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Soil

Soil Formation

The process of soil formation began millions of years ago. Many different processes: physical, chemical and biological, break down rocks into sands, silts and clays and mix in organic materials to form soil.

Physical Processes

- uneven heating of rock. Hot sun throughout the day and cold temperatures at night can cause cracking and flaking of some types of rocks.
- expansion of water upon freezing. Rainwater enters cracks in the rock and as it freezes it expands and exerts pressure which may break off pieces of rock.
- seas pounding and tides and rivers flowing, tumble rocks together, wearing them away. Stones in a stream are often smooth and round due to the action of water wearing them away.
- Glaciers carrying boulders wear away the underlying rocks as they flow over them.

Chemical Processes

- rainwater contains a little dissolved carbon dioxide and is slightly acidic. This acid reacts chemically with some rocks eg. Limestone and gradually breaks them down.
- some plants eg. Lichen produce acids which can cause rocks to wear away.

Biological Processes

- Plant roots can penetrate into cracks causing rocks to break up.
- Action of soil organisms can break up rocks.

Weathering is the breakdown of rocks to produce inorganic particles such as clay, silt and sand. These particles can be eroded by the movement of water and wind. In this way, soils can be formed containing particles that were weathered from rocks many miles away and were then eroded and deposited elsewhere.

What is Soil?

Soil can be divided up into **organic** and **inorganic** components.

The inorganic components include:

- **sand** particles, which are the largest
- **silt**
- **clay** particles which are the smallest
- **gravel** or small stones

The organic component includes

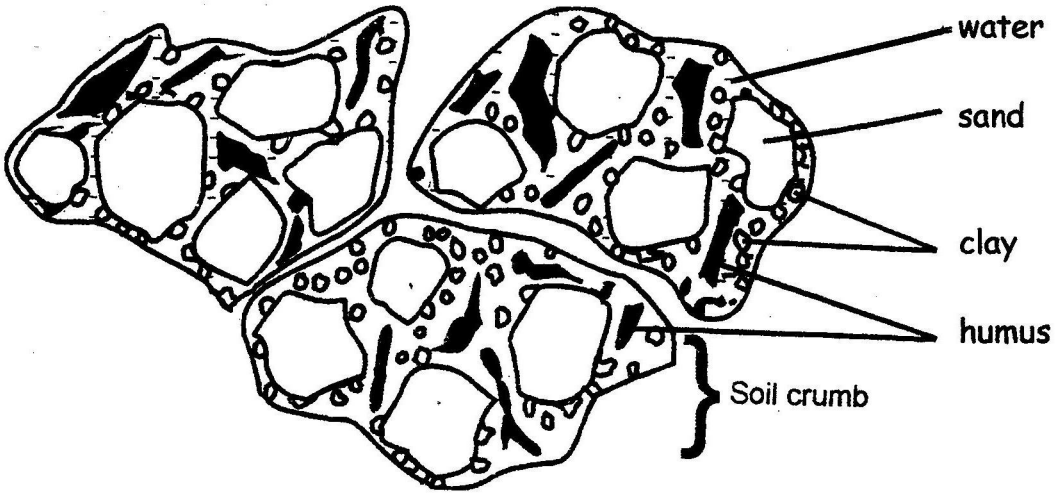
- **humus,** which is formed from dead and decaying organic matter like leaves

In addition, soil contains:

- **air,** which provides oxygen so that soil organisms and plant roots can respire
- **water**, which is taken up by plant roots to be used in photosynthesis and to maintain leaf turgor .

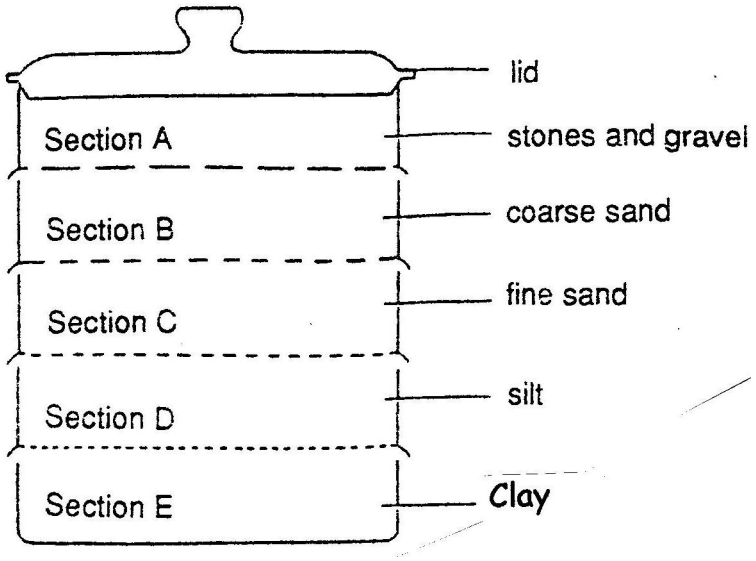
Clay, silt and sand particles are all held together by humus, to form irregular shaped lumps with diameters of less than 1cm called **soil crumbs**. A good crumb structure helps to prevent soil erosion, aerates the soil and improves soil drainage.

A soil crumb



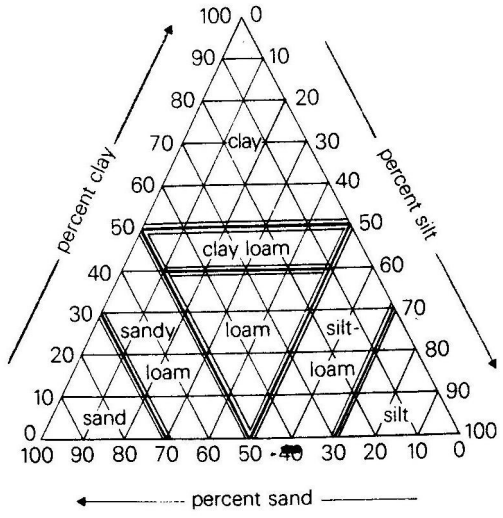
The inorganic components of soil can be separated using a **soil sieve**. The soil is first dried to prevent it sticking to the sieve and clogging it up and then crushed to break up the soil crumbs. It is then placed in the top and shaken until all the soil has separated out. The mass soil in each section can then be determined.

