Increasing agricultural yields

Techniques used to increase agricultural yields:

- Rotation Fertilisers Irrigation Mechanisation
- Insect control (insecticide), weed control (herbicide), fungi control (fungicide)
- Selective breeding of animals and plants
- Genetically modified organisms
- Controlled environments: Greenhouses and hydroponics

Crop rotation:

- It is the systematic planting of different crops in a particular order over a several years in the same grown space
  (Or)
- It is a method of farming where a number of different plant are grown one after the other on a field so that the soil stays healthy and fertile
- **For example**, if the **maize** has been grown one year then this might be substituted with **rice** the next year, **potatoes** the year after and **peas** and **beans** in the fourth year
- In the fifth year the field might be used for maize again
- Growing the same crop in the same field year after year will quickly **deplete** the soil of the range of nutrients that a particular plant requires to yield well
- With rotation, a crop that draws upon one kind of nutrient is followed in the next growing season by a crop that draws mostly on another range of nutrients
- Or a crop that actually returns the depleted nutrient to the soil through a process known as nitrogen 'fixing'.
- Crops such as **clover**, are able to add nitrogen to the soil because their roots have special **nodules** attached
- The nodules contain **bacteria** that feed by 'fixing' or extracting nitrogen from the atmosphere to produce nitrate chemical compounds

- Clover, along with plants such as peas, beans and alfalfa, are from a family called **'legumes'**
- They all provide subsequent crops with substantial amounts of nitrogen
- Leguminous crops in the rotation are also often used as a fodder crop on which livestock can graze
- This has an advantage of animal manure being available for ploughing back into the soil
- In addition to maintaining soil fertility and improving crop yields, rotation can also bring other benefits
- Its helps to **control** the build- up of bacteria, fungus or parasites that might cause plant disease or insect pest that might feed upon them
- In turn this saves the farmer money because they will need to use fewer chemical pesticides
- If deep- rooted crops are alternated with shallow- rooted crops in the rotation then this will help to improve soil structure

Fertiliser:

- A fertiliser is any natural or synthetic substance that is added to soils to supply one or more nutrients removed by growing crops
- When plants are harvested and removed from the soil, an important link in the carbon or nutrient cycle is broken – that of decomposition
- In natural ecosystems the nutrient ions present in plants are allowed to decomposed by bacteria, which break down organic molecules and release nutrients back into the soil
- Removing part of or all harvested crops exhausts the soil's mineral ion content, particularly N, P, K
- Heavy ploughing also accelerates decomposition of organic matter and increases the release of mineral ions from the soil
- Without intervention by the farmer, the humus content of the soil eventually drops to a point where it cannot supply enough nutrients to feed the crop adequately

- Fertilisers are used to replace lost nutrients and maintain the productivity of the land through constantly providing optimum conditions for plants growth
- On intensive commercial farms, synthetic chemical-based fertilisers made by pharmaceutical companies in laboratories used to replace these N,P,K nutrients
- They are either mixed with water and sprayed onto land or scattered over the soil as small nodules that slowly dissolve when it rains
- Organic farmers who seek to farm in an environmentally sustainable manner replace lost fertility through the use of rotation, including nitrogen fixing legumes, composted waste produced on the farm and natural animal manures rather than chemical fertilizer

Fertiliser:

- improves soil fertility,
- replaces nutrients taken out of soil by previous crops,
- organic fertilisers maintain soil texture/structure

Overuse of chemical fertiliser:

- Serious environmental problems can arise from the overuse of both natural and synthetic fertilisers
- Eutrophication occurs when fertilisers are washed off the land by rainwater into river and lakes
- High concentrations of nitrate and phosphate build up in the water and cause very rapid algae growth known as ‘blooms’
- Such algal blooms can be devastating to aquatic life because they cover the water surface entirely and prevent light and oxygen reaching other water plants, fish and insects
- Bacteria then break down the dead plants and aquatic creatures, which can leave the river or lake completely devoid of life

- Overuse of chemical fertilisers - particularly nitrogen – can lead to soil acidification and contributes to greenhouse gas emissions and global warming
- When nitrogen fertiliser is applied to soils, a powerful greenhouse gas called **nitrous oxide** is released

Other effects of overuse of chemical fertilizer:

- It food chain effect
- kills top link or carnivores or even predator birds
- It upset web
- direct poisoning of beneficial species
- due to that pests evolve resistance

Disadvantage:

Cost, over-use of chemical fertilisers leading to leaks into surface water courses or underground stores, unfavourable environmental consequences

Irrigation:

- Irrigation is the artificial **supply of water** (as opposed to rain-fed watering) to agricultural land and is an important method of increasing **yields** and **productivity** on farms
- Delivering water to growing plants

Sources of irrigation:

- Wells, Tube wells, Ponds, Lakes, Rivers, Dams, Canals

Irrigation:

