1 Start-up capital	A. Novel idea
2.2 Entrepreneur	B. Board of Directors
2.3 Business plan	C. Current balance sheet
2.4 Management team	D. How the business operates
2.5 Financial details of a business plan	E. Takes a long time
	F. Fundraising
	G. Market analysis data (5 X 1) (5)

3. Read the following case study of a potato farmer in Limpopo province, and then answer questions that follow:

SUCCESSFUL BLACK COMMERCIAL FARMER FUELLED BY POTATO PASSION: MR SOLLY RATJOMANE

Solly is a successful black commercial potato producer in the Limpopo Province. The 56-year old farmer owns Marinaspruit, a 1 430-ha farm near Dendron. He has been producing potatoes for the last 26 years and has continued to reap the rewards of being in the potato industry. The key to his prosperity, according to him, is hard work, commitment, determination, risk-taking and never shying away from asking questions from knowledgeable industry advisors and producers. Solly is the only wholly owned successful black commercial potato farmer in Limpopo Province. Under his brand name, "Solly's Boerdery", he supplies fresh produce markets and wholesalers in South Africa with potatoes and also exports his crop to Botswana. Informal buyers make 2% of the market and normally they make arrangements with Solly to collect potatoes at the farm in order to supply hawkers and spaza shops. The farm makes a significant contribution to job creation, having 25 permanent workers. During the potato harvest period, an additional 66 women are also employed by the business. Solly's two sons help him to manage the farms. The eldest son manages the 446 ha of leased land where potatoes and livestock are produced. The youngest helps to manage the 1 430 ha farm. Solly's sons introduced him to the idea of selling his produce through internet.

Farmer's Weekly (June 2016)

3.1 Solly Ratjomane is an entrepreneur. Support the statement. (2)

3.2 Deduce FOUR entrepreneurial success factors displayed by the farmer above. (4)

3.3 Identify a sentence that shows that Solly had good interpersonal and communication skills. (1)

3.4 Name the FOUR different components of SWOT analysis. (4)

3.5 Supply one example for each aspect mentioned above in QUESTION in 3.4 based on the case study above (4)

3.6 Name FOUR marketing channels related to a free marketing system. (4)

4. Read the following case study of a potato farmer in Limpopo province, and then answer questions that follow:

Every business should have a business plan, and it is hard work, many people spend a year or more writing their plan. But the hard part is developing a coherent picture of the business that makes sense, appealing to others and provides a reasonable road map for the future. Unfortunately, even though many of the underlying businesses are viable, the vast majority of plans are hardly worth the paper they're printed on.

4.1 State THREE reasons for an entrepreneur to draw up a business plan (3)

4.2 Most "bad" business plans share one or more common problems. Suggest THREE problems encountered when drawing up a business plan (3)

TOTAL: 25 MARKS

ACTIVITIES: SUGGESTED ANSWERS

4.3 ACTIVITIES

Agricultural marketing, price determination, demand and supply

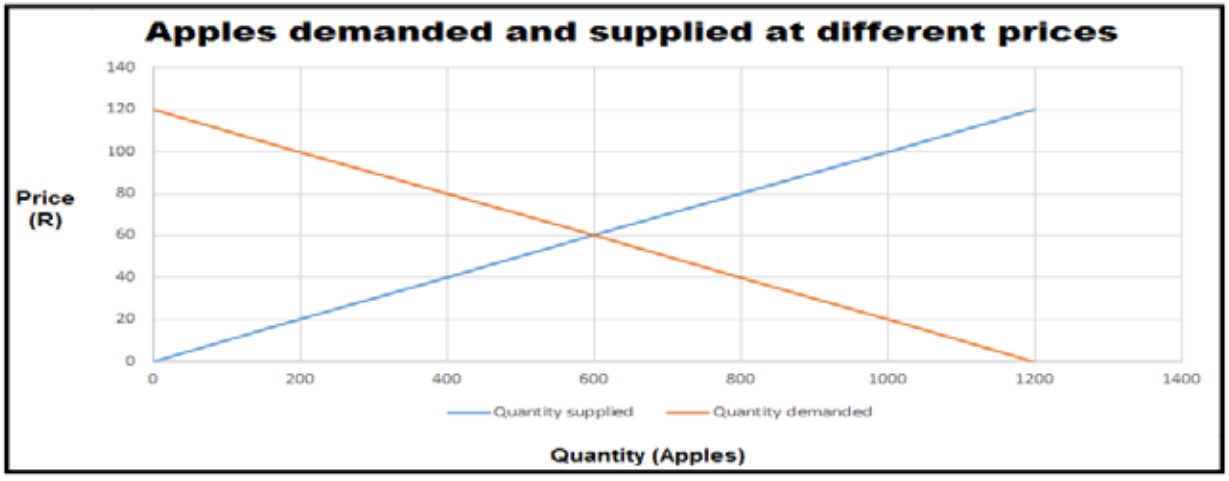
1. **Multiple choice question**				2. **Match column A and B**			
1.1	**B** √√	1.6	**D** √√	2.1	**J** √	2.6	**C** √
1.2	**C** √√	1.7	**B** √√	2.2	**I** √	2.7	**F** √
1.3	**C** √√	1.8	**A** √√	2.3	**G** √	2.8	**E** √
1.4	**A** √√	1.9	**D** √√	2.4	**A** √	2.9	**B** √
1.5	**D** √√	1.10	**C** √√	2.5	**H** √	2.10	**D** √
			(10 X 2) (20)				(10 X 1) (10)

3. **Differentiation between marketing and selling**:

MARKETING	SELLING
• Profit orientated	• Product orientated √
• Long terms plans are made	• Short-term objective is to sell the product √
• Emphasis on satisfying consumer wants	• Consumer needs and satisfaction neglected √
• Various departments work together	• Sales department does not work with others √
• Technological innovation is important	• Reduced costs for maximum sales and profit √ (5)

4. **Supply and demand of apples:**

4.1 Graph



Marking Checklist for the graph:

Criteria	YES	NO
Correct type of graph – line graph	1√	0
Suitable caption / heading / title	1√	0
Y-axis –correct label (Price)	1√	0
X-axis –correct label (Quantity)	1√	0
Units (Rand)	1√	0
Accuracy/correct plotting	1√	0

(6)

4.2 **Equilibrium price of apples:**
R60,00√/ 2kg bag of apples √ (2)

4.3 **Price of apples:**
R100,00√ / 2kg bag of apples √ (2)

4.4 **Deduction on availability and price of apples:**

- Demand doubles at price R20.00: 1000 X 2 = 2 000√
- Supply increases by 45%: 45/100 X 200 = 90 √
- 200 (original supply) + 90 (45% supply increase) = 290√
- There will be shortage of apples/demand is above the supply√
- The price will increase√ (5)

4.5 **Advantages of processing:**

- Improves the quality of a product (value adding) √
- Increases the shelf life√
- Makes the product more appealing to the customer√
- Solves the oversupply problem and reduces wastage√
- Enhances food security√
- Creates job opportunities for low-income groups√ (Any 4) (4)

5. **Marketing channels**

5.1 Large supermarkets√ (1)

5.2 **Reasons to support answer in QUESTION 5.1:**

- Supply to large supermarkets is guaranteed√
- Large supermarkets are built in areas where there is high demand√
- There is more profit√ (Any 2) (2)

5.3 **Market – highest security risk:**

- Local people who buy directly from the farm√ (1)

5.4 **Justification:**

No guarantee√ of demand√ (2)

TOTAL: 60 MARKS

4.5 ACTIVITIES

Market equilibrium:

1. Terminology:

1.1 A cartel √
1.2 Monopoly √
1.3 Market equilibrium √
1.4 Ceiling price √
1.5 Niche marketing √
1.6 Mass marketing √
1.7 Monopsony √
1.8 Multi-segment marketing √
1.9 Market intelligence √
1.10 Floor price √ (10 X 2) (20)

2.

2.1 Market equilibrium / The quantity of goods producers and consumers are willing to trade at different prices √ (1)

2.2 (a) A √
(b) D √
(c) E √
(d) C √
(e) B √ (5)

3

3.1 (a) Graph **A** √
(b) Graph **C**√
(c) Graph **B** √ (3)

3.2 (a) Niche marketing √
(b) Mass marketing √
(c) Multi-segment marketing √ (3)

4. (a) Price – fixing / Fixed√ prices √ (2)

(b) Advantages of the phenomenon:

- Increases sale volume, √
- Saves time √
- Sets the right price the first time. √
- Buyers can determine an exact budget in advance √
- Buyers become aware of the total cost before the project even begins √
  (Any 4) (4)

5. Eco-labelling
   Eco-labelling is a method of labelling√ that communicates information, educates and increases consumer awareness on the impact of a product on the environment√. (2)

TOTAL: 40 MARKS

4.7 ACTIVITIES

Agricultural marketing systems

1. Multiple choice questions:
   1.1 B √√
   1.2 B √√
   1.3 C √√
   1.4 A √√
   1.5 D √√ (2 X 5) (10)

2. Replacement of terms:
   2.1 Consumer √
   2.2 Retailer √
   2.3 Agri-marketing chain √
   2.4 Grading √
   2.5 Marketing Act of 1996 √ (5)

3. Match column A and column B question:
   3.1 A √
   3.2 G √
   3.3 E √
   3.4 C √
   3.5 B √
   3.6 D √
   3.7 F √ (7 X 1) (7)

4. Terminology:
   4.1 Supply √
   4.2 Price elasticity √
   4.3 Marketing chain √
   4.4 Consumer Protection Act √
   4.5 Green market. √ (10)

5 Marketing channels:
5.1 **A:** Fresh Produce√ **B:** Internet marketing√ **C:** Farm gate marketing√ (3)

5.2 Tabulation:

Channel	Advantages	Disadvantages
Fresh Produce	• Farmers can take advantage of higher prices in times of short supply. √ • The market can sell large quantities of the farmers' produce. √ • The farmer can employ the services of an agent to perform the task of marketing. √	• Prices fluctuate. √ • Markets far from the point of production√ • Harvesting time is critical to the success of the crop√ • Produce must conform to accepted grade and packaging standards. √ • Higher marketing costs√
Internet marketing	• It is very fast. √ • The cost is relatively low√ • 24 hours a day, √	• Attracting customers may not be easy√ • Online marketing is not free. √

		• Deliver is direct√ • This form of business is not capital intensive√ • It can reach a global audience. √	• Not all consumers shop online. √ • Many people prefer the live interaction√ • Visitors refuse to use their credit cards√ • There is a lot of competition √ • The possibility of fraud is a risk. √
	Farm gate	• Producers may obtain product market price without marketing costs. √ • Product will be fresh√ • Products are sold at a low price. √ • There are no transport costs. √ • Better suited to smaller scale farmer. √ • Farmer can sell produce him/herself√	• The farmer will have to accept the local price for his or her product. √ • The farmer will not, necessarily be wen located to reach customers. √ (Any 2 X 3) (6)
	5.3 Factors that hamper marketing of agricultural products: ● Seasonal fluctuation√ ● Perishability√● Standardisation√ ● Ineffective control over production√ ● Long-term production√ ● Wide product distribution√ ● Locality-restricted production√ ● Intermediaries (middlemen) are required for marketing√ (Any 3) (3)		
6.	6.1 Adequate infrastructure: • Infrastructure will ensure that there is enough space√ and shelter for storage and processing√. • Additional roads will make it easier to transport agricultural goods from the production site to the markets√. • Suitable shelters for storage must be built will enable products to last longer√. • These aspects work together to make the agri-business chain more effective√. (Any 2) (2)		
	6.2 Ways to streamline and improve the agri-business chain • Target correct harvest time √ • Improve infrastructure: √ • Cooling system for storage √ • Have well trained graders and packers √ • Sophisticated grading machines of a high standard √ • High quality packing material √ • Transport produce in cooler containers √ • Marketing using internet and cell phone applications √ • Reduce transport cost by combining loads√ • Use transport companies with good track record √ (Any 3) (3)		

1. Multiple choice questions:

1.1 C√√
1.2 D√√
1.3 B√√
1.4 B√√

2. Match the items:

2.1 F√
2.2 A√
2.3 D√
2.4 B√
2.5 C√ (1 X 5) (5)

1.5 C√√ (2 X 5)
(10)

3. 3.1 Solly saw an opportunity with its risk√ in the potato industry to make a profitable (2)
business

3.2 Hard work√, commitment√, determination√, risk-taking√ and never shying away (4)
from asking questions from knowledgeable industry advisors and producers√

3.3 Never shying away from asking questions from asking questions from knowledgeable industry advisors and producers√ from knowledgeable industry
advisors and producers from asking questions from knowledgeable industry (2)
advisors and producers√

3.4 Strengths, √ Weaknesses, √ Opportunities√ and Threats √ (4)

3.5 SWOT analysis for Soll's business:

Strengths:

- Solly is a successful black commercial potato producer in the Limpopo Province√
- Owns Marinaspruit, a 1 430-ha farm near Dendron√
- He has been producing potatoes for the last 26 years√
- hard work, commitment, determination, risk-taking and never shying away from asking questions from knowledgeable industry advisors and producers√
- Solly is the only wholly owned successful black commercial potato farmer in Limpopo Province√
- His brand name, "Solly's Boerdery", √
- He supplies fresh produce markets and wholesalers in South Africa√
- exports his crop to Botswana√
- Informal buyers make 2% of the market√
- The farm makes a significant contribution to job creation, having 25 permanent workers√
- During the potato harvest period, an additional 66 women are also employed by the business√
- Solly's two sons help him to manage the farms√

Weaknesses:

- The 56-year old farmer√

Opportunities:

- exports his crop to Botswana√
- Informal buyers' market can be increased√
- Solly's sons introduced him to the idea of selling his produce through internet. √

Threats:

- Export duties√
- Inflation √

- Diseases, √
- Drought√ (4)

3.6 Farmgate√, Fresh produce√, stock sales√, Direct marketing√ and Internet marketing √ (4)

(Any 4)

4. 4.1 To document your novel idea, √
   - To calculate costs, √
   - To advertise the farming business, √
   - To attract partner(s) to your farming business and to assess and improve the plan√ (3)

   4.2 They may not know what to write. √
   - They may not know how to structure the content. √
   - It might take a long time to write. √
   - It might contain too much detail. √
   - They might over-estimate and be overly optimistic in terms of figures. √
   - It might be difficult to translate a novel thought into a business plan. √ (3)

Chapter 5

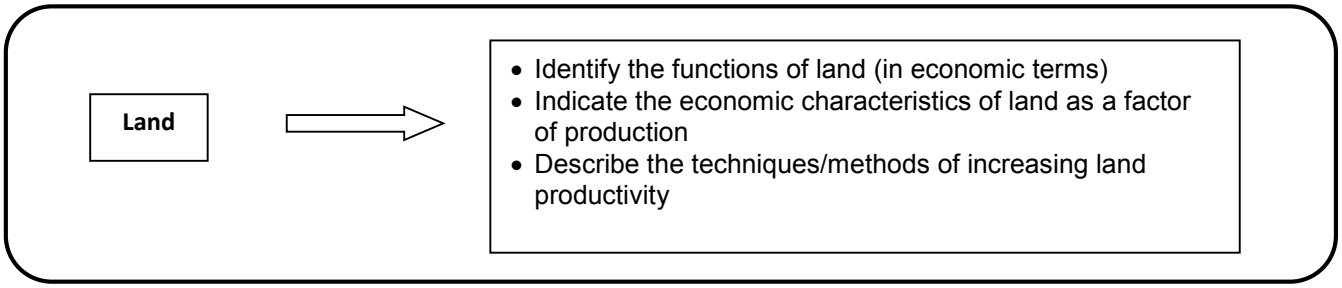
AGRICULTURAL ECONOMICS: PRODUCTION FACTORS

There are FOUR production factors in Agriculture. These are land, labour, capital and management.

