CHAPTER 3

AGRICULTURE AND THE ENVIRONMENT

The Soil:

Soil it is fundamental to the growth of the plant.

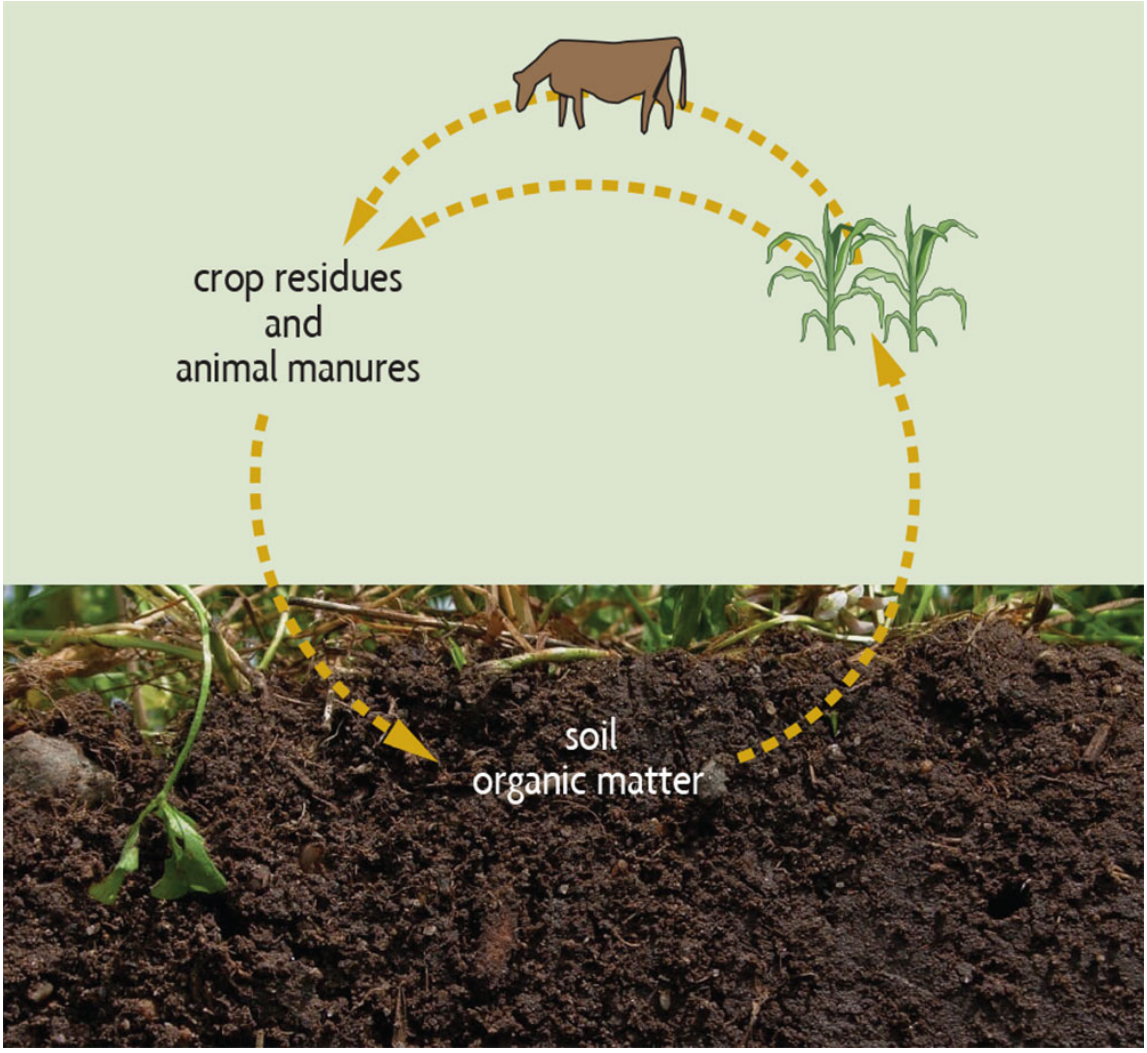
Soil Composition:

Soil is a mixture of organic matter, minerals, gases, liquids, and organisms that together support life.

• **Mineral Particles**: combination of rock fragments and other inorganic substances.

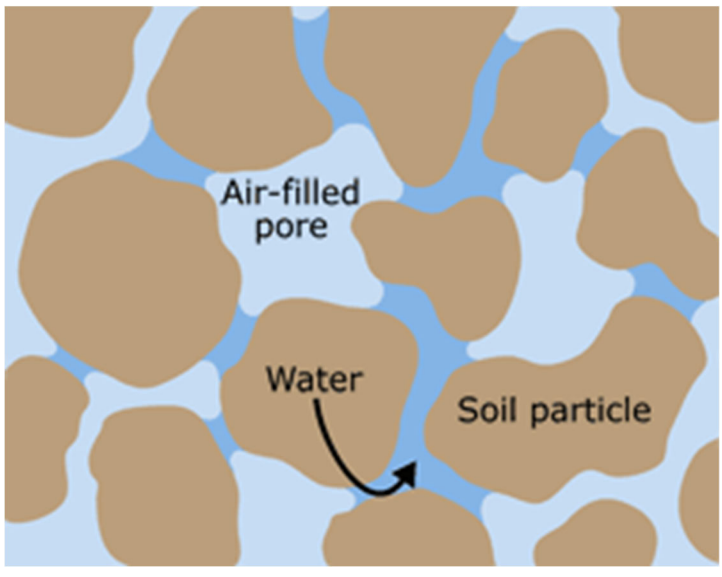
- They are formed due to physical, chemical and biological weathering of the parent rock.

• **Organic Content**: mixture of living plants, animals, microorganisms and their dead remain.



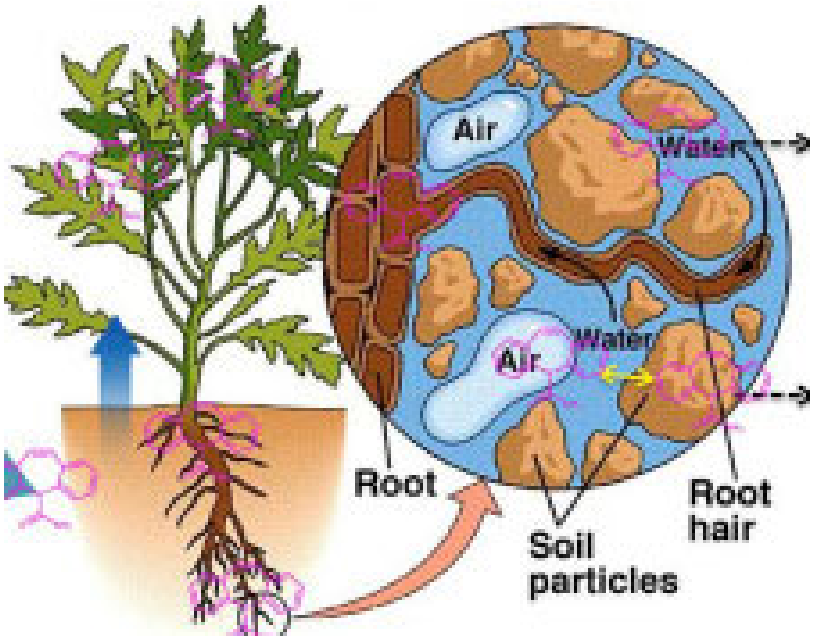
• **Air:** held within the pore spaces (between the mineral particles and organic content).

- Air enters the soil by diffusion.

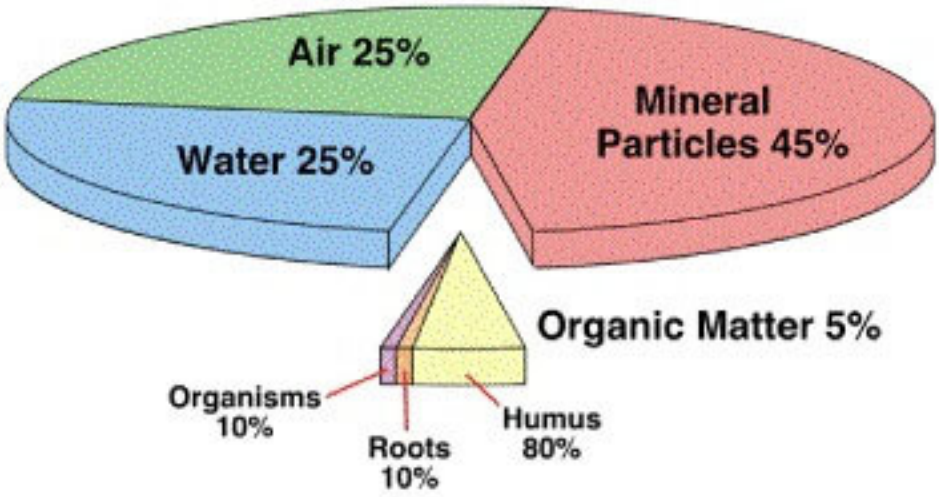


• **Water**: held within the pore spaces (water that is available for plant growth).

- Water enters the soil when there's precipitation or when the soil is irrigated.



The proportion of components in a typical cultivated soil.



What is Humus?

Humus is dark, organic material that forms in soil when plant and animal matter decays.

The Proportion of Soil Components Depends on:

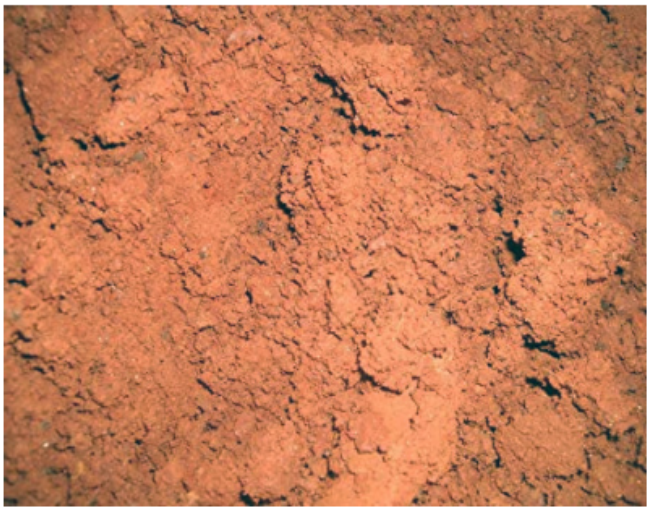
- **Type of soil.**

Sandy soil

Sandy Soil is light, warm, dry and tends to be acidic and low in nutrients. Sandy soils are often known as light soils due to their high proportion of sand and little clay (clay weighs more than sand).

These soils have quick water drainage and are easy to work with. They are quicker to warm up in spring than clay soils but tend to dry out in summer and suffer from low nutrients that are washed away by rain.

The addition of organic matter can help give plants an additional boost of nutrients by improving the nutrient and water holding capacity of the soil.



Clay Soil

Clay Soil is a heavy soil type that benefits from high nutrients. Clay soils remain wet and cold in winter and dry out in summer.

These soils are made of over 25 percent clay, and because of the spaces found between clay particles, clay soils hold a high amount of water.

Because these soils drain slowly and take longer to warm up in summer, combined with drying out and cracking in summer, they can often test gardeners.

Silt Soil

Silt Soil is a light and moisture retentive soil type with a high fertility rating.

As silt soils compromise of medium sized particles they are well drained and hold moisture well.

As the particles are fine, they can be easily compacted and are prone to washing away with rain.

By adding organic matter, the silt particles can be bound into more stable clumps.

Peat Soil

Peat soil is high in organic matter and retains a large amount of moisture.

This type of soil is very rarely found in a garden and often imported into a garden to provide an optimum soil base for planting.

Chalk Soil

Chalk soil can be either light or heavy but always highly alkaline due to the calcium carbonate (lime) within its structure.

As these soils are alkaline they will not support the growth of ericaceous plants that require acidic soils to grow.

If a chalky soil shows signs of visible white lumps then they can't be acidified and gardeners should be resigned to only choose plants that prefer an alkaline soil.

Loam Soil

Loam soil is a mixture of sand, silt and clay that are combined to avoid the negative effects of each type.