- Water is important for proper **growth and development** of flower, fruits and seeds of plants
- Water is essential because **germination of seeds** does not takes place under dry conditions

- **Nutrient** is dissolved in water get transported to each part of the plant
- Irrigation was first used in **Mesopotamia** and **Egypt** 8000 years ago when canals were cut from the Tigris, Euphrates and Nile rivers to divert flood waters on to fields
- These canals and irrigation techniques such as the **shaduf** developed at the same time are still commonly used by farmers in these area today
- Irrigation is practised by more than half the farmers in the world because they need more water for their **crops and livestock** than is available from rainfall alone
- It is particularly important in regions with marked **dry seasons**
- The great advantage of irrigation is that it enables a farmer to control precisely how much water is taken up by plant roots and when
- As a result, yields obtained from using irrigation are almost always higher than yields obtained from relying on just natural rainfall
- The main types of irrigation include **surface, localised irrigation**, **sprinkler irrigation**, **sub or seepage** and **in- ground irrigation**

Traditional method:

- In this method **cattle or human labour** is used
- This methods are **cheaper**, but less efficient

The various traditional ways are

- Moat (pulley- system)
- Chain pump (for lifting water)
- Dhekli and Rahat (lever system)

Surface irrigation:

- This is the most common but least efficient system of irrigation and is often called **flood irrigation**
- It involves covering the entire cultivated area with water
- Terraced rice field use this technique with the movement of water from one field to another being controlled by mud dikes or embankments and narrow channels
- Water loss through evaporation is considerable
- Surface irrigation is the oldest method of irrigation
- It can be subdivided into furrow, basin irrigation

Localised irrigation:

- This is a much more precise and targeted approach, and is highly efficient because evaporation is minimised
- **Drip irrigation**, which delivers small drops of water to the roots of each plant through a network of narrow rubber pipes located above, on or just below the soil surface, is a good example of localised irrigation
- It is the best technique for watering fruit plants, garden and trees
- The system provides water to plants drop by drop
- Water is not wasted at all
- It is boon in regions where availability of water is poor
- Other names micro, trickle irrigation

The advantages of trickle drip irrigation:

- It is Sustainable - water conserved or not wasted or less required
- water directed at roots
- most absorbed by plant
- fewer weeds (germinate)
- less water lost by evaporation; surface runoff

- no wet leaves so fewer leaf diseases
- work can continue during watering; no risk of water-related diseases
- soil structure is not damaged from water falling on bare soil
- insecticide / fungicide use is reduced as they are not washed away
- leaching reduced; risk of salinisation reduced

Why drip irrigation method is better for the environment?

- The water is delivered only where needed around the plant,
- so that less water needs to be stored or used for the same output, less of
- The water remains unused so that salination is less likely.

Sprinkler irrigation:

- This system seeks to imitate natural rainfall
- This system is more useful on the uneven land where sufficient water is not available
- Water is piped through a hose to a central location where it is then distributed over the fields in a fine spray from overhead high- pressure sprinklers
- The sprinklers rotate slowly, which avoids any one area becoming waterlogged
- Such sprinkler system are often mounted on wheels to enable easy movement from one field to another
- It is very useful for sandy soil
- Other names – overhead irrigation

Sub or seepage irrigation:

- This system provides plant roots with water from beneath the soil
- It can only be used effectively in areas of the world such as Florida in the USA where the **water table** (the level below which the ground is saturated(holding) with water) is close to the surface
- A combination of pumping stations, canals and weirs are used to raise the water table enough to dampen plant roots from below
- It is much less wasteful of water than both surface and sprinkler irrigation systems as there is little evaporation and the farmer has a lot of control over raising and lowering the water table
- However, it needs very careful management to avoid waterlogging the soil
- All crops require air in the soil(specifically oxygen) and will quickly start to die back if air is prevented from entering
- Waterlogging will also cause salination – build- up of the dissolved salts of sodium, magnesium and calcium in the soil

In- ground irrigation:

- This involves burying the entire irrigation system of pipes, sprinklers, drippers and valves underground
- It is costly to set up and to maintain, for this reason is usually confined to servicing individual properties and streets in residential areas
- It is not suited practically or financially to farms with fields that may cover many square metres

Use irrigation water:
Water allows plant growth when rainfall is too little or too unreliable,
Allows use of otherwise favourable conditions for crops (such as fertile soils, sunshine), increases size of crops/fruit and the amount produced
Disadvantage:

Overuse leading to salinisation, costs (of all types) of building
Infrastructure for supply (especially large dams), competing use for a scarce natural resource

Suggest reasons why adding too much water reduces yield:
The pore spaces fill up with water, so no or little air or oxygen for plants

Interaction between salt in the soil and irrigation water can increase salination. Explain how irrigation increases salination.