5.1 Land

Learning objectives:

At the end of this unit the learners should be able to demonstrate knowledge of the following content:



Terminology

CONCEPTS	DEFINITION
Land	A piece of ground that can be used for building or agricultural production
Law of diminishing returns	If there is an increase of the input in the production process, the output will increase but a point will be reached where further increase in the input will result in the decline of the output.
Soil	It is an area of land with its inherent characteristics, including its resources and characteristics.

Functions of land

- Provides space / medium for plant to grow
- Source/Supplies raw materials.
- Supplies minerals
- Provides food

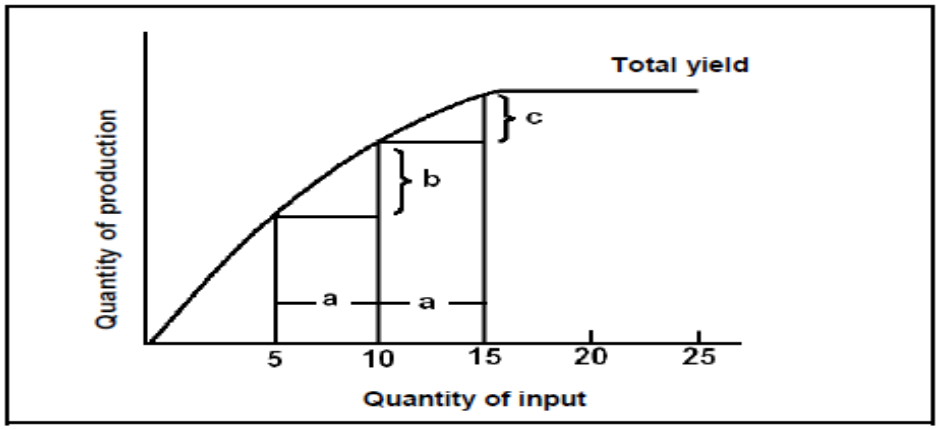
Economic Characteristics of land

- Arable land is limited
- Land is indestructible but degradable
- Land is restricted for certain types of plants/differences in production capacity
- Land is found in a specific environment

- Subject to the law of diminishing returns
- Soil is durable

Law of diminishing returns

The yield capacity of land is mainly determined by the physical characteristics of the soil. It can be increased to a certain limit by increasing capital and labour inputs per unit or by means of improved technology. A point will be reached where production no longer increases with increased units of input. The graph below shows that a point is reached where the yield per added factor of production will start to decline.



Techniques/methods of increasing land productivity

- Adaptation of production systems to scientific methods
- Water provision /Supply water
- Consolidation of uneconomical farm units
- Utilisation of improved agricultural methods

ACTIVITY

1. Various options are provided as possible answers to the following questions. Choose the answers and write down a letter (A-E) next to the question number (1.1.1-1.1.10)

1.1 The following is not a part of the four production factors in Agricultural Sciences on the answer book.

a) Land
b) Labour
c) Capital
d) Management
e) Demand

1.2 One good thing about land is that ….
a) Land is subjected to the law of diminishing returns
b) Soil is durable
c) Arable land in South Africa is limited
d) Climatic condition of land can be changed
e) Soil is degradable

1.3 Method of increasing land productivity includes…
a) Consolidation of uneconomical farming units.
b) Giving land to everyone
c) Allow mixed farming
d) Bring back the land tuner system
e) Grow draught resistance crops.

1.4 The type of labour whose job is only there throughout the year.
a) Seasonal labour
b) Part time labour
c) Permanent labour
d) Casual labour
e) Skilled and unskilled labour.

1.5 Method of increasing labour productivity

a) Improving economic conditions of workers
b) Making workers to work long hours
c) Appointing workers based on gender
d) Working without supervision
e) Allowing workers to work as they please.

1.6 Problem associated with capital is…
a) High rate of interest
b) Production
c) Saving
d) Credit
e) Cash flow

2. Answer the following questions on land.

2.1 Write down FOUR functions of land as a production factor (4)

2.2 Write down THREE techniques/methods of increasing land productivity (3))

3. The table below shows the amount of fertilizer applied and the quantity of potatoes produced on piece of land.

INPUT (BAGS FERTILZER)	YIELD (BAGS OF POTATOES)
5	10
10	20
15	35
20	35
25	36
30	35

3.1 Identify the economic characteristics shown by the data in the table above. (1)

3.2 Deduce the relationship between fertilizer input and the potato yield. (4)

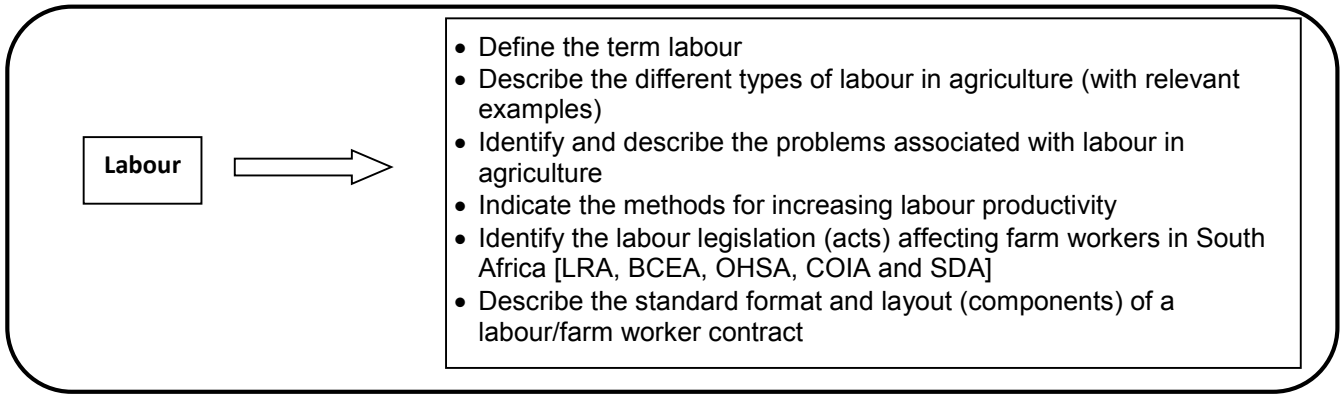
3.3 Draw a line graph based on the data in table 2.5 above (6)

3.4 Define the Law of diminishing returns (3)

5.2 Labour

Learning objectives

At the end of this unit the learners should be able to demonstrate knowledge of the following content:



Terminology

CONCEPTS	DEFINITION
Casual labour	Labour that works less than 24 hours per month
Contract	A formal and legal binding agreement between the employer and the employee.
Health and disability Insurance	It is the type of insurance where workers are insured against disability or sickness.
Labour	Physical and mental endeavour which is employed in the expectation of remuneration/ physical or mental process which is applied in the work place with the expectation of being paid or remunerated a wage or a salary.
People/human risks	This takes place when the skill is lost due to death, disability, divorce, illness etc.
Permanent labour	A labour whose job is there throughout the year. They are full time workers.
Planning	A process that involves deciding what to do, when to it how to do it and who is going to do it/ a mental process where a manager determines what needs to be done by whom and when.
Salary	Remuneration for skilled workers who are permanent workers
Skilled labour	Labour that knows how to do the job, they may be permanent or temporary
Temporary labour	Labour whose job is only during a certain period of the year
Unskilled labour	Labour not specialised on how to do the job, may be permanent or temporary
Wage	Remuneration for unskilled workers who are usually temporary

5.2.1 Types of labour and problems associated with labour

Types of labour and their definitions

There are different types of labour with different functions.

- **Casual labour:** Type of labour that works less than 24 hours per month.
- **Permanent labour:** Type of a labour whose job is there throughout the year. They are full time workers.
- **Temporary labour:** Type of labour whose job is only during a certain period of the year e.g. shearing of sheep.
- **Seasonal labour:** Type of labour that is only available during specific season e.g. harvesting time.
- **Part time labour:** They work mostly less than the ordinary hours for the sector e.g. mechanic, or mornings only.

- **Skilled labour:** Type of labour that knows how to do the job, they may be permanent or temporary e.g. mechanic, engineer etc.
- **Semi-skilled:** They do have a certain level of training in most cases but not formally educated e.g. driver
- **Unskilled labour:** Type of labour who do not have any formal skills or training e.g. sheep shearing.

Problems associated with labour in agriculture

- Scarcity of labour
- Lack of skills
- Lack of training
- HIV / AIDS
- Productivity competition with industry

IMPACT OF HIV / AIDS AND THE WAYS TO ADDRESS THEM

HIV AND AIDS IMPACT ON PRODUTIVITY

- Absenteeism of workers which leads to decline in productivity
- Difficult to plan due to absenteeism
- Loss of skills and experience
- Agricultural operations cannot be completed on time due to labour shortages

ADDRESSING HIV and AIDS

- Education awareness and training
- Provide access to condoms
- Supplying medication like anti-retroviral drugs
- Discouraging multi sexual partners
- Have support groups for supporting the affected workers

Methods for increasing labour productivity

- Improve economic conditions of workers : good salaries, medical aid and pension
- Improve on educational matters e.g. training
- Improve on living and working conditions e.g. proper housing.
- Improve on addressing HIV and AIDS e.g. awareness and providing condoms.
- Improve on motivating workers e.g. giving them bonuses and paid leave

Labour legislation Act that affect workers in S.A

There are labour legislation Acts in South Africa. These are:

- Labour relations Act No. 66 of 1995: Responsible for right of labours to strike, stay- ins etc.
- Basic Conditions of Employment Act No. 75 of 1997: Responsible for fair labour practice.
- Occupational Health and Safety Act No. 85 of 1993: Responsible for safety in the work place.
- Compensation for Occupational Injuries and Diseases Act No. 85 of 1993: Responsible for regulating the health and safety of workers.
- Skills development Act No. 97 of 1998: Responsible for workers skills through training.

Layout/Components of farm worker contract.

A contract is a formal and legal binding agreement between the employer and the employee.
When the farm worker starts working, a contract must be entered into wherein there must be compliance with the Basic Conditions of Employment Act

- The contract must include the details of the employee and the employer.

- The contract must include the agreement on wages
- The contract must include the number of hours per day.

ACTIVITY

1.1 Explain how the farmer will increase labour motivation and productivity under the following headings:

a) Training:
b) Social conditions
c) Economic conditions (6)

1.2 Differentiate the following type Agriculture.

a) Casual labour
b) Seasonal labour
c) Skilled labour (6)

2.Write down FOUR impact of HIV / AIDS and the ways to address them (8)

3. Describe the functions of the following labour legislation Acts in South Africa.

3.1 Labour relations Act No 66 of 1997 (2)
3.2 Occupational Health and Safety Act No. 85 of 1993 (2)
3.3 Compensation for Occupational Injuries and Diseases Act No.1993 (2)

4. Below is an extract from a contract of employment between a farmer and a farm worker:

CONTRACT OF EMPLOYMENT

1. **Particulars of employer:** NEMUKULA
2. **Name:** MUTANGWE
3. **ID:** 5971909396990
4. **Particulars of employee:**
   4.1 Name: MUDILIZI
   4.2 ID: 650823765935
5. **Job title:** SPRAY OPERATOR
6. **Duration of contract:** 1 February 2018 to retirement
7. **Mode of payment:** MONTHLY SALARY BY CHEQUE
8. **Amount:** R3 500
9. **Terms of employment:**
   9.1 Working hours: 07:00 to 17:00
   9.2 Leave: One week paid leave per annum
10. **Protective clothing:** None

Signature:…… Date: 01/02/2018 at: MUTANGWE FARM
(employee – farm worker)

Signature:…… Date: 01/02/2018 at: MUTANGWE
(employer – farmer owner)

4.1 Indicate the type of farm worker who signed the contract above. Justify your answer. (3)

4.2 Select an item from the contract of employment above that relates to the following labour legislation:

(a) Basic Conditions of Employment Act, 1997 (Act 75 of 1997) (1)

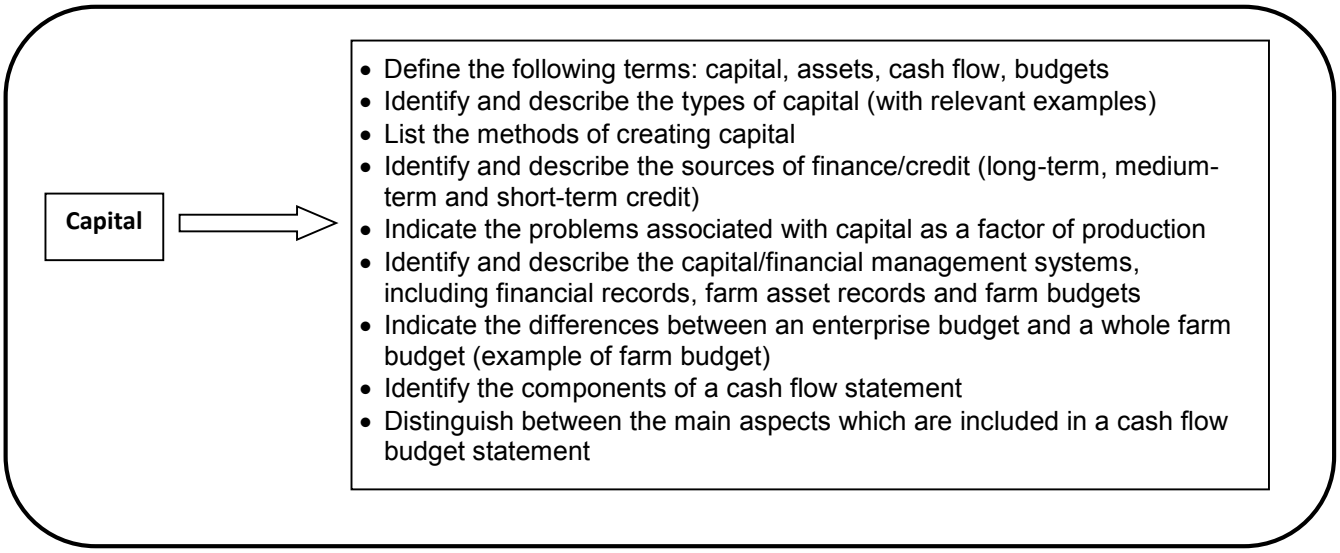
(b) Occupational Health and Safety Act, 1993 (Act 85 of 1993) (1)

4.3 Identify an aspect in the contract of employment that contributes to the problem of the scarcity of farm labour. Motivate your answer. (2)

5.3 Capital

Learning objectives:

At the end of this unit the learners should be able to demonstrate knowledge of the following content:



Terminology

CONCEPTS	DEFINITION
Assets	Money or assets used in the production process / a financial that shows how income will be generated and how it will be spent.
Balance sheet	It is a sheet that summarises the assets and liabilities of a business
Budget	an estimate/projection of costs, revenue (income and expenditure) regarding foreseeable situations/ financial that shows how income will be generated and how it will be spent.
Capital	money or equipment that are used for production purposes./ Wealth accumulated through savings that is employed in the production process
Cash analysis book	type of a book used to record money coming to the farm and money going out of the farm
Cash flow	It is the movement of money/cash in or outside the business enterprise
Cash flow budget statement	is the budget for the whole farm and all the enterprises in the farm.
Cash flow statement	It shows the money coming and going out of a business over a period of time/ involves receipts and payments that took place over a given period of time.
Closing balance	It is the amount remaining in an account at the end of the accounting period.
Credit	A loan made from a financial institution e.g. bank.
Enterprise budget	Is the budget that is intended for a particular farm enterprise
Expenditure	Payment made for goods and services
Equity scheme	Is a financial arrangement between the land reform beneficiaries and labourers to buy shares in a farm.
Financial risks	The risks that takes place when the manager is unable to pay the debt on time.
Fixed assets	Are assets that are of a long term in nature like such as land and buildings and cannot be easily changed into cash.
Fixed Capital	Type of capital invested over a long period e.g. buildings, land, dam etc.
Fixed improvements	Are immovable assets such as dams, silos and buildings
Income	Money that an individual or business receives in exchange of the sale of goods or exchange of for providing a good or service
Income statement	It is a summary of all income and expenditure in a financial statement.
Inventory	It is a record keeping system where assets are recorded.
Liabilities	It is the farm /company's financial debt, or money owned./ all the things that the farmer has to pay.
Long term credit	A credit in which the repayment takes a longer period and is used to purchase land and fixed improvements.

