Unit I - ENVIRONMENTAL CONCERNS

Environmental basis for agriculture and food – Land use and landscape changes – Water quality issues – Changing social structure and economic focus – Globalization and its impacts – Agro ecosystems

The environment matters to agriculture because:

- It provides the basis for food and agricultural systems.
- Agriculture can have positive (e.g. conserving habitat for wild species) and negative (e.g. pollution, soil degradation) impacts on the environment.
- Environmental degradation and lack of access to environmental assets undermines food security and deepens poverty, with women and children most affected.

Agricultural bio diversity and its role

- The variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the ecosystem structures, functions and processes in and around production systems, and that provide food and non-food agricultural products.
- Agricultural biodiversity plays key roles in: decomposition and nutrient cycling; natural pest control; soil conservation; pollination and seed dispersal; local and global climate; the water cycle; and biomass production.

Agriculture's impacts on the environment

Agriculture can either sustain or degrade the environment.

- Agricultural landscapes in providing products for human sustenance, supporting biodiversity and maintaining ecosystem services.
- Negative impacts include: Conversion of forests, grasslands and other habitats for agricultural use
- Degradation of soil quality
- Pollution of soil and surface water, aquifers and coastal wetlands through use of pesticides and fertilizers
- Significant loss of crop and livestock genetic diversity through the spread of industrial monocultures, reducing resilience in the face of climate and other changes

Interactions between agriculture and the environment (or) Issues between agriculture and the environment

Soil quality: Related issues are contamination, erosion, desertification, nutrient supply and moisture balance.

- Soils can be damaged by changes in land use practices such as deforestation, the removal of hedgerows, overgrazing, and neglect of soil conservation methods, contamination, erosion, desertification, nutrient supply and moisture balance.

Water quality and quantity:

- Related issues are leaching of nutrients and pesticides, water extraction and drainage and flooding.
- Contamination of both ground and surface waters caused by high levels of production and use of manure and chemical fertilisers is a serious problem, particularly in areas of intensive livestock or specialised crop production.

Air quality:

- Related issues are emissions of greenhouse gases and ammonia.
- Agriculture is responsible for about 8% of total greenhouse gas emissions but is the principal source of methane (from cattle production) and nitrogen oxide (from grazing livestock) contributing around 40% of these two gases.

Biodiversity:

- Related issues are genetic, species and ecosystem diversity.
- Agricultural area remains under low intensity systems - mainly either grazing land under various systems of livestock management or permanent crops under traditional management.

Landscape:

- Agriculture can lead to the loss of important landscape features such as hedges and ponds, the enlargement of fields and the replacement of traditional farm buildings with industrial structures.

Food safety and animal welfare concerns:

- Related issues are the effect of agricultural practices on human health rather than the physical environment.
- There is also concern about the consequences for the quality and safety of the food supply of the increasing use of pesticides and drugs, leading to encouragement to organic farming

Land use and landscape changes

Land use change is a process by which human activities transform the natural landscape, referring to how land has been used, usually emphasizing the functional role of land for economic activities.

There are many types of land use:

- Recreational - fun, non-essentials like parks.
- Transport - roads, railways, and airports.
- Agricultural - farmland.
- Residential - housing.
- Commercial - businesses and factories.

The important types of land use in the country are:-

- Forests area, Land not available for cultivation, Cultivable waste land, Net area sown

Land-use Changes in India

Land-use in a region, to a large extent, is influenced by the nature of economic activities carried out in that region. However, economic activities change over time, land, like many other natural resources, is fixed in terms of its area.

(i) The **size of the economy** grows over time as a result of increasing population, change in income levels, available technology and associated factors. As a result, the pressure on land will increase with time and marginal lands would come under use.

(ii) Secondly, **the composition of the economy** type of change is common in developing countries like India. This process would result in a gradual shift of land from agricultural uses to non-agricultural uses. The agricultural land is being used for building purposes.

(iii) Thirdly, though the contribution of the agricultural activities reduces over time, the pressure on land for agricultural activities does not decline.

Landscapes classified in to four major types :

- **intact** – in which landscapes contain most original vegetation with limited clearing;
- **variegated** – in which landscapes are dominated by original vegetation, but include gradients and buffers of modified habitat;
- **fragmented** – contains discrete patches of vegetation in a modified matrix;
- **relictual** – with little (less than 10%) of the original vegetation remaining, surrounded by highly modified landscape.

EFFECTS OF LANDSCAPE CHANGE ON SPECIES AND POPULATIONS

1. The harmful effects of landscape change on species reproduction may be direct when habitat loss and fragmentation affect individual performance within habitat.
2. Landscape change effects on reproduction; for example, flowering, fruiting and seed set of the permanent herbal plant through a gradient of forest loss and fragmentation, in 2 years with different climatic conditions
3. It effects landscape scale, forest habitat availability and subdivision, forest edge length, population size and subdivision, and flower, fruit and seed production.
4. Flower and fruit production decreased in landscape regions with lower forest habitat availability, and fruit production decreased in areas with a smaller amount of forest edge. There was also a negative indirect effect of habitat loss on seed production, through population size reduction.
5. Landscape change effects on reproduction differed between the 2years, becoming evident after a mild winter that favoured long-lasting flowering, but disappearing, or even changing sign, when winter harshness shortened flowering.
6. Synthesis and applications. The contrasting effects of the different processes of landscape change and the potential additive role of climatic variability must also be considered in management purposes.

How does agriculture affect the landscape?

Reduced -soil fertility, soil erosion due to land clearance and grazing. Contaminated soils produced due to pesticides or overuse of fertilisers. Water pollution led from run-off or animal wastes, leading to eutrophication.

How did farming change the environment?

Ultimately, the environmental impact depends on the production practices of the system used by farmers. Some of the environmental issues that are related to agriculture are climate change, deforestation, genetic engineering, irrigation problems, pollutants, soil degradation, and waste.

How does agriculture impact natural landscape?

Landscape changes cause the disappearance of traditional agricultural landscape and are responsible for vegetation modifications which have an impact on regional climate, carbon sequestration, and biodiversity losses. Agriculture also has impact on the natural systems and ecosystem services on which humans depend.

What is land cover change?

Land Cover Change. Land cover change is defined as the loss of natural areas, particularly loss of forests to urban or exurban development, or the loss of agricultural areas to urban or exurban development.

Water quality as a global issue

Agriculture, as the single largest user of freshwater on a global basis and as a major cause of degradation of surface and groundwater resources through erosion and chemical runoff, has cause to be concerned about the global implications of water quality.

Global freshwater quality problem:

- Five million people die annually from water-borne diseases.
- Ecosystem dysfunction and loss of biodiversity.
- Contamination of marine ecosystems from land-based activities.
- Contamination of groundwater resources.
- Global contamination by persistent organic pollutants.
- Decline in sustainable food resources (e.g. freshwater and coastal fisheries) due to pollution.
- Cumulative effect of poor water resource management decisions because of inadequate water quality data in many countries.

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What is Water Pollution?

Presence of foreign impurities (organic, inorganic, biological) in such quantities so as to constitute a health hazard by lowering the water quality and making it unfit for use.

Or

Water pollution is any chemicals, biological or physical change in water quality that has a harmful effect on living organisms or makes water unsuitable for desired uses.

Causes:

Point sources: - Discharge pollutants at specific location through pipes, ditches or sewers into bodies of surface water. Ex: flow of water pollutants from sewerage system, industrial effluent etc.

Non point sources: - Cannot be traced to any single site of discharge. They are usually large land areas or air sheds that pollute water by runoff, subsurface flow or deposition from the atmosphere. Ex: agricultural land (pesticides, fertilizers, mining, construction sites)

Sources of Water Pollution: The key causatives of water pollution in India are:

- Urbanization.
- Deforestation.
- Industrial effluents.
- Social and Religious Practices.
- Use of Detergents and Fertilizers.
- Agricultural run-offs- Use of insecticides and pesticides.

Classification of water pollutants:

1. suspended matter
2. thermal discharge
3. pathogens (bacteria, fungi, protozoa fungi)
4. natural organic pollutants
5. synthetic organic pollutants
6. inorganic chemicals
7. radioactive waste, oil, sediments

Effects of Water Pollution

1. Objectionable colour and odour is unacceptable and unsuitable for drinking and other purposes.
2. highly turbid and very hard water is unpleasant to drink, food processing
3. acid and alkaline water cause serious health problem
4. These contaminants like DDT remain in the fats and are not degraded in the body. Over the years the amount of DDT increases in the body. This is called biomagnification.
5. Pollutants such as pesticides are non biodegradable and accumulate in the food chain known as Biomagnifications / bioaccumulation
6. water borne infectious enteric disease like typhoid, cholera, dysentery, are the predominant health hazard arising from drinking contaminated water
7. radioactive pollution enter human body through food and get accumulated in thyroid gland, liver, bones and muscles
8. biodegradable waster deplete D O in the receiving stream, affect the flora cause creates anaerobic conditions
9. non biodegradable waste and pesticides travel the food chain and ultimately reach human where they accumulate in fatty tissues
10. thermal discharge in stream depletes D O
11. Toxic substances polluting the water ultimately affect human health. Some heavy metals like Pb, Hg, Cd cause various types of diseases
12. Nitrogen & phosphorus helps in the growth of algae which when die and decay consume oxygen of water. Changes in pH, O_2, temperature will change many physico – chemical characteristics of water
13. phosphate, nitrate, promote the growth of algae and encourage eutrophication
14. Industrial effluents result in addition of poisonous chemicals such as arsenic, mercury, lead may reach human body through contaminated food.

Pollution Management and Control

There are many approaches that could be adopted in water pollution control and management. It could be through prevention, practice efforts or join a project/program; Regulation and monitoring or engaging in control measures by reducing or minimizing waste. Prevention of water pollution includes the following ways:

1. Prevent Ground water contamination.
2. Greatly reduce non point runoff
3. Reuse treated waste water for irrigation
4. Find substitutes for toxic pollutants.
5. Work with nature to treat savage.
6. Practice four R's of resource use (Refuse, Reduce Reuse, Recycle).
7. Reduce resource waste
8. Reduce birth rates.
9. Use Nitrogen fixing plants to supplement the use of fertilizers.
10. Adopting Integrated pest management to reduce reliance on pesticides.
11. Planting trees would reduce pollution by sediments.
12. For controlling water pollution from point sources, treatment of waste water is essential.
13. Waste water should be properly treated by primary and secondary treatments to reduce the BOD, COD levels to the Permissible levels.
14. Advanced treatment for removal of nitrates & phosphate.
15. Proper Chlorination should be done to prevent the formation of chlorinated hydrocarbons or disinfection should be done by ozone or UV.

