Via Afrika Agricultural Sciences

Grade 10 Study Guide

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Via Afrika

Our Teachers. Our Future.

Vicki van der Westhuizen

Study Guide

Via Afrika Agricultural Science

Grade 10

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Contents

Introduction to Agricultural Science

Agricultural Sciences is the study of the relationship between soils, plants and animals in the production and processing of food, fibre, fuel and other agricultural commodities that have an economic, aesthetic and cultural value. Agricultural Sciences is an integrated science. It combines knowledge and skills from Physical Sciences, Life Sciences, Social Sciences, Earth Sciences, Engineering, Mathematics and Economics. This subject must be seen within the holistic science framework rather than as an isolated science.

In Agricultural Sciences you will:

- develop an awareness of the management and care of the environment, natural resources and the humane treatment of animals through application of science and related technology
- develop problem-solving mechanisms within the contexts of agricultural production, processing and marketing practices
- be aware of the social and economic development of the society at large through personal development in commercial and subsistence farming enterprises
- become informed and responsible citizens in the production of agricultural commodities, caring for the environment and addressing social justice issues
- be aware of agricultural indigenous knowledge and practices through understanding agricultural sciences in historical and social contexts.

Rationale for Agricultural Sciences

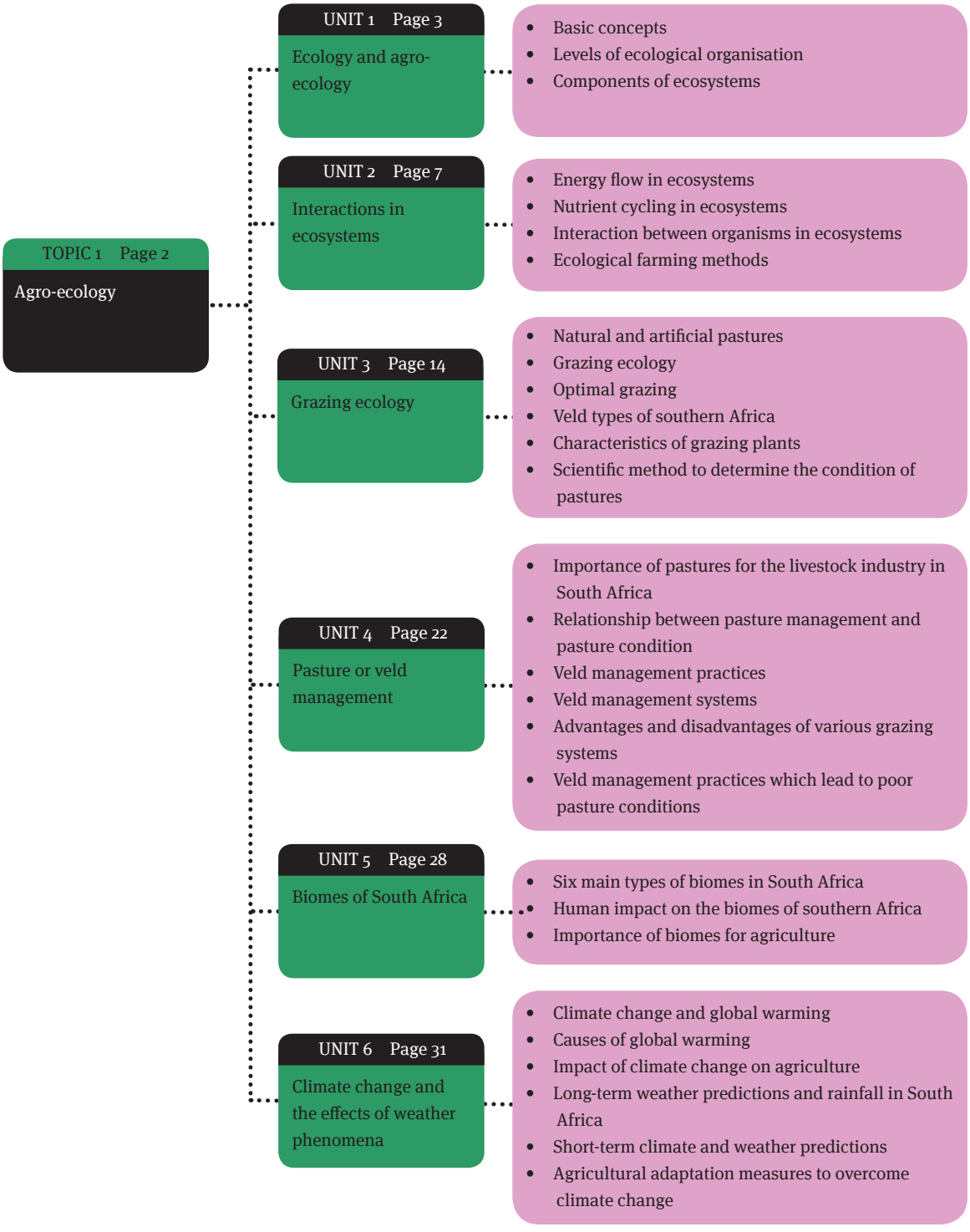
The interdependence of people and natural resources and the increasing demand on the latter has led to a need for proper utilisation, management and conservation of agricultural and natural resources. Relevant education at secondary school levels can contribute to meeting these demands in a sustainable way. An appreciation and awareness of the importance of natural resources and a responsibility towards their preservation should be fostered from an early age through the Natural Sciences learning area.

To fulfil the increasing demand for food and fibre and to meet the aspirations of communities, the acquisition of relevant knowledge, skills, attitudes and values is of vital importance.

Topic 1

Agro-ecology

Overview



What you will cover in Topic 1

Unit 1

Ecology and agro-ecology

1.1 Basic concepts

1.1.1 Ecology

Ecology is the branch of biology that deals with the relations of organisms to:

- one another
- their physical surroundings.

1.1.2 Agro-ecology

Agro-ecology is a special branch of ecology. It looks at how these relations of organisms to one another and to their physical surroundings apply to agriculture.

1.1.3 Agro-ecosystems

- A farm is an ecosystem. It includes agricultural plants and systems, and so it is called an agro-ecosystem.
- Knowledge of agro-ecology and agro-ecosystems helps us to:
  - choose the best animals and plants to farm on a particular piece of land
  - use the land in a productive way to provide food, fuel and fibres
  - preserve the land for the use of future generations.

1.2 Levels of ecological organisation

1.2.1 Biosphere

The biosphere is that part of our planet Earth (crust, water and air) that supports living organisms. There are three main environments on Earth:

- the sea
- fresh water
- land.

1.2.2 Biomes

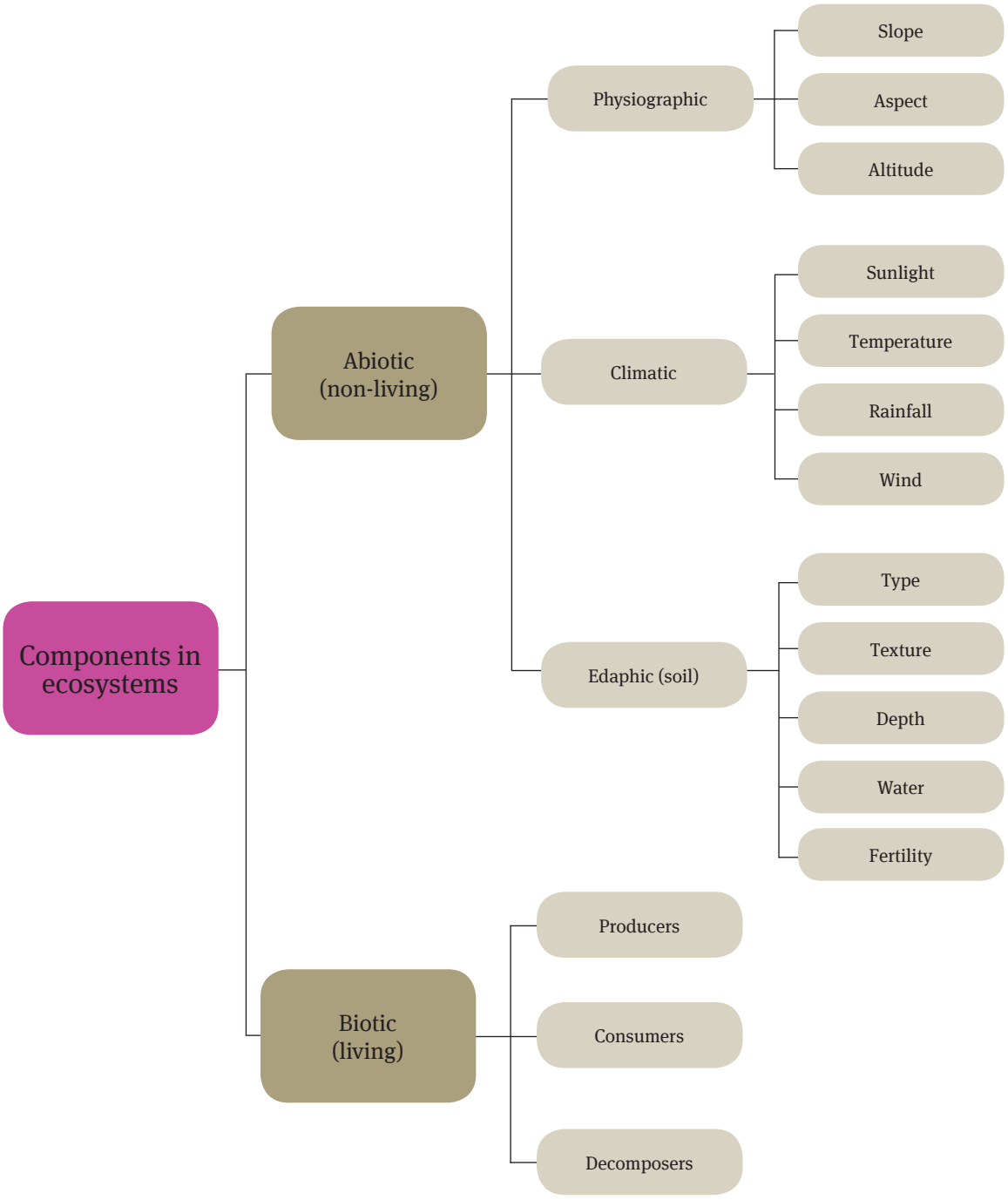
Different parts of the land have different climates. Climates divide the land into smaller environments called biomes or ecological regions. Biomes are areas that have similar types of plants and animals. The plants and animals in one biome are different from those in other biomes. There are six main biomes or ecological regions on Earth:

- forests
- Savanna
- Grasslands
- Tundra
- semi-deserts
- deserts.

An environment (ecosystem) consists of living things and non-living things. The living things are structured into layers, or levels of organisation:

- community: all the plants and animals in the ecosystem (e.g. a forest consists of trees, moss, ferns, birds, insects, etc.)
- population: a group of organisms of the same species (e.g. all pine trees in a forest)
- individual: the separate members of a population (e.g. a single pine tree).

1.3 Components of ecosystems



Components in ecosystems

An ecosystem consists of non-living things (abiotic factors) and living things (biotic factors).

1.3.1 Abiotic factors

Physiographic factors

Physiographic factors refer to the appearance of the land (rivers, hills, mountains or valleys). The appearance of the land is determined by the slope, aspect and altitude. These affect plant growth because they affect the climate.

- Slope: a measure of the steepness of the land.
  - In heavy rain, water that doesn't enter the soil runs down the slope. The steeper the slope, the more runoff; therefore, steeper slopes support less plant growth. There are three types of slope: flat land, gentle slope and steep slope.
- Aspect: the direction in which the slope faces (N, S, E, W).
  - The climate of a slope changes with the aspect. In the southern hemisphere, north-facing slopes are usually hotter and drier than south-facing slopes. West-facing slopes have afternoon sun, whereas east-facing slopes have morning sun. West-facing slopes are usually hotter and drier than east-facing slopes, but not as hot as north-facing slopes.
- Altitude: the height above sea level.
  - Temperature decreases with increasing altitude because the atmosphere (which holds heat) gets thinner higher up. Altitude can cause the climate to change over very short distances.

Climatic factors

Climate is influenced by:

- Sunlight: intensity and duration per day. Plants need sunlight to photosynthesise.
- Temperature: how hot or cold the air is. Temperature decreases as we move from the equator towards the poles – affects plants and animal life.
- Rainfall: plant and animal life are influenced by:
  - precipitation: water that comes from the air – rain, hail, frost, snow, dew and mist
  - average annual rainfall: the amount of rain that usually falls in one year, measured in millimetres. (Ecosystems with a high average annual rainfall support more plant and animal life than those with a low average annual rainfall. Water-loving plants grow in wet areas; drought-tolerant prefer low rainfall.)
- Wind: plants use the oxygen in air for photosynthesis.
  - the direction and strength of the wind influences an ecosystem
  - wind influences rainfall patterns, for example, wind from the sea contains more moisture than wind from the land
  - wind spreads seeds and pollen.

Edaphic factors (factors that influence the soil)

- Soil types differ in:
  - size of the soil particles
  - amount of water they hold
  - amount of air they contain
  - colour
  - depth
  - type and amount of minerals they contain.
- Soil texture:
  - sandy (grainy and loose)
  - clay (sticky and dense)
- Soil depth:
  - from a few centimetres to over two metres deep
  - plants get minerals, water and air from soil, so deep soils support more plant growth than shallow soils.
- Soil water:
  - refers to water holding capacity (the ability of soil to hold water), for example:
    - sandy soils drain quickly and have poor water holding capacity – can't support much plant growth
    - clay soils hold a lot of water and drain slowly – contain little air, e.g. wetland areas.
- Soil fertility:
  - fertile soil contains many nutrients and supports plant growth
  - poor soil lacks nutrients and doesn't support plant growth.

1.3.2 Biotic factors

- Producers: Green plants that make their own food through photosynthesis.
- Consumers: Organisms that can't make their own food; they eat other organisms:
  - herbivores (cows and sheep) feed on plants
  - carnivores (lions) eat animals
  - omnivores (people) eat plants and animals.
- Decomposers: Break down dead plants and animals through decay – minerals return to the soil.

Unit 2

Interactions in ecosystems

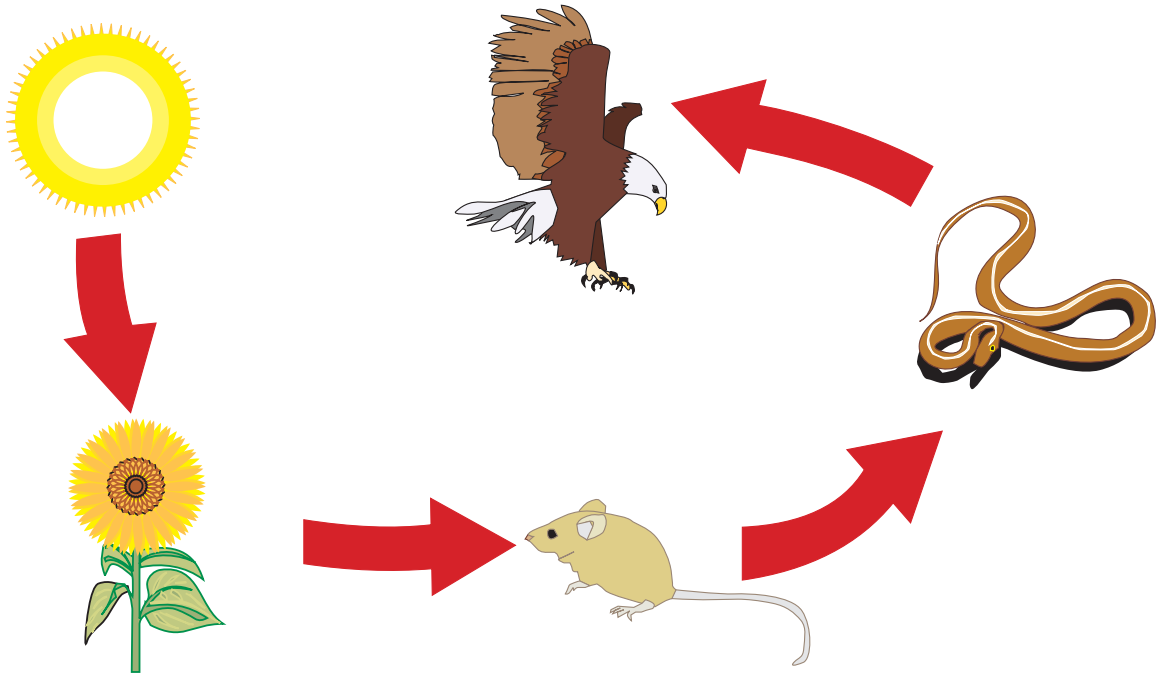
2.1 Energy flow in ecosystems

Energy flows from one thing in an ecosystem to another:

- the sun (non-living) is the main source of energy in an ecosystem
- plants (living) change sun energy into chemical energy, in the form of carbohydrates
- animals eat the plants and absorb the energy
- the energy is passed on from one living thing to the next.

2.1.1 Food chains

A food chain is a hierarchical series of organisms. Each organism in the chain is dependent on the next organism as a source of food.



A food chain

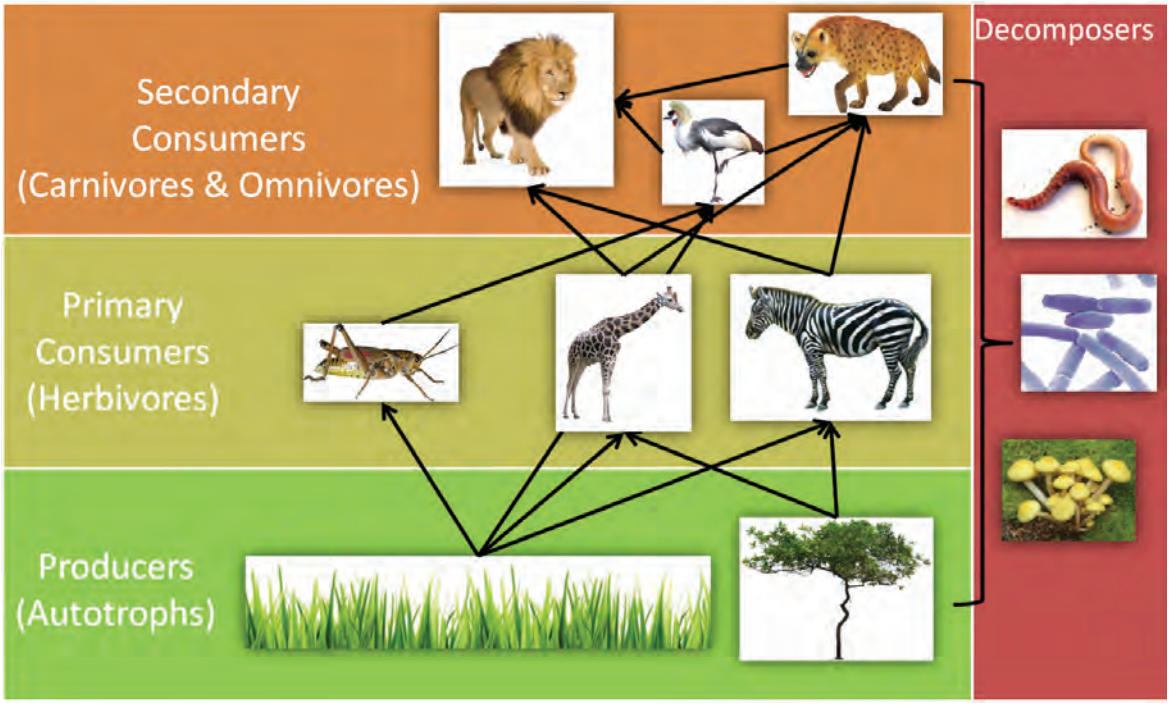
Sunlight is a source of light energy. The sunflower uses nutrients from the soil + water + carbon dioxide, to change the sun's light energy to chemical energy, or food. The mouse eats sunflower seeds. The snake eats the mouse. The owl eats the snake. When the owl dies, it will decompose, and the nutrients return to the soil.

Each step in this food chain is called a trophic level:

- the producers (plants) are the first trophic level
- the herbivores that eat the plants are the second trophic level
- the carnivores are the third trophic level.

2.1.2 Food webs

Animals do not only eat one type of prey. For example, snakes eat mice, insects, small birds and frogs. A food web is a way of showing all the connected food chains in an ecosystem.



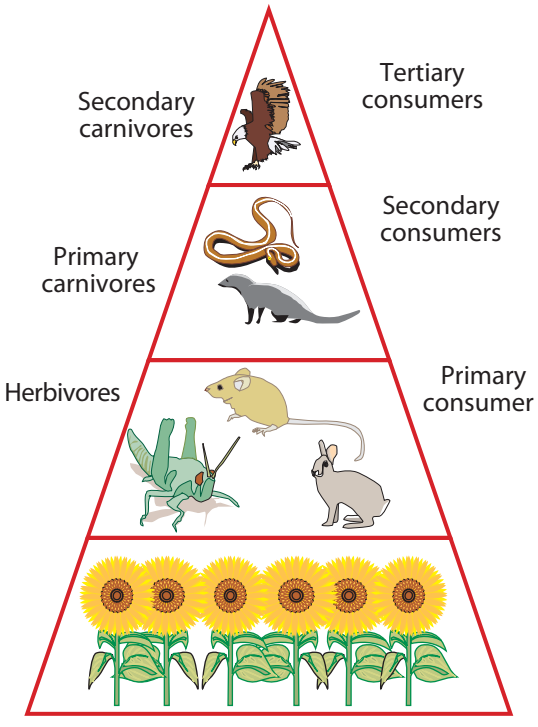
A food web

2.1.3 Ecological pyramid

An ecological pyramid is a diagram to show all the trophic levels in an ecosystem.

The first trophic level is the bottom of the pyramid.

- The first trophic level consists of producers.
- This level contains the most energy.
- Energy decreases as it goes up through the levels.
- Some food chains only have three trophic levels, whereas others have five.



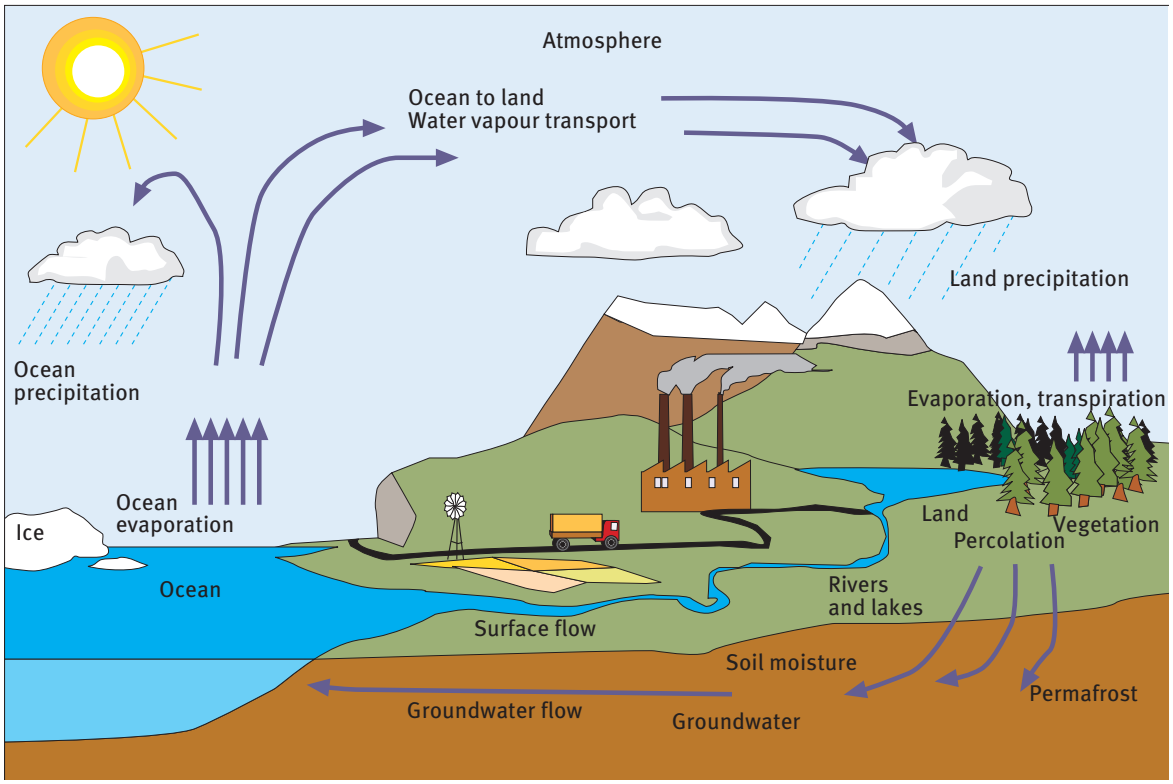
An ecological pyramid

2.2 Nutrient cycling in ecosystems

The supply of nutrients in an ecosystem (water, carbon, nitrogen) is limited. They move through ecosystems in continuous cycles:

non-living things → living things → non-living things.

2.2.1 The water cycle



The water cycle

Water molecules move continuously from one reservoir to another:

- Water in the ocean or a river = in the liquid phase.
- Evaporation: water changes to the gas phase / water vapour.
- Sublimation: ice changes to vapour.
- Evaporation and sublimation use heat energy from the sun.
- Condensation: vapour rises up into the atmosphere and cools down – form drops (change back into liquid).
- Precipitation: drops combine with others – form clouds – become heavy and fall to the ground as rain, snow or hail.

The sun heats the Earth: surface water + water in the soil evaporates and rises into the air. Plants take up soil water with their roots. This water moves up through the plant and evaporates from the leaves. The water in the air rises and forms clouds. The clouds produce rain and the cycle begins again.

2.2.2 The carbon cycle

- Carbon = a building block of vitamins, carbohydrates, fats and proteins.
- Main source of carbon = carbon dioxide (CO_2).
- Photosynthesis: plants use CO_2 to make organic substances, for example, carbohydrates.
  - Carbohydrates contain carbon.
- Living organism eats the plants and absorbs the carbon → organism dies and carbon returns to the soil.
- Living organism breathes in oxygen and breathes out CO_2 → carbon returns to the atmosphere in the form of CO_2.

2.2.3 The nitrogen cycle

- Nitrogen = building block of protein.
- Nitrogen forms part of the atmosphere, but living things can't absorb it from the atmosphere:
  - Step 1: Nitrogen fixing. Legumes have bacteria on their roots. Bacteria fix atmospheric nitrogen by changing it to ammonia (NH_3).
  - Step 2: Nitrification: Nitrifying bacteria in the soil changes the ammonia to nitrates (NO_2). Plants can absorb nitrates.
- Lightning and fertiliser add nitrogen to the soil.
- When plants die, they are broken down by decomposers and the nitrogen is returned to the soil in the form of ammonia. Nitrifying bacteria in the soil change the ammonia to nitrates (NO_2).
- Heavy rain: denitrifying bacteria change nitrates back to nitrogen gas, which returns to the atmosphere.
- Leaching: nitrates are soluble. When water runs off, nitrates are removed from the soil. Nitrates in drinking water are harmful to humans and animals.

2.3 Interaction between organisms in ecosystems

2.3.1 Competition

Organisms compete for limited resources (food, water, territory):

- Intraspecific competition: animals of the same species (e.g. two male lions) competing to mate with the same lioness.
- Interspecific competition: animals of different species (e.g. cheetahs and lions) competing for same prey.

Competition affects the structure of the community. Animals or species that cannot compete effectively will leave the ecosystem or die.

2.3.2 Predator and prey

Predation is when a predator (the animal that hunts) eats its prey (the animal that is hunted). There are different forms of predation:

- a lion ambushes and kills its prey, and eats it
- a snake swallows its prey (frog) whole
- a jellyfish subdues prey with venom before eating it
- a rattlesnake's venom starts to digest the prey even before swallowing it.

2.3.3 Mutualism

Both organisms benefit from the relationship, for example, ungulates and bacteria in its intestines:

- bacteria produce cellulase (enzyme) that digests cellulose = benefits ungulate because their food is digested
- bacteria benefit because they live in an environment that supplies food.

2.3.4 Commensalism

One organism benefits, the other doesn't, but is not harmed either, for example, a shark and remora:

- remora attaches itself to shark – benefits = transport and food.
- shark does not benefit, but is not harmed.

2.3.5 Parasitism

- One organism (parasite) lives on or within and feeds on another (the host).
- The parasite benefits, but the host is weakened, for example, dodder (visible) on plants and cholera bacterium inside the digestive tract of humans.
    - In both cases the host is harmed while the parasite benefits.

2.4 Ecological farming methods

In the past, conventional farming methods were used to increase yields and maximise profits without concern for the environment, for example:

- synthetic fertiliser to increase the yields of crops
- herbicides to get rid of weeds
- pesticides to get rid of pests
- hormones and antibiotics.

From the end of the 1900s: ecological farming systems started becoming popular.

2.4.1 Organic farming

Does not use:

- synthetic fertilisers, herbicides and pesticides on crops
- hormones, food additives, antibiotics for livestock
- hormones or food additives to promote growth in livestock
- antibiotics to rid livestock of diseases, unless necessary.

Does use:

- crop rotation – growing a different crop on the same land each year for 3 – 5 years to rest the soil because different crops:
  - absorb different nutrients from the soil
  - attract different weeds and pests (crop rotation prevents weeds and pests from establishing themselves).
- green manure – a cover crop that is planted to add nutrients and organic matter to the soil.
  - This crop is left on the land for a while, and then ploughed into the soil.
  - Clover is often used for bacteria (nitrogen fixing)
- compost – decomposed plant matter to add nutrients
- biological pest control – natural enemies
- mechanical weed control – with implements, e.g. a cultivator or hoe.

2.4.2 Biological farming

Farmers use biological farming systems, for example:

- ensuring soil has correct nutrient balance:
  - the soil is tested for ten nutrients (boron, calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sulphur and zinc) to determine the amount of nitrogen to be added
- ensuring that soil contains sufficient microbes for correct pH level (acidity and alkalinity)
- using natural fertilisers, such as compost, as far as possible
- no herbicides and pesticides
- rotating crops every year or two.

2.4.3 Conservation farming

Farmers use natural ecological processes to:

- get rid of pests and weeds
- reduce soil erosion on their farms
- increase the soil's fertility and structure
- save water.

They do this in three ways:

- minimal soil disturbance: no land tilling – soil is not disturbed so
  - soil minerals are maintained
  - erosion is minimised
  - water is not lost from the soil
  - production cost due to tilling is saved.
- retaining crop residues – the land isn't tilled, so residues of previous crops create a permanent organic cover (mulch):
  - prevents soil erosion
  - prevents soil moisture from evaporating.
- crop rotation with two or more crop types – frequent crop rotation = natural pesticide and herbicide because different crops attract different weeds and pests.

2.4.4 Game farming

The hunting and the selling of live game animals and game products (e.g. venison, hides, etc.)

2.4.5 Sustainable or alternative farming

Uses the same approach as biological and organic farming:

- crop rotation
- avoid or minimise the use of pesticides, herbicides and fertilisers
- cover the soil to minimise erosion and control weeds
- control pests with natural predators
- enrich the soil by organic methods.

Unit 3

Grazing ecology

3.1 Natural and artificial pastures

- Natural pasture:
  - an area where people have not intervened.
- Artificial pasture:
  - an area where people have planted grass types or other plants for grazing: first remove the existing vegetation and then sow seeds of a grazing plant, e.g. alfalfa or orchard grass.

3.2 Grazing ecology

- A pasture is an ecosystem on its own, because it has a selection of living and non-living things within the same environment.
- The study of the relationship between the parts of the pasture's ecosystem is called grazing ecology.
- Grazing ecology determines the type and number of animals that can be kept on a piece of land.

3.2.1 Ecological succession in grassland

The type of veld growing in an area can change as time passes. If this happens by itself, without the interference of people, it is called plant succession or ecological succession.

On a ploughed area of bare soil, plants will start to grow on the bare soil. The first plants to grow will not be the same as the plants that were there before the land was ploughed:

- The first plants to grow on bare land (pioneer species) are usually annuals.
- After some time, perennial plants, including grasses, begin to grow on the land.
- The type of perennial grasses changes over time.
  - If the temperature and rainfall are high enough, woody bushes and then trees start to grow amongst the grasses.
  - If there is no fire to destroy the woody plants, then the area will become covered in forest. The change from pioneer species to forest can take a long time.
  - The plants in the forest are called climax species. Forest plants are called climax species because there will not be much more change in the type of plants once the forest stage is reached.
  - If the temperature and rainfall are not high enough for forest to grow, or if regular fires kill the woody plants, the climax species will not be forest plants, but some other type of veld, for example:
    - In the grasslands of the cool lower rainfall areas, perennial grasses are the climax species because the climate stops them from changing from grass into another veld type. The climatic climax grasslands are usually sweetveld.

- If there is no fire, the grasslands in the warm high rainfall areas in the east of the country will slowly change into forest. The climate in this area is suitable for forest, but fires keep the area a grassland.
- In the Karoo, small bushes are the climax species because low rainfall stops the Karoo veld from changing to forest.
- In the savanna areas, low trees and grass are the climax species. The temperatures are high enough for trees to grow, but the low rainfall stops the change to forest.

Grasslands at the climax stage are the best for grazing animals. Climax species of grass are usually the most palatable (soft, tasty and nutritious).

Pioneer species are usually unpalatable (tough, taste and smell bad). Grazing and invader plants can also cause ecological succession.

Grazing

- Overgrazing
  There are more grazing animals than plants for them to eat.
  - The animals eat most of the grass plants → the plants do not set seed → few new plants grow → perennial grass plants get weak because they do not have time to re-grow → soil is left bare → it begins to erode → pioneer species (unpalatable) become plentiful.
    - In savanna veld, bushes grow more thickly → the veld can no longer be used for grazing animals, such as sheep and cows.

- Selective grazing
  Animals eat the most palatable plants and leave the unpalatable ones → only the unpalatable plants remain and the veld is of little use for grazing farm animals.

- Undergrazing
  This happens in fire climax grasslands, when the climax species begin to be replaced by taller species as the grassland slowly begins to change to forest.
  - These taller grass species are good for thatching roofs, but are usually unpalatable.

Plant invaders

Invaders are brought by people from another area or country, e.g. Lantana, Imbricate cactus, Port Jackson.

Because they have no natural enemies, they increase fast and replace the plants that used to grow in the veld.

3.2.2 Adaptations by game animals before agriculture

Before organised and commercial agriculture, there were no fences, farm boundaries or grazing camps.

- Large herds of game moved across southern Africa in search of grazing and water.

Results

- Short periods of high intensity grazing, followed by a long period of rest during which the veld could recover fully.
- Veld was not over-grazed because it was grazed by different species of animals – not only by one kind of livestock: some species grazed close to the ground, others further from the ground, while some species grazed small trees; also, some species preferred one type of grass, while others preferred another type.
- Different animals have different trampling patterns, so the veld did not become completely trampled in one spot.
- Natural veld fires occurred when the veld conditions could benefit, and not during every season.

These are the natural, balanced grazing conditions that modern ecological pasture scientists are trying to copy.

3.2.3 Selective and non-selective grazing

Selective grazing happens when grazing animals do not graze all the plants in a particular area, but prefer certain plants, for example:

- type of animal – some animals are 'picky eaters' (sheep are more selective in what plants they eat).
- plant selection – animals eat only the palatable plants, and leave the unpalatable ones. After a time, only the unpalatable plants remain and the veld is of little use for grazing farm animals.
- height selection – animals only eat a part of the plant, preferring to leave the lower parts of the plant.
- area – this is when animals prefer a certain area in the veld, such as next to a river, or if animals are kept in camps, they might prefer a certain spot in the camp.

Non-selective grazing happens when you force the grazing animals also to graze the unpalatable grasses. This happens when the veld is dominated by unpalatable grass. However, overgrazing can happen easily.

3.2.4 Zero grazing

Animals are enclosed and fodder brought to them to prevent tick-borne diseases and other health hazards. This is often done in dairy farming.

3.3 Optimal grazing

Optimal grazing refers to making the best use of the available veld or pasture. For optimal grazing you must consider:

- carrying or grazing capacity
- stocking rate (SR).

3.3.1 Carrying or grazing capacity

The grazing capacity is the average number of animals that a particular farm can sustain over a period of time. The grazing capacity is based on the stocking rate.

3.3.2 Stocking rate (SR)

- SR = the number of animals that can graze on one hectare of land, for the grazeable part of one year (not winter), without doing damage to the condition of the veld.
- If more animals than is indicated by the SR are allowed to graze = overgrazing and the veld is damaged: most of the grass is eaten → no seed is produced → no new plants grow → bushes grow more thickly and veld becomes unsuitable for grazing.

3.4 Veld types of southern Africa

In southern Africa there are three veld types:

Veld type	Climate	Soil characteristics	Plant characteristics
Sweetveld	Warm temperature with lower rainfall (250–500 mm). No frost	Soil does not get washed away. Soil remains nutritious.	Palatable and nutritious. Can be used all year round.
Sourveld	Higher rainfall area, moderate summer temperatures, very cold winters with frost.	Nutrients in the soil are washed out. Soil less nutritious. Soil is acidic.	Plants store nutrients in their roots during winter. Leaves less palatable and nutritious. Sourveld can only be used in the summer.
Mixed-veld	Combination of sweetveld and sourveld. Higher rainfall and lower temperature.	Soil less acidic and more nutritious than sourveld areas.	Leaves more palatable than sourveld plants, but veld must be watched carefully to prevent over-grazing.

Climate, soil and plant characteristics of veld types

3.5 Characteristics of grazing plants

3.5.1 Nutritive value

Grazing plants differ in their nutritive value. Some plants are more nutritious than others. Some plants are only nutritious for parts of the year (season of use).

Nutritive value of sourveld and sweetveld

- Sourveld can be grazed only during the growing season (spring and summer):
  - the excess must be cut and baled
  - in autumn, the grasses become unpalatable (plants move the nutrients to the roots)
  - sourveld is found in the high rainfall areas (east), so it grows thickly.
- Sweetveld can be grazed the whole year:
  - it is found in drier areas than sourveld, so it grows less thickly than sourveld
  - fewer animals can graze on an area of sweetveld than on the same area of sourveld, but they can graze throughout the year
  - sweetveld also retains its nutritional value throughout the growth season.
- Mixed-veld is a mixture of sweetveld and sourveld
  - it can be grazed for 6–11 months of the year.

In the past, communities in sourveld and mixed-veld areas moved their cattle to nearby sweetveld areas when the grasses became unpalatable. This is no longer possible for many communities, so farmers in sourveld and mixed-veld areas have to find other ways to feed their animals when grasses are unpalatable.

3.5.2 Resistance to grazing and ecological status

- Grazing resistance is the ability of plants to survive and grow in grazed systems.
- Light to moderate grazing can:
  - stimulate plants to grow
  - increase their nutritive value
  - increase the cycling of nutrients.
- If a pasture is over-grazed, the plants don't produce enough seeds and the roots show decreased growth, so the grazed plants can't compete with others.
  - Therefore, the composition of the plant community changes → the grazed plants are replaced by weedy species that are more resistant to grazing and less productive and palatable than those with low grazing resistance.
  - Ecological succession takes place:
    - palatable plants are replaced with less palatable plants
    - the ecological status of the grazing area changes back to the pioneer stage.

3.6 Scientific method to determine the condition of pastures

The condition of the veld must be monitored to change the grazing procedures before it is damaged. It is difficult to return damaged veld to a productive state.

3.6.1 Condition of pastures

The condition of the veld depends on two factors:

- the type of plants growing there → veld is in –
  - good condition if most of the plants are palatable
  - poor condition if most of the plants are unpalatable.
- the amount of soil that is covered by plants, as bare soil erodes easily → veld is in –
  - good condition if most of the soil is covered by plants
  - poor condition if a lot of the soil is bare.

3.6.2 Pasture condition scoring

The farmer walks through the pasture and scores 10 categories on a scale from 0 – 4 to:

- determine condition
- see what can be done to improve condition.

The following categories are examined:

1 Plant desirability
   - Desirable plants: provide nutrition of a high quality for the biggest part of the season, (e.g. cool season grasses, legumes and warm season grasses).
   - Undesirable plants: plants that animals don't graze (e.g. thistles, toxic or woody plants).
   - Intermediate plants: palatable but not nutritious (e.g. dandelions).

   Species mostly undesirable = 0. Species mostly desirable = 4

2 Plant diversity
   - The number of different kinds of plants in the pasture:
     - Only one type of plant = narrow diversity
     - More than five kinds of plants = broad diversity; important to keep the pasture in good condition.

   Narrow diversity = 0. Broad diversity = 4

3 Plant density
   - How close together the plants in the pasture grow: bare spots encourage erosion and the growth of weeds.

   % of ground cover less than 55% = 0. % of ground cover more than 95% = 4.

4 Plant vigour
- Do the desirable and intermediate plants (see category 1) grow healthily?
- Do they have a healthy colour and re-grow quickly after grazing?

Desirable plants grow weakly = 0. Desirable plants grow strongly = 4.

5 Legumes in pasture
- Important for binding atmospheric nitrogen into the soil → improves soil quality.
- grow strongly during hot, dry periods, when other desirable plants don't grow strongly

% of legumes less than 10% = 0. % of legumes more than 40% = 4.

6 Severity of use
- How many animals?
- How often?
- Beware of under-grazing and overgrazing.

Light use, not very often = 0. Heavy use, very often = 0. Moderate use with adequate resting periods = 4.

7 Uniformity of use
- Are the plants grazed evenly, to a similar height, OR
- Spotty grazing, where some parts of the pasture are grazed, and other parts are not grazed?

Spotty grazing = 0. Even grazing = 4.

8 Soil erosion
- If the plant cover on sloping areas is not dense enough → soil erosion.

Heavy erosion = 0. Slight erosion = 4.

9 Woody canopy
- Trees provide shade for animals, but:
  - can also block sunlight
  - compete with grass for water and nutrients
  - can cause uneven grazing and manure distribution in the pasture
  - if animals group together below a tree, they trample the ground → erosion.

% of pasture covered by tree canopy more than 40% = 0. % of pasture covered by tree canopy less than 11% = 4.

10 Plant residue

Decaying plant material gives nutrients to the soil, but:

- too many decaying plants, the nutrients will not be properly cycled (a layer of more than 4 cm deep).
- too little decaying plants, water will run off more easily from the ground (a layer of less than 1 cm deep).

Too little decaying material = 0. Too much decaying material = 4.

Add up the scores and evaluate the condition of the pasture:

Score	Condition of pasture
0 – 10	Very poor
11 – 20	Poor
21 – 30	Good
31 – 40	Very good

Signs that the condition of the veld is getting worse

- The ground cover by grasses is decreasing. There are more and bigger areas of bare soil.
- There are fewer perennial grasses. Many of the grass plants grow from seeds after rain falls.
- The bushes are growing more thickly, especially those that animals do not like to eat.
- More animals are dying from eating poisonous plants.
- Animals produce less milk and young than they used to.
- People show signs of malnutrition because of the shortage of animal products to eat.

Unit 4

Pasture or veld management

4.1 Importance of pastures for the livestock industry in South Africa

Pastures are the foundation of the livestock industry in South Africa. It provides food and plays other important roles:

- It is the primary source of food for livestock in commercial and subsistence farming.
  - The higher the quality of food that livestock get, the better the quality of products that we get from them.
- It provides a source of genetic material for pasture plants.
  - If the biodiversity of pastures decrease, the general quality of pastures decreases.
- It maintains agricultural resources.
  - Well-managed pastures prevent soil erosion, because plant cover is kept intact.
  - Water sources are maintained, because soil does not wash into rivers, and water runoff is kept to a minimum.
- Well-managed pastures keep the natural balance in the environment, by cycling nutrients (nitrogen fixing) and maintaining the balance between oxygen and carbon dioxide in the atmosphere.

4.2 Relationship between pasture management and pasture condition

A pasture is an important natural resource, so management is important.

- Pasture management = manipulating the natural vegetation to increase productivity.
- Proper pasture management improves and maintains the health and function of a pasture. Only a pasture that is in good condition can be productive.
- A pasture that is in good condition:
  - has enough nutritious grazing plants.
    - So, the purpose of pasture management is to remove undesirable plants (such as weeds) and to make sure that the pasture has the maximum amount of climax species.
  - has no bare patches.
    - Pasture managements prevents over-grazing and keeps the pasture properly drained.
    - If water remains after the rain, grazing plants will ‘drown’. If that area is then grazed, bare patches will form.

4.3 Veld management practices

4.3.1 Stocking rate (SR)

SR is the number of animals that can graze on one hectare of land, for the grazeable part (not winter) of one year, without doing damage to the condition of the veld.

4.3.2 Animal ratio

- The term 'animal ratio' is used when more than one type of animal grazes the same pasture, for example, sheep, goats and cattle.
  - The animal ratio is the ratio between the different animals grazing the same pasture.
- It is important to know which type of food each animal type prefers, to make sure that all animals get enough food to eat, while still managing the pasture properly to prevent over-grazing.
- The type of diet each type of animal prefers, is influenced by factors including:
  - their behavioural patterns (e.g. goats graze on the higher ground, while sheep do not)
  - their anatomy (the characteristics of the body of the animal)
  - physiological requirements and limitations (e.g. some types of animals need more cellulose than other types)
  - body size (larger animals need more food than smaller animals).
- Animal ratio can also refer to the ratio between male and female animals, for example, a dairy farmer keeps more cows than bulls.

4.3.3 Grazing systems

A grazing system is a particular strategy that a farmer uses to let his animals graze. It is important for the farmer to know the conditions on the farm:

- the type of plants on the farm
- the type of livestock he keeps and their feeding preferences.

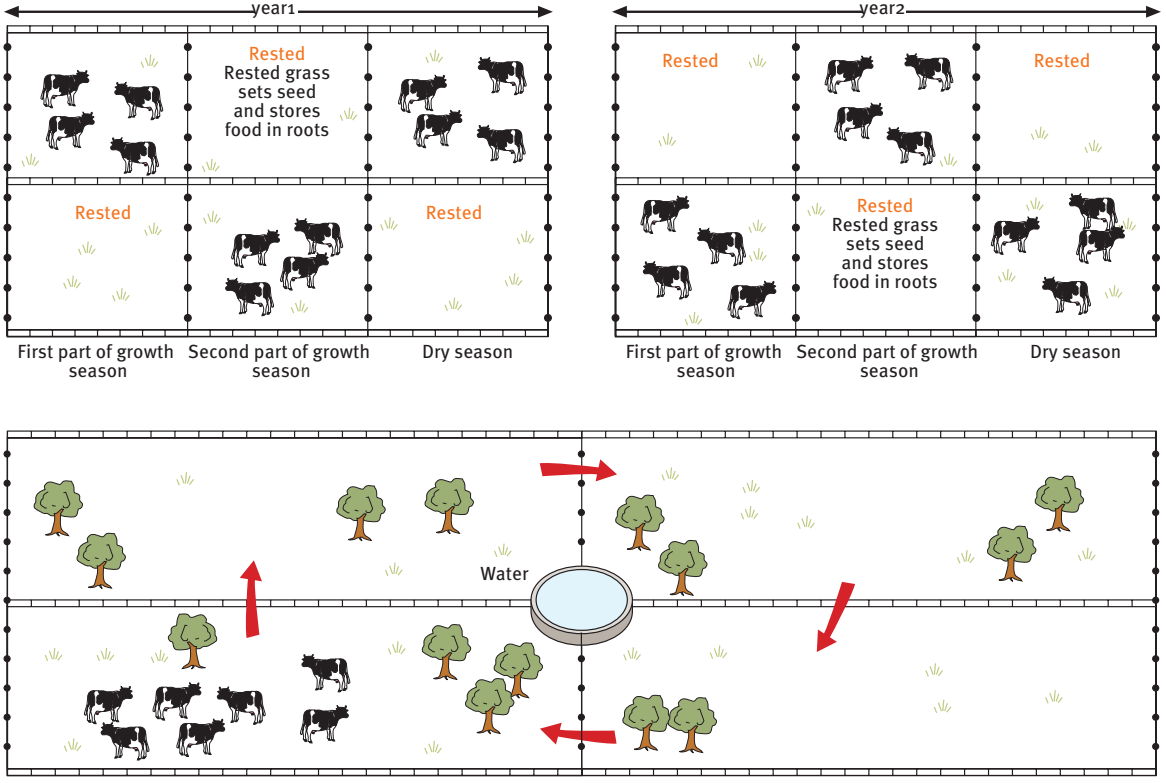
There are three types of grazing systems:

- slow rotational grazing
- continuous grazing
- game and communal grazing.