Medium Term credit	Credit in which the repayment takes place over a short time and used to buy for movable assets.
Movable capital	Type of capital goods invested for a medium term like livestock and machinery that are used in the production processes
Net worth	It is defined as assets minus the liabilities.
Opening balance	It is the amount of money in a bank account when it is opened/ the amount of money that is available in the bank when starting a month or a year.
Overcapitalisation	It is when more than required capital is employed in a business
Profit or loss	Is defined as income minus the expenses/ difference between income and expenditure
Saving	Type of income not spent and has accumulated and is invested in fixed improvement or new equipment
Short term credit	A credit which is repaid back over a short period of time
Undercapitalisation	It is when less than required capital is employed in a business.
Whole farm budget	It is the budget for the whole farm and all the enterprises in the farm.
Working Capital	Capital goods invested for a short term like seeds, fuel and fertilizers and is used for production processes

TYPES OF CAPITAL AND METHODS OF CREATING CAPITAL

Types of capital:

There are three types of capital namely fixed capital, movable capital and working capital.

- **Fixed capital:** Type of capital invested over a long period e.g. buildings, land, dam etc.
- **Movable capital:** Type of capital goods invested in durable assets for a medium term like livestock and machinery that are used in the production processes.
- **Working capital:** Type of capital goods invested for a short term like seeds, fuel and fertilizers and is used for production processes.

METHODS OF CREATING CAPITAL

There are methods that are used to create capital that is used for production production processes.

SOURCES OF CAPITAL / CREATION OF CAPITAL

Capital can be created by :

- **Production**: Type of profit invested which comes from farming operation or farming enterprises. The profit can be invested for the following season/s.
- **Savings:** Type of income not spent and has accumulated and is invested in fixed improvement or new equipment.
- **Credit:** A loan made from a financial institution e.g. bank.

Types of credit in Agriculture:

- **Long term credit:** A credit in which the repayment takes a longer period and is used to purchase land and fixed improvements. Repayment is longer than 10 years and can be 20 to 30 years.
- **Medium term credit:** A credit in which the repayment takes place over a short time and used to buy for movable assets e.g. livestock, tractors and repayment is for a period of 1-5 years and may extend up to 10 years.
- **Short term credit:** A credit which is repaid back over a short period of time. Repayment may be 12 years or less. It is used for production goods like feed, fuel and seeds within one production season.

Problems associated with capital as a production factor

• Under-capitalisation • Over-capitalisation • Subject to high risk	• Depreciation • Scarcity of capital • Subjected to the law of diminishing returns • High interest rate. • Interest rates may change

Financial management systems

- **Financial records:** These are records that show money that is coming in and money that is spent in a business over a period of time. A financial record can be used to calculate the return on investments
- **Assets:** These are resources that have economic / financial value that the farmer owns. e.g.
- Livestock, plantations and machinery
- **Inventory:** It is a record keeping system where assets are recorded.
- **Fixed improvements:** These are immovable assets such as dams, silos and buildings.
- **Fixed assets:** These are assets that are of a long term in nature like such as land and buildings and cannot be easily changed into cash.

Financial management systems makes the farmer to do the following:

- Put sound management on the farm capital
- Keep an inventory of assets
- Draw up a sound budget.
- Preparing budgets
- Do analysis and compare financial results.
- Keep a cash analysis book
- Put a sound plan regarding the future of the business.
- Preparing key financial statements, balance sheets, income statement, cash flow statement

The differences between whole farm budget and an enterprise budget:

- **Whole farm budget:** It is the budget for the whole farm and all the enterprises in the farm.

An example of a whole farm budget with different enterprises:

ESTIMATED COSTS		**ESTIMATED RETURNS**	
ITEM	**AMOUNT (R)**	**ITEM**	**AMOUNT (R)**
Water (Irrigation)	10 200	Milies	35 500
Fertilizer	33 000	Maize meal	65 000
Maize seeds	5 000	Compost	34 500
Labour	25 000	Haylage	32 200
Pesticides	20 500	Silage	56 700
Agents	15 000		
Transport	19 500		
TOTAL COSTS	128 200	**TOTAL RETURNS**	223 900
BROLER PRODUCTS			
Chicks	2 500	Broilers	90 000
Feeding equipment	10 000	Manure	
Labour	11 500		
Feeds (mash)	12 000		
Water	3 000		
Transport	2 000		
Vaccines	1 800		

TOTAL COSTS	43 600	**TOTAL RETURNS**	135 000
WHOLE FARM TOTAL COSTS	5 923 500	**WHOLE FARM TOTAL RETURNS**	4 195 9000

- **Enterprise budget:** It is the budget that is intended for a particular farm enterprise.

An Example of an enterprise budget:

- The following is a budget for a rose producer. The roses are produced by an emerging small-scale farmer who set up this enterprise as part of an Agric-BEE initiative. The production of roses takes place in a greenhouse on a small holding.
- The budget below shows estimates for the 2009/2010 financial year. The fixed capital budget is not included.

Estimated cost			Estimated returns		
Item	**Amount**		**Item**	**Amount**	
Water	10 300	00	Roses (floral shop)	350 000	00
Manure	22 345	45	Roses (nursery)	120 000	00
Labour	24 500	00	Compost	7 500	00
Electricity	13 308	00			
Potting soil	8 800	00	**Total returns**		
Vegetative material	45 555	50			
Chemicals	18 756	30			
Total costs					

- **Cash analysis book:** This type of a book used to record money coming to the farm and money going out of the farm. (i.e. receipts and payments)
- **Balance sheet:** It is reflects / summarises the assets and liabilities of a business.
- **Liabilities:** It is the farm /company's financial debt (money that farm /company owes.
- **Net worth:** It is defined as assets minus the liabilities.
- **Income statement:** It is a summary of all income and expenditure in a financial statement.
- **Profit:** It is defined as income minus the expenses

Components of cash flow statement

- **Income:** Money that an individual or business receives in exchange of the sale of goods or exchange of for providing a good or service.
- **Expenditure:** Payment made for goods and services (e.g. salaries, wages and inputs)
- **Profit or loss:** It is defined as income minus the expenses/ difference between income and expenditure.
- **Opening balance:** It is the amount of money in a bank account when it is opened/ the amount of money that is available in the bank when starting a month or a year.
- **Closing balance:** It is the amount remaining in an account at the end of the accounting period.

Main aspects which are included in a cash flow budget statement

- **Cash flow budget statement:** It is a projection and shows anticipated income and expenditure, profit or loss of an enterprise. It is an estimate of all cash receipts and all cash expenditures expected to occur during a certain time period.
- **Cash flow statement**: It involves receipts and payments that took place over a given period of time.

ACTIVITY

1

1.1 Mention FOUR problems associated with capital as a production factor (4)

Examples of capital are listed below

Land, buildings, livestock, machinery, fuel, pesticides

1.2 Tabulate the farm capital listed above under the following headings:

a) Movable capital (2)
b) Fixed capital (2)
c) Working capital (2)

1.3 When large capital investments are made in a farming operation, capital is required and must come from some sources. Mention THREE of such sources. (3)

2. Read the case study below and then answer the questions that follow:

A family in a rural area of the country decided to pursue farming. The father worked for a construction company for 20 years and received a pension package of R189 000,00 which he invested in land to start the farming enterprise. The family had too little capital and they approached the Vukuzenzele Trust for a grant. They were given a total of R80 000,00.

The family used this grant to purchase an irrigation system for R7 000,00 and a tractor for R58 000,00. R15 000,00 was used for pesticides, seeds and fertilisers.

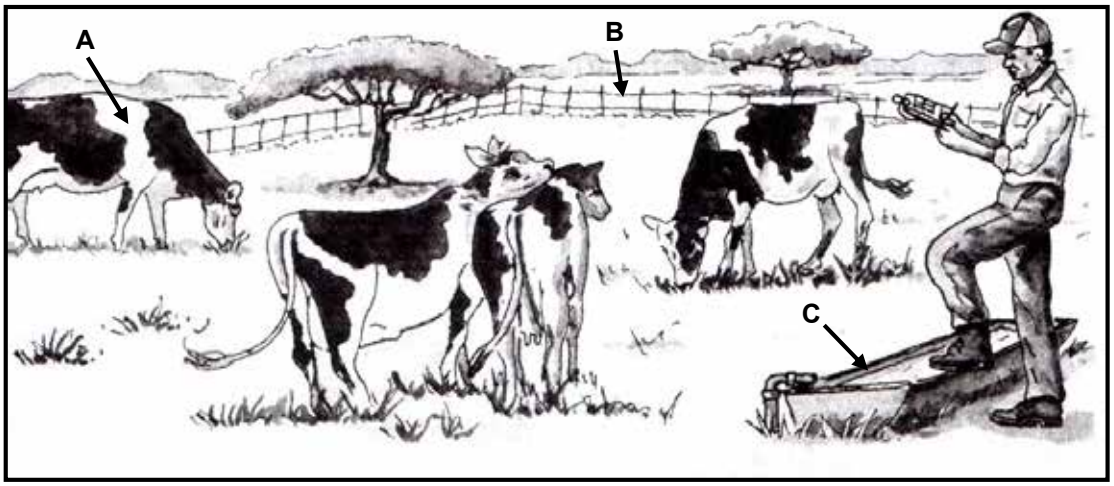
2.1 Tabulate THREE forms of capital used by the family and give an example of each from the case study above. (3) (6)

2.2 Name TWO sources of capital used by the family and give an example of each from the case study above. (4)

2.3 Calculate the total value of the assets for this farming enterprise.(2) (2)

2.4 Define the *net value* of a farming enterprise. (2)

3.



3.1 Indicate the types of capital represented by **A** and **B** in the diagram above. (2)

3.2 Give ONE example of floating capital that would be relevant for the farming operation illustrated above. (1)

5.4 Management
Learning objectives:

At the end of this unit the learners should be able to demonstrate knowledge of the following content:

Management

- Define the concepts of farm management/management, strategic farm risk management
- Identify and explain the principles/components of management
- Indicate the general management skills needed to manage a farm business
- Identify and describe the internal and external forces which affect/influence farming businesses
- Discuss the primary sources of risk in farming business
- Identify and discuss the main risk management strategies/techniques (diversification strategies, risk- sharing strategies)
- Discuss the law of diminishing returns as applicable to all factors of production – interpretation of graph

CONCEPTS	DEFINITION
Business management skills	This will involve short term and long term planning.
Communication skills	The skills of communication which is good for all the workers on the farm.
Co-ordination	Involves synchronising all parts of an activity for its smooth running
Control	Involves checking and verification of the results of the decision making / involves checking if the plans are implemented correctly.
Decision making	It is making a choice between different alternatives/ solution of a problem.
An entrepreneur	Is a person who is able to generate a business from a novel idea and becomes successful.
External forces	Are forces that the manager has little or no control over them
Farm Management	Farm management involves a day to day organization and coordination of resources

Financial Management skills	The skills wherein the manager is well vested on financial matters regarding borrowing, investing and full understanding regarding taxation so as to guard against financial losses
Financial records	Show money coming in and money spent in a business over a period of time.
Interest	Is an amount that the financial institution charges for lending capital.
Internal forces	These are forces that originate on the farm itself.
Land	A piece of ground that can be used for building or agricultural production
Law of diminishing returns	If there is an increase of the input in the production process, the output will increase but a point will be reached where further increase in the input will result in the decline of the output.
Leading	Involves giving direction, guidance and setting the plan to motion
Legal risks	The types of risks when the manager is taken to court for having ignored some regulatory standard on the farm.
Legislation	A law or set of laws made by the government.
Management	Involves organisation and coordination of activities (human, and financial) of a business.
Market risks	It is a risk which gives rise to an oversupply or undersupply of a product in the market.
Organisation and coordination	Involves ringing together physical, human and financial resources to achieve objectives/bringing together of all parts of an activity for production.
Planning	Is a mental process where a manager determines what needs to be done, by whom and when.
Problem management skills	The skills to be able to manage problems when they arise or to prevent them from arising.
Production	Profit invested which comes from farming operation or farming enterprises.
Production risks	These are risks that may come due to breakdown of machinery, weather or pests that may damage the crops.
Property and liability insurance	It is an insurance that insures the property, machinery against things like storms, hail damage, injury of the visitor etc.
Risk sharing	Belonging to different farming associations/cooperatives or farming organizations

Management principles/Components of management:

- **Planning:** It involves deciding what to do, when to it how to do it and who is going to do it. It involves financial planning, farm activity planning and market planning.
- **Organisation and coordination**: It. involves ringing together physical, human and financial resources to achieve objectives
- **Leading:** It involves giving direction, guidance and setting the plan to motion.
- **Control:** It involves checking and verification of the results of the decision making. Control can be delegated, must be economical and must always leads to corrective action.

General management skills needed to manage a farming business

- **Business management skills**. This will involve short term and long term planning. The staff must know what is to be done on a day to day basis (i.e. daily operations)
- **Financial management skills**. The manager must be well vested on financial matters regarding borrowing, investing and full understanding regarding taxation so as to regard against financial losses.
- **Communication skills:** Communication is a two way process. Both stakeholders including the manager must understand one another.
- **Problem solving skills:** In any given institution where people are, challenges/problems will be there. The manager must be a person who can solve the problems. He must be as well be a good listener.

- **Production and operational skills:** The manager must have good knowledge of production of a farming enterprise and the operational skills of that particular farming enterprise e.g. crop farming, poultry farming, piggery etc..

The internal and external forces that which affect/influence farming business.

- **Internal forces**: These are forces that originate on the farm itself. E.g. Demands of wages by labourers where the options would be that of negotiations. It could be the soil fertility that has dropped that would need soil analysis.

- **External forces:** These are forces that the manager has little or no control over them. They can be brought by natural forces like draught, hail or floods. Price for certain farming enterprise like milk that the manager may receive are controlled.

The primary sources of risk in farming business.

- **Production risks**: These are risks that may come due to breakdown of machinery, weather or pests that may damage the crops e.g. army worm which recently damaged maize crop in South Africa, Zambia, Zimbambwe, Namibia, Mozambique and Uganda.

- **Marketing risk:** If there is an oversupply of a product in the market, price will fall.
- **Financial risk:** These may take place when the manager is unable to pay the debt on time.

- **Legal risks**: This takes place when the manger is taken to court for having ignored some regulatory standard which resulted in the death of a labourer/worker.

- **People /Human risk:** This takes place when the skill is lost due to death, disability, divorce, illness etc. This affect production negatively.

Main risk management strategies/techniques (Diversification strategies, risk – sharing strategies)

- **Minimise safety risks**: Avoid short cuts and make workers have proper protective clothing (Proper protective gear). Working machinery or equipment must be well serviced.