Control measures of water pollution

1. Lay down standard for
    a. drinking water
    b. disposal of waste water into water course/sewer/land
2. Regular monitoring
3. Treatment

a. domestic treatment
    1. screening
    2. sedimentation
    3. filtration, pH adjustment
    4. disinfection
b. waste water treatment
    i. preliminary treatment
    ii. primary treatment
    iii. secondary treatment

4. Advanced treatment for recycling, reduce and reuse
5. **Public Awareness**
   The public should be made aware of the dangers of water pollution. This will ensure that the water bodies are not contaminated and are maintained clean

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Sustainable agriculture

Sustainable agriculture is farming in sustainable ways (meeting society's food and textile needs in the present without compromising the ability of future generations to meet their own needs) based on an understanding of ecosystem services, the study of relationships between organisms and their environment.

Sustainable agriculture is the act of farming using principles of ecology, the study of relationships between organisms and their environment. It has been defined as "an integrated system of plant and animal production practices having a site-specific application that will last over the long term."

Benefits of Sustainable Agriculture

1. Contributes to Environmental Conservation: Sustainable agriculture helps to replenish the land and other natural resources such as water and air. This replenishment ensures that these natural resources will be able for future generations to sustain life.

2. Public Health Safety: Sustainable agriculture avoids hazardous pesticides and fertilizers. As a result, farmers are able to produce fruits, vegetables and other crops that are safer for consumers, workers, and surrounding communities. Through careful and proper management of livestock waste, sustainable farmers are able to protect humans from exposure to pathogens, toxins, and other hazardous pollutants.

2. Prevents Pollution: Sustainable agriculture means that any waste a farm produces remains inside the farms ecosystem. In this way the waste cannot cause pollution.

3. Reduction in Cost: The use of sustainable agriculture reduces the need for fossil fuels, resulting in significant cost savings in terms of purchasing as well as transporting them. This in turn lessens the overall costs involved in farming.

4. Biodiversity: A sustainable farm produces a wide variety of plants and animals resulting in biodiversity. During crop rotation, plants are seasonally rotated and this results in soil enrichment, prevention of diseases, and pest outbreaks.

5. Beneficial to Animals: Sustainable agriculture results in animals being better cared for, as well as treated humanely and with respect. The natural behaviours of all living animals, including grazing or pecking, are catered for. As a result they develop in a natural way. Sustainable farmers and ranchers implement livestock husbandry practices that protect animals' health.

6. Economically Beneficial for Farmers: In exchange for engaging with sustainable farming methods, farmers receive a fair wage for their produce. This greatly reduces their reliance on government subsidies and strengthens rural communities.

7. Social Equality: Practicing sustainable agriculture techniques also benefits workers as they are offered a more competitive salary as well as benefits. They also work in humane and fair working conditions, which include a safe work environment, food, and adequate living conditions.

8. Beneficial for Environment: Sustainable agriculture reduces the need for use of non-renewable energy resources and as a result benefits the environment.

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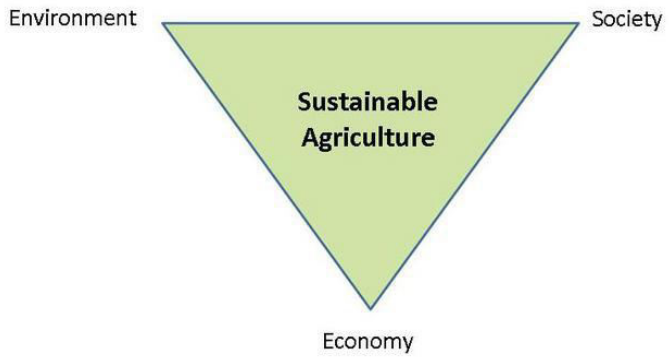
Changing social structure and economic focus

- Food and fiber productivity has increased due to new technologies, mechanization, increased chemical use, specialization and government policies that helped maximizing production and reduction of food prices.
- Leads to topsoil depletion, groundwater contamination, air pollution, greenhouse gas emissions, new threats to human health and safety due to the spread of new pathogens, economic concentration in food and agricultural industries, and disintegration of rural communities.
- Sustainable agriculture integrates three main goals – environmental health, economic profitability, and social equity (Figure 1).



Sustainable Agriculture and the Management of Natural Resources

- When the production of food and fiber degrades the natural resource base, the ability of future generations to produce and flourish decreases.
- A sustainable agriculture approach seeks to utilize natural resources that they can regenerate their productive capacity, and also minimize harmful impacts on ecosystems beyond a field's edge.
- One way that farmers try to reach these goals is by considering how to capitalize on existing natural processes, or how to design their farming systems to incorporate crucial functions of natural ecosystems.
- For example, farmers aiming for a higher level of environmental sustainability might consider how they can reduce their use of toxic pesticides by bringing natural processes to bear on limiting pest populations.

Sustainable Agriculture and Society

- Agro ecosystems cannot be sustainable in the long run without the knowledge, technical competence, and skilled labour needed to manage them effectively.
- Social institutions that promote education of both farmers and scientists, encourage innovation, and promote farmer-researcher partnerships can increase agricultural productivity as well as long-term sustainability

Globalization and the role of agriculture

Globalization refers to increases in the movement of finance, inputs, output, information, and science across huge geographic areas. The gains from globalization increase net income in many places and facilitate decreases in levels of poverty and increase levels of food security.

The rapid changes have allowed a great increase in specialization in agriculture, and consequently lower costs and rapid growth in trade.

Competing in the context of globalization

1. **Cost reductions in one place have immediate impacts in other places** : Cost reduction and associated production increase constantly occurs in agriculture, and the pace is accelerating, due to the forces of globalization.
2. **Cost reduction largely derives from technological advance :** Increase the basic research with high productivity. Low-income countries are improving their agricultural research capacity to reduce costs and prices
3. It is agricultural growth that reduces poverty.
4. **Opening the economy to trade and market forces**: Exports require imports, but trade restrictions tend to drive up the cost of exports through higher costs of vital inputs and technology.
5. **Investing in agricultural research and dissemination**: Low-income countries need to invest in agricultural research and technology dissemination. Identifying supporting mechanisms such as research and training to minimise the exclusion of small resource poor farmers from value chains is also important.
6. **Investing in rural infrastructure**: Given the deplorable state of rural infrastructure in low-income countries, massive investments are needed. (Economic risk reduction services such as insurance, irrigation, storage are required).

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Agroecosystem

- Agriculture + ecosystem =Agroecosystem
- Any ecosystem largely created and maintained to satisfy a human want or need is called an agroecosystem
- Agroecological research is the idea that, by understanding ecological relationships and processes, agroecosystems can be manipulated to improve production and to produce more sustainably, with fewer negative environmental or social impacts and fewer external inputs

How do agro ecosystems differ from natural ecosystems?

Ecology Six ways difference: • Maintenance at an early succession state • Monoculture • Crops generally planted in rows • Simplification of biodiversity • Plough which exposes soil to erosion • Use of genetically modified organisms and artificially selected crops

Differences: in natural ecosystems, recycling of minerals previously used by organisms is the most important source of nutrition, while in agro ecosystems exogenous minerals are added, sometimes in large amounts, to compensate for that which leaves the ecosystem as the harvested crop. Examples of relatively diverse traditional agro ecosystems include shifting cultivation, traditional rainfed rice systems, home gardens, and traditional shade coffee and cacao systems.

What are agricultural ecology and its importance?

Simply stated, **agricultural ecology** is the study of **agricultural** ecosystems and their components as they function within themselves and in the context of the landscapes that contain them.

Agro-ecosystem analysis (AESA)

"Agro ecosystem analysis (AEA) is a methodology for analyzing of agricultural livelihood systems and for planning and prioritizing research and development activities"**.** It was developed in the late 1970s and has since been used for research and extension planning in a range of locations and environments.

Principles of agro ecology or agro ecosystem

- Recycling nutrients and energy on the farm, rather than introducing external inputs;
- Integrating crops and livestock; diversifying species and genetic resources in agro ecosystems over time and space;
- Focusing on interactions and productivity across the agricultural system, rather than focusing on individual species.

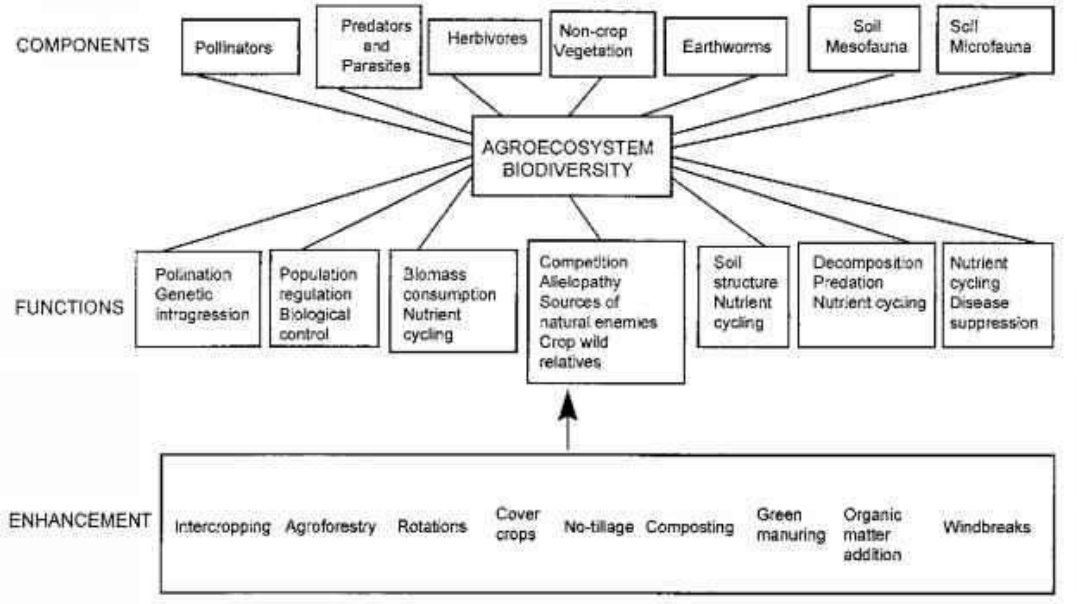
What is Agro ecosystems Management?

Agro ecosystems management integrates economic, ecological and social values to tackle challenges and find opportunities. It takes a broad view that ranges from the ground under your feet to your neighbouring farms and communities, and from farm to market to consumer.

Common features of practices

- Maintain vegetative cover as an effective soil and water conserving measure, met through the use of no-till practices, mulch farming, and use of cover crops and other appropriate methods.
- Provide a regular supply of organic matter through the addition of organic matter (manure, compost, and promotion of soil biotic activity).

- Enhance nutrient recycling mechanisms through the use of livestock systems based on legumes, etc.
- Promote pest regulation through enhanced activity of biological control agents achieved by introducing and/or conserving natural enemies and antagonists.