Slow rotational grazing

- The grazing area is divided into camps:
  - one is grazed while the others are rested.
- The camps are usually fenced, but the animals can also be herded.

The diagrams on the next page show slow rotational grazing with two camps and with four camps. These types of camps allow the veld to rest so that the grass plants can produce seeds and store food in their roots.



A six-camp rotation over two years (above); a four-camp rotation (below)

Four factors must be kept in mind when considering a slow rotational grazing system:

1 The number of animal units that will be using the grazing system.
   - Calculate the forage requirements of the herd.
     - This is done in animal units (AU): 1 AU = the daily forage needed by a dry cow (approximately 12 kilograms of dry forage per day).

2 The size of the area that will be needed to graze that number of animals: this depends on:
   - the feeding requirements of the herd
   - how much forage the veld produces.

3 How large each camp should be, which depends on:
   - the amount of available pasture at the beginning of the grazing period
   - the AU of the herd
   - how long each grazing period should be.

4 The number of camps needed, which depends on:
   - the number of days that the animals will graze in the veld
   - how long the rest period should be.
     - The length of the rest period depends on how quickly the pasture re-grows, which is influenced by the weather conditions and the season.

Continuous grazing

This is when animals graze the same area at all times of the year:

- usually used in communal grazing lands
- the animals move freely in search of food except when they are herded during the crop-growing season.

Game and communal farming

Communal farming = when animals roam freely without any fences and grazing camps.

- was practised in traditional farming before the arrival of Europeans when there was enough land for communities to move their animals to fresh grazing areas so that grass had time to grow and set seed before it was grazed again
- provided a better opportunity for animals to live in a more natural habitat.

Fencing and owning of land by single farmers stopped many communities from moving their animals to fresh grazing lands. The result is:

- not enough grazing land for all the animals of the community
- communal grazing lands become overused
- each person owned fewer animals
- a decrease in the amount of meat and milk produced.

Today there are very few communities that farm communally. Game farmers practise communal farming because game needs more space to move around.

4.3.4 Veld burning

Burning can damage the veld and must only be done according to the following rules.

Sourveld

Sourveld becomes unpalatable in winter. If sourveld grass has not been grazed low for a long time, dead leaves collect above the roots. Fire is used to remove dead leaves. This helps the animals to reach the new green growth and lets the new growth get enough sunlight to grow well.

- Burn only after the first rains in spring when there is enough water for new growth to protect the soil. (Some farmers burn in winter, before the rains, to give their animals grazing when it is scarce. This damages the veld because the grasses do not have enough water. When the first rains fall, there is less grass covering the soil and it can erode easily.)
- Do not burn an area more often than once every four years.
- Burn on a cool day when there is no wind, otherwise the fire can get out of control.

Sweetveld

Never burn sweetveld.

4.4 Veld management systems

Farmers need to know:

- what type of grazing their animals prefer
- what type of grazing their veld contains
- how the grazing is influenced by the grazing patterns of their animals and the weather.

Sound veld management systems involve setting up camps (farming units) that take into account the following:

- resting period
- defoliation (removal of leaves)
- weather conditions
- veld separation.

4.4.1 Resting period

Grazing plants need to rest in order for new plants to grow: use slow rotational grazing. The length of the resting period is influenced by:

- the condition of the pasture (the more damaged the pasture, the longer the resting period)
- the number of animals that graze the pasture (the more animals, the longer the resting period).

4.4.2 Defoliation (removal of leaves)

Grazing animals remove the leaves of the plants when they graze. As a result, photosynthesis takes place at a much slower rate → the plants cannot produce food for growth.

4.4.3 Weather conditions

Weather conditions influence grazing conditions:

- Heavy rainfall: pastures can easily become waterlogged → grazing plants drown → reduces the ground cover and leads to erosion.
- Drought: plants do not recover quickly from grazing → erosion takes place.

4.4.4 Veld separation

Fences between grazing camps:

- prevent animals getting into a camp that is being rested
- separate different veld types from one another, to prevent over- or under-grazing. (Animals will rather graze sweetveld than sourveld, so if a strong fence does not separate these different veld types, the sweetveld will be overgrazed, while the sourveld will be undergrazed.)

4.5 Advantages and disadvantages of grazing systems

When choosing a grazing system, their advantages and disadvantages must be considered.

Grazing system	Advantages	Disadvantages
Slow rotational	• The condition of the grass can improve from year to year. • Grass can be kept for grazing in the dry season or when there is drought	• High fencing costs. • Workers are needed for fencing and moving cattle. • Selective grazing can easily take place if the animals are not moved often enough. • The animals may lose condition in the winter if they are not given licks. • Water needs to be supplied to each camp.
Continuous grazing	• Low fencing costs. • Little work needed for fencing or moving animals. • If the correct number of animals are kept, so that the grass is not overgrazed, then the condition of the veld can improve. • If the animals are given licks in the dry season, they won't lose weight.	• The veld is not rested, and the veld condition may get worse. Soil erosion may begin. • Fewer animals can be kept, to prevent overgrazing. • There may not be enough food for the dry season so that animals become weak and thin.
Communal grazing	• The numbers of animals kept on one hectare of land is usually higher than on commercial farms. • Communal grazing lands give people many other products, such as wild foods, medicines, building materials and fuelwood.	• In communal areas people need to be organised to work together. • In times of drought, the animals become thin and weak and some may die.

4.6 Veld management practices which lead to poor pasture conditions

Good veld management practices improve the condition of a pasture. Poor veld management, like those listed below, practices can quickly damage a pasture.

- Overgrazing:
  - erosion
  - increase in pioneer species (less palatable).
- Wrong stocking rate:
  - overgrazing
  - undergrazing.
- Not removing poisonous plants (e.g. Lantana):
  - sick animals.
- Not allowing sufficient rest time
  - increase of pioneer species.
  - poor water management
  - if not well-drained, pasture becomes waterlogged, which leads to loss of grazing
    - groundcover must be kept intact so that if rain falls runoff is kept to a minimum.

Unit 5

Biomes of South Africa

5.1 Biomes of South Africa

There are six main types of biomes in South Africa.

Biomes of South Africa

5.1.1 Savanna

- Covers over one-third the area of South Africa.
- Characterised by a grassy ground layer and an upper layer of woody plants. If the upper layer is near the ground, it is called shrubveld. If the upper layer is dense, it is called woodland.
  - The intermediate stages are called bushveld.
- Location: Limpopo (bushveld), parts of KwaZulu-Natal, the North West province, Northern and Eastern Cape.
- Climate: warm areas with summer rainfall (650–1000 mm annually) and dry winters.
- Fauna: the wild animals of Africa (e.g. elephant, buck, rhino, zebra and giraffe) were previously found in large numbers in the savanna. Today there are many game reserves in savanna areas. Some farmers and communities keep game instead of cattle, but the area is also suitable for cattle, sheep and goats.
- Flora: combination of low trees and grass.

5.1.2 Forest

- Important tourist attraction in South Africa, but they have been exploited for timber.
- Location: in patches, with larger areas along the Garden Route (Knysna), KwaZulu-Natal, the Eastern Cape, Mpumalanga and parts of Limpopo.
- Climate: restricted to frost-free areas with high rainfall (800–1 000 mm throughout the year). Summers are warm; winters are mild.
- Flora: mostly large trees with plants that grow beneath and on the trees. Used for commercial plantations and the wood is used for paper and in the building industry.
- Fauna: Forest areas are not useful for grazing animals, as there is little grass.

5.1.3 Grassland

- The cornerstone of the maize crop, and many grassland types have been converted to this crop. Sorghum, wheat and sunflowers are also farmed on a smaller scale.
- Location: found chiefly on the high central plateau of South Africa, and the inland areas of KwaZulu-Natal and the Eastern Cape
- Climate: true grassland is found in cool areas, with 400–700 mm of rain per year, during the summertime. The summers are hot and the winters are dry.
- Flora: mainly grasses, few trees or bushes. Fire, caused by people and lightning, prevents growth of trees and bushes.
- Fauna: the grasslands are the best areas for farming grazing animals, such as sheep, cattle and goats.

5.1.4 Fynbos

- Includes two key vegetation groups: fynbos and Renosterveld.
- Location: only found in the winter rainfall areas of the Western and southern Cape; nowhere else in the world.
- Climate: rainfall is 400–1 200 mm per year. The summers are hot, with dangers of fire. The winters are cold and wet.
- Flora: mostly bushes with hard leaves. There are also reeds, which look like grass that people use for thatching roofs. There were few trees in the fynbos until people began to plant trees from other areas / countries.
- Fauna: there is little farming with grazing animals on the fynbos, as this veld type is not suitable for grazing. In certain areas people farm sheep and goats.

5.1.5 Nama Karoo (semi-desert)

- The second-largest biome in South Africa.
- Location: western half of the central plateau of South Africa, at altitudes between 500 and 2 000 m, with most of the biome failing between 1 000 and 1 400 m.
- Climate: hot, dry area with little rain in summer (400 mm per year).
- Flora: mostly small, low bushes.
- Fauna: the Nama Karoo is a sheep farming area. Farmers need large areas of land to feed their sheep, because the area is too dry to produce much plant growth.

5.1.6 Succulent Karoo

- This biome has an equal status to the other biomes in South Africa – it is not a subtype of a Karoo biome.
- Location: situated to the west of the Nama Karoo, to the west and south of the central plateau of South Africa, and above the Cape Fold Belt. Namaqualand, famous for veld flowers during spring, falls within this region.
- Climate: very dry with less than 100 mm of winter rain per year. The summers are hot and the winters are mild with no frost.
- Flora: mostly small bushes with stems and leaves that store water (succulents).
- Fauna: this is a sheep farming area.

5. 2 Human impact on the biomes of southern Africa

- Human activities can damage the biomes, for example, pollution, which influences the quality of the water, soil and air. Severe air pollution causes global warming and climate change.
- If a biome is damaged, the biodiversity is damaged as well. Biodiversity is important for healthy crop production.

5.3 Importance of biomes for agriculture

Different forms of agriculture are practised in the different biomes, because each biome has certain characteristics (climate, fauna and flora) that support a particular branch of agriculture. For example:

- The fynbos biome (Western Cape) supports the entire fynbos-producing industry. The bulk of the flowers are exported to Europe, so this industry earns foreign currency for South Africa.
- The grasslands, savanna and the Karoo produce the bulk of animal forage material.
- The forest biome supports the tropical and sub-tropical fruit industry, as well as plantations for the paper and wood industry.

Unit 6

Climate change and effects of weather phenomena

6.1 Climate change and global warming

- Our planet is presently going through a period of climate change.
- Climate change = long-term change in the distribution of weather patterns over periods of time that range from decades to millions of years.
- There has always been climate change, but our climate change is caused by people and is happening more quickly than previous climate changes.
- In our time, climate change = global warming, because the climate of the Earth is becoming warmer due to human activities.

6.2 Causes of global warming

- The main cause = changes in the gases that make up the air:
  - Normally, the sun heats the Earth during the day; at night the earth cools off.
  - But, the gases from air pollution, especially carbon dioxide, absorb the heat from the sun and thereby prevent cooling at night. (There has been an increase in carbon dioxide in our atmosphere because of industrialisation and the accompanying deforestation.)
  - The result is that the earth is becoming warmer.
- Air pollution is mainly caused by:
  - smoke from coal, wood or veld fires
  - smoke from factories
  - exhaust gases from motor vehicles that burn petrol and diesel
  - smoke from power stations that burn coal.

6.3 Impact of climate change on agriculture

- Causes and effects of global warming are international – every country is affected.
- Some of the effects of climate change on agriculture are:
  - A rise in sea level: The ice at the North and South Poles is melting and sea levels are rising = a problem especially for island nations and low-lying countries.
  - Inability of species to adapt: If the climate changes quickly, plants and animals may not be able to adapt and could become extinct. Some areas could become unsuitable for the crops and farm animals. Farmers will have to change their choice of crops and animals. However, it will be difficult to predict exactly how the climate will change and therefore how the farming systems should change.
  - Unpredictable seasons: The world's weather patterns are complex and interdependent. One change may lead to another, and then another, so that the delicate balance is destroyed. Climate changes will affect what crops can grow where, the length of the growing season, and the types of pests that attack them.
- In dry countries, droughts are becoming longer and hotter.

- Rainy seasons have become more erratic and unpredictable.
- In the Northern Hemisphere, rain, wind and storms, as well as floods and other natural disasters, are becoming more frequent.

6.4 Weather predictions and rainfall in South Africa

Scientists try to predict weather for months ahead to help farmers to plan.

6.4.1 El Niño and La Niña

- El Niño = when the temperature of the surface of the sea in the equatorial Pacific Ocean off the South American coast becomes warmer than normal → influences the movement of air → changes global climate patterns. (It happens around Christmas.)
- La Niña = the opposite of El Niño → the sea surface temperatures in the equatorial Pacific become cooler than normal.

El Niño and La Niña influence both rainfall and temperature patterns worldwide. In general, southern Africa receives below-average rainfall during El Niño and above-average rainfall during La Niña. But this = unpredictable → South Africa has a number of different rainfall regions and they are not all affected in the same way (e.g. in 1997–98 El Niño was the strongest on record, but not all of South Africa received below-normal rainfall; some regions received high rainfall due to moist air from the Indian Ocean.

6.5 Short-term climate and weather predictions

Short-term weather conditions (e.g. floods, hailstorms) are predicted by the SA Weather Service. Farmers can take preventive measures based on these predictions.

6.6 Agricultural adaptation measures to overcome climate change

- Climate change creates different conditions: need more comprehensive adaptation measures from those needed for short-term weather conditions. These measures include better land and water management, as well as new agricultural technology.
- Scientists agree that climate change will reduce rainfall, while warmer temperatures will cause plants to need more water. Therefore, rainfall needs to be captured and stored better, e.g. by building stone banks, waterways or vegetation strips.
- Crops and land need to be managed better, for example:
  - fertiliser micro-dosing (fertiliser is applied with the seed when planting it)
  - minimising soil disturbance (no-tillage)
  - crop rotation
  - conservation agriculture
  - using crop varieties that can deal with a greater variation in temperature and less water.

Topic 1

Topic questions

Topic 1: Questions

- Answer the questions below.
- Give yourself one hour.
- Check your answers afterwards and do corrections.

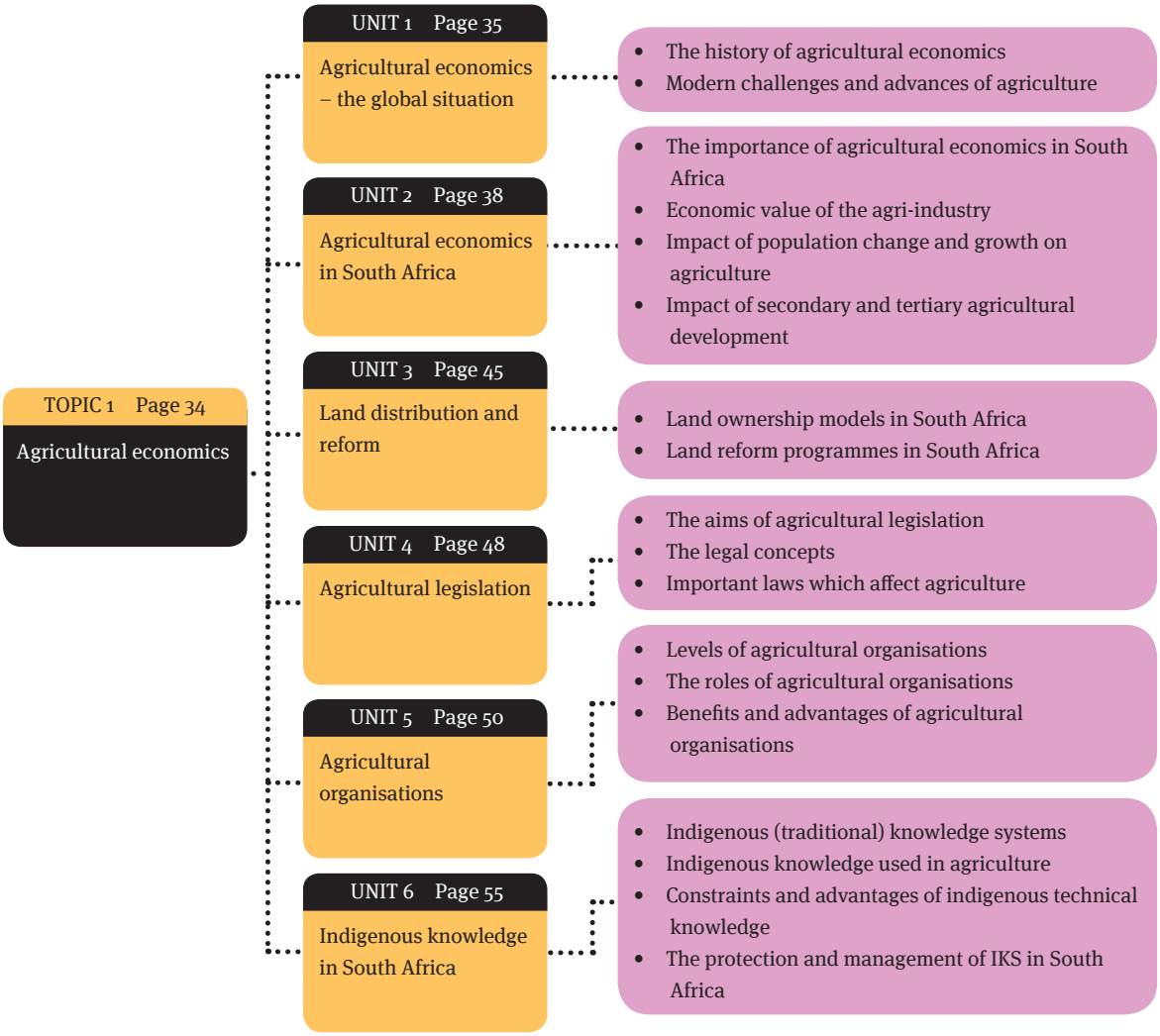
1	Define ecology?	(2)
2	Describe what an agro-ecosystem is.	(3)
3	Draw a diagram to show the levels of organisations in an ecosystem.	(8)
4	Discuss the physiographic factors in an ecosystem. Explain the influence that each physiographic factor has on an ecosystem.	(12)
5	Draw and label a simple a food chain.	(5)
6	Describe the five types of interaction that are found in ecosystems. Provide an example of each type of interaction.	(15)
7	List the main features of biological farming.	(5)
8	What is selective grazing?	(3)
9	What is stocking rate?	(4)
10	List the three main veld types in South Africa.	(3)
11	Name the ten categories that are scored to determine the condition of pasture.	(10)
12	Identify the six main types of biomes in South Africa.	(6)
13	List the four main causes of global warming.	(4)

[Total marks: 70]

Topic 2

Agricultural economics

Overview



What you will cover in Topic 2

Agriculture is the most important primary industry in any country of the world:

- It supplies the real needs of the people and it is a key economic driver for individual livelihoods, poverty alleviation and our nation's economic growth.
- Countries must examine population growth, the economic value of food products and the industries that arise from agriculture and contribute to the economy. It is important for countries to do this so they can plan for problems regarding food security, providing employment and earning foreign exchange.
- Trends (population growth and shift, global demand and climate predictions) help government to make agriculture policies to help ensure food security.
- Farmers study which products are best suited to their circumstances and are in demand, the government legislation, agricultural policies, assistance programmes and organisations to help ensure the success of their agricultural ventures.

Unit 1

Agricultural economics – the global situation

1.1 The history of agricultural economics

Civilisation started with the development of agriculture: resulted in the development of tools and methods of production.

- The domestication of plants started about 10 000 years ago (the Neolithic Age) when the hunter-gatherers first began growing crops in Mesopotamia (today called Iraq) followed by Egypt.
- Then came the domestication of animals for food (meat, milk and eggs), clothing (leather), for draught power, to assist with hunting and for companionship. At first, agriculture was simple subsistence farming.
- Pastoralists developed when the areas settled became overgrazed and the soil exhausted. They migrated to new, unsettled areas where they may also have planted new crops. Once these pastures and / or soil were exhausted, they moved on again. As methods of production improved, surplus product (usually food in the form of crops or animals) was produced for the family or clan. This could be bartered or sold for money. Those that produce surplus crops for sale are called cash croppers.
- The domestication of crops and animals led to urbanisation. Food was brought to urban areas and sold. The urban dwellers had to produce or manufacture other goods or services in order to buy or barter for food.
- Methods of production improved as science enabled a better understanding of the environment, the basic inputs of agriculture, of breeding, of how to control pests, parasites and diseases, mechanisation and how to market the produce.
- This led to both the intensification and commercialisation of agriculture where the production of food, fibre and the other primary products became a business and making a profit the major goal.

1.1.1 The primary, secondary and tertiary industries

- Agriculture is a primary industry. The primary products are the raw materials produced directly from the natural resources of agriculture, such as meat, milk, eggs, wool, skins, vegetables, fruit, wood and cotton.
- The primary products are either consumed as they are (e.g. fresh vegetables), or are processed further to produce secondary agricultural products, such as meat pies, cheese, canned vegetables and fruit, bread, furniture, clothing and leather goods. Non-food products (or commercial products), such as tobacco, alcoholic drinks, tea and coffee are also manufactured as secondary products.
- Tertiary industries, such as services providing finances, transportation, marketing and sales, have also developed around agriculture. Agriculture-related tertiary industries are developing rapidly and include the hospitality (tourism) and hunting aspects of game ranching.

1.2 Modern challenges and advances of agriculture

A number of factors have driven the development of agriculture to where it is today as a serious business and an industry of critical importance in all countries.

1.2.1 Challenges

- Degradation of land:
  - Unwise and unscientific farming methods + poor decision making in the siting of cities, dams, roads and other structures that use up valuable agricultural land, have led to soil degradation. As a result, it has become important to practise optimal production techniques to preserve soil and vegetation.
- Climate change:
  - Global warming and climate change have an impact on the productivity of agricultural land. For example, the world Economic Forum was told in May 2011 that climate change is expected to cut Africa's ability to produce food by 50%.
- Population increase and population shift:
  - Population increase and urbanisation will put further pressure on the land and agricultural practices and production. To meet the expected growth in world's population by 2050, food production must rise by at least 70%, from a declining land area. Therefore, agriculture needs to use more scientific and sustainable methods of production, including more intensive production methods, use of cultivars or hybrid seed, more effective fertilisation methods, more effective weed, pest and disease control, and improved soil cultivation preserving water retention.
- Urbanisation:
  - Due to industrial development, urbanisation is speeding up. This leads to land and water pollution. Positively, industrial development leads to more efficient forms of preserving food, reducing the massive wastage of food through spoilage.
- Reduction of farm numbers:
  - The economies of scale (high input costs with low outputs) have driven many smaller farmers off the land, resulting in lower agricultural production. Farmers must be incentivised to stay on the land.
- Globalisation:
  - Globalisation has resulted in increased competition from other agricultural countries, which makes it difficult for our farmers to stay in business. Therefore, it is important that farmers produce products efficiently and at competitive prices, because they have to compete with cheaper, more efficiently produced imported foods. For this reason, marketing has also become essential to promote their products on global markets. In addition, globalisation means that plants, animal and their products are easily and quickly moved all over the world. This increases greatly the introduction of diseases and parasites or unwanted weeds from one country to the next.

1.2.2 Advances

Through the privatisation and commercialisation of food production, massive advances have taken place in agriculture. These have made farming much more efficient and – to date – able to cope with the increased demand for food.

- Scientific understanding:
  - Research has led to advances in all aspects of production through better understanding and utilisation of natural resources (e.g. better weather forecasting leads to better timing of plantings; contour ploughing, erosion control with stone banks and terraces, all contribute to preservation of soil quality and the retention of moisture). Understanding genetics has led to breeding drought resistant crops (e.g. salt bush for fodder). Vegetable cultivars have been developed that are more disease resistant and higher yielding. Livestock breeds have been developed that are better suited to local conditions.
- Chemical usage:
  - Research has led to economically effective inputs, such as fertilisers and stock remedies
- Training:
  - New knowledge gained through research is passed on to farmers through training.
- Marketing/Competitive edge:
  - Globalisation has created a need for countries to be able to market their products effectively. One of the most successful strategies is to identify a competitive edge.

Unit 2

Agricultural economics in South Africa

2.1 The importance of agricultural economics in South Africa

In South African agriculture we have the following challenges:

- soil depth is poor
- precipitation is low
- evaporation rate is high, leading to high moisture loss.

As a result, only 12% of the total area of South Africa is arable. The rest of the agricultural land of South Africa is rangeland with comparatively low carrying capacity.

- The number of farms is shrinking (from 57 980 in 1993 to 39 966 in 2007 = 21% less).
- This makes successful agriculture difficult.

As a result, in order to compete, we have to utilise all our strengths:

- Stock remedies:
  - Locally developed remedies and crop protection products lead to better and more economic production.
- Effective and cheaper mechanisation:
  - Leads to better management increased production.
- Training:
  - Farmers must receive training, which can be done through universities, colleges and schools, as well as through other institutions (e.g. the Agricultural Research Council, the Department of Agriculture, Forestry and Fisheries and through private companies, such as Afrivet Training Services).
- Competitive edge:
  - South Africa's wildlife presents a competitive edge in terms of tourism and for the export of game meat (venison) = highly sought after in Europe and the USA.
- Development of local breeds:
  - The development of local breeds adapted to our climate, environment and market are advantageous for production in South Africa, and are suitable for export (e.g. Dohne merino, Bonsmara, Dorper, Boschvelder layers).

2.1.1 Contribution of agricultural economics

South Africa has a dual agricultural economy: the commercial sector and the subsistence sector. (Through subsistence farming, millions of people worldwide are able to survive in the rural areas.)

Agriculture is important to all South Africans for the provision of food security, a provider of raw materials, rural development, the provision of jobs and the economic stability of the country.

Food security

- Food security is measured against the Food and Agriculture Organisation's (FAO) 'minimum dietary requirement for each person'.
- The right to food security is enshrined in Section 27 of South Africa's Constitution. Food security means people have sufficient affordable food.
- It includes:
  - food availability
  - food access
  - food reliability in terms of nutritional value
  - food health
  - food distribution.

In 2000, the South African Government introduced an Integrated Food Security Strategy to ensure co-ordination between the various State Department efforts to fight malnutrition and ensure food security by 2015.

The main role players are the Department of Social Welfare and the Department of Agriculture, Forestry and Fisheries.

- This Integrated Food Security Strategy is important because at their meeting in South Africa during May 2011 the World Economic Forum listed food security and decline of the infrastructure as the two main challenges facing the continent of Africa.
  - Food shortages (or a lack of affordable food) have been one of the main causes of all the major revolutions in the world.
  - Due to a growing demand for food and a declining supply, food prices have risen dramatically in the past decade.
    - For example, the average price of vegetables has increased from R9,65 per ton in 1999 to R29,66 per ton in 2010
    - = an increase over a decade of more than 300%.

Agricultural economics contributes to influencing production and prices in an effort to ensure food security and national stability.

Work

Agriculture is a provider of work and employment in the primary, secondary and tertiary agri-industries.

Rural development

Agriculture increases a flow of income from sold goods and services to the rural areas.

- This attracts secondary and tertiary agri-industries (services) to these rural areas.
- In this way, agriculture stimulates rural development, and improves quality of life.

Economic stability

- Agriculture creates work → contributes to the spread of money through the economy → can lead to economic stability.
- It also stimulates a two-way trade between countries and provides South Africa with a foreign exchange income (forex) from the export of agricultural produce, such as wine, fruit and wool → forex can be used to import products that we do not produce (e.g. computer technology and certain medicines).

Draught

Especially in the rural areas, draught animals play an important part in transport, e.g. donkey carts and horses, and in ploughing.

Conservation

Farming, especially animal production, and more specifically game ranching, contributes to the conservation of our natural resources (land, water, vegetation and game) if the production is optimised and sustainably managed.

2.2 Economic value of the agri-industry

The agri-industry in South Africa has massive economic value. For example, the gross value of agricultural production in 2009/10 was R126 433 million.

Sector	Gross value (R millions)	% Contribution
animal production	64 860	51,3
horticulture	32 493	25,7
field crops	29 080	23,0
Total	126 433	100,0

Contribution of various sectors to the gross value of agricultural production in South Africa

Many factors influence the economic value of different agriculture sectors. For example:

- A drop in the number of farmers leads to lower production, which pushes prices up.
- Population increase and increased urbanisation pushes demand for agricultural products up, which pushes up prices.
- Increased standards of living demand different types of agricultural products (e.g. meat) which leads to an increase in demand and can push up prices if supply does not increase.
- Health consciousness can lead to demand of different types of agricultural products (e.g. fish and chicken) which leads to an increase in demand and can push up prices if supply does not increase.
- The increase in horticultural products from around 15% to over 25% can be ascribed to better methods of preservation (refrigeration along the supply chain) and a shift to a healthier diet.

Taking into account the contribution of secondary and tertiary agri-industries, agriculture contributes 3% to the gross domestic product (GDP) of South Africa.

- 2005 R1, 401 billion 2,2%
- 2006 R1,572 billion 2,4%
- 2007 R1,793 billion 2,9%
- 2008 R2,058 billion 2,7%
- 2009 R2,181 billion 3,0%

Currently, South Africa is net importer of agricultural produce.

- Although South Africa generally has unfavourable agricultural natural resources, the country must strive to be a net food exporter.
- So, we must focus on research into more economically sustainable farming methods, and utilise our competitive edge (game farming).
  - Cattle and sheep farmers in the Limpopo Bushveld and the Eastern Cape struggled to survive financially.
    - In response, they began game ranching.
    - With an income from tourists and hunting this has been very successful.

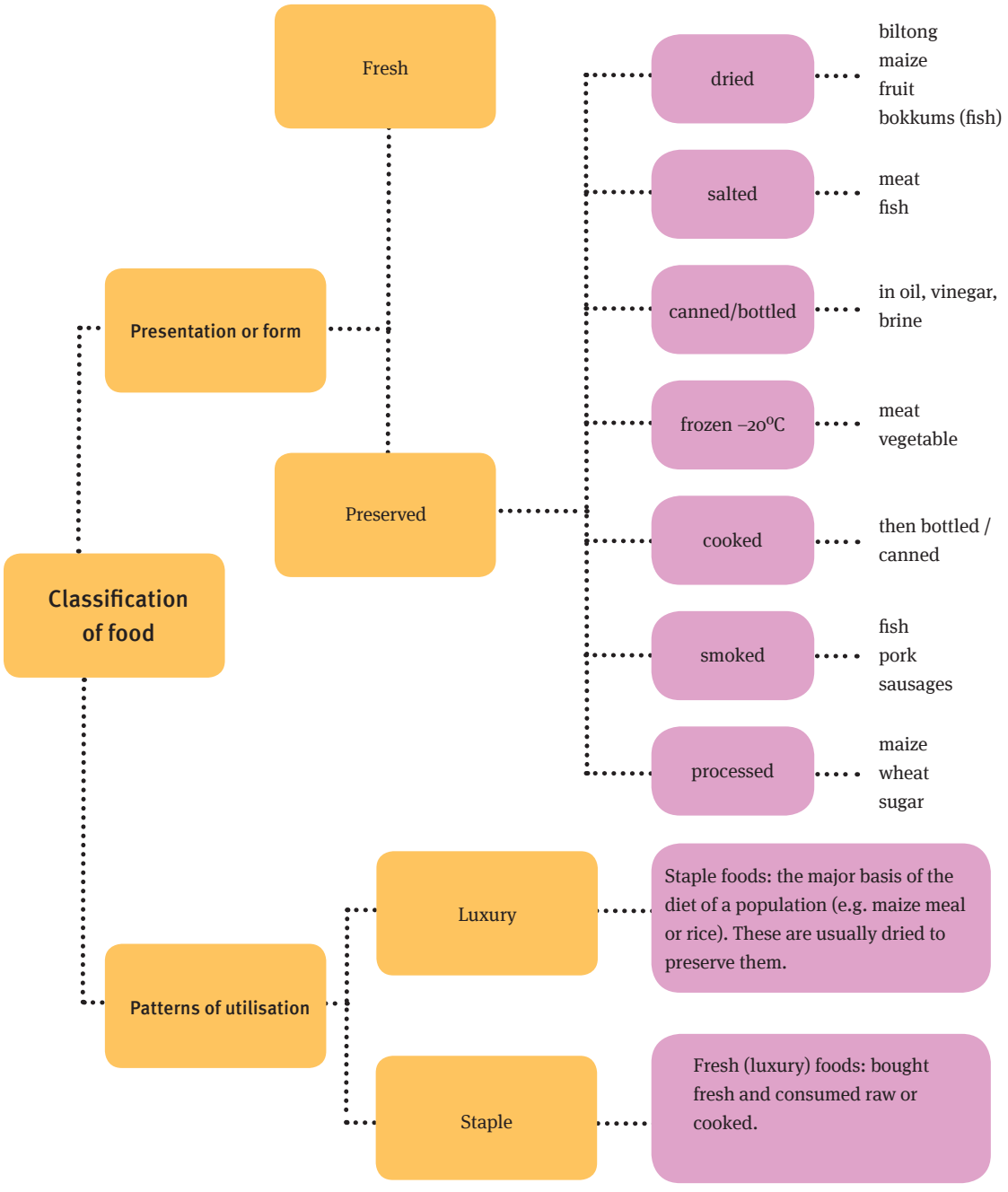
Exports		Imports	
Product	**Value (R billions)**	**Product**	**Value (R billions)**
wine	5,927	rice	3,410
citrus	5,580	chicken	3,3
grapes	3,464	oil cake	2,358
pome fruits	3,047	wheat	2,284
cane sugar	2,639	ethyl alcohol	2,139
wool	1,683	palm oil	1,776
		red meat	1,0

The value of the main South African agricultural exports and imports

2.3 Classification and usage patterns of food products

There are various ways of classifying food:

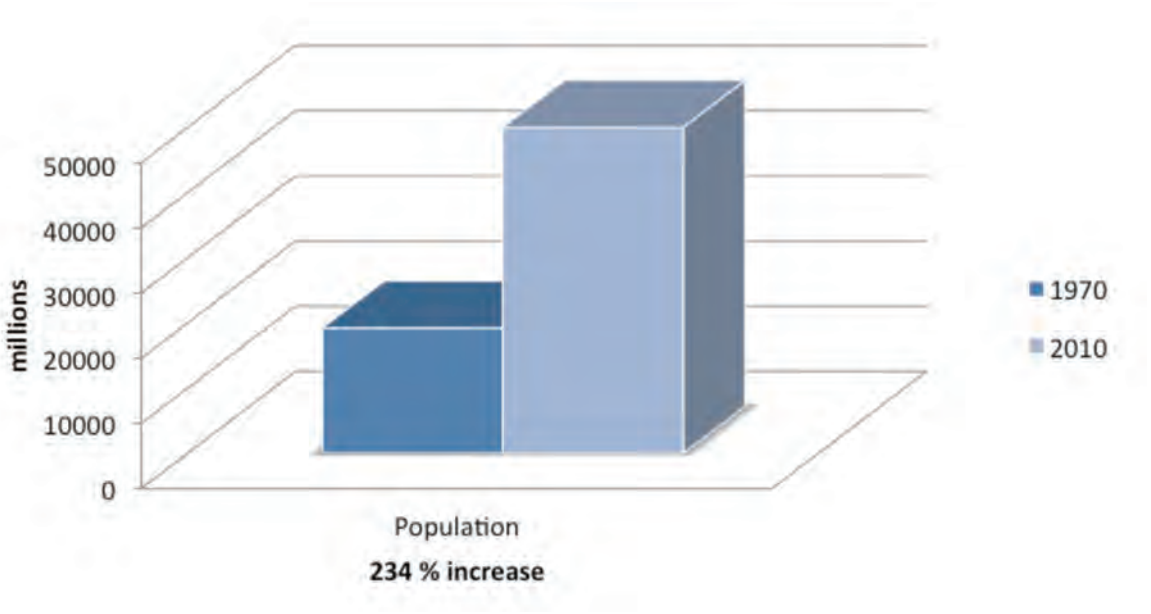
- One method is by identifying its origin, such as plant or animal.
  - For example, crop plants may can be classified into field crops, horticultural crops, fodder crops and forestry.
  - Each sub-category can be further classified.
    - For example, forestry can be sub-divided into hardwood, softwood and indigenous. (See Topic 6 for additional information.)
- Other methods of classification are:
  - according to the presentation or form (See the mindmap on the next page.)
  - according the utilisation pattern. (See the mindmap on the next page.)



Classification of food

2.4 Impact of population change and growth on agriculture

- The highest rate of population increase (growth) was seen in the 1950s after the Second World War when it peaked at 2,2% in 1963.
- Over the last 50 years the world population has increased from 3 billion (1959) to 7 billion (2011). Population growth in Africa, Asia and South America is faster than in the developed world, resulting in a rapid increase in the demand for food.



The growth in South Africa's population

- South Africa's population growth rate is currently 2,5% per year. This means one million extra people every year who need food. This population increase puts pressure on our food security.
- For food security to be maintained, food production must increase at the same rate as the population. However:
  - in 2010, we consumed more maize that we produced. This is a staple food for many South Africans. We need a 100% increase in production by 2050.
  - wheat consumption exceeded production by 60% in 2010 and will have exceeded it by over 100% by 2025.
  - beef demand is set to increase by 150% and mutton by 130% if trends continue.
  - similar increases in demand are expected for poultry and fresh produce.
- Migration to cities means that food supply must increase and be moved to the cities.
  - In the cities, a more sedentary life style, and possibly greater wealth and education, changes the way people eat.
    - There is a focus on healthy eating: less fat and more fresh fruit and vegetables; white instead of red meat.

Year	White meat (kg/year)	Red meat (kg/year)	Eggs (kg/year)	Total (kg/year)
1970/1	6,24	43,72	4,07	54,03
1980/1	14,10	37,09	4,80	55,99
2009/10	32,62	25,14	8,60	66,36

The growth in demand for animal derived food over the past 40 years in South Africa

From the above table the following trends can be seen:

- The consumption of white meat has more than doubled since 1980.
- The consumption of red meat has declined by more than a third over the same period.
- The consumption of eggs has almost doubled.
- Protein intake per person per year has increased about 20% in 30 years.
- There has been a shift from red meat to white meat and eggs.

2.5 Impact of secondary and tertiary agricultural development

Secondary industries add value to the raw agricultural products. Other benefits of the secondary industries are:

- a more convenient product
- a better quality product
- a longer lasting (better preserved) product, which means less spoilage and wastage
- differentiation (segmentation) of the market, because the buyer can choose between white, brown and whole wheat bread, and low GI bread for dieters and diabetics
- stimulation of industries, such as mills, bakeries, outlets (shops of different types)
- the creation of work all along the supply chain
- the government earns more taxes from the higher prices and the additional employees
- exports may be stimulated if a really good and different product can be manufactured, such as an unusual type of health bread.

Tertiary industries spring up around agricultural products and secondary agri-industries. For example:

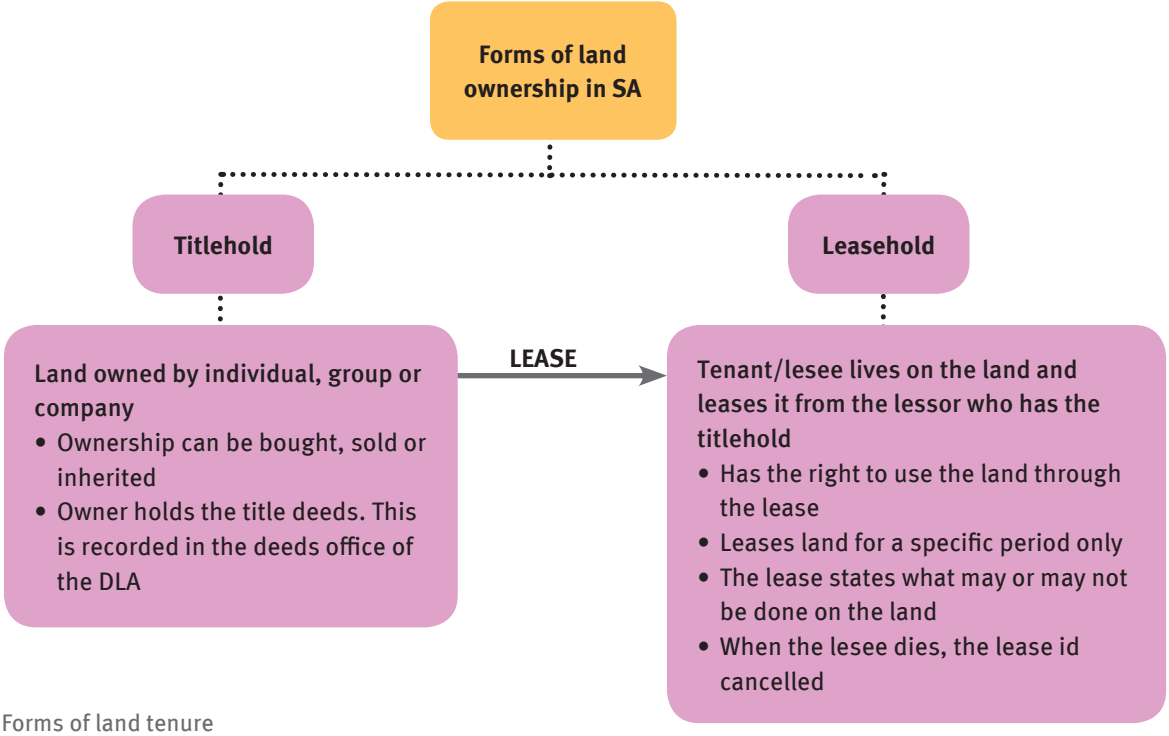
- The farmer, the miller and the baker all require funding from the Land Bank or other banks.
- They all require transport to move their products.
- The baker needs an advertising agency.
- All these institutions need infrastructure, such as factories or offices, and vehicles, as well as people to do the work.

Unit 3

Land distribution and reform

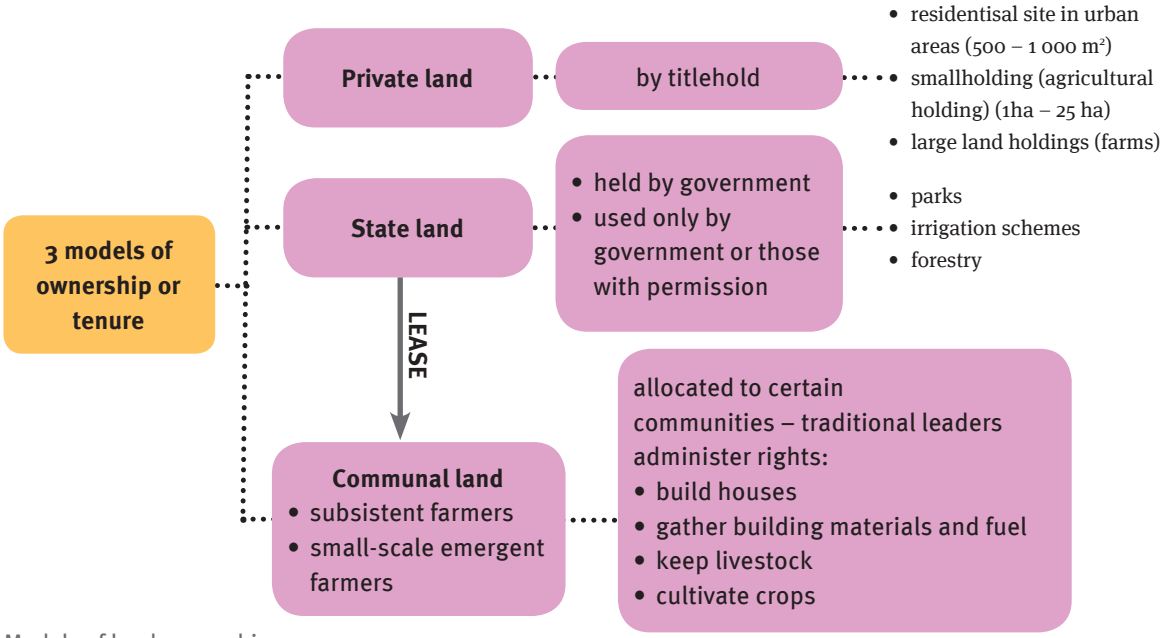
3.1 Land ownership models in South Africa

Land tenure describes the way land is held or owned. Generally, the two main forms of land tenure are titlehold and leasehold, shown in the mindmap below.



Forms of land tenure

During apartheid, land was taken away from many occupiers. So, land ownership in South Africa is complicated. There are three models of land ownership or tenure.



Models of land ownership

3.2 Land reform programmes in South Africa

Land reform programmes started in 1994 to transfer 30% of all agricultural land to previously disadvantaged peoples within 15 years. A three-component strategy was proposed to achieve the goal.

3.2.1 Land restitution

- Aim: to return land or provide redress to communities forced to move off their land after 1913.
- Applicants must prove that they were dispossessed to the Commission on Restitution of Land Rights, which is led by the Chief Land Claims Commissioner and the nine provincial Land Claims Commissioners, as established by the Restitution of Land Rights Act passed in 1994.
- By the end of 2008, more than 74 000 claims involving 1,4 million beneficiaries had been settled.

3.2.2 Tenure reform

The Department of Rural Development and Land Reform is busy with a Bill that will grant farm workers tenure security to their homes on the farms where they work.

3.2.3 Land redistribution programmes

1 Agricultural development:
   - The Land Redistribution for Agricultural Development sub-programme (LRAD).
     - Previously disadvantaged persons may apply for grants to obtain land for agriculture. Persons granted money are called beneficiaries.
     - To qualify, applicants must develop a business plan and provide a contribution of at least R5 000,00.
   - The Settlement Land Acquisition Grant (SLAG) was put in place to encourage people to co-operate and apply as a group:
     - individual contributions and the size of the grant are scaled up accordingly
     - implemented as the amounts granted in the LRAD programme were small
     - this programme came to an end in 2006, by which time only 3% of agricultural land had been transferred.