Water dissolves salt crystals; which makes brine, comes to surface
(or)
Alternatives to dissolves and salt; water evaporates, leaves salt

An environmental problem which often results from using this method of irrigation is salinisation.

How and why salination occurs
(Or)
Give reasons for salination occurrence in any given area:

- Over-use of irrigation water in hot or dry climates
- Moisture in the soil is evaporated due to high temperatures and leaving residue of salts
- Salts are drawn up from lower levels in soil to the surface by high rates of evaporation.
- A hard crust of salt forms on the ground surface
- high concentrations of salt accumulate around plant roots
- (Residual sodium ions left as dominant in the soil solution after calcium and magnesium are precipitated as carbonates by evapotranspiration)
- most crops cannot tolerate high levels of salt
- crops can no longer be grown on the land

Controlling pests and diseases:

- If crops are attacked by pests and diseases, or if invasive weeds are allowed to grow up unchecked, then agricultural yields will fall
- Intensive commercial farmers spray their crops with a wide range of chemical produced synthetically in laboratories and **designed** to kill or control specific weeds, insects or pathogens. These are known as **pesticides**

Three main types of pesticides

- Fungicide
- Herbicides
- Insecticides

Fungicides:

- **Fungicides**, worth over US$20 billion, are sold by pharmaceutical companies to farmers every year to kill fungi that attack plants
- For example, 14 different varieties are available in the USA to control **soya bean rust** - a windblown disease that attacks the crop's leaves causing lesions and eventually killing the plant
- Spraying young soya bean plants with fungicide can increase crop yields by as much as 20 percent compared with untreated plants

Herbicides:

- Herbicides are chemical sprays, used against **weeds**, which absorb the toxins through their roots or leaves
- Most herbicides are selective in that they act only on specific species of weeds leaving the farmer's crop unharmed
- The mostly used herbicide is **glyphosphate**
- More than 300 glyphosphate herbicides manufactured by forty different companies are registered for use in Europe alone

- It is sprayed on cereal crops including wheat, barley, oats, rye and maize

Weedicides:

- Undesirable plants are called weeds
- The removal of weeds are called weeding
- Weeds are controlled by using weedicides like 2,4,D
- They do not damage the crops
- The weedicides are diluted with water to the extent required and sprayed in the fields with a sprayer

Insecticides:

- Insecticide kill insects that attack crop plants
- The most widely used insecticides are called **neonicotinoids** and are designed to kill sap- feeding insects such as aphids
- Neonicotinoids are systemic, which means that the chemical is taken up by the plant either from its roots (as a seed coating before planting or soil drench) or through its leaves
- The toxin remains active in the crop plant for many weeks, protecting it through the growing season
- Aphids that eat any of the plant foliage are poisoned
- While there is no doubt that the use of pesticides have increased agriculture yields and helped the world to feed a rapidly growing population
- Their use had some serious ecological impacts
- Non- selective or broad spectrum pesticides can cause considerable damage they destroy not just the target weed or insect but also harmless and potentially useful insects

- For example, spraying a broad spectrum insecticide on cereal crops will aphids but also destroy ladybirds(a small beetle that is harmless to the crop plant and actually feed on aphids
- Destroying the ladybirds then breaks the **food chain** for birds such as swallows and swifts, which rely on ladybirds for an important part of their diet
- Another serious ecological problems known as bioaccumulation can be caused by the use of systemic pesticides
- This gradually build-up of pesticide- spread toxins in organisms in increasing amounts up the food chain
- It particularly affects top predator animals and birds
- DDT was one of the first chemicals to be used as a pesticide in the 1950s
- It was sprayed onto plants(producers at the lowest trophic level of the food chain) e.g. **potato plants** – which absorbed in small quantities
- Insects such as the **potato beetle** (a primary consumer) were poisoned when they began to eat the plant but did not die immediately
- So the concentration of toxins built up in their systems
- Secondary consumers such as birds like **robin** then ate many of the beetles, which meant that even higher levels of toxins build up in their bodies
- Finally, top consumers or apex predators such as the **peregrine falcon**, which consumed hundreds of robins, ingested the highest amounts of DDT of all because they were at the top of the food chain
- The ingested DDT made it very difficult for the falcon to absorb calcium and the lack of calcium made the shell of their eggs very thin
- As a result many eggs broke during incubation and populations of peregrine falcons were decimated

Spray with pesticides:

- destroys insects etc. which eat or damage crops,
- kills weeds which would compete for nutrients or water with the crops

Disadvantage:
chemical pesticides also kill other useful insects, destroy habitats for birds and wildlife, has knock-on effects in natural food chains

Explain how the overuse of pesticides may damage the environment around a farm.