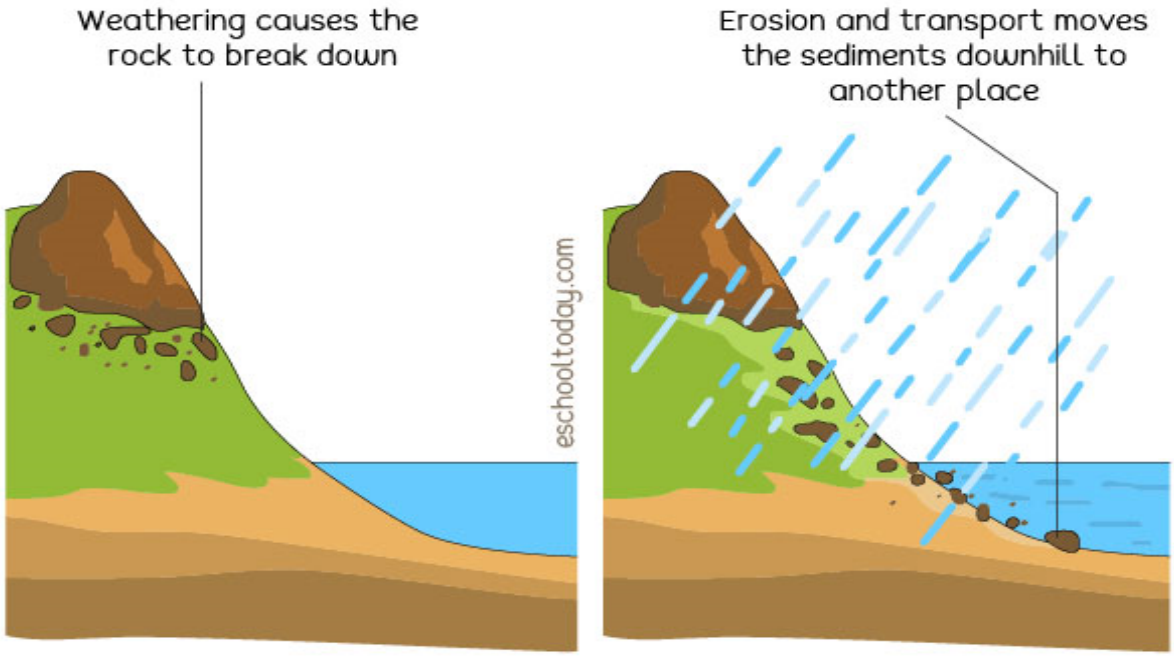
These soils are fertile, easy to work with and provide good drainage. Depending on their predominant composition they can be either sandy or clay loam.

As the soils are a perfect balance of soil particles, they are considered to be a gardeners best friend, but still benefit from topping up with additional organic matter.

- **Way it has been managed.**
- **Local climatic conditions.**
- **Size of the mineral particles.**

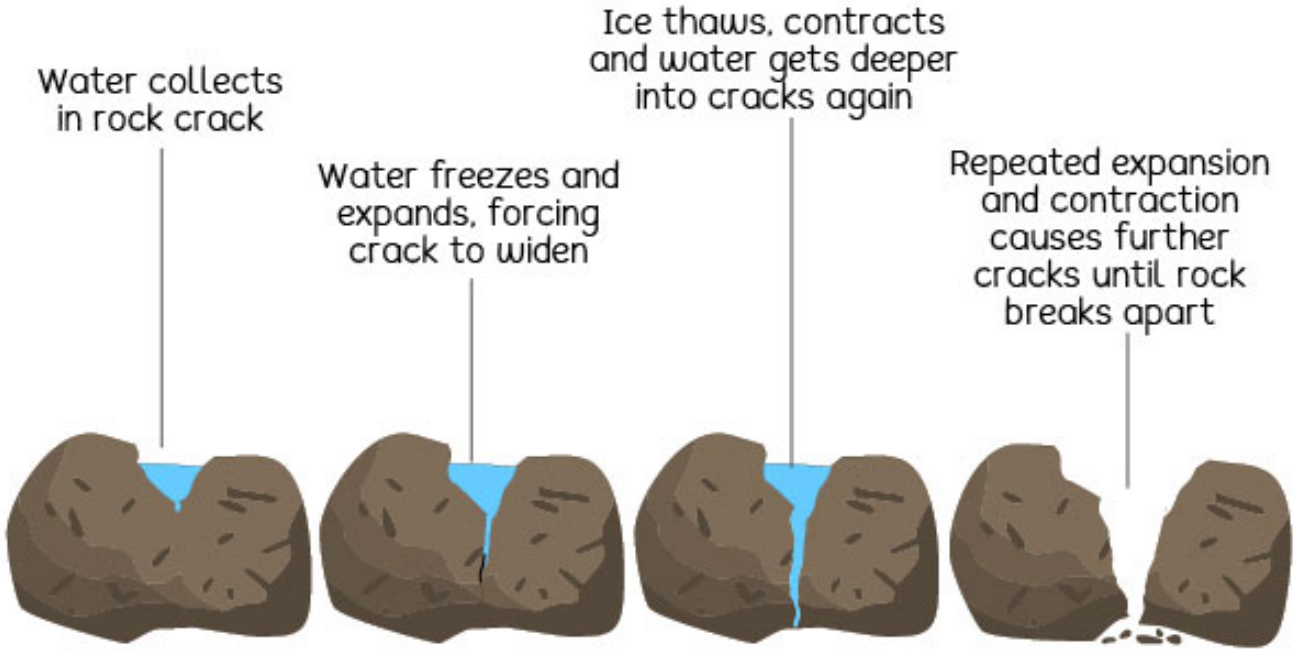
Where do the soil components come from?

- The mineral particles (which occupy the largest volume within the soil) are formed from the **weathering** and erosion of the parent rock (the rock underlying the soil).
- Weathering is the process by which rocks are broken down into smaller particles.
- Movement of these particles is known as **erosion**.

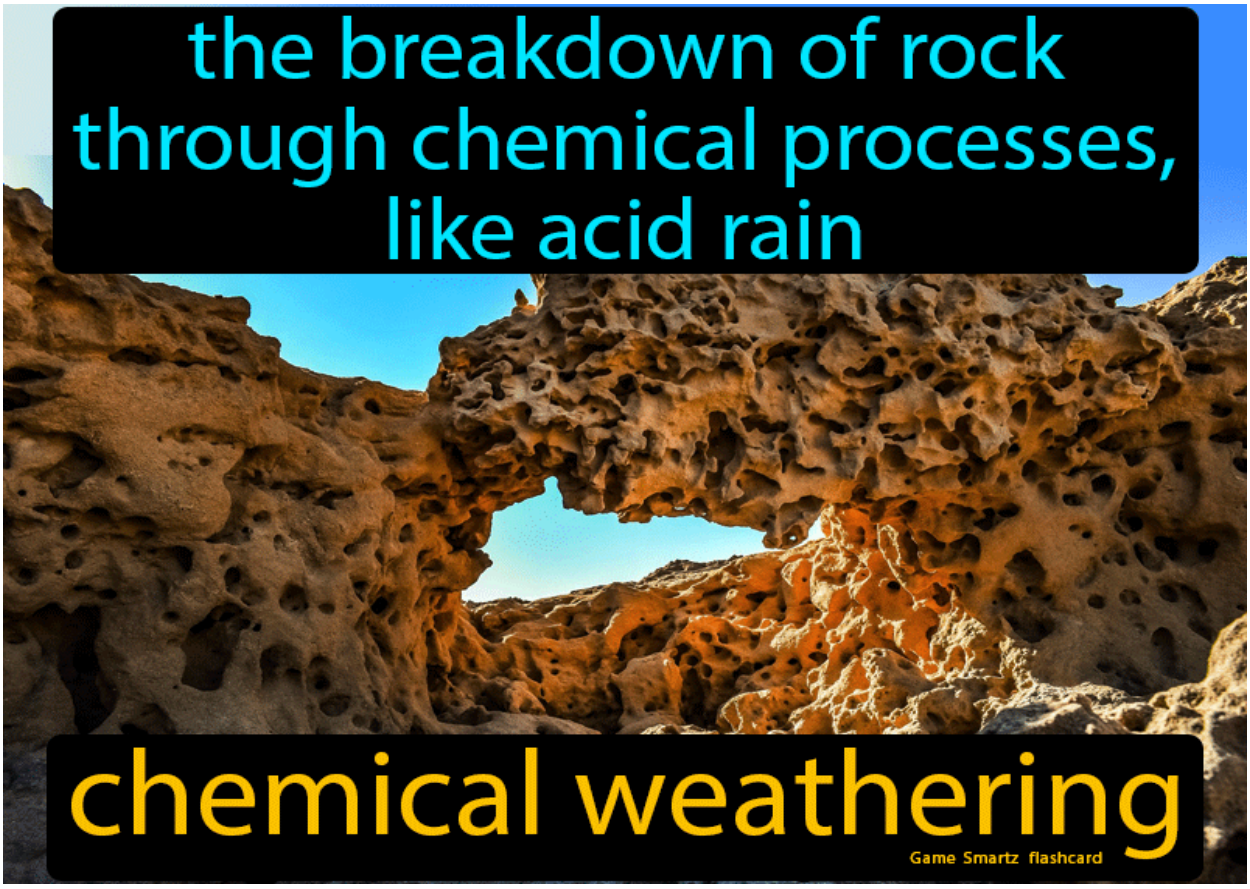


- **The weathering of rock can take a number of forms:**

Physical Weathering: is caused by frost, heat, water and ice or wind.



Chemical Weathering: is caused by carbon dioxide (in the air) combined with water to form a weak acid, carbonic acid. This acid reacts with alkaline minerals in the rock, causing the rest of the rock to crumble.

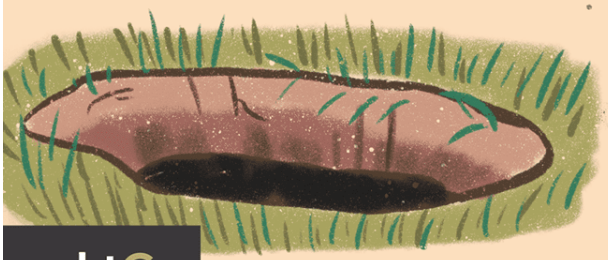


Types of Chemical Weathering

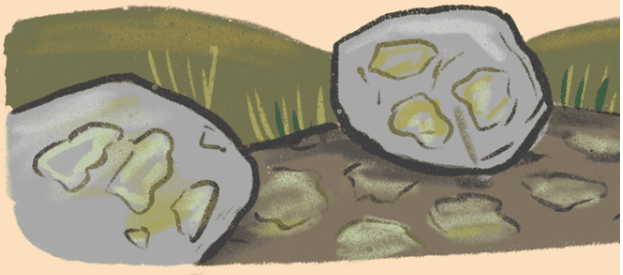
Reaction With Water

Reaction With Oxygen

Reaction With Acid



Reactions With Organisms



Biological Weathering: is caused by processes such as the growth of plant roots into the cracks, movement of animals across the rocks and organisms in the soil can produce carbon dioxide which combines with water to form carbonic acid.