2 Settlement:
   - Provides land to previously disadvantaged people for settlement.

3 Non-agricultural enterprises:
   - Provides land to previously disadvantaged people for:
     - non-agricultural purposes (e.g. ecotourism)
     - secondary or tertiary agricultural processing.

Challenges facing land reform

Progress has been slow, because of a lack of:

- funds and access to credit
- infrastructure
- expertise and training
- access to markets and marketing expertise

To address these challenges, the departments of Agriculture, Forestry and Fisheries and of Land Affairs started projects and programmes to help. For example:

- Micro Financing Initiative for South Africa (MAFISA): to provide funding to accredited Development Finance Institutions (DFIs) to lend production funding to targeted agricultural end users within targeted areas. (Was successfully piloted in Limpopo, then discontinued due to administrative complications.)
- Land and Agrarian Reform Project (LARP): started in 2008, but no funding was allocated to this programme, so it never got off the ground.
- The Comprehensive Agricultural Support Programme (CASP): is intended to provide post-settlement support to beneficiaries of land reform. This programme has had a good impact but has limited funding.
- Proactive Land Acquisition Strategy (PLAS): is functional and making an impact, although it is hampered by insufficient funding.

Unit 4

Agricultural legislation

4.1 The aims of agricultural legislation

The aims of agricultural legislation are to:

- enforce the provisions of the Constitution
- promote agricultural production
- regulate all sections of the agricultural sector so that they contribute to the functioning of the state, to food security and to the economy and welfare of people
- form the legal framework for running the agricultural sector
- prescribe the framework for good agricultural practices
- protect our natural resources from exploitation, pollution and degradation
- protect workers from exploitation, unfair discrimination and abuse.

There are also specific laws with specific aims, such as

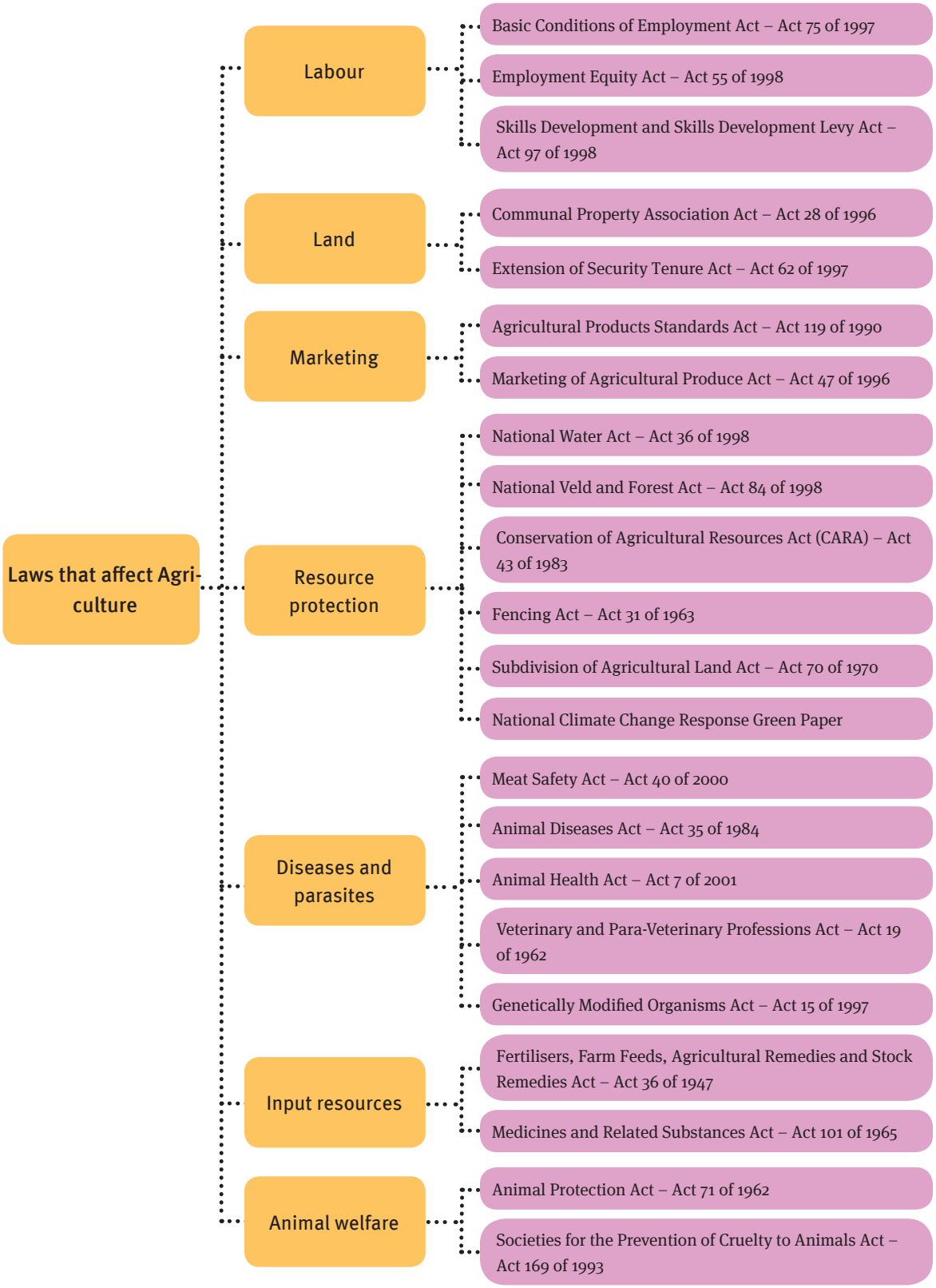
- control introduction of plants and livestock diseases and parasites into South Africa
- managing disease outbreaks
- controlling the safety and quality of our food
- controlling the selling and marketing of agricultural produce.

4.2 The legal concepts

- The Constitution:
  - The Constitution is the supreme law of the land. It provides the basic principles with which all other laws must comply.
- Green paper:
  - A green paper is a preliminary report on a government proposal for a new or amended law. It is published to stimulate discussion before legislation is written and published. It gives suggestions for public debate and consultation, which are then used to draft a law.
- White paper:
  - When the government proposes a law, it is published as a white paper to give people the opportunity to comment. Then the law is drafted and presented to parliament for consideration. If it is accepted, it is passed by parliament and becomes a law.
- Regulations (by-laws):
  - Laws are broad in concept and lack detail. As time passes, the detail changes and so regulations are published from time to time to fill in the appropriate detail. Regulations are promulgated by the minister and do not need to go back to parliament for consideration.
- Amendments:
  - When a law becomes out-dated due to changing circumstances, it is amended.

4.3 Important laws which affect agriculture

Some of the main laws in South Africa that affect agriculture are summarised below.



Laws that affect agriculture

Unit 5

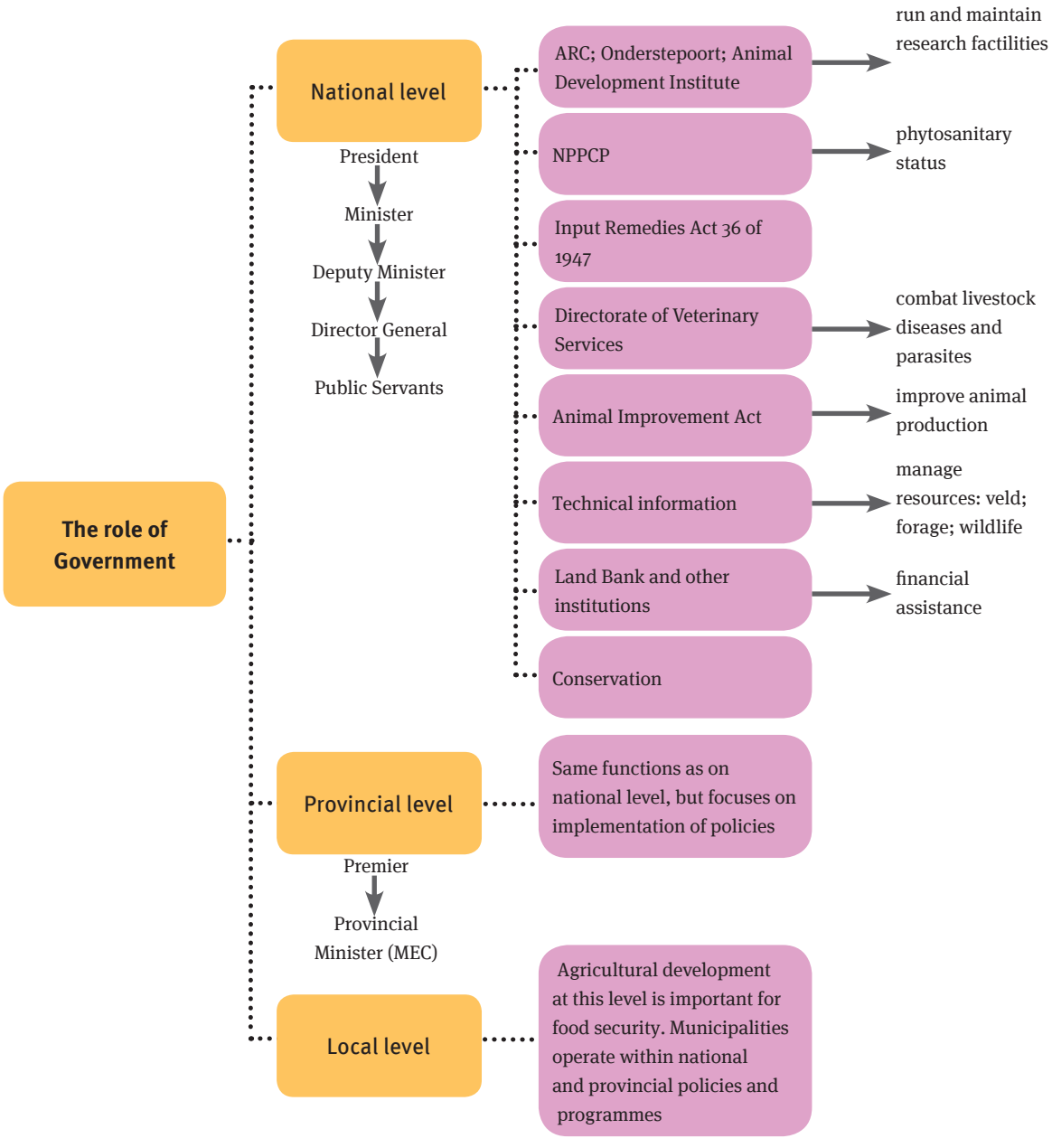
Agricultural Organisations

5.1 Levels of agricultural organisations

Agriculture is organised and managed by the government and by private industry bodies at national, provincial and local levels.

5.1.1 The role of government

Because agricultural development is vital to our country, the government – through its various structures at different levels – manages it.



The role of government in agriculture

5.2 The roles of agricultural organisations

Community-based organisations are made up of farmers and stockowners who join together in a union. They operate on local, provincial and national levels. Organisation is from the bottom up: from local to national levels, e.g. Agri-SA. Each level will negotiate with the governmental structures at its appropriate level. So the national farmers' unions act as the mouthpiece for all farmers at national level.

5.2.1 Aims

- National level: to ensure the best financial and social position for the farmer within the national economy
- Local and provincial level: issues specific to a region, e.g. bad roads, security and communications.

5.2.2 The Agricultural Research Council (ARC)

- The ARC was established in 1990 through the Agricultural Research Act, Act No. 86 of 1990.
- The ARC is the principal agricultural research institution in South Africa.
- It runs 12 research institutions and most experimental farms, which carry out research into important aspects of agriculture.

There are four research focus areas.

1 Horticulture

- ARC Institute for Tropical and Subtropical Crops (Mbombela/Nelspruit):
  - handles the cultivation tropical and subtropical fruits, as well as tea, coffee, spices, pecan nuts, Macadamia nuts, and cashew nuts. Exotic crops are also evaluated, including cacao, coconut, annona (custard apple) types, and sapote (ShuShu).
- ARC Roodeplaat Vegetable and Ornamental Plant Institute (Pretoria):
  - works on commercial and indigenous vegetables. It also researches the production and development of ornamentals and indigenous flora such as fynbos and on natural products and medicinal plants.
- ARC Infruitec-Nietvoorbij (Stellenbosch):
  - focuses on deciduous fruit, alternative crops (e.g. berries, figs and olives), indigenous herbal teas, and regional medicinal plants. Attention is paid to extending the shelf life of agricultural products, with a focus on post-harvest processes, such as wine and brandy production, as well as cold storage, drying, canning, juicing and jam production.

2 Animal production and health

- ARC Onderstepoort Veterinary Institute (OVI) (Onderstepoort, Pretoria):
  - focuses on veterinary research to improve the understanding of the diseases and parasites affecting our livestock as well as on improving the production of vaccines and diagnostic tools. They also produce vaccines against redwater, heartwater and gallsickness.
- ARC Animal Production (Irene, Gauteng):
  - focuses on technologies to improve the quality of animals, and on developing genetic and physiological methods to identify and study superior livestock breeding material in order to improve the efficiency and production of our national herd. They also study the nutritional needs of animals in order to enhance the quality of meat and dairy products, and different holistic and integrated land use and management strategies to ensure sustainable utilisation of our land resources.

3 Natural resources and engineering

- ARC Soil, Climate and Water (Pretoria):
  - studies characterisation, sustainable utilisation and protection of natural resources. Its research includes soil science, agro-meteorology, water utilisation and water analytical services.
- ARC Engineering (Pretoria):
  - the engineers focus on agricultural mechanisation, irrigation and alternative energy, and the innovation of energy sources and application in rural areas, such as the use of methane gas from manure or compost to cook food.
- ARC Plant Protection Research Institute (Pretoria):
  - handles the control of pests through effective pesticide management, and biological and integrated control strategies. They also research and help rural communities with bees and honey production.

4 Grain and industrial crops

- ARC Grain Crops Institute (Potchefstroom):
  - works towards the improvement and cultivation of summer grain crops (e.g. maize, sorghum and millet) and oil and protein seeds (e.g. sunflowers, groundnuts, soya beans, cow peas lupins and Bambara). Research focuses on plant breeding, the evaluation of cultivars, grain quality and entomology.
- ARC Small Grain Institute (Bethlehem):
  - focuses on the improvement and cultivation of small grain crops (winter grains) such as wheat, barley, oats, rye and Triticale, and covers the same aspects of research on these crops as the above institute does, only on small grains.
- ARC Institute for Industrial Crops (Rustenburg):
  - researches cotton and tobacco, as well as industrial crops such as hemp, sisal, flax and cassava. It also researches the re-introduction of indigenous crops such as cowpeas, Bambara, millet and sorghum.

5.2.3 National Agricultural Marketing Council

The National Agricultural Marketing Council (NAMC):

- was established by the Marketing of Agricultural Products Act, Act No. 47 of 1996
- with the mission to:
  - provide policy and strategy recommendations to the Minister (DAFF).
  - focus on the optimising the strategic position of the South African agricultural sector in dynamic global markets.
  - supply information on the marketing of South African agricultural products.

There are four divisions:

- Market and Economic Research Centre (MERC):
  - researches and tries to understand agro-food market chains (including cost of inputs and selling prices – local and global), trade, risk management and information systems.
- Agricultural trusts:
  - MERC was appointed in 2008 to manage the reporting on agricultural trusts. There are numerous agricultural trusts with mandates to promote all aspects of each specific industry, e.g. Citrus Trust, Cotton Industry Trust, Deciduous Fruit Industry Development Trust and the Maize and Meat Trusts.
- Agribusiness development:
  - this division collaborates with industries to design programmes to improve market access and encourage new business development in previously disadvantaged agribusiness.
- Statutory measures:
  - the Act provides for statutory measures such as levies, control of exports and the collecting, keeping and registration of agricultural exports.

5.2.4 Council for Scientific and Industrial Research (CSIR)

- The CSIR was established by an Act of parliament in 1945 = South Africa's main scientific and technical research organisation.
  - Research focuses on many sectors of the economy with the aim to improving the quality of people's lives.
  - Its industrial and other programmes are run by the Department of Science and Technology:
    - can impact and assist in the improved delivery of agricultural products through the study of climate change, sustainable energy, forestry resources, pollution, and waste and ecosystems.

5.3 Benefits and advantages of agricultural organisations

5.3.1 Government organisations

- The Department of Agriculture, Forestry and Fisheries protects and assists farmers and stockowners through laws.
- Research findings from the ARC, CSIR and others benefit farmers, e.g. new vaccines, new development of cultivars or crops (e.g. peppadews)
- The National Agricultural Marketing Council (NAMC) provides information on the latest pricing trends of products, both locally and internationally.

5.3.2 Community-based organisations

- Agri-SA gives a voice to all farmers from local and regional chambers, to national level through contact with DAFF.
- The Agricultural and Veterinary Chemicals Association (AVCASA), through its subsidiaries: Crop Life, The South African Animal Health Association (SAAHA), and the Agricultural Chemicals Distributors of South Africa (ACDASA), is a voluntary association of private companies that provide inputs such as agricultural remedies. They provide training on the safe use of chemicals.

Unit 6

Indigenous knowledge in South Africa

6.1 Indigenous (traditional) knowledge systems

Indigenous (traditional) knowledge systems (IKS) are knowledge systems passed down by word of mouth over hundreds (and even thousands) of years, based on people's close interaction with the environment. Much of this information is useful and is being tested scientifically by scientific or evidence-based knowledge. Indigenous knowledge is now being used in agriculture and medical science.

Scientific knowledge	Indigenous knowledge
Modern (couple of hundred years)	Old (thousands of years)
International	Local
Not necessarily suitable for African conditions	Developed in Africa for local conditions
Written and accurately recorded	Passed on by word of mouth (verbal)
Proven by scientific testing	Determined by observation
Accurate analyses and dosing	Dosing determined by trial and error
In some cases may place stress on environment	Generally adapted to the environment
Suitable for mass production	Only suitable for sustainable harvesting

Comparison of indigenous and scientific knowledge

6.2 Indigenous knowledge used in agriculture

6.2.1 Indigenous livestock breeds

- Meat, milk and eggs:
  - Indigenous animal breeds are better adapted to the climate, they have a smaller impact on the environment and they are more resistant to many of our indigenous diseases and parasites. Examples are Nguni cattle, Pedi sheep, the indigenous goat and various chicken breeds such as the Venda, Ovambo and Zulu chickens.
  - They are suitable for subsistence farming where there is no focus on production.
- Crossbreeding:
  - They have specific traits that are good and these are used in crossbreeding to improve the survivability of the modern, imported breeds that have been selected for production traits. Examples of such crosses are the Boer Goat, (which is exported all over the world because of its good characteristics), the Kalahari Red goat, the Dorper sheep, Afrikaner cattle and the Boschvelder layer chickens.
- Game animals:
  - Even better adapted to our environment and its challenges (water shortages, diseases like, and parasites like ticks).

- Because of their scarcity, they are considered a delicacy, their meat fetching high prices overseas.
- This is a unique opportunity that SA is still not fully utilising.

6.2.2 Indigenous vegetation

- Construction and manufacturing:
  - Indigenous peoples know which grasses, sedges and reeds are suitable for basket weaving, for the construction of shelter, for fishing nets and utensils such as brooms and place mats.
- Medicine:
  - Many indigenous plants have been identified through indigenous knowledge as having medicinal effects:
    - *Hoodia gordonia* (bitter ghaap) is a leafless succulent with large pale grey/pink flowers. It grows in the dry western parts of South Africa. It was traditionally used to suppress hunger and thirst. Scientific analysis has identified an active ingredient called P57, and scientific testing has shown an appetite suppressant effect that acts on the brain. An extract of Hoodia is sold commercially to help people diet. Because it is a desert plant, it is not very numerous and it cannot sustain wild harvesting, so large-scale cultivation has been initiated.
    - *Hypoxis hemerocallidea*, (African potato, or *inkomfe* in isiZulu) is a perennial with long green leaves and yellow star-shaped flowers. Traditionally, it was used for the treatment of enlarged prostate glands. Modern analytical methods have extracted the ingredient beta-sitosterol. It is now grown commercially and used in products in Europe to treat prostate enlargement and as an immune stimulating tonic.
    - *Sutherlandia frutescens* (cancer bush, or *phetola* in Setswana) is a shrub with a silvery appearance and red flowers. It is found all over South Africa, Lesotho and Botswana. Studies show that it has an active ingredient called canavanine, which has anticancer activities. It has also been reported to be effective in helping people with TB and who are HIV-positive.
    - *Lippia javanica* (fever tea, or *inzinziniba* in isiXhosa; *umsuzwana* in isiZulu) is a tall shrub with hairy green leaves and a strong lemony smell. It is now cultivated to extract oil used in mosquito repellent candles.
    - Powdered bark of *Albiza adianthofolio* and *A. anthelmintica* (false paperbark, or *umhlandlothi* in isiXhosa; *umgadankawu* in isiZulu) was used widely to treat tapeworm in livestock.

6.2.3 Food and drink

- Some indigenous food crops are being improved, for example, Bambara bean, the cowpea, millet and sorghum. Amadumbe is an indigenous plant that produces a tuber that is used like a potato.

- Various indigenous herbs are used to produce medicinal and non-medicinal teas, for example, Rooibos, Honey bush (anticarcinogenic) and Boegoe / buchu tea (anti-ageing and diuretic properties).

6.3 Constraints and advantages of indigenous knowledge

6.3.1 Constraints

- Indigenous knowledge was not written down and recorded and was sometimes inaccurately passed on, and folklore added.
- Measurement and analyses of the active ingredients could not be done, so the dosing is inaccurate.
- The knowledge has not necessarily kept pace with the demands of a growing population, rapidly increasing demand, and the consequent need for focus on productivity.

6.3.2 Advantages

- Thousands of years of knowledge and experience can be accessed.
- There is information on where to look and what research to do to prove or disprove the claims.
- The gene pool has not been interfered with, so it is broader than that of 'developed' European breeds. This ensures the benefits of biodiversity are there when we need them.
- Local breeds are better adapted to local conditions and have less impact on the environment.
- The use of indigenous crops benefits biodiversity, counters malnutrition, and improves food security and soil fertility.

6.4 Protection and management of IKS in South Africa

- The Department of Agriculture, Forestry and Fisheries recognises the benefits of conserving and investigating indigenous knowledge.
  - Some of its divisions have specific programmes to investigate and record this information.
  - Many of the ARC Institutes are gathering, researching, recording and storing this information.
  - Both government and private institutions, like the Breed Society, are preserving the genetic material of these breeds and cultivars.
- Some of the national and multinational pharmaceutical companies researching IKS to find new medicines for diseases, such as malaria.

Topic 2

Topic questions

Topic 2: Questions

- Answer the questions below.
- Give yourself one hour.
- Check your answers afterwards and do corrections.

1 Name five main concerns in Agricultural Economics. (5)
2 Discuss four modern challenges faced in agriculture. (12)
3 Over the past four decades there has been a shift in the eating patterns of South Africans. In what ways did these eating patterns change and why did they change? (10)
4 Describe the three models of land ownership in South Africa. (9)
5 Name three important laws that affect agriculture. (6)
6 Name the main three agricultural organisations in South Africa and briefly describe the main functions of each. (9)
7 Give four differences between scientific knowledge and indigenous knowledge (IK). (8)
8 Name three indigenous medicinal plants.
9 Discuss four advantages to using IK in agricultural production. (8)

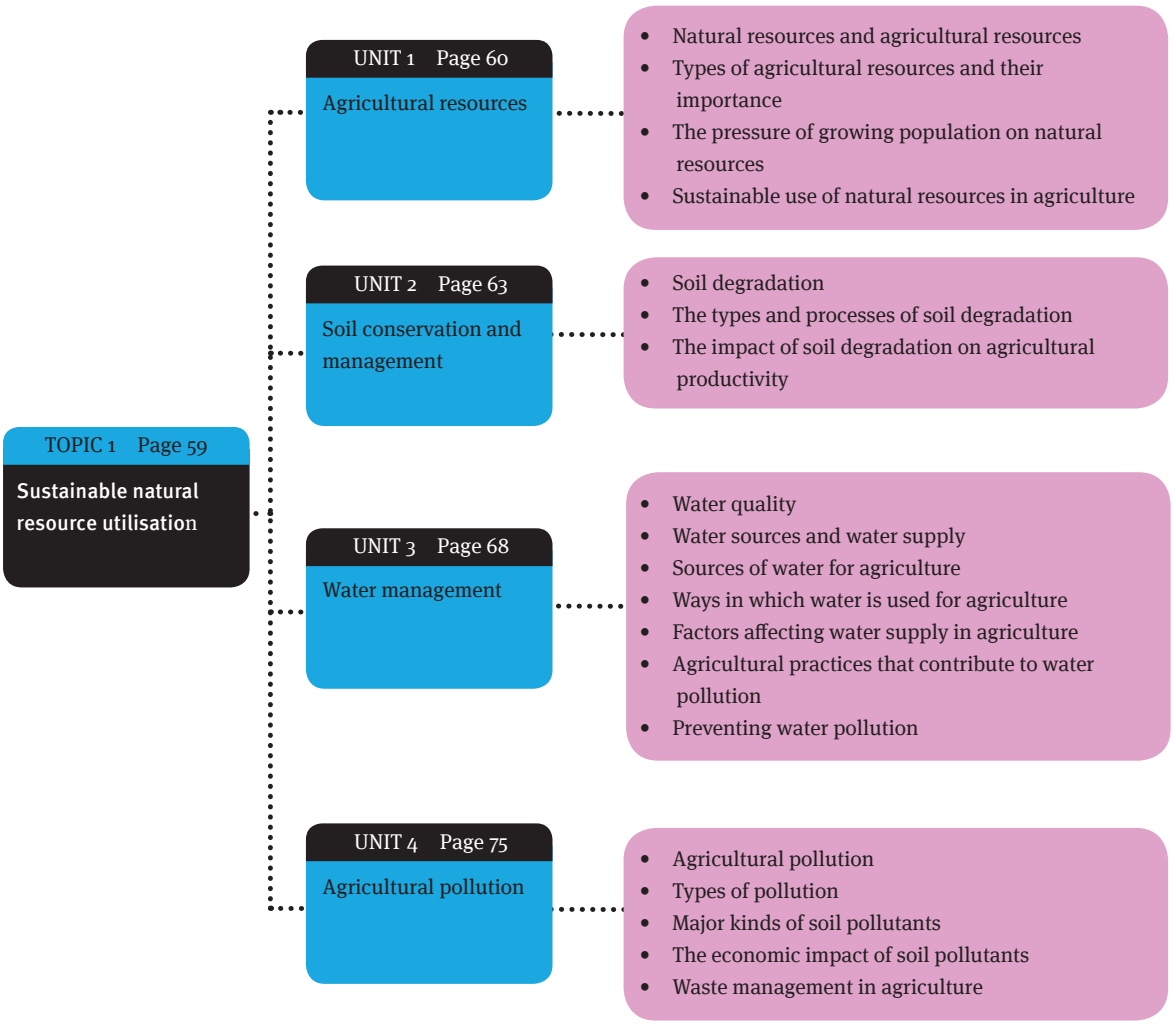
[Total marks: 70]

Topic 3

Sustainable natural resource utilisation

Overview

The two most important natural resources in agricultural production are soil and water, therefore they have to be used in a sustainable way.



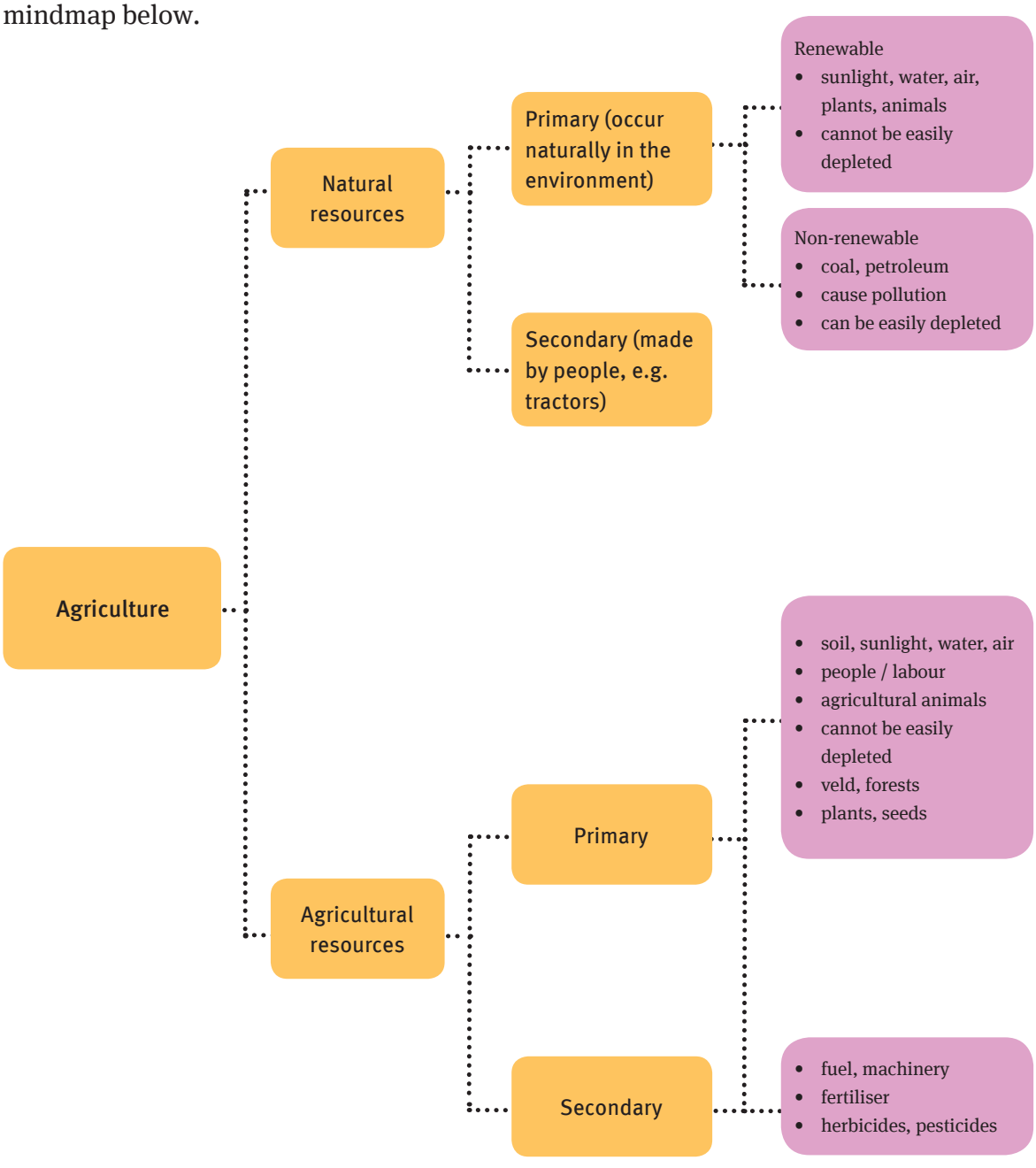
What you will cover in Topic 3

Unit 1

Agricultural Resources

1.1 Natural resources and agricultural resources

Farmers use natural resources and agricultural resources, as summarised in the mindmap below.



Natural and agricultural resources

1.2 The pressure that a growing population exerts on natural resources

1.2.1 Population growth

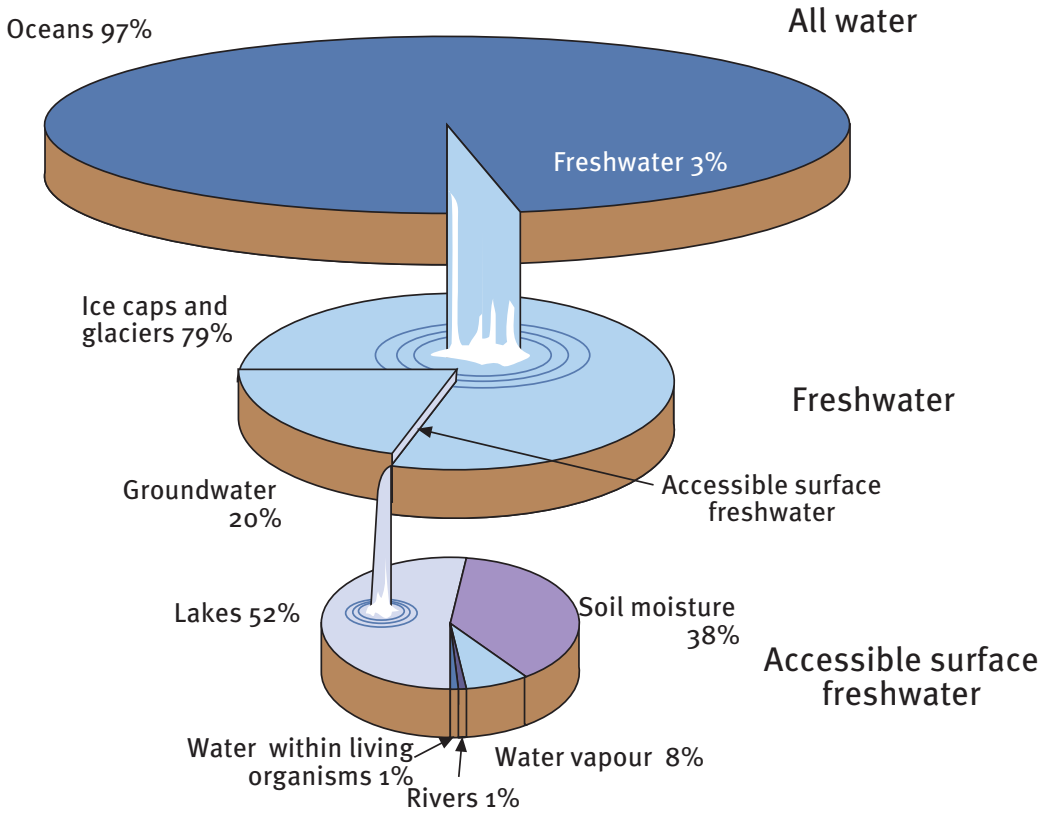
South Africa's annual population growth rate is between 2% and 2,5%: Nearly a million people per year → more food is needed, using the same amount of soil and water → puts pressure on natural resources.

Pressure on the soil

Soil is a complex mixture of organic and inorganic matter that takes thousands of years to form = a non-renewable resource. In addition:

- Only a small part of the Earth's surface can be used for agriculture.
- Because of increasing demand for food, traditional farming methods (e.g. 10-year fallow period) have been replaced with use of chemicals and fertilisers non-sustainable practices because they lead to soil degradation.

Pressure on water



Only about 0,36% of the total amount of water on Earth is available to meet human needs

70% of the surface of the earth is covered with water:

- 97% is seawater
- 3% of the water on the planet is fresh
  - 79% of fresh water is frozen in the polar caps and the ice glaciers.
  - 20% is hidden away in underground water sources, (e.g. aquifers and wells)
  - Only about 0,036% of the total amount of water on the planet is found in surface water sources such as rivers, lakes and dams.

Increased pressure on water due to:

- population growth and the resulting need for increased agricultural output
- climate change.

Many countries in Africa, including SA, will shift from water surplus to water scarcity as a result of population changes alone between 2010 and 2025.

1.3 Sustainable use of natural resources in agriculture

- In agriculture, soil and water are strongly linked. Good soil conservation practices conserve water; good water conservation practices conserve the soil.
- Only a small part of the soil and water can be used for agriculture → both must be used in a sustainable way. In addition:
  - Water is in short supply in most of southern Africa.
  - Soil can easily be degraded, eroded or washed into the sea.
- Link in modern agriculture between natural resources and food security → if natural resources are compromised, the world population will not have food security.
- The sustainable utilisation of natural resources in agriculture involves the following:
  - Conserving the soil so that rain does not wash it into rivers or dams, wind does not blow it away and chemicals (e.g. fertiliser and pesticides) do not pollute it.
  - Conserving water by checking tanks for leaks, and making sure it is not polluted by agricultural chemicals or animal waste.
  - Managing the animal waste on the farm and using it to enrich the soil.
  - Properly planning farm processes, such as ploughing and irrigation, so that they do not have a negative impact on the environment and natural resources.

Unit 2

Soil conservation and management

2.1 Soil degradation

Overgrazing = about 35% of soil degradation. Mismanagement of arable land = 35%.

- Soil degradation = any process that causes the condition of the soil to degrade or lose its nutrients:
  - loss of the quality of the soil → no longer a good medium for plants to grow in
  - the loss of the soil itself, through soil erosion.
- Soil conservation = the process to stop the degradation of soil and repair the damage so that the condition of the soil improves and is maintained.

2.2 The types and processes of soil degradation

Soil degradation can happen through:

- loss of soil quality
- loss of soil through erosion.

2.2.1 Loss of soil quality

Two factors play a role in the quality of soil: soil nutrients and soil structure. So, anything that affects soil nutrients of soil structure can result in soil degradation. The quality of the soil can be degraded or decreased in three ways:

- physical degradation
- biological degradation
- chemical degradation.

Physical degradation

Happens when the structure of the soil is damaged by:

- wrong cultivation methods, e.g. using the wrong implement
- ploughing when the soil is too wet or too dry

Ploughing when the soil is too wet

- Dense layers of tightly packed soil (plough bank / smear layer) form at the bottom of the layer that was ploughed.
- When it is compacted → contains less air → can store less soil water → plant roots cannot penetrate layers of compacted soil → plant growth is decreased: crop yields are negatively affected.
- The most common cause of compaction = tractors, harvesting machinery and implement wheels that travel over wet soil.
- Wet soil compacts more readily, because the water allows the soil particles to be rearranged more easily.
- Some soil types also compact more easily than others: soil containing more organic material compacts less easily.

Avoiding and fixing compaction

To avoid compaction:

- Don't drive on wet soil and don't use high compaction tools, such as disc ploughs and heavy tractors while soil is wet.
- If soil is compacted:
  - leave the field for a season or two to rejuvenate
  - use a combination of reduced or no tillage and reduce tractor traffic
  - 'deep rip' (ploughing to a greater depth) to minimises the effects of compaction, but don't drive on the field again if the soil is wet: this will settle the compacted layer again.

Avoiding physical degradation

Inspect soil regularly using a spade to see deeper layers.

Avoiding biological degradation

- Always use cuttings from registered nurseries.
- Use only certified propagation material.

Avoiding chemical degradation

- Use biodegradable herbicides and pesticides
- Use the natural enemies of the particular pest.

Ploughing when the soil is dry

- Ploughing when the soil is too dry will leave big clods in the soil.
- These clods are difficult to break when a new seedbed for the next crop is created.

Biological degradation

This is caused by:

- Cuttings from unregistered nurseries, or illegally imported plants and seeds, can spread pests (eelworm) or pathogens.
- Agricultural practices such as tillage and increasingly converting areas with natural vegetation to agricultural land.
  - These practices cause the disappearance of natural soil bacteria and microbes.
  - The fertility of the soil decreases.
- Replacement of primary plant communities (climax) by secondary communities.

Chemical degradation

- Due to use of chemicals e.g. Atrazine (herbicide) to kill weeds and pests.
- Chemicals have to be leached from the soil before next crop is planted.

2.2.2 Loss of soil through soil erosion

Soil erosion is the loss of the soil itself through the action of wind or water. Soil erosion causes great damage to the land, because it removes the topsoil. Without topsoil

- crops don't grow well = poor harvests
- grazing doesn't grow well = animals become thin → do not produce much milk and many young animals die.
- not enough plants to hold the soil when it rains, or when the wind blows = more soil is carried away → fertile areas soon become deserts → no food can be produced.

Thousands of tons of fertile topsoil are transported by the wind and water to rivers, dams and the sea. This causes siltation, which leads to floods.

Causes of soil erosion

- Removal of plant cover: Farming methods that remove plant cover are –
  - ploughing
  - overgrazing
  - veld burning
  - deforestation.
- Slope: The steeper the land, the greater the rate of erosion.

Warning signs

- muddy water in streams and rivers
- dams filled with mud
- plants with bare roots
- dust storms
- new soil deposits (water carries soil from higher ground to lower ground, new soil deposits in the lower parts means that soil erosion has taken place higher up and washed the soil down)
- pedestals
- bare ground
- deep cattle and foot paths.

Effects of soil erosion

- The topsoil is removed, which decreases fertility. Fertiliser has to be added.
- It reduces the amount of water that sinks into the soil.
- The cost of farming increases, which leads to increase in food prices.
- Damage to infrastructure and the environment:
  - sediment on roads, waterways and rivers (due floods)
  - fertilisers and pesticides washed into rivers.

How to prevent soil erosion on a slope

Note: Farmers should not use slopes greater than 15° for growing crops, because it is difficult to prevent erosion on slopes that have more than a 15° gradient. There are five ways to hold the soil on slopes:

1 Contour ploughing:
   - On a slope of 0°–3° by ploughing along the slope.

2 Vegetation strips:
   - On slopes of 3°–15°. Plant strips of 1–8 m wide along the contours between crop areas. The strips stop runoff and hold the soil. After a few years, the rain will move the soil down the slope between the strips and the slope between the strips will start levelling.

3 Stone banks:
   - On slopes of 3°–15°. Pile stones along the contours. Crops are planted along the contours between the stone banks. Stone banks are especially useful:
     - when the soil contains many stones that hinder ploughing or planting
     - to repair land where there is erosion
     - in low rainfall areas to increase the amount of water that goes into the soil.

4 Contour banks:
   - On a slope of 3°–15°. Difficult to construct, so farmers should consult an agricultural extension officer. Farmers need to work together to plan a system for the entire area. A contour bank system consists of three parts:
     - the contour banks – a ditch with a bank or wall of soil on the downward slope
     - the cut-off drain – it catches the water that runs off the land above the field, which gives the water time to soak into the soil
     - the grass waterway – it carries any extra water away from both ends of the contour banks and the cut-off drain.

5 Terraces:
   - On slopes steeper than 15°. Terraces are steps that are cut into the slope. Crops are grown on the flat part of the step and the soil is supported on the upright part of the step by grass, trees or stones. Terraces flatten out. Plan where to put the cut-off drain and terraces before building terraces.

2.3 Impact of soil degradation on agricultural productivity

Soil degradation leads to loss of fertile soil for food production:

- The global loss of productive land through soil degradation = 5–7 million ha per year. Every year 25 000 million tons of topsoil is washed away (according to FAO).
- Worldwide, soil erosion puts the livelihoods of nearly 1 000 million people at risk.
- In SA 300–400 million tons of soil is lost every year. To replace the soil nutrients with fertiliser would cost R1 000 million.

2.3.1 Other impacts of soil degradation on agricultural productivity

Agricultural activities themselves lead to loss of soil:

- for every ton of maize, wheat, sugar or other agricultural crop that is produced, South Africa loses an average of 20 tons of soil.
  - Soil erosion:
    - difficult to plough land
    - disturbs or removes seeds, leading to crop loss
    - fertiliser and pesticide lost – replaced at great cost
    - soil quality changes: if the lighter soil particles are washed away, only the bigger particles remain, affecting the water-holding ability of the soil and making it less able to withstand drought → can result in the type of soil changing.
  - Soil deposits: slow the emergence of new plants after germination; may even stop germination.
- Sedimentation fills rivers: rivers hold less water and flood easily.

Unit 3

Water management

3.1 Water quality

- Water quality is measured according to the physical, chemical, biological and aesthetic properties of water, based on what the water is to be used for.
- In SA, the Department of Water Affairs (DWA) is responsible for water quality. It has to ensure fitness of use for the four broad categories of water use that are recognised in the National Water Act (No. 36 of 1998):
  - domestic purposes
  - industrial purposes
  - agricultural purposes
  - recreational purposes.
- The water quality requirements of these water uses and those for the protection of the health of aquatic ecosystems form the basis on which the overall fitness for use of water is judged.
- The DWA has published a set of water quality guidelines → give the acceptable levels of impurities for different uses, including crop irrigation and livestock watering.

Important definitions:

- Water supply: how much water you have.
- Water source: where the available water is stored (surface or underground).

3.2 Sources of water for agriculture

- All water used for agriculture comes from rain. Rain forms part of the water cycle.
- When it rains, one of a number of things can happen. It can fall:
  - on the soil, and then remain in the top layer of the soil (soil water)
  - on the soil and then enter the soil (subsoil or groundwater)
  - in the sea, lake, dam or river (surface water).

3.2.1 Soil water

- Soil water = water or moisture found in the top layer of soil.
- Some soil types hold water better than others:
  - sandy soils = permeable → don't hold water very well → water drains easily
  - clay soils = not very permeable → holds water very well → water doesn't drain easily.

3.2.2 Groundwater

- Groundwater = water that enters the soil and moves down through the soil until it reaches rock.
  - The water collects above the rock and in cracks in the rock.

- Groundwater is available in different ways:
  - Where the layer of rock meets the side of a hill, the groundwater comes out of the ground in the form of a spring.
  - Where there is a shallow layer of soil above the rock, the groundwater may rise up to the surface and form a vlei. Vleis usually occur in low-lying places and may only have surface water during the rainy season.
  - People dig wells or boreholes to reach the groundwater. Boreholes are usually deeper than wells and supply more water. This is because boreholes often reach deep groundwater that is trapped below a layer of rock.

3.2.3 Surface water

- Surface water = water on the surface of the earth.
- When it rains, the runoff water that moves along the top of the soil goes into streams → the streams join with rivers → the rivers may join into a larger river that flows on to the sea or to a lake.
- People sometimes build dams along streams and rivers to store some of the water.
- Not all surface water can be used for agriculture (e.g. seawater needs to be desalinated).

3.3. Ways in which water is used for agriculture

3.3.1 Water uses for livestock farming

- For drinking purposes for their livestock:
  - take animals to a river or stream in morning or evening
  - collect water in a water tank and flow the water to water troughs
  - use a windmill to pump water from a well or borehole → store the water in a water tank and flow into drinking troughs.
- Other purposes:
  - to dip their animals
  - to clean animal pens, milking sheds, etc.
  - to irrigate artificial pastures (e.g. alfalfa).

3.3.2 Water used for crop farming

- Water used to water (irrigate) crops.
- Water management done by:
  - choosing crops according to rainfall (e.g. planting drought-tolerant crops: sorghum instead of maize)
  - growing crops that have a short growing season (e.g. sunflower)
  - conserving rainwater in the soil
  - using suitable irrigation → has advantages –
    - increases the chances of a good harvest
    - enables crops in low rainfall areas that could not normally grow there
    - enables farmers to grow plants during the dry season.

Conserving rainwater in the soil

Rainwater can:

- run off along the surface of the ground ⇢ does not reach plant roots
- evaporate
- enter the soil.

So, to conserve water:

- reduce evaporation by mulching
- increase the amount of rainwater that enters the soil:
  - Method 1: stop soil erosion.
  - Method 2: pocketing water → make shallow pockets in the soil.
  - Method 3: end-of-season ploughing → at the end of the rainy season the soil is still moist → when the next rainy season starts, the soil is loose.
  - Method 4: no-tillage farming → crop remains to form mulch → prevents evaporation and soil doesn't become compacted
  - Method 5: preserving the plant cover → decreases water runoff → prevents soil compaction.