UNIT – II: ENVIRONMENTAL IMPACTS

Irrigation development and watersheds – mechanized agriculture and soil cover impacts – Erosion and problems of deposition in irrigation systems – Agricultural drainage and downstream impacts – Agriculture versus urban impacts

1. What are the benefits and main problems of irrigation and drainage systems?

Irrigation: Irrigation is the artificial application of water to land for the purpose of agricultural production. Effective irrigation will influence the entire growth process from seedbed preparation, germination, root growth, nutrient utilization, plant growth and re-growth, yield and quality.

Benefits of irrigation system

- To grow more pastures and crops
- To have more flexibility in their operations as the ability to access water at times when it would otherwise be hard to achieve good plant growth is imperative.
- Producers can then achieve higher yields and meet market/seasonal demands especially if rainfall events do not occur.
- To produce higher quality crops as water stress can dramatically impact on the quality of farm produce
- To maximize benefits of fertilizer applications. Fertilizers need to be 'watered into' the ground in order to best facilitate plant growth.
- To take advantage of market incentives for unseasonal production
- Since irrigated land can potentially support higher crops, pasture and animal production, it is considered more valuable.
- the cost benefits from the more effective use of fertilizers and greater financial benefits as a result of more effective agricultural productivity

Problems of irrigation system

While irrigation has provided a number of important benefits the potential drawbacks of over/under watering include,

Under-watering

- Loss in market value through yield reduction
- Reduction in fruit size and quality

Over-watering

- Unwanted vegetative growth
- Losses of valuable water to the water-table
- Irrigation water travelling over soil can cause erosion. The excessive displacement of the top soil can also affect soil fertility and increases the need for water treatments.
- Irrigation can cause pesticides, pathogens and weeds to spread during irrigation
- Cause runoff
- Increased operational costs (labour, pumping, cost of water)
- Leaching of nutrients (eg. salt, phosphorus) may lead to algal growth, salinity an nitrate build ups (poisoning) elsewhere in the catchment
- Downgraded product quality and reduced yield.
- Higher operational costs for the producer (hence, reduced profits)
- Pressure on water resources with the Increasing demand for water use by urban dwellers

2. <u>What are direct, indirect and adverse effects of irrigation on environment?</u>

Environmental impacts of irrigation are the changes in quantity and quality of soil and water as a result of irrigation and the ensuing effects on natural and social conditions at the tail-end and downstream of the irrigation scheme.

<u>Direct effects</u>

- The impacts stem from the changed hydrological conditions owing to the installation and operation of the scheme.
- An irrigation scheme often draws water from the river and distributes it over the irrigated area.
- As a hydrological result it is found that:
    - ✓ the downstream river discharge is reduced
    - ✓ the evaporation in the scheme is increased
    - ✓ the groundwater recharge in the scheme is increased
    - ✓ the level of the water table rises
    - ✓ the drainage flow is increased

<u>Indirect effects</u>

The effects there of on soil and water quality are indirect and complex,

- ✓ Water logging
- ✓ soil salination
- ✓ danger of land degradation
- ✓ Impacts on natural, ecological and socio-economic conditions is very difficult.
- ✓ use water wells for irrigation - the overall water level decreases. This may cause water mining, land subsidence and, along the coast, saltwater intrusion.

The effects of irrigation on water table, soil salinity and salinity of drainage and groundwater, and the effects of mitigation measures can be simulated and predicted using agro-hydro-salinity models.

Irrigation may have both positive and negative impacts on the environment. To be sustainable, irrigation must avoid the negative impacts.

Adverse impacts

1. **The reduced downstream river flow may cause**:

- ✓ reduced downstream flooding
- ✓ disappearance of ecologically and economically important wetlands or flood forests
- ✓ reduced availability of industrial, municipal, household, and drinking water
- ✓ reduced shipping routes.

2. **Increased groundwater recharge, water logging, soil salinity**

- ✓ increased storage of groundwater that may be used for irrigation, municipal, household and drinking water by pumping from wells
- ✓ Water logging and drainage problems in villages, agricultural lands, and along roads - with mostly negative consequences.
- ✓ increase the water-borne diseases like malaria, yellow fever, dengue
- ✓ Drainage water moves through the soil profile it may dissolve nutrients such as nitrates, leading to a buildup of those nutrients in the ground-water aquifer. High nitrate levels in drinking led to "blue-baby syndrome

3. **Reduced downstream river water quality**

- ✓ It may lead to reduced public health.
- ✓ Polluted river water entering the sea may adversely affect the ecology along the sea shore
- ✓ The natural build up of sedimentation can reduce downstream river flows due to the installation of irrigation systems.

4. **Affected downstream water users**

- ✓ Downstream water users often have no legal water rights and may fall victim of the development of irrigation.
- ✓ land and water resources blocked by new irrigation developments without having a legal recourse

5. **Lost land use opportunities**

- ✓ Irrigation projects may reduce the fishing opportunities of the original population and the grazing opportunities for cattle.
- ✓ The livestock pressure on the remaining lands may increase considerably
- ✓ overgrazing may increase, followed by serious soil erosion and the loss of natural resources

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2. Explain water conservation and Watershed management

Need for water conservation:

- Population increases water requirement also increases
- Due to deforestation annual rainfall decreases
- Over exploitation of ground water

Ways of water conservation

- Reducing evaporation loss
- Reducing irrigation loss
- Reuse water
- Avoid sewage discharge

Water conservation method

- Rain water harvesting
- Watershed management

Rain water harvesting

Objective:

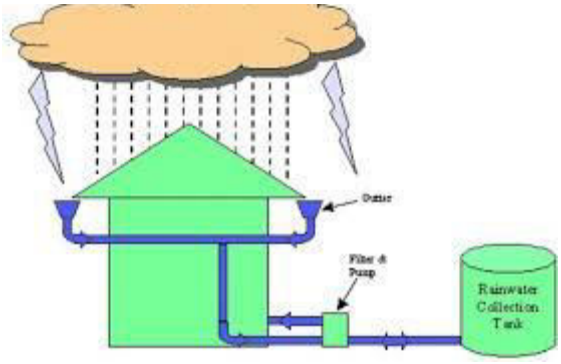
To meet increasing demands of water, Raise water table by recharging ground water, Reduce ground water contamination from salt water intrusion

Roof top rainwater harvesting

- Involves collecting water that falls on roof of house
- Rainwater from roof top, road surface, play ground diverted to surface tank

Advantages of rainwater harvesting

- Increases the well water availability
- Raise ground water level
- Minimizes soil erosion



Watershed management:

It is defined as land area bounded by divide line from which water drains under influence of gravity in to stream, lakes, and reservoir.

Eg. Pits, dams, Farm, ponds, Himalaya.

Types

1. Micro
2. Mini
3. Macro Watershed Management;

The management of rainfall & resultant runoff.

Forestry

Halt deforestation, provide vegetative cover, degraded land and supplement folder and fuel wood resources available to rural communities

Agriculture

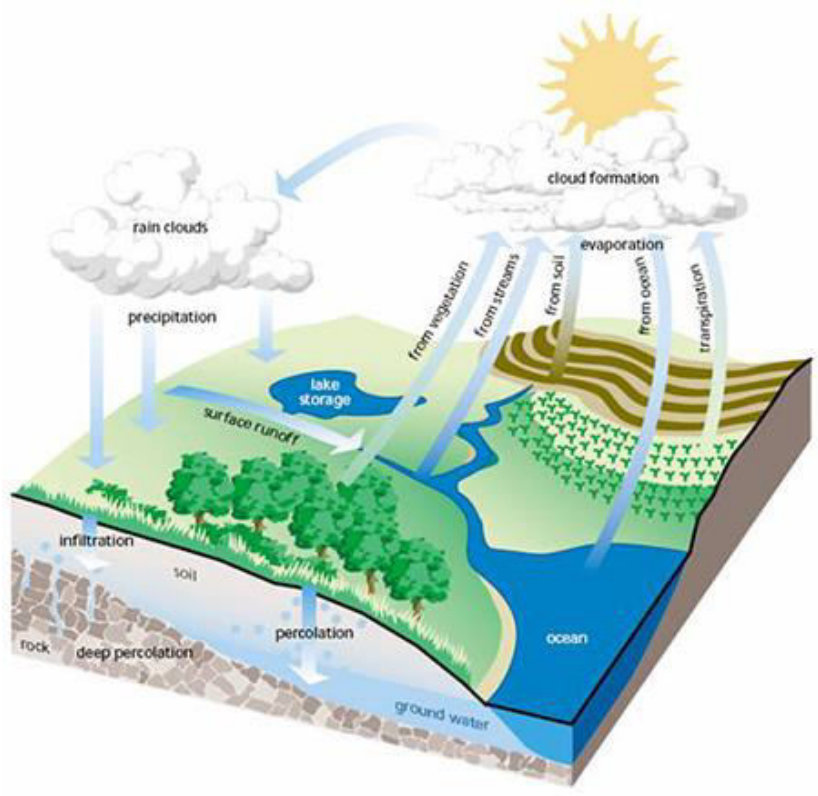
- Aims to increase agricultural productivity in sustained manner and to diversify crop production
- Major objective shall be achieved through organizing farmers, training camps and exposure visits.
- Construct check dams, water harvesting tanks, storage tanks and channels , repair of Old channels , implementing measures to check soil erosion

Horticulture

- establishment of private orchard
- Rejuvenation of existing orchards
- Distribution of horticulture plant for home garden planting.
- Animal husbandry
- Energy conservation
- Community participation
- Training and awareness programme

Advantages of Watershed projects

- Improved access to drinking water in project areas during drought
- Increase in cultivation area leading to increase in employment
- Increase in crop yield, resulting better income to rural population
- Improved availability of fodder for animals and increase in milk yield
- Increase in employment & involvement of women
- Increase in net returns from all crops.
- Decrease in soil erosion.
- Restoration of ecological balance.



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3. <u>Explain in detail about Mechanization of Agriculture and its Benefits and Problems in brief</u>

<u>Mechanization of Agriculture</u>

Mechanization of agriculture and farming process connotes application of machine power to work on land, usually performed by bullocks, horses and other draught animals or by human labor.

Benefits of Mechanization of Agriculture (any 8 points)

(1) It Increases Production:

- Mechanization increases the rapidity and speed of work with which farming operations can be performed
- By this quickening of agricultural practices the human labour required is minimised.

(2) It Increases Efficiency and Per Man Productivity

- Mechanization raises the efficiency of labor and enhances the farm production per worker.
- The combined, effect of fewer hours and more bushels per acre has resulted in more than halving labour requirements per unit of production

(3) Mechanization Increases the Yield of Land Per Unit of Area:

- Increase in the yield of crops, due to mechanization of farms, has been traced from 40 to 50 per cent

(4) Mechanization Results in Lower Cost of Work

- It has been accepted by all that one of the methods of reducing unit costs is to enlarge the size
- It is found that the cost of production and the yields can be adjusted properly if mechanization is resorted to.