Soil particles can be classified into three groups according to their size:

Particles type	Size of particles	Texture	Characteristics
Sand	2.0 – 0.02 mm	Gritty	Large pore size Drains well Contains large air spaces
Silt	0.02 – 0.002 mm	Silky or soapy	Less friction than sand Particles slippery
Clay	<0.002 mm	Sticky when wet	Particles held together tightly Poor air spaces or drainage Forms a hard mass when dried

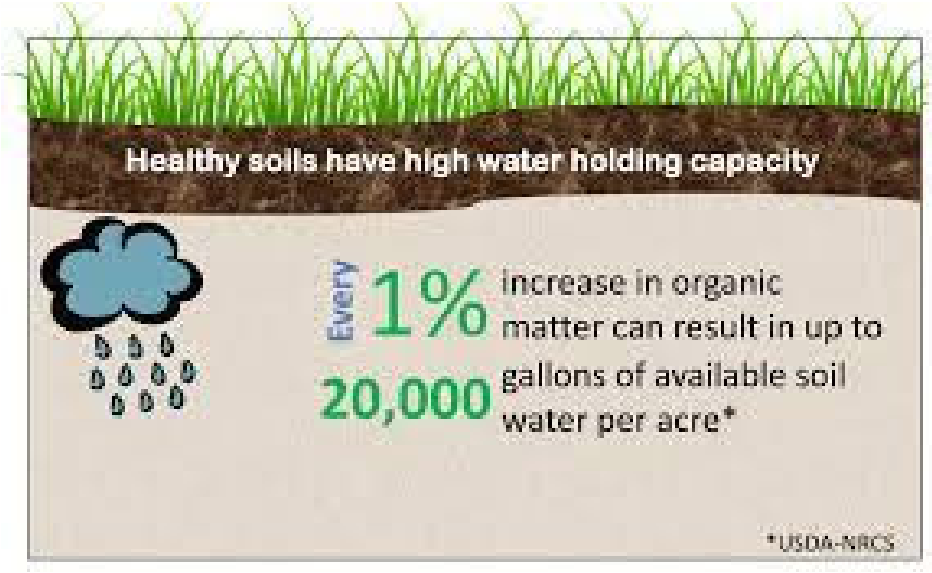
Soils for Plant Growth:

- Most plants require a combination of factors to grow successfully. These include:
    - **The availability of important nutrients to support plant growth.**
    - **Anchorage to hold the roots securely.**
    - **A supply of water.**
    - **Oxygen around the roots to enable the root cells to respire.**
- NPK: Plants require a supply of nitrogen, phosphorus, potassium and a range of other elements to construct proteins and carry out life processes

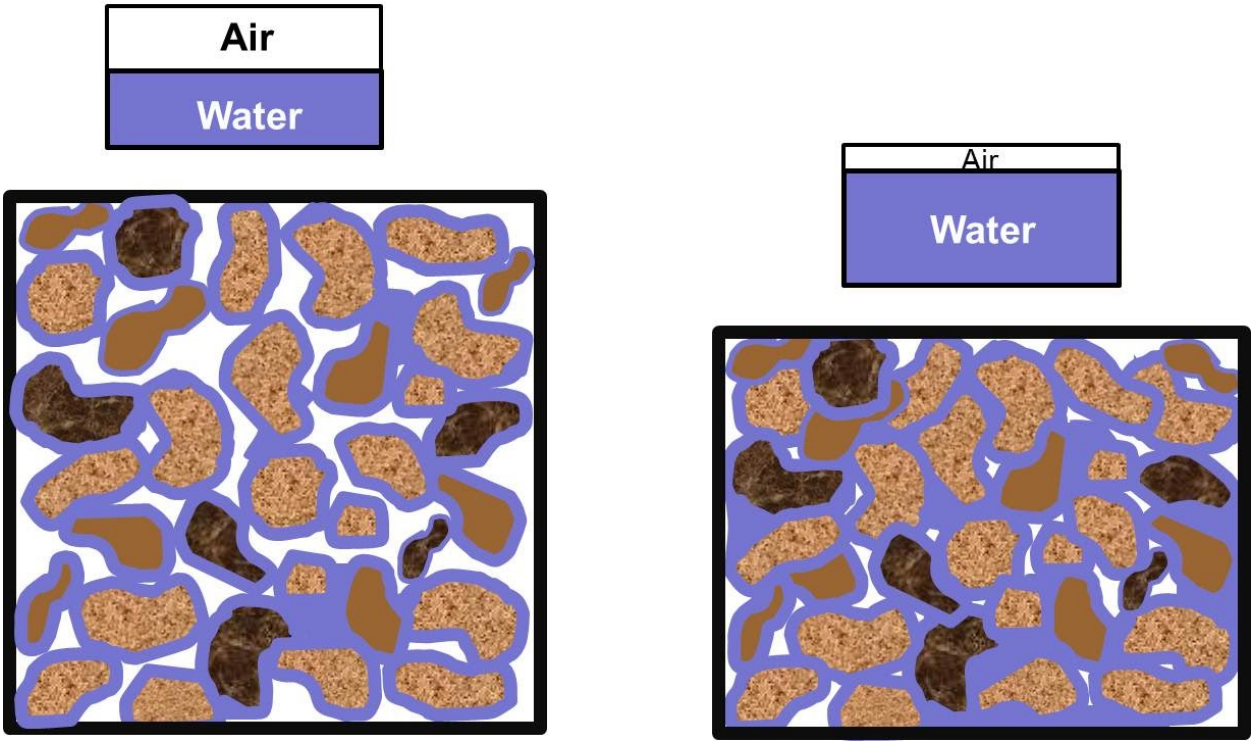
ELEMENT	**SUPPLIED AS**
NITROGEN	Nitrate ions (NO^{-}_{3})
PHOSPHORUS	Phosphate ions (PO_4^{-3})
POTASSIUM	Potassium ions (K_{+})

- **Organic content:** many different decomposers that produce humus (rich in nutrients) are involved:
    - **Earthworms:** break down vegetation; mix the soil; aerate the soil; spread organic matter through the soil.
    - **Fungi:** feed directly on dead matter; digest hard woody items; aid plants to take up nutrients through their roots.
    - **Bacteria:** work on organic matter; convert waste products to simple chemicals; **some convert nitrogen to nitrates ∴ important in nitrogen cycle.**

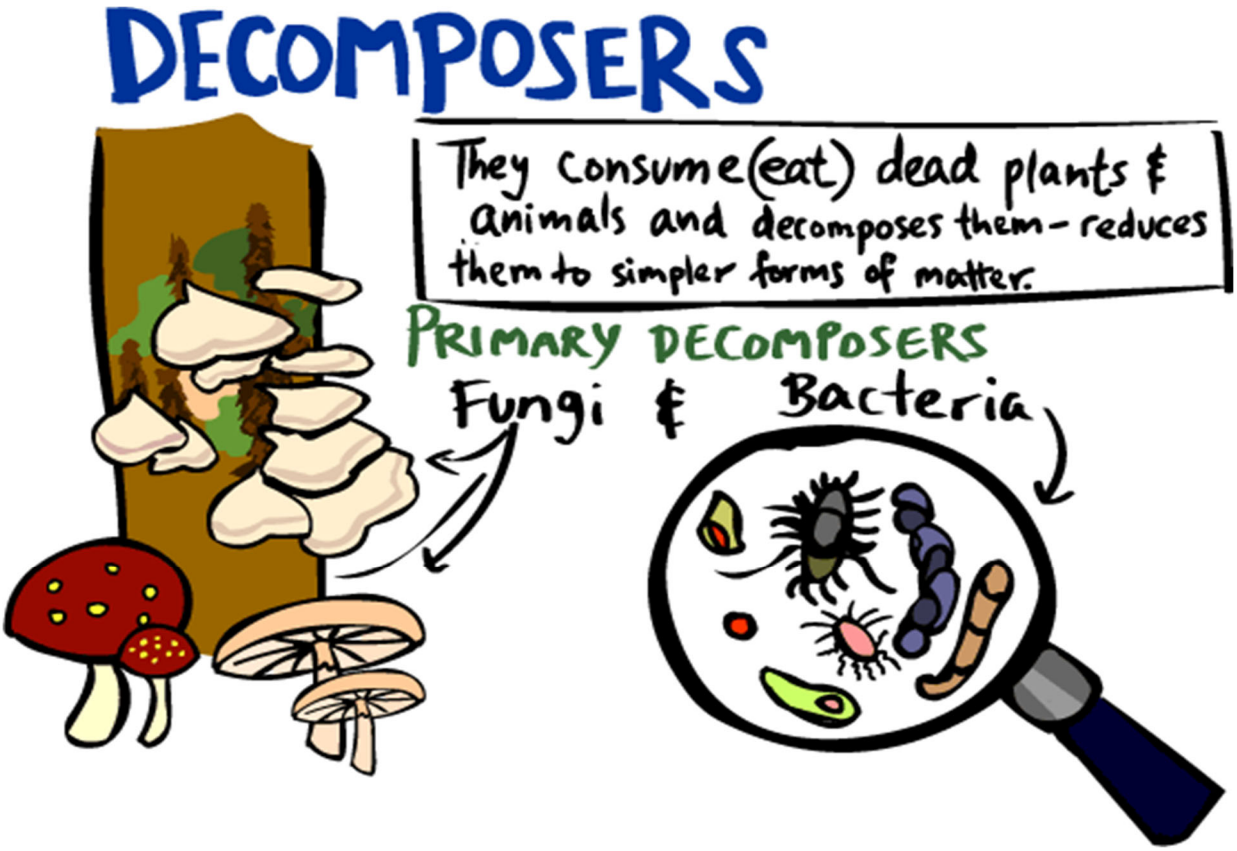
- **High levels of organic matter have the following positive effects:**
  - Increase the water-holding capacity (like a sponge), that means less irrigation is required.



  - Increase air spaces in the soil.



- Increase no. of decomposers, tunnels and burrows in the soil, providing additional drainage and less compaction.



- Prevent the loss of mineral nutrients (humus holds onto mineral nutrients).

- **Soil pH:**
  - Depends on the type of parent rock and pH of water that flows into the area.
  - Affects the uptake of nutrients by plant roots.
  - Affects the availability of nutrients.
  - Farmers can try changing the pH of the soil either to acidify it (using fertilizers that have an acidic effect) or make it alkaline (adding ground limestone).

- **Signs of Mineral Nutrients Deficiency in Plants:**

Plant nutrients	Symptoms of Deficiency
Nitrogen (N)	Slow growth, yellowing leaves (oldest first)
Phosphorus (P)	Leaves dull with blue-green colour. Leaves fall early
Potassium (K)	Poor quality fruits and seeds, leaves with brown edges
Sulfur (S)	Yellowing of leaves (youngest first)
Calcium (Ca)	Death of plant tissues. Poor fruit storage
Magnesium (Mg)	Yellowing of leaves between the leaf veins. Early leaf fall.
Iron (Fe)	Yellowing of leaves between the veins (youngest leaves first)
Copper (Cu)	Dark green leaves become twisted and withered (Young leaves first)
Zinc (Zn)	Leaves show poor development, grow only to very small size.
Boron (B)	Leaves misshapen and malformed. Hard areas in fruits and other storage organs.

Sandy soils verses clay soils:

SAND	Clay
Larger air spaces.	Poor air spaces.
Drains well.	Poor drainage.
Poor retention of humus.	Retains humus.
Easier to cultivate.	Hard to cultivate.

The properties of organic matter mean that when it is added to either of the two types soil it helps reduce their negative impacts (it provides additional water-holding capacity to sandy soils and increases the size of air spaces in clay soils.

Agriculture

Agriculture is defined as cultivation of animals, plants and fungi for food and other products used to sustain human life.

It depends on number of factors:

- **Climate.**
- **Culture.**
- **Technology.**
- **Economics.**

Agriculture types:

Arable Agriculture:

Arable farming involves **growing crops such as wheat and barley** rather than keeping animals or growing fruit and vegetables. Arable land is land that is used for arable farming.

Examples:

wheat, and barley, oilseed rape, peas and beans, sugar beet and potatoes

Pastoral Agriculture:

Pastoral farming is aimed at producing livestock, rather than growing crops. Examples include dairy farming, raising beef cattle, and raising sheep for wool.

Mixed Agriculture:

Mixed farming is a type of farming which involves both the growing of crops and the raising of livestock. Such agriculture occurs across Asia and in countries such as India, Malaysia, Indonesia, Afghanistan, South Africa, China, Central Europe, Canada, and Russia.

OR

The cultivation of crops alongside the rearing of animals for meat or eggs or milk defines mixed farming. For example, a mixed farm may grow cereal crops such as wheat or rye and also keep cattle, sheep or poultry.

Subsistence Agriculture:

Subsistence agriculture occurs when farmers grow food crops to meet the needs of themselves and their families on smallholdings. Subsistence agriculturalists target farm output for survival and for mostly local requirements, with little or no surplus.

Commercial Agriculture:

Commercial Agriculture is a cropping method in which crops are raised and livestock are raised in order to sell the products on the market in order to make money.

Agriculture types

SUBSISTENCE	COMMERCIAL
• Cultivation of food to meet the needs of the farmers and their families;	• Cultivation of food with the main aim of selling them for cash;
• Surplus is bartered for other goods (or cash).	• Some food may be used by the farmers.
• **Examples**: wheat and rice.	• **Examples:** tea, coffee, cocoa, sugarcane, cotton, rice, wheat and corn.

ARABLE	PASTORAL
• Production of plants for consumption by humans.	• Production of animals or animal-related products.
• **Examples**: rice, wheat, maize and soybeans.	• **Examples**: grass/grain (to feed the animals), milk, wool eggs.

MIXED

• Farms that grow crops for food and rear animals.

Extensive Production:

Occur when there is small amount of production from a large area of land.

Intensive Production:

Occur where large amounts are produced from small areas of land.