Quality of irrigation water

Water tests	
Testing for salinity and sodicity	Dissolved salts in water or soil causes salinity. Water with a high amount of salt becomes saline. If you use saline water to irrigate your crops, the soil will become saline. Very few types of crops grow well in saline soils. The only way to get the salts out of the soil is to wash the salts down. This is done by watering the soil with a large amount of water that does not contain salts. The soil needs to be washed down every 1–2 years Sodium-containing salts in the water causes sodicity.
Testing for toxic chemicals	Irrigation water may contain toxic chemicals, e.g. boron and manganese. This will make the soil toxic too.
Turbidity	Turbidity is muddiness caused by soil particles and organic materials in the water. These particles can block sprinkler and drip irrigation systems. These problems can be reduced with the use of settling tanks and filters.
Biological matter	Micro-organisms from human sewerage, animal housing or runoff water can endanger animal and plant health.

Water laboratories test water to ensure suitable quality.

3.4 Factors affecting water supply in agriculture

Water supply is influenced by rainfall. The rainfall of an area has three important aspects:

- average annual rainfall
- seasonal distribution
- intensity.

3.4.1 Average annual rainfall

- Rainfall in SA is extremely variable: it ranges from droughts to flooding.
- Only one third of SA receives more than 600 mm of rain, the minimum for successful crop production.
- The remaining two-thirds of the country is used for livestock grazing natural vegetation.

3.4.2 Seasonal distribution

The season in which it rains determines the crops:

- crops that grow well in cooler temperatures will grow better in winter rainfall areas
- crops that grow well in warm or hot temperatures will grow better in summer rainfall areas than winter rainfall areas
- winter cereals (wheat, barley, oats) are grown in winter in the winter rainfall areas or under irrigation in the summer rainfall areas.

3.4.3 Intensity

Most of South Africa faces a shortage of water. Even in the higher rainfall areas on the eastern side of the country, periods or seasons of drought can occur.

- In most summer rainfall areas, thundershowers occur: short and intense rainfall → results in the flooding of rivers and low-lying areas → flooding can wash away crops and the fertile layer of topsoil.
- If the intensity is too low, especially when temperatures are high, the rainfall may evaporate.
- In the winter rainfall areas, the rain usually falls in long periods of soft rain.

To avoid crop failure, farmers need to manage water well.

3.5 Basic agricultural practices that contribute to water pollution

- Agriculture uses 70% of the Earth's surface water supplies.
- The largest part of agricultural water is recycled back to surface and groundwater, the rest is lost through evaporation.
- Agriculture contributes to water pollution through:
  - ploughing
  - irrigation
  - fertilising
  - manure spreading
  - using pesticides
  - cleaning feedlots, pens and milking stables.

3.5.1 Ploughing

- Loose soil is washed away by rain or carried away by wind.
- Soil can be carried into surface water and cause siltation of dams and riverbeds.
- Pesticides or phosphorus from fertiliser stick to soil particles and can get into surface water.

3.5.2 Irrigation

Irrigation can pollute ground and surface water sources through runoff of salts, pesticides and fertiliser.

3.5.3 Fertilising

- Run-off of nitrates and phosphorus causes eutrophication → fish die and water tastes unpleasant.
- Nitrates leach into groundwater sources. Nitrates in surface and groundwater are a threat to public health. Soluble fertilisers contain nitrates and water with high levels of nitrate, which
  - encourages the growth of algae and bacteria that use up the oxygen in the water → fish and other water animals can't survive.
  - makes the water unsafe for human and animal consumption.
  - contaminates edible fish → causes health problems in humans.
- Fertiliser and pesticides contain high levels of trace elements e.g. selenium → causes ecological damage and health problems if it gets into surface water sources.

3.5.4 Pesticides

- Pesticides kill pests but they also kill other living creatures.
- Pesticides can run off into surface water and:
  - damage its ecosystem
  - cause growth problems and infertility in animals → can upset the delicate balance between predators and prey in the ecosystem
  - cause illness in people who eat contaminated fish
  - get carried over long distances by the wind → pollutes water sources thousands of kilometres away
  - leach into groundwater → contaminates wells → causes illness in humans.

3.5.5 Manure spreading

Too much manure can pollute ground and surface water with:

- nitrogen
- phosphorus
- pathogens.

3.5.6 Cleaning of feedlots, pens and milking stables

Feedlots, pens and milking stables must be cleaned, but:

- the wastewater can get into surface water sources → contaminates it with urine, faeces and pathogens
- if contaminated water is used to irrigate crops → the crops can become contaminated
- nitrogen and metals in the urine can leach into the groundwater → contaminates the groundwater.

3.6 How to prevent water pollution

3.6.1 Practices that farmers can implement

- Irrigate crops in a precise and planned way:
  - take care that the water lands on the crops only
  - don't let irrigation systems run unsupervised or for lengthy periods to:
    - prevent soil from becoming waterlogged
    - reduce water runoff
    - use less water.
- Test the soil to avoid over-fertilising.
- Keep the soil covered with vegetation to prevent the build-up of soluble nitrogen, which can run off into surface water or leach into groundwater.
- Implement soil erosion control measures.
- Manage the period between crops. Plant green manure crops between harvesting and planting again. Do not plough plant material left over from harvesting (for example straw or roots) into the soil too soon.
- Do not apply too much manure to the soil.
- Apply pesticides properly:
  - do not apply too much
  - only apply it in suitable weather conditions (not in windy or rainy weather)
  - limit aerial spraying
  - only use pesticides for what they are intended
  - dispose of empty pesticide containers in the correct way
  - don't flush out pesticide containers in rivers or other reservoirs.

3.6.2 Legislation to prevent water pollution

National Water Act (Act No. 36 of 1998)

The Act states that:

- The Minister of Water Affairs is the public trustee of the nation's water resources (surface and groundwater). The Minister must ensure that these resources are protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner.

- Persons who wish to use water, e.g. farmers, have to apply to the Department of Water Affairs to register that use. Water uses that involve farming operations include:
  - abstraction of water from a water resource (pumping water from a river)
  - storing of water
  - impeding or diverting the flow of water in a watercourse
  - irrigating land with waste water
  - discharging waste into a water resource
  - disposing of waste in a manner which may detrimentally impact on a water resource
  - altering the bed, banks, course or characteristics of a watercourse
  - removing and disposing of water found underground.
- Water may be used without authorisation for reasonable domestic use, domestic gardening, animal watering (not feedlots), fire fighting and certain recreational purposes.

Sustainable Utilisation and Protection of Agricultural Resources (SUPAR) Bill

The Bill seeks to:

- maximise productivity and sustainable utilisation of natural agricultural resources
- provide for the control of weeds or invader plants
- provide for the subdivision and change of utilisation of agricultural land.

The Bill will replace the Conservation of Agricultural Resources Act, No. 43 of 1993 (CARA) and the subdivision of Agricultural Land Act, No. 70 of 1970.

Unit 4

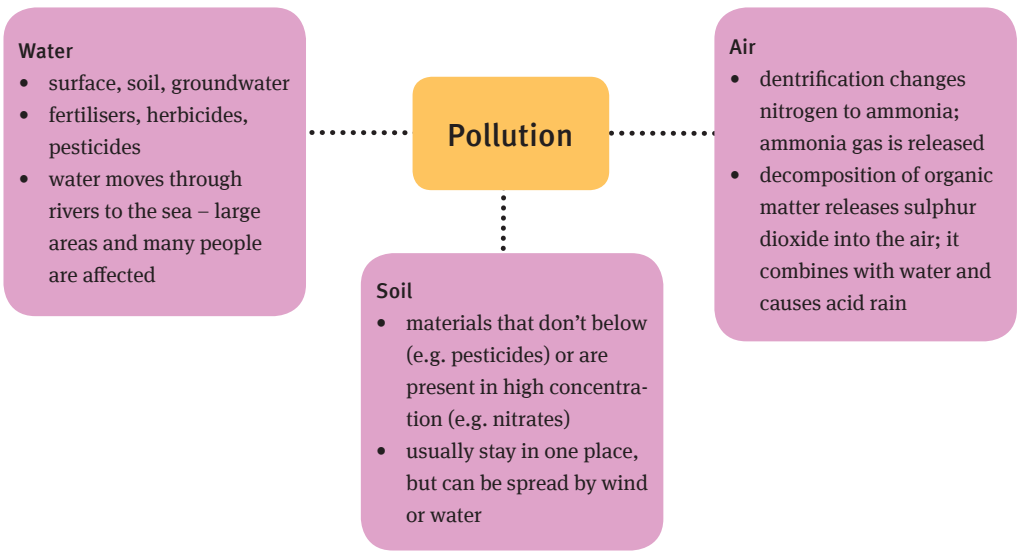
Agricultural pollution

4.1 Agricultural pollution

- To pollute = to put harmful substances (dirt, oil, chemicals, germs) into the air, water or soil.
- These harmful substances are called pollutants or contaminants → can cause harm to the environment, people and animals.
- Agricultural pollution is the pollution of water, soil or air by agricultural activities → affects agriculture because farmers use the water, soil or air again.
- Three factors determine the severity of a pollutant:
  - its chemical nature (whether it is a salt, heavy metal, acid, etc.)
  - its concentration (the higher the concentration, the more harmful it is)
  - its persistence (the longer it stays in the air, water or soil before it is broken down, the more harmful it is).

4.2 Types of pollution

Types of pollution are summarised in the mindmap below.



Agricultural pollution

4.3 Major kinds of soil pollutants

4.3.1 Fertiliser

- Chemical fertiliser can pollute the soil and water:
  - too much fertiliser used → soil is polluted. (Different crops need different types and amounts of minerals. Test the soil to determine amount required.)
  - Fertiliser nutrients are soluble: rain causes runoff → can contaminate water sources.

- To control soil pollution:
  - proper application methods and doses
  - reduce the use of chemical fertiliser by crop rotation or organic compost.

4.3.2 Herbicides and pesticides

- If not biodegradable → they stay in the soil → continue killing plants and animals.
- The harmful substances can build up in ecosystems, e.g. DDT → becomes more concentrated as it moves up the food chain.
- Best to use biological methods (natural enemies) of pest control.

4.3.3 Wrong irrigation practices

- Irrigation can increase the salination and acidification of soil. If the soil is not properly drained, salination and acidification will increase.
- If soil is irrigated with treated wastewater, it can cause pollution with heavy metals, e.g. cadmium (Cd). (Heavy metals are metals with densities of more than 5,0 Mg m^3. Low concentrations are not toxic, or could even be beneficial. Higher concentrations are toxic.)

4.3.4 Improper soil management

- Farm soil should be protected against erosion and proper draining systems should be created to maintain the soil.
- If soil is not protected, the structure of the soil can change → become less suitable for the crops.

4.3.5 Spillages

Use proper waste management to get rid of harmful substances, e.g. diesel.

4.4 The economic impact of soil pollutants

Soil pollution decreases the quality of soil and water. Economic consequences include:

- Increased soil salinity due to:
  - poor irrigation practices, poor fertilising practices and low drainage → soil becomes unsuitable for agricultural purposes → fewer crops are produced → food becomes more expensive. (If soil is badly degraded, farmers must find alternative land to farm.)
- Loss of fertility:
  - because farmers apply fertilisers without testing the soil first, the balance between nutrients in the soil becomes upset → this changes the soil structure, disturbs the chemical balance of the soil and kills the natural organisms → lower crop production → food becomes more expensive. (If soil loses too much fertility, farmers must find alternative land to farm. Also, plant cover is damaged, which leads to erosion.)

- Crops that grow in polluted soil will contain harmful contaminants.
- Soil pollution causes water pollution, due to runoff into surface water sources and leaching into groundwater sources. Alternative water sources have to be found = very expensive.

4.5 Waste management in agriculture

- Waste management in agriculture deals with the waste produced by farming activities, e.g. wasted feed, animal bedding and runoff from feedlots and holding areas.
- If this waste is not managed properly → water sources are polluted.
- Adding manure to the soil saves money → it increases the organic content of the farmland and saves the cost of fertiliser.

4.5.1 Farm Waste Management Plan

- Farm Waste Management Plan (FWMP) determines where the waste is produced, what it can be used for, and where it should be stored.
- FWMP must have a map to indicate:
  - pastures where animals graze (if rotational grazing is practised, note for how long the animals remain in one pasture)
  - fields where crops are grown (if crop rotation is practised, note when the field is planted and with what)
  - water sources, such as rivers, wells, etc.
  - areas of risk e.g. a slope near a river.
- The FWMP should address:
  - what type of waste is produced, and how much of each type of waste
  - when is the waste produced (continuously, or only periodically)
  - how much land is available for spreading
  - how much storage space is available.

4.5.2 Manure

- Can be stored:
  - in piles on the field where it will be spread
  - in tanks below or on the ground.
- Should only be applied in suitable weather conditions (no rain and no snow).
- Do not spread near water sources. Divert runoff from areas above the fields where it will be spread.
  - Use soil management practices to prevent runoff.
- Regularly check storage tank for leaks.
- If there are many animals → install a digester → generates biogas for electricity.

4.5.3 Silage

- Silage = feeding material (fodder) made from grass crops (e.g. maize, sorghum or alfalfa).
  - The plant material is first allowed to ferment and stored for use when grazing is scarce.
- The process of making silage is called silaging or ensiling.
- Two methods are used:
  - put plant material in a silo = a strong plastic container, plastic bag or tower, or a trench or pit in the ground that is lined with clay or cement and covered with a large plastic sheet
  - first bale the plant material, and then wrap the bales in plastic.
- During fermentation a liquid is formed → contains nitric acid → can pollute water sources and cause eutrophication.
  - To minimise the amount of liquid that is formed → make sure that water cannot reach the plant material.
  - To prevent pollution of water sources → do not make the silo closer than 10 metres from a water source.

Topic 3

Topic questions

Topic 3: Questions

- Answer the questions below.
- Give yourself one hour.
- Check your answers afterwards and do corrections.

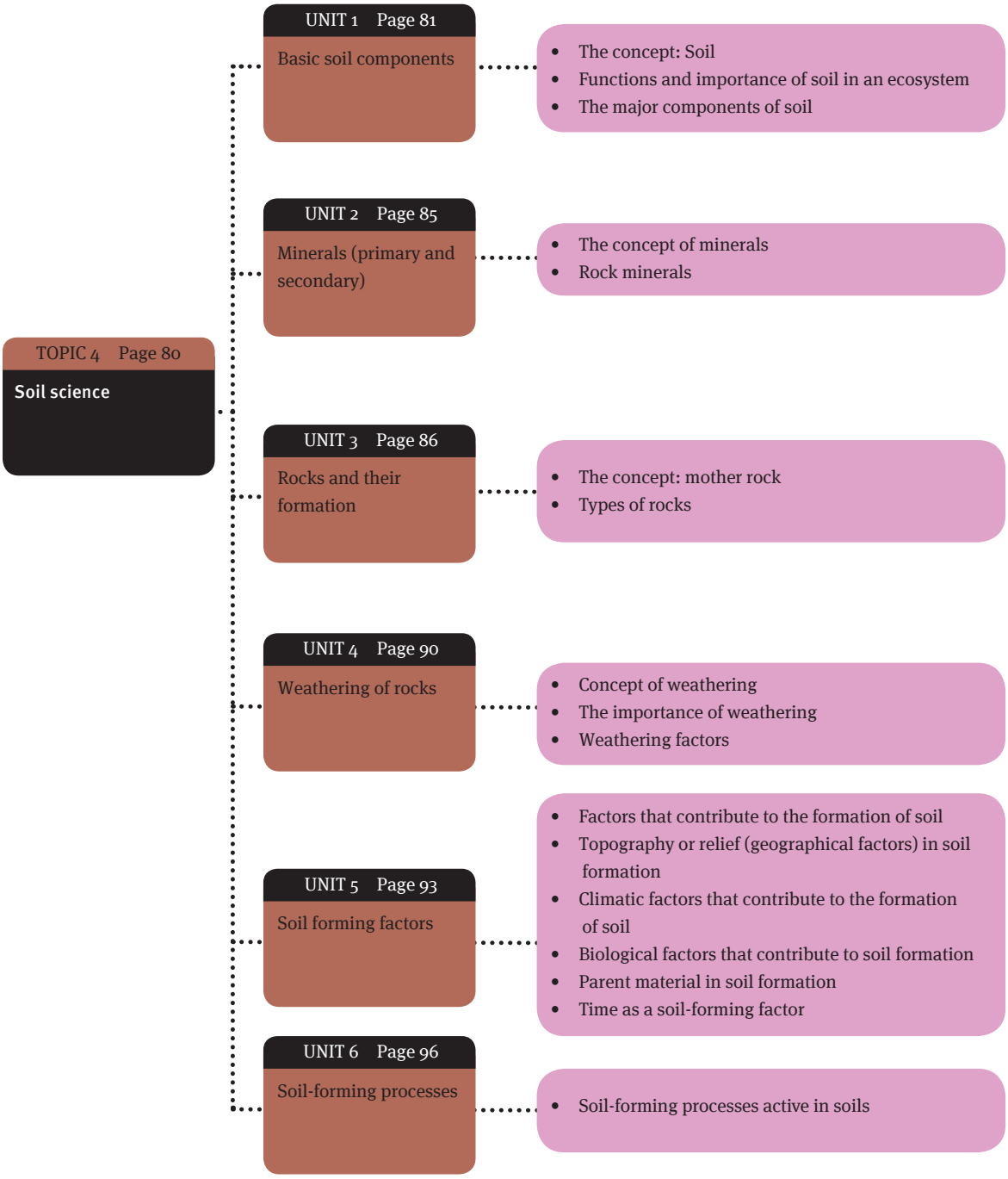
1	Describe the pressure a growing population places on natural resources.	(5)
2	Outline three agricultural practices that can contribute to the sustainable utilisation of natural resources in agriculture.	(6)
3	Describe the three types of soil degradation.	(6)
4	Name five warning signs that soil erosion is taking place.	(5)
5	Define water quality.	(6)
6	What is meant by water source?	(1)
7	Describe the water cycle.	(10)
8	Describe five methods that farmers can use to increase the amount of water that enters the soil.	(10)
9	What is agricultural pollution?	(4)
10	List the five major soil pollutants.	(5)
11	Describe the three factors that determine the severity of a pollutant.	(6)
12	What is silage and how does it contribute to pollution?	(6)

[Total marks 70]

Topic 4

Soil science

Overview



What you will cover in Topic 4

Unit 1

Basic soil components

1.1 What is soil?

- Soil, air and water are the three major natural resources.
- Soil is the upper layer of the Earth → supports all plant and animal life.
- Soil consists of three main components:
  - minerals from rocks (below or nearby the soil)
  - organic matter (most important part of soil)
  - the living organisms that live in the soil.
- Type of soil depends on the proportion of each of the above, as well as on:
  - climate
  - vegetation
  - the surrounding terrain
  - human activities.
- Soils have different textures depending on the size and amount of mineral particles, e.g. sandy, silty and clayey soils.
- Organic matter (the most important part of soil) is partially decomposed organic material, rich in nutrients. The darker the soil, the greater the concentration of organic matter.
- Erosion can take place in soils that are not well looked after.

1.2 The main functions and importance of soil in an ecosystem

- Soil is the basis of life.
- Soil is an ecosystem of plants and animals.
  - plants and animals change the composition and structure of soil
  - soil is important because it provides plants with food in the form of nutrients (e.g. nitrogen, potassium, phosphorus, boron and zinc).

1.2.1 Plants in a soil ecosystem

- Plant roots get energy to grow from sugars through photosynthesis.
- When roots have developed, they absorb soil nutrients and water to make the plant grow.
- When plants die, the remaining nutrients stay in the roots and enrich the soil.

1.2.2 Animals in a soil ecosystem

- Visible: earthworms, ants and burrowing animals.
- Microscopic: bacteria, fungi and nematodes.

1.2.3 Other reasons why soil is important

- It provides plants with anchorage
- It provides nutrients (minerals and water for photosynthesis)
- Soil is the habitat for soil micro- and macro-organisms
- Some soil particles are used for commercial purposes (e.g. glass)
- It cleans water as it percolates to form spring water
- Soil prevents floods and drought by absorbing rainwater, storing it and releasing it later.

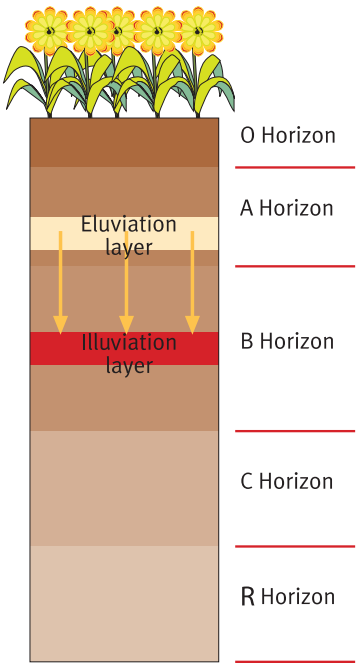
1.3 The major components of soil

1.3.1 Soil profile

Soils vary according to geographical location, climate, etc., but most soils have a distinct profile or sequence of horizontal layers. These horizons result from the processes of: chemical weathering, eluviation, illuviation and organic decomposition.

Parts of a soil profile

- O = Organic:
  - The topmost layer of most soil – lying on the surface of the soil at various levels of decomposition and humus. Not present in cultivated fields.
- A = Topsoil:
  - Darker (brown or black) than lower layers (but not in arid or dry areas), loose and crumbly, with varying amounts of organic matter. Consists of rock material that has been chemically and physically broken down and changed, and mixed with organic materials, particularly plant roots. It is full of plant and animal life. The most productive layer.
- B = Subsoil:
  - Light colour, dense and low in organic matter. Also consists of altered rock material, but contains much less plant life (mainly roots) and living creatures. However, minerals can be broken down, and nutrients released from this layer for use by roots of plants.
- C = Parent material:
  - Usually below half a metre, this layer consists mostly of unconsolidated organic and mineral material, unaltered rock or glacial deposits, the matter from which the soil is formed.
- R = Bedrock:
  - The solid rock that underlies the soil and other unconsolidated material. This soil layer simply consists of unweathered bedrock.



A soil profile

1.3.2 Soil components

Components of soil are grouped into two kinds:

- Inorganic components of soil –
  - The inorganic components form the major part of soil: water, air and mineral materials (small stones, sand, silt and clay) that never decay or rot.
- Organic component of soil –
  - The organic component of soil is made up of decomposed leaves, roots, bones and animal droppings, etc.
  - It is called humus (formed in a process called humification).
  - About 5% of the soil is humus.
  - Our ancestors used decomposed organic matter = source of nutrients in the soil:
    - Guano for nitrogen
    - Wood ash for potash
    - Animal bones and hooves for calcium and phosphorus.

The importance of humus

- Humus is a dark-coloured, loose colloid.
- It is the 'life-force' of soil → it helps the soil retain moisture and encourages the formation of good soil structure.
- It helps to suppress diseases in the soil.
- The dark colour helps to absorb heat in the soil for microbial activities, seed germination and chemical reactions.
- Improves soil structure by binding loose soil and preventing soil compaction.
- Increases the water-holding capacity of the soil and prevents drainage and erosion.
- Has great cation holding capacity → makes it very fertile
- Has a lasting effect as a source of plant nutrients in the soil.
- Releases minerals stored in decomposable materials into the soil for plants.

1.3.3 Soil air

- There are pores between soil particles: big (macro-pores) or small (micro-pores), depending upon the type and size of the soil particles.
- Soil air is the volume of air that fills the soil pore spaces where there is no water.
  - Soil air makes up about 25% of the total volume of the soil.
  - The movement of air in the soil pore spaces is called aeration.
  - Soil air contains gases, e.g. oxygen (O_2), nitrogen (N_2) and carbon dioxide (CO_2).

The importance of oxygen in the soil

- It is necessary for the respiration of plants, roots and soil organisms
- It helps to decrease carbon dioxide concentration in the soil
- It is necessary for organic matter decomposition in the soil
- Seeds in the soil require oxygen to sprout
- Some chemical processes, like oxidation, take place in the presence of oxygen
- Soil air prevents the development of fungi in the soil that can harm plants.

Practical ways to improve aeration

- Cultivation or tillage
- Ploughing
- Adding bulky organic material
- Draining waterlogged areas.

1.3.4 Soil water

Concepts related to soil water

- **Saturation** – all soil pores are filled with water; occurs right after a rain → represents 0 bars.
- **Field capacity** – moisture content of the soil after gravity has removed all the water it can. Usually occurs 1–3 days after rain → represents 1/3 bar.
- **Wilting point** – soil moisture percentage at which plants cannot obtain enough moisture to continue growing ⇢ represents 15 bars.
- **Oven dry** – soil that has been dried in an oven at 105°C for 12 hours → all soil moisture has been removed. (This point is not important for plant growth, but is important for calculations, because soil moisture percentage is always based on oven-dry weight.)
- **Plant available water** – the water held in soil at a water potential of between -1/3 and -15 bar.

- Soil water makes up about 25% of the total volume of the soil.
- The volume of water found in a soil type depends on:
  - soil structure – soil structure is the arrangement of particles into aggregates. Soil structure also affects air movement and the resistance of the soil to erosion and plant root growth
  - soil texture – the composition of sand, silt and clay in a soil type
  - soil content – this affects soil behaviour, like air movement, water movement and the retention capacity for nutrients and water. Organic matter component of the soil, exposure of the soil surface to solar radiation, the vegetative cover of the soil surface and the topography of the land all influence soil content.

Categories of soil water

- Hygroscopic water = a very thin layer of soil water, when the soil is about air dry, that attaches firmly to the soil particles. It is not accessible to plant roots.
- Capillary water = the quantity of water held in the soil macro- and micro-pores (basically = the water absorbed by plant roots)
- Gravitational water = the excess water that moves freely after the capillary pores are saturated → moves down deep into the soil as a result of the Earth's gravitational pull.

How to conserve soil water

- Introduce organic matter into the soil
- Practise mulching in dry areas
- Control weeds regularly to reduce transpiration
- Adopt farm practices, such as regular stirring of the topsoil → encourages water infiltration and discourages soil erosion.

Unit 2

Minerals (primary and secondary)

2.1 The concept of minerals

- Minerals are the inorganic substances that occur in the crust of the Earth, in soils.
- Minerals originate from mother rocks through rock weathering.
- Rock weathering forms soil. The soil contains the same elements as the mother rock.

2.2 Rock minerals

- Rock minerals are also called the inorganic soil fraction → consists of various soil particles (e.g. sand, silt clay stones and stones) → help determine soil type, texture and characteristics (e.g. water holding capacity).
- Minerals are naturally occurring solid substances that occur in the Earth's crust.
- They have definite chemical composition, crystalline structure, colour and hardness. Some are good for commercial activities. Examples of minerals found in soil include:
  - gold and diamond
  - ore, e.g. iron ore and copper ore
  - rock forming minerals, e.g. sand and clay.

2.2.1 Classification of rock minerals

- Primary minerals: Occur in their original form during the formation of rocks.
  - When rocks are formed, they contain minerals that are in their original forms with their basic properties like shape, colour and elements.
  - Primary minerals are found in soil but are not formed in soil.
  - Examples = apatite, calcite, dolomite, feldspars and quartz.
- Secondary minerals are formed in soils: When the primary minerals undergo physical and chemical changes (e.g. oxidation and temperature variations), they lose some of their original properties.
  - They regroup to form new minerals that are different from their original forms.
  - Secondary minerals are all the minerals that have undergone chemical changes from their original forms.
  - Examples = mica clays, kaolinite clay, and candites.

2.2.2 Characteristics used in mineral identification

- Colour = the first characteristics you notice. (Streak = the colour revealed below the surface of a mineral when you scratch it.)
- Lustre = the way in which a mineral reflects light.
- Hardness, cleavage and fracture:
  - Diamond is the hardest and talc is the softest mineral.
  - Cleavage refers to the way minerals break. Minerals like Mica that break along smooth, flat surfaces have perfect cleavage.
  - Minerals like quartz that break with curved, rough surfaces have fracture.

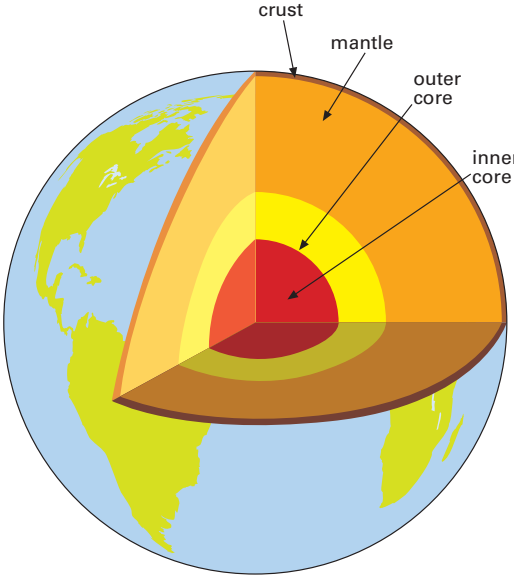
Unit 3

Rocks and their formation

3.1 The concept: mother rock

The Earth is built up of layers → from the inner core → then the outer core → followed by the mantle → and finally the crust.

- The crust of the Earth consists of different combinations of minerals found in different types of rocks.
- The quantity and quality of minerals found in the different types of rocks differ.
- All soils are formed when rocks break down.
- The rocks that break down to form soil are called the mother rock or the parent material.
- Soils formed from the mother rocks or parent rocks have the physical and chemical properties of the parent or mother rocks.



The Earth's structure

3.2 Types of rocks

We get three main types of rocks:

- Igneous rocks
- Sedimentary rocks
- Metamorphic rocks.

3.2.1 Igneous rocks

- Formed when molten magma or lava cools and solidifies → usually during volcanic activity.
- May or may not form crystals below the surface of the Earth:
  - If it is formed by the crystallisation of magma below the surface of the Earth, igneous rocks = intrusive rocks or plutonic rocks.
    - Intrusive igneous rocks have very large crystal sizes, because the cooling of magma deep in the interior of the Earth is much slower than the cooling process outside the Earths' crust.
    - Examples = dolerite, granite and gabbro.
  - If the crystallisation of the magma takes place on the surface of the Earth, the igneous rocks = extrusive or volcanic rocks.

- Extrusive rocks are fine-grained in texture, because they cool down faster on the surface and there is not time for large crystals to develop.
- Example = basalt.

- Igneous rocks have various properties and mineral deposits, for example, tin and uranium are commonly associated with granites, while ores of chromium and platinum are obtained from gabbros.
- Igneous rocks are generally opaque, rough and dark in colour. Most of the crushed stones on our tarred roads are from igneous rocks.

3.2.2 Sedimentary rocks

- The Earth's crust is constantly being eroded by rivers, runoff, glaciations and wind.
  - The eroded pieces are carried along by water, wind and glaciers (agents of erosion) and are eventually deposited as layers of sediment = bedding.
  - Rocks form from this sediment (bedding), e.g. shale, sandstone and siltstone.
- Some sedimentary rocks are organically formed from the remains of plants, animals and trees, e.g. limestone = shells of animals and coal = layers of carbonised trees and plants.

3.2.3 Metamorphic rocks

- Metamorphic rocks have transformed physically and chemically as a result of heat (150–2 000°C).
- Any type of rock can undergo metamorphosis, e.g. sandstone to quartzite, limestone to marble.

3.2.4 Properties of minerals

The table below shows the properties of some common minerals.

Rock type	Occurrence	Colour	Products after weathering	Economic or agricultural importance
Apatite	Igneous and metamorphic rocks	Green	Phosphates	Phosphatic fertilisers
Calcite	Most sedimentary rocks	White or colourless	Calcium	Agricultural lime Cement
Quartz	In all rocks especially igneous rocks	Colourless, white or pink	Sand fraction of soil	Glass, abrasives and electrical components
Feldspars	All igneous rocks	Grey or white	Clay, potassium and calcium	Potash
Dolomite	Most sedimentary rocks	White or grey	Calcium and magnesium	Dolomitic agricultural lime
Talc	Metamorphic rock	White or grey	Magnesium silicate	Softest known mineral; used in Talcum powder
Diamond	Igneous rocks	Colourless, pale yellow or pale blue	Carbon	Hardest known mineral; used in jewellery and for cutting tools

The properties of some common minerals

3.3 The cultivation properties and suitability of soil from rocks

- The physical and chemical properties of a soil depend on the rocks from which the soil is formed.
- Soil = rock that has broken down after millions of years of weathering (involving water, wind, movement, chemical action and varying temperatures).
- Cultivation properties of soil and its suitability for agricultural purposes depend on the composition of the original rock and the processes that have acted on it.

3.3.1 Soil from igneous rocks

Igneous rocks are intrusive or extrusive, according to how they are formed. So, the suitability of soil formed from igneous rocks depends on whether the parent material is of plutonic origin (extrusive) or volcanic origin (intrusive).

- When plutonic igneous rocks (e.g. granite) disintegrate → the soil particles that form are large and course. They are generally not suitable for crop production because they:
  - make the soil loose
  - have poor water holding capacity
  - are usually light in colour
  - are generally not fertile because they may be acidic with no nutritious value to plants.
- Volcanic or extrusive igneous rocks, for example, basalt, weather to form fine grains consisting of clay.
- The soil from fine grains is fertile and suitable for many crops, because it:
  - is smooth and plastic
  - has good water holding capacity
  - has good cation exchange capacity and so is very rich
  - is dark in colour:
    - dark soil colour is good for heat conduction and retention
    - is ideal for soil microbe activities in the soil (makes soil fertile).

3.3.2 Soil from sedimentary rocks

Soils formed from sedimentary rocks that contain organic deposits are suitable for crop cultivation. This is because:

- Sedimentary rocks erode easily.
- When sedimentary rocks disintegrate, different soil particles (clay, silt, sand) come loose.
- Often, organic residue, like humus, may be a constituent of the sediments that break loose.
- A good combination of soil particles (loamy soil) is formed from the sediments.

- The dark colour from sedimentary rocks comes from organic matter inclusions in the sedimentary rocks.
- Soils from most sedimentary rocks, like alluvial deposits, contain humus → are very fertile (high mineral content).

3.3.3 Soil from metamorphic rocks

The suitability of the soil formed from metamorphic rocks depends upon the rock type that went through metamorphosis to form the soil type. However, metamorphic rocks are hard and resist erosion → so they are mostly not suitable for crop cultivation because:

- They produce weak soils that contain few minerals good for plant growth.
- They usually produce red soils due to the way the parent materials are formed from warmth, temperature changes and pressure.
- They weather slowly to resist acidification of soil.
  - Soils that develop from rocks with low amounts of weatherable minerals (ferromagnesian) and low iron content (quartz-mica schist), for example, calcite and dolomite are:
    - reddish yellow
    - have silty clay textures and blocky structures
    - low iron oxide content.

Unit 4

Weathering of rocks

4.1 Concept of weathering

- Soils are formed from mother rock or parent material.
- Rocks are subjected to soil forming factors (e.g. weathering) over a period → the outer layer of the rock loosens and crumbles to form soils.
- Rock weathering takes place through:
  - mechanical or physical weathering
  - chemical weathering
  - biological weathering.
- Rock weathering forms soil → it releases biochemical elements, such as calcium, potassium, iron and phosphorus into the soil as nutrients.

4.2 The importance of weathering

Weathering is important for the following reasons:

- Soil formation:
  - Rock weathering is the basis of soil formation. It is important for the release of biochemical elements that have no gaseous form, for example, calcium (Ca), potassium (K) iron (Fe) and phosphorus (P).
- Nutrient cycling:
  - Weathering of parent materials contributes to nutrient cycle formation in soil.
- Duricrust formation:
  - Duricrust is a hard, thin layer near the surface of soil, usually a few millimetres thick → formed by the accumulation of soluble minerals deposited by mineral-bearing waters that move upwards, downwards or laterally by capillary action. Minerals often found in duricrust include silica, iron, calcium and gypsum.
- Ore deposits:
  - An ore is a type of rock that contains minerals with important elements including metals. Ores are extracted through mining.
- Clay mineral formation:
  - Clay minerals are formed over long periods of time by the gradual chemical weathering of rocks. End product of rock weathering = clay mineral formation. Clay is an important soil component because of its cation absorption capacity.
- Coastal landforms:
  - The combined effect of waves, currents and tides results in rock disintegration. Beach drifting transports sand grains along the beach as the waves strike the shore. The continuous deposit of weathered materials over a long period of time → leads to the formation of landforms at the coast.
- Salt from the ocean:
  - Salt in rocks = released from weathered rocks → drained into oceans →form salts.

4.3 Weathering agents and processes

- The agents that are responsible for the breaking down of rocks (weathering) are physical/mechanical, chemical and biological agents.
- So, soil formation always involves one or all of the processes below to bring about soil formation.

4.3.1 Physical/mechanical weathering

- Physical or mechanical weathering causes the disintegration of rocks without chemical change.
- The primary process in physical weathering is abrasion.
- All physical weathering agents involve energy in the breaking down processes.
- Physical weathering agents are:
  - wind
  - water (rain, rivers, ocean, and lakes)
  - temperature.

Wind

Strong winds have much energy → can carry soil particles in their way.

- These soils can hit the surfaces of exposed rocks with a strong force → can further remove particles from the rock surfaces.
- Over many years, a considerable pile of soil may be formed at the base of the rocks.
- This type of weathering is common in desert areas where evaporation is higher than precipitation.

Water

Water has a dual role in rock weathering → causes physical and chemical weathering.

- Running water (e.g. streams) has the energy to carry loose stones downstream.
- The swiftness of the running water removes soil particles from the sides and the riverbed.
- Loose stones carried by the running water rub against each other, causing them to break into smaller particles.
- Strong sea waves carry and roll sea stones towards the beach. The stones rub against each other → causes weathering.

Temperature changes

- Can cause weathering, e.g., with daily temperature variation → repeated cooling and heating of a rock surface → weakens surface and it breaks in smaller pieces.

Note:

Chemical and physical weathering often go hand in hand, for example, cracks due to physical weathering will increase the surface area exposed to chemical action + the chemical action of minerals in cracks can aid the disintegration process.

4.3.2 Chemical weathering

- The agents of chemical weathering are water, oxygen and carbon dioxide.
- The five main chemical processes involved in rock weathering are: dissolution/solution (water); hydration (water); hydrolysis (water); carbonation (air); oxidation (air).

Water as an agent of chemical weathering

- Dissolution/solution:
  - Some rocks (e.g. gypsum and rock salt), dissolve in water when they stay in water for years, because materials that bond the soil particles dissolve.
- Hydration:
  - Water combines with rocks in rivers, ponds and in the sea. The rocks absorb water gradually to become saturated. The hydrogen and oxygen atoms in the water → cause the rocks to chemically change their original status to form a weaker rock. The newly formed rock weakens → disintegrates to form soil.
- Hydrolysis:
  - When a chemical disintegration of rocks takes place in the presence of water, hydrolysis has taken place: H+ or OH- replaces an ion in the mineral.

Air as an agent of chemical weathering

- Carbonation:
  - During rainfall, the raindrops collect carbon dioxide in the atmosphere. When the carbonated water combines with rocks → they form dilute carbonic acid (weak acid). The acid dissolves rocks (e.g. limestone) → releases colloids and granules from the limestone.

$H_2o + CO_2 \rightarrow H_2Co_3 \rightarrow H^+ + HCo_3$

water + carbon dioxide → carbonic acid → hydrogen ion + bicarbonate ion

- Oxidation:
  - During rainfall the raindrops combine with the oxygen in the atmosphere. The oxygen reacts with rock minerals that contain iron → forms iron oxides → causes rocks to break apart.

4.3.3 Biological weathering

- In biological weathering, living organisms (e.g. plants and animals) → cause rock to decompose. For example: plant and tree roots can work their way into the crevices of a rock → forces the rock apart → causes it to fracture.
- Some creatures (e.g. worms and termites) can be responsible for biologically weathering rocks and rock particles → they physically break rocks apart during physical activities such as boring.
- When plants and animals decay → they release carbon dioxide (CO_2) into the air. When the CO_2 mixes with water → it forms carbonic acid → can break down the minerals in rocks.

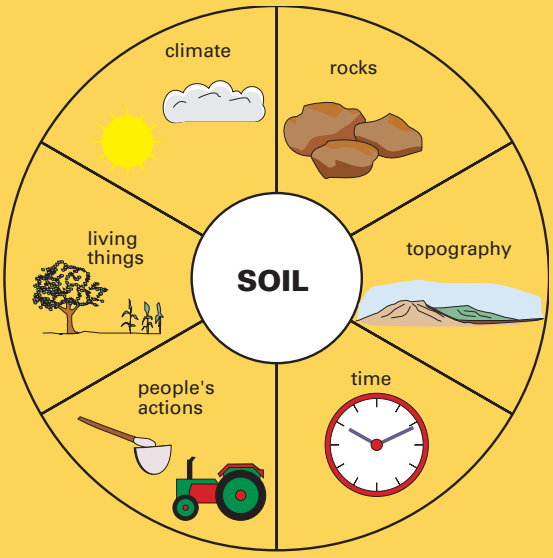
Unit 5

Soil forming factors

Soil formation factors

Natural processes of soil formation take thousands of years to create very small amounts of soil.

- The process of soil formation and development by soil forming factors is called pedogenesis.
- There are five natural factors that combine with the activities of people to contribute towards the formation of soils:
- Soil formation can be represented by the equation:
  - S = F (P, R, Cl, O, T), where
    - S = Soil
    - F = factors
    - P = Parent material
    - R = Relief/topography
    - Cl = Climate
    - O = Organisms
    - T = Time



5.1 Topography/relief in soil formation

Topography/relief (geographical factors) = the appearance of the area, e.g. mountains, valleys, water patterns, cliffs. Can affect the rate of soil formation in the following ways:

- Soil forming materials drop from high altitudes and pile up in valleys to form more soil over the years than could be formed on the upper land surfaces. Temperature differences between high and low altitudes causes rock disintegration.
- The effect of solar radiation, the impact of rainfall and wind action on soil formation is greater on high lands than in valleys.
- Runoff erodes soil particles and debris, and deposits it lower down → causes more soils to form in low-lying areas.

5.2 Climatic factors contributing to the formation of soil

Climatic factors or elements of climate → break down parent materials → form soils.

5.2.1 Sunlight and temperature

- The influence of sunlight and temperature are inter-related:
  - the temperature of the parent material is the result of solar radiation.
- Hot / cold temperature variations → cause expansion and contraction → as a result, rocks disintegrate.

- High temperatures speed up chemical processes (e.g. oxidation).
  - This action → causes the elements in the soil to be released causing lines of weaknesses and eventual disintegration.
- Water stored in the pore spaces of rocks freeze in very cold regions.
  - When water freezes, it expands → causes gradual disintegration.

5.2.2 Wind

- The effect of wind as a soil-forming agent is more visible in the areas with less or no vegetation (e.g. deserts).
- When strong winds move over bare soil surface → the wind removes loose soil particles. This is called abrasion.
- The soil particles deposited by wind pile up over years to form a sheet of soil.

5.2.3 Rain

- Torrential rain on sand stone removes particles of sand to form sandy soil.
- Swift and high volumes of runoff after torrential rains run over rock surfaces.
  - The runoff removes loose soil particles as it moves down the slope.
  - Friction between rolling stones → causes disintegrating.

5.3 Biological factors contribute to the formation of soil

5.3.1 Plants

- Roots penetrate layers of rocks. As the roots grow thicker → they cause disintegration and crumbling.
- Decomposition of plants form humus.
- During respiration of plant roots, carbon dioxide is released into the soil.
  - CO_2 dissolves in soil water to form carbonic acid → causes rocks to disintegrate.

5.3.2 Animals

- Macro- and micro-organisms in the soil affect decomposition of waste materials to form soil.
- Animals like rats, mice and rabbits that burrow deep in the soil scratch parent materials to form soil.
- Droppings and beddings of animals decompose to form soil.

5.3.3 Human activities

Human activities, such as road construction, terracing, rock quarrying, excavation for new settlements and mining, break down rocks.

5.4 Parent material in soil formation

All types of soils are formed from a source. Soils are formed from hard rocks (mother rock), unconsolidated sediments and decomposed plants and animals (humus).

5.4.1 Parent materials and geology

- The rate of soil formation, the structure of a soil, the texture of a soil and all other physical and chemical characteristics of a soil depend on the geology of the area. The geological processes provide the parent material.
  - Melted rock flows away from inside the earth through volcanicity (the activity of volcanoes) and eventually cools and hardens.
    - During the process, minerals crystallise and new rock types are formed.
    - These types of rocks are called igneous rocks.
    - Igneous rocks are the original parent material rocks formed on the earth.
  - All soil types formed from rocks on the earth depend upon the processes of their development from the igneous rocks.
- The parent material also determines the minerals in soil.
  - The structure, texture, aeration and drainage status of all soils are the result of the mineral particles that originate from the parent material.

5.4.2 Parent materials and mineral soils (mineralogy)

- The minerals found in soils, but not formed in the soil, are primary minerals.
  - Primary minerals come from igneous rocks and have not undergone any changes since they were formed.
  - Secondary minerals are formed when the primary minerals undergo physical or chemical changes.
  - Mineral parent material is the particle sizes that make the soil = sand, silt or clay.
  - Mineral particles are classified according to the mode of deposition:
    - Colluvium deposits → mineral materials are transported and deposited at the base of cliffs and mountains by the force of gravity from cliffs.
    - Alluvium mineral materials are transported by water during floods → they have wide ranges in particle sizes.
    - Outwash mineral materials are glacial materials that have been carried by water after glacial melting → it usually is made up of a range of particle sizes, from gravel to sand.
    - Beach deposits are sandy = the result of wave action.

5.5 Time as a soil-forming factor

It takes time for soils to form from rocks → from the formation of the bedrock to the period when soil particles are derived from the parent material:

- magma from volcanic eruptions takes time to settle and cool down.
- it takes hundreds of years for the agents of rock weathering to act on the parent rocks to disintegrate or erode to form soils.
- the rate of disintegration and erosion depends upon the type of parent material and the prevailing weathering agents.
- organic matter in the soil takes some time to decompose completely to form humus.

Unit 6

Soil-forming processes

6.1 Soil-forming processes active in soils

6.1.1 Mineralisation

Mineralisation = the release of organic compounds during decomposition of organic residues by oxidation to form soluble or gaseous chemical compounds.

- The chemical compounds may then take part in further soil processes or be utilised by plant life.
- Mineralisation is an essential process in the formation of humus.

6.1.2 Humification

- The process whereby the carbon of organic residues is transformed and converted into humic substances (humus) through biochemical processes.

6.1.3 Leaching

- The removal of soluble nutrients from an upper soil horizon to a lower soil zone beyond the reach of plant roots.
  - Leached nutrients are not available to plants.

6.1.4 Luviation

The movement of soluble minerals or colloidal suspension (substances with large molecules) from one place to another within the soil.

- Soil horizons that:
  - lose materials through luviations are called the eluvial layer
  - receive material are the illuvial layer.

6.1.5 Gley soil

Gley soils are sticky and difficult to cultivate.

- Formed in waterlogged areas where there is little oxygen in the soil.
- Greenish-blue-grey or mottled colour.
  - The grey colour is the result of the reduction, under anaerobic conditions, of ferric iron to the ferrous state.

6.1.6 Plinthite formations

- Plinthite soils contain high iron and low humus content, and do not have most essential elements → therefore poor for crop growth.
  - The high iron content causes phosphorus to be fixed and made unavailable to crops.
    - It is a highly weathered mixture of clay with quartz and other diluents.
    - It commonly appears as red mottles, usually in platy or rectangular patterns.

6.1.7 Inversion

Human activities, e.g. ploughing and tilling, contribute to soil inversion = the topsoil is fully turned upside down.