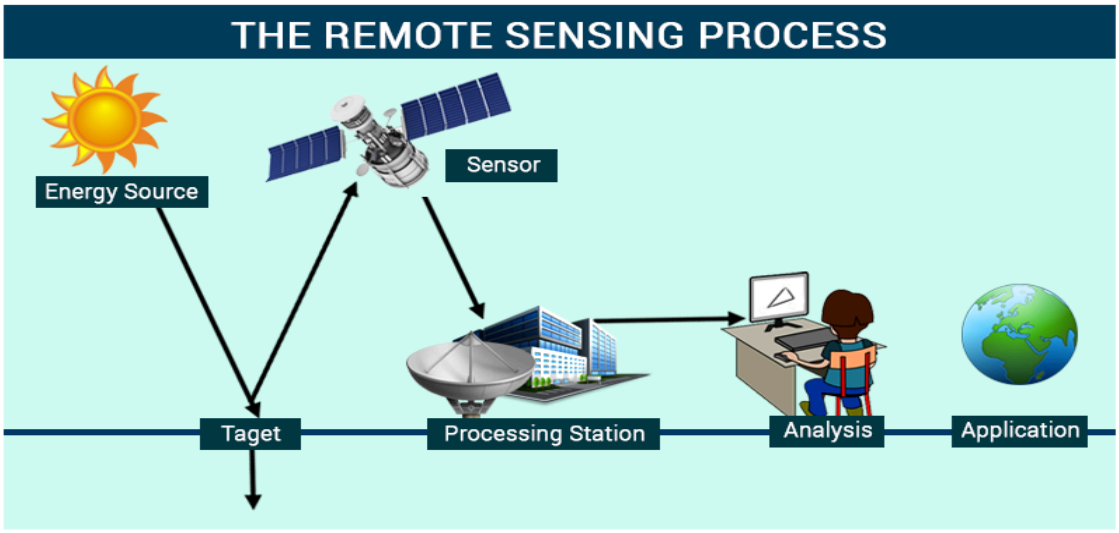
Key points:

- pests containing pesticides eaten by predators
- which are eaten by higher level predators
- concentration of pesticide increases
- biomagnification / bioamplification / bioaccumulation
- killing of beneficial species
- food chain / web disturbed
- pesticide resistance
- leach into water

Mechanisation:

- The process or an act of implementing/introducing the control of equipment with advanced technology
- usually involving electronic hardware; "automation replaces human workers by machines"
- The use of computers and computer- based technology as a substitute for human labour has enabled commercial farmers to significantly **increase** the productivity of their land
- In USA in 1940, the average farm fed 19 people; today it would feed 155 people
- Machinery has helped to make farm work **easier** and **faster** and enabled land that was previously impossible to farm to be brought into **cultivation**

- Farms have become **larger** and **more efficient** because they need fewer workers
- Modern farms are today equipped with a glittering range of powerful equipment that complete tasks with precision and with far less human toil than required by previous generations
- They use **satellite imagery** and **GPS** guidance in combination with robotically controlled machinery as a means of increasing agricultural yields
- This is known as **precision agriculture**
- There is also increased use of information technology
- The use of **remote sensing** (scanning of the Earth from satellites)
- The generation of infrared images of the land combined with **GIS** and **GPS** is used to accurately spread fertilizer, seed, water, pesticides and to track crop yields from individual fields.
- This enables farmers to both reduce **costs** and to **increase yields**
- This increases efficiency by reducing waste and allows inputs to be used in a more targeted manner
- Satellite-based optical and radar imagery are used wide in monitoring agriculture



- In the case of dairy farming, **modern milking equipment** and labour saving technology mean that it is quite feasible for one person to run a herd of 100 dairy cows
- **Automatic calf feeders** are common on Irish farms, while robotic milking systems which greatly reduce the labour requirement in herd management are becoming more and more common

Increased use of machinery:

- Sowing or spraying etc. done more evenly or in a more controlled way, more can be done more quickly while weather conditions are favourable, large scale or more efficient operations possible, larger areas brought into cultivation by new technology
- tractors and combines can do more work than people and more speedily
- farmers able to take advantage of favourable weather conditions or more chance of avoiding bad weather
- allowed more specialised farming on a larger scale than ever possible with hand labour

Disadvantage:

- heavy machinery compresses soil or damages soil structure, encourages loss of wildlife habitats through clearance of vegetation for easy use of machinery, high costs to small farmers in developing countries

Selective breeding:

- Selective breeding or **artificial selection** enables farmers to increase yields through only breeding from certain individual animals or plants
- A dairy farmer may identify those cows that are producing most milk in a herd and only breed from those animals
- These cows then pass on their genes to their offspring and in time the farmer will have a whole herd of high- yielding cows
- Similarly, an arable farmer may crossbreed a high grain- yielding variety of rice with variety that is highly resistant to disease to create a hybrid that combines both advantages
- The IR36 hybrid variety of rice was created by crossbreeding a high- yielding species, that suffered from lodging or falling over, with a strong- stemmed dwarf variety
- The result was a high- yielding dwarf plant that no longer collapsed in the wind or when heavy seed heads developed
- This hybrid formed part of what was known as the **Green Revolution** in farming