(5) It Brings in other Improvements in Agricultural Technique:

- In its training come improvements in the sphere of irrigation, land reclamation and the prevention of soil erosion.
- Besides, ploughing by tractor reclaims more land and thereby extends the cultivated area as the tractors smoothens hillocks, fills in depressions and gullies and eradicate deeps-rooted weeds. It also prevents soil erosion.

(6) It Modifies Social Structure in Rural Areas:

- It results in a significant modification of the social structure in rural areas.
- It frees the farmers from much of the laborious, tedious, hard work on the farms.
- The pressure on land decreases and the status of the farmers improves.

(7) It Leads to Commercial Agriculture:

- Mechanization results in a shift from 'subsistence farming' to 'commercial agriculture.
- **This in its turn gives rise two tendencies:**
  (i) Gradual replacement of domestic or family by commercial methods, and
  (ii) Search for international markets for agricultural produce.

(8) It Releases Manpower for Non-Agricultural Purposes:

- Since the mechanization of agriculture results in the employment of lesser number of persons on farms, surplus manpower may be available for other economic activities.

(9) It Results in Better Use of Land:

- The substitution of gasoline tractor for animal power means reduced demand.
- To an exchange economy and a system of land utilization in which cultivator rests in the local self-sufficient economy.

(10) It Increases Farm Income:

- It turns loose economic agglomerates into social economies to closely knit by a thousand lines of interdependence.
- It constitutes, the lion's share to the public funds which support education, health and law and order.

<u>Problems of Mechanization Agriculture:</u>

(1) Small Sized Farms:

- A tractor cannot be used to plough a quarter of an acre plot.

- This is not a valid criticism because such farm machinery like a pump set can be installed even in a small farm of half an acre.

(2) Surplus Agricultural Workers:

- The basic defect of mechanization is that it will result in too many agricultural workers becoming surplus.
- Millions of farmers will be thrown out of land and will have to be provided alternative sources of employment.Use of farm machinery may create unemployment only in the short period.

(3) Surplus Cattle:

- It will render the existing cattle population surplus and unnecessary.
- To cut down the existing cattle population will be a difficult problem.

(4) Poor, Illiterate and Ignorant Farmers:

- The Indian farmers are, in general, poor and, therefore, will not be able to buy expensive tractors and other farm machines.
- Besides, the farmers are uneducated. They will not be able to understand the use as well as the working of expensive farm machinery.
- Farmers can always join together and purchase expensive farm machinery. Or the village co-operative society can purchase it and hire it out to farmers.

(5) Imports:

- India may not be in a position to produce farm machinery on a large scale. Necessarily, therefore, they will have to depend upon foreign countries..

(6) No Increase in Productivity of Land:

- Mechanization may not increase productivity of land. In India, the crucial problem is to increase the productivity of land, because land is a scarce resource of the country.
- The increase in the productivity of land is much more important than the increase in the productivity of labor
- In a country like Japan, where mechanization of farming is not adopted, productivity per hectare has been maximized because of intensive cultivation.

(7) Lack of Spare Parts and Service Facilities and Shortage of Power:

- There is also lack of spare parts and service facilities in the rural areas, and an acute shortage of kerosene, petroleum and diesel oil.
- This need to be imported from abroad at a high cost and this might lead to a heavy drain on foreign exchange reserve.

4. <u>Discuss the role of mechanization in agricultural sustainability</u>

The importance of machines and tools in sustainable agriculture

1. Sustainable mechanization is the practice of introducing the proper machinery to farmers to ensure that their agricultural production
2. Sustainable agricultural mechanization refers to all farming and processing technologies from basic hand tools to motorized equipment.
3. It takes into account the farmer's outputs, from crop production to marketable products and the impact this has on a farmer's income.
4. Sustainable mechanization by providing training to farmers on using appropriate tools, equipment and machinery and on environmentally-sound agricultural practices.

Holistic View of Sustainability

1. Farming tools are environmentally sound, economically affordable, adaptable to local conditions.
2. Mechanization looks to achieving larger and better harvests and increased income or new jobs for farmers.

Moving on from subsistence farming

1. By increasing harvest outputs, mechanization means that famers can move on from subsistence farming to market-oriented farming.
2. The employment of rural youth increasing in urban settings rather than in the fields.
3. By easing and reducing the hard labor (age, gender or physical well-being of the farmer).
4. It can also relieve labour shortages, improve timeliness of agricultural operations
5. Rotational and inter-cropping practices reduce the risk of pests, soil degradation and the effects of unfavorable climate conditions.

Intensification without degradation

1. Designating appropriate machines and tools to the agricultural production chain is increasing outputs in a sustainable way.
2. Carefully chosen machinery can allow crops to be grown and harvested with minimum-to-no soil disturbance
3. Soil surface protected by organic cover, manage crop rotations to enhance soil health and conserve crop nutrients by machanisation.

Sustainable mechanization:

1. Farmers need knowledge of appropriate machinery and tools for their farming practices is critical to agricultural sustainability.

5.Explain in detail about the erosion and problems of deposition in irrigation systems

Problems of irrigation system

While irrigation has provided a number of important benefits the potential drawbacks of over/under watering include,

Hinterland effect

- The development of irrigation schemes in developing countries is often associated with an increase in intensity of human activity
- Typical activities are: more intensive rain fed agriculture; an increase in the number of livestock; and, greater use of forests, particularly for fuel wood.
- All these activities are liable to increase erosion in the area by decreasing vegetative cover
- Its contributes in detrimental effect on the local fertility and ecology as well as contribute to sediment related problems.

River morphology

- The capacity and shape of a river was results from its flow, the river bed and bank material, and the sediment carried by the flow.
- A fast flowing river has more energy and is able to carry higher sediment loads than a slow moving river.
- Sediments settle out in reservoirs and in deltas where the flow velocity decreases.
- A river is said to be in **regime** when the amount of sediment carried by the flow is constant so that the flow is not erosive nor is sediment being deposited.
- Changes to the river morphology may affect downstream uses, in particular navigation and abstraction for drinking, industry and irrigation. The river ecology may also be adversely affected.

Channel structures

- Increased suspended sediment will cause problems at intake structures in the form of siltation as well as pump and filtration operation.
- Degradation of the river bed is likely to threaten the structural integrity of hydraulic structures (intakes, head works, flood protection etc.) and bridges.

Sedimentation

- Irrigation schemes can fail if the sediment load of the water supply is higher than the capacity of the irrigation canals to transport sediment.
- Canal desilting is an extremely costly element of irrigation maintenance and design measures should minimize sediment entry.

Estuary erosion

- Changes to the morphology of river estuaries can result from increased erosion or sedimentation.
- Areas of mangrove may be threatened by changes to the estuary morphology and special studies may be required to determine any adverse impacts.
- Navigation and fishing may also be adversely affect

6. Elaborate long term and short term downstream impacts on agriculture drainage

Long Term Impacts from Agricultural Drainage

Good drainage improves the productivity of agricultural soils. New watercourses (ditches) were constructed to further drain land and make agriculture possible. Modifications such as channel straightening and removal of streamside vegetation have had large and often negative impacts related to water quality, water quantity, fish, and fish habitat.

Increased Winter Storm Flows

- Prior to modification for drainage and agriculture, winter rains were intercepted by vegetation and absorbed into the ground.
- Drainage infrastructure facilitates rapid surface flows that can result in damage to fish and habitat and to increased flooding downstream.

Reduced Summer Flows –

- Historically, winter storm water was stored in wetlands and in the soil, becoming available at a later time to supplement low summer flows.
- Drainage infrastructure removes water from the system during winter and spring months, resulting in decreased summer flows and associated negative impacts to water quality and fish.

Vegetation Removal

- Trees and shrubs that once lined watercourses were removed in order to allow access for modifying the watercourse.
- Water quality protections and fish habitat provided by the native vegetation were also lost.

Disconnection from Floodplain and Meander Zone

- As watercourses were deepened and straightened to improve drainage, they lost connection to the surrounding floodplain and lost the natural meanders essential to fish habitat.

Short Term Impacts from Drainage Maintenance

Drainage maintenance activities have negative impacts to natural resources including water quality, fish and fish habitat. Vegetation removal using mowers or herbicides, dredging and other maintenance work can muddy the water, kill fish, and remove fish habitat.

Removing Fish Habitat

- Riparian cover, aquatic vegetation, submerged woody debris, and channel features such as pools and riffles are all essential habitat features for fish.
- Mowing or applying herbicides to vegetation on the channel banks and dredging the channel will improve drainage, but also removes important habitat features.

Altering the Channel

- Straightening, widening, or smoothing out the bottom of a channel reduces the quantity, quality, and diversity of available habitat.
- Widening the channel can change water depth and allow higher flows to pass downstream.
- Higher flows can wash fish out of the system, disrupt pool formations, and increase bank erosion.

Fish Kills

- Fish can be removed from the channel in an excavator bucket and buried in spoils, crushed in the water by dredging equipment, due to sediment release, low dissolved oxygen levels, or reduced flow during dredging.

Removing Vegetation

- Bank vegetation helps keep the water cool in summer by blocking sunlight.
- Higher water temperatures are stressful to most fish species, particularly salmon and trout, which require cold water.
- Removing this vegetation can reduce or eliminate an important source of food for fish and result in high water temperatures that are harmful to fish.

Reduced Water Quality

- Drainage maintenance work, including dredging, also has significant impacts to water quality. Suspended sediment changes fish behavior, inhibits their ability to find food, clogs their gills
- Affects their ability to resist disease or may directly kill fish.
- Sediment released during maintenance activities can disrupt downstream habitat by

clogging gravels and filling in pools, side channels

- Drainage maintenance activities can also reduce water quality by releasing pollutants trapped in bottom sediments
- Reducing the amount of dissolved oxygen available to fish and other aquatic organisms.
- Maintenance work is complete, water temperatures may increase due to exposure of the water surface to sunlight.

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1. What is urban agriculture and why is it important?

Gardens create more than healthy, delicious food. Urban agriculture brings people together with a common interest — food. The overall health of a community is benefited by increasing its capacity to create an environment that truly sustains its residents.

2. How can you limit the impact of irrigation?

- Reduce Site Water Requirements. ...
- Improve Distribution Uniformity (DU) ...
- Use Pressure Regulation. ...
- Convert to Drip Irrigation. ...
- Improve Management Practices. ...
- Use Smart Controllers.

3. What is a possible result of increased irrigation of agricultural fields?

The expansion and intensification of agriculture made possible by irrigation has the potential for causing: increased erosion; pollution of surface water and groundwater from agricultural biocides; deterioration of water quality; increased nutrient levels in the irrigation and drainage water resulting in algal blooms

4. How can irrigation affect erosion?

Soil type, field slope, and flow rate all affect surface irrigation erosion, with flow rate being the main factor that can be managed. Ideally, sprinkler irrigation will have no runoff, but application

rates on moving irrigation systems can exceed the soil infiltration rate, resulting in runoff and erosion.