A soil sieve



Once the proportion of inorganic particles in the soil is known it is possible to work out the type of soil using a soil triangle.

A soil triangle



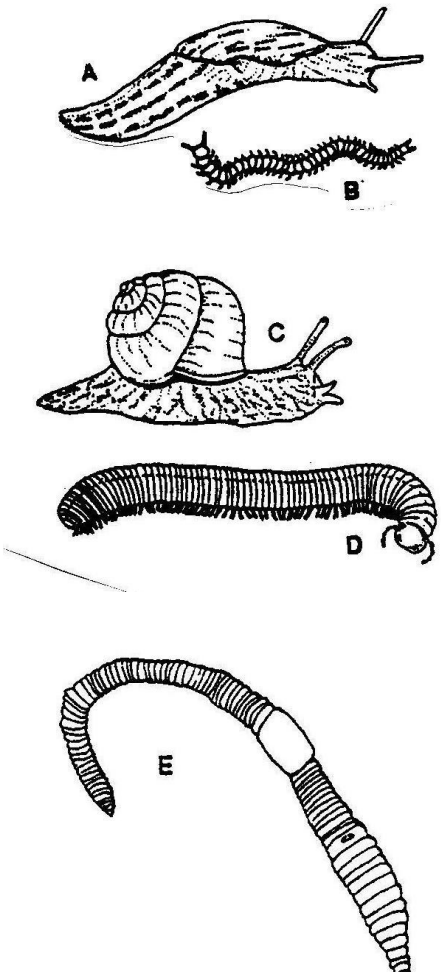
A soil containing 30% sand, 30% clay and 40% silt is a loam soil.

Soil Organisms

Soil also contains living organisms, which are found in the top layer of soil. They can be divided up into two types

1. **Micro-organisms** which cannot be seen by the naked eye. They are responsible for bringing about decay of organic matter and recycling nutrients in the soil by nitrification, denitrification and nitrogen fixation (see nitrogen cycle). They include:
   - saprophytic fungi (feeding on dead and decaying organic matter)
   - bacteria

2. **Macro-organisms** which can be seen by the naked eye and have a variety of roles. They include:



- Slugs (a) and snails (c) which are a pest in the soil because they eat the leaves of plants therefore allowing less photosynthesis so plants grow slower or die.
- Centipedes (b) which are a pest in the soil because they are carnivorous and therefore eat other beneficial soil organisms.
- Millipedes (d) which are a pest in the soil because they feed on roots and stems of living plants, decreasing photosynthesis so plants grow slower or die
- Woodlice are beneficial in the soil because they feed on, and help to decompose, organic matter and so contribute to recycling and soil formation.
- Earthworms (e) are beneficial to the soil because they produce burrows which improve drainage and aerate the soil. They also help to decompose organic matter and so contribute to recycling and soil formation.

Soil Types

A **clay** soil contains a large proportion of small clay particles. Clay soils have the following characteristics:

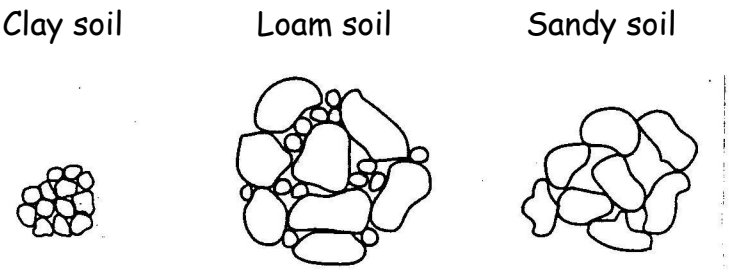
- they have poor drainage because the clay particles are small so there are few air spaces for the water to drain through
- they are often waterlogged (all air spaces are taken up by water) because the small particles have a large surface area so there is more area for water to cling to
- they are heavy to cultivate because of all the water
- they take a long time to heat up in spring but cool down slowly in autumn, so are called cold late soils because there is a lot of water to heat up
- they are often rich in nutrients because they do not leach (wash) out

A **sandy** soil contains a large proportion of sand particles. Sandy soils have the following characteristics:

- they have rapid drainage because the particles are large so there are large air spaces for water to drain through
- they are dry because the large sand particles have a small surface area so there is less area for the water to cling to
- they are light to cultivate because they are so dry
- they warm up quickly in the spring and cool down rapidly in autumn so are called warm, early soils because there is less water to warm up
- they are often low in nutrients because they leach out

A **loam** soil contains roughly equal proportions of sand, silt and clay. Loam soils have the following characteristics:

- they do not become waterlogged or dry out quickly
- they are easy to cultivate
- they are the best soil for growing crops



Soil Characteristics

The further down in the soil the less humus, air and bacteria but the more water that is present.

Soil pH is important in determining which plants grow in a particular soil. Some plants grow better in acidic soils (pH 1-6) eg. Heathers. Some plants grow better in alkaline soils (pH 8-14) eg. Carnations. However, most plants will grow best in neutral soils (pH 7).

Plants can only absorb nutrients from the soil when they are dissolved in the soil water. In the soil, positively charged nutrient ions (cations) are often attached to the negatively charged surfaces of the humus and clay (these are called cation exchange surfaces). This means that they are not dissolved in the soil water and therefore not available to the plant.