- Inversion is used to bury weeds deep in the soil to prepare land crops.
- Advantages are:
  - weed seeds are buried deep in the soil to prevent sprouting
  - it controls plant diseases and pests
  - it encourages mineralisation of nitrogen
  - microbial activities are encouraged
  - it enhances even mixture of soil nutrients for both deep rooted and shallow crops
  - green manure and organic matter are incorporated into the soil.

6.1.8 Bioturbation

- Bioturbation = the churning of soil by organisms and plants roots organisms (e.g. earthworms) and burrowers (e.g. moles, rats, rabbits) that dig deep into the soil and push subsoil to the soil surface
  - → this leads to a change in the composition of the soil.
- Bioturbation has similar advantages to soil inversion.

Topic 4

Topic questions

Topic 4: Questions

- Answer the questions below.
- Give yourself one hour.
- Check your answers afterwards and do corrections.

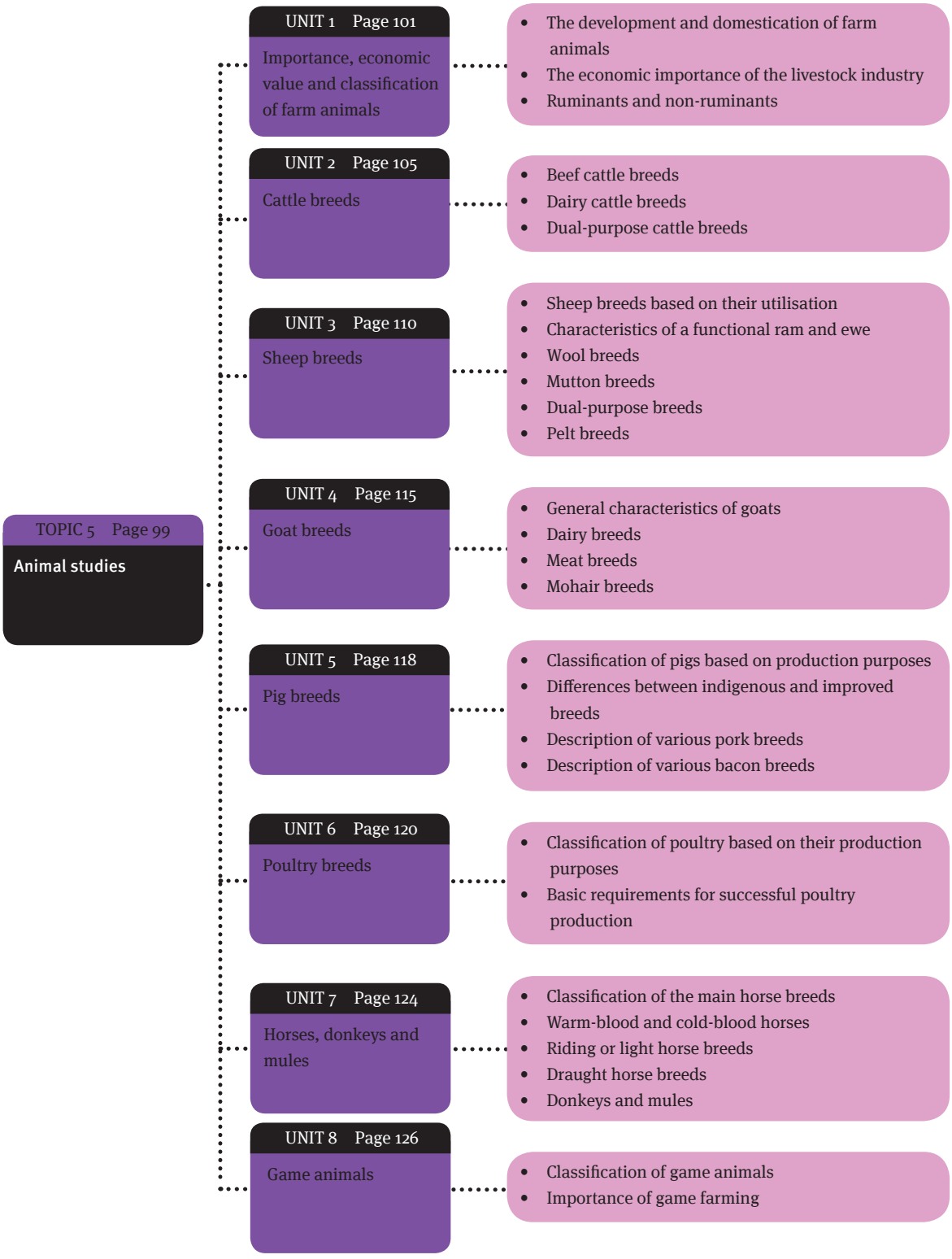
1	What are the three main components of soil?	(3)
2	Soils have a distinct profile consisting of horizontal layers. How are these layers formed?	(4)
3	Give five reasons why soil is important.	(5)
4	Explain why humus is important in agriculture.	(5)
5	How can aeration in the soil be improved?	(4)
6	Describe the three characteristics used in mineral identification.	(6)
7	Briefly describe how igneous rocks are formed. Give examples of the different types of igneous rocks.	(10)
8	Describe the processes of physical weathering.	(15)
9	Name the three ways in which water causes chemical weathering.	(3)
10	Soil formation can be represented by the equation S = F (P, R, Cl, O, T). What do these letters stand for?	(7)
11	How do animals contribute to soil formation?	(3)
12	Briefly describe four soil-forming processes.	(8)

[Total marks: 70]

Topic 5

Animal studies

Overview



What you will cover in Topic 5

Unit 1

mportance, value and classification of farm animals

Our ancestors domesticated animals → made farming with animals possible. The development of different breeds of each of the species made these farm animals even more useful to humans:

- farming with livestock provides a continuous source of protein, which allows us to live in settlements instead of having to hunt for food.
- animal production provides South Africa with source of income when we export.
- a healthy livestock industry gives a country food security, which is the ability to be independent of other countries for our food supply.
- South Africa is rich in wild animal species. Some species can be farmed on natural veld for meat, trophies and skins. Preserving the 'Big Five' provides us with a source of income from tourism, while allowing us to preserve the natural environment.

1.1 The development and domestication of farm animals

Twelve thousand years ago our ancestors were nomadic. They relied on the natural environment for all their resources. They were called hunter-gatherers because they survived by gathering food supplies, such as fruit, nuts and eggs, and by hunting.

- In what is today the Middle East, they developed a relationship with the grey wolf.
  - Some of the tamer cubs became permanent companions of humans. They were useful as they guarded families and helped with hunting.
  - By keeping the tamest wolves and allowing them to breed with each other, humans gradually created a new species of animal: the domestic dog.
  - Through selection and breeding, humans selected the genes for tameness. From this ancestral dog, the 400 dog breeds that exist today have been bred by selecting them for various physical and behavioural characteristics. This was the beginning of animal domestication.
- Groups of hunter-gatherers began to settle down and cultivate crops, such as barley and oats. Using the same method they used for domesticating the dog, they tamed, selected and bred other wild animals. This caused physical and behavioural changes that made them suitable for farming.
  - SHEEP were derived from a hairy sheep called the mouflon, from the mountains of Asia.
  - PIGS were derived from a species of wild boar found in Eurasia.
  - GOATS were probably derived from the bezoar mountain goat of Iran.
  - CATTLE were domesticated from the now extinct aurochs that roamed through Europe, North Africa and Asia.
  - CHICKENS were bred from a species of wild fowl from India and Asia.
  - DONKEYS were derived from the wild ass of Egypt.
  - HORSES were bred from a wild species that occurred on the Eurasian steppes.

Not all wild animals carry the genes for domestication so humans, as they migrated to various parts of the world, took their domestic animals with them.

- The wild animals of southern Africa were not found to be suitable for domestication, but when the Khoekhoe migrated southwards they brought their cattle and fat-tailed sheep with them.
- African migrations brought the ancestor of Nguni cattle.
- The Dutch brought pigs with them in 1652, and since then various breeds of livestock have been imported, and these have been crossbred (mating animals from two different breeds) with existing stock for increased production.

1.1.1 The concept and development of breeds

An animal breed is a variety of a particular animal species, for example, a fox terrier. A breed is created by crossing closely related animals that resemble each other, to establish and maintain a recognisable form or characteristic.

- Breeders of farm animals found that by selecting animals for a certain characteristic and crossing them with similar animals, they produced a group of animals with the same characteristics.
  - When this process was continued with successive generations they could produce a group of animals that were very different from the original stock.
  - Crossbreeding is used in modern farming to produce an animal that combines good characteristics of both breeds (e.g. the selection and crossbreeding of cattle that produced more milk than others gave rise to the modern dairy animal).
- The advantages of pure breeds are that they have predictable or stable characteristics that can be used by the farmer, for example, a production trait such as milk production, or adaptability to climatic conditions.
- Purebred animals can develop genetic problems.

1.2 The economic importance of the livestock industry

The livestock industry in South Africa has great economic importance:

- it provides employment
- the products earn farmers and the country money in foreign currency.

In the agricultural sector, livestock plays a larger part than either field crops or horticulture. The gross national income from animal products in 2010 was R64 billion.

- South Africa has about 50 000 large, well-developed commercial farms.
  - Commercial farms provide about 10% of South Africa's formal employment, as well as work for casual labourers.
  - Many farmworkers live on the farms and their children receive education at farm schools. Commercial farms therefore provide livelihoods, housing and basic education to about one million employees and six million of their family members.

- Livestock production on these farms almost meets the basic needs of our population, but we still need to import.
- South Africa exports surplus products, mainly wool and mohair, totalling nearly R2 billion in value.

- There are also about 240 000 small-scale farmers who provide a livelihood to their family members and occasional employment to others.
  - They supply local and regional markets where large numbers of informal traders make a living.
- There are a further approximately 3 million farmers, mostly in the communal areas of the former homelands, who are subsistence farmers, producing food primarily to meet the needs of their families.

1.2.1 Cattle

Cattle have been a symbol of wealth since ancient times.

- Today South Africa has about 13,8 million cattle:
  - 60% are owned by the commercial farming sector
  - 40% are owned by rural farmers for personal use and do not come to market. These cattle have great potential for contributing to food security, since we have to import R1 billion worth of beef into the country.
- Cattle are economically important because they:
  - provide a large percentage of our food requirements in the form of beef and dairy products.
  - earn income → in 2010, R14 billion was earned from slaughtered cattle and calves, and R9 billion from milk production; cowhides are also sold.
  - are still used as draught animals in the rural areas (oxen).
  - source of wealth in black African communities → used for lobola.

1.2.2 Sheep

Sheep numbers have decreased from 40 million a few decades ago to 24,6 million.

- They are important because they can graze in the most arid parts of the country
- The annual wool production is 48,3 million kg, which earns roughly R1,6 billion. South Africa is the world's leading producer of Karakul.
- South Africa imports R1 billion of mutton per year.

1.2.3 Goats

Goats number roughly 6,3 million.

- Meat goats are raised for use in rural areas. The meat is seldom sold to main markets because of the belief that it is unpalatable and because it has a bad smell, despite the fact that the meat of young animals is tasty.
- Goat milk and cheese is becoming more popular.
- South Africa is a leading exporter in the world of mohair (Angora goats).

1.2.4 Pigs

Pigs number 1,6 million.

- Commercial farming industry = intensive → produces pork, ham, bacon and lard.
- Pig hides are used for leather products and the hair is used in various industries.
- Indigenous pigs are an important subsistence animal in southern Africa.

1.2.5 Poultry

Poultry = all types of birds that produce meat, eggs or feathers (e.g. chicken, duck, geese, quail, pheasant, guinea fowl). Chicken = most commonly farmed and important.

- The broiler chicken (meat) and egg industry is at times, depending on the size of the maize crop, the biggest agricultural sector in South Africa, and the biggest contributor to protein in our diet.
- More than 850 million broiler birds are hatched, grown and slaughtered annually and 16 million eggs are produced daily.
- Despite this, a further R2 billion worth of poultry meat needs to be imported annually.

1.2.6 Mules and donkeys

These animals are used mainly as work animals in the rural areas where machinery is limited. Donkey carts can provide rural families with a means of transport.

1.2.7 Horses

Horses are now used mainly for racing, showing and jumping, or for other sports such as polo and endurance riding. They are also used for work, for example in the mounted police. Horse trails in the countryside encourage tourism.

1.2.8 Animal by-products

Livestock are kept mainly for products such as meat, milk, eggs and wool, but there are many by-products from this industry:

- Manure: is used for soil fertilisation to ensure better crop yields; it can be sold for garden use and also for use as fuel.
- Carcass by-products: although livestock are slaughtered mainly for meat and hides, there are many other parts of the carcass that can be utilised for maximum economic benefit:
  - Carcass meal is made from the parts which are not sold as fresh meat and sold to the pet food industry.
  - Bones, hooves and ears of various animals are dried and sold for dog treats.
  - Blood meal (dried powdered blood) is used in animal feeds or fertiliser.
  - Intestines are used for sausage casings.
  - Animal fat can be used for cooking, for making soap and other cosmetics, for feedstock and for bioenergy.

1.3 Ruminants and non-ruminants

- Ruminants = cattle, sheep, goats and wild antelope (herbivores):
  - Regurgitate their semi-digested food for chewing into finer particles (chewing the cud).
  - Unable to digest it themselves. Stomachs divided into four parts (i.e. rumen, reticulum, omasum and abomasum) in which micro-organisms break down the cellulose in the plant material.
  - Rumination allows the material to be broken down further so the micro-organisms can digest the plant fibre more effectively.
  - When the micro-organisms have broken down the plant matter, the stomach content moves down into the intestines where the absorption of nutrients occurs.
- Non-ruminants = horses, pigs and poultry:
  - Monogastric: one simple stomach.
  - However, like ruminants, horses are herbivores and they have a long colon or hindgut in which micro-organisms help with breakdown of plant material.
  - Pigs, like humans, are omnivores, which means they eat both plant and animal material. Unlike ruminants and horses, they cannot use grass as food.

Species and alternate terminology	Adult male	Young male	Castrated male	Adult female	Young female	Young
Species and alternate terminology	Adult male	Young male	Castrated male	Adult fe-male	Young female	Young
Cattle						
(bovine)	bull	steer	ox (plural oxen)	cow	heifer	calf
Sheep						
(ovine)	ram	-	wether	ewe	-	lamb
Goats						
(caprine)	ram/buck	-	wether	doe/nanny	-	kid
Pigs						
(porcine, swine, hogs)	boar	-	barrow	sow	gilt	piglet
Horses						
(equine)	stallion	colt	gelding	mare	filly	foal
Donkeys	jack	colt	gelding	jenny	filly	foal
Chickens	rooster	-	capon	hen	-	chick

Terms used in livestock science

Unit 2

Cattle breeds

2.1 *Bos indicus* and *Bos taurus*

2.1.1 *Bos indicus* (African type)

- Also called zebu → originated in South Asia, possibly in India.
  - also known as humped cattle → characterised by: fatty hump on their shoulders, drooping ears and a large dewlap (loose fold of skin hanging under the throat).
  - well adapted to hot, arid climates: the hump helps in the storage of water, the loose skin helps in heat dissipation; also have sweat glands all over their bodies.
  - fairly resistant to African diseases and parasites.
  - farmed throughout the tropics, for beef, dairy and as draught oxen.
  - there are about 75 breeds of zebu: some came to Africa → became established as separate breeds; others were imported more recently from Asia.

2.1.2 *Bos taurus* (European type) or taurine cattle

- Originated in Europe, northeastern parts of Asia and some parts of Africa.
- Thrive in cooler climates, they are not adapted to hot, dry places as they do not have humps or dewlaps, and they usually have their sweat glands on their noses.
- Vary in size and body structure, depending on the uses for which they were bred.
  - Some are plump and round, others lean and angular.
- Seldom used for draught.
- Beef breeds produce good quality meat,and dairy breeds produce plentiful milk.
  - They do better on good quality food.
- Tend to be susceptible to drought and African diseases.
- Hybrids or crosses have been developed by interbreeding taurine breeds with zebu.
  - This achieves the taurines' good quality of meat and quantity of milk, along with the zebus' ability to thrive in hot climates.

2.2 Beef cattle breeds

- First domesticated cattle were used for their milk and meat, and also as draught animals (this role was largely taken over by the horse, and later by machinery).
- In time, specialisation took place and cattle were specially selected for milk production (dairy cattle) or for meat production (beef cattle).
  - Those bred for both are called dual-purpose animals.

2.2.1 General characteristics of a beef bull and cow

- Beef breeds are developed to provide meat, and so they need to grow fast, gain good weight per quantity of fodder consumed, and produce good meat (carcass) quality.
- Good meat has a high cutability (a large percentage of lean meat), and marbling (fat between the muscle, known as 'taste fat', is well-distributed).

- Bulls should have a large frame size, with a compact, block-like conformation, good depth, muscular straight shoulders and well-developed hindquarters.
  - Able to stand squarely on four strong feet with well-structured legs to ensure easy gait over long distances. They must be fertile and sire 50 calves per year.
- A mature cow should be lean and refined.
  - Cows must have well-developed udders. They should be fertile and able to calve easily, with low mortality.

2.2.2 Description of various beef breeds

South Africa → farm with indigenous and exotic breeds. Indigenous breeds = bred from stock originated in Africa; exotic breeds = bred from stock originated elsewhere.

Some of our indigenous breeds

Afrikaner		
Origin	**Characteristics**	**Adaptation**
Descended from zebu ancestors. It is thought to have crossed into Africa from Yemen about 2 000 years ago, gradually migrating southwards, and reaching the southern tip of Africa with the Khoekhoe, who herded them and used them for meat and milk. Later, the Boer farmers modified them into strong draught animals; it was largely Afrikaner oxen that drew the Voortrekker wagons on the Great Trek of 1835.	Deep red colour. Long spreading horns. Large animals; a cow can weigh 600 kg and a bull 1000 kg. Thick hides and their meat is tender. They have a docile temperament, and the cows have excellent mothering abilities. They are remarkable for their longevity.	Hardy, heat-tolerant and well adapted to withstand arid veld conditions. Legs are adapted for walking effortlessly up to 40 km a day. Resistant to most of the country's endemic diseases, such as redwater, heartwater and gallsickness. Short shiny hair discourages tick attachment.
Drakensberger		
Origin	**Characteristics**	**Adaptation**
Like Afrikaners, they came with the Khoekhoe. The Dutch, on their arrival in South Africa, soon acquired some. During the Great Trek: several trekkers left the Cape with this breed, which they called Vaderland cattle. Most of these families settled along the Drakensburg range, and today the cattle are known as Drakensbergers. They have now spread throughout South Africa.	Glossy black, smooth-coated, medium- to large-framed breed. Placid. Excellent calving abilities. Tender meat.	Perform well in the harsh sour veld, and they do even better in the sweet veld. Resistant to African diseases, ticks, ultra-violet radiation and eye problems. Can withstand extremes in temperature and climate. Strong legs with a hard hoof ensuring an easy gait over rough terrain.
Nguni		
Origin	**Characteristics**	**Adaptation**
Originally came with the Nguni people from the north; they appear to be a hybrid of Zebu and taurine East African cattle. The mainstay of traditional Zulu culture. Shaka bred pure white Ngunis for his royal herd, and produced different colour patterns for the several regiments of his army.	Multicoloured with variously patterned hides, but noses are always black-tipped. Their horns come in a variety of shapes. Despite their medium size, they make excellent draught animals.	Like our other indigenous breeds, Nguni thrive in climatically the most harsh and disease-ridden areas.

Some of our exotic breeds

Hereford		
Origin	**Characteristics**	**Adaptation**
From Herefordshire in England. The first two bulls were imported in 1890 to improve our national herds. Later cows were added, so we now have a pure Hereford breed.	Red with a white head. Short down-turned horns.	Suited to hard work and poor grazing. Not resistant to African diseases or ultra-violet radiation.
Sussex		
Origin	**Characteristics**	**Adaptation**
Sussex cattle originated on the poor clay soils and pastures of Sussex in southeastern England. In 1903 the Agricultural College of Potchefstroom sent someone to England to select a cattle breed suited to our conditions, and the Sussex was chosen.	Red-brown coat with a creamy white switch to the tail. Medium-sized, long-bodied White horns. Placid, but can be stubborn. Suited to draught work.	Non-selective grazing habits and are able to thrive under harsh conditions. They have a thin summer coat and many sweat glands, but grow a thick coat in winter: suited to both hot summers and cold winters.
Charolais		
Origin	**Characteristics**	**Adaptation**
A French breed that settled in the fertile Charolles area. One bull and three cows were imported to South Africa in 1955.	Creamy white to wheaten in colour with a pink muzzle Pale hooves and horns. (Now being bred black and red as well). They are medium- to large-framed with a general coarseness of appearance.	Can easily withstand a variety of weather conditions and temperatures. Good draft animals.
Aberdeen Angus		
Origin	**Characteristics**	**Adaptation**
Developed from cattle native to the counties of Aberdeenshire and Angus in Scotland. Ten Aberdeen-Angus cattle were imported to South Africa in 1895 (to a Free State farm).	Solid black or red, although the udder may be white Naturally polled (no horns). Undemanding and good-natured.	From Scotland, is therefore adapted for extreme winters, and winter rainfall, e.g. Western Cape. Fully pigmented eyes: resistant to eye cancer. Widely used in crossbreeding to pass on the polled trait, and to reduce the likelihood of difficult calving.
Brahman		
Origin	**Characteristics**	**Adaptation**
Imported from India, it is named for the sacred cow of Hinduism.	Typical hump, dewlap and large droopy ears of the zebu. Coat is short and can be light to dark grey, various shades of red, or black. Usually horned, though some bloodlines are naturally polled. Docile and intelligent.	Able to withstand heat and are extensively crossbred to gain their advantages in hot climates. Oily skin and smooth coat, which helps to repel insects. Resistant to parasites and African diseases.

2.3 Dairy cattle breeds

- Farmers should choose a dairy breed that is adapted to the climate and conditions of the farm environment, as some breeds tend to be more heat resistant and better foragers than others.
- The commonly used dairy breeds are exotic and therefore susceptible to African diseases, particularly those borne by ticks.

2.3.1 General characteristics of a dairy bull and cow

- Dairy breeds are developed to convert forage efficiently into milk for human consumption and for the production of various dairy products.
- The cows need to be able to provide surplus milk, well in excess of that required by their young.
- For commercial purposes, consistently high yields with a good butterfat and protein composition are essential.
- Cows should have a feminine appearance, with a wedge-shaped outline. They should not be over-muscular, heavy, or have fat deposits.
- They need a good pelvic shape for easy calving. They should be productive through a long lifespan.
- Udders should be well formed for ease of milking and strong for capacity. Cows should be very good-natured for easy management in the dairy.
- Bulls should be strong, masculine, well-formed and hardy. They should have good general muscle development with no excessive fat, and must be reproductively sound and efficient.

2.3.2 Description of various dairy breeds

Holstein-Friesland		
Origin	**Characteristics**	**Adaptation**
Bred in the north of what is today known as the Netherlands (North Holland and Friesland), the Dutch settlers brought them to South Africa.	Bred to have distinctive black and white markings, though red and white is now acceptable. They are large framed. Their outstanding characteristic is their high yield of milk, though it has a relatively low butterfat content. They are good-natured and easy to milk.	Not very heat resistant. Not very good foragers.
Jersey		
Origin	**Characteristics**	**Adaptation**
From island of Jersey in the English Channel. Were first imported to South Africa in 1881.	Fawn-coloured and relatively small, with cows weighing up to 450 kg. Characterised by extreme leanness, with almost hollow backs, and very good udders. Milk is 'yellow' – a high butterfat content and the highest protein content of all the breeds. Cows are famous for their good temperament, but the bulls are sometimes aggressive.	Adapted to a wide range of climatic and geographical conditions. Heat resistant. Good foragers. Can be frail and vulnerable to disease.

Guernsey		
Origin	**Characteristics**	**Adaptation**
From the Isle of Guernsey, a tiny island in the English Channel off the coast of France, where they had been taken by French monks. Were imported to South Africa in 1923.	Fawn and white coloured. Although larger than the Jersey, they are similar in many respects, such as excellent temperament, ease of calving and milk with high butterfat content.	Efficient grazers and can adapt to a wide range of farming practices. Like the Jersey, they are a little fragile.
Ayrshire		
Origin	**Characteristics**	**Adaptation**
From the county of Ayr in southwest Scotland. Were first imported in 1893.	Speckled red to brown and white, although they were originally black. Medium sized. Milk is white, but has a relatively high butterfat content.	Relatively hardy. Good foragers. Can produce well under harsh conditions.

2.4 Dual-purpose cattle breeds

2.4.1 General characteristics of the dual-purpose cattle breeds

- Sometimes, in order to provide both beef and dairy, the herd will be a mixture of dairy and beef breeds.
- However, it is easier and more economical to have one breed, a dual-purpose breed, able to meet both requirements. This is provided for by hardy animals that:
  - grow fast
  - calve easily
  - produce surplus milk
  - provide good carcass.

2.4.2 Description of various dual-purpose cattle breeds

Simmentaler		
Origin	**Characteristics**	**Adaptation**
From valleys of the Simme River in Switzerland. Imported in 1905 by Pres. Steyn to his farm near Bloemfontein.	Colour varies from pale fawn to dark red, spotted with white. The face is usually white. Shortish horns curve up and back.	Have adapted well to many different environments.
Red Poll		
Origin	**Characteristics**	**Adaptation**
Developed in England in the late 1800s. Bought to South Africa by Cecil John Rhodes.	They are deep red with a white tail switch, naturally polled.	A very efficient grazer Tends to suffer in very harsh climates.
Pinzgauer		
Origin	**Characteristics**	**Adaptation**
From the mountainous forests of central Europe. Imported to Namibia in 1902, and then acquired in South Africa.	Predominantly chestnut with white markings. They are known for their longevity.	Resilient and robust. Strong legs for rough terrain.

Unit 3

Sheep breeds

3.1 Sheep breeds based on their utilisation

- First domesticated sheep were used for their hides, milk, and meat. When people learned how to spin wool into strong fibres (about 6 000 years ago), sheep began to be favoured for their fleece.
- Worldwide, there are now more than 200 different breeds of domestic sheep, and each can be classified into one of the following groups, according to utilisation:
  - Mutton breeds:
    - They produce meat (mutton and lamb).
    - These are non-wool breeds.
  - Wool breeds:
    - They produce varying qualities of wool.
    - Fine wool is used for the clothing industry.
    - Medium wool is usually felted into blankets, or used for jerseys and socks.
    - Coarse fibres are used to make carpets and tapestries.
  - Dual-purpose breeds:
    - They produce both quality wool and mutton.
  - Pelt breeds:
    - Lambs are slaughtered to give a superior pelt used in high-quality garments.

3.2 Characteristics of a functional ram and ewe

- Sheep should be robust with strong straight legs and hard well-formed hooves.
  - They should have good teeth and a proper bite.
- Rams should show a bold masculine appearance and carry good fleshing.
- Ewes should have a well-balanced udder with two functional medium-sized teats.

3.3 Wool breeds

The main wool breed is the Merino due to its skin area, follicle density, fibre diameter and fibre length, which are well suited to wool breeding.

3.3.1 General characteristics of wool and the wool breed

The wool from one sheep is called a fleece, from many sheep, a clip. A sheep produces from 1 to 12 kg of wool annually. The weight of clean wool produced is determined by:

- Skin area:
  - The bigger the sheep, the greater the area of skin on which wool can grow. Due to their larger size, rams usually produce more wool than ewes of the same breed. Skin area should not be increased by wrinkles, as loose skin is susceptible to skin disease.

- Follicle density:
  - Wool fibres are produced from follicles in the skin. The total number of follicles per skin area is called the 'population density'. Sheep with a denser population of follicles produce a greater quantity of wool, which is also of finer texture. The follicles come in two types: primary and secondary. The ratio of primary to secondary follicles is called the S/P ratio. The sheep with the finest fleece will have the highest population density and the highest S/P ratio.
- Fibre diameter:
  - this is the most critical factor in determining what the wool will be used for, and consequently, its price. Samples can be taken and tested. The diameter of the primary and secondary follicles is written as dp/ds and is measured in microns. Ultra-fine grades of wool are less than 17,5 microns, while strong grades are closer to 22,6 microns. The sheep with the finest fleece will have a low dp/ds ratio.
- Fibre length (closely related to staple length):
  - The longer the fibre, the more wool. Sheep with long staple will have higher yields.

Wool breeds are selected for their large frames, plain bodies (few wrinkles), open faces, long staple, dense fleeces, good character, and ease of handling. Colour can also be considered: the whitest wool is often the most sought after as it is easier to dye.

Description of Merino breed

Merino		
Origin	**Characteristics**	**Adaptation**
The Phoenicians introduced Merinos to North Africa. From there they were taken to Spain, which soon became noted for its fine wool. Initially, exporting Merinos was a crime punishable by death; the king had sole right to export them. In 1790 the king gave some to the House of Orange, they did not thrive in the Netherlands and were passed on to the Dutch government in South Africa: we became the first country outside Europe to own Merinos. In 1800s the wool industry was the most profitable economic activity. Great Trek – the trekkers took flocks into the interior. Since then they have been crossbred with Merinos from other countries to form our own resilient South African strain. Out of our current population of 25 million sheep, nearly 15 million are Merinos.	Medium to large framed rams have long spiral horns growing close to the head. Although the quality of meat is very good, it is not that plentiful., Wool is fine and soft and produced in quantity. A good ram produces up to 12 kg of wool a year. It is mostly used in the clothing industry, and since Merino wool is excellent at regulating body temperature, it is often used in high quality performance athletics wear (running, cycling, mountain climbing etc.).	Various types of Merino have been developed to adapt to different regions, from the drier Karoo to the wetter or irrigated areas. The original Merinos did not do well in high rainfall areas, such as in Holland.

3.4 Mutton breeds

Sheep production for mutton is divided into fat-tailed breeds and mutton breeds.

3.4.1 General characteristics of fat-tailed and mutton breeds

Fat-tailed breeds (Blackhead Persian, the Ronderib Afrikander, Van Rooy, Karakul):

- Characterised by their large tails and hindquarters.
- The carcass quality is quite good, with most of the fat concentrated in the tail area (up to 5 kilograms per 27 kilogram carcass).
  - Specifically bred for the unique quality of the fat stored in the tail area.
  - The fat is semi-fluid and readily adaptable as a form of butter, and is used for cooking and sausage making, though animal fats have decreased in popularity.
- They are hardy and adaptable and able to withstand desert life.

Description of fat-tailed breeds

Ronderib Afrikander		
Origin	**Characteristics**	**Adaptation**
An indigenous sheep, bred from the big, wide tailed, long-legged, hairy sheep of the Khoekhoe.	A fat-tailed meat sheep with a soft, shiny covering of wool and hair. Have been bred to produce white wool. Amber coloured horns. As their name suggests, they are characterised by a round-ribbed, rather than the usual flat-ribbed appearance. The tail has three sections and is very distinctive. It hangs down near the hocks and can weigh up to 6 kilograms.	They are heat tolerant and well adapted to harsh dry climates, as they store energy in their tails. They have long thin legs for walking great distances in search of grazing and water. They are very resistant to African diseases and parasites.
Van Rooy		
Origin	**Characteristics**	**Adaptation**
In 1906 Senator Van Rooy of Bethulie district experimented with breeding a sheep out of the Ronderib Afrikander that would have excellent conformation for slaughter lamb production. The result was a hardy breed named after Van Rooy.	It is a fat tailed, white sheep with just enough wool between its bristly hair to protect it from cold.	Good ability to utilise natural grazing in arid areas. Drought tolerant.

3.4.2 General characteristics of mutton breeds

A worldwide trend towards more lean meat = preference for mutton breeds.

- Must have a round neck and loin, a straight back and straight well-muscled legs.
- Specialised mutton breeds:
  - mature fast
  - have high feed conversion efficiency
  - high weight gains
  - high carcass yield
  - produce good quality mutton.

Description of mutton breeds

Dorper		
Origin	**Characteristics**	**Adaptation**
Developed in South Africa in the 1930s by crossing the fat-tailed Blackhead Persian ewes with a Dorset Horn ram. The name is abbreviated from a combination of Dorset and Persian. They were bred to produce a high quality carcass under extreme conditions. The second largest breed in South Africa and has spread to other countries like Australia and America.	Black or white headed. It produces a short, light coat of wool and hair that is shed in late spring and summer. The Dorper skin is much sought after, it comprises a high percentage (20%) of the income in South Africa.	The Blackhead Persian brought to the Dorper its hardiness, thriftiness, fertility and valuable skin. The Dorset Horn strain brought fast-growing, heavily muscled lambs. With its thick, protective skin it is well adapted to survive in the most arid areas of the country. Has the ability to browse as well as graze, so it can eat plants left by other sheep. Does not need shearing Not prone to blowfly strike like long-woolled sheep.
Damara		
Origin	**Characteristics**	**Adaptation**
The Damara arrived in southern Africa hundreds of years ago. The indigenous people of Namibia farmed and traded with them. The name is derived from the Damara area of Namibia. Their commercialisation and characterisation started in the late 1950s and early 1960s, leading to their importation to South Africa and their establishment as a popular breed.	It is a fat-tailed meat sheep with a long tail that tapers down to a thin end. It has a lively appearance and hard, strong teeth. It has strong flocking instincts, a long productive lifetime, good mothering ability and is very fertile.	The Damara has a high level of immunity to blue tongue and a resistance to parasites. It is suited to the drier parts of southern Africa and to any veld type.

3.5 Dual-purpose breeds

Due to the fluctuation of wool demand, and consequently wool prices, it is economically sound to use breeds that can go to the mutton market when wool is down, and vice versa. These are known as dual-purpose breeds.

3.5.1 Description of various dual-purpose breeds

Dohne Merino		
Origin	**Characteristics**	**Adaptation**
To keep pace with the fluctuating wool market over the last half century, the agricultural department has modified flocks through breeding to ensure their economic viability. This led to the development at the Dohne Agricultural Research Station of the highly efficient dual-purpose sheep, the Dohne Merino, a breed that produces both top quality meat and ultra-fine wool (60:40 mutton to wool).	Large-framed. White wool. Naturally polled.	Specifically bred for adaptability to all farming regions in South Africa.

Dorset Horn		
Origin	**Characteristics**	**Adaptation**
The county of Dorset in England.	Medium sized with pink nose. Spiral horns. Wool is of the highest quality: fine, densely grown, and very white. Known for its all round qualities as a meat and wool producer and its ability to lamb throughout the year.	Prone to diseases: high mortality rate.
Dormer		
Origin	**Characteristics**	**Adaptation**
A cross between Dorset Horn rams and South Africa Mutton Merino ewes; the name is an abbreviated combination of the two. Developed in South Africa to meet the need for a slaughter lamb that could produce meat rapidly and economically.	It has the Merino wool characteristics, but a better mutton conformation.	The main object of developing the Dormer was to achieve a mutton breed that could adapt to the cold and wet conditions of the winter rainfall areas of South Africa. Disease resistant. Has a long breeding season and lambs easily.

3.6 Pelt breeds

The lambs are slaughtered for their skins very soon after birth. The pelts are used to manufacture exclusive garments. The economic advantage of pelt breeding in our very arid areas is considerable since the ewe ceases lactation and her nutritional needs are then about half that of a lactating ewe.

3.6.1 Description of the Karakul breed

Karakul		
Origin	**Characteristics**	**Adaptation**
Karakul sheep were imported from Asia to Namibia, and from there they spread to the North Western Cape and surrounds. They were upgraded by crossing with indigenous breeds.	Hardy, fat-tailed sheep with a narrow body, sloping rump and coarse, wiry hair. Lambs are evaluated within 36 hours after birth and some are slaughtered for their pelts. Mature Karakuls are shorn twice a year: floor-rugs and curtains.	Remarkable for their adaptability to arid and semi-desert areas.

Unit 4

Goat breeds

4.1 General characteristics of goats

- Different goat breeds were developed to produce milk, meat and fibre.
- Most breeds have a pair of horns, unless they carry the dominant poll gene.
- Both male and female goats can have beards.
- Some breeds of sheep and goats look similar, but can be distinguished by the tails: in goats = short and point upwards; in sheep, tails hang down and usually = larger.
- Female has an udder with two teats.

4.2 Dairy breeds

- The dairy doe is fine and feminine, with a thin neck, strong spine, wide sprung ribs and barrel shaped chest.
- Does may have wattles (fleshy growths) on either side of the neck. The udder when full must not droop below the hocks. Depending on the breed, does can produce an average of 3 litres of milk a day, with an average of 3,5% of butterfat.
- Bucks, or males, are more strongly built and often have beards

4.2.1 Description of dairy breeds

Saanen		
Origin	**Characteristics**	**Adaptation**
Originate from the Saanen Valley in Switzerland.	The largest dairy goat with the highest milk production and butterfat content (3–4%). Creamy white in colour with smooth, short hair. Erect ears that point forward.	Sensitive to sunlight so needs shade; tan forms are recommended for use in hot countries.
Toggenburg		
Origin	**Characteristics**	**Adaptation**
Originate from Switzerland.	Medium-sized dairy goat. Coat colour varies from light fawn to dark chocolate, with white marking on the face and legs. A medium milk producer with low butter-fat content of the milk.	Sensitive to heat and does better in cooler climates.

4.3 Meat breeds

- More heavily muscled than the dairy breeds, although there is some variation in size.
- Either horned or polled and usually have floppy ears. They mostly have short, smooth hair, although they may grow some down in winter.
- The meat of young animals is palatable, but because it is low in fat it can be tough if overcooked or cooked at high temperatures.

4.3.1 Description of meat breeds

Savanna goat		
Origin	**Characteristics**	**Adaptation**
South Africa's indigenous goats were originally called Savanna goats. From these the white savannah goat was developed, which is now exported to other countries.	The indigenous goats varied in horn size, coat type, colour, ear length and size because they had been the product of natural selection rather than selective breeding. White savannahs have short white hair, floppy ears and backward curving horns.	White savannahs are pure white yet highly suitable for hot dry climates because they have black skin, which protects them from ultraviolet radiation.
Boer goat		
Origin	**Characteristics**	**Adaptation**
The Boer goat was improved by crossbreeding the indigenous African goat with an Indian breed for better muscling, growth rate, fertility and carcass traits. They are now used for meat production in many other countries, as well as in South Africa.	Usually white with brown heads. Floppy ears and backward curving horns. Heavily built, full-grown bucks weighing roughly 120 kg and does 90 kg.	Hardy, but is still susceptible to the tick-borne disease called heartwater.
Kalahari Red		
Origin	**Characteristics**	**Adaptation**
Selected from red coloured animals of various breeds, including the indigenous goats and red Boer goats.	Reddish colour, with a short shiny hair coat. Floppy ears and backward curving horns.	Developed to survive in hot semi-desert conditions. Very athletic, disease resistant and has a voracious appetite.

4.4 Mohair breeds

The Angora goat produces a long, curling, silky fibre called mohair, which is highly sought after. It is similar to the fibre produced by the Cashmere goat.

4.4.1 Description of the Angora breed

The Angora goat		
Origin	**Characteristics**	**Adaptation**
Angora goats originate from the region of Ankara in Turkey. A small flock was imported into South Africa in 1838 and these animals formed the basis of the current Angora industry. They are some of the few purebred animals left in the world.	Lightly built, smaller than most sheep and goat breeds, the average weight being 75 kg. The bucks have pronounced horns, which tend to form a spiral in older animals, while the does have smaller horns that do not spiral. Angoras produce a unique fibre called mohair, which grows in long silky curls.	Good foragers and because they browse rather than graze. Ideal for semi-desert regions where other species do not thrive, e.g. Valley Bushveld habitat (EC), which is the main mohair producing area in South Africa Yet they are fragile: newborn kids and newly shorn animals are susceptible to chilling during cold, wet weather. Susceptible to heartwater. The ewes have a tendency to abort, probably because the animals are highly inbred.

Mohair wool

- Mohair is chemically similar to wool, but it has a smoother surface and has a thin, smooth scale.
  - These features make the fibre strong, elastic and shiny and able to retain dye pigments well.
- Mohair is classified according to the ringlet or locks produced:
  - Type C, or highly curled hair, is the finest type, of highest value in the market.
  - Type B, which is a flat wavy type, is bulkier.
  - Kid mohair, which is very fine, is used for luxury knitted garments like jerseys, shawls and scarves.
  - Mohair from adults is used for making suits, coats, rugs, blankets, curtains and upholstery.

Unit 5

Pig breeds

5.1 Classification of pigs based on production purposes

- When pigs were first domesticated they were used for their meat (pork) and also for their fat (lard).
- When commercial farmers began to practise intensive pig farming, they evaluated the speed at which pigs grew and when fat was laid down on the muscle so that they could produce the correct animal for market requirement, for example
  - a pig for meat, or
  - a pig with more fat for bacon and lard production.
- Commercial pigs are bred to produce meat rapidly on high quality feed.

5.1.1 Pork production

- Pork is produced from young pigs:
  - 14–16 weeks old
  - weigh roughly 60–70 kg when they are slaughtered.
- Porkers are fed with a diet that encourages rapid growth and maximal meat production with minimal fat deposits.

5.1.2 Bacon production

- Bacon is produced from older, heavier pigs weighing 70–90 kg.
- The meat of an older animal has more fat deposits than a younger one → makes it suitable for producing bacon.
- Young boars intended for bacon production must be castrated before they reach maturity.
  - Such boars are called barrows.

5.2 Differences between indigenous and improved breeds

With the exception of the wild pig species, there are no real indigenous pig breeds in South Africa. Those regarded as African have probably arisen from imported breeds that originally became feral (wild) and then developed their own characteristics as they adapted to conditions. These indigenous breeds differ from the pig breeds used in intensive commercial production systems in that they can forage for food.

5.2.1 The Kolbroek

- Is thought to have come from China.
- It is a short, heavy pig with a flat face.
- It can live in semi-wild conditions in rural areas where it forages for food.

5.2.2 The Windsnyer (Wind cutter)

- Is a narrow-bodied, long-nosed breed with a sharp back.
- They can be black, brown or spotted.
- It can survive well on waste and scraps around households and farms.

5.3 Description of various pork breeds

A small pool of breeds is used in the commercial intensive pork production units, namely the Large White, Landrace, Duroc, Hampshire, and Chester White. These breeds are continually crossbred to produce piglets that:

- have good food conversion efficiency
- are able to produce the lean meat required by the market.

5.3.1 Large White

- Very large, sturdy pink-coloured pig with a thin, white hair coat.
- A characteristic head with a short snout, dished face and erect ears.
- The sows are good mothers.
- Less susceptible to stress than, for example, the Landrace.
- It is the most numerous breed in intensive systems.

5.3.2 Landrace

- Originated in Denmark and was then improved by breeders in the USA.
- It is a white pig with a long body and flatter back than most other breeds.
  - It has a long, narrow head, smooth jowls and large heavy ears.
  - The rump is long and meaty and the hams are plump.
- It is the second most numerous breed, and is used in crosses with the Large White.

5.4 Description of various bacon breeds

Modern piggeries slaughter baconers at a heavier mass than porkers. Male piglets intended for bacon production are castrated.

5.4.1 Hampshire

- Black pig with a white belt across the body and shoulders.
- It is used for cross breeding with other breeds to improve performance.

5.4.2 Tamworth

- A distinct bacon type breed of English pig, but is not used much in South African piggeries.
- Long rather than wide.
- Brown haircoat.
- Rugged, thrifty and active.

Unit 6

Poultry breeds

6.1 Classification of poultry based on their production purposes

The poultry industry supplies more than 60% of all the animal protein consumed in South Africa annually. Poultry production is classified according to the scale and type of farming employed for raising the birds. For example:

- Intensive production systems = the major methods for raising poultry and producing poultry products.
  - The birds are raised in large numbers in small, usually specifically designed houses.
  - It is a highly sophisticated industry, based on scientific principles and requires constant and intense management and high quality feed.

6.1.1 Broiler production

- Broilers are heavy breeds used for meat production.
- They are bred for their fast growth rate.
- Large numbers of broiler chickens are raised in specifically designed houses and fed specifically balanced diets from when they hatch.
- At six to seven weeks, at a weight of about 2 kg, they are slaughtered for their meat, which is then sold fresh, frozen, or as value-added products, such as chicken fingers, portion, etc.
- This competitive industry requires the most efficient birds with respect to growth rate, survivability and feed conversion. Only the modern breeds, such as Cobb 500 and Ross broilers, meet these stringent standards.

6.1.2 Egg production

- Layer hens and dual-purpose hens are kept for the production of fresh eggs.
- They are lighter and grow more slowly than broiler fowls and so it is not economical to raise roosters of these breeds on expensive balanced grower feed.
- The 22 million layers in South Africa lay about 300 eggs per year, producing about 6.6 billion eggs per year.
- Layer birds are raised on the ground until they are at point of lay (16 weeks) at which time they are put into specifically designed layer houses, 3 or 4 to a small wire cage called 'battery cages'. In these small cages they live, eat and lay eggs for 52 weeks, producing up to 300 eggs each.
- The breeds used need to be efficient with respect to egg production, egg quality, survivability and feed conversion. Hi-Line, Hybro and Amberlink meet these very stringent standards.

Poultry breeds				
System	**Intensive**	**Intensive**	**Semi-intensive**	**Extensive**
Type	Heavy breeds	Light breeds	Dual purpose	Indigenous breeds
Product	Broilers (meat)	Layers (eggs)	Dual purpose (meat & eggs)	Subsistence (meat & eggs)
Breeds	Cobb 500 (USA)	Hi-Line (USA)	Koekkoek (SA)	Ovambo
	Ross (UK)	Hybro (Netherlands)	Boschvelder (SA)	Venda
		Amberlink (USA)	Rhode Island Red	Naked-neck
			New Hampshire	
			Australop	

A summary of the breeds used in various production systems in South Africa

6.1.3 Other types of poultry production systems

- Breeder farms on which layers or broilers are bred. Old breeders are sold as spent hens or Cornish hens → slaughtered for meat.
- Semi-intensive production and free range farms → are favoured by members of the public who prefer a more humane and organic type of farming system where the birds have more space.
- Subsistence or backyard farming.
- Hobby farming.

6.2 Basic requirements for successful poultry production

6.2.1 Housing

The housing requirements depend on the intensity of the system employed to rear the birds.

- Extensive systems:
  - housing is a simple shelter against the elements.
- Semi-intensive backyard systems:
  - normally consists of a small shed to provide shelter and a place for the hens to lay their eggs. It allows them to forage in the day, but they can be closed in at night for protection against the weather and predators. In commercial farming, semi-intensive free-range systems also exist.
- Intensive production systems:
  - hold between 100 and 10 000 birds, all of the same age. From 12 to 20 birds occupy one square metre of house floor space. Because of the density of the birds, ventilation is very important, as the build-up of ammonium gas from the faeces can cause diseases of the lungs. Some of the intensive houses are air conditioned to maintain optimal temperature, humidity and fresh airflow. Other requirements are:

- a concrete floor to allow disinfection
- absorbent bedding such as sawdust
- orientation of the house along a north-south direction
- walls for shade and protection against wind
- a double-sloped corrugated iron roof at least 2 m from the ground, with a 60 cm overhang to keep rain out.

- Layer houses:
  - similar to intensive systems, but hens are kept in rows of small, raised, wire cages (5 or 6 per cage). They are automatically fed and given water through piping with nipples in each small cage. Droppings fall through the cage to the floor for easy cleaning. Eggs roll into a collector.