Increasing Agricultural Yields

The demands of food keep on increasing as the global population increase. And there is pressure on food production in number of was, including:

- An increasing world population needing more resources.
- Climate change affecting the availability of fertile farmland.
- Increases in the standard of living creating a demand for more food variety.
- Increasing settlement sizes reducing available farmland.
- Larger populations impacting on the availability of water for irrigation.

Techniques for Improving Crop Yield:

There are some successful techniques that help farmers meet the need for increased food production to feed growing population.

1. **Crop Rotation:** is the principle of growing different types of plants in different plots each year. Related groups of plants are grown together during a season, then at the start of the next season moved to different plot of land that has been just used for a different plant group.

- Continually growing the same plants in the same place causes:
  - a build-up of diseases in the soil that affect plant growth.
  - an increase in the pest that attack the plants.
  - a depletion in soil nutrients.
- A large plot of land usually divided into four smaller areas, each to contain a particular type of plant:

1. **Legumes**: have nitrogen-fixing bacteria in their root nodules.

The legume family consists of plants that produce a pod with seeds inside. The term "legume" is used to describe the seeds of these plants. Common edible legumes include **lentils, peas, chickpeas, beans, soybeans, and peanuts**.

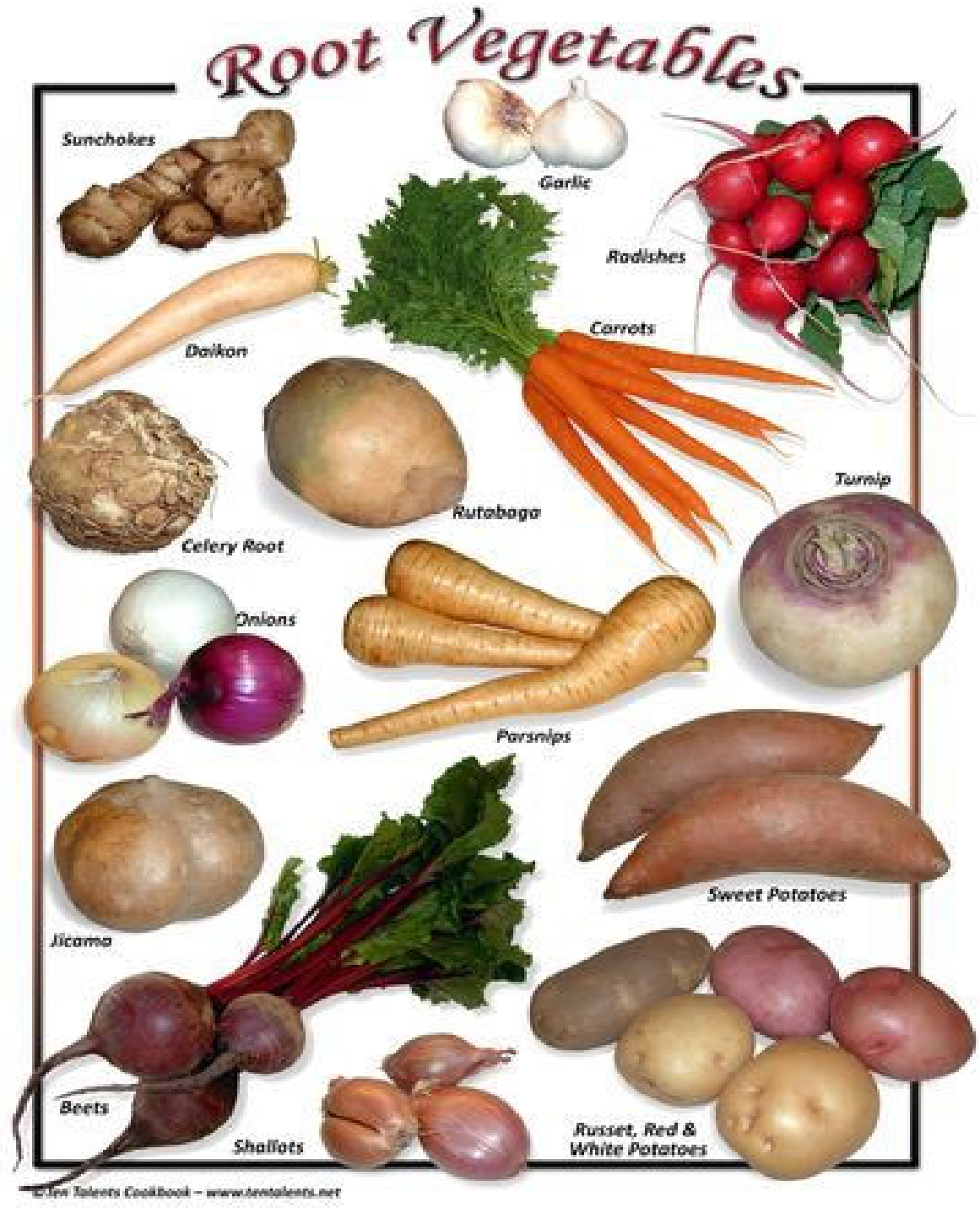
2. **Leafy crops**: vegetables that are required for their leaves (require a lot nitrogen left by legumes).

What is a leafy crop?

Leafy vegetables are a highly variable group of crop plants that broadly can be defined as vegetables grown for their edible leaves. ... Leafy vegetables include, among others, spinach, turnip, parsley and lettuce.

3. Root Crops: have deep root systems.

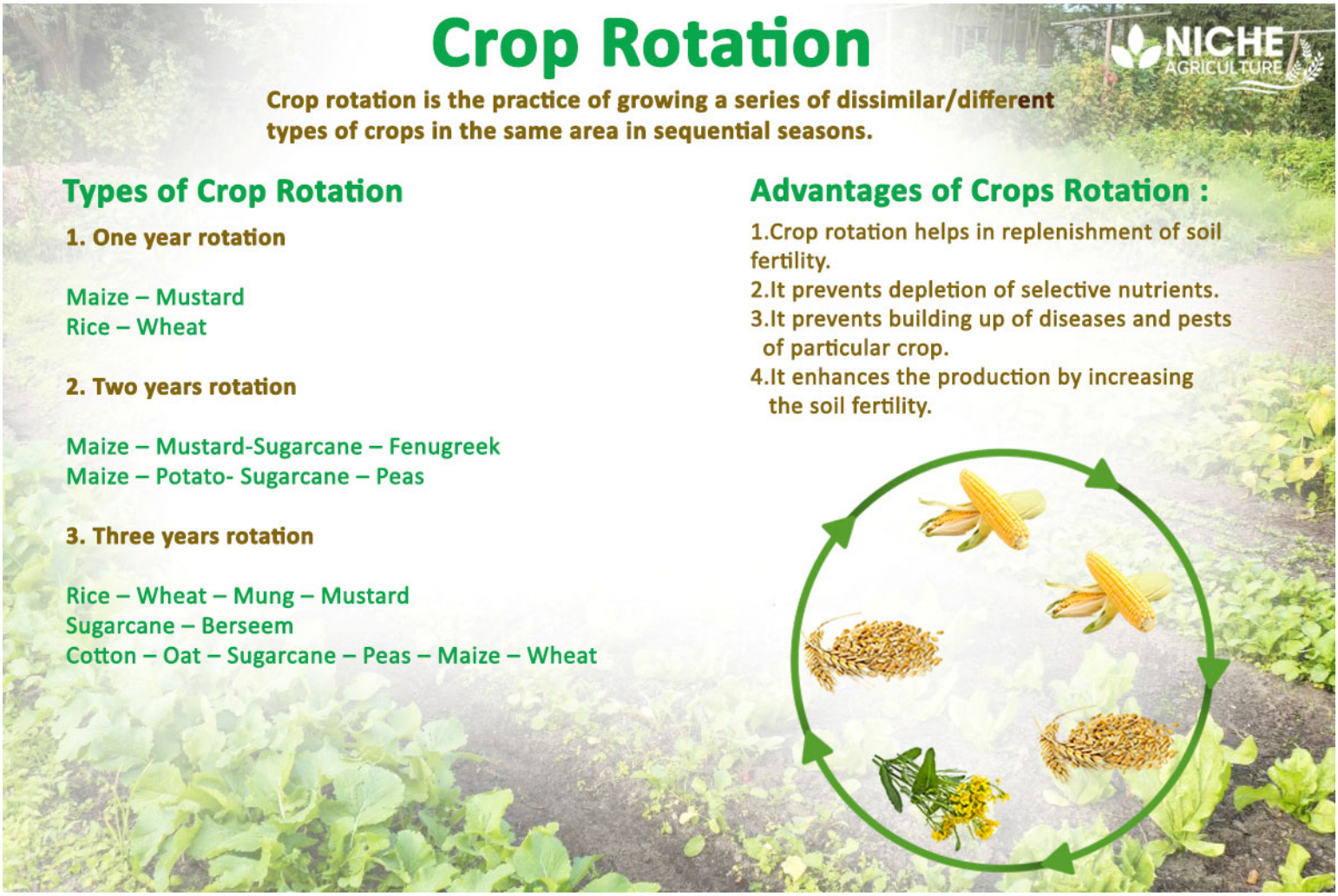
Root crops are underground plant parts eaten by humans as food.



4. **Fallow:** the land is ploughed but left barren for a period to restore soil fertility and to avoid surplus production.

Advantages of Crop Rotation:

- Diseases in the soil affecting the plant are left behind.
- Pests need to find a new site ∴ their population is reduced.
- The soil in the new plot is likely to have the essential nutrients.
- Crops ready to harvest at different times ∴ less potential waste, less labour and machinery needed.



2. **Fertilizers:** contain minerals such as nitrogen, potassium and phosphorus. Add on to the nutrients available in the soil.

Advantages and disadvantages of different types of fertilizers:

TYPE	ADVANTAGES	DISADVANTAGES
ORGANIC	• Uses natural resources. • Supplies organic matter.	•Unpleasant to handle. • Harder to transport. • Variable in composition.
INORGANIC	• Meet a particular need. • Easier to store.	•Cost of manufacture. • Transportation costs.
QUICK ACTING	• Deficiency problems are dealt with swiftly.	• Easily leach out in heavy rain.
SLOW ACTING	•No need to reapply.	• Little immediate impact.

3. **Irrigation:** supplying water to the crops.

Why is irrigation important?

- Large percentage of a plant is made up of water.
- Essential for cell activity.
- Used in photosynthesis.
- Mineral nutrient uptake requires water in the soil.
- The water must be free from pollution and low in salt.

The process of supplying water can be divided into three stages:

a: storage of the water.

b: transportation to the required site.

c: application to the plant.

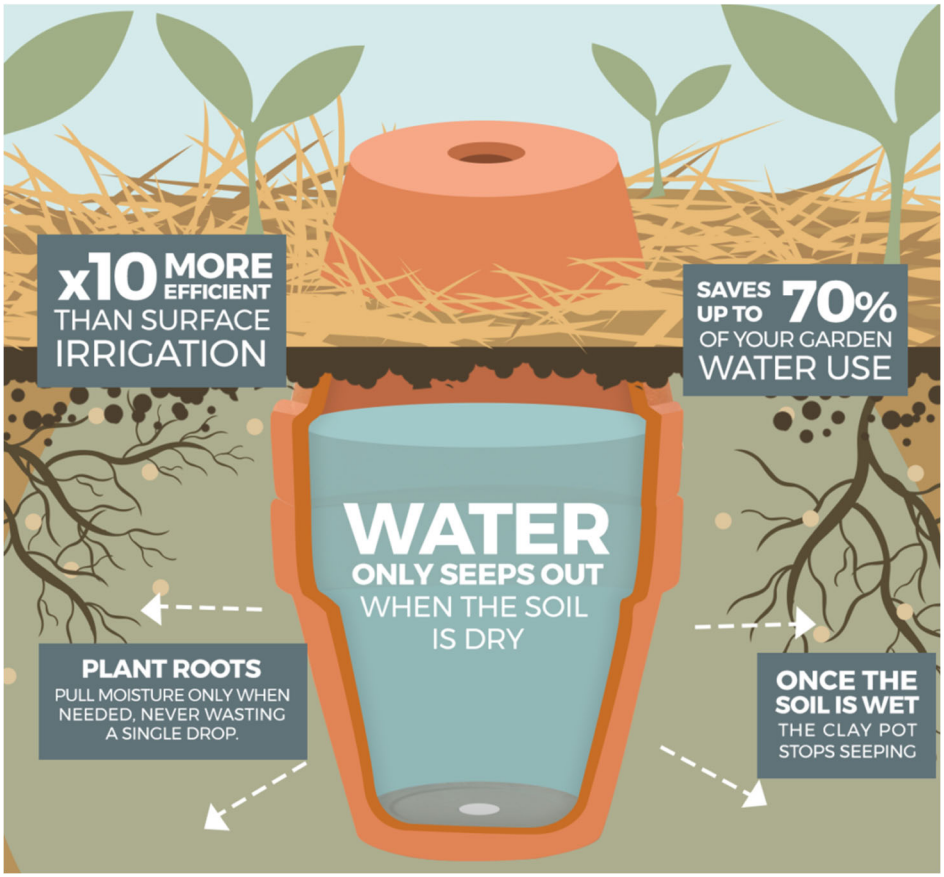
- Common water application methods:

a: OVERHEAD SPRINKLERS

ADVANTAGES	DISADVANTAGES
• Easy to setup. • Can cover a large area from one sprinkler. • No need to attach pipes to each plant.	• Large droplets may cap the soil. • Small droplets may be blown away by wind. • Water lands on leaves and soil, which evaporates quickly.