Soil pH influences the availability of nutrients in the soil in a number of ways.

1. At neutral pH the cations are released from the cation exchange surfaces and this therefore increases the concentration of potassium, magnesium and calcium in soil solution.
2. At very low soil pH's (acidic conditions) aluminum ions become soluble and these can kill the plant. This can occur as a result of acid rain.
3. Low pH can prevent earthworms and bacteria from living in the soil and so reduce the rate of decomposition and nutrient recycling
4. Nitrates become available in neutral to alkaline pH's.
5. In alkaline soils humus can be broken down too quickly causing nutrients to be leached and so be unavailable to plants.
6. Liming raises the pH of the soil solution therefore making more nutrients available and allowing plants to grow more successfully.
7. Liming also improves drainage in clay soils by causing clay particles to stick together (flocculate) producing larger particles with larger air spaces.

In permanent grassland the soil tends to be acidic because the plants take up the calcium and pass it on to the animals which use it to make bones and teeth so it is not recycled.

Addition of two year old (well rotted) FYM:

- to an alkaline soil helps to neutralise it
- to a nutrient poor soil will add nutrients because as it decomposes it will release nutrients such as nitrogen(N), phosphorus (P) and potassium (K) into the soil to improve fertility
- improves crumb structure because it helps to bind the inorganic particles together

Testing Soil pH

- place a small quantity of soil in a test tube and add distilled water which has a neutral pH.
- add barium sulphate to increase the rate of sedimentation of the soil.
- once the solution is clear add a few drops of universal indicator solution.
- compare the colour to a pH chart.
- make sure tube is dry so the barium sulphate does stick and obscure the colour.

If the **soil temperature** is too low roots cannot respire and seeds cannot germinate so there is less plant growth.

Leaching is when soil nutrients dissolve in rainwater and are carried out of the soil into rivers. Nitrates (nitrogen in the soil) are very soluble and so are easily leached from the soil. Poor drainage in soils results in **waterlogging**. This is when all the air spaces are filled up with water. Lack of air in the soil prevents respiration of soil organisms and plant roots, so there will be few organisms in a waterlogged soil and plant growth will be stunted. Diseases such as club root of *Brassicas* (cabbage family) flourish in wet soils.

Weeds

Removal of weeds is important because if weeds are allowed to grow they will compete with the plants for light, water and nutrients therefore reducing the growth of the plants and in some instances killing them. Weeds can be controlled in a number of ways:

Cultural Weed Control

- Mulching. This involves covering the soil to stop light reaching it and so prevent weeds growing. Bark chips and grass cuttings can be used both of which decay to release nutrients, although the bark looks decorative.
- Covering the soil in black polythene prevents light reaching it and so stops any potential weeds from growing. It also increases soil temperature.
- Hoeing cuts the base of the weed off just above the surface thus killing it.
- Topping which uses a machine to remove the top of the weed. This has to be done on a regular basis before flowering.

Chemical Weed Control

- Herbicides can be sprayed on to the area to kill weeds. However these cannot be used on an organic plot and they may kill other plants as well as damaging the environment.

Organic Weed Control

- Growing cover crops whose leaves completely cover the soil. This prevents light reaching the soil so the weeds cannot photosynthesise.

Types of Ecosystems

An **ecosystem** is an area characterised by the species present. The type of ecosystem depends on the climate, the type of soil and which other organisms are present. Plants and animals are adapted to the particular ecosystem in which they live.

A **habitat** is the place in an ecosystem where an organism lives.

Ecosystem	Characteristics	Animals	Plants
Deciduous Woodland	Found where there is warm summers and mild winters and plenty of rain. Deciduous trees lose their leaves in winter because it is too cold and dark for much photosynthesis to occur so the trees will not grow. Loss of leaves allows the trees to reduce water loss in transpiration.	Woodmice, foxes, badgers and tawny owls. Tawny owls nest in the hollowed out branches of the trees and feed on the abundant small mammals in the woodland.	Broadleaved trees such as oak, ash and beech with bluebells and wild garlic on the ground. Bluebells make use of the light and warmth in early spring to photosynthesise and store food before the leaves re grow.
Coniferous Woodland	Conifers are adapted to living in cold climates where the ground is often frozen in winter and the soil is poor and often acidic. They have needles which are not lost in winter so they do not have to waste energy each spring re growing them. The needles also help reduce water loss in winter when water may be unavailable if it is frozen. Their shape means that any snow will fall off and roots are shallow to absorb precious nutrients.	Deer and squirrels are found in these woodlands although they have a lower species diversity than deciduous woodlands because the trees are not native.	Scots Pine and Juniper are native to Britain. Most coniferous woodland in Britain has been planted with species such as Douglas Fir and Sitka Spruce.

Meadows	Meadows are traditionally cut for hay in July. If fertilisers are not added to the soil then a wide range of wild flowers such as poppies will grow. However, if the soil becomes nutrient rich then the wild flowers will be out competed by grasses	A wide range of invertebrate species are present such as the marbled white butterfly, burnet moth, bees and hoverflies as well as birds such as goldfinches.	Mixtures of grasses such as Cocksfoot, Timothy and Common Bent are found here as well as clover.
Ley Grassland	Rye grass produces a very high yield allowing several cuts for silage, however it requires high levels of fertilisers to maintain productivity. They have a lower species diversity than meadows.	Small mammals such as wood mice and weasels are found here.	Leys are grasslands created by sowing agricultural strains of grasses, particularly rye grass, often together with clover.
Wetland	Water plants are characterised by luxuriant growth and often have large leaves as loss of water from the leaves is not a problem. These plants often have large air spaces within their leaves to store air due to lack of oxygen in the soil.	Otters, water vole and birds such as reed warblers as well as fish such as sticklebacks, frogs and newts, snails, diving beetles and damselflies.	Marsh Plants such as willow, yellow iris and water mint as well as water plants such as duckweed and water lilies.