5. What are the limitations of farm mechanization?

- Machines are readily available in the country.
- The cost of hiring machines is too high.
- The cost of maintenance is high.
- The operation of machines demands and high nay or wages which farmers cannot afford.

UNIT – III: CLIMATE CHANGE

Global warming and changing environment – Ecosystem changes – Changing blue-green-grey water cycles – Water scarcity and water shortages – Desertification.

Global warming

Global warming is a long-term rise in the average temperature of the Earth's climate system; an aspect of climate change shown by temperature measurements and by multiple **effects of the warming**

An increase in the average temperature of the Earth's atmosphere and oceans

Causes of Climate Change or global warming

- Human Impacts- Atmospheric greenhouse gases trap some of the outgoing energy, retaining heat
- Natural Impacts- Change in sun's energy output Volcanoes Water Vapor Clouds
- Greenhouse Gases - CO2 Methane Nitrous oxide Fluorinated compounds
- Since industrial revolution, atmospheric concentrations of carbon dioxide increased 30%, methane more than doubled, nitrous oxide raised by 15%.
- These increases have enhanced the heat-trapping capability of the earth's atmosphere

Greenhouse Gas Emissions

Animal agriculture, manure, natural gas, rice paddies, landfills, coal, and other anthropogenic sources contribute about 450 million tons of methane each year

Atmospheric concentrations of CO2 and CH4 have increased by 31% and 149% respectively above pre-industrial levels since 1750

Effects or Impacts of Global Warming on environment

1. **Rising Sea level:** Flooding of fresh water marshlands, low-lying cities, and islands with marine water is one of the major effects of global warming.
2. **Changes in rainfall patterns:** In some areas, droughts and fires happen, whereas in other areas, flooding takes place. This all is due to changes in rainfall pattern.

3. **Melting of the ice peaks:** Due to melting of the ice peaks, there is loss of habitat near the poles. Now the polar bears are considered to be greatly endangered by the shortening of their feeding season because of declining ice packs.

4. **Melting glaciers:** There is a significant melting of old glaciers.

5. **Spread of disease:** There is spread of diseases like malaria due to migration to newer and currently warmer regions.

6. **Thinning of Coral Reefs** due to warming seas as well as acidification because of carbonic acid formation: Almost one-third of coral reefs are now severely damaged by warming seas.

7. **Loss of Plankton** owing to warming seas: The large (900 miles long) Aleutian island ecosystems consisting of whales, sea lions, sea urchins, kelp beds, fish, and other aquatic animals, has now reduced due to loss of plankton.

8. Positive Effects

- Can stimulate plant growth in places where CO2 and temperature are the limiting
- Melting Arctic ice may open the Northwest Passage in summer, which would cut 5,000 nautical miles from shipping routes between Europe and Asia

Explain the impacts of global warming on Agriculture

Impacts of global warming on Agriculture

- Climate affects crop growth and quality, livestock health, and pests.
- Climate change could affect farming practices, as well as pest control and the varieties of crops and animals that could be raised in particular climactic areas.
- These could affect the availability and price of agriculture products

Crops

- Data have shown that levels of atmospheric CO_2 are increasing.
- Climate change is going to permanently alter weather patterns, temperatures, and rainfall.

- In addition, other factors such as location, soil fertility, crop varieties, and management practices will all affect future yields.

Temperature Increase

- If temperatures increase, cooler areas of the country might be more habitable for some of the main food crops grown– thus, expanding the areas in which certain crops could be grown or moving their ranges north.
- Research on new crop varieties and technological advances could improve yields in spite of reductions due to temperature increases.
- If climate change reduces the global amount of arable land, however, total yields could still decrease.

Extreme Weather Events

- Extreme weather events include heat waves, droughts, strong winds, and heavy rains.
- Droughts are damaging because of the long-term lack of water available to the plants.
- Heat waves can cause extreme heat stress in crops, which can limit yields if they occur during certain times of the plants' life-cycle (pollination, pod or fruit set).
- Strong winds can cause leaf and limb damage, as well as "sandblasting" of the soil against the foliage.
- Heavy rains that often result in flooding can also be detrimental to crops and to soil structure. Most plants cannot survive in prolonged waterlogged conditions because the roots need to breathe.

Carbon Dioxide Increase

- Carbon dioxide is critical to photosynthesis (and thus plant growth).
- Higher levels of carbon dioxide will result in higher harvestable crop yields. However, this depends critically on the availability of sufficient water and nutrients necessary for plant growth.

- Some scientists believe that one drawback to this increased productivity will be crops with lower nutrient and protein levels.
- If true, leads impact on long-term human health if additional fertilizers were not incorporated into crop production.

Weeds, Pests and Disease

- Weeds have become more prolific and are expected to invade new habitats as global warming increases.
- Herbicides become less effective in a higher carbon dioxide environment, meaning that higher rates of herbicides will be necessary to achieve the same levels of control.
- Insect pests, some of which carry plant diseases, could become more prolific and widespread as temperatures increase.
- It is also possible that increases in temperature, moisture and carbon dioxide could result in higher populations of destructive pests.

Irrigation and Rainfall

- Changes in climate may also impact the water availability and water needs for agriculture.
- If temperature increases and more sporadic rainfall events result from global warming, it is possible that irrigation needs could increase in the future.
- Plants growing in a high carbon dioxide environment may have lower water needs.
- the lack of available water due to increased droughts and heat waves.

Livestock

- While crops could be impacted by climate change, it is likely that farm animals would be even more susceptible to changes in the climate.
- Livestock and livestock-related activities such as deforestation and increasingly fuel-intensive farming practices are responsible for human-made greenhouse gas emissions

Disease

- Insect parasites and diseases could also become more prolific as global warming progresses.
- New diseases may also emerge in the Southeast that were once considered to inhabit only tropical areas.
- It is expected that in cases of increased heat stress and humidity, most livestock will not be able to fight these diseases without the use of costly medicines.

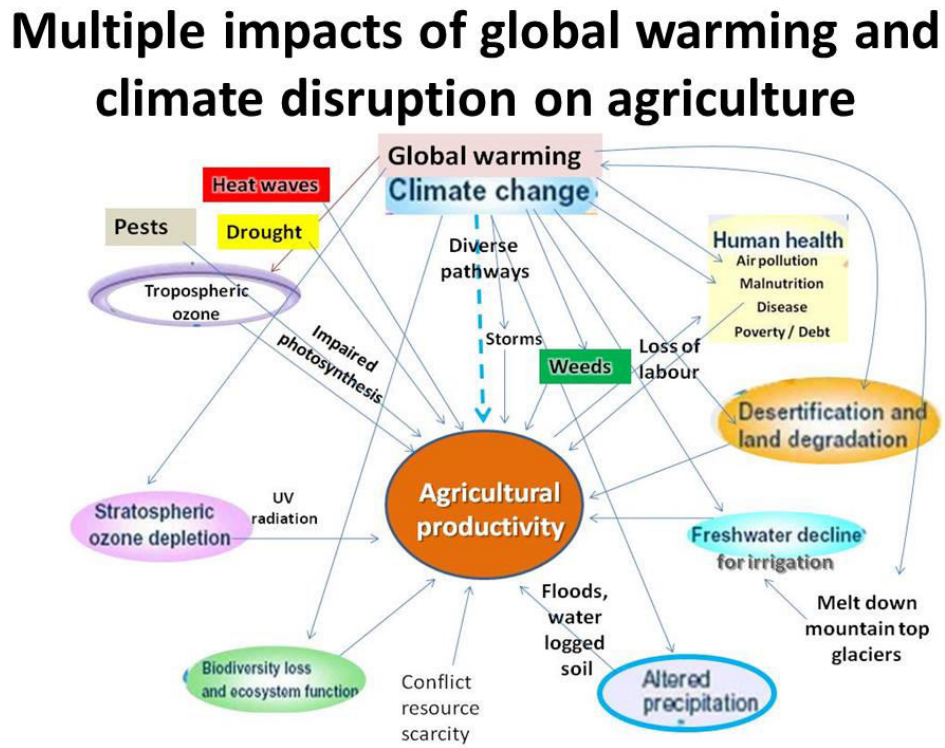
Impacts of Agriculture on global warming

Positive Impacts :

1. Carbon sequestration in soils,
2. Agriculture as carbon cap and storage,
3. Local food systems and greenhouse gas emissions

Negative Impacts

4. Industrial agriculture's huge carbon footprint
5. Greenhouse gas emissions from fertilizer and pesticide use
6. Land use changes and agriculture



Explain in detail about eco system services

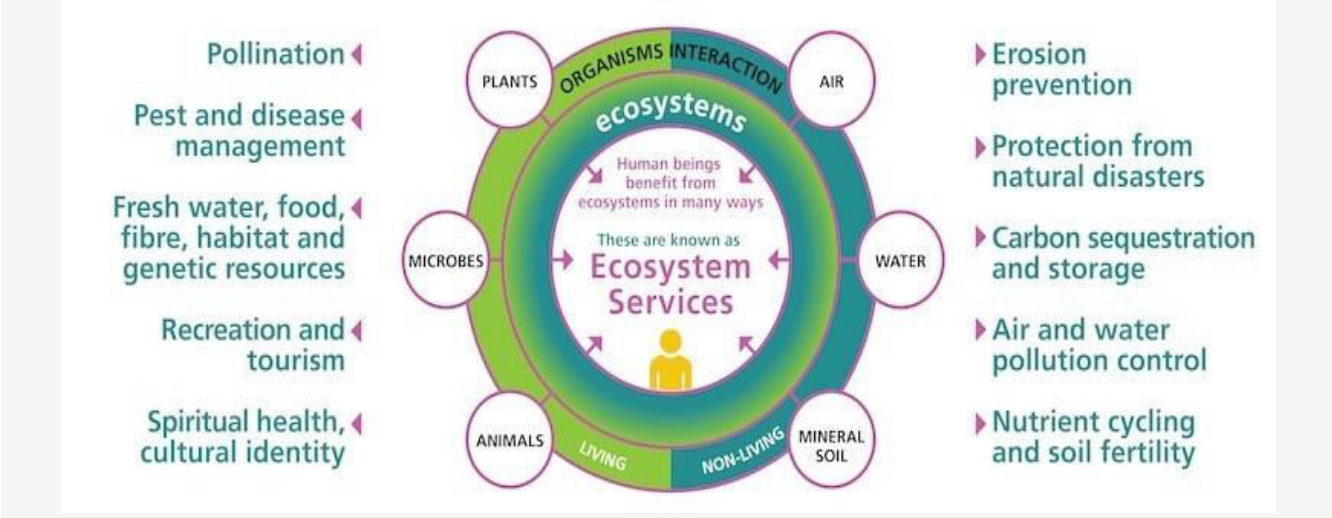
ECOSYSTEM SERVICES

Ecosystems are communities formed by the interaction between living (plants, animals, microbes) and non-living organisms (air, water, mineral soil). Human beings are both part of ecosystems and benefit from ecosystems in many ways. The benefits are known as **ecosystem services**.