6.2.2 Management

- Management systems for intensive production systems of broilers and egg production must be scientific and use an 'all in – all out' system that allows effective disease control. For example:
  - In broiler houses 10 000 day-old broiler chicks are placed in the house and then kept for 6 weeks, after which all are sent for slaughter.
  - During week 7, the house is emptied, the litter removed and the house cleaned and disinfected.
  - The next week a new batch of day old chicks is brought in.
- Layers are also managed according to an 'all in – all out' system, but the cycle is 52 weeks long.
- Other important management activities include:
  - supplying the correct type of feeders and drinkers with proper spacing and height to ensure all birds can feed and drink
  - instituting vaccination and medication against the diseases.
- In the case of both broilers and layers extra hours of light (daylight) can be provided to increase production.

6.2.3 Breeding

Breeding for intensive production systems (e.g. the broiler and layer breeds) are selected for specific characteristics as shown in the table below.

Broilers	Layers
Fast growth rate	Good egg laying (>300 eggs per 52 weeks)
Good feed conversion rate	Good feed conversion
Uniformity of size and growth rate	Uniform size and colour of eggs
Good skin colour	Hard shells
Disease resistance	Disease resistance
Good temperament	Good temperament

Breed characteristics of broiler and layer poultry

6.2.4 Nutrition

- Extensively raised poultry find most of their own food consisting of wild seeds, greens and insects.
  - Their production can be improved by giving them a supplement of leftover food or a small amount of ready mixed feed.
- Feeding intensively raised broiler chickens or layers requires well balanced rations which give high levels of production, a fast growth rate in broilers and almost an egg a day for a full year from layers.
  - Most big producers produce their own scientifically balanced concentrate feeds → made mainly from maize, sunflower and soya to which vitamins and minerals are added.
  - Some poultry producers buy ready-made feeds from specialist feed companies → supplied as mash, crumbles or pellets.

Broilers have a starter, a grower and a finisher ration. Layers also get a starter ration, followed by a layer grower mash.

- The amounts to be fed differ with the age of the birds and also with the type of bird, for example, whether it is a layer or broiler.
- The food must be stored properly to protect it against insects and rodents.

Unit 7

Horses, donkeys and mules

7.1 Classification of the main horse breeds based on their purposes

- Light horse breed = riding horse → suitable for dressage, jumping, racing and polo.
- Draft horse breeds = bigger and stronger → used to pull loads, such as carts, farm implements and carriages.
- All our horses have been imported, but some local breeds like the Boerperd and the Nooitgedacht have been bred and adapted to local conditions.
- The Basuto pony is a small, hardy breed that has been adapted for the cold mountainous regions in Lesotho where it is used as a riding horse, providing local people with transport in difficult terrain.
- The zebra is the only indigenous member of the equine family in southern Africa.

7.2 Warm-blood and cold-blood horses

After horses were domesticated in the northern hemisphere, various types developed due to the different environmental conditions:

- In Europe a large, heavily muscled horse with a long hair coat was selected, which was suited to doing heavy work because of its strength and its calm temperament. This gave rise to the so-called cold blood breeds.
- In the Middle East, smaller, light-bodied horses developed = thin skinned, long-legged, fast, sensitive and energetic. These horses were referred to as the hot bloods.
- Since the development of the various breeds, there has been crossbreeding of the hot bloods with cold bloods to produce horses suitable for particular purposes. These are now referred to as warm bloods.
- Most modern breeds are warm bloods because some crossbreeding has occurred.

7.3 Riding or light horse breeds

The light horse breeds are those that have mainly hot blood characteristics of slim body and slim legs: this makes them suitable for athletic activities, e.g. racing or jumping.

7.3.1 Arabs or Arabian horses

- Predominantly a hot blood breed, originating from the Middle East.
- They are small (14–15 hands), short backed, but very strong horses with a distinct head shape and high tail carriage.
- They are good natured, quick learners and have a willingness to please, which makes them suitable for riding and endurance.
- The coat colour is usually grey although there are other colours.
- The skin has dark pigmentation that protects them from the sun.

7.3.2 Saddle horse (American Saddlers)

- Developed in Kentucky in the USA for riding.
- Have a high stepping gait and very upright head carriage = good for showing.
- Comfortable gait and steady temperament = pleasure riding and jumping.

7.4 Draught horse breeds

Draught horses are mainly cold bloods (size and strength).

7.4.1 Percheron

- Originated in France during the 1600s. First used as a war-horse, later used for pulling coaches, ploughs or carts in agriculture and heavy industries.
  - As machinery has replaced them, they have been crossbred with hot or warm blood breeds. Now used for riding, cattle herding and even meat production.
- The typical Percheron = very large (16–17 hands high). It has a grey coat and has large heavy hooves and long hair, or feathering, around the hooves.
- They are placid and easy to handle despite their great size and strength.

7.4.2 Hackney

- Developed in England.
- A warm blood used specifically for pulling carriages. It has great stamina and can trot at high speed for long distances, because of its powerful hindquarters and characteristic high knee and hock action.
- The average Hackney is 15 hands high and can be brown or black.

7.5 Donkeys and mules

7.5.1 Donkeys

- Averaging nine hands high, with large ears, a woolly hair coat and powerful bodies.
- Derived from desert animals, they are hardy and able to survive on poor vegetation, but do not do well in wet, swampy areas.
- Were used as working animals on farms or in villages for transport, riding, pulling carts and in food or water mills (still used in the rural areas of developing countries).
- Some communities use donkeys as a food source.
- They are resistant to horse sickness, an African disease that kills horses.

7.5.2 Mules

- Some equine species can cross breed, but most matings are sterile (no offspring). An exception is the mating of horses and donkey: produces a mule. Less often a horse stallion and a donkey jenny produce a ‘hinny’.
- Exceptionally strong and are used for farming and forestry.
- Resistant to African horse sickness.

Unit 8

Game animals

8.1 Classification of game animals

- Game farming is the commercialisation of wildlife by private landowners.
- It is a rapidly growing branch of agriculture in southern Africa.
- It began because only 16,4% of South Africa is considered as having high agricultural potential, from the point of view of soil quality, rainfall and evaporation, as shown in Figure 5.49. The remaining 80% of land is agriculturally marginal and is only useful for extensive grazing.
- In areas where harsh conditions, poor grazing and indigenous diseases makes profitable livestock farming difficult, game ranching has many advantages over livestock farming:
  - game animals, because they have been in southern Africa longer than livestock, are better adapted to the climate, vegetation and local diseases.
  - they are able to utilise veld better than livestock, because there are many species each with their own particular feeding preference.
- The type of game ranching practised will depend on the region, the size of the land and species farmed/kept.
- The main categories of activity are tourism, hunting or harvesting for meat (venison), breeding of rare or endangered species and conservation (see table below).
- Conservation of wild animals is generally done by government, but the preservation of some endangered species has been achieved by the efforts of private landowners, in particular the rhinoceros species and the bontebok.

Use	Group	Species
Tourism larger game farms/reserves	"Big 5"	elephant, hippopotamus, lion, leopard, buffalo
	other species	zebra, giraffe, antelope (duiker to eland), crocodile
Hunting/harvesting Mainly on semi extensive private game ranches	trophy	lion, elephant, buffalo, other big game
	meat	antelope: mainly common species such as springbuck, blesbuck, wildebeest, impala, kudu warthog, crocodiles (also intensively farmed), ground birds
Breeding of species mainly on semi-intensive game ranches	rare species	disease-free buffalo, rare antelope such as sable, roan, tssesebe, nyala
	colour variants	golden wildebeest, black impala
Conservation extensively in state game reserves semi-intensively on private game ranches	all species	large herbivores, large carnivores, antelope, small mammals and birds
	rare and valuable species	cheetah, African wild dogs, smaller antelope (red or blue duiker, oribi)

Wild animal species used for game ranching or farming

8.2 Importance of game farming

- Game numbers have increased in South Africa since 1850 → means that the biodiversity of the country has increased.
- Economically game farming generates income from
  - breeding of rare species
  - local hunting
  - trophy hunting (mainly foreigners bringing foreign exchange to South Africa)
  - eco-tourism, with a total gross income of more than R2 billion per year
  - meat production.
- The average game ranch is 983 ha, with an economic output of R220/ha compared with R80/ha on conventional stock farms.
  - Three times more staff is employed on game ranches than on livestock farms.
  - The gross income from wildlife ranching annually in South Africa is R7,7 billion compared with the poultry (R20 billion) and red meat (R18 billion) industries.
- South Africa imports about R2 billion of red meat annually, so sustainable wild game meat production has a lot of potential → to contribute to food security.

Topic 5

Topic questions

Topic 5: Questions

- Answer the questions below.
- Give yourself one hour.
- Check your answers afterwards and do corrections.

1 Give a brief overview of the development and domestication of farm animals. (12)

2 Give two reasons why the livestock industry in South Africa is important for the economy. (2)

3 Briefly describe how digestion takes place in ruminants and non-ruminants. (4)

4 Complete the table of animal terms (white blocks). (10)

Species and alternate terminology	Adult male	Young male	Castrated male	Adult female	Young female	Young
Cattle (bovine)	bull		ox (plural oxen)	cow		calf
Sheep (ovine)	ram	–		ewe	–	lamb
Goats (caprine)	ram/buck	–		doe/nanny	–	
Pigs (porcine, swine, hogs)		–		sow		piglet
Horses (equine)	stallion	colt	gelding	mare	filly	foal
Donkeys		colt	gelding		filly	foal
Chickens	rooster	–		hen	–	chick

5 Name the two main types of the genus Bos and give three characteristics of each. (8)

6 What are the general characteristics of a beef bull? (5)

7 Name three dairy cattle breeds. (3)

8 Give the classification of sheep breeds based on their utilisation. (4)

9 Name two meat goat breeds and give a brief description of each. (6)

10 Name the two main pork breeds and give a description of each. (6)

11 List the four basic requirements for successful poultry production. (4)

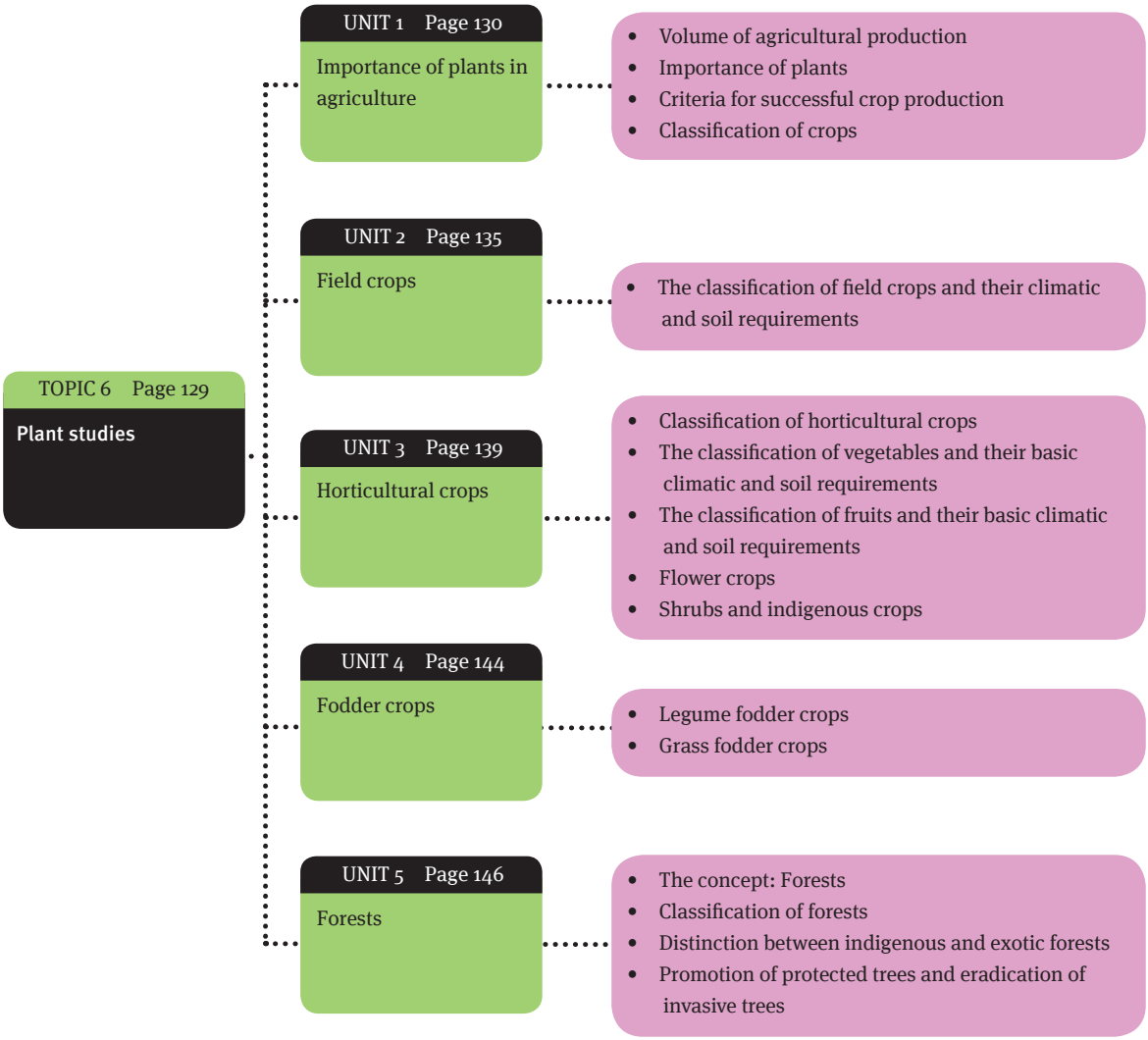
12 Give four reasons why game farming is important for the South African economy. (4)

[Total marks: 70]

Topic 6

Plant studies

Overview



What you will cover in Topic 6

Unit 1

Importance of plants in agriculture

1.1 Volume of agricultural production

Due to the aridity of land in South Africa, only 13,5% can be used for crop production, and only 3% is considered high potential land.

- But South Africa has a large agricultural sector = net exporter of farming products.
- Biggest exports = sugar, grapes, citrus, nectarines, wine and deciduous fruit.
  - Agricultural exports = 8% of South African total exports for the past five years.
  - Almost 1 000 agricultural cooperatives and agribusinesses in South Africa.
  - Agricultural industry contributes around 10% of formal employment (low compared to other parts of Africa) and provides work for casual labourers.
  - It contributes around 2,6% of the GDP.
  - South Africa is the eighth largest wine producer in the world, and the eleventh largest producer of sunflower seed.
  - The largest locally produced crop is maize, and it has been estimated that 9 million tons are produced every year, with 7,4 million tons being consumed.
- The gross value of agricultural production is determined by the quantity produced and prices received by producers.
- In these terms, the largest contributors towards the gross value of field crops for the past five seasons are:
  - maize (48,6%)
  - sugar cane (14,2%)
  - wheat (12,5%)
  - sunflower seed (6,7%)
  - hay (6,0%).

1.1.1 Maize

- In 2009/10:
  - South Africa had the largest commercial maize crop in 29 years, around 13,0 million tons (an increase of 8,2 tons compared to 2008/9)
  - The estimated area that producers planted is 2,742 million ha:
    - Commercial white maize planting : 1 719 700 ha = an increase of 15,5% compared to 2008/9
    - Commercial yellow maize plantings: 1 022 700 ha = an increase of 9,0% compared to 2008/9.
- The average annual gross value of maize for the period 2004/5–2009/10 is R14 041 million.

1.1.2 Wheat

In terms of value of production, wheat is the second most important field crop produced in South Africa.

- In the 2009/10 season, this crop contributed approximately 11% to the gross value of field crops.
- The average annual gross value of wheat for the past five years up to 2009/10 amounts to R3 619 million, compared to R14 041 million for maize, which is the most important field crop.
- The estimated area planted to wheat for the 2010 season is 558 100 ha, which is 13,1% less than the 642 500 ha of the previous season.
  - Of this area, 265 000 ha (47%) are in the Western Cape and 204 000 ha (37%) are in the Free State.
  - According to producers, the decrease in plantings can be attributed mainly to the relatively low producer prices of wheat.

1.1.3 Sorghum

Sorghum is the third most important grain crop (after maize and wheat), but it contributes only a small percentage to the total domestic grain crops.

- For the past five seasons, South Africa produced on average 212 700 tons of sorghum p.a. The estimated average annual gross value 2009/10 amounts to R363 million.
- During the 2009/10 production season (April to March):
  - produced mainly in the Free State (57,7%), followed by Mpumalanga and Limpopo (17,3% each) and the North West (6,3%).
  - An estimated 86 675 ha were planted, an increase of 1,4% compared with the 85 500 ha planted during 2008/09.
- Sorghum contributed approximately 1,3% to the gross value of field crops.

1.1.4 Sunflowers

- Commercial seed production during 2009/10 was approximately 516 265 tons, which is 35,6% lower than the previous season and 17,1% lower than the average of 622 600 tons for the previous 5 years.
- During the 2009/10 production season, the bulk of the crop was produced in the Free State (46%) and North West (37%) provinces.
- The contribution of sunflower seed to the gross value of field crops during the season is approximately 5,6%, compared to the 47,6% of maize.
  - The average annual estimated gross value of sunflower seed for the 5 years up to 2009/10 amounts to R1 934 million, compared to the R14 041 million for maize.

1.1.5 Soya beans

- Contributes about 4,9% to the gross value of field crops, and the estimated average annual gross value of soya beans for the past five seasons up to 2009/10 amounts to R106 million.
- The planting of soya beans = between 46 000–311 450 ha over the past 20 years.
- For two consecutive seasons, the area dedicated to soya-bean production has increased rapidly from an estimated 237 750 ha to an estimated 311 450 ha.

1.1.6 Cotton

- The area planted reached its peak during the 1987/88 production season, when an estimated 181 676 ha were planted. Since then, plantings have decreased substantially (e.g. total area planted the 2009/10 production season is estimated at 5 420 ha).
- The domestic production of cotton lint for the 2009/10 marketing season is estimated at 44 920 bales of 200 kg each, which is a drop of 8,5% from the 49 100 bales produced for 2008/09.
  - Lower cotton production means that more cotton lint will probably have to be imported.

1.1.7 Sugar cane

There are currently approximately 35 300 registered cane growers → produce on average approximately 20 million tons of sugar cane a year in areas extending from the Eastern Cape Province, through KwaZulu-Natal to Mpumalanga.

- Large-scale growers are responsible for approximately 85% of the total sugar cane production, while 8,4% of the total crop is produced by small-scale farmers and 6,5% by milling companies.
- The South African sugar industry produces an average of approximately 2,2 million tons of sugar per season.

1.2 Importance of plants

1.2.1 Economic importance of agriculture

- In monetary terms, agriculture is less important to our economy than mining and secondary industries:
  - In 1930 agriculture contributed about 30% of the GDP
  - In 1960 = 11,1%
  - In 1999 = 5%.
- Despite this decline, the farming industry remains vital to the economy, development, and stability of the southern African region.
  - The various sectors of the industry employ approximately one million people, or 8% of the workforce.
- Primary agriculture currently contributes about 3% to the GDP of South Africa.
  - However, there are strong linkages into the economy, so that the agro-industrial sector comprises about 7% of GDP.
- The total contribution of agriculture to the economy increased from R38 billion in 2002 to R68 billion in 2008.
  - The total gross value of agricultural production for 2007/08 = R199 billion.
  - Of this, over R65 billion came from field crops and horticulture, as shown in the table on the next page.

Gross value of agricultural production: 2008	
Crop	**(R'000)**
Field crops	
Maize	18 592 005
Wheat	4 759 004
Hay	2 483 645
Grain sorghum	458 224
Sugar cane	4 118 551
Groundnuts	675 156
Tobacco	194 742
Sunflower seed	3 320 212
Cotton	113 077
Other	2 608 718
Total	**37 323 334**
Horticulture	
Viticulture	3 037 520
Citrus fruit	5 406 395
Subtropical fruit	1 843 832
Deciduous and other fruit	6 931 431
Vegetables	5 749 887
Potatoes	3 491 404
Other	1 656 145
Total	**28 116 596**
Grand Total	**65 439 930**

Total gross value of field crops and horticulture production for 2007/08

1.2.2 Other reasons why plants are important

- Oxygen is a by-product of photosynthesis that takes place in plants.
- Most of the food that we eat comes from plants.
- Many plants are used as medicines: 80%–85% of all medicinal drugs originate in wild plants.
- Plants have aesthetic importance: decoration and aroma.
- Plant roots reduce runoff and increase the rate of water entry into the soil.
- The leaf canopy of plants, like trees and shrubs, breaks the impact of raindrops on the soil surface, and the roots of plants bind the soil to prevent soil erosion.
- Grasses are used for roofing in the rural areas. Wood is used for sculptural and carpentry designs.
- Plants are important for the resources they provide for commercial activities:
  - Fibres and cotton are made into cloths.
  - Wood used for buildings and furniture.
  - We get gums, pulp for paper and rubber.
  - Fuels and gases, like diesel and ethanol, are being made from plants.

- Plants are a source of fuel in the rural areas (wood for cooking fires). In addition, coal is obtained from decomposed plants that have been buried underground for millions of years.

1.3 Criteria for successful crop production

Crops include grain crops, root crops, vegetable crops, forestry crops and fodder crops. The table below indicates some of the criteria that should be followed for successful crop production.

Criteria for successful crop production – Things to take into consideration					
Tillage management	**Application of manure**	**Water requirements**	**Variety/cultivar selection**	**Pest and disease control**	**Weed control**
Ploughing date, planting times, labour management and control, mulching, marketing strategies, harvest management.	Soil test for pH, correct organic / inorganic application of manure, application at the right time.	Correct application of irrigation.	Identification of the right cultivar depending upon length of season.	The use of appropriate pesticide with correct measurement.	Early weed control.

Criteria for successful crop production

1.4 Classification of crops

Crop plants are classified into four categories:

- Field crops
- Horticultural crops
- Forestry crops
- Fodder crops.

Unit 2

Field crops

2.1 The classification of field crops and their climatic and soil requirements

- Field crops can be classified into a number of categories, such as:
  - grain crops (maize, wheat and sorghum)
  - oil seed crops (sunflower and soya beans)
  - industrial crops (sugar cane and cotton).
- Field crops are usually grown commercially on a large scale, but are also cultivated by small-scale and subsistence farmers.
- The gross income from field crops increased from 2007 by 26,7% to R29 872 million for the year ended June 2008.

2.1.1 Grain crops

- The grain industry is one of the largest industries of South African agriculture, producing between 25% and 33% of the total gross value of agricultural production.
- The gross value of grain production is usually around R12 billion per annum.

Maize / corn (Zea maize)

- The largest locally produced field crop.
- Produced on large scale mainly in the North West, the Free State and Mpumalanga.
- Sun-loving:
  - it grows well in areas where there is no frost.
- It requires a well-drained loamy soil with a lot of nitrogen and potassium in the soil.
- Maize requires a well-distributed annual rainfall of between 450 mm and 900 mm.
- The staple food in many homes in South Africa: it can be eaten in many different ways:
  - fresh
  - processed: samp, maize rice and maize flour
  - manufactured: popcorn, corn flakes and biscuits.
  - porridge and breakfast cereals
  - alcoholic beverages, like *mqombothi*
  - corn oil, which is used for cooking oil, salad oil and margarine.
- White maize is the most important source of carbohydrate for human consumption.
  - Animals (e.g. fowls) are mostly fed with yellow maize because it is rich in both carbohydrates and Vitamin A.
  - Poultry animals (chickens) and livestock animals (pigs and cattle) are fed with feeds and concentrates that contain a high proportion of maize.

Wheat

- Produced mainly in the winter-rainfall areas of the Western Cape and the eastern parts of the Free State
- Wheat is more demanding with regard to soil, climatic conditions and water supply than other cereal crops. It requires heavy, deep, well-aerated soils, rich in humus, with a high water capacity and a pH between 5,5 and 7,5. Nutrient-rich clay and black earth soils are ideal. Wheat is sensitive to soil salinity.
- Uses of wheat include flour production for making pasta, bread and cakes; breakfast cereals; and the preparation of alcoholic beverages. The husks are given to livestock as a feed supplement and to pigs as a good source of vitamins

Sorghum

- One of the best examples of drought-tolerant grain crops. It does well under very hot and dry conditions. During drought, sorghum stays dormant and then continues to grow with the onset of the rains.
- Cultivated mostly in the drier parts of the summer-rainfall areas, such as Mpumalanga, the Free State, Limpopo and the North West.
- It is regarded as a sun-loving crop because it grows well under summer conditions.

2.1.2 Oil seed crops

Sunflower

- Grown for the seeds. Oil is obtained from matured seeds for:
  - edible cooking oil
  - soap, candles and margarine
  - the waste after the oil has been extracted is used for poultry-feed and livestock.
- South Africa is the world's 12th largest producer of sunflower seed.
- Produced in the Free State, the North West, on the Mpumalanga Highveld and in Limpopo.
- Sunflower, compared to other crops, performs well under drought conditions and is very sensitive to waterlogging. Sunflower adapts relatively well to a wide variety of soil types.
- Traditionally, sunflower cultivation was limited to soils where the clay percentage varies between 15 and 55% (sandy loam to clay soil types). At present the major planting areas are in soils with a clay percentage of less than 20%.

Soya beans

- Mainly produced in Mpumalanga, the Free State and KwaZulu-Natal. Small quantities are produced in Limpopo, Gauteng and North West.
- Sun-loving; require temperature range of 21 to 27°C for very successful seed set. An average rainfall distribution of 450 – 700 mm is required for optimum production.
- It does well on most soils and does not require soils rich in nitrogen for good yields.

2.1.3 Industrial crops

An industrial crop is grown to produce goods to be used in the production sector, rather than food for consumption.

Sugar cane

- South Africa is one of the world's leading cost-effective producers of high-quality sugar. The industry includes the agricultural activities of sugar cane cultivation and the industrial factory production of raw and refined sugar, syrups and specialised sugars and a range of by-products.
- The sugar industry makes an important contribution to the national economy.
  - Direct employment within the sugar industry totals 85 000 jobs.
  - Direct and indirect employment is estimated at 350 000 jobs, including employment in rural areas.
  - The South African Cane Growers' Association and the milling companies undertake development projects and are involved in Black Economic Empowerment (BEE) through a range of initiatives.
- For cultivation, sugar needs:
  - tropical/temperate climate = minimum 1 500 mm annual moisture.
  - fertile, nutrient-rich, sandy, alluvial or loamy soil that is well drained with an optimum soil pH of about 6,5. Excess nitrogen causes significant cane growth but lowers the sugar content of the plant.

Cotton

- Cultivated in Mpumalanga, Limpopo, the Northern Cape, KwaZulu-Natal and North West.
- Constitutes 74% of natural fibre and 42 % of all fibre processed in South Africa.
- The quantities of cotton lint for the 2006/2007 marketing year were:
  - Mpumalanga = 36 000 bales (1 bale = 200kg)
  - Limpopo = 12 332 bales
  - Northern Cape = 11 103 bales.
  - Eastern Cape = 132 bales of cotton lint.
- About 75% of local production is harvested by hand.
- Cotton is grown under irrigation as well as in dry land conditions.
- With a normal growing period of 200 days, the cotton plant requires:
  - Temperature:
    - A relatively high temperature over a long growing season; needs abundant sunshine especially from December to February. Adequate sunshine is necessary for boll production and maturation.
    - Temperatures under 20°C have a slowing down effect on the growth of the plant, especially during the flowering and boll phases.
    - Low temperatures just after planting time (at germination) as well as low night temperatures during any stage of growing, are potentially harmful.
    - For good germination, seedbed soil temperature = at least 18°C.

- Water:
  - Cotton = a drought-tolerant plant that can provide relatively good yields under dryland conditions, even in areas where the rainfall is less than 500 mm annually.
  - For profitable, good quality yields, higher, evenly spread rainfall (about 500 mm to 1250 mm) is required.
  - Therefore, cotton in South Africa is mainly cultivated under irrigation.
- Soil:
  - Performs best in deep, fertile, sandy loam soils with reasonable drainage.
  - Does not do well in sandy soils or heavy clay soils (clay soils present problems with the germination of seedlings).
  - Prefers a deep soil, one metre or more.
  - As cotton is very susceptible to waterlogged conditions, soils with poor drainage should be avoided.
  - Although cotton is relatively tolerant as far as pH is concerned, the best results are obtained with a pH of between 5,5 and 7,5. The plant is quite sensitive to aluminium poisoning and should therefore not be planted in soils with a pH value of below 5,5 (determined in water) where the aluminium concentration is high.
  - Has high tolerance to brackish soil.

Unit 3

Horticultural crops

3.1 Classification of horticultural crops

- Horticulture = scientific study and cultivation of fruits, vegetables, flowers and ornamental plants. Some of the areas in horticulture are:
  - Floriculture – the production and marketing of flowers and floral crops
  - Pomology – the production and marketing of fruits
  - Olericulture – the production and marketing of vegetables
  - Landscaping – the designing, production and marketing of landscape plants
  - Post-harvest physiology – maintaining the quality of horticultural products and preventing them from spoiling
  - Viticulture – the production and marketing of grapes
  - Oenology – all aspects of wine-making
  - Arboriculture – the study of trees, vines and shrubs
- Plant agriculture is divided into:
  - agronomy (herbaceous field crops, mainly grains, forages, oilseeds and fibre crops)
  - forestry (forest trees and products)
  - horticulture: edibles (garden crops, particularly fruits, vegetables, spices and herbs) and ornamentals (highly perishable because they are utilised in the living state, with water essential to quality)
- Fruit crops are cultivated for their fruit. Trees or shrubs bearing nuts are often treated as a special category of fruit crops.
- Vegetable crops are commonly herbaceous plants grown as annuals or biennials and occasionally as perennials that have edible parts (including, confusingly, the botanical fruit). Examples of edible parts include the root (sweet potato), tuber (potato), young shoot (asparagus), leaf (spinach), flower buds (cauliflower), fruit (tomato), and seed (pea).
  - Plants grown for ornamental use (e.g. cut flowers, bedding plants, interior foliage plants or landscape plants) = big group = thousands of species.

3.1.1 Economic importance of horticultural crops

The floriculture industry employs about 17 500 people.

- There is a strong demand for South African floriculture products and markets worldwide (e.g. Germany, the United Kingdom, Japan and the Netherlands).
- In the local market, many people retail different kinds of flowers, fruits and vegetables for their daily income. Some of these people set up stalls along the roadside to sell their vegetables.
- South Africa = main exporter of protea cut flowers = more than half of the proteas sold on the world market. South African proteas and Cape greens, whose cultivation is mainly concentrated in the Western Cape, are marketed in Europe.

3.2 The classification of vegetables and their basic climatic and soil requirements

The table below summarises the classification of vegetables and their basic climatic and soil requirements.

Classification of vegetables and their basic climatic and soil requirements

Sub division	Edible parts	Climate	Soil requirements
Root vegetables			
Beetroot *(Beta vulgaris)*	Crown and leaves. Eaten raw, cooked; leaves can be grated or cooked.	Cool climate. Annual rainfall of 700 – 1 000 mm and full sunlight. Average day temperature of 200C but range of 5 – 300C.	Grows best in deep, friable, well-drained soil with a lot of organic matter; pH of 6,5 – 8.
Carrots *(Daucus carota)*	Roots are eaten raw or cooked. It can be canned, dehydrated or frozen; processed into infant food, juice, sauces and stews. Used as fodder for horses.	Optimum growth at 16 – 200C . Regular water supply. Low temperatures induce flowering.	Loamy sand and organic soils, well aerated and deep crumbly. Optimum pH is 6 – 6,5.
Leaf vegetables			
Cabbage *(Brassica oleracea)*	Raw leaves in mixed salads, sliced and cooked.	Average daily temperature of 15 – 200C is the best. A regular water supply is ideal for high yield.	Medium heavy, well-drained and fertile loamy soils with good moisture retaining capacity. Enough organic matter.
Spinach *(Spinacea oleracea)*	Leaves are cooked or sliced and half cooked.	A hardy, cool-season crop; young plants tolerate low temperatures. Prefers enough mild sunlight. Requires much water during growing period.	Performs best in a moist, sandy loam, high in organic matter. Optimum pH of 6,2 – 6,9.
Stem vegetables			
Potatoes *(Solanum tuberosum)*	Tubers are eaten in many forms, e.g. boiled, baked, roasted, fried or processed into powder.	Optimum day temperature range from 20 to 250C. Rainfall of 500 – 700 mm.	Deep soil with good water retention and aeration. Soil pH range from 4,4 to 6,7.
Fruit vegetables			
Tomato *(Lycopersicon esculentus)*	Eaten fresh, in salads, fried or baked; used in soups and sauces; processed into tomato sauce, juice and puree. Canned or sun-dried.	Requires sunny environments. Optimum temperature range is 21 – 240C. Well-distributed rainfall: 20 mm/week in cool regions. Sensitive to water logging	Grows well in many soil types, from sandy loam to clay-loam soils, preferably rich in organic matter and a soil pH of 6 – 6,5.
Flower vegetables			
Cauliflower *(Brassica oleracea)*	The head or capitulum.	Average daily temperatures of between 15 – 200C. Low temperatures favour early flowering. Resistant to frost.	Grows best in medium to heavy well-drained loamy and rich fertile soils with good moisture-retaining capacity, and good organic matter content. Optimum pH is 6 – 7.

The classification of vegetables and their basic climatic and soil requirements

3.3 The classification of fruits and their basic climatic and soil requirements

Fruits can be classified into:

- Tropical fruits (e.g. bananas)
- Subtropical fruits (e.g. avocados)
- Deciduous fruits (e.g. apples, grapes).

3.3.1 Tropical fruits (e.g. bananas)

- There are two broad types of bananas:
  - bananas that are eaten ripe (musa sapientum)
  - bananas that are cooked and eaten green or fried in oil when ripe (musa paradisiacal).
- Bananas grow well:
  - in the subtropical regions of Southern Africa
  - medium to high temperature ranges from 22 – 35°C
  - an even rainfall distribution range of 95 – 105 mm per month
  - in a rich loamy soil with a lot of organic matter.
- Mostly cultivated between Port Shepstone and Port Edward in KwaZulu-Natal.

3.3.2 Subtropical fruits (e.g. avocados)

- Climatic requirements:
  - warm (mean daily temperature range of 20 – 240°C), moist and fairly humid conditions
  - an evenly distributed annual rainfall of 1 000 mm
  - in well-drained soil with about 20 – 30% clay.
- Mostly cultivated in KwaZulu-Natal, Mpumalanga and Limpopo.

3.3.3 Deciduous fruits (e.g. apples and grapes)

- Deciduous fruits shed their leaves during a certain period of the year and may be scarce if not cultivated in greenhouses.
- Deciduous fruits require temperate conditions in which some months of the year are very cold and wet.
- The Western Cape and the Langloof Valley in the Eastern Cape: large-scale production of deciduous fruits, such as grapes, apples and pears.
- Plums, peaches and apricots are produced on a large scale on the highveld of Mpumalanga and in the eastern parts of the Free State.
- Apples do well in regions that do not experience very high temperatures.
  - They require well-aerated soils with good organic matter content.
  - Perfect conditions are a crumbly soil with medium fertility and slightly on the acid side. Extremes of acid or alkaline soil will need to be corrected before planting.

- Soil type so greatly influences the flavours and characteristic of grapes that grapes grown on neighbouring farms can have a different taste.
  - Generally, grapes require well-drained sandy loam soil. Grapes prefer cool winters with winter rainfall of about 750 mm per year to allow them to move into a desired state of dormancy.
  - They require moderate to warm summers to allow for ripening.

3.4 Flower crops

- Ornamental horticulture (floriculture) is the intensive production of flowers and ornamental shrubs and plants. A floriculturist grows flowers and a florist sells flowers and flower arrangements.
- The South African horticulture industry has the opportunity to develop into a significant player on the international market. The horticulture industry employs over 17 500 people.
- The main types of flower crops extensively used in South Africa are the fynbos, garden flowers and cut flowers.

3.4.1 Fynbos

- Major vegetation type of botanical region known as Cape Floral Kingdom. It is the smallest (90 000 km^2) but richest (9 000 species) of the world's six floral kingdoms. More than 6 000 species are endemic.
- Three main types of fynbos:
  - proteas: large with feathery leaves
  - restiose grasses
  - Ericas.
- Fynbos promotes agro-tourism.

Climate

- Mediterranean climate: cool wet winters and hot, dry summers.
- Resistant to strong coastal winds.
- Summer droughts, extremely poor, well-leached soil and intense fires every 4 to 20 years are necessary for the development of fynbos.

3.4.2 Garden flowers

- Grown for beauty and fragrance.
- Annuals (1 year); biennials (2 years) and perennials (evergreen and deciduous).

3.4.3 Cut flowers

- In demand because of beauty and fragrance; used for a variety of occasions.
- Commercially grown on farms for export, for retail to supermarkets and florists.
- Should be long-stemmed, fragrant and have good vase life.

3.5 Shrubs and indigenous crops

Shrubs are woody plants that have many small, leafy branches. Two indigenous shrubs have become important crops.

3.5.1 Rooibos (*Aspalathus linearis*)

- Endemic to South Africa. The Khoesan discovered that the tea has medicinal benefits.
- Naturally distributed in the winter rainfall area from about Van Rhynsdorp in the north to the Cape Peninsula and the Betty's Bay area in the south. The area experiences cold wet winters and hot dry summers with about 300 – 350 mm of rain per annum.
- Cultivated
  - mainly in the Cederberg area about 250 km north of Cape Town.
  - adapted to the highlands with hot, dry summers and cold, wet winters.
  - rainfall = 300–350 mm p.a.
  - likes well-drained sandy soil.
  - no fertilising is required.
- Harvested, cultivated *Aspalathus linearis* is used as Rooibos tea.
  - It is rich in polyphenol antioxidants, but has a low tannin content and no caffeine.
  - Rooibos Limited in Clanwilliam (Western Cape) is the market leader in the supply of rooibos. It has a local market share of 80% and an international market share of between 50 and 60%.
  - There are over 200 contracted farms involved in the supply of rooibos.

3.5.2 Honeybush tea (*Cyclopia intermedia*)

- Endemic to South Africa.
- Sweeter than rooibos.
- Contains isoflavones (reduces cholestrol and high blood pressure).
- 23 species grow in the Cape fynbos biome; 5 of these are now cultivated as a commercial crop, with a production of more than 100 tons of processed tea p.a.
- Adapted to the same climate and soil requirements as rooibos.

Unit 4

Fodder crops

- Cultivated to feed livestock; Includes hay, straw, silage, compressed and pelleted feeds, oils, mixed rations, sprouted mealies and other grains.
- There are a number of reasons why fodder is important in the keeping of livestock:
  - It provides all the nutrients that livestock require
  - It is relatively cheap to provide livestock with fodder, such as hay
  - A growing fodder is a wildlife habitat and provides watershed protection for rivers
  - Growing fodder conserves the environment by preventing water and wind erosion.
  - Can be classified as legume fodder crops and grass fodder crops.

4.1 Legume fodder crops

Trifoliate plants that bear seeds in pods (e.g. beans) and nuts in shells (e.g. peanuts).

4.1.1 Lucerne (*Medicago sativa*)

- Also known as Alfalfa (which means 'best fodder')
- The most important fodder crop grown under irrigation in the Karoo.
- Does well in most South African soils. It is drought resistant. It can be cultivated under dry conditions, where the annual summer rainfall is higher than 400 to 500 mm, and in winter rainfall, where the annual rainfall is higher than 350 to 400 mm. Lucerne grows well in deep and well-drained neutral soil, which must be free of impervious layers.
- Lucerne:
  - is very rich in protein and minerals
  - produces a very high yield per hectare
  - has a sweet taste for all ruminants
  - the roots fix nitrogen in the root nodules → released as nitrates into the soil.

4.1.2 Red clover (*Trifolium pratense*)

- One of the clover species that is used as a fodder crop in South Africa.
- Clovers are annual or perennial herbs. They regenerate freely and produce a lot of fodder.
- Red clover grows in a wide range of soils, but prefers well-drained loamy soils. Drought resistance is high when grown on deep soils because of the deep-rooting characteristic. Optimum temperatures for growth are between 200 and 250°C, with mild winters.
- It is a rich source of protein in the diet of ruminants. It is also a good source of hay and can be mixed with rye grass fodder for ruminants.

4.2 Grass fodder crops

Grass fodder is the cheapest fodder for farmers who domesticate animals; grass constitutes the largest vegetation in the world.

4.2.1 Kikuyu grass

Kikuyu grass is a perennial low-growing, warm-season grass adapted to wetter regions. It is mostly fed to dairy cattle in wetter areas as grazing grass.

- Ideal as a fodder grass because it stays fresh and green for long periods, thus maintaining its water and nutrient content. It goes dormant under unfavourable conditions, like drought, but grows vigorously with the onset of favourable conditions.
- It has deep roots and spreads fast. It has underground runners (rhizome) and stolons (above ground runners) which makes it a good fodder crop for controlling soil erosion. Kikuyu can easily invade other vegetation under favourable conditions.

4.2.2 Rye grass

- There are two basic types of rye grass:
  - Annual rye grass: useful in pasture because it grows fast and therefore provides quick, short-season forage and hay forage, and prevents soil erosion. It is a cheap source of fodder for ruminants.
  - Perennial rye grass: very palatable and easily digestible in ruminants. It is fast growing, but easily invades or competes with other grasses in the field.
- Rye grass is a fast-growing cool-season grass that adapts to many soil types and climatic conditions.
- In warmer regions, rye grass requires irrigation to maintain colour and nutrients.

Unit 5

Forests

5.1 The concept: Forests

There are natural forests and plantations in South Africa.

- Natural forest = a multilayered vegetation unit dominated by trees (evergreen or semi-deciduous), with 75% or more crown cover and very little grass.
  - Found mainly in the mountain areas near the coastal belts of the Eastern Cape.
  - They cover 504 803 ha of South Africa.
- Plantations = area planted with trees for commercial use.
  - In South Africa = 1,3 million ha (one of world's biggest).
  - A commercial plantation = blocks of trees where the trees of one block are all mostly the same species and age, and have all been planted at a fixed spacing.
  - These species are mostly exotic and are light-demanding.
  - Harvesting is by felling a whole compartment at the same time.
  - Commercial plantation forestry in South Africa = the large planted forests → supply raw materials (e.g. mining; construction; furniture; paper; energy).
- The forestry sector employs about 170 000 people and contributes more than R16 billion annually to the economy of South Africa.

5.2 Classification of forests

Forest crops (wood) can be classified into:

- Hardwood: from deciduous trees, e.g. oak, maple and mahogany,
  - used in construction for trusses, beams, and doorframes
- Softwood: from evergreen or coniferous trees, e.g. pine and cedar.
  - used for making indoor furniture, such as kitchen cupboards.

5.3 Indigenous forests (natural forests)

- Occur mainly along the southern and eastern highlands of South Africa.
- Good source of herbal medicine, building materials, fuel wood (e.g. for fires).
- A habitat for most wild animals like monkeys.
- Indigenous trees = hardy and well adapted to the climate of South Africa. Indigenous trees live long and some (e.g. Baobab) can grow very big.

5.4 Exotic trees

- From other countries, reaching new areas outside of their origin in one of two ways:
  - self-introduction on their own → has been happening over millions of years at a slow rate through wind and water
  - with human assistance that may be deliberate or accidental → for food or aesthetic purposes, or as part of international commerce.

- An example of an exotic tree in South Africa = eucalyptus (gum) tree. Some exotic trees → economic and aesthetic value; others → invasive and detrimental to the ecosystem, e.g. the gum tree extracts volumes of soil water from aquifers.

5.5 Promotion of protected trees and eradication of invasive trees

- Invasive alien species are one of the main threats to biodiversity.
- They impose enormous costs on agriculture, forestry, fisheries and other human enterprises, as well as on human health.
- Rapidly accelerating human trade, tourism, transport and travel over the past century have enhanced the spread of invasive species.
- Invasive trees:
  - grow faster, and so they mature earlier
  - produce many more seeds for self-propagation
  - are not known by the local animals so their leaves are not disturbed by rodents
  - herbalists do not disturb them because they are foreign
  - lead to loss of agricultural land
  - threaten the quality and quantity of soil water
  - invade grazing-land for animals
  - multiply rapidly to take over the indigenous trees in an area.
- Environmental researchers estimate that over 10 million hectares of land in South Africa is occupied by alien plants. If not controlled effectively, they will:
  - affect our water resources
  - take over most of our arable land
  - increase bush fires
  - cause soil erosion
  - pollute water and affect aquatic life.
- It will cost the government over R600 million a year over 20 years to control the spread of alien plants.
- According to the ARC, there are four basic methods to control invasive alien plants:
  - Mechanical control: removing the invasive plants by physically uprooting them, slashing, mowing, ringbarking or bark stripping them.
  - Chemical control: the application of registered herbicides to the invasive plants or to the soil surrounding them with the aim of killing them.
  - Biological control: the use of host-specific natural enemies to reduce the population of the invasive plant to the barest minimum.
  - Indirect control: the use of other methods that do not directly control the plants, but involve measures such as:
    - the use of fire
    - checking entry ports for introduction of alien crops
    - over-sowing beneficial plants at areas infested by alien crops.

Topic 6

Topic questions

Topic 6: Questions

- Answer the questions below.
- Give yourself one hour.
- Check your answers afterwards and do corrections.

1 How much of South Africa's land can be used for crop production? (1)

2 Name the five largest contributors towards the gross value of field crops for the past five seasons, and state the contribution of each as a percentage. (10)

3 Give five reasons, apart from their importance to the economy, why plants are important. (5)

4 Indicate whether the following statements are true or false: (15)

- a In terms of value of production, wheat is the second most important field crop produced in South Africa.
- b Soya beans contribute about 4,9% to the gross value of field crops.
- c The South African sugar industry produces an average of approximately 2,2 million tons of sugar per season.
- d South Africa has one of the largest commercial plantation areas in the world, covering 1,3 million ha.
- e Stem vegetables require deep soil with a pH range of 5,5 – 7,6.
- f Leaf vegetables require an average daily temperature of 15 – 200°C.
- g Carrots require low temperatures to flower.
- h Cauliflower is not resistant to frost.
- i Deciduous fruits require cold, wet conditions during some months of the year.
- j Apples are a subtropical fruit.
- k Fynbos requires extremely poor soil and intense fires every 4 – 20 years.
- l The roots of lucerne fix nitrogen in the root nodules.
- m Rooibos requires and annual average rainfall of 450–600 mm.
- n Red clover grows in a wide range of soils, but prefers well-drained loamy soils.
- o Fodder provides all the nutrients that livestock require.