Moorland	Moorland is a semi natural habitat over 300m, that was formed when woodland was cleared and grazed 1,000 years ago. It has to be carefully managed by humans otherwise the heather would not regenerate.	Animals such as red grouse, hen harrier, adders and lizards live within the heather	Plants such as heather, bilberry and cotton grass live here. They are adapted to living in acidic soils which are often waterlogged.
Lowland Heath	This is found below 300m and is characterized by acidic soils which are very nutrient poor	There is a high animal diversity which includes, grasshoppers, dragonflies, moths, ants, spiders and sand lizards.	Gorse and heather are characteristic plants.

Left: Deciduous Woodland
Below: Coniferous Woodland
Right: Wetlands
Below Right: Lowland Heath

Food Chains and Webs

A food chain shows the feeding relationship between plants and animals. Food chains always start with a **producer**. Producers are **green plants,** which are able to make their own food using energy from the sun by **photosynthesis**. Food webs are the interaction between lots of different food chains.

Producer	Primary Consumer	Secondary Consumer
Green plant	Herbivore	Carnivore/Predator
e.g. grass	e.g. rabbit	e.g. fox

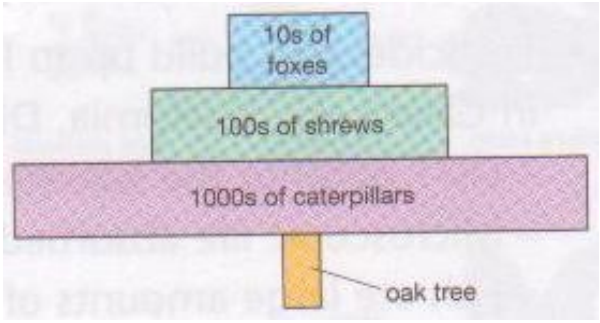
Herbivore: An animal that only eats plants
Carnivore: An animal that only eats other animals
Predator: An animal that captures and eats other animals (prey).

The arrow represents the **direction of energy flow** between trophic levels of the food chain. The source of all the energy is the sun. Energy is lost at each stage along the food chain in three ways:

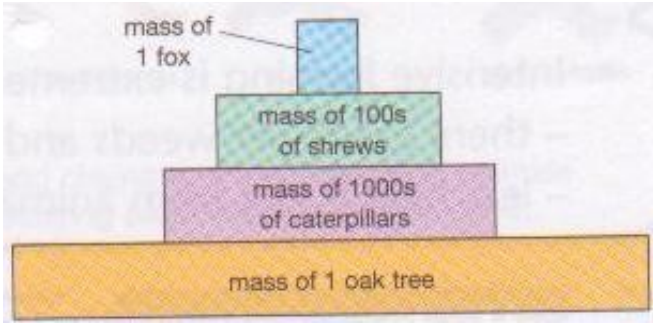
- in respiration to produce energy for warmth and movement
- as waste(faeces and urine)
- as indigestible parts e.g. bones and fur

Food Pyramids

The number of organisms at different trophic levels can be counted and the information shown in a **pyramid of numbers**. A woodland food chain does not show a pyramid shape because only one large tree supports all the other organisms.



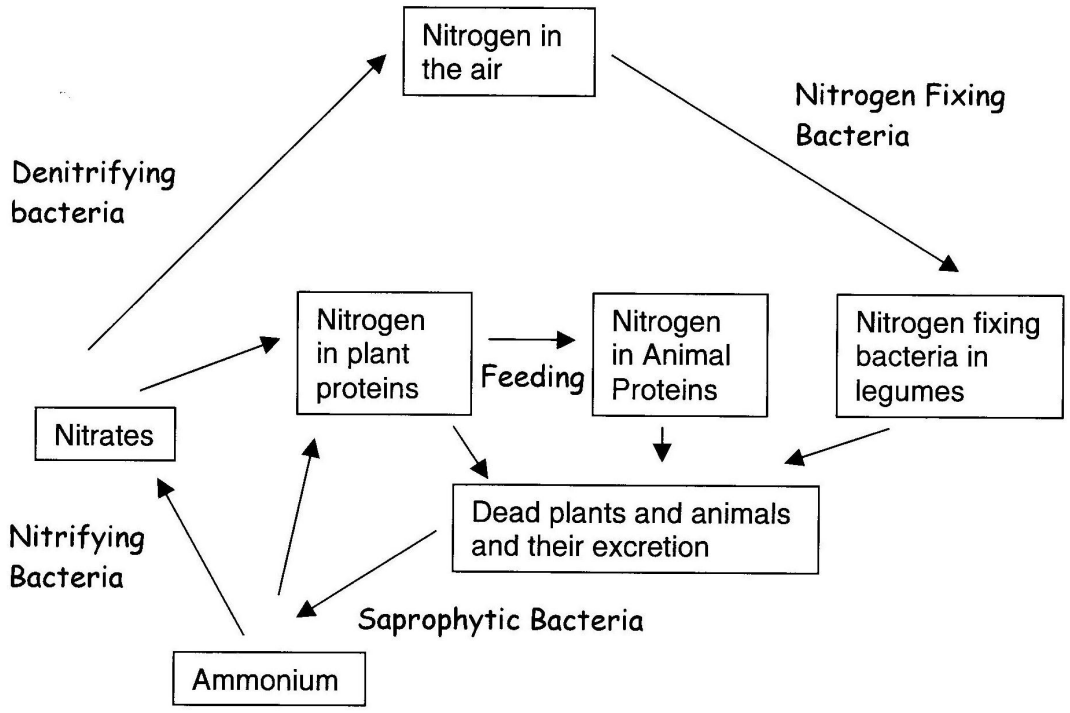
A **pyramid of biomass** is a better way of showing trophic levels because the mass of the organisms is used.