Examples of what selective breeding can produce:

- hens that lay big eggs of a particular colour
- cattle that produce lots of meat
- tomato plants that produce lots of tomatoes
- crops that are resistant to certain plant diseases

Plant breeding

- high yielding varieties (e.g. IRN 8 rice seeds) enabling the Green Revolution

- seeds bred for special physical conditions e.g. more drought resistant varieties of wheat
- more wind resistant wheat varieties
- more recently GM crops for more consistent yields e.g. herbicide resistant means better
- weed control or bt toxin gene included to kill insects

Green revolution:

Revolution = change/big difference
Green = referring to plants/output from farming

What is meant by the term *Green Revolution*?

- Introduction of high yielding (or) hybrid varieties of rice or wheat into developing countries.
- Use of pesticides or herbicides, improved management, increased use of mechanisation or machinery or modernisation of farming.

One feature of the Green Revolution is that more of the land is owned by fewer people.
Do you think that this is a good thing? Give reasons for your answer.

Yes: good because then the full benefits of increased yields can be felt; many plots of land far too small; to be efficient

No: unemployment; less technology; bad because poorer farmers may lose their land; thus all the benefits of land ownership; such as secured food for family or profits for own use.

Problems resulting from the Green Revolution:

- Pesticides build up along food chains (Bioamplification/magnification) it may kill predators
- Danger to humans
- Fertilisers leached and enrich water - kill fish -deplete O2

Genetically modified organisms:

- The removal of a genes from one organism and transfer it into another to create different plant varieties and new seeds for new varieties of crops
- The DNA that has been altered by this process and which now contains lengths of nucleotides from two different organisms is called **recombinant DNA** (rDNA)
- The organism which now expresses the new gene or genes is known as a **transgenic organism** or a **genetically modified organism** (GMO)
- The GM plants grown around the world are crop plants modified to be resistant to herbicides, such as **glufosinate**and**glyphosphate**, or crops that are resistant to insect pest
- These modification increase crop yield
- A few crops, such as vitamin A – enhanced rice, provide improved nutrients

Insect – resistant crops:

- GM plants protected against attack by insect pests
- **Maize** is protected against the **corn borer**, which eats the leaves of the plants and then burrows into the stalk
- **Cotton** is protected against pests such as the **boll weevil**
- In both the plants, yield is improved
- Insect- resistant tobacco also exist, and is protected against the tobacco bud worm
- Bt toxin is produced by a bacterium called ***Bacillus thuringiensis***(Bt)

- Bt toxin gene has been cloned from the bacteria and been expressed in plants to provide resistance to insects without the need for insecticides; in effect created a bio pesticide
- E.g. Bt cotton, rice, tomato, potato, soyabean

Data:

- Over 50 million hectares of GM crops are grown in 13 countries around the world.
- The highest percentages are grown in the USA (68%), Argentina (22%), Canada (6%), and China (3%)

How are seeds used for GM crops different from seeds that have been used by farmers for thousands of years?

- Seeds are made by scientists or by genetic modification
- Whereas other seeds were developed from wild/natural plants.

People hold different views about GM crops.

What do supporters of GM crops say?

• Higher food output and foods that can offer higher levels of nutrients and vitamins.

• Disease resistant, which means higher output and less pesticide use. (There is less leakage of chemicals into rivers and seas as well).

• Herbicide tolerant, which means that farmers can use weed killers and control weeds without damaging their crops.

• Hunger in developing countries will be reduced.

• More efficient use of existing farm land, so that fewer forests will need to be cleared in the future for new farm land.

One scientist says, *'The world cannot afford to miss the new opportunities created by new scientific discoveries and technologies'*.

What do people opposed to GM crops say?

• It is dangerous to use genetic engineering to create plant and animal varieties that could not have been created in nature.
• This may create 'super weeds' without controls, replacing existing varieties of plants and animals from the ecosystem and reducing biodiversity.
• Use of natural crop varieties will be reduced, also reducing biodiversity.
• Greater use of herbicides (weed killers) will result in a higher concentration of chemicals in food and water runoff from the land.
• Increases in food output have not been as great as supporters have claimed.

One environmentalist says, *'New organisms can never be removed from the environment once they have been created, so that these scientists are gambling with the natural world'*.

Explain why the scientist supports GM crops and the environmentalist opposes their use.

Scientist - for their use:

- Advantages for food output and nutrition.
- Less need for new farm land to be cleared.
- Less pollution from chemical pesticides.
- GM crops allow more people to be fed on less land with less damage to the environment.