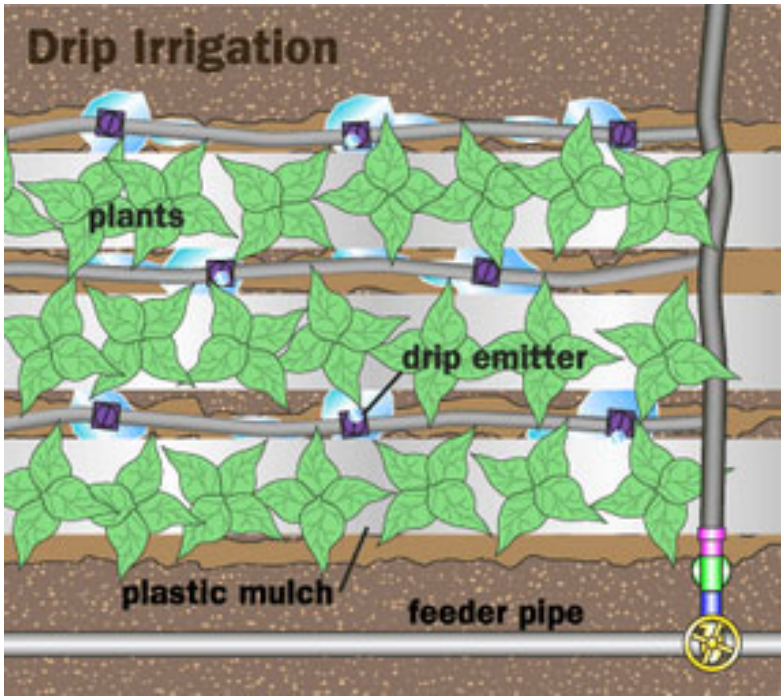
b: CLAY POT IRRIGATION SYSTEM

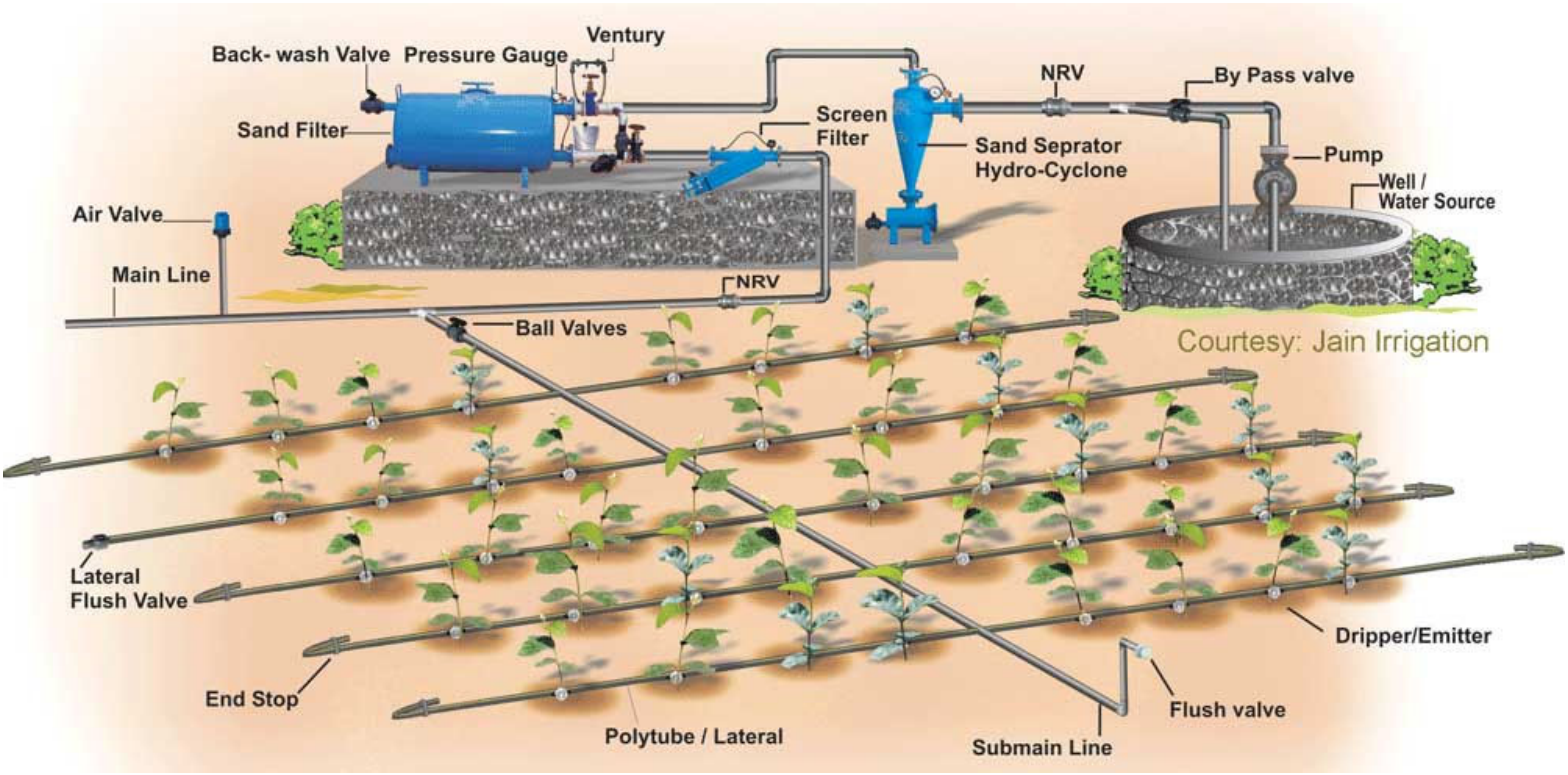
ADVANTAGES	DISADVANTAGES
• Simple technology. • Easy to check the amount of water. • High efficiency.	• Only suitable for permanent plants. • Large labor cost.



C: TRICKLE DRIP SYSTEM

ADVANTAGES	DISADVANTAGES
• Water placed directly at the base of the plant; • Automated and controlled via computer. • Water is used very efficiently.	• Expensive to install; complex to maintain. • Grit can block tubes. • Inflexible; cannot be moved easily.




Back- wash Valve
Pressure Gauge
Ventury
Sand Filter
Screen Filter
NRV
By Pass valve
Sand Seprator Hydro-Cyclone
Pump
Well / Water Source
Air Valve
Main Line
NRV
Ball Valves
Courtesy: Jain Irrigation
Lateral Flush Valve
Dripper/Emitter
End Stop
Polytube / Lateral
Flush valve
Submain Line

d: FLOOD IRRIGATION

ADVANTAGES	DISADVANTAGES
Inexpensive.	Inefficient use of water.
Can cover large areas quickly.	Damages soil structure.

4. Control of Competing Organisms:

- Weeds are plants that is growing in an inappropriate place. They need to be controlled because they:
  - Compete with crops for light, water and nutrients.
  - Reduce the quality of a seed or grain crop.
  - Might be poisonous.
  - Make cultivation difficult.
  - Can block drainage systems with excessive growth.
  - Can be a source of pests and diseases.
  - Can look untidy (impact on tourism areas).
- Chemical control of weeds is the most efficient system for a large area. Weed-killing chemicals are known as **herbicides.**

- **Advantages of Herbicides:**
  - Easier to manage;
  - Alternatives may be less effective
  - Cheaper;
  - Results are more predictable;
  - Less labor needed;
  - Effect is more rapid.

- **Alternatives to herbicides are cultural controls:**
  - **Hand weeding and hoeing;**



- **Weed barriers;**

- **Flame Guns.**

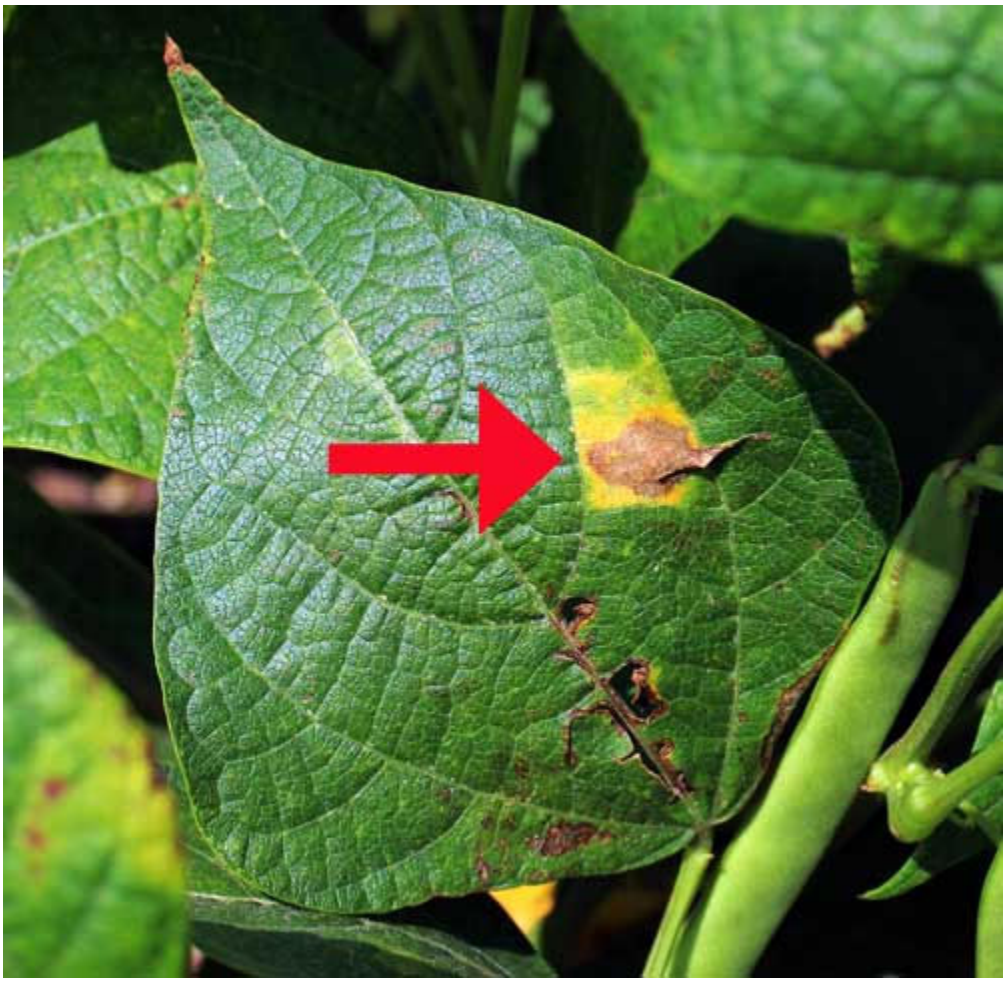
5. Controlling Pests and Diseases:

- A pest is an animal that attacks or feed upon the crop plant. A chemical used to control a pest is known as a **pesticide**.

- The most common pests of plants are insects and a chemical used to control insects is called an **insecticide.**

Pesticides are chemicals that may be used to kill fungus, bacteria, insects, plant diseases, snails, slugs, or weeds among others. ... Insecticides are a type of pesticide that is used to specifically target and kill insects. Some insecticides include snail bait, ant killer, and wasp killer.