A **pyramid of energy** is the most accurate way of displaying information about food chains as this will always be a pyramid shape.

The Nitrogen Cycle

The atmosphere is made up of 78% nitrogen but this cannot be used by plants. All organisms need nitrogen to make protein, which is used for growth and repair. Nitrogen must be constantly recycled so that it does not run out.



Four different types of bacteria in the soil are involved in the nitrogen cycle:

l. **Decomposers** feed on dead and decaying organic matter and break it down
2 .**Nitrifying bacteria** convert ammonium ions to nitrates so that plants can absorb them.
3. **Nitrogen fixing bacteria** live in the root nodules of **legumes** and convert nitrogen gas into ammonium ions for the plants to use. Legumes are grown in crop rotation so that they can increase the level of nitrogen in the soil if they are ploughed back into the soil. This is known as green manuring.
4. **Dentrifying bacteria** convert nitrates in the soil into nitrogen gas. This nitrogen is no longer available for the plants to use for growth so these bacteria are not beneficial in the soil.

Eutrophication

Farmers add nitrogen to their fields in the form of nitrate fertilisers in order to increase the growth of their crops. Nitrates are very soluble and are easily leached from the bare soil over winter. This leads to **eutrophication**. This occurs as follows:

- Nitrate fertilisers are leached into rivers
- **Increased** growth of algae
- Death of water plants due to competition for light from the algae. Also death of algae due to their short life cycle.
- **Increased** reproduction of decomposers due to increased food source
- **Increased** use of **oxygen** in **respiration**
- Decreased oxygen in water leading to death of aerobic organisms.

Types of Farming

Monoculture

This is when the same crop species is grown on the same area of land year after year.

Advantages:

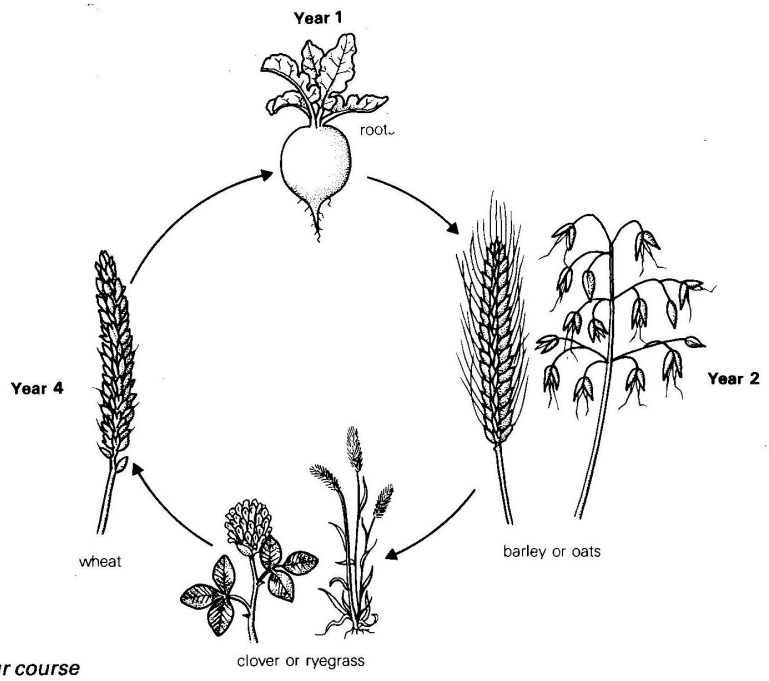
- the farmer can specialise in growing only one type of crop that is well suited to the land.
- The farmer will need fewer types of fertilisers, pesticides and cultivation equipment

Disadvantages:

- monoculture depletes the soil of nutrients so large amounts of inorganic fertilisers have to be used.
- it can lead to poor crumb structure if organic matter is not added
- monoculture encourages the build up of pests so large amounts of pesticides are therefore needed and this can cause pollution.
- it can lead to removal of hedgerows and an increase in soil erosion
- it can lead to loss of wildlife habitats so reducing species diversity

Mixed Cultivation

This is when there is a yearly change of crop in fields. For example:



A Norfolk four course rotation

Clover is a legume, so it can fix nitrogen gas into nitrates for use by the plant. The farmer can plough the clover back into the soil then this increases the level of nitrates in the soil. Alternatively the land can be left fallow for a year which means that nothing is grown on it.

Advantages:

- fewer nutrients are removed from the soil because the different crops remove different nutrients from different soil depths. This means that fewer fertilisers are needed so less pollution.
- fewer pests are present because the crop that is the pests food is constantly being moved to a different field. Also if the pest over winters in the soil they cannot re-infect the same crop. Therefore fewer pesticides are needed and there is less pollution.

Disadvantages:

- farmers must have cultivation equipment for a range of crops
- reduced profit due to a non productive field
- restrictions on which crops can be grown

Inorganic Farming

This involves the use of:

- inorganic fertilisers which contain large, known quantities of man made nutrients
- chemical pesticides and herbicides
- monoculture

Advantages:

- higher crop yields
- food is cheaper to buy

Disadvantages:

- fertilisers may leach into the rivers causing eutrophication
- hedgerows are often removed in monoculture
- herbicides may kill plants that provide habitats for animals
- pesticides may kill insect pollinators or other non harmful insects
- chemicals may remain on the food and be harmful to humans who eat it

Organic Farming

This involves the use of:

- organic fertilisers which contain smaller, unknown quantities of natural nutrients
- biological pest control where a predator is introduced to kill its prey, the pest.
- crop rotation or mixed cultivation.