What are ecosystem services?

- Ecosystems are communities formed by the interaction between living (plants, animals, microbes) and non-living organisms (air, water, mineral soil).

- Human beings are both part of ecosystems and benefit from ecosystems in many ways. The benefits are known as **ECOSYSTEM SERVICES**.



Types of eco system services

Supporting services

These include services such as nutrient cycling, primary production, soil formation, habitat provision and pollination. These services make it possible for the

ecosystems to continue providing services such as food supply, flood regulation, and water purification.

Provisioning services

- food, crops, wild foods, and spices
- raw materials and genetic resources
- biogenic minerals
- medicinal resources
- energy

Regulating services

- Carbon sequestration and climate regulation
- Predation regulates prey populations
- Waste decomposition and detoxification
- Purification of water and air
- pest and disease control

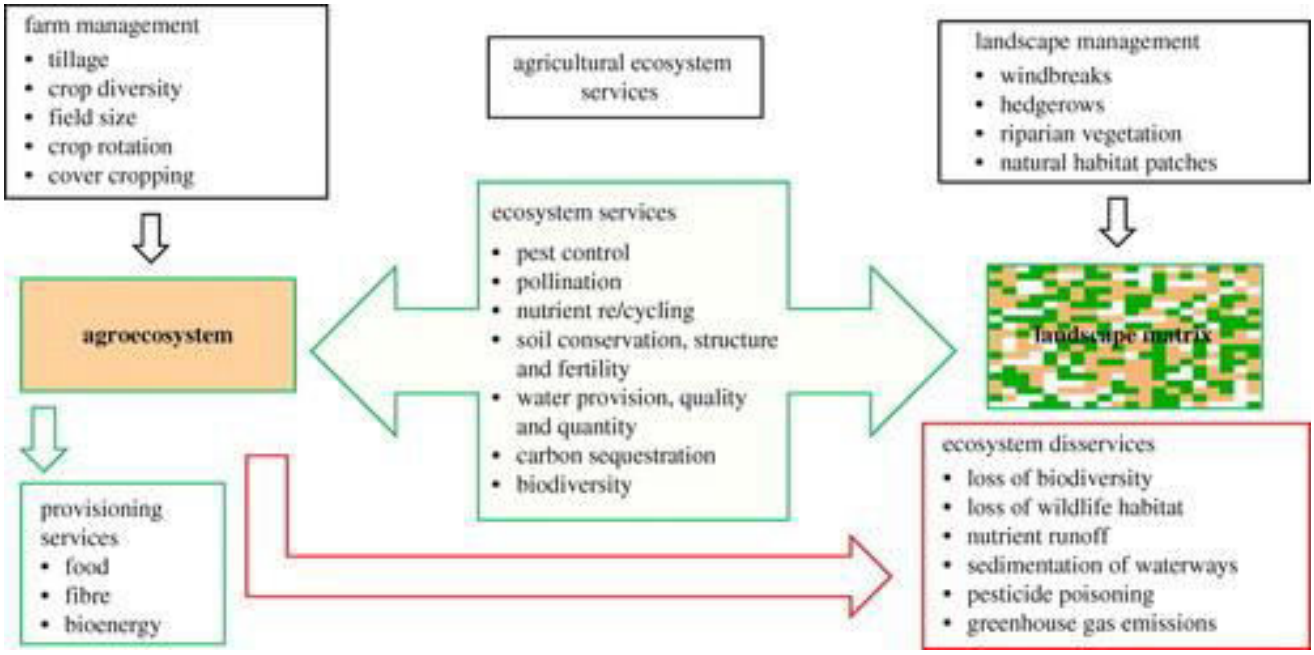
Cultural services

- Cultural, spiritual and historical (including use of nature for religious or natural)
- recreational experiences (including ecotourism, outdoor sports, and recreation)
- science and education (including use of natural systems for school excursions, and scientific discovery)

Explain the Ecosystem services flowing to agriculture in detail

Ecosystem services flowing to agriculture

The production of agricultural goods is highly dependent on the services provided by neighboring natural ecosystems.



(a) Biological pest control

- Biological control of pest insects in agro ecosystems is an important ecosystem service that is often supported by natural ecosystems.
- Non-crop habitats provide the habitat and diverse food resources required for birds and bats, and microbial pathogens that act as natural enemies to agricultural pests and provide biological control services in agro ecosystems.
- These biological control services can reduce populations of pest insects and weeds in agriculture, thereby reducing the need for pesticides.
- Because the ecosystem services provided by natural enemies can substitute directly for insecticides and crop losses to pests can often be measured, the economic value of these services is more easily estimated than many other services.

(b) Pollination

- Pollination is another important ecosystem service to agriculture that is provided by natural habitats in agricultural landscapes.
- Like biological control, pollination services are more readily quantified than many other services. Early estimates of the value of pollination services were based on the total value of animal-pollinated crops.
- Most crops are only partly dependent on animal pollination, a dependence ratio or a measure of the proportion reduction in production in the absence of pollinators can provide a better approximation of production losses in the absence of pollinators.
- A recent assessment of agricultural vulnerability to loss of pollination services based on the ratio of the economic value of insect pollination to the economic value of the crop
- For example, West African countries produce 56 per cent of the world's stimulant crops with a vulnerability to pollinator loss of 90 per cent. The loss of pollination services in these crops could have devastating effects on the economies of such countries in the short term and lead to significant restructuring of global prices in the longer term

(c) Water quantity and quality

- The provision of sufficient quantities of clean water is an essential ecological service provided to agro ecosystems, and global water use.
- Perennial vegetation in natural ecosystems such as forests can regulate the capture, infiltration, retention and flow of water across the landscape.
- The plant community plays a central role in regulating water flow by retaining soil, modifying soil structure and producing litter.
- Forest soils tend to have a higher infiltration rate than other soils, and forests tend to reduce peak flows and floods while maintaining base flows
- In addition, soil erosion rates are usually low, resulting in good water quality and they can help regulate groundwater recharge

(d) Soil structure and fertility

- Soil structure and fertility provide essential ecosystem services to agro ecosystems.
- Well-aerated soils with abundant organic matter are fundamental to nutrient acquisition by crops, as well as water retention.
- Soil pore structure, soil aggregation and decomposition of organic matter are influenced by the activities of bacteria, fungi and macro fauna, such as earthworms, termites and other invertebrates.
- Micro-organisms mediate nutrient availability through decomposition of detritus and plant residues and through nitrogen fixation.
- Agricultural management practices that degrade soil structure and soil microbial communities include mechanical ploughing, disking, cultivating and harvesting, but management practices can also protect the soil and reduce erosion and runoff.
- Conservation tillage and other soil conservation measures can maintain soil fertility by minimizing the loss of nutrients and keeping them available to crops.
- Cover crops facilitate on-farm retention of soil and nutrients between crop cycles, while hedgerows and riparian vegetation reduce erosion and runoff among fields.

(e) Landscape of ecosystem services to agriculture

- Agricultural landscapes span a continuum from structurally simple landscapes dominated by one or two cropping systems to complex mosaics of diverse cropping systems embedded in a natural habitat matrix.
- Water delivery to agro ecosystems depends on flow patterns across the landscape and can be influenced by a variety of biophysical factors.
- Both natural biological control services and pollination services depend crucially on the movement of organisms across the agricultural landscape,
- The spatial structure of the landscape strongly influences the magnitude of these ecological services to agricultural ecosystems.

- In complex landscapes, natural enemies and pollinators move among natural and semi-natural habitats that provide them with re-fugia and resources that may be scarce in crop fields.
- Protection of groundwater and surface water quality can be threatened by intensification because of increased nutrients, agrochemicals and dissolved salts

What are services and disservices of eco system from agriculture

Ecosystem services and disservices from agriculture

Ecosystem processes operating within agricultural systems can provide some of the same supporting services described above, including **pollination, pest control, genetic diversity for future agricultural use, soil retention, and regulation of soil fertility, nutrient cycling and water**.

(a) ***Ecosystem disservices from agriculture***

Agriculture can contribute to ecosystem services, but can also be a source of disservices, including **loss of biodiversity, agrochemical contamination and sedimentation of waterways, pesticide poisoning of non-target organisms, and emissions of greenhouse gases and pollutants**

1) **Nutrient cycling and pollution**

Nitrogen and phosphorus fertilizers have often harmful, effects on natural ecosystems.

Impacts of nutrient loss from agro ecosystems include groundwater pollution and increased nitrate levels in drinking water, eutrophication, increased frequency and severity of algal blooms, hypoxia and fish kills, and 'dead zones' in coastal marine ecosystems.

2) Emissions of greenhouse gases

Agricultural activities are estimated to be responsible for 12–14% of global emissions of greenhouse gases, not including emissions that arise from land clearing.

(b) **Ecosystem services from agriculture**

Maintaining the quality of air and soil, providing flood and disease control, or pollinating crops are some of the 'regulating services' provided by ecosystems.

1) Local Climate Air Quality

Ecosystems influence the local climate and air quality. For example, trees provide shade whilst forests influence rainfall and water availability both locally and regionally. Trees or other plants also play an important role in regulating air quality by removing pollutants from the atmosphere.

2) Carbon sequestration and storage

Ecosystems regulate the global climate by storing greenhouse gases. For example, as trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues.

3) Moderation of extreme events

Ecosystems and living organisms create buffers against natural disasters. They reduce damage from floods, storms, tsunamis, avalanches, landslides and droughts.

4) Waste-water treatment

Ecosystems such as wetlands filter effluents, decompose waste through the biological activity of microorganisms, and eliminate harmful pathogens.

5) Erosion prevention and maintenance of soil fertility

Vegetation cover prevents soil erosion and ensures soil fertility through natural biological processes such as nitrogen fixation. Soil erosion is a key factor in the process of land

degradation, loss of soil fertility and desertification, and contributes to decreased productivity of downstream fisheries.

6) Pollination

Insects and wind pollinate plants and trees which is essential for the development of fruits, vegetables and seeds. Animal pollination is an ecosystem service mainly provided by insects but also by some birds and bats. In agro-ecosystems, pollinators are essential for orchard, horticultural and forage production, as well as the production of seed for many root and fibre crops. Pollinators such as bees, birds and bats affect 35 percent of the world's crop production, increasing outputs of around 75% of the leading food crops worldwide.

7) Biological control

The activities of predators and parasites in ecosystems that act to control populations of potential pest and disease vector.