- A crop disease is caused by fungi, bacteria or viruses (pathogens).



- The most common are fungal diseases and are controlled by **fungicides.**

Alternative to Insecticides:

BIOLOGICAL CONTROL: FIND NATURAL PREDATORS

Natural enemies of insect pests, also known as biological control agents, include **predators, parasitoids, pathogens, and competitors**.

EXAMPLES

Dragon fly (odonota)

Lady beetles (Coccinellidae)

Greenlacewings(Chrysopidae)

wasps (vaspidae)

Soldier beetles (Cantharidae)

hover flies (Syrphidae)

Stink bugs (Pentatomidae)

spider

BIRD

ADVANTAGES	DISADVANTAGES
•No chemical residues are left in the crop; • No impact of sprays in the surrounding ecosystems; • No need of reapplication; • The predators will die naturally when the pests are controlled.	• Not as instant as chemical control; • Pests may breed faster than the predator; • Predator may feed on an unintended plant.

6. Mechanization:

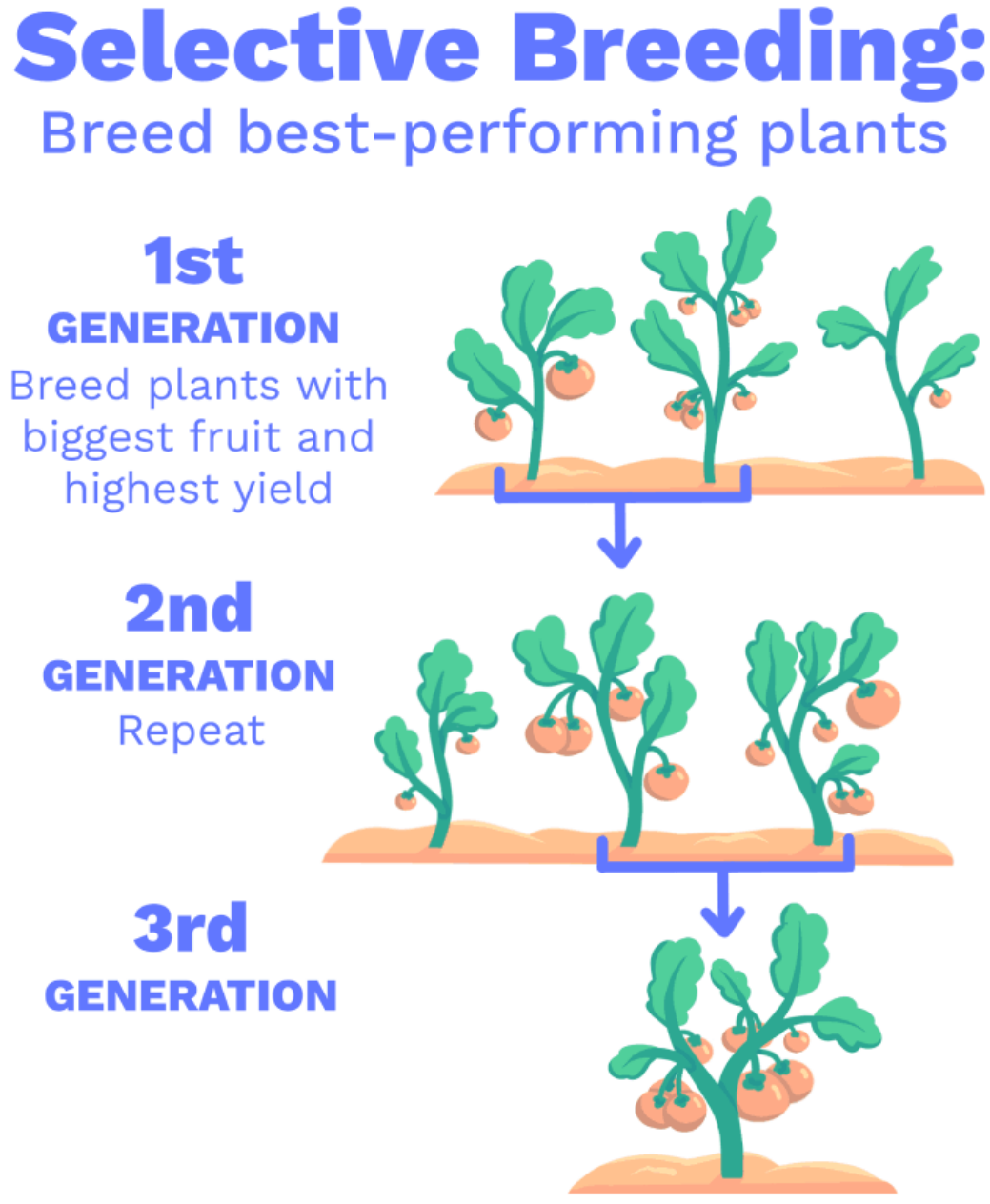
- Larger area can be cultivated;
- Reduces labour cost;
- Ploughing can be done even when soil is heavy
- Additional attachments can be done to apply fertilisers and pesticides.
- Tractors also have the capacity to transport large loads, which is useful at harvest time.


CLAAS

7. **Selective Breeding:** is a traditional method used for improving the performance of crops and livestock. It is as follows:

- Choose parents that exhibit the desired characteristics of the species;
- Raise the offspring from these parents;
- Select the best offspring that shows the desired characteristics;
- Repeat the process.
- This can be applied to both plants and animals. Examples: beef cattle, dairy cattle, wheat and rice.

Drawbacks: slow process; less success rate.



8. **Genetically Modified Organisms (GMO):** the DNA of one organism is inserted into another.

ADVANTAGES	DISADVANTAGES
• Disease and pest-resistance may increase; • Nutritional value may increase; • Crops can be grown in inhospitable areas; • Herbicide resistance may increase; • Crops with longer storage lives.	• Unknown impact of the new characteristics on human health; • Products are not natural; • Genes might get into wild plants if they interbreed with GMOs ∴ reducing biodiversity; • Reduction in the gene pool.

What does reducing the gene pool mean?

Gene pool decreases when the population size is significantly. Some of the consequences when gene pool is small are low fertility, and increased probability of acquiring genetic diseases and deformities.

9. Controlling the crop environments:

- Over very large areas it can be difficult or expensive to try and control the environment, although there are some important techniques such as:
    - Providing shade for cattle.

- **Using windbreak at the edges of crops to reduce wind speed.**

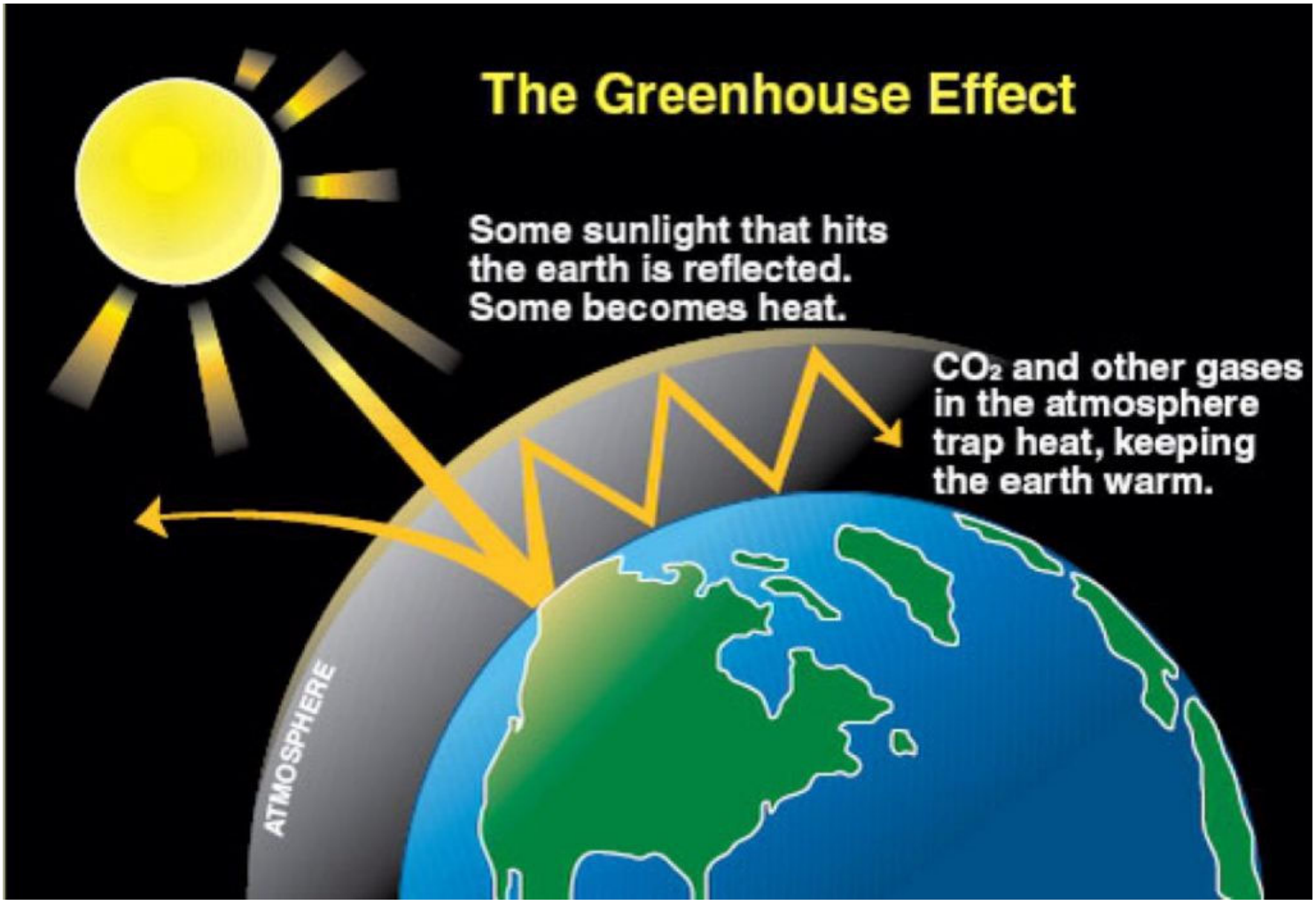
- Removing trees that shade a crop in order to maximize the light the plants receive.

- Over smaller areas, it is possible to invest more money in controlling the environment.
    - **Greenhouse:** used to manage the environment for plant growth.
- Growing blueprint: the ideal environment conditions needed by a plant for maximum growth.
    -