5 What does the study of agronomy include? (4)

6 List the five categories of vegetable classification and give an example of each. (10)

7 Describe the climatic and soil requirements of bananas. (3)

8 What are the three main types of flower crops grown in South Africa? (3)

9 Name four negative effects alien plants have on the environment. (5)

10 Describe the five ways in which alien plants can be controlled. (10)

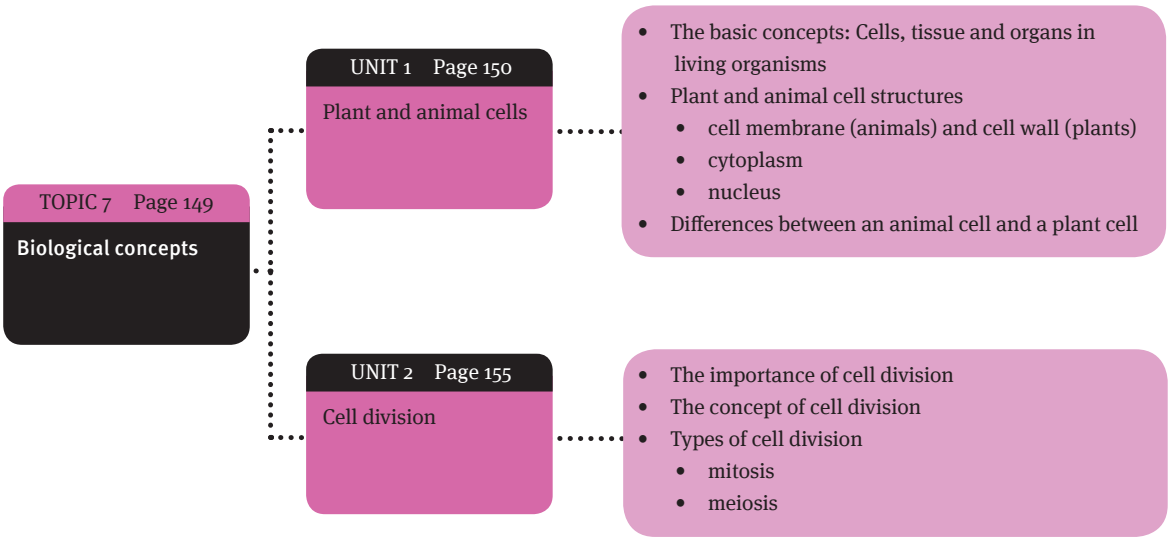
11 Name the two categories of fodder and give an example of each. (4)

[Total mark: 70]

Topic 7

Biological concepts

Overview



What you will cover in Topic 7

Unit 1

Plant and animal cells

1.1 Basic concepts: cells, tissue and organs in living organisms

1.1.1 Cells

All living organisms are made up microscopic cells.

- Unicellular = consists of one cell (amoeba).
- Multicellular = consists of millions – billions of cells (humans)
- All cells have a cell membrane.
  - Inside the cell is a jelly-like fluid = cytoplasm.
    - Organelles are suspended in the cytoplasm.
    - Each organelle has a special function in the cell.

1.1.2 Tissue

A tissue is a group of cells that have the same structure and function.

- Animals are composed of tissue, such as nerve tissue and muscle tissue. Animals also contain blood, which is the only liquid tissue in animals.
- Plants contain different kinds of tissue, such as parenchyma and cork.

1.1.3 Organs

An organ = a group of tissues that have the same structure and function.

- Animals have organs, e.g. a heart, a brain, a stomach and a liver.
- Plants have organs, e.g. roots, stems, leaves and fruit.

1.1.4 Organisational levels of multicellular organisms

The relationship between cells, tissue and organs show how a multicellular organism is organised.

- The first level of organisation is the cell.
- The highest level of organisation is the organ.

1.2 Plant and animal cell structures

Plant and animal cells are alike in many ways, but there are some differences.

- Animal cells differ from one another, according to their own specialised function, for example, cells in liver tissue are different from cells in lung tissue.
- Plant cells differ from one another according to their function in the leaf, stem, root or flower.
- Cells also differ in size: from 2–15 micrometres in diameter (micrometre / micron, is one thousand times smaller than a mm: symbol = µm.)

Cells have three main parts or components:

- cell membrane (animals cells) / cell wall (plant cells)
- cytoplasm
- nucleus.

1.2.1 Cell membrane (animal cells)

- Also called the plasmalemma or plasma membrane.
  - made up of protein and fats.
  - very thin, with tiny pores that allow certain substances to go into or out of the cell = semi-permeable.

1.2.2 Cell wall (plant cells)

- Only plant cells have a cell wall = one of the main differences between plant and animal cells.
- The cell wall is situated outside the cell membrane.
  - The cell wall is not living tissue.
  - It is made up of cellulose.
- Each plant cell has a primary cell wall, but as the cell ages, each plant cell forms secondary and tertiary cell walls:
  - older cells have thicker walls than younger cells
  - with woody plants, the outer two cell wall layers contain lignin, which makes the cell wall rigid and solid.
- When secondary and tertiary cell walls form, no extra cellulose is deposited in certain places → known as pits.
  - The pits allow cytoplasmatic threads (plasmodesmata) to go through from one plant cell to the next. The cytoplasmatic threads (plasmodesmata) allow water, glucose and amino acids to pass from one cell to the other.
- Two plant cells are separated by another type of wall = middle lamella → made up of pectose.

1.2.3 Cytoplasm

- Cytoplasm is the jelly-like fluid content in the cell.
- The cytoplasm contains organelles: each has its own function.

1.2.4 The nucleus

The nucleus is the 'control centre' of a cell. It is situated in the centre of the cell.

- The nucleus is surrounded by a double membrane and nucleoplasma (fluid).
- The nucleus contains nucleoli. Each nucleolus contains RNA molecules that help with the production of proteins.
- The nucleoplasma contains the chromatin network, which contains the DNA of the cell. DNA contains the hereditary material of the cell and determines what the cell looks like. The chromatin network plays a very important role during cell division.

1.2.5 Cell organelles and their main functions

The cytoplasm of animal and plant cells has various organelles suspended in them:

- Endoplasmic reticulum (ER)
- Ribosomes
- Mitochondrion
- Golgi apparatus
- Lysosomes
- Plastids
- Vacuoles

Endoplasmic reticulum (ER)

Endoplasmic reticulum (ER) = a network of fine membranes that look like tubes. These tubes connect the cell membrane with the outer membrane of the nucleus.

- The ER is a transport system inside a cell.
  - Different substances move through the ER inside of the cell.
- Sometimes there are small particles on the surface of the ER → called ribosomes.
  - ER with ribosomes is called ribosomal ER or 'rough ER'.
- Sometimes there are no ribosomes on the ER.
  - The ER is then called 'smooth ER'.

Ribosomes

- Ribosomes are found on the surface of the ER.
- Some ribosomes can occur in small groups in the cytoplasm.
  - Such ribosomes are called polyribosomes ('poly' = many).
  - They consist of RNA and contain enzymes.
  - They use the enzymes to make proteins out of amino acids.

- The mitochondrion is the 'powerhouse' of a cell.
- The process of respiration takes place inside the mitochondrion.
  - During this process, molecules that contain energy are broken down and the energy is released.
  - The cell can use the energy to perform different functions.
  - Cells that need more energy (e.g. cells is muscle tissue) have much more mitochondria than cells that do not need much energy.
- Mitochondria have an oval or sausage shape.
- Their walls consist of two membranes:
  - the inner membrane and the outer membrane.
    - The inner membrane has folds → called cristae.
    - Respiration takes place on the surface of the cristae.
    - The space between the two membranes is filled with liquid.

Golgi apparatus

Golgi apparatus = a collection of membranes stacked on top of one another (like pancakes).

- Golgi apparatus is normally situated close to the nucleus and works closely with the endoplasmic reticulum.
- The Golgi apparatus modifies proteins and brings them to the cell surface where they can be secreted.
  - Secretions include hormones, enzymes, antibodies and other molecules.
  - Cells that have a secretory function, for example gland cells, contain more of these organelles than other cells.

Lysosomes

- Similar to mitochondria.
- Sac-like structures that have two membranes.
- More often found in animal cells than plant cells.
- Liver cells contain many lysosomes.
  - Lysosomes contain various enzymes that help with the digestion of large molecules, such as protein.
  - These enzymes are responsible for the destruction of old cells.
    - This is known as autolysis.

Plastids

- Only appear in plant cells.
- They vary in size and can be round, oval or disc-shaped.
- There are three types of plastids:
  - Chloroplasts: in the cells of all the green parts of a plant → contain chlorophyll, which gives plants their green colour. Chloroplasts are oval in shape and are surrounded by a single membrane. They also have an inner membrane. Photosynthesis takes place in the chloroplasts.
  - Chromoplasts: Chromoplasts are responsible for the red, orange and yellow colour of many flowers, fruits and autumn leaves. Often called the 'colour plastids'. The colour is produced by a number of pigments. The most important pigments = carotenoids and xantophylls. Chromoplasts are important because:
    - bright colours of flowers attract insects for pollination
    - bright colours of fruits attract insects and animals that help in the distribution of seeds
    - animals produce vitamin A from the carotenoids that they eat.
  - Leucoplasts: plastids that contain no colour or chlorophyll. They only appear in cells that are not exposed to sunlight (e.g. the cells in the roots and seeds of plants). If leucoplasts are exposed to sunlight, they change into chloroplasts and start to produce chlorophyll (e.g. potatoes that start to turn green if they are exposed to sunlight). The main functions of leucoplasts = store nutrients (such as starch) and to manufacture oils and some proteins.

Vacuoles

Vacuoles are hollow spaces in the cytoplasm filled with a watery fluid called cell sap.

- Occur in plant and animal cells, but are more well-developed in plant cells.
- Older cells have larger vacuoles than younger cells. Eventually, the vacuoles join to form one large, central vacuole.
- The tonoplast, a cytoplasmic membrane, surrounds the vacuoles. The cell sap consists of water, in which substances like sugars, salts, pigments and gases are dissolved.

1.3 Differences between a plant cell and an animal cell

Difference between plant and animal cells		
Factor or part	**Plant cell**	**Animal cell**
General appearance	Large, with distinct boundaries	Smaller, with indistinct boundaries
Cell boundary	Distinct cell wall of cellulose present on both sides of the middle lamella Contains plasmodesmata	No cell wall; only a living cell membrane No plasmodesmata
Space between cells	Usually present	None
Lysosomes	None	Contains lysosomes, especially liver cells
Plastids	Occur commonly	None
Vacuoles	Common in plant cells. Occupies the largest part of the cell	Much smaller, not always clear
Starch grains	Usually occur	None; contains oil globules
Protein	Usually none	Usually occurs

The differences between an animal cell and a plant cell

Unit 2

Cell division

2.1 The importance of cell division

Cell division is perhaps the most important process in living cells.

- All living creatures (unicellular or multicellular) begin life as one cell (zygote).
- Almost immediately, this cell divides to form two cells (multicellular).
- The two cells divide to form four cells, and so on.
- Cell division takes place throughout the life of any living organism to:
  - repair damaged cells
  - grow
  - reproduce.

The study of cell division is very important:

- helps to find a cure for diseases such as cancer, because cancer is the uncontrollable division of cells.
- has enabled scientists to perform artificial insemination of cattle, as well as cloning.

2.2 The concept of cell division

During cell division, a cell divides to form two cells. This means that information about the characteristics of the 'mother cell' must be passed on to the two 'daughter cells'.

- Hereditary information is contained in the DNA (deoxyribonucleic acid) of the cell.
  - The DNA and proteins are the chromatin network of the cell.
  - When cell division is about to begin, the chromatin network forms tightly coiled strands, called chromatids.
  - Two such chromatids are joined by means of a centromere to form a chromosome.
  - Chromosomes are a very important part of cell division.
- The cytoplasm and cell membrane of the cell must also divide. This happens during the process of cytokinesis.

2.3 Types of cell division

2.3.1 Mitosis (in all body cells)

Each living cell grows until it reaches its maximum size. Then the adult cell (or 'mother cell') divides to form two new cells (or 'daughter cells'). In this way, new cells are formed that are necessary for growth and for replacing old cells.

There are four phases to mitosis:

- prophase
- metaphase
- anaphase
- telophase.

The prophase (first phase)

- The cell membrane starts to break down
- The chromatin network starts changing. The threads become shorter and thicker and are now called chromatids.
- Two chromatids are joined by a centromere to form a chromosome.
    - Each different species has a certain number of chromosomes.
        - The human body has 46 chromosomes in each cell.
- The nuclear sap changes from a fluid to a gel
- Larger cell structures, such as the plastids (plant cells) and mitochondria disappear.
- The nucleolus disappears.
- Spindle threads start forming in the cytoplasm.

Metaphase (middle phase)

- First, the chromosomes start arranging themselves so that the centromeres are along the middle of the cell (or 'equator')
- Then, some spindle threads stretch from one end (or 'pole') of the cell to the other (continuous spindle threads).
- Other spindle threads are attached to the chromatids and are called chromosomal spindle threads.'

Anaphase (separation phase)

- The centromere of each chromosome divides into two equal parts.
- The two chromatids of each chromosome start moving away from each other towards the opposite poles, pulled along by the chromosomal spindle threads.
- As soon as the chromatids start to divide, they are known as daughter chromosomes.

Telophase (two new nuclei form)

- The spindle threads disappear.
- A nuclear membrane begins to develop around the chromosomes at each pole
- The chromosomes become thinner and lengthen → become the chromatin network of each of the two new cells
- A nucleolus appears in each nucleus
- In plant cells, the cell wall starts developing at the equator. In animal cells, a constriction starts → will eventually lead to the separation of the daughter cells
- At the end of this phase, the mother cell has divided into two identical halves. The chromosomes of the new daughter cells are exactly the same as those of the mother cell from which they formed.
- The cells have now reached the interphase.

- Between two episodes of mitosis, the cell rests and prepares for the next episode of mitosis. Mitoses and the interphase make up the cell cycle.

The importance of mitosis

- The zygote cannot grow without the process of mitosis.
- New cells must continuously be made to replace old cells.
  - This cannot take place without mitosis.
- Mitosis ensures that the daughter cells are identical to the mother cell.
  - During mitosis chromosomes are duplicated, so the genetic material of the mother cell is also duplicated.
  - The two daughter cells are identical to each other, but also to the mother cell from which they developed.

2.3.2 Meiosis

- Each species has a definite, specific number of chromosomes, for example:
  - Humans have 46 chromosomes (23 pairs) in each cell
  - Horses have 64 chromosomes (32 pairs) in each cell
  - Sheep have 54 chromosomes (27 pairs) in each cell.
- Meiosis takes place in sex cells (also called gametes), and not in other body cells.
- During meiosis, the number of chromosomes is halved.
  - So each male sex cell (sperm cell) and female sex cell (ovum or egg cell) only contains 23 chromosomes each.
  - When a sperm cell fertilises an egg cell, the zygote that forms has 46 chromosomes.
  - If the number of chromosomes in a sex cell were not halved during meiosis, the zygote would have 92 chromosomes, instead of 46 chromosomes.
    - Therefore, during meiosis, a diploid set of chromosomes (2n) is reduced to a haploid set of chromosomes (n).
    - This ensures that the zygote that is formed as a result of fertilisation has a diploid set of chromosomes → keeps the number of chromosomes the same from one generation to the next.

Meiosis occurs in two stages that follow one another in rapid succession.

First meiotic division

The phases of division are described by the same names as with mitosis.

Prophase

The prophase of meiosis is more complicated than that of mitosis. With meiosis:

- The nuclear membrane and the nucleolus disappear.
- Spindle threads form and meet at the poles of the cell.
- The chromatin network shrinks and the chromosomes become visible as separate threads.

- The chromosomes synapse (or combine) in homologous pairs.
  - Homologous pairs are pairs of the same chromosome.
    - Each chromosome then forms a bivalent (also known as a tetrad).
    - A bivalent is a homologous pair of chromosomes that is wound around each other. In other words, a bivalent is two chromosomes with two centromeres.
- The chromosomes then shrink and become thicker.
- Each chromosome of the bivalent then unravels lengthwise to become two chromatids, so that each bivalent contains four chromatids. The centromeres do not divide.
- Now a crossing over process takes place between chromatids at points called chiasmata. Chromatids break and rejoin, so that each chromatid joins to its homologous partner. Crossing over allows the chromosomes to exchange genetic material, allowing for more different combinations of genetic material.

Metaphase

- The bivalents arrange themselves on the equator of the cell.
- The two centromeres of each bivalent are on either side of the equator.

Anaphase

The two chromosomes of each bivalent move to opposite poles.

Telophase

- First, the chromosomes regroup at the poles. Each of the chromosomes consists of two chromatids joined together by a centromere.
- Next, two separate cells develop, each with only half the number of chromosomes of the parent nucleus.

Second meiotic division

- The second meiotic division happens just after the first meiotic division (separating the two chromatids of each chromosomes)
- The second meiotic division is usually the same as ordinary mitosis, except that the prophase is of very short duration.
  - Therefore, the second meiotic division actually only really starts with metaphase.

Prophase II

- No significant changes take place in the chromosomes.
- The DNA in the cell does not replicate.
- Nuclear membrane and nucleolus disappear.
- Asters and spindle fibres are formed.

Metaphase II

The chromosomes arrange themselves along the equator of the cell, forming a single metaphase plate (as in mitosis).

Anaphase II

- Each centromere divides.
- The two daughter chromatids of each chromosome move to opposite poles of the cell.
- Finally, they reach the poles of the cell. Each pole now has haploid number of chromosomes and half the amount of DNA.

Telophase

- At the poles, the daughter chromosomes form a new chromatin network.
- The nuclear membrane and nucleolus reappear.
- In plant cells, a cell plate is formed along the equator. In animal cells, a constriction appears.
- The mother cell has now divided into four cells that are all different from the mother cells and from each other.

The importance of meiosis

- Meiosis reduces the diploid number of chromosomes to a haploid number. This ensures that the number of chromosomes of an organism stays constant from one generation to the next.
- Meiosis makes the exchange of chromatin segments possible, thereby mixing genes. If this did not happen, parents and children – as well as siblings in a family – would have been almost like clones of one another.

2.4 The differences between mitosis and meiosis

The table below shows the differences between mitosis and meiosis.

Differences between mitosis and meiosis

Mitosis	Meiosis
Takes place in somatic cells (cells in the body)	Takes place in the sex cells (gametes)
One division of the mother cell gives two daughter cells, identical to one another and the mother cell	Two divisions of the mother cell give four haploid gametes, each different from one another and the mother cell
Number of chromosomes in the nucleus of mother and daughter cells remain the same	Mother cell has a diploid (2n) number of chromosomes. The four gametes are all haploid (n). Therefore, the number of chromosomes in the mother cell is halved.
No pairing of homologous chromosomes	During prophase of the first meiotic division, pairing of homologous chromosomes takes place
No crossing-over between chromosomes	Crossing-over takes place
Centromeres split during anaphase	Centromeres only split during anaphase of the second meiotic division (and not during the anaphase of the first meiotic division)
The daughter cells have exactly the same genetic make up as the mother cell	The gametes have different genetic material than the mother cell

The differences between mitosis and meiosis

Topic 7

Topic questions

Topic 7: Questions

- Answer the questions below.
- Give yourself one hour.
- Check your answers afterwards and do corrections.

1 Draw a diagram of a plant cell with its main components. (8)

2 What are the following called? (5)

   a Cytoplasmic threads in plant cells.

   b The separating wall between two plant cells.

   c The jelly-like fluid content in the cell.

   d Ribosomes that occur in small groups in the cytoplasm.

   e The watery fluid in vacuoles.

3 State where plastids occur, give a brief description of the three types and state the function of each. (9)

4 What is the function of the cytoplasmic threads? (3)

5 Draw a diagram of a plant cell and name all the parts. (20)

6 What are the three main functions of cell division in a living organism? (3)

7 Describe the process that takes place during the prophase of mitosis. (8)

8 What are the differences between meiosis and mitosis? (14)

[Total marks: 70]

Answers to questions

TOPIC 1

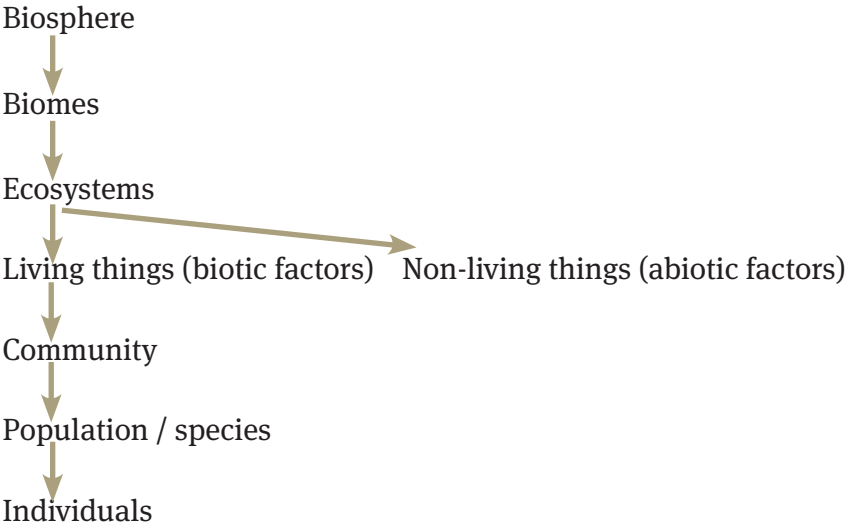
QUESTION 1 (2)

Ecology is the study of all the relationships between living organisms and the environment in which they lives

QUESTION 2 (3)

An agro-ecosystem is an ecosystem that consists of agricultural plants and animals.

QUESTION 3 (8)

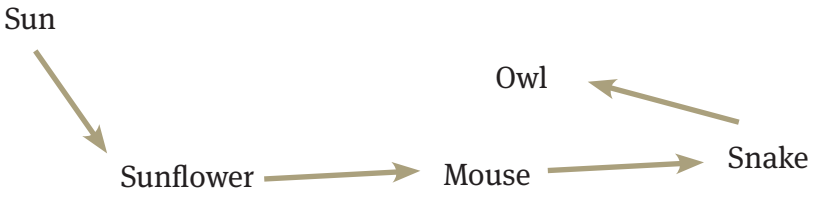


QUESTION 4 (12)

Slope: This refers to the steepness of the land. The steeper the slope, the more runoff occurs: not much plant life can be supported.
Aspect: The direction in which the slope faces. In the southern hemisphere, north-facing slopes are hotter and drier as they receive more sunlight. This influences plant life.
Altitude: The height of the land above sea level. Temperature decreases with increasing altitude. This affects plant and animal life.

Answers to questions

QUESTION 5 (5)



QUESTION 6 (15)

1 Competition: Organisms compete for limited resources (food, water, territory):
- Intraspecific competition: animals of the same species (e.g. two male lions) competing to mate with the same lioness.
- Interspecific competition: animals of different species (e.g. cheetahs and lions) competing for same prey.

2 Predator and prey: A predator (the animal that hunts) eats its prey (the animal that is hunted) e.g. a lion and an antelope.

3 Mutualism: Both organisms benefit from the relationship, e.g. ungulates and bacteria in intestines of cattle: bacteria produce cellulase (enzyme) that digests cellulose.

4 Commensalism: One organism benefits, the other doesn't, but is not harmed either, e.g. shark and remora.

5 Parasitism: One organism (parasite) lives on or within and feeds on another (the host). The parasite benefits, but the host is weakened, e.g. cholera virus.

QUESTION 7 (5)

- Ensuring soil has correct nutrient balance: the soil is tested for ten nutrients to determine the amount of nitrogen to be added.
- Ensuring that soil contains sufficient microbes for correct pH level (acidity and alkalinity).
- Using natural fertilisers, such as compost, as far as possible.
- No herbicides and pesticides.
- Rotating crops every year or two.

QUESTION 8 (3)

Animals eat the most palatable plants and leave the unpalatable ones. The result is that only the unpalatable plants remain and the veld becomes of little use for grazing farm animals.

QUESTION 9 (4)

Stocking rate (SR) is the number of animals that can graze on one hectare of land, for the grazeable part of one year, which excludes winter, without doing damage to the condition of the veld.

Answers to questions

QUESTION 10 (3)

Sweetveld; sourveld; mixed veld.

QUESTION 11 (10)

Plant desirability; plant diversity; plant density; plant vigour; legumes; severity of use; uniformity of use; soil erosion; woody canopy; plant residue.

QUESTION 12 (6)

Savanna; forest; grassland; fynbos; succulent Karoo; Nama Karoo.

QUESTION 13 (4)

Fires; industry; vehicles; power stations.

[Total marks: 70]

TOPIC 2

QUESTION 1 (5)

- The money earned by this sector of the economy
- Planning with regard to food security
- Population growth
- The International and local conditions
- Land issues
- Laws (Any five).

QUESTION 2 (12)

- Degradation of land: This is due to injudicious and unscientific farming methods and poor decisions about siting of cities, dams, etc. that use agricultural land. This results in damage to the soil, vegetation and water.
- Climate change: Global warming and climate change, due to massive release of carbon dioxide and other greenhouse gasses, has an impact on the productivity of agricultural land.
- Population increase and population shift: Population increase and urbanisation put pressure on the land and agricultural practices and production. To meet the expected growth in world's population by 2050, food production must rise by at least 70%, from a declining land area. Agriculture needs to use more scientific and sustainable methods of production, including more intensive production methods.
- Globalisation: It is becoming more important to produce more cheaply and efficiently to compete against imported products. Plants, animals and their products

are easily and quickly moved all over the world. This increases the introduction of diseases and parasites or unwanted weeds from one country to the next.
- Decreasing number of farms: There is a need for higher production. Small farms are being consolidated into bigger units.
- Urbanisation: Due to industrial development, urbanisation is speeding up. This leads to land and water pollution. (Any 4)

QUESTION 3 (10)

Due to urbanisation, and increase in wealth and education, people are more aware of healthy eating habits:
- Less fat and more fresh fruit and vegetables; white instead of red meat.
- The consumption of white meat has more than doubled.
- The consumption of red meat has declined by more than a third.
- The consumption of eggs has almost doubled.
- Protein intake per person per year has increased about 20%.
- There has been a shift from red meat to white meat and eggs.

QUESTION 4 (9)

- Private land: Private ownership or private tenure is by a titlehold and is a right protected by our Constitution. Private land may be used, bought and sold as the owner wishes, so long as other laws such as environmental laws are adhered to. A title hold of private property may be for three types of property: an urban residential site, a smallholding / agricultural holding and large land holdings (farms).
- State land: This is land held for the people by the government and is used for national parks, state run irrigation schemes and forestry. Only government departments or those with the permission of the government may utilise this land.
- Communal land: This is a form of state-owned land that has been allocated to certain communities in a form of leasehold tenure where the communities have certain rights administered by a traditional leader.

QUESTION 5 (6)

- the Basic Conditions of Employment Act, Act No. 75 of 97
- the Employment Equity Act, Act No. 55 of 1998
- the Skills Development Act and Skills Development Levy Act, Act No. 97 of 1998.
- the Communal Property Association Act, Act No. 28 of 1996
- the Extension of Security Tenure Act, Act No. 62 of 1997
- the Agricultural Products Standards Act, Act No. 119 of 1990
- the Marketing of Agricultural Produce Act, Act No. 47 of 1996
- the National Water Act, Act No. 36 of 1998
- the National Veld and Forest Fire Act, Act 84 of 1998 the Fencing Act, Act No. 31 of 1963

- the Conservation of Agricultural Resources Act, Act No. 43 of 1983
- the Subdivision of Agricultural Land Act, Act No. 70 of 1970
- the Conservation of agricultural Resources Act (CARA)
- the Meat Safety Act, Act No. 40 of 2000
- the Animal Diseases Act, Act No. 35 of 1984
- the Animal Health Act, Act No. 7 of 2000
- the Veterinary and Para-veterinary Professions Act, Act No. 19 of 1982
- the Genetically Modified Organisms Act, Act No. 15 of 1997
- the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, Act No. 36 of 1947
- the Medicines and Related Substances Act, Act No. 101 of 1965
- the Animal Protection Act, Act No. 71 of 1962
- the Societies for the Prevention of Cruelty to Animals Act, Act No. 169 of 1993. (Any 3)

QUESTION 6 (9)

1 Agricultural Research Council (ARC)
It is the main research institution in South Africa and aims at contributing to a better quality of life and to ensure resource conservation. It coordinates the agricultural research done by the state.

2 National Agricultural Marketing Council (NAMC)
Provide policy and strategy recommendations regarding marketing to DAFF
Improve the strategic position of SA in the global market
Supply information on the marketing of agricultural products.

3 Council for Scientific and Industrial Research (CSIR)
The main functions of the CSIR are research and technical innovation.

QUESTION 7 (8)

Scientific knowledge	Indigenous knowledge
Modern (couple of hundred years)	Old (thousands of years)
International	Local
Not necessarily suitable for African conditions	Developed in Africa for local conditions
Written and accurately recorded	Passed on by word of mouth (verbal)
Proven by scientific testing	Determined by observation
Accurate analyses and dosing	Dosing determined by trial and error
In some cases, may place stress on environment	Generally adapted to the environment
Suitable for mass production	Only suitable for sustainable harvesting

Answers to questions

QUESTION 8 (3)

- Hoodia gordonia (bitter ghaap)
- African potato (Hypoxis hemerocallidea / inkomfe)
- Cancer bush (phetola)
- Fever tea (Lippia javanica / inzinziniba)
- False paperbark (Albiza adianthofolio / umhlandlothi) (Any 3)

QUESTION 9 (8)

- An indication is given on where to look and what research to do to prove or disprove the claims.
- The gene pool has not been interfered with, so it is broader than that of 'developed' European breeds. This ensures the benefits of biodiversity are there when we need them. For example, it is only recently that the genes for resistance to ticks in indigenous cattle have been recognised and used in cross breeding to reduce the damage caused by ticks to our national herd.
- Local breeds are better adapted to our local environment, therefore they do better under local conditions and they have a less severe effect on the environment.
- The use of indigenous crops benefits biodiversity, counters malnutrition, and improves food security and soil fertility.

[Total marks: 70]

TOPIC 3

QUESTION 1 (5)

- Land: A small part of the Earth's surface can be used for agriculture. Only 12% of South Arica's land is suitable for agriculture. The increasing demand for food resulted in traditional farming methods being replaced with use of chemicals and fertilisers. These practices are non-sustainable as they lead to soil degradation.
- Water: Only about 0,036% of the total amount of water on the planet is found in surface water sources such as rivers, lakes and dams.
- SA's annual population growth rate is between 2% and 2,5%. This means that nearly a million more people per year need food, using the same amount of soil and water.

QUESTION 2 (6)

- Conserve the soil: so that rain does not wash it into rivers or dams, it is not blown by wind, and not polluted by chemicals (including fertiliser, herbicides and pesticides).
- Conserve water: check tanks for leaks, ensure it is not polluted by chemicals or animal waste.
- Manage animal waste on the farm: use it to enrich the soil.

Answers to questions

- Plan farm processes (e.g. ploughing and irrigation): to avoid negative impact on the environment and natural resources.

QUESTION 3 (6)

- Physical degradation: when the structure of the soil is damaged by wrong cultivation methods or ploughing when the soil is too wet or too dry.
- Biological degradation is caused by cuttings from unregistered nurseries, or illegally imported plants and seeds, spread of pests or pathogens, and by tilling and converting areas with natural vegetation to agricultural land.
- Chemical degradation is caused by the use of chemicals.

QUESTION 4 (5)

- Muddy water in streams and rivers
- Dams filled with mud
- Plants with bare roots
- Dust storms
- New soil deposits: water carries soil from higher ground to lower ground
- Pedestals
- Bare ground
- Deep cattle and footpaths. (Any 5)

QUESTION 5 (6)

Water quality is the physical, chemical, biological and aesthetic characteristics or properties of water, which determine its fitness for use and its ability to maintain the health of aquatic ecosystems.

QUESTION 6 (1)

It is where the available water is stored (surface or underground).

QUESTION 7 (10)

The water in rivers, etc. is in the liquid phase. Through evaporation, this water changes to the gas phase. Ice changes to water vapour through sublimation. Evaporation and sublimation use heat energy from the sun. The water vapour rises up into the atmosphere and cools down. When the vapour cools down, tiny drops of water form (condensation). The tiny droplets combine with one another to form clouds. When these droplets become heavy enough, they fall to the ground in the form of rain, snow, or hail (precipitation). Plants absorb water through their roots. The water moves up through the plant and evaporates from the leaves. The water in the air rises and forms clouds. The clouds produce rain and the cycle begins again.

Answers to questions

QUESTION 8 (10)

Method 1: stop soil erosion.
Method 2: pocketing water – make shallow pockets in the soil.
Method 3: end-of-season ploughing – at the end of the rainy season the soil is still moist; when the next rainy season starts, the soil is loose.
Method 4: no-tillage farming – crop remains form mulch; prevents evaporation and soil doesn't become compacted.
Method 5: preserving the plant cover to decrease water runoff and prevent soil compaction.

QUESTION 9 (4)

Agricultural pollution is the pollution of water, soil or air by agricultural activities.

QUESTION 10 (5)

Fertiliser; herbicides and pesticides; wrong irrigation practices; improper soil management; spillages.

QUESTION 11 (6)

The severity of a pollutant is determined by its:

- chemical nature – whether it is a salt, heavy metal, acid, etc.
- Its concentration – the higher the concentration, the more harmful it is.
- Its persistence – the longer it takes to break down, the more harmful it is.

QUESTION 12 (7)

Silage is fodder made from grass crops (e.g. maize, sorghum or alfalfa). The plant material is first allowed to ferment and stored for use when grazing is scarce. The process of making silage is called silaging or ensiling. During fermentation a liquid is formed, which contains nitric acid, which can pollute water sources and cause eutrophication.

[Total marks: 70]

TOPIC 4

QUESTION 1 (3)

Minerals from rocks; organic matter; living organisms that live in the soil.

QUESTION 2 (4)

Chemical weathering; eluviations; illuviation; organic decomposition.

Answers to questions

QUESTION 3 (5)

- It provides plants with anchorage
- It provides nutrients (minerals and water for photosynthesis)
- Soil is the habitat for soil micro- and macro-organisms
- Some soil particles are used for commercial purposes (e.g. glass)
- Clay soil can be used to prevent sunburn and for cultural decorations or clay pots
- It cleans water as it percolates to form spring water
- Soil prevents floods and drought by absorbing rainwater, storing it and releasing it later. (Any 5)

Question 4 (5)

- It is the 'life-force' of soil as it helps the soil retain moisture and encourages the formation of good soil structure.
- It helps to suppress diseases in the soil.
- The dark colour helps to absorb heat in the soil for microbial activities, seed germination and chemical reactions.
- Improves soil structure by binding loose soil and preventing soil compaction.
- Increases the water-holding capacity of the soil and prevents drainage and erosion.
- Has great cation holding capacity, which makes it very fertile.
- Has a lasting effect as a source of plant nutrients in the soil.
- Releases minerals stored in decomposable materials into the soil for plants. (Any 5)

Question 5 (4)

- Cultivation or tillage manually with farm tools
- Ploughing
- Adding bulky organic material
- Draining waterlogged areas.

Question 6 (6)

- Colour: the colour of a mineral, when powdered or scratched.
- Lustre: the way in which a mineral reflects light.
- Hardness, cleavage and fracture: Diamond is the hardest and talc is the softest mineral. Cleavage refers to the way minerals break. Minerals like Mica that break along smooth, flat surfaces have perfect cleavage. Minerals like quartz that break with curved, rough surfaces have fracture.

Question 7 (10)

Igneous rocks are formed when molten magma or lava cools and solidifies – usually during volcanic activity. If it is formed by the crystallisation of magma within the Earth, it is called intrusive rocks or plutonic rocks. Intrusive igneous rocks have very large

crystal sizes, because the cooling of magma deep in the interior of the Earth is much slower than the cooling process outside the Earths' crust (e.g. dolerite).

If the crystallisation of the magma takes place on the surface of the Earth, the igneous rocks are called extrusive or volcanic rocks. Extrusive rocks are fine-grained in texture because they cool down faster on the surface and there is not enough time for large crystals to develop, e.g. basalt

Question 8 (15)

- The primary process in physical weathering is abrasion. It is the disintegration of rocks without chemical change. However, chemical and physical weathering often go hand in hand, e.g. cracks due to physical weathering will increase the surface area exposed to chemical action. The chemical action of minerals in cracks can aid the disintegration process. The agents of physical weathering are wind and water.
- Strong winds have much energy that can carry soil particles in their way. These soil particles can hit the surfaces of exposed rocks with a strong force that can further remove particles from the rock surfaces. This is common in desert areas.
- Running water (e.g. streams and rivers) has the energy to carry loose stones downstream. The swiftness of the running water removes soil particles from the sides and the riverbed. Loose stones carried by the running water rub against each other, causing them to break into smaller particles. Strong sea waves carry and roll sea stones towards the beach. This causes abrasion.
- Temperature changes can cause weathering if there are extreme temperature variations.

Question 9 (3)

Dissolution / solution; hydration; hydrolysis.

Question 10 (7)

- S = Soil
- F = Factors
- P = Parent material
- R = Relief/topography
- Cl = Climate
- O = Organisms
- T = Time

Question 11 (3)

- Macro- and micro-organisms in the soil affect decomposition of waste materials to form soil.

- Animals like rats, mice and rabbits that burrow deep in the soil scratch parent materials to form soil.
- Droppings and beddings of animals decompose to form soil.

Question 12 (8)

1 Mineralisation is the release of organic compounds during decomposition of organic residues by oxidation to form soluble or gaseous chemical compounds. The chemical compounds may then take part in further soil processes or be utilised by plant life.

2 Humification is the process whereby the carbon of organic residues is transformed and converted into humic substances (humus) through biochemical processes.

3 Leaching is the removal of soluble nutrients from an upper soil horizon to a lower soil zone beyond the reach of roots of plants.

4 Luviation is the movement of soluble minerals or colloidal suspension (substances with large molecules) from one place to another within the soil. Soil horizons that:
   - lose materials through luviations are called the eluvial layer
   - receive material are the illuvial layer.

5 Gley soil is formed in waterlogged areas where there is little oxygen in the soil. The grey colour is the result of the reduction, under anaerobic conditions, of ferric iron to the ferrous state.

6 A plinthite formation is a highly weathered mixture of clay with quartz and other diluents.

7 Inversion: Human activities, e.g. ploughing tilling, contribute to soil inversion: the topsoil is fully turned upside down. Inversion buries weeds deep in the soil.

8 Bioturbation: The churning of soil by organisms and plants roots – organisms (e.g. earthworms) and burrowers (e.g. moles, rats, rabbits) dig deep into the soil and push subsoil to the soil surface. This leads to a change in the composition of the soil. (Any 4)

[Total marks: 70]

TOPIC 5

Question 1 (12)

Twelve thousand years ago our ancestors were nomadic hunter-gathers who relied on the natural environment for all their resources. There were no cities, towns or farms, and no farm animals. In what is today the Middle East, they first developed a relationship with the grey wolf.

Answers to questions

Some of the tamer cubs became permanent companions of humans. They were useful as they guarded families and helped with hunting. By keeping the tamest wolves and allowing them to breed with each other, humans gradually created a new species of animal: the domestic dog. Through selection and breeding, humans selected the genes for tameness. From this ancestral dog, the 400 dog breeds that exist today have been bred by selecting them for various physical and behavioural characteristics. This was the beginning of animal domestication.

Our ancestors started settling down and cultivating crops. They used the same method that they used on wolves for taming, selecting and breeding other wild animals. This caused physical and behavioural changes that made these animals suitable for farming. From these animals we derived sheep, goats, cattle, horses, pigs and poultry.

As humans migrated to various parts of the world, they took their domestic animals with them. The wild animals of southern Africa were not found to be suitable for domestication, but when the Khoekhoe migrated southwards they brought their cattle and fat-tailed sheep with them. African migrations brought the ancestor of Nguni cattle. The Dutch brought pigs with them in 1652, and since then various breeds of livestock have been imported, which have been cross-bred with existing stock for increased production.

Question 2 (2)

- It provides employment.
- The products earn farmers and the country money in foreign currency.

Question 3 (4)

Ruminants are unable to digest their food themselves. Their stomachs are divided into four parts, in which micro-organisms break down the cellulose in the plant material. They regurgitate their semi-digested food for chewing into finer particles. Rumination allows the material to be broken down further so the micro-organisms can digest the plant fibre more effectively.

When the micro-organisms have broken down the plant matter, the stomach content moves down into the intestines where the absorption of nutrients occurs.

Non-ruminants are monogastric, which means they have one simple stomach, in which food is digested.

Answers to questions

Question 4 (10)

Species and alternate terminology	Adult male	Young male	Castrated male	Adult female	Young female	Young
Cattle (bovine)	bull	**steer**	ox (plural oxen)	cow	**heifer**	calf
Sheep (ovine)	ram	–		ewe	–	lamb
Goats (caprine)	ram/buck	–	**wether**	doe/nanny	–	**kid**
Pigs (porcine, swine, hogs)	**boar**	–	**barrow**	sow	**gilt**	piglet
Horses (equine)	stallion	colt	gelding	mare	filly	foal
Donkeys	**jack**	colt	gelding	**jenny**	filly	foal
Chickens	rooster	–	**capon**	hen	–	chick

Question 5 (8)

1 Bos indicus (African type) also called zebu.

- Originated in South Asia, possibly in India.
- Also known as humped cattle, as they are characterised by a fatty hump on their shoulders, as well as by drooping ears and a large dewlap (a loose fold of skin hanging under the throat).
- Well adapted to hot, arid climates: hump helps in the storage of water, loose skin helps in heat dissipation, and they have sweat glands all over their bodies.
- Fairly resistant to African diseases and parasites.
- Farmed throughout the tropics, for beef, dairy and as draught oxen.

2 Bos taurus (European type) or taurine cattle.

- Originated in Europe, northeastern parts of Asia and some parts of Africa.
- Thrive in cooler climates, they are not adapted to hot, dry places as they do not have humps or dewlaps.
- Usually have their sweat glands on their noses.
- Vary in size and body structure, depending on the uses for which they were bred. Some are plump and round, others lean and angular.
- Seldom used for draught.
- Beef breeds produce meat of a very good quality, and dairy breeds produce plentiful milk; they do better on good quality food.
- Tend to be susceptible to drought and African diseases.

(Any 3 characteristics of each)

Answers to questions

Question 6 (5)

Bulls should have a large frame size, with a compact, block-like conformation, good depth, muscular straight shoulders and well-developed hindquarters. They should stand squarely on four strong feet with well-structured legs to ensure easy gait over long distances. They need good reproductive soundness and efficiency. A bull should be able to produce 50 calves per year. (Any 5)

Question 7 (3)

Holstein-Friesland; Jersey; Guernsey; Ayrshire. (Any 3)

Question 8 (4)

Mutton breeds; wool breeds; dual-purpose breeds; pelt breeds.

Question 9 (6)

1 Savanna goat
- White savannahs have short white hair, floppy ears and backward curving horns.

2 Boer goat
- Usually white with brown heads.
- Floppy ears and backward curving horns.
- Heavily built, full-grown bucks weighing roughly 120 kg and does 90 kg.

3 Kalahari Red
- Reddish colour, with a short shiny hair coat.
- Floppy ears and backward curving horns

(Any 2)

Question 10 (6)

1 Large White
- Very large, sturdy pink-coloured pig with a thin, white hair coat.
- A characteristic head with a short snout, dished face and erect ears.
- The sows are good mothers.
- Less susceptible to stress than the Landrace.
- It is the breed most used in intensive systems.

2 Landrace
- Originated in Denmark and was then improved by breeders in the USA.
- It is a white pig with a long body and flatter back than most other breeds. It has a long, narrow head, smooth jowls and large heavy ears. The rump is long and meaty and the hams are plump.
- It is the second most numerous breed, and is used in crosses with the Large White.

Answers to questions

Question 11 (4)

Housing; management; breeding; nutrition.

Question 12 (4)

- Game numbers have increased in South Africa since 1850, which means that the biodiversity of the country has increased.
- Game farming generates income from breeding of rare species, local hunting, trophy hunting and eco-tourism, and from meat production.
- The average game ranch is 983 ha, with an economic output of R220/ha compared with R80/ha on conventional stock farms.
- Three times more staff is employed on game ranches than on livestock farms.
- The gross income from wildlife ranching annually in South Africa is R7,7 billion compared with the poultry (R20 billion) and red meat (R18 billion) industries.
- South Africa imports about R2 billion red meat annually. Game meat production could therefore contribute to food security. (Any 4)

[Total marks: 70]

TOPIC 6

Question 1 (1)

13,5%

Question 2 (10)

Maize (48,6%); sugar cane (14,2%); wheat (12,5%); sunflower seed (6,7%); hay (6,0%).

Question 3 (5)

- Oxygen is by-product of photosynthesis.
- Most of the food that we eat comes from plants.
- Plants are used as medicines.
- Plants have aesthetic importance: decoration and aroma.
- Plants roots reduce runoff and increase the rate of water entry into the soil.
- The leaf canopy of plants, like trees and shrubs, break the impact of raindrops on the soil surface, and the roots of plants bind the soil to prevent soil erosion.
- Grasses are used for roofing in the rural areas.
- Wood is used for sculptural and carpentry designs; for buildings and furniture; gums, paper and rubber.
- More recently, fuels and gases, like diesel and ethanol, are being made from plants.
- Plants are a source of fuel in the rural areas (wood for cooking fires).
- Coal is obtained from decomposed plants. (Any 5)

Answers to questions

Question 4 (15)

a True
b True
c True
d True
e False
f True
g True
h False
i True
j False
k True
l True
m False
n True
o True

Question 5 (4)

Herbaceous field crops / grains, forages, oilseeds, and fibre crops.

Question 6 (10)

1 Root vegetables (e.g. beetroot, carrots)
2 Leaf vegetables (e.g. cabbage, spinach)
3 Stem vegetable (e.g. potato)
4 Fruit vegetables (e.g. tomato)
5 Flower vegetables (e.g. cauliflower)

Question 7 (3)

- Medium to high temperature ranges from 22–35°C.
- An even rainfall distribution range of 9–105 mm per month.
- Rich loamy soil with a lot of organic matter.

Question 8 (3)

Fynbos, garden flowers and cut flowers.

Question 9 (5)

- Use scarce water resources
- Take over most of our arable land
- Increase bush fires

- Cause soil erosion
- Pollute water and affect aquatic life.

Question 10 (10)

- Mechanical control: removing the invasive plants by physically uprooting them, slashing, mowing, ring-striping or bark-striping them.
- Chemical control: the application of registered herbicides to the invasive plants or to the soil surrounding them with the aim of killing them.
- Biological control: the use of host-specific natural enemies to reduce the population of the invasive plant to the barest minimum.
- Indirect control: the use of other methods that do not directly control the plants, but involves measures like the use of fire, checking entry ports for introduction of alien crops and over sowing beneficial plants at areas infested by alien crops.

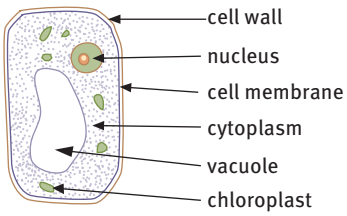
Question 11 (4)

- Legume fodder crops, e.g. lucerne or red clover
- Grass fodder crops, e.g. kikuyu or rye.

[Total marks: 70]

TOPIC 7

Question 1 (8)



Question 2 (5)

a Plasmodesmata
b Middle lamella
c Cytoplasm
d Polyribosomes
e Cell sap

Question 3 (9)

1 Chloroplasts: Occur in all the green parts of a plant: contain chlorophyll, which gives plants their green colour. Photosynthesis takes place in the chloroplasts.
2 Chromoplasts: Chromoplasts are responsible for the red, orange and yellow colour of many flowers, fruits and autumn leaves.