- **Using good agricultural farming practices:** These will include rotational grazing and nutrient management planning.

- **Good cooperation and support for farmers with their neighbours:** This will include sharing of labour and skills that will minimize costs on outsourcing.

- **Attention to business management:** A farm manager must always analyse the impact of decisions on the financial performance before a new practice is implemented.

- **Making use of free assistance:** The States Departments do give free assistance and advice or warning on certain things e.g. the army worm invasion.

- **Health and disability insurance for workers:** If workers are insured, production will be good because they will be able to get good health services.

- **Property and liability insurance:** It is good to insure the property, machinery against things like storms, hail damage, injury of the visitor etc.

Diversification of risks:

There is a saying that you cannot put all your eggs in one bucket. The following can be done to diversify the risks.

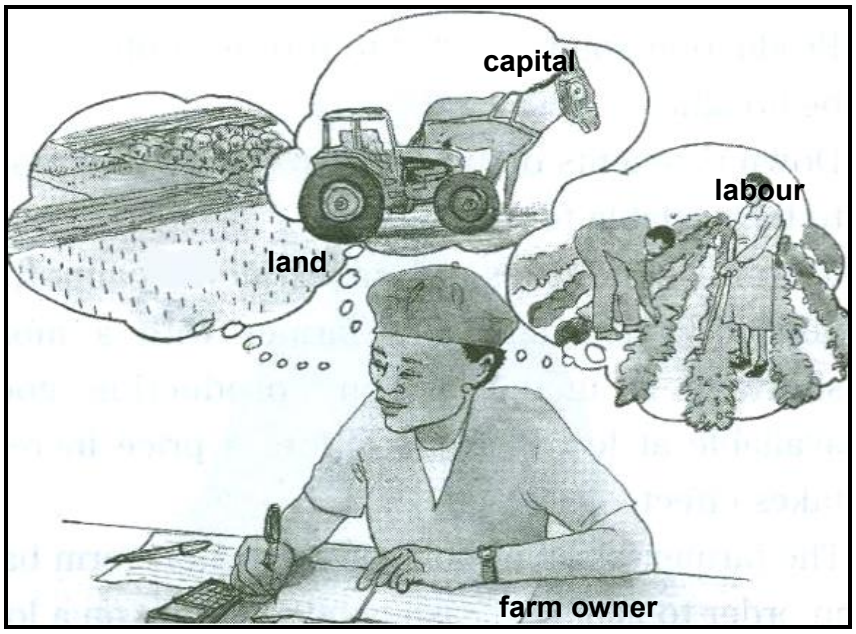
- Planting of different crops (i.e. mixed farming)
- A farmer can spread his/her investment over several enterprises (pig farming, poultry farming cattle farming etc.)
- Geographical diversification (have different land types wherein there are different soil types and different climatic conditions.

- **Risk sharing:** This can be done by belonging to different farming associations/cooperatives or farming organizations.

- **Safety risk advices:** Food poisoning chemicals must never be put on food containers (e.g. putting poisonous chemicals on a coca cola bottle).

ACTIVITY

1. The illustration below shows a farm owner busy with management tasks.



1.1 Identify a production factor that is represented by the farm owner in the illustration above. Motivate your answer. (2)

1.2 State TWO ways to improve the productivity of land as a production factor. (2)

2. Explain how efficient planning by a farm manager can improve the working conditions of farm labourers with reference to the following:

(a) Day-to-day planning (2)

(b) Efficient mechanization (2)

3.a) Name and explain briefly FOUR Management principles/components (12)

b) There are sources of risks in farming business. Mention 4. (4)
c) Explain 3 things that can be done to diversify the risks in agriculture (6)

MEMORANDUM ON PRODUCTION FACTORS (CHAPTER 5)

1

1.1 A✓ 1.4 C✓

1.2 B✓ 1.5 A✓

1.3 A✓ 1.6 A✓

2

2.1

- Provides space / medium for plant to grow✓
- Source/Supplies raw materials.✓
- Supplies minerals✓
- Provides food✓

2.2

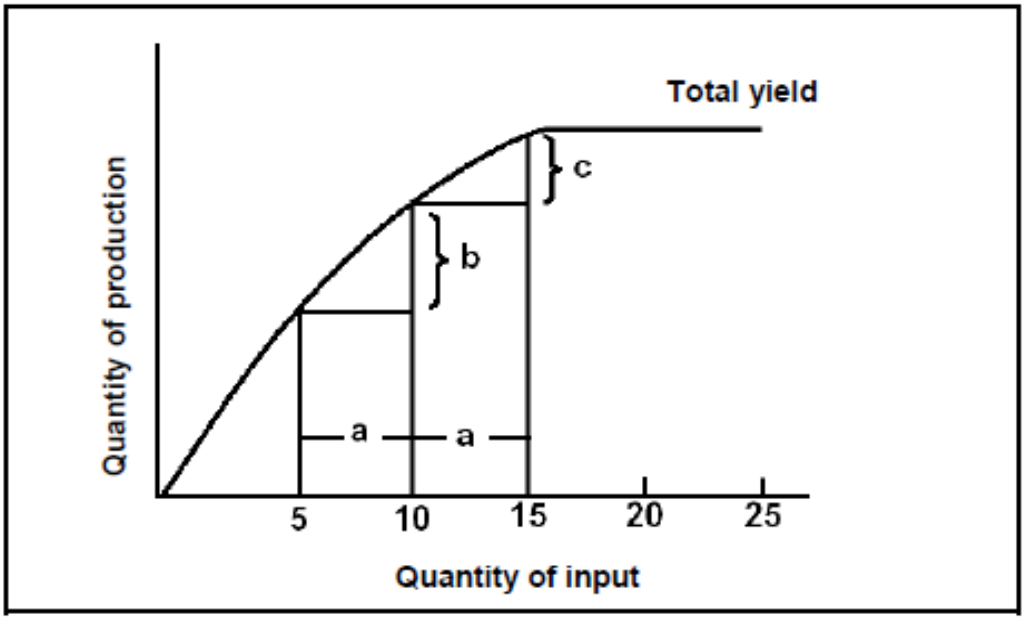
- Adaptation of production systems to scientific methods✓
- Water provision /Supply water✓
- Consolidation of uneconomical farm units✓
- Utilisation of improved agricultural methods✓ (Any 3)

3

3.1 Law of Diminishing returns✓

3.2 With the addition of fertilizers,✓ yield will increase to a certain limit,✓ but a point will be reached✓ wherein further increase in fertilizer application will not make an increase in production but a decline.✓ (4)

3.3 Graph on the Law of Diminishing Returns



a) Correct heading✓

b) Correct type of graph (line graph)✓

c) Correct plotting of X axis✓

d) Correct plotting of Y axis✓ (4)

3.4 With the addition of fertilizers,✓ yield will increase✓ but a point will be reached wherein further increase in fertilizer application will not make an increase in production but a decline.✓ (3)

5.2

1. Labour

2.1 a) Improve on educational matters✓✓

b) Improve on living and working conditions e.g. proper housing✓✓

c) Good salaries, medical aid and pension✓✓ (6)

1.2 a) Casual labour: Type of labour that works less than 24 hours per month✓✓

b) Seasonal labour: Type of labour that is only available during specific season e.g. harvesting time.✓✓

c) Skilled labour**:** Type of labour that knows how to do the job, they may be permanent or temporary✓✓ (6)

2. a) Impact of HIV/AIDS

- Absenteeism of workers which leads to decline in productivity✓
- Difficult to plan due to absenteeism✓
- Loss of skills and experience✓
- Agricultural operations cannot be completed on time due to labour shortages✓ (4)

b) Ways to address HIV/AIDS

- Education awareness and training✓
- Provide access to condoms✓

- Supplying medication like anti-retroviral drugs✓
- Discouraging multi sexual partners✓
- Have support groups for supporting the affected workers✓ Any 4 (4)

3. Legislations

3.1 Labour relations Act No. 66 of 1995: Responsible for right of labours to strike, stay- ins etc.✓✓ (2)

3.2 Occupational Health and Safety Act No. 85 of 1993: Responsible for safety in the work place.✓✓ (2)

3.3 Compensation for Occupational Injuries and Diseases Act No. 85 of 1993: Responsible for regulating the health and safety of workers.✓✓ (2)

4. Extract

4 .1 - Permanent work✓ (1)
- He earns monthly salary and will get retirement✓✓ (2)

4.2a) Working hours (7:00 -17:00)✓ (1)
b) One week paid leave per annum.✓ (1)

4.3Low wages✓, one week paid leave✓, no protective clothing✓. (3)

5.3

1. Capital

1.1 Under-capitalisation,✓ b) Over-capitalisation,✓c) Scarcity of capital,✓ d) High rate of interest, ✓ e) Depreciation✓

1.2 a) Livestock✓, Machinery ✓ (2)
b) Land✓, Buildings ✓ (2)
c) Fuel✓, Pesticides✓ (2)

1.3 Production✓, Saving✓, Credit✓

2 . Case Study

2.1 a) Fixed capital - land ✓
b) Movable capital – tractor✓
c) Working capital – seeds, fertilizer, pesticides✓

2.2 -Savings✓ : Investment ✓
- Credit✓: Got grant from Vukazenzele Trust✓ (4)

2.3 190 000+7 000 + 58 000 + 15 000 = R269 000✓✓ (2)

2.4 Net value of a farming enterprise is the value which is left ✓ after costs have been deducted.✓ (2)

3. Diagram on Capital

3.1 A : movable capital✓
B : Fixed capital✓ (2)

3.2 Floating capital: Cattle✓ (1)

5.4 Management

1.1 Management✓: The farm owner is seen doing the managerial work e.g. planning.✓

1.2-Adaptation of the production factors to the scientific methods✓
-Water provision✓
-Consolidation of uneconomical farm units✓
-Utilisation of improved agricultural methods✓

2. a) Day to day planning will enable workers to know what is that which they are supposed to be doing per day.✓✓
b) Efficient mechanization will relieve workers from doing hard labour.✓✓

3. Management principles/Components of management:

(a)

- Planning✓**:** It involves deciding what to do, when to it how to do it and who is going to do it. It involves financial planning, farm activity planning and market planning.✓✓

- Organisation✓ and coordination: It. involves ringing together physical, human and financial resources to achieve objectives✓✓

- Leading✓**:** It involves giving direction, guidance and setting the plan to motion.✓✓

- Control✓**:** It involves checking and verification of the results of the decision making can be delegated, must be economical and must always leads to corrective action. ✓✓

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b)

- Production risks ✓
- Marketing risks✓
- Financial risks✓
- Legal risks✓
- People / Human risks✓

c)

- Minimise safety risks✓: Avoid short cuts and make workers have proper protective clothing (Proper protective gear). Working machinery or equipment must be well serviced. ✓

- Using good agricultural farming practices✓**:** These will include rotational grazing and nutrient management planning.✓

- Good cooperation and support for farmers with their neighbours**:**✓This will include sharing of labour and skills that will minimize costs on outsourcing.✓

- Attention to business management✓:A farm manager must always analyse the impact of decisions on the financial performance before a new practice is implemented.✓

- Making use of free assistance✓**:** The States Departments do give free assistance and advice or warning on certain things e.g. the army worm invasion.✓

- Health and disability insurance for workers✓**:** If workers are insured, production will be good because they will be able to get good health services.✓

- Property and liability insurance✓**:** It is good to insure the property, machinery against things like storms, hail damage, injury of the visitor etc.✓

Chapter 6

BASIC AGRICULTURAL GENETICS

6.1 Monohybrid/Dihybrid inheritance

Learning objectives:

By the end of this unit the learner should be able to demonstrate knowledge of the following content.

Agricultural Genetics

- Define basic terminology related to genetics.
- Distinguish between genotype and phenotype
- Distinguish between dominant and recessive
- Be able to do a monohybrid cross and how it relates to Mendel's law of segregation
- Be able to do a dihybrid cross and how it relates to Mendel's law of independent assortment
- Use the Punnet square, schematic diagrams and pedigree diagrams to solve genetic problems
- Distinguish between qualitative and quantitative characteristics

6.1.1 Terminology:

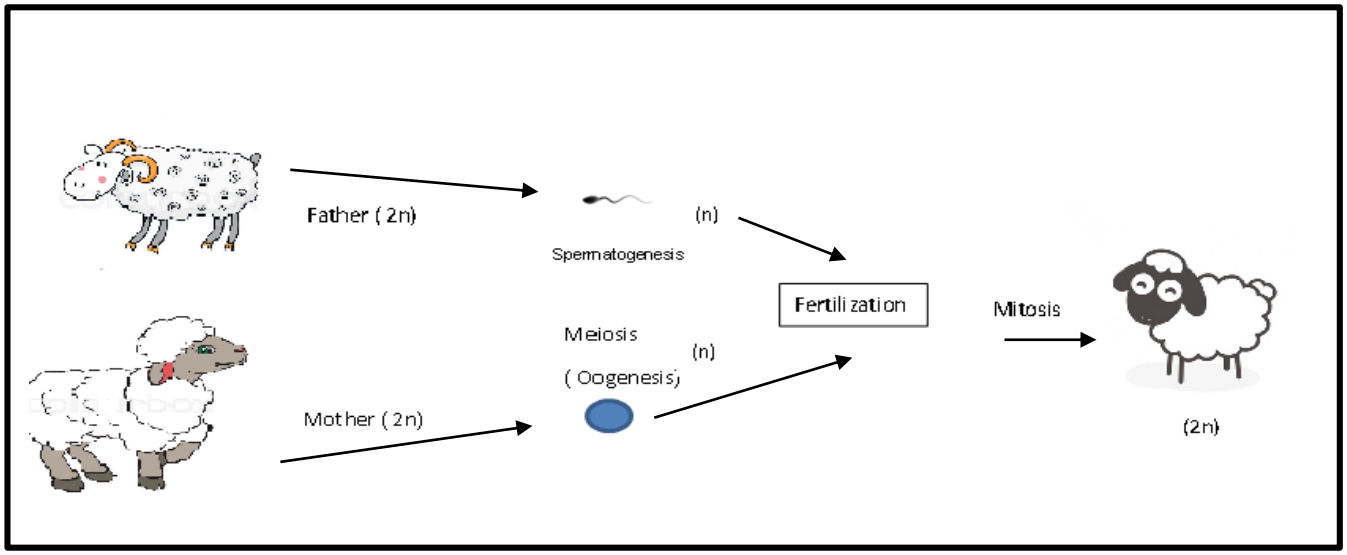
TERM	DEFINITION
Allele	- Variation of the same gene
Dihybrid cross	- a genetic cross which involves 2 pairs of contrasting characteristics
Dominant	- an allele that masks the effect of another & is expressed in the appearance of an individual (phenotype)
Co-dominance	- type of inheritance where both alleles are dominant and fully expressed in the phenotype
Incomplete dominance	

	- type of inheritance where both alleles are partially expressed, often producing an intermediate characteristic.
Gametes	- a reproductive cell having haploid number of chromosomes
Gene	- unit of heredity that carries information for each characteristic of an organism
Genetics	- study of inheritance/ genes
Genotype	- genetic makeup of an organism
Heterozygous	- having different alleles of a gene e.g. Tt
Homologous pair	- chromosomes of the same shape & size from each parent
Homozygous	- having identical alleles for a particular gene e.g. TT or tt
Meiosis	- reduction division of sex cells that gives rise to 4 haploid daughter cells
Monohybrid cross	- genetic cross which involves 1 characteristic with 2 alleles
Phenotype	- physical appearance of an individual due to genetic makeup
Pure breed	- an organism that is homozygous for a genetic trait and therefore continually gives rise to offspring with the same trait
Recessive	- an allele that is masked by the presence of a dominant allele and only appears in the phenotype if the organism is homozygous

The basis of genetics is underpinned by Mendel's Laws: These laws can be summarized as follows:

- The genetic characteristics of an organism are controlled by genes that occurs in pairs.
- Mendel's law of dominance – Of these genes one is dominant and the other is recessive
- Mendel's law of Segregation – When gametes form the genes separate randomly, so each gamete gets one gene.
- Mendel's law of Independent Assortment: In a dihybrid cross, the genes of the different characteristics segregate independently from each other (unless they are on the same locus)

When dealing with genetics and the predicted outcome of certain crosses. The importance of meiosis should not be underestimated. It is the process where the principles of segregation and independent assortment of genes are illustrated. Furthermore it is also during this process where the the gametes are formed resulting in haploid sex cells (sperm/ pollen & ovum)



6.1.2 Monohybrid and Dihybrid inheritance

6.1.2.1 Monohybrid inheritance: The type of genetic cross where only ONE characteristic is involved, e.g. colour or length. You can be requested to provide the cross either in a Punnet square or a schematic diagram.