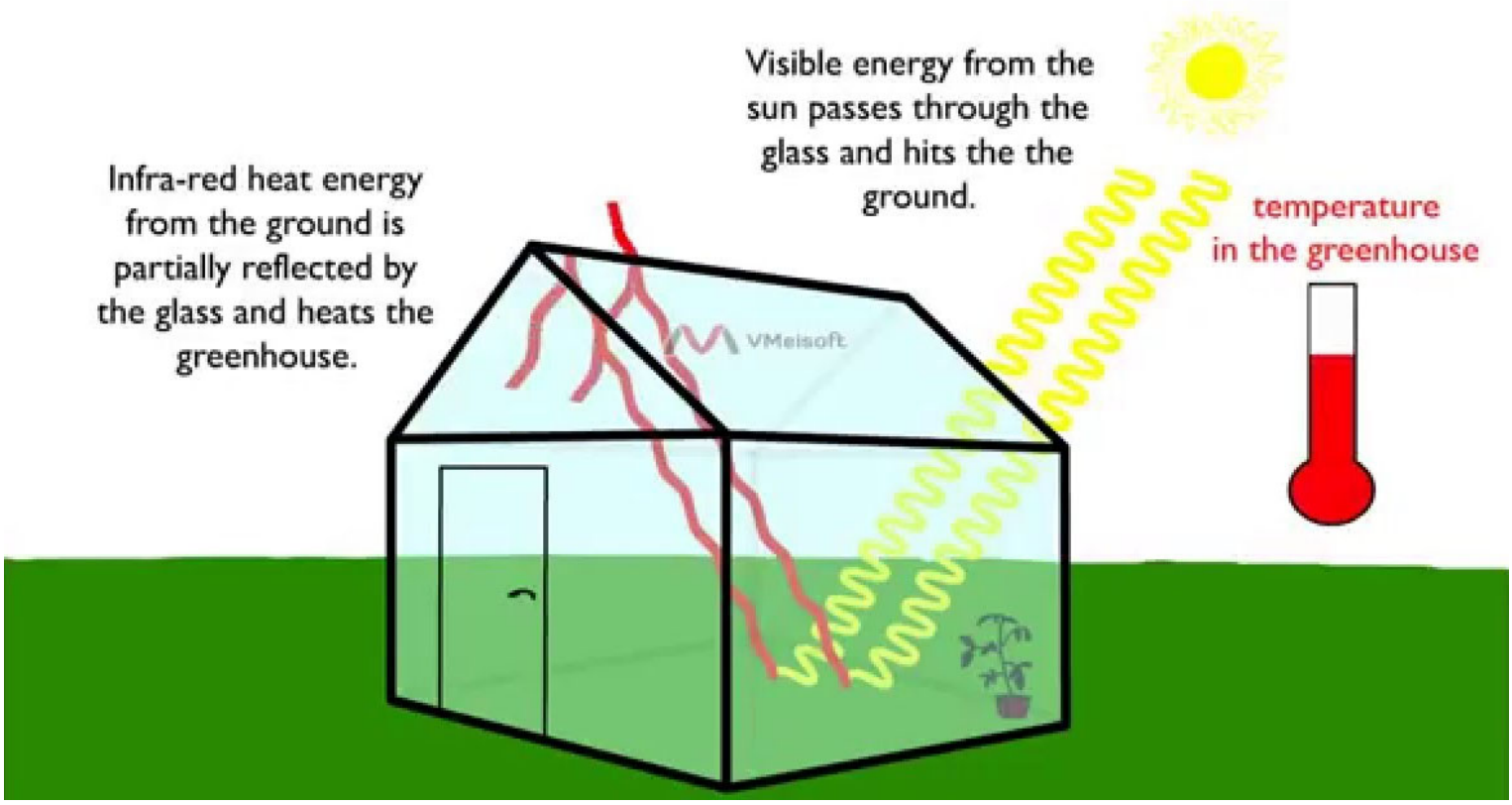
GROWTH FACTOR	HOW TO INCREASE	HOW TO DECREASE
TEMPERATURE	Operate heating system (e.g. insulation).	Open roof ventilators.
LIGHT	Supplementary lighting.	Shading material in the roof.
HUMIDITY	Misting units.	Open roof ventilators.
DAY LENGTH	Supplementary lighting.	Shading material and curtains.
WATER	Sprinkler or irrigation.	Drainage material underneath.

The Greenhouse Effect:

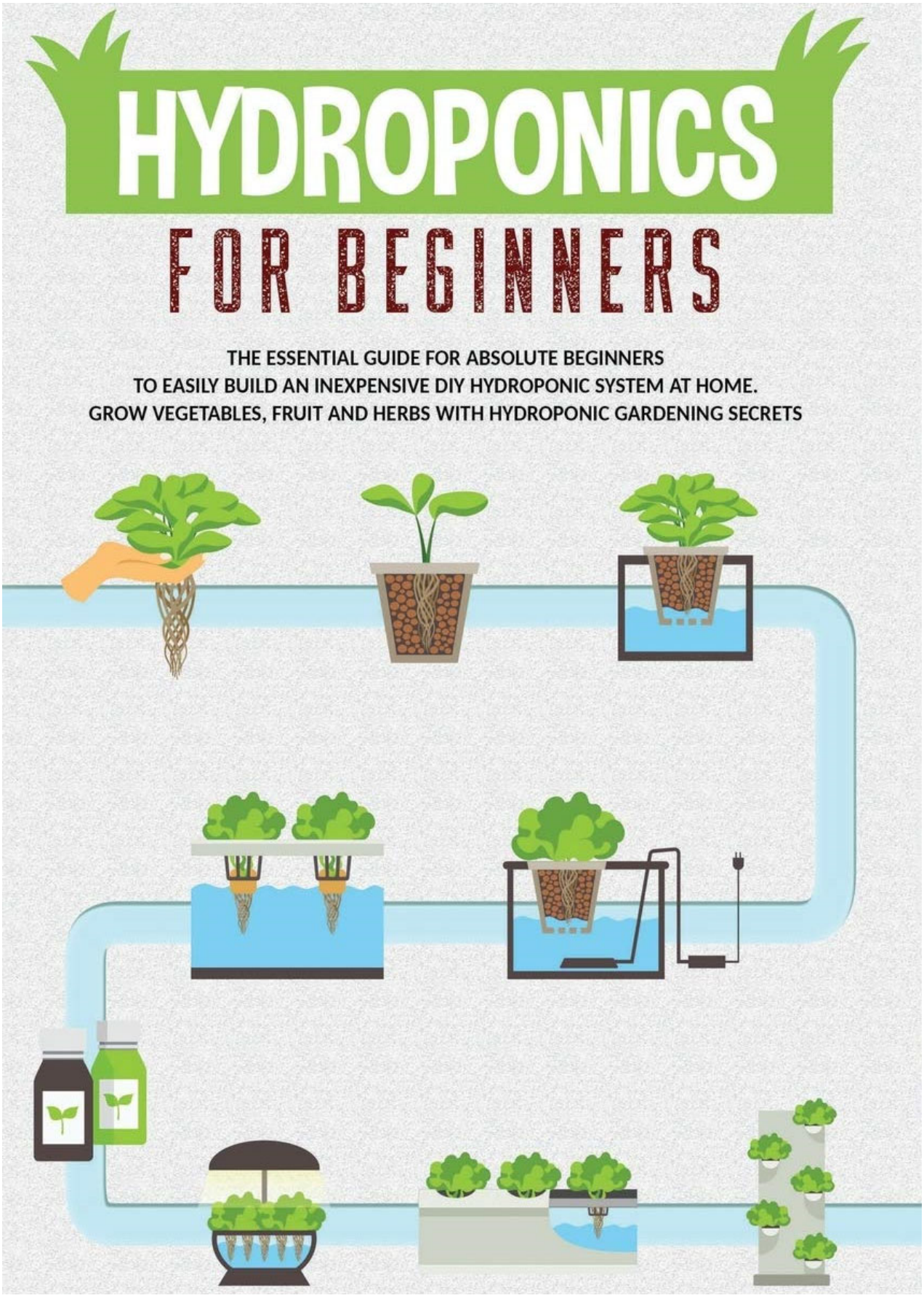
- Greenhouses heat up using the sun's rays. This effect been noticed and gives the name to the global warming effect.
- In the case of greenhouse, sunlight passes the glass (or other transparent material). Moving through the glass causing the wavelength of the energy to change, converting a proportion of the energy into heat, which is trapped and so the temperature inside becomes warmer.



The Greenhouse Effect



10. **Hydroponics**: growing plants without soil, with the nutrients the plant needs dissolved in water.



ADVANTAGES	DISADVANTAGES
• No need for soil; • Can be used anywhere; • Easy to harvest; • Exact nutrients needed are provided; • Water is recycled; • Pollutants are not released into the environment. • provides high yields. • No weeds or pests and disease.	• Expensive to set up; • Suitable for small production areas; • Technical knowledge required; • Disease, if present, may spread rapidly; • Plants can die quickly if conditions are not maintained.

Key Terms

Legumes: plants that contain nitrogen-fixing bacteria in their roots to produce a source of nitrate.
Gene: a sequence of DNA that responsible for a characteristics of a living organism.
Genetically modified organism (GMO): an organism whose genetic material has been altered by genetic engineering.

The Impact of Agriculture on People and the Environment

➢ Overuse of Herbicides and Insecticides:

Regular use of one insecticide can cause **resistanc**e within the pest population.

Solution:
use a range of different pesticides.

- Also cause **unintended environmental damage**: beneficial insects like bees are also affected and food web is disturbed.
- **Spray drift**: herbicides stay longer in the soil and may affect the next crop.
- Heavy rainfall can cause leaching of the chemicals into nearby lakes causing damage to other organisms.

➢ Overuse of Fertilisers:

- Addition of extra mineral nutrients is waste of money and resources if the soil has reached its maximum level;
- Heavy rain can dissolve the nutrients and cause leaching;
- Excess water containing dissolved fertilisers drain into nearby lakes and rivers, leading to eutrophication;
- Nitrates from fertilisers if consumed can cause diseases such as blue-baby syndrome;
- Large quantities can affect the pH of the soil and in turn, the availability of minerals;
- Too much of trace elements can be toxic to the plant.
- Too much fertiliser dehydrates the plant (scorching);
- Imbalance of nutrient makes the plant produce lots of foliage, but no flower.

Solution: strict limits on where, when and how the fertilisers must be applied; can replace with organic fertilisers.

Misuse of irrigation: too much irrigation can have various negative effects:

- **Damage to soil structure**: when wet, air pockets are lost and the soil is compacted;
- **Death of plant roots** as waterlogged soils prevent plant roots from getting enough oxygen;
- **Loss of nutrients** as they are dissolved and washed away with water;
- **Soil erosion**: large amount of water run-off will take some of the soil particles with it.
- **Soil capping**: surface of the soil becomes hard.
- **Salinisation**: salt content of the soil can increase. Over-irrigated soils become waterlogged and therefor the salt move through the soil. When the sun causes evaporation of water, the salt is left behind and plants will have difficult taking up water by osmosis.

- **Prevents soil cultivation** as it's difficult to cultivate soil with a high-water content.

- **Overproduction and Waste:**
  - **Waste from overproduction**: the unsold proportion of the crop.
  - **Waste of storage space**: may take longer to sell a crop; some crops need special conditions.
  - **Waste of transportation**: to sell a crop, a farmer may need to travel longer distances.
  - **Waste of quality products**: low quality means less demand.
  - **Waste of labour**: not an efficient use of time and labour if too much is produced.

- **Exhaustion of Mineral Ion Content:**
  - The farmers use the soil over and over again with little to no rest which leaves the soil depleted of nutrients and minerals.

    Solution: Crop rotation, mixed cropping and leaving the land fallow.

- **Cash Crops Replacing Food Crops:**
  - Most commercial farmers prefer to grow crops that generate more cash. This causes a decline in the staple food available.

- **Mechanization:** while the use of machinery has increased yield, it does have a number of impacts:
  - For machine work efficiently, field have been made larger.
  - Removing natural vegetation that may provide habitats for other organisms.
  - Machines use fossil fuels which are non-renewable resources and their exhaust gases also contribute to air pollution.
  - Large machine exerts high pressure on the soil through tyres causing soil compaction.
  - Use of machinery can affect jobs and employment.

Soil Erosion:

What is soil erosion?

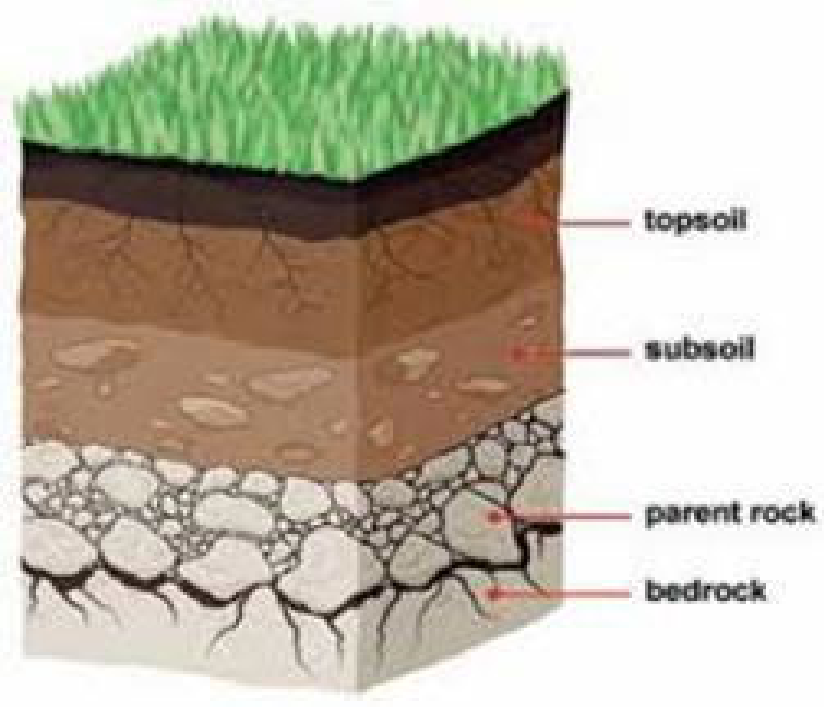
Soil erosion is the displacement of the upper layer of soil; it is a form of soil degradation. This natural process is caused by the dynamic activity of erosive agents, that is, water, ice, snow, air, plants, animals, and humans.