Advantages:

- it is more environmentally friendly
- the food does not contain chemicals so is safer to eat
- it can be more profitable than inorganic farming because the produce can be sold at a higher price

Disadvantages:

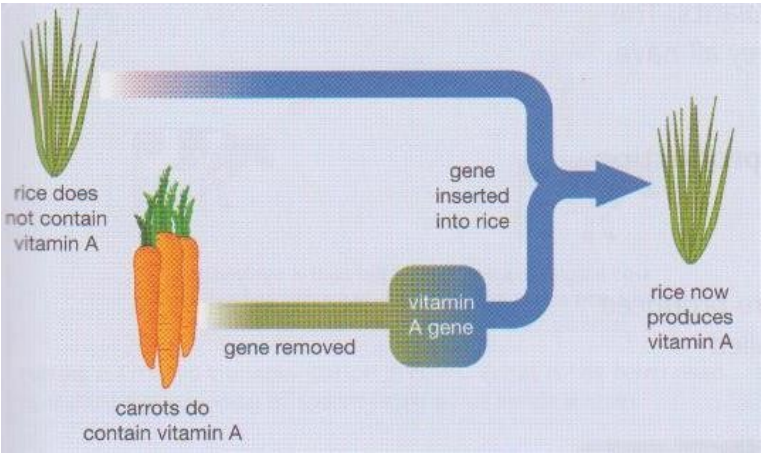
- it produces a lower yield
- food is more expensive for the consumer to buy

Most people cannot tell the difference between organic and inorganic food when they eat it so it tastes the same.

Genetic Modification of Food (GM Crops)

This is when a gene is removed from one living organism and put into another. The GM organism makes the protein that the new gene codes for. This can:

- produce crops which are resistant to disease. This means that fewer pesticides and herbicides have to be sprayed which is beneficial to the environment.
- produce herbicide resistant crops, allowing herbicides to be sprayed to kill weeds but not the crop. This can be environmentally harmful because it encourages excess use of herbicides.
- produce rice which contains vitamin A. Rice is the main diet for people living in Asian countries. It does not contain vitamin A, which is needed to prevent night blindness. Scientists have taken the gene to make beta-carotene from carrots and have put it into rice plants. Humans eating the rice can then convert the beta-carotene into vitamin A.



Disadvantages of GM:

- GM crops are sterile however if they mutate, they can cross pollinate with natural crops and alter these.
- Some people believe that it is wrong to alter living organisms and 'play God'.
- The long term consequences of eating GM food has not yet been determined.
- It takes a lot of research to produce a GM animal which people believe is unacceptable. GM animals often develop diseases and die young.

Intensive Farming:

Animals such as battery hens are kept in sheds in confined spaces and fed on concentrated feed stuffs to increase their yield.
Crops such as cereals are grown in monoculture using inorganic methods to increase productivity.

Advantages:

- greater yield
- easier to feed the animals
- easier to observe and monitor animals health
- cheaper food
- not much land is needed

Disadvantages:

- problems with disposal of waste material causing more pollution
- problems with cleaning out
- the animals cannot behave naturally
- high capital outlay
- overcrowding causing stress
- rapid spread of disease through the herd
- visual and smell pollution

Extensive Farming:

Animals such as sheep are left to graze on the hills.
Crops are grown in mixed cultivation with few inorganic fertilisers or pesticides.

Advantages:

- little money needed to start farming
- the animals are allowed to behave naturally
- not much labour is needed
- causes less damage to the environment

Disadvantages:

- large amounts of land are needed
- low yield
- small profits
- difficult for the farmer to monitor health

Land Use Issues

Land is needed for a variety of uses today.

1. Agriculture
2. Industrial activity
3. Urbanisation such as building houses, shops and schools
4. Leisure e.g. walking, watersports, biking
5. Waste disposal

When land is used for these purposes then natural habitats are lost. This means that there are fewer habitats for wildlife, less food for them to eat and fewer places for them to breed. Waste land could be improved by using it as a conservation area, nature reserve, for leisure activities such as dog walking or for school practical activities if it is near a school.

Conservation:

Farmers can improve their land environmentally and therefore increase its species diversity in a variety of ways:

- Leaving conservation headlands (areas around the edge of fields where no chemicals are sprayed)
- Planting trees and hedges and digging ponds. This increases the number of wildlife habitats available thus increasing biodiversity.

Preservation:

Preservation is the simplest form of conservation and involves maintaining buildings and land in exactly the same state.

Pollution

Air pollution:

- **Carbon dioxide** from burning fossil fuels like coal causes **global warming** . Short wave radiation from the sun enters the atmosphere and is converted into long wave infrared radiation which cannot pass out. The atmosphere therefore heats up.

  Sulphur dioxide from burning fossil fuels and from factories causes acid rain.

  Carbon monoxide and Nitrous oxides from car and tractor exhausts.

Noise pollution:
This can be caused by cars, tractors and animals.

Visual pollution:
This can be as a result of farm buildings, slurry stores and wind turbines.