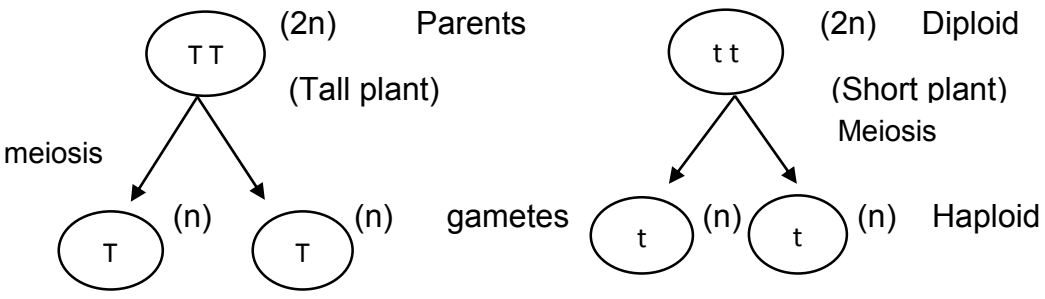
The following example will show you how to present both:

In commercial crop production, wheat producers prefer a shorter plant, for several reasons. It makes harvesting easier, the shorter plant use less energy for vegetative growth and more is available for production. Shorter plants are also not prone to falling over due to wind.

Plant breeders are crossing a Homozygous tall plant with a Homozygous short plant. The allele for tall is dominant over short. Use T and t. (T= Tall : t= short)

Step 1: Identify the genotype of the parents. The one will be TT and the other t t

Step 2: Identify the alleles that are allocated to every gamete.

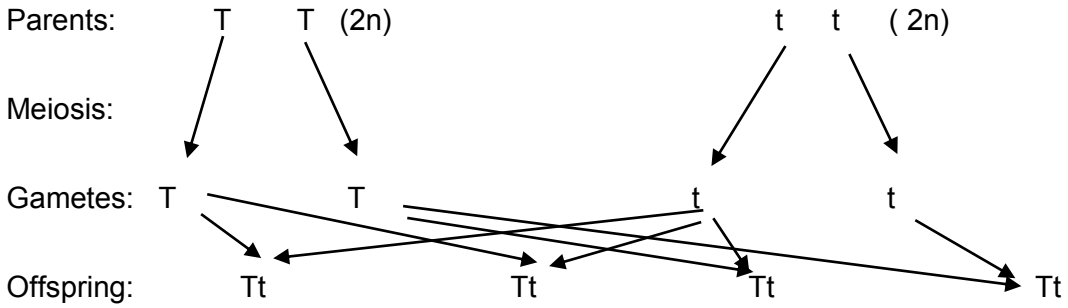


Step 3: Draw the Punnet square and populate it

♀ / ♀	T	T
t	Tt	Tt
t	Tt	Tt

All the offspring will be phenotypically tall but will also carry the allele for short.
Therefore in a follow up breeding process researchers will cross the heterozygous (T t) offspring from the F1 generation with each other.

Schematically it can be presented as follows:

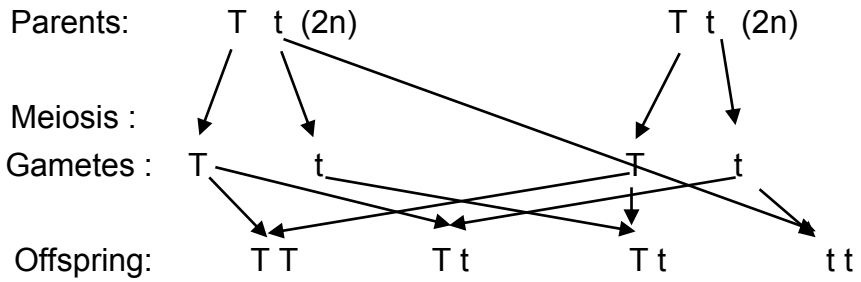


A cross between two of the F1 offspring will look as follows:
The genotype of both parents is T t

	T	t
T	T T	T t
t	T t	t t

The genotype ratio is thus 1:2: 1 (1TT: 2Tt: 1tt) or 25% TT : 50% Tt : 25% tt)
The phenotype ratio is 3(tall): 1 (short).

Schematically the above can be illustrated as follows:



6.1.2.2. Dihybrid Inheritance: A Dihybrid cross involves TWO characteristics:
Mendel's law of segregation as well as Mendel's law of Independent assortment is valid in a dihybrid cross.

Mendel's law of independent assortment states:
During gamete formation, segregating pairs of alleles assort independently of each other.

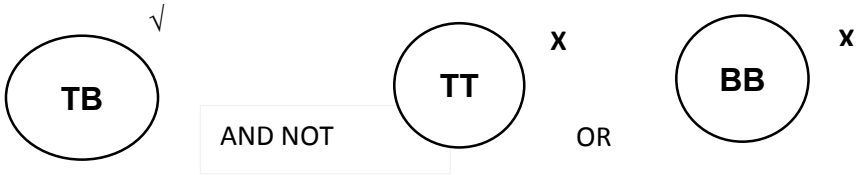
This simply **means** that characteristics does not necessarily get inherited together, and that the characteristics are transmitted to the offspring independently of each other.

You have **tall** plant with **big** seeds (TTBB) and a **short** plant with **small** seeds (ttbb). The desirable traits is a **short plant with big seeds** (ttBB) (Only purebred plants can be used in plant breeding)

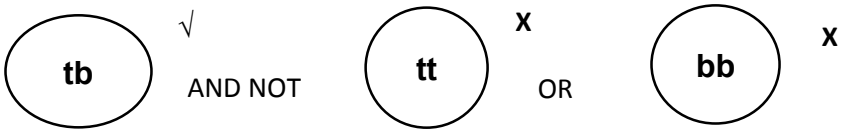
Step 1: Identify the genotype of the parents : In this case it has been given to you being (TTBB) and (ttbb)

Step 2: Identify the gametes after meiosis for each parent:

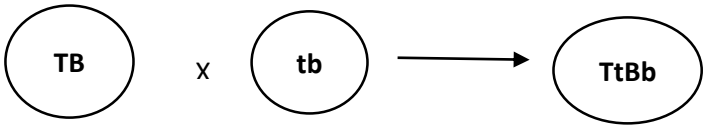
Parent 1 : genotype TTBB : The gametes will be:



Parent 2 : genotype ttbb: The gametes will be:

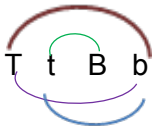


Step3: Do the cross to get the F1generation:



The genotype of all the offspring in the F1 generation will be **Tt Bb**
The phenotype of all the offspring will be tall plants with big seeds. - But it is heterozygous for both characteristics , which plant breeders cannot use.

Step 4 : Cross two of the F1 generation with each other:
Genotypes of both parents: Tt Bb x Tt Bb
Identify the gametes of the parents (Which will be the same in this case)
How???



Gametes: TB Tb tB tb

FOIL: To Identify the gametes.
First letters –T B
Outside letters – Tb
Inside letters - tB
Last letters - tb

Step 5: Do the F 2 cross in the Punnet square

	TB	**Tb**	**tB**	**tb**
TB	**TTBB**	**TTBb**	**TtBB**	**TtBb**
Tb	**TTBb**	**TTbb**	**TtBb**	**Ttbb**
tB	**TtBB**	**TtBb**	**ttBB**	**ttBb**
tb	**TtBb**	**Ttbb**	**ttBb**	**ttbb**

Phenotype ratio: 9:3:3:1

9 Tall plants with large seeds, 3 Tall plants with small seeds, 3 short plants with large seeds and 1 short plant with small seeds.

6.1.2.3. Qualitative and Quantitative characteristics

Quantitative Characteristics – Influenced by a group of genes – polygenic inheritance **(Related to continuous variation)**	**Qualitative Characteristics – Influenced by a single pair of genes** **(Related to discontinuous variation)**
Environmental factors have an influence in the determination of the trait	Environmental factors have no influence in the determination of the trait
Shows continuous variation of the trait in a population	Does not show any variation, it is either there or not.
Example: Milk production in cattle. Egg production	Example : Horns/ polled animals

6.1.3 Activities: Punnetsquare

Question 1:

Bb represents a black-furred farm animal and bb represents a farm animal with white fur. The Punnet square below represents the genotypes of the offspring. Black is the dominant trait.

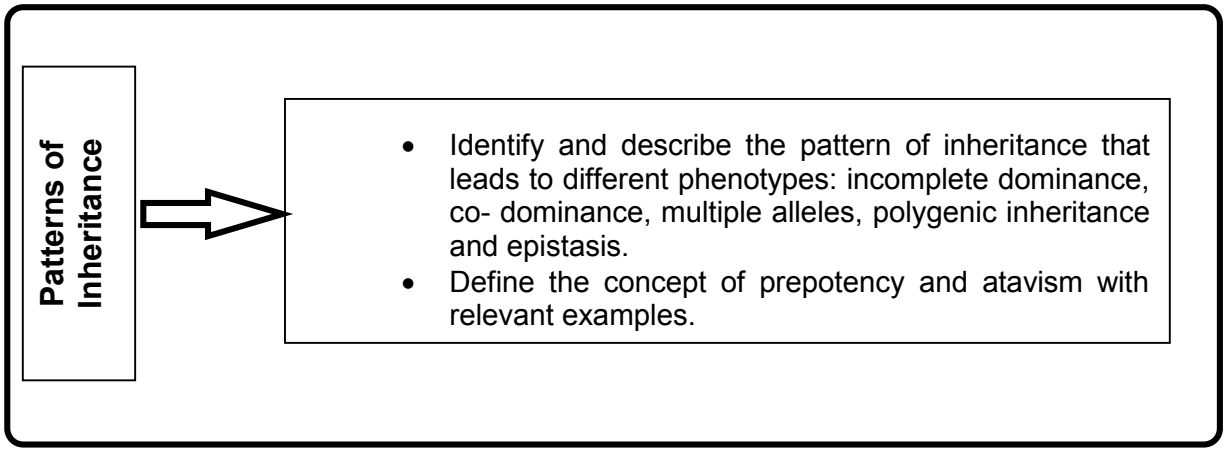
		FEMALE	
MALE	♂ \ ♀	b	b
	B	Bb	Bb
	b	bb	bb

1. Identify the phenotype(s) visible in the offspring. (2)
2. Identify the gender of the heterozygous parent. (1)
3. Calculate the percentage of the offspring that is heterozygous black. (2)

Question 2

A Farmer is farming with goats. The dominant allele (B) produces black fur and the recessive allele (b) produces white fur. Use a Punnet square to show the possible phenotypes and genotypes of the F1 generation for fur colour if two heterozygous goats are crossed. (6)

6.2.1 Patterns of Inheritance
Learning objectives:
By the end of this unit the learner should be able to demonstrate knowledge of the following content:



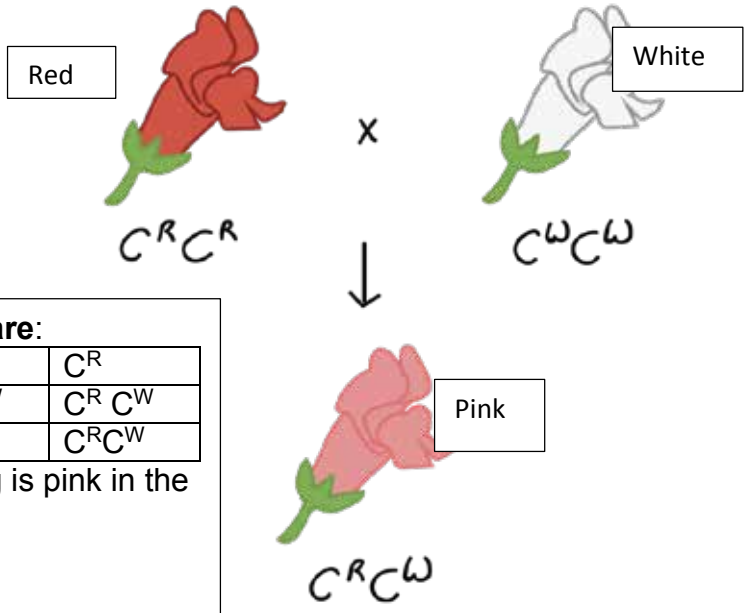
TERM	DEFINITION
Atavism	- reappearance of a characteristic in an organism after a period of absence
Epistasis	- masking of the phenotypic effect of alleles at one gene by alleles of another gene
Mutation	- sudden/random change in the structure of DNA
Polygenic	- trait controlled by many genes
Polyploid	- an organism with more than 2 sets of chromosomes
Prepotency	- ability of one parent to transmit more characteristics to its offspring than the other parent

There are other patterns of inheritance that are **exceptions** to Mendel's classification of Inheritance:

6.2.1.1 Incomplete dominance:

For example, in the snapdragon, a cross between a homozygous white-flowered plant and a homozygous red flowered plant renders all pink flowered offspring. This type of relationship between alleles, with a heterozygote phenotype intermediate between the two homozygote phenotypes, is called **incomplete dominance**.

Illustration of Incomplete dominance:



The Punnet square:

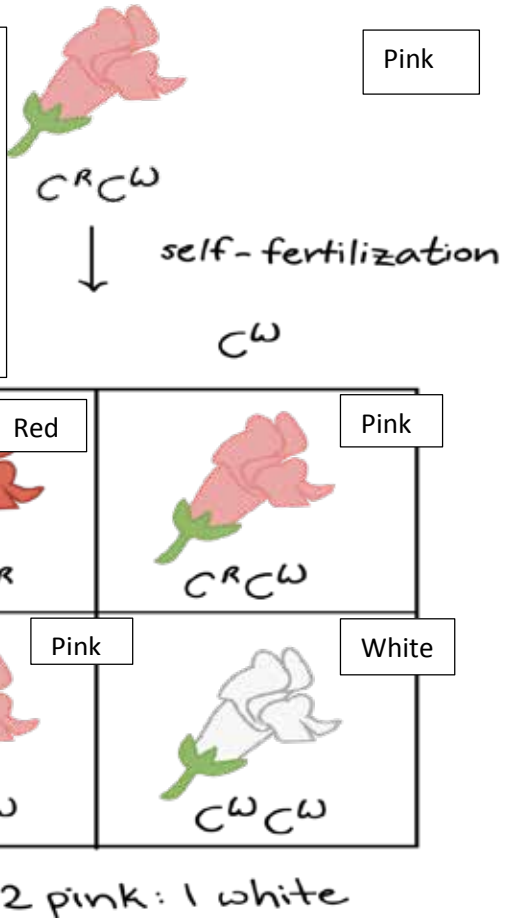
	C^R	C^R
C^W	$C^R\ C^W$	$C^R\ C^W$
C^W	C^RC^W	C^RC^W

All the off –spring is pink in the F1 generation

For the F2 generation:
The punnet square

	C^R	C^W
C^R	C^RC^R	C^RC^W
C^W	C^RC^W	C^WC^W

Phenotype ratio:1:2:1
Genotype ratio: 1:2:1



6.2.1.2 Co – dominance: Both alleles are simultaneously expressed in the heterozygote.

The principles of inheritance for co- dominance is the same as for incomplete dominance but the outcome is different, and phenotypically both alleles will be expressed. E.g. In a cross between a red animal and a white animals the coat colour will have both red and white hairs. The colour are then being described as **roan.**

Example: A cross between black and white animals where both colours is co- dominant the offspring will be black and white roan.