Overcultivation: Soils that are cultivated regularly lose soil structure and are more vulnerable to erosion as they break down to smaller particles.

Causes and Impacts of Soil Erosion:

There are a number of horizontal layers of soil, the topsoil is the most fertile soil.

The structure of topsoil allows the most root growth because it holds water but also supports air spaces. It is a dark because it contains organic matter. Loss of this layer can affect the fertility of the soil.



Soil profile

- **Causes of Soil Erosion:**
  - **Removal of natural vegetation**: no more roots to bind the soil together or slow down the torrents of water, so flash flooding and rainwater run-off pick the soil and carry it away.

  - **Overcultivation**: ploughing breaks the soil into smaller and lighter particles. These are more easily carried away by wind.

- **Overgrazing**: livestock reduces the vegetation to nearly ground level, sometimes leaving no roots to hold the soil. Animals trample down the plants and their hoofs compact the ground.

- **Wind Erosion**: deforestation (due to need for space, excessive grazing, increase in development of arable crops) increases the chance of soil getting eroded by wind.

- **Water Erosion**: water can erode soils in a number of ways:

- Heavy rainfall carries the particles away.
- Rainwater run-off: excess water that can't be absorbed by soil will transports the soil from that area;

- Soil compaction reduces infiltration;

Gully Erosion: gullies and streams contain a volume of water erodes local soil forms deeper and deeper crevices (a narrow opening).

Impacts of Soil Erosion:

- **Topsoil is Removed:** the most productive layer is absent (subsoil lacks in nutrients ad air spaces).
- **Organisms living in the topsoil lose their habitat:** impact on the entire ecosystem.
- **Silting up of water courses:** flooding occurs as water bodies can't hold excess water (space taken up by silt).

- **Silt deposits can form lagoons:** providing breeding grounds for mosquitoes. Silt affects the quality and availability of water for drinking.

- A lagoon is a shallow body of water separated from a larger body of water by a narrow landform

- **Aquatic organisms are buried under the silty layer:** preventing light from reaching the underwater plants (low oxygen levels in ecosystem ∴ no photosynthesis).

Desertification: the process by which fertile land becomes desert.

- Severe droughts lead to migration of the whole community.
- Risk of famine and malnutrition, leading to lesser food source.

Managing Soil Erosion

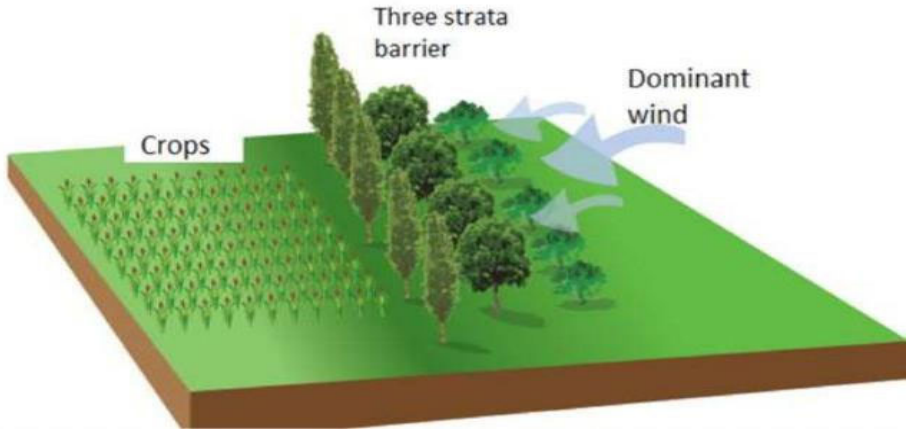
- **Terracing:** prevents the erosion of soil by rainwater on steep slopes.

  - In a natural slope: water runs down, increasing in speed and volume, carrying soil in the run-off.
  - In a terraced slope: water is held in the flat terraced areas, causing less risk of run-off and more chance of infiltration.
  - Often used for cultivation of rice.

- **Contour Ploughing:** ploughing of land along the contour in a parallel way.
  - Ridges and troughs (furrows) run along the contour.
  - Each furrow holds water and prevents large torrents of water running down the slope, preventing the formation of gullies and run-off of topsoil.
  - Useful for all gradients of slope

- **Bunds:** artificial banks at the edges of growing spaces to hold back water.
    - Useful for crops that require moist soils e.g. rice.
    - The water is retained on the terrace.
    - Increases the quantity and fertility of the soil.

- **Windbreaks**: a permeable barrier used to reduce the impact of wind on an area.
- Without windbreaks, the soil is eroded away.
- Solid structures, like walls, force the wind into smaller spaces, increasing wind speed and causing eddy currents.
- Permeable structures, like vegetation, allow some wind to pass through, decreasing its speed and thus, the amount of wind erosion.
- Advantages: additional habitats for beneficial insects; roots of the windbreak prevent erosion due to run-off.



- **Maintaining crop cover:**

What is maintaining crop cover?

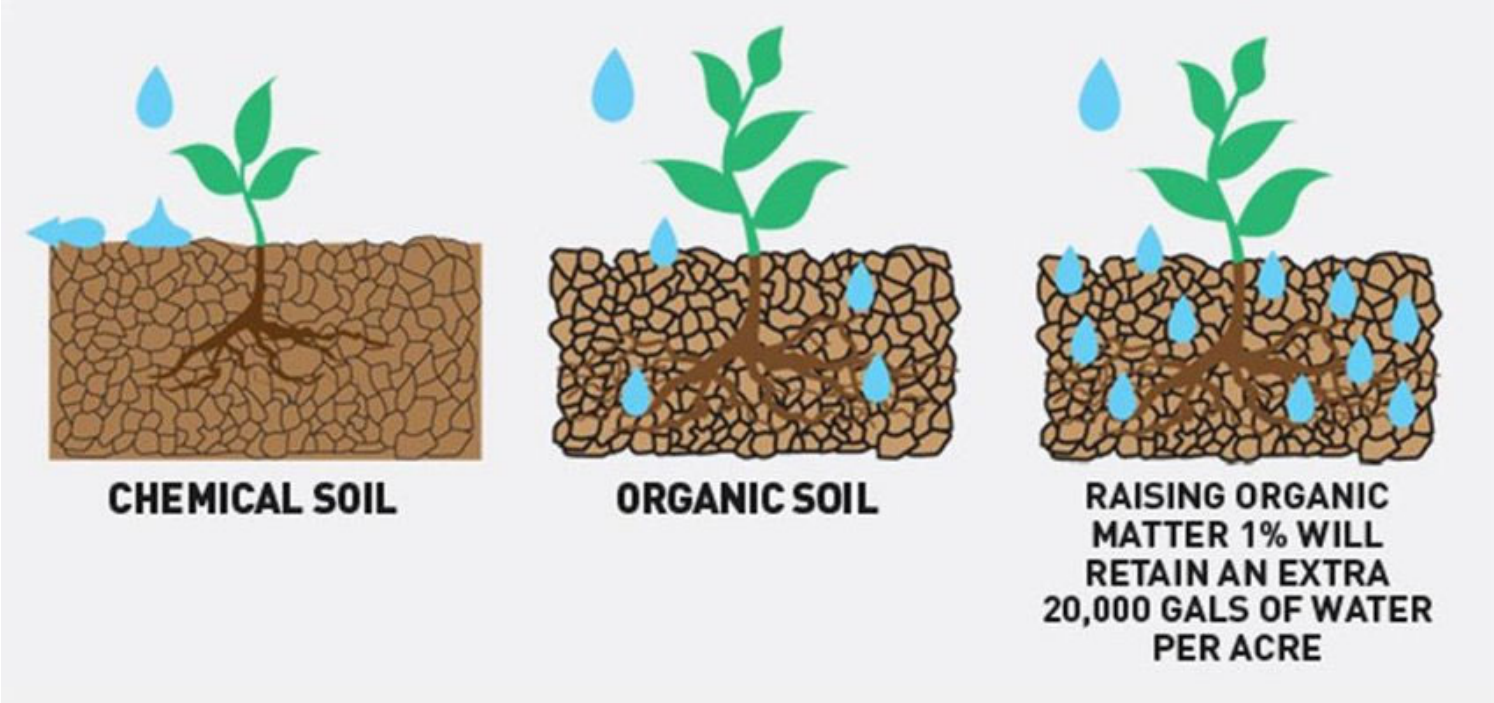
The harvest of low residue row crops, such as corn silage or soybeans, usually means the soil surface of a field will be left bare until the next crop is planted and a new plant canopy is established.

- Sowing legumes immediately after a crop has been harvested prevents soil erosion.
- It also provides more nitrogen to the soil, increasing its fertility, for the next major crop.
- When cultivating, the legumes can be simply ploughed.

- **'No dig' method:**
  - Existing vegetation is left until the new crop is grown.
  - Rather than cultivating the soil, herbicides are applied to kill the weeds.
  - Roots of the existing vegetation bind the soil until the major plant is established.

Risks: herbicide residues build up. If the control of the cover vegetation is ineffective, it may compete with the main crop as a weed.

- **Addition of Organic Matter to Improve Soil Structure:**
  - Provides additional air gaps in the soil improves soil structure;
  - Increases decomposers in the soil as they feed on the matter;
  - Adds nutrients to the soil after decomposition.
  - Acts like a sponge, holding the extra water, preventing dehydration of the soil;
  - Reduces soil erosion as the organic matter acts like a base to smaller particles.



- **A multi-layering approach to cropping:**
    - A row of trees acts as windbreak;
    - Tree canopy can provide shade for smaller plants that don't thrive for sunlight;
    - Provide a natural habitat for animals, that feed on pests; tree leaves fall to the ground and add on to the organic matter.

• **Mixed cropping**: growing more than one type plant in the same area.

- Resources in the soil, like nutrients, are used more efficiently.

• **Intercropping:** rows of a different crop are grown between the rows of the main crop. This maximises the use of space and other resources.

Sustainable Agriculture:

- **Aims of sustainable agriculture:**
  - ✓ Meeting the needs of the population for agricultural products;
  - ✓ Making efficient use of non-renewable resources;
  - ✓ Supporting the natural ecosystem by following natural processes with farming techniques;
  - ✓ Sustaining the economic independence of farmers.

- **Organic Fertilisers:**
  - ✓ Are slow acting ∴ reduces the risk of eutrophication;
  - ✓ Are a waste product ∴ using them saves on disposal costs;
  - ✓ Are already present on many farms ∴ minimal transport costs;
  - ✓ Do not require energy for their manufacture;
  - ✓ Also improve soil structure.

- **Managed Grazing:**
  - ✓ Prevention of overgrazing;
  - ✓ Ensure sufficient grazing by preventing scrubland plants from establishing because they are eaten as young seedlings;
  - ✓ Maintaining appropriate soil fertility by animal waste;
  - ✓ Maintaining good drainage prevents compaction of the soil.

- **Crop Rotation**.

Choice of Varieties:(breeding)

✓ **Use of pest-resistant varieties of crops**: reduces pesticide use.

✓ **Use of drought-resistant varieties of crops**: reduces water usage for irrigation.

✓ **Use of herbicide-resistant varieties of crops**: reduces herbicide use.

- **Irrigation**: efficiency in the use of water it is a priority.

Trickle drip irrigation provides the following sustainable benefits:

✓ Minimizing the amount of water used.

✓ Targeted delivery of water to the plants.

✓ The ability to only use the system when the plants need water.

✓ A reduced risk of Salinisation.

- **Rainwater Harvesting**: the collection of rainwater, for example from the roofs of buildings, and its storage in a tank or reservoir for later use.

Key Terms

Resistance: the ability of a living organism to survive when exposed to a toxic chemical.
Eutrophication: a sequence events starting with enrichment of water by mineral nutrients or organic matter that leads to a reduction in oxygen levels in the water and the death of fish and other animals.
Osmosis: the process by which mineral molecules pass through the semi-permeable membrane from a weaker solution to make the concentration of the mineral the same both sides of the membrane.
Desertification: the process by which fertile land becomes desert.
Famine: a lack of access to food, often over a large area.
Malnutrition: not having enough of the correct nutrients to eat, causing ill health.
Terracing: the artificial development of flat area for growing crops in a sloping terrain.
Intercropping: the technique of growing other crops between the rows of a main crop.