Environmentalist - against their use:

Environmentalist opposing their use –

- Using plants which are not naturally created.
- This is dangerous because bio-diversity is likely to be reduced.
- Some of the claims made by those in favour such as less environmental damage and more food output have not been met.
- GM crops are dangerous because farmers are going into unchartered areas with unproven results.

Reasons why the farmers would reject the GM bean:

- Genes might escape to other species by means of pollination
- could upset balance of nature
- Not a local plant so may not survive
- cost of GM
- cost of buying new GM seed each year
- fear or suspicion of GM crops

- Possibility of super weeds, moral objections, health concerns

Benefits gained from growing genetically engineered crops:

- Higher yield or more profit due to pest or disease resistance and herbicide tolerance
- Better due to increased nutrient content, control ripening, colour and flavor improved and size

Controlled growing environments:

- One way of increasing productivity on a farm is to remove plants and animals entirely from the natural world and cultivate or tend to them in artificial conditions
- The farmer then has complete control over all growing conditions:
- Water, light, heat, the availability of food, and fertilizer

Controlled growing environments:

- Greenhouses
- Hydroponics

Greenhouse:

- A greenhouse is a good example of a controlled environment
- In the Netherlands, massive greenhouses are used to grow peppers in constant light conditions, which reduces their growing season by four weeks
- This reduces the farmer’s cost and increases profit
- If extra carbon dioxide is pumped into the greenhouses then plants such as tomatoes will photosynthesise faster, which has the effect of increasing sugar production, improving flavour and yield

Hydroponics:

- Hydroponics involves immersing plant roots only in a water solution of minerals and nutrients within a greenhouse
- As no soil is involved, it offers farmers the possibility of high yields at reduced costs, which boosts profits
- Hydroponics also enables the farmer to isolate growing plants from outside pests, diseases and weeds, which further reduces costs because less pesticide is used

Impact of agriculture:

The impact of agricultural practices on the environment and people

Soil erosion – causes:

What is soil erosion?
Removal of topsoil

- If not managed carefully, intensive farming can lead to both **overcultivation** and **overgrazing** of land
- Both factors can cause serious soil erosion when topsoil is washed or blown away by heavy rain or strong winds
- Overcultivation is the continuous and excessive use of farmland for crops to a point where soils are depleted of nutrients and the soil structure is severely broken down by a lack of organic matter
- **Overgrazing** degrades the land by stripping away its vegetation cover as a result of the density of livestock being greater than **carrying capacity** of the soil

- Overgrazing by increasing number of livestock farmers is a particular problem in many dry regions of the world such as the **Sahel** in **Africa**
- Higher density farming means that cattle herds now tend to be fenced into confined area and are no longer allowed to roam in search of fresh pasture and water
- This situation is made worse by the construction of boreholes at specific locations to bring underground water to the surface and create water holes
- This allows animals to stay all year in places that previously they may have only grazed for a few months
- Consequently they gather around the borehole and overgraze the surrounding area causing serious **soil erosion** and **desertification**

Impacts:

- Soil erosion quickly removes the essential nutrients in Topsoil layer (contain most nutrients) from the land
- Nutrients are also lost from degraded soil through leaching (soaking away the soluble nutients)
- Fertile land coming to resemble a desert
- Desertification – habitat loss and the silting of the rivers
- Removing the protective cover of vegetation and its roots, and allowing the soil structure to disintegrate to a point where the land no longer has an economic or ecological value, is termed **land degradation**
- Often land degradation leads to soil erosion (the removal of top soil)

Causes and impacts of soil erosion:

- Removal of natural vegetation by over cultivation and overgrazing
- Water and wind erosion

- Loss of habitats
- Desertification
- Silting of rivers
- Displacement of people
- Malnutrition and famine

- Soil erosion can also leads to the displacement of people when they are forced off the land they have been farming because of desertification
- A good example is the infamous **Dust Bowl event** of the dry High plains region (especially the states of Texas and Oklahoma) of the united states in the 1930s which forced tens of thousands of farmers and their families to abandon the land

Poor management of farmland by people causes and increases soil erosion: Agricultural practice can increase the risk of soil erosion:

The ways in which farmers cause soil erosion are

- removal of plant cover;
- Overgrazing, overcropping
- over-cultivation,
- monoculture,
- use of heavy machinery,
- overuse of the land,
- overstocking,
- deforestation, clearing more trees
- loss of minerals,
- ploughing,
- using artificial fertilisers
- loss of root binding, lack of interception or infiltration/soil saturation removal of topsoil/fertile layer; surface
- run-off; erosion by water; wind; flooding

Methods to reduce soil erosion:

Land reform:

- land ownership is changed, land taken out of hands of landlords and given to local people
- increased community involvement; more incentive to conserve the soil