Black parent genotype: C^B C^B
White parent genotype: C^W C^W
The punnet square:

	C^B	**C^B**
C^W	**C^BC^W**	**C^BC^W**
C^W	**C^BC^W**	**C^BC^W**

All the offspring will be roan

6.2.1.3.Epistasis: Occurs when the effects of one gene are modified or changed by one or several other genes. The genes that modify another gene's effect are called modifier genes.

Example: Charolais carry the modifier (epistasis genes II or Ii or ii). The modifier gene is only active in it's dominant form. When you cross a Charolais with red of black cattle, the offspring are white. This is the result of the modifier gene on different chromosomes blocking the red and black genes.

Without the modifier gene	With II or Ii	With ii
BB – Black Bb- Black bb- Red	BBII – White BBIi – White BbIi – White bbIi - White	BBii – Black Bbii –Black Bbii - Red

6.2.1.4 : Prepotency

Prepotency is the ability of one parent to pass its genetic characteristics to its offspring. This is due to the fact that one parent has more homozygous dominant alleles than the other parent. The offspring will not only show external resemblances of the prepotent parent but will also produce and behave like the prepotent parent

6.2.1.5: Atavism

Atavism is a phenomenon where a particular characteristic is absent in many generations and then suddenly reappears. The genes are "switched off' by various genetic mechanisms and then "switched on" after many generations. The ancestral gene is then expressed in the phenotype

6.2.1.6 Multiple alleles :

When more than two alleles control the expression of a certain trait e.g blood groups in humans.

The human ABO blood type is a good example of multiple alleles. Humans can have red blood cells that are of type A (I^A), type B (I^B), or type O (i). These three different alleles can be combined in different ways following Mendel's Laws of Inheritance. The resulting genotypes make either type A, type B, type AB, or type O blood. Type A blood is a combination of either two A alleles (I^A I^A) or one A allele and one O allele (I^Ai). Similarly, type B blood is coded for by either two B alleles (I^B I^B) or one B allele and one O allele (I^Bi). Type O blood can only be obtained with two recessive O alleles (ii). These are all examples of simple or complete dominance.

Type AB blood is an example of co-dominance. The A allele and the B allele are equal in their dominance and will be expressed equally if they are paired together into the genotype I^A I^B. Neither the A allele or the B allele is dominant over each other, so each type is expressed equally in the phenotype giving the human an AB blood type.

6.2.1.7 Polygenic Inheritance:

In modern sense, the inheritance mode of polygenic patterns is called **polygenic inheritance**, whose main properties can be defined as follows:

Polygenic inheritance, also known as quantitative inheritance, refers to a single inherited *phenotypic trait* that is controlled by two or more different *genes*.

e.g Milk production are controlled by 3 pairs of genes (Aa , Bb and Cc).

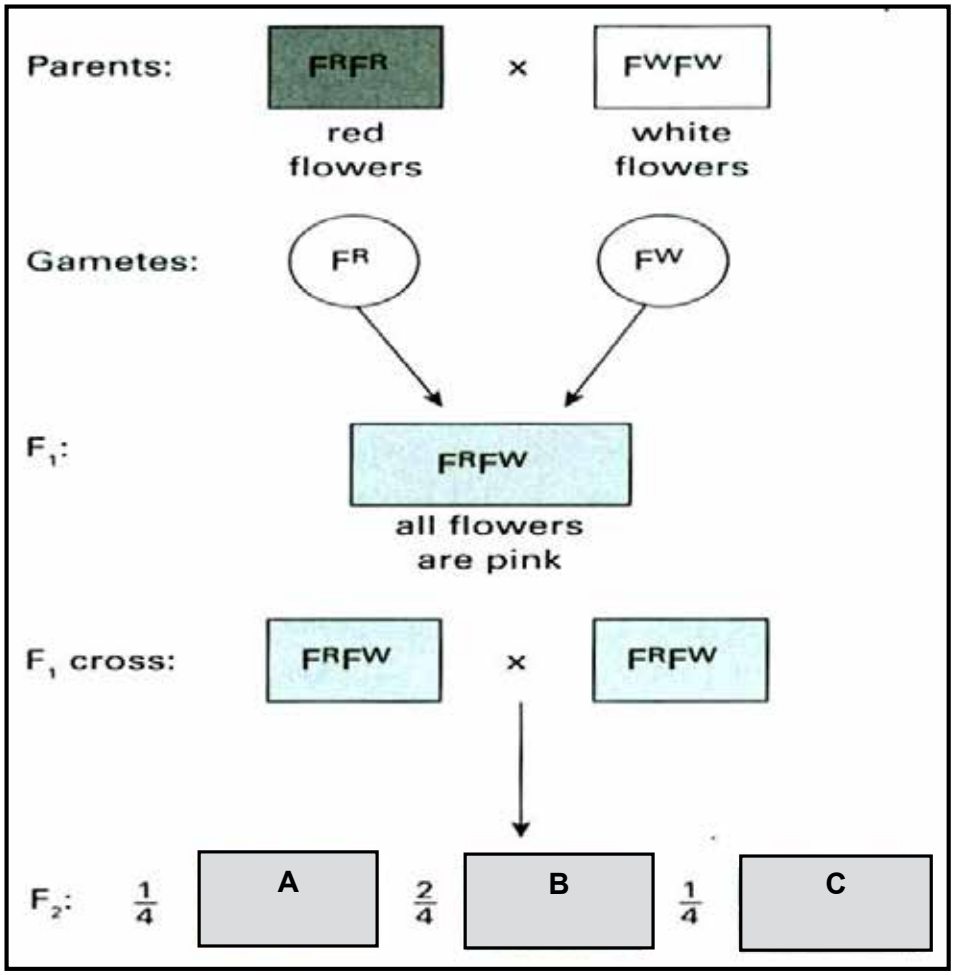
If the genotype aabbcc renders 4000 liters of milk and every dominant gene adds another 400 litres the following will happen

Genoptype	Phenotype
aabbcc	4000 liters
Aabbcc	4000 +400
AAbbcc AaBbcc AabbCc	4000 + 2(400)
Aa Bb Cc	4000 + 3(400)
AABBCC	4000+ 6(300)
	etc

6.2.3 Activities: Incomplete dominance

Question 1:

When snapdragon plants with red flowers (F^RF^R) are crossed with snapdragon plants with white flowers (F^WF^W), the F_1 generation is heterozygous (F^RF^W) and all have pink flowers. It appears that neither the red nor the white allele is dominant.



1. Identify the type of dominance illustrated in the diagram above. (1)

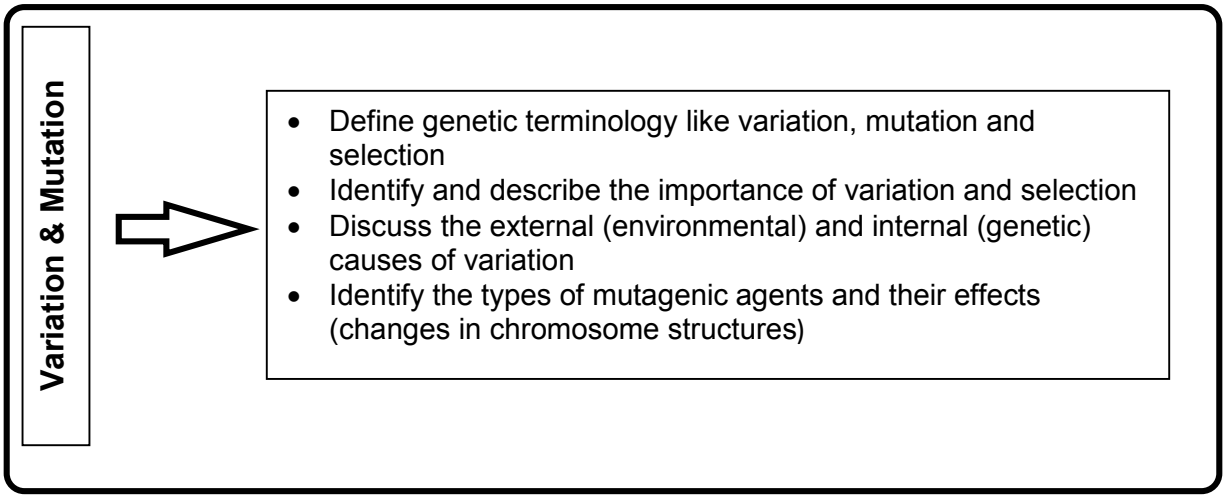
2. Complete the diagram by inserting the labels of the genotypes represented by **A**, **B** and **C**. (3)

3. Determine the phenotypic ratio for the F_2 generation. (2)

6.3 Variation and Mutation

Learning objectives:

By the end of this unit the learner should be able to demonstrate knowledge of the following content:



6.3.1 Terminology:

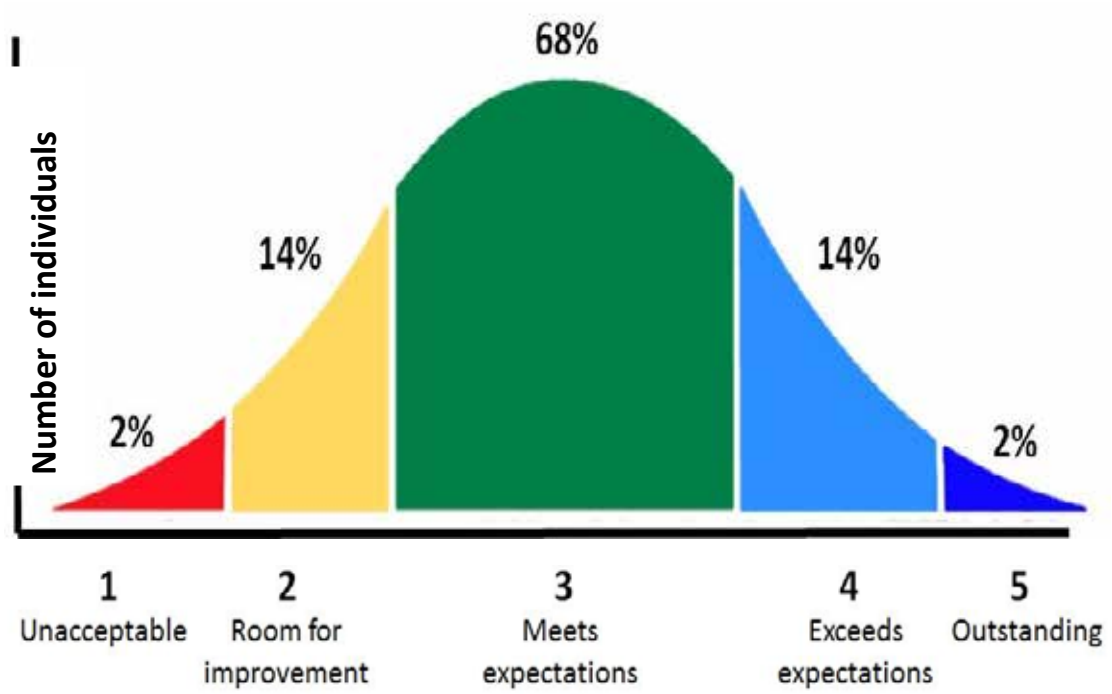
TERM	- DEFINITION
Variation	- differences between individuals of the same species
• **Continuous variation**	- type of variation in which the characteristc can take on a complete range of forms from one extreme to the other (Quantitative characteristics)
• **Discontinuous variation**	- type of variation that has a few clear cut forms with no forms in between. (Qualitative characteristics)
Mutation	- the changing of the structure of a gene, resulting in a variant form which may be transmitted to subsequent generations,

6.3.2 Variation

We can say that variation refers to the differences in characteristics between individuals of the same species.

Variation is the raw material the breeder has available for herd and flock improvement e.g. variation among size, rate of growth, efficiency of feed utilization, **milk production**, speed, milk fat %, etc.

Variation as explained occur through normal distribution as shown by the Bell Curve as seen below:



- The majority of the population falls in the average(meet expectations) band.
- The smallest numbers in a population will be on the extremes of the curve regarding a specific characteristic(Unacceptable and Outstanding)

6.3.2.2.The causes of variation can be :
Environmental or External variation

Environmentally caused variations may result from one factor or the combined effects of several factors, such as climate, food supply, and actions of other organisms. For example identical twins that differ in height and size due to different feeding patterns. These variations do not involve any hereditary alteration and in general are not transmitted to future generations.

Genetic or Internal variation:

Genetic variation is a measure of the genetic differences that exist within a population. The genetic variation of an entire species is often called genetic diversity. Genetic variations are the differences in DNA segments or genes between individuals and each variation of a gene is called an allele. For

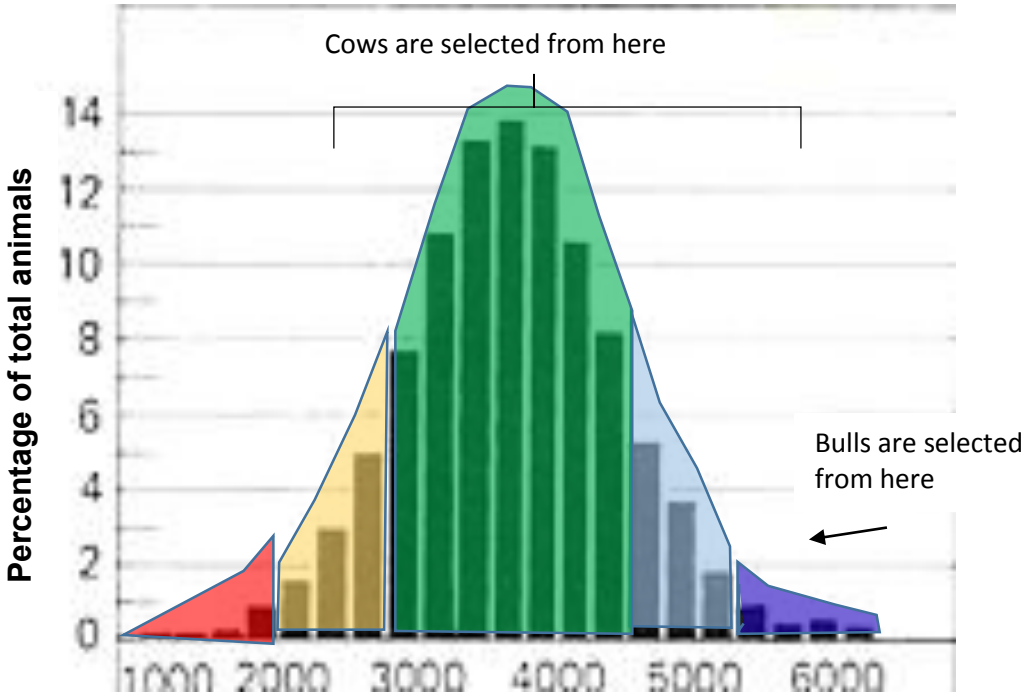
example, a population with many different alleles at a single chromosome locus has a high amount of genetic variation. Genetic variation is essential for natural selection because natural selection can only increase or decrease frequency of alleles that already exist in the population. Genetic variation is caused by:

- mutation
- random mating between organisms
- random fertilization
- crossing over (or recombination) between chromatids of homologous chromosome during meiosis

The last three of these factors reshuffle alleles within a population, giving offspring combinations which differ from their parents and from others.