8) Regulation of Water Flow

Water flow regulation is a key service provided by land cover and configuration, but its dynamics are poorly understood by most policy makers and land management organizations

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Explain the changing of blue, green and grey water cycles with flow chart and explain the conversion of rain water in to Blue, green, and grey water

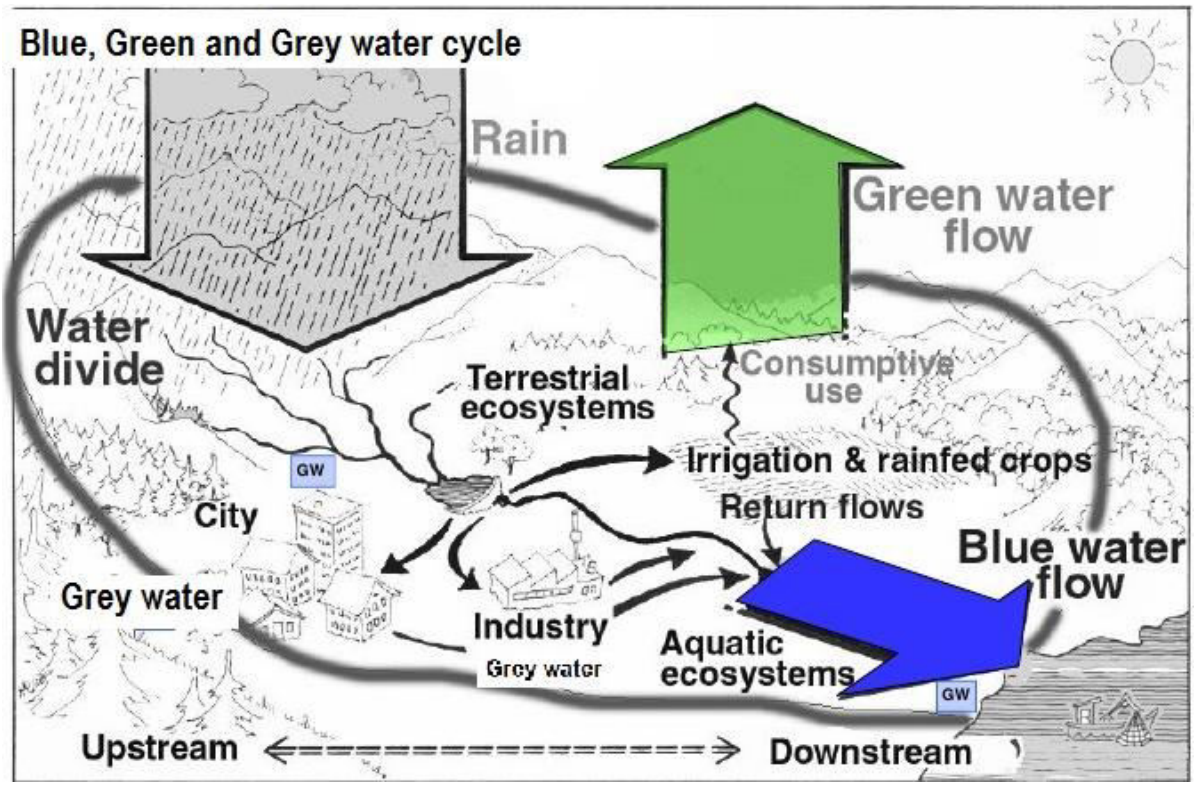
Blue, green, and grey water cycles

It is the volume of water required for making a product and the water used in the production chain. Different kinds of 'coloured water' (green, blue, grey and black-which is not virtual water) are classified based on where they are found in nature or the level of contamination of wastewater.

- **Green water** is the soil moisture from precipitation, used by plants via transpiration. It is part of the evaporation and transpiration flux in the hydrologic cycle. "Green water" is the amount of rainfall that is either intercepted by the vegetation,or enters the soil and is picked up by plants and evapotranspired back into the atmosphere. Some 65% of all rain water is cycled through the green water cycle and is the water source for rainfed agriculture.

- **Blue water** is the freshwater: surface and groundwater. It is stored in lakes, streams groundwater, glaciers and snow.

Blue water" is the amount of rainfall that enters lakes, rivers and groundwater. This is the main source of water that we use and manage for industrial, domestic and irrigation purposes. Only 30-35% of all water within the hydrological cycle is blue water.

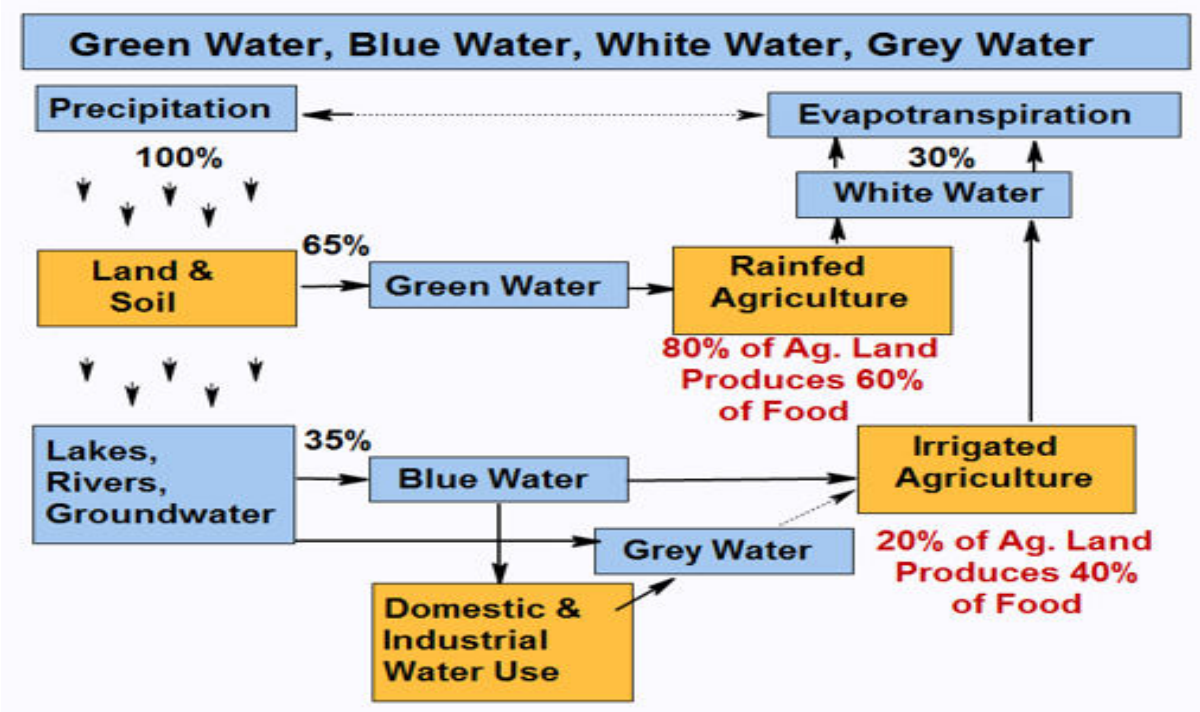


- **Grey water** is polluted water which was **not in contact with faecal matter** .

Grey water is the product water of domestic activities: bathing, laundry and dishwashing or polluted water due to pesticides in agriculture and nutrients from fertilizers.

It can be recycled and reused, not for drinking, but for irrigation. Grey water contains soap and fat particles, even hair. This water flows through the man-made infrastructure.

Flowchart shows the % of rainfall that moves through the different hydrological systems and how much is then used for rain fed and irrigated agriculture.



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What are effects of Water scarcity and water shortage? What are the main causes for the water scarcity? Mention the Solutions for Water Scarcity

Water scarcity and water shortage

Water scarcity is the lack of fresh water resources to meet water demand. The essence of global water scarcity is the geographic and temporal mismatch between freshwater demand

and availability. The increasing world population, improving living standards, changing consumption patterns, and expansion of irrigated agriculture are the main driving forces for the rising global demand for water.[Climate change, such as altered weather-patterns (including droughts or floods), deforestation, increased pollution, green house gases, and wasteful use of water can cause insufficient supply

Water Scarcity on Agriculture

Agricultural water security is highly susceptible to green water scarcity. Crop production critically depends on plant roots taking up soil moisture, transporting it up to the leaves to balance transpiration losses during the intake of airborne carbon dioxide associated with photosynthesis. Plant growth is thus a function of green water accessibility in the root zone.

Water scarcity has a huge impact on food production. Without water people do not have a means of watering their crops and, therefore, to provide food for the fast growing population. According to the International Water Management Institute , agriculture, which accounts for about 70% of global water withdrawals, is constantly competing with domestic, industrial and environmental uses for a scarce water supply.

What are the main causes for the water scarcity?

1. ***Water pollution*** - There are many sources, for example pesticides and fertilizers that wash away from human waste or industrial waste and pollute the ground water. Some effects are immediate, when harmful bacteria from human waste contaminate water and others like toxic substances from industrial processes, may take a few years until they effect the environment. This process makes the water unusable.

2. ***Overuse of Water*****:** Water overuse is a huge issue that a lot of people are dealing with. It may be overused on people, animals, land, or any other number of things. It may also be used for recreational activities without any care about the effects that it may have on the world around them.

3. ***Agriculture*** **uses**- 70% of the world's accessible freshwater, however approximately 60% of the used water is wasted. This is due to absorbent irrigation systems, inefficient application

methods as well as a growing cultivation of crops. This insufficient use of water is drying out rivers, lakes and underground aquifers.

4. ***Population growth*** - The population growth already occurred and will continue at an unpredictable rate. That way, anxiety about water availability grows as freshwater use continues at unsustainable levels.

5. **Drought:** A drought is, in short, an area which is not getting enough rainfall to be able to sustain the life that is residing there.

Water management methods

Irrigation management

- Irrigation is a method of transporting water to crops in order to maximize the amount of crops produced.
- This causes more water than necessary to be used or for there not to be enough water to ensure healthy crops.
- According to the World Bank, irrigation management works to upgrade and maintain irrigation systems, such as groundwater irrigation, that are already in place and expands the areas of irrigation to increase the amount of crops being produced.

Rainfed agriculture.

- Rainfed agriculture is the most common method of agriculture in developing nations.
- According to the book,*Rainfed Agriculture: Unlocking the Potential*, 80% of the land farmed around the world is rainfed and it "contributes about 58% to the global food basket".
- Some techniques in water management for rainfed agriculture include the use of supplemental irrigation and water harvesting techniques, such as rain catchment systems and weirs or sand dams.

- These techniques help provide much needed water to areas where rainfall is inconsistent. Having this water helps to increase the number and quality of the crops grown.

Solutions for Water Scarcity

1) **Education:** There are plenty of opportunities out there that people can use in order to learn more about the world around them. By educating those who are not dealing with water scarcity, they can be in a position to help. Those who are dealing with it can get educated on how they can prevent the problem from becoming even worse in the future.

2) **Recycle Water:** There are plenty of technologies out there that allow you to recycle rainwater and other water that you may be using in your home. Consider learning about how you can recycle water. Not only does it help to prevent scarcity, but it can save you some money as well.