Dry land farming:

- straw / mulch / layer of weeds covers the soil
- stops soil drying so less likely to be eroded; reduces evaporation

Contour ploughing:

- ploughing of the land around slopes
- creates a water break reducing the effects of rills and gullies; allows more time for water
- to soak into the soil reducing surface run-off;

Rural development programmes:

- training (from government or NGO);

Cash crops replacing food crops:

- In MEDCs almost all farms produce food in order to generate income for the farmer
- In most LEDCs the majority of farmers own smallholdings of less than 0.02 sq km, which they operate on a subsistence or semi- subsistence basis
- For these farmers, converting their land to produce a cash crop such as coffee – which can be exported for profit to MEDCs – has many attractions
- A cash crop farmer will have cash to buy food locally, employ relatives and pay for family expenses such as medical and school bills
- However, making the change can also have serious consequences for the family, the local community and the environment

Consequences – 1

- Farmers have little power to set the price for their cash crops

- This determined by the wholesalers whole act as buyers for large manufacturers and retailers in MEDCs
- Wholesalers will always seek to reduce purchase prices to a minimum

Consequences – 2

- Farmers are very vulnerable to changes in demand (and therefore prices) for cash crops in MEDCs
- For example health advice to consume less refined sugar, give up smoking and drink less coffee
- These will affect sugarcane, tobacco and coffee farmers in LEDCs if demand falls

Consequences – 3

- If cash income drops, farmers may not be able to buy enough food from other sources and their families may suffer from malnutrition or be forced to migrate to work in towns and cities

Consequences – 4

- Because small plots of land are not really viable for cash crop production, many farmers allow their land to be absorbed into large estates or plantations that then have the power to control what they produce and where they live

Consequences – 5

- Converting from subsistence farming to cash- crop monoculture can have serious impacts on the ecosystem
- Cash crops (especially fruit production) require much greater volumes of water than subsistence crops like maize

- As a result, local water supplies may become depleted

- Planting the same crop every year quickly removes the particular nutrients required by the plant and expensive chemical fertiliser are then required to replace them
- These may pollute water tables through run-off and further reduce the profits of the farmer

Overproduction and waste:

- The widespread use of intensive production methods in MEDCs (USA and EU) means that more food is often produced than consumers require
- The UN estimates that as much as one-third of all the food produced in the world each year is never consumed by people
- Around 550 billion cubic metres of water wasted globally in growing crops that never reach the consumer

There are several reason for the overproduction of food in MEDCs:

Reason 1

- Farmers receive guaranteed minimum prices for what they produce, irrespective of what they produce
- This system of paying subsidies is designed to protect the income of farmers if the price of food products drop on the world market
- The US government spends about US$10 billion a year on farm subsidies
- If the farmers produce more of a commodity than they can sell then the government buys up the surplus at the agreed price

Reason 2

- Demand for food in many MEDCs is not interesting because of **low population growth**, which means the market for the most farm products is saturated
- Saturated - (supply a market beyond the point at which there is demand for a product)

Reason 3

- **Produce** may not be harvested by farmers because of damage caused by **pests**, **disease**, and **weather**, or because its quality does not meet the extracting **standards** of retailers, especially multinational supermarket chains
- Each year farmers in Europe are forced to throw away millions of tonnes of perfectly healthy and nutritious fruit and vegetables because they do not meet the '**cosmetic standards**'

For example:

- Without any **blemishes** (small mark spoil the appearance of product) or bruises (discoloured in an area) and being the perfect colour, size and shape) required by super markets
- 'Ugly' produce is rejected and wasted
- As a result as much as 30 percent of fruit and vegetable crops are never harvested
- Overproduction – another serious problem in many MEDCs is the wastage of food by consumers
- Waste almost as much food(222 million tonnes) as the entire food production of the countries of sub- Saharan Africa (230 million tonnes)

- Some of this wastage is due to supermarket promotions such as ‘buy one get one free’ offers, which encourages consumers to buy more than they need
- Poor packaging and consumer knowledge about storing foods at home is also a factor
- If all fresh meat was sold by supermarkets in packaging that could be resealed, its fridge life would be extended significantly
- Date labelling also leads to food wastage when consumers confuse ‘use by’ and ‘sell by’ dates and consequently throw away perfectly edible food

Managing soil erosion:

Strategies to reduce soil erosion

- Terracing
- Contour ploughing
- Bunds
- Wind breaks
- Maintaining vegetation cover
- Addition of organic matter to improve soil structure
- Planting trees, mixed cropping, intercropping and crop rotation

Terracing:

Flat platforms made on hillside, it slows runoff of water and thus slowing soil erosion downhill

Explain how terracing reduces soil erosion.

- It stops rapid flow of water or run-off or more infiltration or carrying soil away.