Why is this information important in selection and breeding?

If this case a farmer wants to improve the milk yield of his herd.
If we apply the above normal distribution curve regarding milkproduction as seen below in a population of dairy cows the distribution will look as follows:



As seen in the graph, the majority of cows produces an average milk yield between 3000-4500kg of milk over a 250 day period. As shown the number of least producing cows and highest producing cows can be found at the extreme ends of the graph.

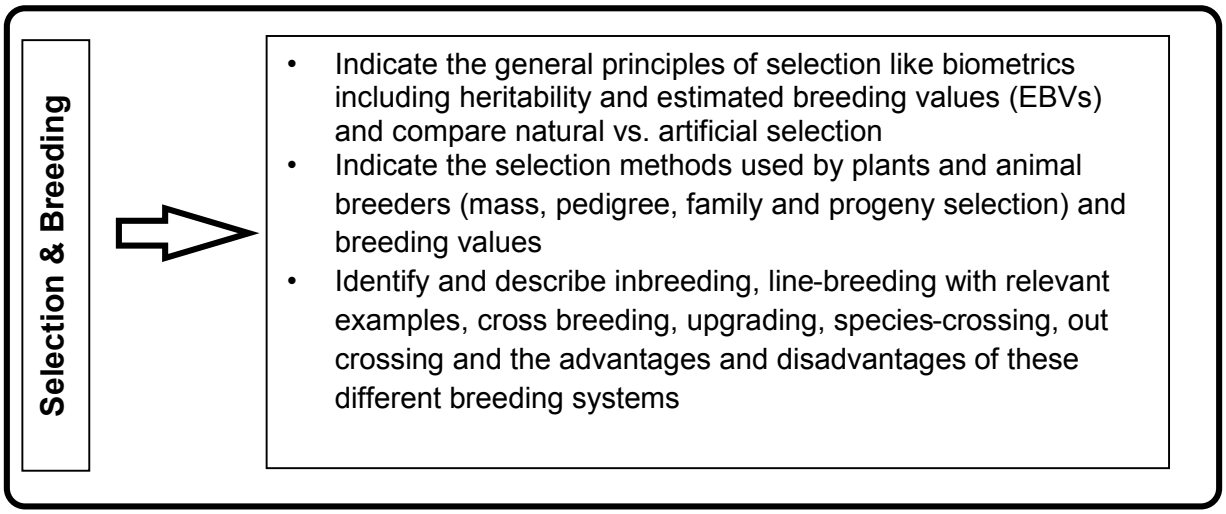
To increase milk production in a **herd** the farmer select bulls from the dark blue band, and breed to cows from the green and light blue band.

Applied principal: When improving the herd for better milk production (or any other **quantitative** characteristic), average and above average cows are being inseminated/mated by the best bulls(top 2%

6.4 Selection

Learning objectives:

By the end of this unit the learner should be able to demonstrate knowledge of the following content:



TERM	DEFINITION
Biometrics	- the measurement and analysis of unique physical or behavioral characteristics
Selection Methods	- the choice of individuals to be used for breeding
• **Mass selection**	- type of selection that is based on the individual animal's performance on the field
• **Pedigree selection**	- type of selection that is based on the quality of the animal's ancestor
• **Family selection**	- type of selection that is based on the quality of the animal's relatives of its generation (full/half siblings).
• **Progeny selection**	- type of selection that is based on the quality of the animal's offspring
Types of Selection	- **Directional selection:** Leads to a shift in the average of the population- left or right - **Disruptive selection**: For both extremes against moderate traits - **Stabilizing Selection**: For moderate traits against both extremes

6.4 .2 Selection is used as a tool for livestock improvement. Selection is the process of allowing certain animals to be parents of future generations while culling others.
Culling is the removal of animals which do not perform to the desired level, from the herd. The animals retained have certain desirable characteristics which make them produce more.

6.4.2.1 The aims of selection:

Selected animals make up the breeding stock. The breeding stock should pass the good qualities to their offspring for better performance, eg .higher milk production or growth to improve the herd. Selection process repeated for many generations increases chances of formation of desirable qualities in an animal. Selection increases occurrence of desirable genes and decreases occurrence of undesirable genes.

Selection helps improve characteristics which are highly heritable.
Heritability means the likelihood of a particular trait to be transmitted to the offspring and they are strongly inherited. A character like milk yield is lowly heritable, i.e. it is weakly inherited and a bigger percentage of the character is affected by the environment.

The degree to which selection affects a character depends on the following factors;
The heritability of the character, The intensity with which the selection is done and the interval between generations and kind of selection being practiced.

Factors to consider when selecting breeding stock.

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

6.4.2.2 Methods of Selection

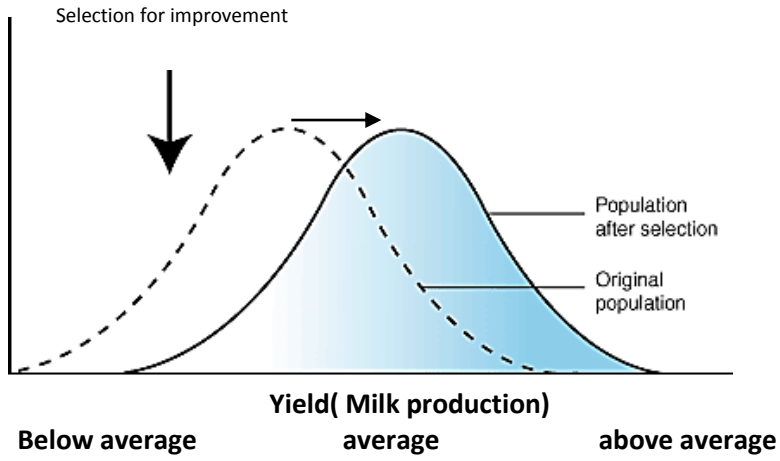
• **Mass selection**	- type of selection that is based on the individual animal's performance on the field
• **Pedigree selection**	- type of selection that is based on the quality of the animal's ancestor
• **Family selection**	- type of selection that is based on the quality of the animal's relatives of its generation (full/half siblings)
• **Progeny selection**	- type of selection that is based on the quality of the animal's offspring

6.4.2.3 Types of Selection

Selection for improving traits/characteristics can either be directional, stabilizing or disruptive

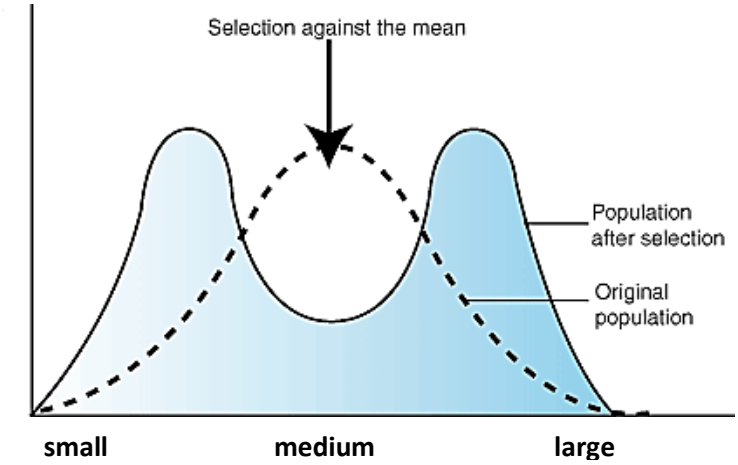
Directional selection : For one extreme against the other extreme

Directional selection- lead to a shift in the average of the population - right or left



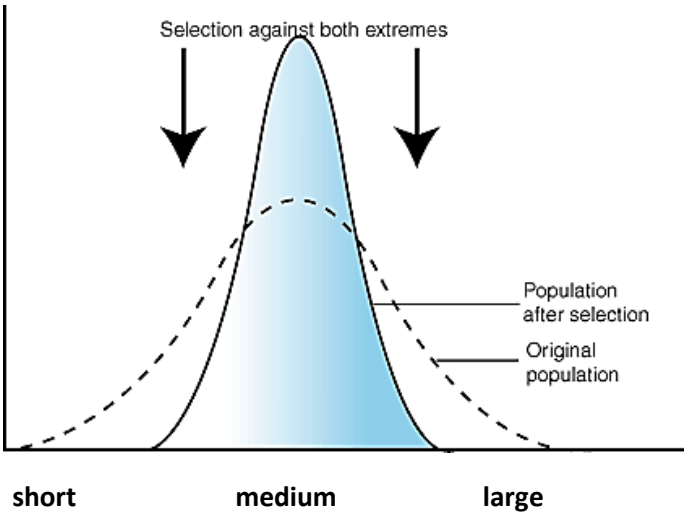
Disruptive selection: For both extremes against moderate traits

In the case of a disruptive selection, selection is done in such a manner that two distinct populations were created e.g Normal Brahman vs miniature Brahman populations



Stabilizing Selection: For moderate traits against both extremes.

In the case of stabilizing selection, selection is done to create a herd where e.g. more animal's weight is concentrated around the average.



e.g Birth weight, to large (heavy) calves will lead to dystocia in the cows, whereas to small (light) calves will have a limited chance of survival.

To achieve any of the above, the following **selection methods** can be used:

Family selection:

Pedigree selection:

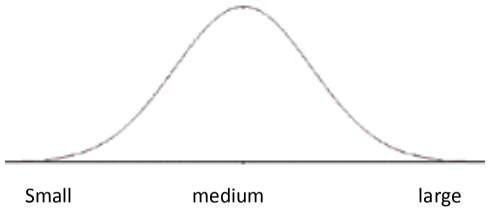
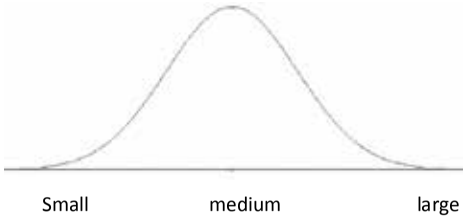
Progeny Selection:

Mass selection:

Activity 6.4.3: Question 1

Types of Selection:

Breeders raise cattle for various reasons. Example: Full/large size cattle for large farms and small sized cattle for small farms or pets. While listening in class complete your understanding of the types of selection and how it is applied in the agricultural sector.

		
Directional-selection	**Stabilizing-selection**	**Disruptive-selection**
Most common phenotype(previous) Most common phenotype now Because peak of the graph ……. This will lead to…..	Most common phenotype(previous) Most common phenotype now Because peak of the graph ……. This will lead to……	Most common phenotype(previous) Most common phenotype now Because peak of the graph ……. This will lead to……
Agricultural Example	Agricultural Example	Agricultural Example

6.4.2.4.Estimated Breeding Value:

An animal's breeding value is its genetic merit, half of which will be passed on to its progeny. While we will never know the exact breeding value, for performance traits it is possible to make good estimates. These estimates are called **Estimated Breeding Values** (EBVs).

In the calculation of EBVs, the performance of individual animals within a group is directly compared to the average of other animals in that group. A group consists of animals of the same sex and age class within a herd, run under the same management conditions and treated equally.

The absolute value of any EBV is not critical, but rather the differences in EBVs between animals. Particular animals should be viewed as being "above or below breed average" for a particular trait.

The heritability of the trait and the genetic correlations with other recorded traits are also important. Accuracy is an indicator of a breeding value's reliability and the risk entailed when a specific trait is selected. Accuracy is low, medium or high (see Table 1).

Table 1. Accuracy of breeding values

Accuracy	Reliability	Risk
<40%	Low	High
40% – 80%	Medium	Medium
>80%	High	Low

If an animal has 40% accuracy for a trait, it won't be very reliable at that point and the risk taken will be very high. On the other hand, it means that the breeding value has a 60% chance of changing in a positive (or negative) direction. If an animal has 80% accuracy, the risk is very low. The breeder can be assured that the animal will perform according to the breeding value.

The farmer notices that one animal in the herd seems to grow bigger than the others. It's slaughter weight is 750kg, whereas the average slaughter weight of the herd is 660 kg. The heritability of weight gain in beef cattle is 85%.

Calculate a simple estimated breeding value of the slaughter weight of an animal.

EB V = slaughter weight – Average herd weight ✓

= 750kg- 660 kg✓

= 90kg✓

Thus 90 x 85%✓

= 76.5KG ✓ (5)

Indicate whether the farmer should slaughter this animal or keep it for breeding purposes. Motivate your answer.
Keep the animal for breeding ✓ The slaughter weight gain has a heritability of 85 % ✓ it has a high chance to be transferred to the progeny. (3)

Suggest a more accurate way of calculating the EBV for this animal. (2)
The use of biometrics ✓✓ (biological statistics)

6.4.2.5 Breeding systems

Related breeding systems :

- **Inbreeding**: mating closely related animals
    - Father and daughter

Advantages	Disadvantages
Help to uncover undesirable recessive characteristics	Lowers the viability of the progeny
Increases hereditary power	Undesirable genes are made homozygotic
Increases the number of homozygote gene pairs	It often gives rise to defective animals

- **Linebreeding:** Mating distantly related animals
    - Mating of individuals with a special type of relationship. Less rigorous form of inbreeding and is aimed at retaining a relationship with a particular outstanding ancestor.
    - Same advantages and disadvantages as inbreeding

Unrelated breeding systems:

- **Outcrossing**: Mating unrelated animals in the same breed.
    - It increases genetic diversity, thus reducing the probability of an individual being subject to disease or genetic abnormalities.

- **Crossbreeding**: Mating animals of same species but different breeds.
    - Advantages: Development of new breeds
    - Applying of heterosis
    - Produce more
    - Grow faster
    - Higher weaning mass
    - More fertile
    - Better adaption
    - Better constitution
    - More resistance against diseases
    - Better utilization of feed
    - Better mothers

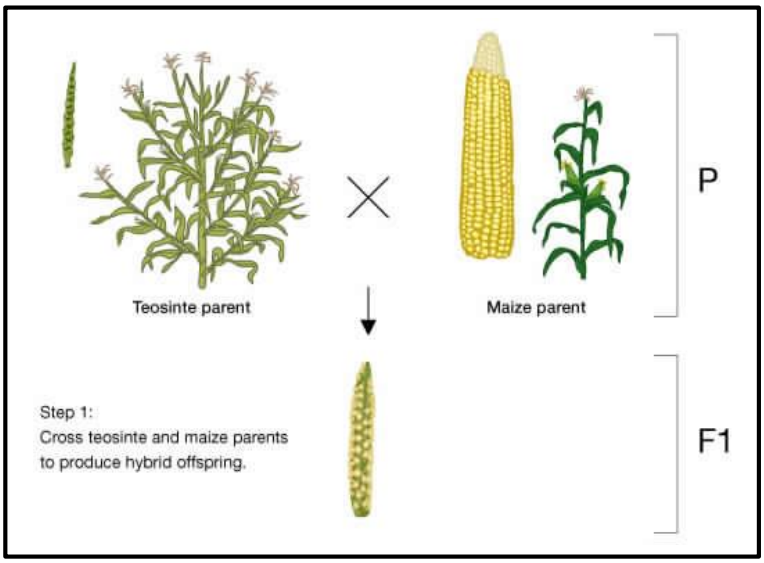
- **Upgrading:** mating purebreds with grade animals
    - Upgrading refers to crossing two livestock breeds with a specific purpose in mind—improving one of the breeds.
    - If accompanied by careful culling and selection of breeding stock,

upgrading can also introduce desirable characteristics (such as size, temperament, or meat or dairy qualities) into an established breed. Some livestock breeders also use upgrading to build herds specially adapted to their climate and pastures.