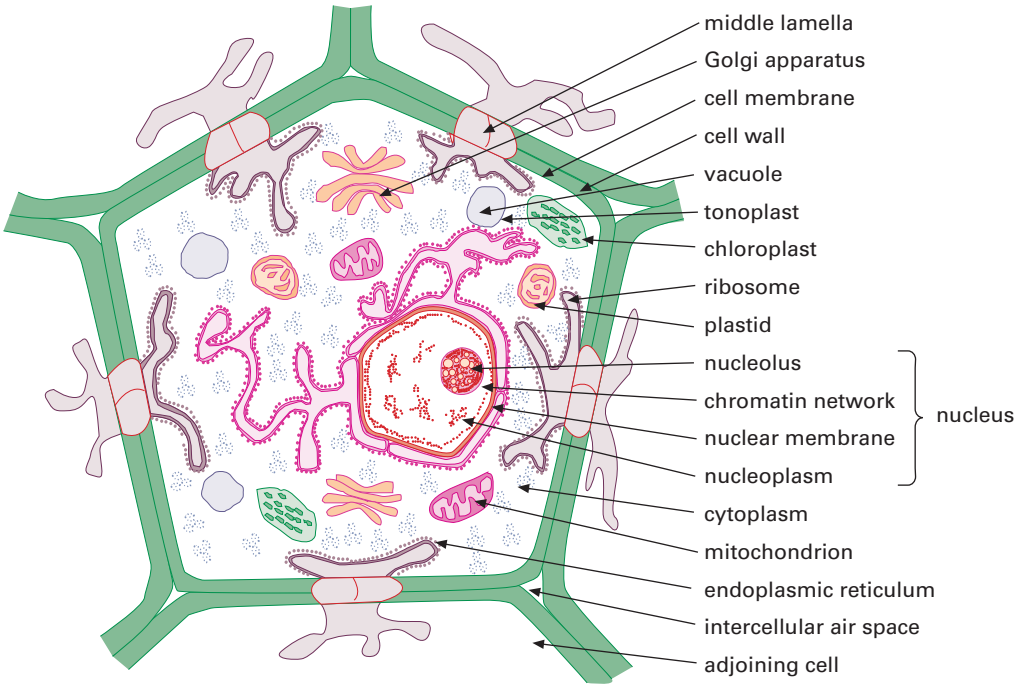
Answers to questions

3 Leucoplasts: Plastids that contain no colour or chlorophyll. They only appear in cells that are not exposed to sunlight, for example the cells in the roots and seeds of plants. The main functions of leucoplasts are to store nutrients (such as starch) and to manufacture oils and some proteins.

Question 4 (3)

They allow water, glucose and amino acids to pass from one plant cell to another.

Question 5 (20)



Question 6 (3)

- Repair damaged cells
- Growth
- Reproduction

Question 7 (8)

Prophase (first phase)

- The cell membrane starts to break down.
- The chromatin network starts changing. The threads become shorter and thicker and are now called chromatids.
- Two chromatids are joined by a centrometre to form a chromosome.
- The nuclear sap changes from a fluid to a gel.
- Larger cell structures, such as the plastids (plant cells) and mitochondria disappear.

- The nucleolus disappears.
- Spindle threads start forming in the cytoplasm.

Question 8 (14)

Mitosis	Meiosis
Takes place in somatic cells (cells in the body)	Takes place in the sex cells (gametes)
One division of the mother cell gives two daughter cells, identical to one another and the mother cell	Two divisions of the mother cell give four haploid gametes, each different from one another and the mother cell
Number of chromosomes in the nucleus of mother and daughter cells remain the same	Mother cell has a diploid (2n) number of chromosomes. The four gametes are all haploid (n). Therefore, the number of chromosomes in the mother cell is halved.
No pairing of homologous chromosomes	During prophase of the first meiotic division, pairing of homologous chromosomes takes place
No exchange of DNA (crossing-over) between chromosomes	DNA exchange (crossing-over) takes place
Centromeres split during anaphase	Centromeres only split during anaphase of the second meiotic division (and not during the anaphase of the first meiotic division)
The daughter cells have exactly the same genetic make up as the mother cell	The gametes have different genetic material than the mother cell

Exam Papers

GRADE 10 FINAL Agricultural Sciences EXAMINATION

AGRICULTURAL SCIENCES Paper 1 100 marks
TIME: 2 HOURS

SECTION A

QUESTION 1

1.1 Various options have been given as answers to the following questions. Choose the correct answer and write only the letter (A – D) next to the question number in the ANSWER BOOK.

1.1.1 Hot deserts are regions where evaporation of water is ____ the rainfall.
A lower than
B higher than
C similar to
D double.

1.1.2 Animals living in the grass tundra have adapted to the very cold conditions in a variety of ways. Indicate which of the adaptations below would be the most effective adaptation:
A A thick layer of fat below the skin
B Growth of dark coloured fur / pelts
C Thin pelts to help regulate body temperature
D Eating large volumes of food.

1.1.3 Typical savannah vegetation is _____
A proteas.
B short grass with shrubs
C tall grass with small deciduous trees.
D indigenous forests.

1.1.4 The practice of keeping/breeding animals under natural conditions in a certain ecological environment, is called _____ production.
A natural livestock
B intensive livestock
C cattle
D extensive livestock

1.1.5 A cattle breed that has a thick hide that makes it difficult for lice or ticks to penetrate the skin is the _____
A Afrikaner.
B Hereford.
B Drakensberger.
C Jersey.

1.1.6 Reasons for the development of new breeds and plant cultivars:

A Adaptation
B Higher production
C Better quality
D All the above-mentioned

1.1.7 An example of a plant that can survive in dry/arid environmental conditions and which is mostly found growing on northern slopes, is called a/an _____

A sciophyte.
B xerophyte.
C hidrophyte.
D epihypte.

1.1.8 A dormant stage of animals in winter months is called _____

A estivation.
B hibernation.
C precipitation.
D astrophication.

(8 x 2) (16)

1.2 Give ONE-word answers for each of the statements or explanations below:

1.2.1 A farmer that grows just enough food for the family to live on

1.2.2 The practice of growing the same crop in the same soil continuously

1.2.3 A plant family that fixes nitrogen in the soil

1.2.4 Returning plant residues to soil to provide nutrients

1.2.5 The cattle breed that adapted to the African continent over the centuries

1.2.6 The practice where different breeds are interbred to develop a new breed

1.2.7 The increase of a country's population that results in the need for greater food production

1.2.8 The dairy breed that produces the highest butter fat in milk

(8)

1.3 Choose an item/word from COLUMN B that matches the description/item/word in COLUMN A.

COLUMN A	COLUMN B
1.3.1 Natural resources 1.3.2 Subtropical fruits 1.3.3 Symbiosis	A contains living organisms B type of top soil, depth, locality C restricts agricultural production D exploitation E bananas, mangoes, litchis F interaction between organisms

(3 x 2) (6)

1.4 Each of the following sentences consists of TWO statements. Choose the correct statement as follows:

- If the 1st statement is TRUE write A
- If the 2nd statement is TRUE write B
- If both statements are TRUE write C

1.4.1	Government plays an important role in developing links with other countries	because	it negotiates trade agreements to ensure good markets for businesses.
1.4.2	An ant and plant lice are examples of mutualism	because	in mutualism one individual derives benefit and the other not.
1.4.3	People can produce food for themselves	because	they are directly dependent on agricultural activities for their food.
1.4.4	Lucerne is not capable of binding nitrogen	because	it contains no nitrogen fixing bacteria.

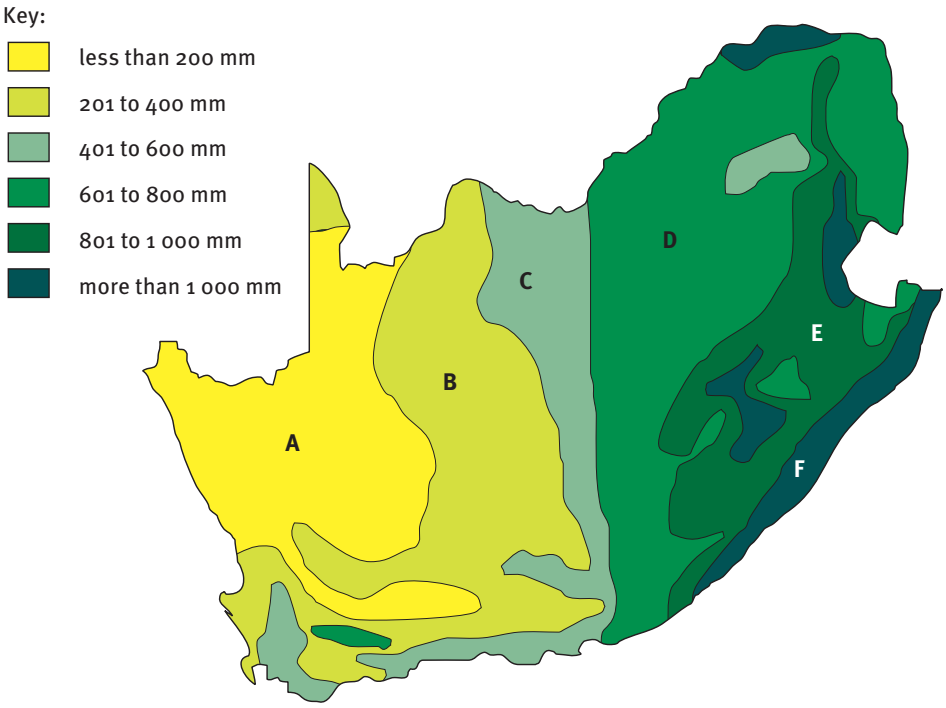
(5 x 2) (10)

TOTAL SECTION A: 40

SECTION B

QUESTION 2

2.1 Study the distribution of rainfall in South Africa as shown in the map and key that accompanies the map.



2.1.1 Indicate what regions (A to F) would be more likely to have these individual rainfall figures. (Write down the LETTERS with the appropriate rainfall figures in the answer book.)

(6)

2.1.2 Identify the region as indicated below.
(a) Region D
(b) Region B

(2)

2.1.3 In which region would one find:
(a) Succulent plants
(b) Subtropical rainforests

(2)

2.2

2.2.1 Explain what the difference is between the following:
(a) Sour veld
(b) Sweet veld. (2 x 2) (4)

2.2.2 Name the TWO abiotic factors that determine the type of veld found in the different ecological regions of South Africa. (2)

2.3 Read the following paragraph and answer the questions that follow:

The San People

The San are the oldest inhabitants of Southern Africa. They are a group of about 100 000 people who know a lot about the plant and animal life of the Kalahari and have learnt how to survive in this harsh environment. They are hunter-gatherers by tradition and have excellent animal tracking and hunting skills. Many of them have been forced off their lands to live in settlement areas where they are unable to hunt or gather food.

The San discovered that the Hoodia succulent cactus plant prevented them from getting hungry and thirsty – very useful when on long hunting journeys. Their indigenous knowledge is now being used to produce a drug for dieting. The San people are very poor and would like to be paid by the drug companies that are using their knowledge.

2.3.1 Name THREE systems of farming used in South Africa today. (3)

2.3.2 The San migrated to gather food. What sort of food did they eat traditionally? (2)

2.3.3 Why do you think did the San people lose their habitat? (1)

2.3.4 What Act did the government put in place to redress the imbalances of land ownership of the past? (1)

2.3.5 Give TWO reasons for modern day migration, away from rural areas. (2)

2.3.6 The San's indigenous knowledge is being put to use by producing a secondary industrial product. Name this product. (2)

2.4 Developing secondary industries is a natural process in meeting the demand of communities. Indicate what raw materials were used to produce the following products:
2.4.1 Wine
2.4.2 School shirts
2.4.3 Bacon
2.4.4 Bread (4)

2.5 During each wet or dry cycle that occurs every seven to nine years, South Africa received an above or below average rainfall just as was experienced in Mozambique a few years ago. These weather phenomena have a devastating effect on agricultural production. Name and give the reasons for each of these weather phenomena:

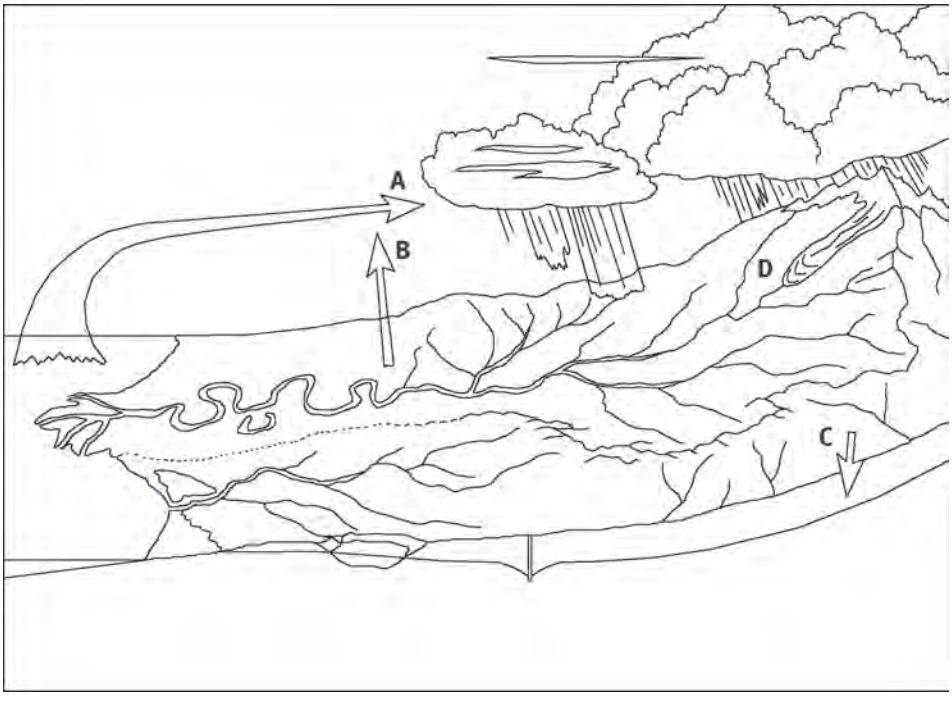
2.5.1 The dry period in a wet cycle

2.5.2 The above average rainfall or even floods (2 x 2) (4)

[35]

QUESTION 3

3.1 Study the water cycle illustrated below and answer the questions that follow:



3.1.1 What is indicated by the letters A to D. (4)

3.1.2 Indicate ONE method how the water loss as indicated by A to D, can be minimised. (4)

3.2

3.2.1 Why is the building of dams advantageous for agricultural production?

Also state TWO negative effects of dams being build for water storage. (2)

3.2.2 What do we call the artificial application of water? (1)

3.3 Give the meaning of the following:

3.3.1 Herbivore

3.3.2 Carnivore (2 x2) (4)

QUESTION 3

4.1 Indicate which of the livestock is best suited to produce the following products:

Dorper, Jersey, Australop, Dormer, Merino, Drakensberger, Angora, Large White, Frieslander, Simmentaler, Leghorn, Saannen

4.1.1 Red meat production

4.1.2 Milk production

4.1.3 Wool production

4.1.4 Egg production

4.1.5 Meat and egg production

4.1.6 Mohair production

4.1.7 Meat and milk production

4.1.8 Meat and wool production

4.1.9 Goats milk production

4.1.10 Pork production (10)

[25]
TOTAL SECTION B: 60

Exam Papers

AGRICULTURAL SCIENCES Paper 2 85 marks
TIME: 1½ HOURS

SECTION A

QUESTION 1

1.1 Various options have been given as answers to the following questions. Choose the correct answer and write only the letter (A – D) next to the question number in the ANSWER BOOK.

1.1.1 The soil forming mineral that is a clear crystal, very hard, transparent to milky white and does not weather is _____

A biotite.
B quartz.
C augite.
D calcite.

1.1.2 The soil-forming mineral that weathers to form soils rich in phosphates is _____

A apatite.
B quartz.
C agite.
D calcite.

1.1.3 In the prevention of pollution it is important that the pesticides used for agricultural purposes must _____

A be biodegradable.
B have after effects.
C not be biodegradable.
D disrupt the food chain.

1.1.4 An example of physical weathering is _____

A running water.
B wind.
C carbonic acid.
D temperature changes.

1.1.5 The indigenous management of fungal diseases and insects was done by _____

A using onion and garlic extracts.
B using chemical insecticides.
C using DDT.
D removing weeds between the crops planted.

1.1.6 Which mineral is an example of a toxic ion in irrigation water?
A Boron
B Iron
C Calcium
D Magnesium Agricultural Sciences

1.1.7 An example of the plant family Graminaceae is _____
A wheat
B beans
C groundnuts
D soya beans

1.1.8 Veld management systems must be based on the principle of _____
A zero grazing.
B severe grazing.
C rotational grazing.
D selective grazing (8 x 2) (16)

1.2 Give ONE word answers for each of the statements below:

1.2.1 The practice where crops are planted without disturbing the soil

1.2.2 The practice where only one crop is grown over and over on the same land

1.2.3 The practice where plant residues are returned to the soil to provide nutrients

1.2.4 The farming method where a farmer grows just enough food for the family

1.2.5 The farming method where a farmer produces on a large scale for profit

1.2.6 The family that legumes belong to

1.2.7 The process refers to organisms changing organic material into humus

1.2.8 The process when minerals in rocks come into contact with oxygen (8)

1.3 Study the different types of crops in COLUMN B and match them with the information provided in COLUMN A. (6)

COLUMN A	COLUMN B
1.3.1 Oil seeds 1.3.2 Field crops 1.3.3 Horticultural crops	A kikuyu B tobacco C deciduous fruits D sunflowers

1.4 Draw a rough map of South Africa. On it, show where the horticultural crops in the list below that grow well.

1.4.1 Wine grapes

1.4.2 Citrus

1.4.3 Bananas

1.4.4 Cherries

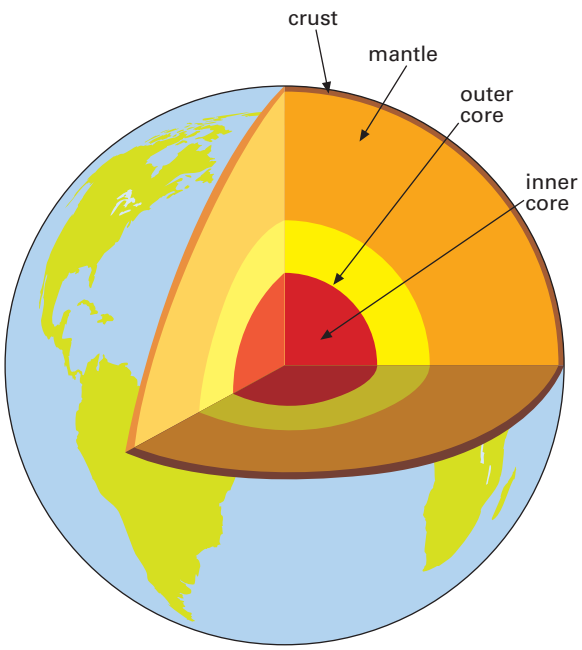
1.4.5 Apricots (5)

TOTAL SECTION A: 35

SECTION B

QUESTION 2

2.1 Study the diagram showing the different layers of the earth and answer the questions that follow:



2.1.1 In which layer do we find magma? (1)

2.1.2 Define the term magma. (2)

2.1.3 Briefly describe the economic importance of the crust. (2)

2.1.4 Define igneous rocks and give an example of each and where they are formed. (5)

2.1.5 What do we call the continuous process of solid rock breaking down to form soil particles? (2)

2.2

2.2.1 Describe the term bare cultivation. (3)

2.2.2 Give FIVE disadvantages of this method of cultivation. (5)

2.2.3 What farming practice would you use to prevent erosion on the slopes? Give a reason for your answer. (2)

2.2.4 Explain the process of weathering. (3)

[25]

QUESTION 3

3.1

3.1.1 Describe step by step how you would go about laying out a compost heap. (6)

3.1.2 How would you go about testing the compost heap to see whether decomposition is actively taking place? (2)

3.1.3 Name FIVE benefits that compost will have for your soil. (5)

3. 2 Cultivated pasture plays a very important role in a sustainable supply of food. Briefly discuss this statement. (4)

3.3 Read the stories about the soil utilisation taking place on two different family farms.

The Mbuza family farm
Every member of the family helps on the farm. Lindiwe helps her grandma collect eggs and feed the chickens. She also helps to hoe the soil and dig in chicken manure. Bongani helps to milk the cows and move them from one pasture to another.

Vegetables also grow well. They make sure never to plant the same vegetables in the same soil two years in a row. 'The vegetables all need different things from the soil,' they say, 'so if we do not plant the same things in the same soil, we give the soil a chance to re-build itself.'

The Mbuza pastures have good grass and the animals are fat. The animals are moved to different pastures to prevent the animals from eating all the grass. 'The soil gets dry and blows away in the wind because there are no roots to keep it in place,' says Mr Mbuza. Bongani helps his father to make fences between the pastures

The Nkondo family farm
They live near the Mbuza family. Although they have more cows and goats than the Mbuza family, they have not built fences around different pastures, so the animals graze all over the farm all the time.

The family used to grow vegetables but now they only grow mealies. 'We bought a small tractor with the money that we get from selling our mealies,' says Mrs Nkondo, 'but I don't think it is so good for the soil because it squashes the soil and only breaks it into big lumps.'

Lately the mealie production on the Nkondo farm has not been so good. The soil is dry and blows away in the wind.

3.3.1 Describe TWO methods used by the Mbuza family to keep their pastures and animals growing well. (2 x 2) (4)

3.3.2 List THREE reasons why the Nkondo family's mealies are not growing well. (3)

3.3.3 Explain why the Nkondo animals are in poor condition. (2)

TOTAL SECTION B: 25

Answers to exam papers

Memorandum: AGRICULTURAL SCIENCES Paper 1

Question 1.1
1.1.1 B
1.1.2 B
1.2.3 D
1.1.4 D
1.1.5 C
1.1.6 A
1.1.7 B
1.1.8 C

Question 1.2
1.2.1 Subsistence
1.2.2 Monoculture
1.2.3 Legume
1.2.4 Zero tillage
1.2.5 Nguni
1.2.6 Crossbreeding
1.2.7 Population growth rate
1.2.8 Jersey

Question 1.3
1.3.1 A
1.3.2 E
1.3.3 F

Question 1.4
1.4.1 C
1.4.2 A
1.4.3 A
1.4.1 B

Question 2.1
2.1.1 A = less than 200 mm; B = 201 – 400 mm; C = 401 – 600 mm; D = 601–800 mm; E = 801– 1 000 mm; F = more than 1 000 mm
2.1.2 (a) D = Parts North West; Limpopo, Gauteng; (b) B = Parts of Northern Cape, Western Cape and Eastern Cape
2.1.3 (a) A; (b) F

Question 2.2
2.2.1 (a) Sour veld = Sour veld develops in areas with high rainfall more than 650mm; low rainfall with cold winter areas; (b) Sweet veld = Sweet veld found in areas with low rainfall areas, 250–500 mm; high temperatures almost no frost
2.2.2 Adaptation of grasses to rainfall and the temperature, will determine the veld types

Question 2.3
2.3.1 Subsistence; small-scale; commercial
2.3.2 Game; certain roots and leaves

Answers to exam papers

2.3.3 They were forced off their land by economic development: mining and agriculture
2.3.4 Restitution Act of 1994
2.3.5 People look for work and for a better life (education, medical care, etc.)
2.3.6 Hoodia succulent cactus plant

Question 2.4
2.4.1 Grapes
2.4.2 Cotton
2.4.3 Pork (pigs)
2.4.4 Wheat

Question 2.5
2.5.1 El Niño – temperatures over equatorial Pacific become warmer = more precipitation
2.5.2 La Niña – temperatures over equatorial Pacific become cooler = less precipitation

Question 3.1
3.1.1 A = Ocean evaporation; B = Land evaporation/transpiration; C = Percolation; D = Runoff
3.1.2 Mulching (prevent evaporation); contour ploughing (minimise runoff)

Question 3.2
3.2.1 Stores water for when it needed; makes water available where needed. Alters river courses; displaces people; causes siltation; can cause flooding
3.2.2 Irrigation

Question 3.3
3.3.1 Plant eating
3.3.2 Meat eating

Question 4.1
4.1.1 Drakensberger
4.1.2 Jersey; Friesland
4.1.3 Merino
4.1.4 Leghorn
4.1.5 Australop
4.1.6 Angora
4.1.7 Simmentaler
4.1.8 Dormer
4.1.9 Saannen
4.1.10 Large White

Answers to exam papers

Memorandum: AGRICULTURAL SCIENCES Paper 2

Question 1.1
1.1.1 B
1.1.2 C
1.1.3 A
1.1.4 C
1.1.5 A
1.1.6 A
1.1.7 A
1.1.8 D

Question 1.2
1.2.1 Minimum cultivation / no-till
1.2.2 Mono culture / mono cropping
1.2.3 Mulching
1.2.4 Subsistence farming
1.2.5 Cash-crop farming
1.2.6 *Leguminaceae*
1.2.7 Humification
1.2.8 Oxidation

Question 1.3
1.3.1 D
1.3.2 B
1.3.3 C

Question 1.4
1.4.1 Western Cape
1.4.2 Eastern Cape (and around Citrusdal in Western Cape)
1.4.3 KwaZulu-Natal
1.4.4 Southeastern Free State
1.4.5 Boland

Question 2.1
2.1.1 Inner core
2.1.2 Melted rock / cooled down gas
2.1.3 Soil is formed in the crust where agricultural production takes place
2.1.4 Igneous rocks form due to cooling down of magna
Granite – very deep cooling down slowly
Dolorite/ gabbro / basalt – shallow with a fine structure
2.1.5 Weathering

Question 2.2
2.2.1 A practice where all the plants are removed from the soil
2.2.2 Destroys structure and therefore weakens aeration; weakens water infiltration; weakens water capacity; hampers root penetration; difficult to till
2.2.3 Contour ploughing – the contours prevent runoff which prevents soil being washed away

Answers to exam papers

2.2.4 When rocks are subjected to soil forming factors, such as weathering, over a period, the outer layer of the rocks loosens and crumbles to form soils. Rock weathering takes place through mechanical weathering, chemical weathering and biological weathering.

Question 3.1
3.1.1 Base – maize stalks; organic material, e.g. grass and leaves; manure; wood ash; lime; topsoil; dry leaves; water
3.1.2 Wire pushed into centre of compost heap – warm when taken out after 24 hrs / Open slightly – warm centre / Push hand in – warm inside
3.1.3 Improved structure; improved aeration; improved inflitration; improved water capacity; easier tillage; better root penetration

Question 3.2
Dung of cattle will fertilize the soil and:
• the urine will provide moisture and helps to form humus.
• After removing the cattle, the dung must be dug into the soil immediately to provide organic matter.

Question 3.3
3.3.1 Rotational grazing – camps rest to recover; Crop rotation – soil minerals replenished
3.3.2 Overgrazing – no rotation of grazing in camps; Over tiling – soil structure broken down; Mono crop cultivation – soil not being replenished
3.3.3 Over populated – carrying capacity of veld exceeded (should lessen animal numbers and practise rotational grazing)

Glossary

abiotic physical rather than biological; not derived from living organisms

abrasion the process by which clasts and other particles are reduced in size

adaptation a change by which an organism or species becomes better suited to its environment

aeration the introduction of air into a material or substance

agents of erosion water, wind and glaciers

agricultural policies a course or principle of action related to agriculture that is adopted or proposed by the government

agricultural production the output from agriculture

agro-ecology the study of the relationship between the environment and agricultural plants and animals

agronomy the science of soil management and crop production

alluvial deposits when loose alluvial material is deposited or cemented into stone (lithified)

alluvium loose, unconsolidated (not cemented together into a solid rock), soil or sediments, eroded, deposited, and reshaped by water in some form in a non-marine setting. Alluvium is typically made up of a variety of materials, including fine particles of silt and clay and larger particles of sand and gravel

amendment a change or addition to a legal or statutory (to do with the laws of a country) document

anaerobic absence of free oxygen

animal ratio the ratio of different animals, or of male to female animals in a pasture

annual population growth rate the rate at which the population increases or decreases in a given year, expressed as a percentage of the total population

artificial pasture an area with plants planted specifically for grazing

average annual rainfall the amount of rain (measured in millimetres or mm) that usually falls in an area in one year

biodegradable when something decomposes naturally

biodiversity the variety of life in the world or in a particular habitat or ecosystem

biological farming systems farmers use biological principles to increase their yields

biological matter living matter

biological pest control farmers use a pest's natural enemy to get rid of it

biological weathering when living organisms cause rocks to decompose

biome a large naturally occurring community of flora and fauna occupying a major habitat

biosphere the part of the Earth that supports life, including oceans, lakes and rivers

biotic of, relating to, or resulting from living things, esp. in their ecological relations

bioturbation the disturbance of sedimentary deposits by living organisms

bivalent homologous chromosomes associated in pairs

breed specific variety of a species

capillary action the ability of liquid to flow against gravity, such as up a plant root

carbohydrates one of the five nutrients in food; used by the bodies of people and animals to get energy

carbon dioxide (CO_2) a colourless, odourless gas produced by burning carbon and organic compounds and by respiration; it is naturally present in air (about 0,03%) and is absorbed by plants in photosynthesis

carcass traits meat characteristics after slaughter

carrying capacity the number of animals that can be grazed on a piece of land

cell cycle the sequence of cell division, resting phase, cell division and so on

cell membrane the 'skin' of a cell, also known as the plasmalemma or plasma membrane

cell wall a non-living tissue made up from cellulose that is situated outside the cell membrane of a plant cell

centromere the point on a chromosome by which it is attached to a spindle fibre during cell division

chemical (or biological) weathering involves the direct effect of atmospheric chemicals or biologically produced chemicals in the breakdown of rocks, soils and minerals

chromatid each of the two threadlike strands into which a chromosome divides longitudinally during cell division. Each contains a double helix of DNA

chromatin network a network of fine threads consisting of protein, RNA and DNA

chromosome a threadlike structure of nucleic acids and protein found in the nucleus of most living cells, carrying genetic information in the form of genes

cleavage the splitting of rocks or crystals in a preferred plane or direction

climate change long-term, significant change in the climate of an area or of the Earth, usually seen as resulting from human activity

climate the weather conditions prevailing in an area in general or over a long period

Glossary

climax species plant species that will remain essentially unchanged in terms of species composition for as long as a site remains undisturbed

colluvium loose bodies of sediment that have been deposited or built up at the bottom of a low-grade slope or against a barrier on that slope, transported by gravity

commensalism one organism benefits from the relationship, while the other organism is not harmed

commercial farming sector large-scale farming for profit

commercial production scientific farming on a large scale for profit

communal farming when animals are allowed to roam freely across the farm, without any fences and grazing camps

community all the plants and animals that live in a particular ecosystem

competition when organisms within the same ecosystem want the same resources, for example food

competitive edge a unique selling point; something special that can be used to sell a product

compost decomposed plant matter that is added to soil to increase the nutrient content of the soil; organic matter that has broken down into humus

condensation when a vapour changes into a liquid

conformation body structure and shape

conservation farming use of natural ecological processes to manage farms

conservation protecting a species

conserve to save and to use wisely

constitution a body of fundamental principles or established precedents according to which a state or other organisation is acknowledged to be governed (in South Africa, the Constitution of 1996 is the highest law in the land, and all other laws are only legal if they are allowed by the Constitution)

consumer price index (CPI) measures the average changes over time of prices paid for goods and services

contaminants substances that decrease the quality of something and make it unhealthy

continuous grazing when animals graze the same area at all times of the year

contour a line on a map joining points of equal height above or below sea level; ploughing along the contours of the land in order to minimise soil erosion

conventional farming methods methods to increase yields by using artificial additives, without considering damage to the environment

crop rotation growing a different crop on the same land each year for a period of three to five years

crossbreeding mating of two different breeds

cultivar a plant variety that has been produced in cultivation by selective breeding

cytokinesis the cytoplasmic division of a cell at the end of mitosis or meiosis, bringing about the separation into two daughter cells

cytoplasm the jelly-like fluid inside a cell, excluding the nucleus, in which all the organelles are suspended

deciduous a tree or shrub that sheds its leaves annually

decomposers organisms that break down dead plants and animals through a process called decay

deforestation the cutting down of large areas of forests

denitrification removal of nitrates or nitrites from soil, air or water

diluents a substance used to dilute another liquid (make it thinner)

diploid containing two complete sets of chromosomes, one from each parent.

DNA the abbreviation for deoxyribonucleic acid, which is the carrier of genetic information

drought-tolerant plants plants that can grow with less water, and continue to grow if little rain falls

dual agricultural economy two separate economies, commercial and communal

dyke an intrusion of igneous rock cutting across existing strata

ecological farming systems using ecological and natural principles to increase yields

ecological pyramid a diagram to show the trophic levels in an ecosystem

ecological succession when the type of plants growing in a pasture changes naturally without the interference of people

ecology the study of the relationships between living organisms and the environment in which they live

economy the wealth and resources of a country or region, especially in terms of the production and consumption of goods and services

ecosystem a biological community of interacting organisms and their physical environment

edaphic of, produced by, or influenced by the soil

El Niño weather phenomenon as a result of the ocean off the South American coast becoming warmer than normal

eluviation the transport of soil material from upper layers of soil to lower levels by downward precipitation

Glossary

of water across soil horizons; this transported material is called illuvial deposit

endangered species a species in danger of disappearing

endoplasmic reticulum a network of membranous tubules (very small tubes) within the cytoplasm of a cell

enzymes substances in living organisms that control chemical processes, for example digestion

equine family members of the family Equidae which includes horses, donkeys and zebras

erode when wind, water or other natural agents gradually wear away soil, rock or land

erosion the gradual removal of soil by wind or water; it is a natural process but can be increased by poor farming practices and deforestation

evaporation when a liquid changes into a gas

exotic breed breed developed in another country with very different conditions

exotic come from some other parts of the world; not indigenous

fauna the animals of a particular region or habitat

feed (or food) conversion efficiency how well the animal converts protein in feed into growth

fertility how fruitful or productive something is

fibre diameter width of fibre

fibre length how long the fibre is

flora the plants of a particular region or habitat

floral kingdom the largest natural units determined for flowering plants

fodder food, especially dried hay or feed, for cattle and other livestock

follicle density the number of follicles per area of skin

food chain a hierarchical series of organisms each dependent on the next as a source of food

food security the availability of enough nutritious food and people's access to it

food web a system of interlocking and interdependent food chains

forage plant material eaten by grazing livestock

foreign currency money a country earns from outside the country

fossil fuels fuels made from coal, which is plant material that was compacted and fossilised many years ago

fracture the physical appearance of a freshly broken rock or mineral, especially as regards the shape of the surface formed

friable (soil) easily crumbled (soil)

game an old English word for wild animals used for food; now refers to wild animals such as buck

gametes a mature haploid male or female germ cell that is able to unite with another of the opposite sex in sexual reproduction to form a zygote

geology geology of an area refers to the origin and evolution of the materials the soil consists of, and the processes that act on it

germination when a seed begins to grow and put out shoots after a period of dormancy

global demand to do with how many goods or services are needed or wanted internationally

global warming the phenomenon of the temperature of the Earth increasing due to the greenhouse effect, mainly caused by pollution

globalisation the process by which regional economies, societies, and cultures have become integrated through communication, transportation, and trade

Golgi apparatus folded membranes within the cytoplasm of most cells, involved in secretion and intracellular transport

grazing capacity the average number of animals that the farm can sustain over a period of time

grazing ecology the study of the relationship between the organisms in the ecosystem of the pasture

grazing system a particular grazing strategy that a farmer uses

green manure a plant that is sown to add nutrients and organic matter to the soil; it is ploughed into the land after a period of time

green paper also known as consultation documents, proposes a strategy to be implemented or sets out proposals on which the government wishes to obtain public views and opinion

gross domestic product (GDP) the total value of goods produced and services provided in a country during one year

gross value total amount earned for all products in one year

groundwater water that collects under the ground above a layer of rock and in cracks in the rocks

growth rate the speed of animals' growth

haploid having a single set of unpaired chromosomes

hardwood broad-leaved deciduous trees, such as oak, ash or beech

herbaceous is a plant that has leaves and stems that die down at the end of the growing season to the soil level; they have no persistent woody stem above ground; they may be annuals, biennials or perennials

Glossary

herbicides chemicals that kill plants; farmers use herbicides to control weeds

homologous pairs pairing at meiosis and having the same structural features and pattern of genes

horticulture the art or practice of garden cultivation and management

humid marked by a relatively high level of water vapour in the atmosphere

humification converting plant remains into humus

humus any organic matter that has reached a point of stability, where it will break down no further and might, if conditions do not change, remain as it is for centuries, if not millennia; the organic component of soil, formed by the decomposition of leaves and other plant material by soil microorganisms

illuviation the accumulation of illuvial deposit in lower levels

indigenous breed breed developed locally

indigenous knowledge knowledge that has been handed down in communities, over thousands of years by word of mouth

individuals members of a population

industrialisation a period characterised by an increase in mechanisation and factories

inorganic substances that do not contain carbon

invader plants plants of alien or foreign origin; weeds

invasive unwanted, spreading quickly in an uncontrolled way that can cause harm

irrigation supplying water to a crop by moving water from the source of the water to the place where the crop is growing

La Niña opposite of El Niño; weather phenomenon as a result of the ocean off the South American coast becoming cooler than normal

land reform changing land laws to make the situation fairer for all people; redressing previous inequalities in land distribution

land restitution actions to reverse injustices related to land ownership

leaching making a soluble chemical or mineral drain away from the soil by the action of a percolating liquid such as rainwater

leasehold the holding of property by lease, not ownership

legal framework basic structure underlying the system of laws; such a framework creates the legal 'space' in which individuals and businesses can function

legislation the laws of a country, as determined by the law-making arm of government, such as parliament

legume an edible plant that grows inside a pod

livestock farm animals regarded as an asset

loamy soil soil composed of sand, silt, and clay in relatively even concentration; loamy soils generally contain more nutrients and humus than sandy soils, have better infiltration and drainage than silty soils, and are easier to till than clay soils; they are gritty, moist, and retain water easily

lustre the manner in which the surface of a mineral reflects light

lysosome an organelle in the cytoplasm of cells containing enzymes that break down or degrade substances enclosed in a membrane

management systems how a farm is organised and run

market requirement what the consumer wants; standards set by the market

marketing a formal structured approach to selling based on analysis of the subject

mechanical weathering involves the breakdown of rocks and soils through direct contact with atmospheric conditions, such as heat, water, ice and pressure

mechanical weed control removing weeds using implements such as hoes

microbe a microorganism, especially bacterium causing fermentation

microbial related to microorganisms, such as bacteria, that cause fermentation

milk production the amount of milk produced by a dairy animal

minerals inorganic substances needed by the human body for good health

mitochondrion an organelle found in large numbers in most cells, in which the biochemical processes of respiration and energy production occur; mitochondrion has a double membrane, the inner layer being folded inward to form layers (cristae)

monogastric animals with a single stomach

mulching a material (such as decaying leaves, bark, or compost) spread over the soil to enrich or insulate the soil

multicellular made up of more than one cell

multiplier effect the variety of products that can be derived from a single raw material

mutualism two organisms benefit from a relationship

natural pasture an area where animals graze that does not contain any plants planted by the farmer

natural resources resources that occur naturally in the environment; also called primary resources

Glossary

natural selection selection of an animal by the environment for survival

no-tillage farming planting a crop without ploughing or digging the soil first; the crop is planted into the leaves and stems that are left over from the previous crop

non-renewable resources natural resources that are limited and may be used up one day

non-selective grazing when animals are forced to eat all the plants in the pasture, not only the palatable plants

nucleoplasm the jelly-like fluid in the nucleus

nucleus dense organelle present in most cells, typically a single rounded structure bounded by a double membrane, containing the genetic material

nutrients substances in food that animals and people need in order to grow and keep healthy; the minerals in soil are sometimes called plant nutrients

nutritive value amount of nutrients a plant contains

orchard a piece of land planted with fruit trees

organ a group of tissues that have the same structure and function

organelles various structures in a cell, each performing a different function

organic farming increasing yields by using natural additives, such as compost

organic matter the remains of plants and animals that use the soil

organic substances containing carbon

outwash is a glacial outwash plain formed of sediments deposited by meltwater at the terminus of a glacier

over-grazing if more animals than the quantity indicated by the stocking rate are allowed to graze the pasture

oxidation the combination of a substance with oxygen

palatable plants that animals like to eat because they are soft and tasty

parasitism one organism (parasite) lives on another organism (host), and the host is harmed

parenchyma the functional tissue of an organ as distinguished from the connective and supporting tissue

pedogenesis the process by which soil is formed

pesticides chemical poisons used to control pests and diseases

pH a figure expressing the acidity or alkalinity of a solution on a logarithmic scale on which 7 is neutral, lower values are more acid, and higher values more alkaline

photosynthesise the process by which green plants and some other organisms use sunlight to synthesise foods from carbon dioxide and water. Photosynthesis in plants generally involves the green pigment chlorophyll and generates oxygen as a by-product

physiographic refers to what the land surface looks like, or the appearance of the land surface

plant taxonomy the science that finds, describes, classifies, identifies and names plants

plantations an area in which trees have been planted for commercial purposes

plasmodesmata threads made of cytoplasm that go through from one plant cell to the next

plastid any of a class of small organelles, such as chloroplasts, in the cytoplasm of plant cells, containing pigment or food

pollutants harmful substances that pollute the air, water or soil

pollute to put harmful substances into the air, water or soil

population growth the rate at which the number of individuals in a population increases

population the number of organisms (people or animals)

pores openings in a cell membrane

precipitation water that comes from the air; it includes rain, hail, frost, snow, dew and mist (fog)

predation when one organism (hunter) eats another organism (prey)

primary agriculture the first level of agriculture involved in the planting and cultivation of crops

primary, secondary and tertiary industries primary industries are concerned with obtaining or providing natural raw materials for conversion into commodities and products for the consumer (mining, agriculture or forestry); secondary industries convert raw materials provided by primary industry into commodities and products for the consumer (also known as manufacturing); tertiary industries are involved in the provision of goods and services

producers green plants that can make their own food through a process called photosynthesis

production systems farming methods (for example beef production systems are classified according to the age at which animals emanating from a production unit are sold. The production unit could be a farm or one of the enterprises in a larger undertaking. A full description of a system includes the age, mass and carcass class at which animals are marketed, as well as the breeding, management and feeding practices followed. In South Africa the most common beef production systems are weaner-, long yearling (tolly)- and two-year old (ox) systems.)

Glossary

protein an organic compound that is an essential part of all living organisms

purebred bred from parents of the same breed or variety

radiation sending out rays, for example from the sun

reafforestation to cover an area by planting trees

regenerate to change back to the original, new condition

regulation a rule or directive made and maintained by an authority; legislation is usually implemented through regulations

renewable resources natural resources that can never be used up over time

reservoir any place where water is stored

resource conservation looking after natural resources (e.g. soil and water) to ensure their quality and that they are not used up or wasted (can also refer to looking after other resources, such as money and farm equipment) wisely so that they are of maximum benefit and last a long time)

ribosomes a minute (very small) particle consisting of RNA and associated proteins, found in large numbers in the cytoplasm of living cells

RNA abbreviation for ribonucleic acid, a nucleic acid present in all living cells; its main function is to act as a messenger carrying instructions from DNA

rock weathering the breaking down of Earth's rocks, soils and minerals through direct contact with the planet's atmosphere; it includes physical, biological and chemical weathering

rough ER endoplasmic reticulum that contains ribosomes on its surface

ruminant hoofed mammals that have a stomach with four compartments; partially digested food is brought back for the animal to chew again, for example cows

salinisation to increase the salt content

salinity a measure of the total amount of dissolved salts in water or soil

scientific or evidence-based knowledge knowledge that comes from experimentation and research, and is based on verifiable evidence

season of use the part of the year when animals can graze the plants

seasonal distribution how something (e.g. rainfall) is spread out across the seasons

sediment particulate matter that is carried by water or wind and deposited on the surface of the land or the bottom of a body of water, and may in time become consolidated into rock

selective breeding selecting specific animals for mating

selective grazing when animals do not graze all the plants in a pasture, but prefer certain plants

self-propagation able to increase itself in number or amount

silage grass or other green fodder compacted and stored in airtight conditions, typically in a silo, without first being dried, and used as animal feed in the winter or in periods where grazing is scarce

siltation when dams and rivers fill up with eroded soil

slow rotational grazing when the grazing area is divided into camps, one of which is grazed while the others are rested

small-scale farmers agricultural production for own consumption with a small surplus for trade

smooth ER endoplasmic reticulum that does not contain ribosomes on its surface

sodicity a measure of the amount of sodium-containing salts in water; it is measured using the sodium absorption ratio (SAR)

softwood conifers, such as pine, fir or spruce

soil compaction when the weight of heavy machinery compresses the soil, causing it to lose pore space; soil compaction may also occur due to a lack of water in the soil

soil conservation the process where we stop the degradation of soil and repair the damage so that the condition of the soil improves and is maintained

soil degradation any process that causes the condition of the soil to lose nutrients (degrade)

soil erosion the carrying away of soil by wind or water

specialisation selection for a specific purpose

species a group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding

stocking rate (SR) the number of animals that can graze on one hectare of land, for the grazeable part of one year, without damaging the condition of the pasture

strategic position relating to how an industry is set up and functioning in order to identify long-term or overall aims and interests and the means of achieving them

streak a long, thin line or mark of a different substance or colour from its surroundings

sublimation when a solid changes into a gas

subsistence agriculture agricultural production at a level sufficient only for one's own use or consumption, without any surplus for trade

subsistence farming when a farmer only produces enough for the use of his or her own household

Glossary

subsoil the deeper parts of soil, beneath the topsoil

supply chain the chain of the product from the farm to the consumer

surface water water that is on the surface of the Earth, such as the water in rivers and lakes

sustainable able to be maintained at a certain rate or level; conserving an ecological balance by avoiding depletion of natural resources

terraces steps that are cut into the slope

tissue a group of cells that have the same structure and function

titlehold the ownership of property by title deed, a legal document

tonoplast a membrane that bounds the chief vacuole of a plant cell

topography the arrangement of the natural and artificial physical features of an area

topsoil the top layer of the soil, which is usually more fertile than the lower layers of soil

transpiration give off water vapour through the stomata (the very small pores on the surface of a leaf)

trifoliate a plant that has three leaflets

trophic level each step in the food chain

turbidity muddiness of irrigation water caused by soil particles and organic materials that are suspended in the water

unicellular made up of one cell

unpalatable plants that animals do not like to eat, because they are tough or have a bad taste or smell

water cycle the way in which water molecules are cycled from one reservoir to the next

water holding capacity ability of soil to hold water

water quality fitness of water for a particular use or for the maintenance of the health of aquatic ecosystems

watercourse a river, stream, or artificially constructed water channel

white paper a means of presenting government policy preferences prior to the introduction of legislation; as such, the publication of a white paper serves to test the climate of public opinion regarding a controversial policy issue and enables the government to gauge its probable impact

wind farm a collection of wind turbines which are used to generate electrical power through their mechanical motions as they are pushed by the wind; the energy generated by a wind farm can be fed directly into the general energy grid after passing through transformers

zero grazing when animals are not allowed to graze outside, but are kept indoors; fodder is brought to them

zygote the product of fertilisation of an egg cell by a sperm cell