- due to no slope or flat surfaces for growing or wall blocking water flow or hold soil back

Terracing benefits:

- It increases area for farming
- It allows high parts to get adequate water, as it does not run away or fertilisers do not run away
- Easier to work the land when flat
- Can use machinery when field is flat

Maintaining vegetation cover:

- Plants and trees build root systems that anchor the soil in place, and add decaying organic matter that improves water retention
- Vegetation cover also reduces the speed of water run-off and the likelihood of the wind removing soil particles
- Regularly adding a mulch of organic matter such as manure to the soil is also effective
- As it allows the soil to soak up water slowly, protects it from raindrop impact and encourages soil to clod
- This the amalgamation or joining together of smaller soil particles into larger pieces more resistant to erosion
- It is very important for a farmer to maintain as much of the existing vegetation cover such as hedges on the farm as possible
- Hedges not only protect the soil as natural wind breaks, but are also the habitat of insects and birds that will prey on crop pests (aphids)
- Use strategic planting of new vegetation, such as native trees on areas like steep hill sides and river banks (because these places are most vulnerable to soil erosion)

Wind breaks:

- Trees planted in rows or wall or fence to protect from soil erosion by wind
- These are lines of trees planted to face the prevailing wind and filter out 50 -60 percent of its strength
- A windbreak will significantly reduce wind on its leeward side to a distance of ten times its height

Intercropping:

- Intercropping (growing two or more crops in the same field or area) also helps to reduce the risk of soil erosion
- **Mixed cropping** is the simplest form of intercropping and involves the intermingling of plants randomly over the area with no arrangement, such as the practice of commonly growing maize, beans and squash together in the countries of Central America
- For example crops with wide shallow roots are planted alongside crops that are deep rooted
- The intercropping of leguminous nitrogen- fixing crops such as **beans** and **peas** alongside **cereal crops** will help ensure the continual replenishment of nutrients in the soil

Contour ploughing:

- It involves ploughing **furrows** across rather than down slopes, following the natural contours of the land
- This creates furrows that curve around the land and are mostly level
- (plough perpendicular to slope or along contours (to form ruts) which slow water runoff)

- **Natural water breaks** are then created by the furrows, which allow rainwater more time to soak into the soil and prevent rapid run-off along gullies down the slope
- Contour ploughing and terraces - both reduce the movement of soil down slope during cultivation (on steep hillsides)

Bunds:

- In addition, a farmer may construct a bund along the contour to slow and encourage greater water uptake by the soil
- A bund is made up of stones or soil and the steeper the slope, the closer they tend to be
- A common type of bund is the **terrace** commonly used by rice farmers in countries of South East Asia

Strategies for sustainable agriculture:

- **Organic fertiliser (crop residue)**
- **Managed grazing (livestock rotation)**
- **Crop rotation**
- **Use of pest resistant and drought resistant varieties of crops**
- **Trickle drip irrigation**
- **Rainwater harvesting**

Crop rotation:

- It is the central to the operation of sustainable farms

- It enables soil fertility to be maintained and increased and soil structure to improve naturally through growing different crops in succession
- Ensuring that leguminous crops such as soya beans are part of the crop rotational cycle has the effect of adding or fixing nutrients, particularly nitrogen, in the soil
- For example, maize grown in a field that last season grew soya beans will need much less added nitrogen than if maize was grown continuously
- Rotation also helps in the natural management of crops pests and diseases without the use of chemical pesticides
- Continuous cropping – of one plant species in the same place guarantees pests that feed and reproduce on that crop (population increases)
- If their host crop is not grown for a year as part of a rotation then their reproductive cycle will be broken and their number will decline
- It help to control weeds and reduce the need for pesticides

Managed grazing/rotational grazing:

- Rotational grazing of animals is practised on sustainable farms for the same reason as crop rotation
- Continuous grazing on the pasture season after season results in declining yields, such as of milk or meat,
- Because the forage (crops grown to be eaten) never has time to regain lost nutrients and energy levels
- Rotational livestock grazing involves a farmer dividing pasture into different paddocks
- Only one paddock of pasture is then used by the animals at any given time
- Livestock is moved from one paddock to another in sequence

- Being left to ‘rest’ enables the forage crops to restore lost energy reserves and vigour and deepen their root systems

Use of pest resistant and drought resistant varieties of crops:

- The biocontrol of crop pests and diseases on sustainable farms often begins with a farmer selecting crops that are well adapted to the specific site conditions of the farm
- For example, be a crop selectively bred to be drought- resistant if the farm is in a dry region
- Crops may also be grown that have been crossbred to be resistant to a particular range of pests and diseases
- The **Alizze** and **Harnas** hybrid varieties of oilseed rape have a high degree of natural resistance to canker and leaf spot disease
- The **XL6 strain** of hybrid rice offers resistance to blast and sheath blight