6.4.3. Activity: Breeding

Question 1.

Study the following picture and answer the questions.



1. Identify the type of breeding system above. (1)
2. Discuss the importance of plant breeding research for the current global problems. (2)
3. State TWO disadvantages of the breeding system in 4.3.1. (2)

Question 2:

The crossings A, B and C below represent different breeding systems applied in cattle farming.

A	B	C
Commercial mixed-breed cow **X** Holstein stud bull	Sussex bull **X** Sussex cow (bull's daughter)	Afrikaner bull **X** Shorthorn cows

2.1 Identify the breeding systems represented by **A**, **B** and **C**. (3)

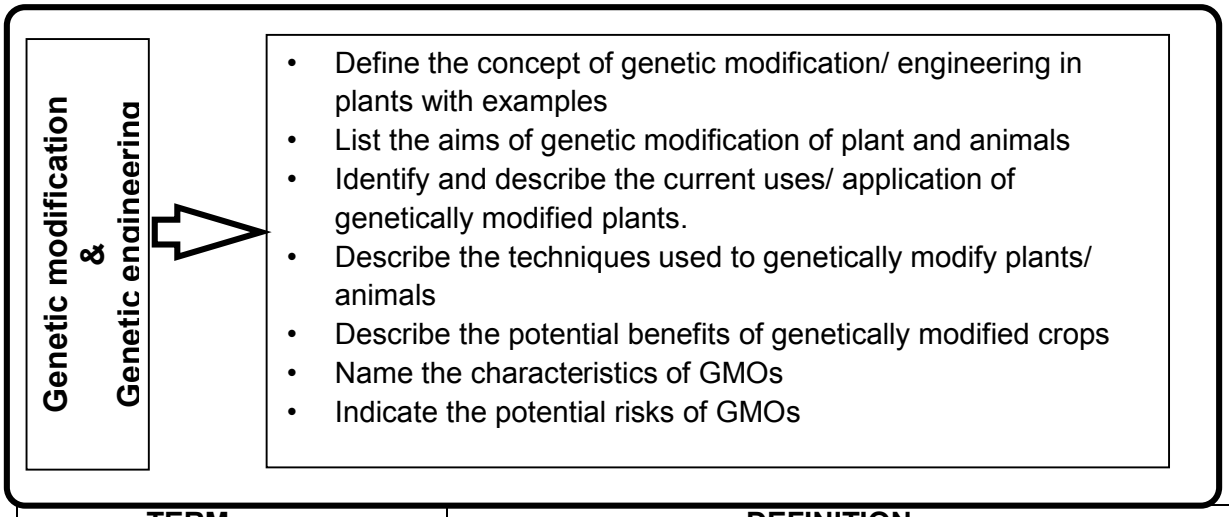
2.2 Indicate the breeding system (**A**, **B** or **C**) that promotes heterosis. (1)

2.3 Explain the advantages of heterosis (hybrid vigour) (3)

2.4 State TWO disadvantages of the breeding system represented by crossing **B**. (2)

6.5 Genetic Modification & Genetic Engineering:

Learning outcome:
By the end of this section the learner should be able to demonstrate knowledge of the following content:



TERM	DEFINITION
Biotechnology	- the use of organisms to produce useful substances
Breeding	- process of producing plants or animals by sexual reproduction
Cloning	- a research activity that creates a copy of some biological entity (a gene/cell/organism)
GMO	- an organism whose genetic characteristics have been changed by inserting gene/s of another organism into its DNA
Genetic modification	- The manipulation of the genetic material of an organism to get desired changes.

6.5.2 Definition: Genetic engineering and genetic modification are terms for the process of manipulating genes, usually outside an organism's normal reproductive process. The concept includes any use of technology to alter the genetic material of a living cell for agricultural, medical or industrial purposes.

Some Examples in Agriculture:
- Tomatoes that have a longer shelf life
- Bt- maize which is resistant to the insect pests
- Crops like rice that has a higher nutritive value
- Strawberries that are cold resistant.

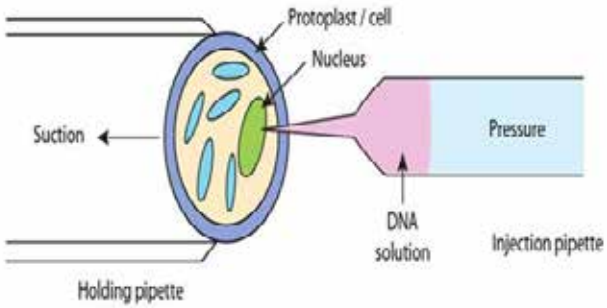
6.5.2.1 Aims of genetic manipulation in plants and animals:

Aims of genetic manipulation in plants	Aims of genetic manipulation in animals
• indirectly improving crop yield by making them pest and disease resistant • directly improving crop yield by improving tolerance to environmental conditions • improving commercial properties such as flavour and shelf life • producing pharmaceutical crops that produce proteins, drugs and vaccines for humans 	• Improving production characteristics such as growth rate, disease resistance and milk production. • improving food quality • producing medicine producing industrial or consumer products, such as fibre 

6.5.2.2The Characteristics of GMO's

- Resistance to pests, diseases and herbicides
- Tolerance of extreme temperature conditions, drought and saline conditions
- Improvements such as nutrient enrichment, yield and shelf life
- Special abilities such as helping to clear pollution and store vaccines
- May be so expensive to acquire that poorer farmers may not be able to afford the seed/material

Food safety of GMOs and potential risks to human health have not been clarified.

The techniques used in genetic modification:	
• Recombinant DNA • Bacterial carriers • Biolistic • Calcium phosphate precipitation • Electroporation • Gene silencing • Gene splicing • Lipofection • Micro-injection • Viral carriers.	 Micro- injection

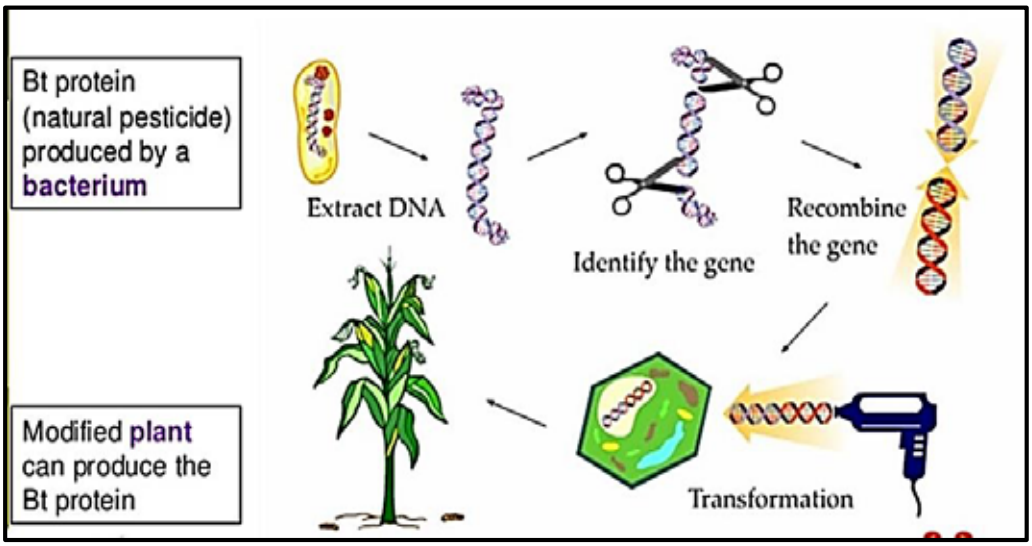
Benefits and risks of Genetic manipulation

Benefits	Risks
• It may become possible to grow crops in previously non-arable areas. • GM crops may be more productive (produce higher yields), and therefore feed a growing world population at lower cost. • Some GM crops are resistant to pests and diseases and therefore reduce the use of chemicals. This is better for the environment. • Some GM crops have a longer shelf life and improved properties such as . Better flavour, colour, texture and nutritional value. • Use of GM crops can have a positive effect on the economy, especially in less-developed countries. Already, implementation of GM cotton crops has led to economic gains in South Africa. • GM crops can allow people to receive medicines and vaccines that are difficult to distribute.	**Environmental hazards**. Unintended harm to other organisms Reduced biodiversity Reduced effectiveness of pesticides Gene transfer to non-target species The toxic effects of insect-resistant plants could potentially also kill beneficial insects such as bees **Human health risks** Unknown effects on human life Increased allergies: Be a possible cause of cancer and the loss of an effective immune system GM crops contain genes that offer resistance to antibiotics **Economic concerns** GM crops are patented and farmers may not retain seed for breeding purposes, which means that they have to buy new seed each year. GM seeds for a particular variety all have the same genetic composition. This makes them vulnerable to infection, which can destroy the entire crop

6.5.3 Activity:

Question 1:

Genetic engineering is also called genetic modification or genetic manipulation.



1. Define the term '*genetic engineering*'. (2)

2. Evaluate the diagram above to identify the techniques used to produce the modified plant. (2)

3. There are potential risks related to GMO's. Discuss ONE of these environmental risks. (2)

Answers to activities:

Activity 6.1.3 : Punnetsquare

Question 1

1. 2 Black (Bb) :√ and 2 White (bb) :√ (2)
2. The heterozygous parent is male :√ (1)
3. 2/4:√ = 50% :√ (2)

Question 2:

The genotype of both parents is Bb (Heterozygous) √ Black √

	B	b
B	BB	Bb
b	Bb	bb

(2x √ for correct punnet square)

Possible phenotypes :3 Black and 1 White √

Possible genotypes : 1 (BB): 2 (Bb) : 1 (bb) √ (6)

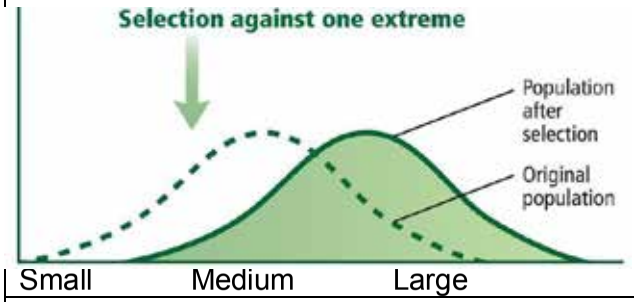
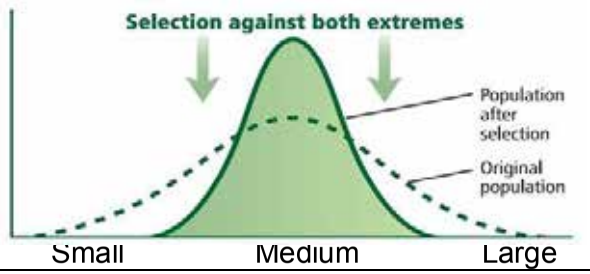
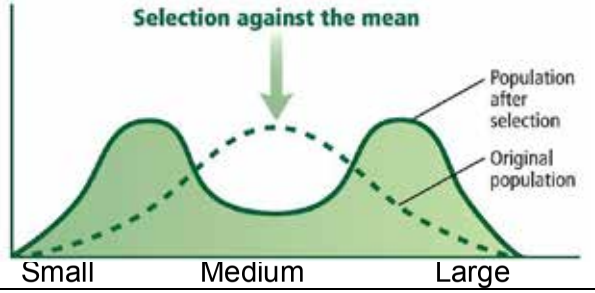
Activity 6.2.3 Incomplete dominance

Question 1

1. Incomplete dominance✓ (1)
2. Genotypes represented by:
   - A - F^R F^R ✓
   - B - F^R F^W✓
   - C - F^W F^W✓ (3)

3. Phenotypic ratio of the F_2 generation
   - 1:2:1✓✓
   - **OR**
   - 1 red: 2 pink: 1 white✓✓
   - **OR**
   - 25%: 50%:25%✓✓ (2)

Activity 6.4.3: Question 1 : Types of Selection

 ✓	 ✓	 ✓
Directional-selection	**Stabilizing-selection**	**Disruptive-selection**
Phenotypes: Small✓, Medium✓, Large✓ Most common phenotype: Medium✓ After selection most common phenotype now is larger.✓ Because peak of the graph – will move to the right.✓ This will lead to an increases of average weight in the population. ✓✓	Phenotypes: Small✓, Medium✓, Large✓. Most common phenotype: Medium✓ After selection most common phenotype remains medium.✓ Because peak of the graph narrowed and remains over medium sized animals.✓ This will lead to more animals weight will be medium.✓✓	Phenotypes: Small✓, Medium✓, Large✓ Most common phenotype: Medium✓ After selection most common phenotype now is Small and large.✓ Because peak of the graph will develop in two places on the left and on the right.✓ This will lead to two distinct populations will developed over small and large individuals.✓✓
Agricultural Examples: Higher milk production✓, higher weaning weight, ✓	Agricultural Examples: Mature mass✓, birth weight✓	Agricultural Examples: Miniature and normal sized breeds✓, colour variation✓.

Activity 6.4.3: Breeding

Question1

1. **Cross breeding**
   Cross breeding✓ (1)

2. **Importance**
   Plant breeding has the ability so significantly contribute to solving the challenges ahead such as food security, ✓ hunger alleviation, ✓ increasing nutritional values✓ and countering higher input costs. ✓ Any 2 (2)

3. **Disadvantages**
   - Hybrid seeds are not adapted to all conditions✓
   - Many other cultivars disappear because of the use of hybrid seeds✓
   - A Few large companies control hybrid seeds ✓
   - Hybrid seeds must be bought every year✓
   - Hybrid seeds and management are expensive✓ Any 2 (2)

Question 2

2.1 **The breeding methods:**
A. Upgrading ✓
B. Inbreeding ✓
C. Crossbreeding ✓
(3)

2.2 **Breeding method for heterosis**
C/A ✓ (1)

2.3 Hybrid vigour:
It can result in offspring having the best characteristics of both breeds,
✓ therefore increased pest & disease resistance, increased production,
✓ better adaptability to harsh environmental conditions✓
(3)

2.4 **TWO disadvantages of inbreeding**
- Loss of vigour/performance/inbreed depression ✓
- Loss of fertility ✓
- Smaller genetic variation ✓
- Increase of lethal genes which can result in death ✓
- Reduced vitality ✓
- Fixation of undesired genes ✓
- Expert knowledge required ✓
- Less resistance to diseases ✓
- Poorly adapted to the environment ✓
- Deformed animals ✓ (Any 2)

(2)

Activity 6.5.3: Genetic engineering

Question 1

1. **Definition**

Genetic engineering is the direct human manipulation✓ of an organism's genome✓ using modern DNA technology (2)

2. **Techniques of GM**

- Recombinant DNA / Gene splicing✓
- Biolistics / Gene gun✓ (2)

3. **Environmental risk**

- Although the BT toxins used in BT crops are specific only to certain classes of insects, the longer term impacts on the ecosystem of their presence in plant foods is not yet well established. ✓✓
- Farmers may use weed killers indiscriminately on herbicide resistant crops if they know their crops are less susceptible to these chemicals, thereby increasing the prevalence of herbicides in the environment. ✓✓
- The toxic effects of insect resistant plants could potentially also kill beneficial insects such as bees. ✓✓
- Insect-resistant or herbicide tolerant crops can potentially cause the development of harmful pest resistance plants, or so-called 'super-weeds'. ✓✓

any (2)

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