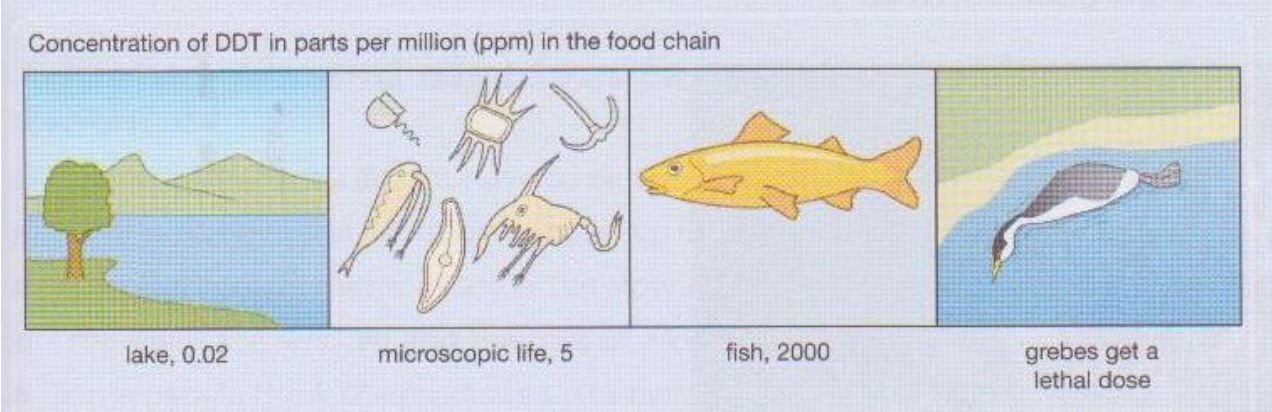
Smell pollution:
This can come from farms during, for example, muck spreading.

Water pollution:
Nitrates from fertilisers are very soluble so they dissolve easily in rainwater and are leached into rivers. This can lead to **eutrophication.** High levels of nitrates in drinking water can also lead to Blue Baby Syndrome where the baby cannot carry enough oxygen in its blood so dies and stomach cancer.

Chemical pollution:
Herbicides kill weeds. This decreases the number of plant species so reducing the number of habitats for animals to live in and the amount of food available for the herbivores. This reduces biodiversity. Herbicides can also leach into rivers and kill water plants reducing biodiversity in aquatic ecosystems.

Pesticides kill insects and other animals. This decreases the number of insects available for carnivores to feed on so decreasing biodiversity. They kill beneficial organisms such as honeybees which reduces the number available for pollination.

Pesticides cannot be broken down in the bodies of organisms. As the pesticide passes along the food chain it becomes more concentrated at each trophic level. This is because large organisms eat a large number of small organisms taking up a lot of pesticide The concentration of insecticide in the water may not be high enough to kill fish, but over the year it does poison carnivores such as the grebe. This is called **bioaccumulation**.



The diagram shows the build up of the pesticide DDT in a food chain. The use of DDT is now restricted world wide due to its effect on carnivores. Many pesticides and herbicides are not biodegradable so do not break down in the soil. Once sprayed, they therefore continue to have an effect on the local plants and animals for many years.

Reducing pollution:

- Use of catalytic converters in cars to reduce air pollution
- Use of renewable energy sources such as wind power to reduce carbon dioxide pollution
- Use of organic fertilisers to prevent pollution from chemical fertilisers
- Use of biological pest control to prevent pollution from chemical pesticides
- Good hygiene to reduce the need for chemical disease control on animals
- Constant vigilance to catch plant and animal diseases early

Managing The Land

People who manage the land have a number of responsibilities:

- to maintain the character of the landscape
- to improve biodiversity
- to manage public access
- to preserve historical features
- to protect resources such as soil and water.

This can be done in a variety of ways.

The Environmental Stewardship Scheme

The Environmental Stewardship is a voluntary scheme which is run by the Department for Environment, Food and Rural Affairs (DEFRA). Farmers and land managers can opt into the scheme in which the government makes payments to them if they improve the natural beauty and diversity of the countryside.

The schemes primary objectives are to:

- Conserve wildlife (biodiversity)
- Maintain and enhance landscape quality and character
- Protect the historic environment and natural resources
- Promote public access and understanding of the countryside
- Natural resource protection

Legislation for Open Access

The Countryside and Rights of Way Act (CROW) was introduced by the national government to allow direct access by the public to large areas of the countryside for activities like walking, sightseeing, bird watching, picnicking, climbing and running.

To make sure the privacy of people who live and work on the land is protected, land that it is used as a garden, park, cultivated land, or land covered by buildings will not be included in the right of access and is known as excepted land

High impact activities, like cycling, fishing, horse riding camping or driving a vehicle are not permitted under the CROW Act unless they already take place with the permission of the landowner.

Landowners can restrict or exclude the public from the land that they own for up to 28 days each year where this is necessary for land management, fire prevention, or public safety.

Special requirements also exist to control dogs on land covered by the CROW Act. There is a general requirement for dogs to be kept on a between 1 March and 31 July, and at any time in the vicinity of livestock. Landowners also have powers to restrict people with dogs from small enclosures for lambing, and across grouse moors.

Green Belt Land

Green belts are part of the national planning policy. In 1947, the Town and Country Planning Act allowed local authorities to include Greenbelts in their development plans. A Greenbelt is a specifically defined area of land around an existing developed area such as a town or city.

Green Belt boundaries are laid out in Local Plans. The Local Plan is the document produced by the planning authority (usually a district or borough council) in England. Land included in the Green Belt must contribute to one or more of the five purposes of the Green Belt

Purposes of including land in Green Belts

- To check the unrestricted sprawl of built-up areas.
- To safeguard the surrounding countryside from further encroachment.
- To prevent neighbouring towns from merging into one another.
- To preserve the special character of historic towns.
- To assist in urban regeneration by encouraging the recycling of derelict and other urban land.

Energy Resources

Electrical energy is an essential part of modern life. Electricity can be generated in a number of ways and there are advantages and disadvantages of each.

Fossil Fuels

The fossil fuels are coal, oil and natural gas. They were formed from the remains of living organisms millions of years ago. About three-quarters of the electricity generated in the UK comes from power stations fuelled by fossil fuels.

Disadvantages:

- they are non-renewable energy resources which means their supply is limited and they will eventually run out
- they release carbon dioxide when they burn, which adds to the greenhouse effect and increases global warming.
- they release sulphur dioxide gas when they burn, which contributes to acid rain.
- obtaining these fossil fuels often involves damaging the environment

Nuclear fuels

Nuclear fuels such as uranium and plutonium **are involved in nuclear reactions** in the nuclear reactor, which leads to heat being released.

Advantages:

- they do not produce carbon dioxide or sulphur dioxide.

Disadvantages:

- they are non renewable
- if there is an accident, large amounts of radioactive material could be released into the environment
- nuclear waste remains radioactive and is hazardous to health for thousands of years so it must be stored safely.

Wind energy

As the wind blows, it transfers some of its kinetic energy to the blades of the wind turbine, which turn and drive the generator.

Advantages:

- it is a renewable energy resource
- there are no fuel costs
- no harmful polluting gases are produced.

Disadvantages:

- wind farms can be noisy and may spoil the view for people living near them.
- the amount of electricity generated depends on the strength of the wind. If there is no wind, there is no electricity.

Water energy

Wave energy is generated when machines use the kinetic energy as the sea rises and falls because of waves on the surface to drive electricity generators.

A tidal barrage is a barrier built over a river estuary which makes use of the kinetic energy as water moves in and out of river mouths each day because of the tides.. The barrage contains electricity generators, which are driven by the water rushing through tubes in the barrage.

Hydroelectric power stations also use the kinetic energy in moving water. But the water comes from behind a dam built across a river valley. The water high up behind the dam contains gravitational potential energy. This is transferred to kinetic energy as the water rushes down through tubes inside the dam. The moving water drives electrical generators, which may be built inside the dam.

Advantages:

- it is a renewable energy resource
- there are no fuel costs
- no harmful polluting gases are produced
- tidal barrages and hydroelectric power stations are very reliable and can be turned on quickly.

Disadvantages:

- it has been difficult to scale up the designs for wave machines to produce large amounts of electricity
- tidal barrages destroy the habitat of estuary species, including wading birds
- hydroelectric dams flood farmland and push people from their homes. The rotting vegetation underwater releases methane, which is a greenhouse gas.

Solar energy

Solar cells are devices that convert light energy directly into electrical energy.

Advantages:

- it is a renewable energy resource
- there are no fuel costs
- no harmful polluting gases are produced.

Disadvantages:

- Solar cells are **expensive and inefficient**, so the cost of their electricity is high.
- Solar cells do not work at night and are not very effective in cooler climates.

Biofuels

These are crops that are grown specifically to burn to produce electricity, for example elephant grass and sugar cane.

Advantages:

- they are renewable

Disadvantages:

- large areas of land are needed to grow the crops
- carbon dioxide is released when they are burnt contributing to the greenhouse effect

Careful monitoring of environmental conditions using ICT can help prevent the waste of electricity. For example the use of thermostats in glasshouses means that the temperature is kept at an optimal level for plant growth. Reducing electricity use benefits the farmer by reducing production costs and also helps to reduce pollution caused by electricity generation.

Use of Machinery

Farmers are now using larger and more powerful machines such as combine harvesters and sprayers (as shown below)

Advantages:

- more efficient
- less labour intensive

Disadvantages:

- hedgerows are removed to allow machinery to maneuver. This leads to decreased biodiversity, fewer habitats for birds and small mammals and increased wind erosion
- soil compaction due to the weight of the machines. This reduces air spaces for the respiration of plant roots and soil organisms. It also reduces drainage and can lead to water logging. A plough pan can form which is compacted layer just below the maximum depth of cultivation.

These effects can be reduced in a number of ways:

- use of wide tyres which spreads the weight of the machine over a larger surface area so reducing pressure
- increasing the length of the boom so that the tractor has to make fewer trips across the field thus reducing contact.

Conservation Bodies

Conservation aims to keep ecosystems stable as environmental conditions change. Preservation aims to keep an area the same overcoming any changing situation.
Conservation Bodies are concerned with conserving wildlife and their habitats. There are four very important bodies:

Worldwide Fund for Nature (WWF)
This is an international organisation that is involved in:

- Fund raising
- Educating the public about the plight of animals such as pandas
- Conservation projects
- Saving endangered animals by setting up wildlife reserves and preventing trade

Royal Society for the Protection of Birds (RSPB)
This is a national organisation that is involved in:

- Running nature reserves for the protection of rare birds
- Educating the general public about the plight of birds
- Carrying out bird census
- Protecting habitats that are important for birds

English Nature
This is a national government organisation that is involved in:

- Running national nature reserves
- Funding research into conservation
- Conserving important habitats in the UK
- Preserving endangered species in the UK
- Protecting landscapes in the UK

Rare Breeds Survival Trust (RBST)
This is a national organisation that is involved in:

- promoting the value of native breeds to the public
- work with breed societies to protect rare breeds
- collect information on the number of rare breeds to ensure they do not become extinct

Risk Assessments

Before carrying out field work it is important that a risk assessment is done.

Hazard	Control
Water	• If in a tidal area ensure that the tide times are known to avoid being caught by the incoming tide • Beware strong currents • Do not enter deep water unless a trained life guard is present
Heat stroke	• In summer, wear a hat, cover up and wear sun cream. • Carry plenty of water to prevent dehydration
Hypothermia	• In winter, wear warm, waterproof clothes • Take plenty of food and hot drinks
Silly behaviour	• Students should be given specific instructions that they must follow at all times
Carrying equipment	• Always bend knees not back when carrying heavy equipment • Use a trolley where appropriate
Unsafe ground	• Wear sturdy shoes with soles that grip • Decide a safe path to walk that avoids slippery areas and uneven rocks
Diseases from the soil or animals	• Avoid contact if possible • Wash hands thoroughly especially before eating
Working in remote areas	• Take a mobile phone in case of emergencies • Always tell people where you will be