3) **Advance Technology Related to Water Conservation:** There has been a lot of work in the world of water conservation, but there is also a lot that needs to be done in order to ensure that the rest of the world is able to conserve water. Putting money and effort into conservation could be life saving.

4) **Improve Practices Related to Farming:** Farming and irrigation are often a huge culprit when it comes to water scarcity. Because of that, we need to improve practices so that we don't use as much water and those who are using water are using it to its fullest potential. Technology also needs to advance in this manner.

5) **Improve Sewage Systems:** Clean drinking water starts with a good sewage system. Without proper sanitation, the water in an area becomes ridden with disease and any number of other problems. By improving the sewage systems in these areas, we can prevent water scarcity from becoming any worse.

6) **Support Clean Water Initiatives:** There are organizations located all over the world that are looking to bring clean water to areas that don't have it. Consider donating to these organizations, either with your time, your skills, or your finances

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6. What is desertification? Explain the causes , effects and prevention of Desertification related agriculture

Desertification

Desertification is defined as a process of land degradation in arid, semi-arid and sub-humid areas due to various factors including climatic variations and human activities.

Effects

1. Vegetation is damaged or destroyed
2. Soil becomes infertile
3. Soil erosion gets worse
4. Increased vulnerability to natural disasters
5. Polluted sources of drinking water
6. Rise of famine, poverty and social conflicts
7. Forcing mass migrations
8. Caused historical collapses of civilizations
9. Extinction of species

Causes of Desertification

Overgrazing: Animal grazing is a huge problem for many areas that are starting to become desert biomes. If there are too many animals that are overgrazing in certain spots, it makes it difficult for the plants to grow back, which hurts the biome and makes it lose its former green glory.

Deforestation: When people are looking to move into an area, or they need trees in order to make houses and do other tasks, then they are contributing to the problems related to desertification. Without the plants (especially the trees) around, the rest of the biome cannot thrive.

Farming Practices: Some farmers do not know how to use the land effectively. They may essentially strip the land of everything that it has before moving on to another plot of land. By

stripping the soil of its nutrients, desertification becomes more and more of a reality for the area that is being used for farming.

Urbanization and other types of land development. As mentioned above, development can cause people to go through and kill the plant life. It can also cause issues with the soil due to chemicals and other things that may harm the ground. As areas become more urbanized, there are less places for plants to grow, thus causing desertification.

Climate Change: Climate change plays a huge role in desertification. As the days get warmer and periods of drought become more frequent, desertification becomes more and more eminent. Unless climate change is slowed down, huge areas of land will become desert; some of those areas may even become uninhabitable as time goes on.

Stripping the land of resources. If an area of land has natural resources like natural gas, oil, or minerals, people will come in and mine it or take it out. This usually strips the soil of nutrients, which in turn kills the plant life, which in turn starts the process toward becoming a desert biome as time goes on.

Natural Disasters: There are some cases where the land gets damaged because of natural disasters, including drought. In those cases, there isn't a lot that people can do except work to try and help rehabilitate the land after it has already been damaged by nature.

Effects of Desertification

Farming becomes next to impossible. If an area becomes a desert, then it's almost impossible to grow substantial crops there without special technologies. This can cost a lot of money to try and do, so many farmers will have to sell their land and leave the desert areas.

Hunger: Without farms in these areas, the food that those farms produce will become much scarcer, and the people who live in those local areas will be a lot more likely to try and deal with hunger problems. Animals will also go hungry, which will cause even more of a food shortage.

Flooding: Without the plant life in an area, flooding is a lot more eminent. Not all deserts are dry; those that are wet could experience a lot of flooding because there is nothing to stop the water from gathering and going all over the place. Flooding can also negatively affect the water supply, which we will discuss next.

Poor Water Quality: If an area becomes a desert, the water quality is going to become a lot worse than it would have been otherwise. This is because the plant life plays a significant role in

keeping the water clean and clear; without its presence, it becomes a lot more difficult for you to be able to do that.

Overpopulation: When areas start to become desert, animals and people will go to other areas where they can actually thrive. This causes crowding and overpopulation, which will, in the long run, end up continuing the cycle of desertification that started this whole thing anyway.

Poverty: All of the issues that we've talked about above (related to the problem of desertification) can lead to poverty if it is not kept in check. Without food and water, it becomes harder for people to thrive, and they take a lot of time to try and get the things that they need.

Solutions for Desertification

Policy Changes Related to How People can Farm. In countries where policy change will actually be enforced on those in the country, policy change related to how often people can farm and how much they can farm on certain areas could be put into place to help reduce the problems that are often associated with farming and desertification.

Policy Changes to Other Types of Land Use. If people are using land to get natural resources or they are developing it for people to live on, then the policies that govern them should be ones that will help the land to thrive instead of allowing them to harm the land further. The policy changes could be sweeping or they could be depending on the type of land use at hand.

Education: In developing countries, education is an incredibly important tool that needs to be utilized in order to help people to understand the best way to use the land that they are farming on. By educating them on sustainable practices, more land will be saved from becoming desert.

Technology Advances. In some cases, it's difficult to try and prevent desertification from happening. In those cases, there needs to be research and advancements in technology that push the limits of what we currently know. Advancements could help us find more ways to prevent the issue from becoming epidemic.

Putting Together Rehabilitation Efforts. There are some ways that we can go back and rehabilitate the land that we've already pushed into desertification; it just takes some investment of time and money. By putting these together, we can prevent the issue from becoming even more widespread in the areas that have already been affected.

Sustainable practices to prevent desertification from happening. There are plenty of sustainable practices that can be applied to those acts that may be causing desertification. By

adding these to what we should be doing with land, we can ensure that we don't turn the entire world into a desert.

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Causes and Effects of Desertification on People and the Environment

CAUSES

1. Overgrazing
2. Unsustainable agriculture techniques
3. Deforestation
4. Unsustainable water management
5. Overpopulation and overexploitation of natural resources
6. Urbanization and development of tourism
7. Famine, poverty and political instability
8. Climate change

EFFECTS

1. Vegetation is damaged or destroyed
2. Soil becomes infertile
3. Soil erosion gets worse
4. Increased vulnerability to natural disasters
5. Polluted sources of drinking water
6. Rise of famine, poverty and social conflicts
7. Forcing mass migrations
8. Caused historical collapses of civilizations
9. Extinction of species

UNIT – IV: ECOLOGICAL DIVERSITY AND AGRICULTURE

Ecological diversity, wild life and agriculture – GM crops and their impacts on the environment – Insets and agriculture – Pollination crisis – Ecological farming principles – Forest fragmentation and agriculture – Agricultural biotechnology concerns.

Ecological diversity

Ecological diversity is a type of **biodiversity**. It is the variation in the ecosystems found in a region or the variation in ecosystems over the whole planet. **Ecological diversity** includes the variation in both terrestrial and aquatic ecosystems

What are the three different types of ecological diversity?

Biodiversity includes three main types: diversity within species (genetic diversity), between species (species diversity) and between ecosystems (ecosystem diversity).

Why is ecological diversity important?

Biodiversity boosts ecosystem productivity where each species, no matter how small, all have an important role to play. For example, A larger number of plant species means a greater variety of crops. Greater species diversity ensures natural sustainability for all life forms.

What is Agricultural Biodiversity?

Agricultural biodiversity is a broad term that includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agricultural ecosystems, also named agro-ecosystems: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes

Agricultural diversity can be divided into two categories:

1. **intra-specific diversity**, which includes the **genetic variety within a single species**, like the potato (Solanum tuberosum) that is composed of many different forms and types
2. **inter-specific diversity** and refers to the **number and types of different species**.

Importance and identification of Agricultural Biodiversity

Why is Biodiversity Important?

Biodiversity boosts ecosystem productivity where each species, no matter how small, all have an **important role** to play. For example,

- A larger number of plant species means a greater variety of crops
- Greater species diversity ensures natural sustainability for all life forms
- Healthy ecosystems can better withstand and recover from a variety of disasters.

1) Genetic resources for food and agriculture:

- Plant genetic resources, including crops, wild plants harvested and managed for food, trees on farms, pasture and rangeland species,
- Animal genetic resources, including domesticated animals, wild animals hunted for food, wild and farmed fish and other aquatic organisms,
- Microbial and fungal genetic resources.

These constitute the main units of production in agriculture, and include cultivated and domesticated species, managed wild plants and animals, as well as wild relatives of cultivated and domesticated species.

2) Components of biodiversity that support ecosystem services upon which agriculture is based. These include a diverse range of organisms that contribute, at various scales to, inter alia, nutrient cycling, pest and disease regulation, pollination, pollution and sediment regulation, maintenance of the hydrological cycle, erosion control, and climate regulation and carbon sequestration.

3) Abiotic factors, such as local climatic and chemical factors and the physical structure and functioning of ecosystems, which have a determining effect on agricultural biodiversity.

4) Socio-economic and cultural dimensions. Agricultural biodiversity is largely shaped and maintained by human activities and management practices, and a large number of people depend on agricultural biodiversity for sustainable livelihoods. These dimensions include traditional and local knowledge of agricultural biodiversity, cultural factors and participatory processes, as well as tourism associated with agricultural landscapes.

Types of conservation

Ex situ conservation

- Conserving biodiversity outside the areas where they naturally occur is known as ex situ conservation. Here, animals and plants are reared or cultivated in areas like zoological or botanical parks.
- Re-introduction of an animal or plant into the habitat from where it has become extinct is another form of ex situ conservation. For example, the Gangetic gharial has been reintroduced in the rivers of Uttar Pradesh, Madhya Pradesh and Rajasthan where it had become extinct.
- Seedbanks, botanical, horticultural and recreational gardens are important centres for ex situ conservation.

In situ conservation

Conserving the animals and plants in their natural habitats is known as in situ conservation. This includes the establishment of

- National parks and sanctuaries
- Biosphere reserves
- Nature reserves
- Reserved and protected forests
- Preservation plots
- Reserved forests

Agro-biodiversity conservation

After the introduction of cotton, tobacco, sugarcane, sunflower, soyabean and so on, farmers became victims of monocultures in their greed for money. Therefore many of the indigenous varieties of crops were lost. Moreover, the hybrid varieties of fruits and vegetables (e.g. tomatoes), introduced for pulp are more susceptible to disease and pests. Though hybrid varieties are preferred, traditional wild varieties of the seeds should be conserved for future use in the event of an epidemic which would completely wipe out the hybrids.

Botanical gardens, agricultural departments, seed banks etc., alone should not be given the responsibility of agro biodiversity conservation. Every farmer, gardener cultivator should be aware of his role in preserving and conserving agro biodiversity.

Convention of biological diversity

- The aim of the convention is to save species and plants from extinction and their habitats from destruction.
- The developed countries are looking for a sustainable supply of biological resources from the developing countries and easy access to them as well.
- The developing countries lacking the technology to exploit their resources are inviting the developed countries to do so.
- This has resulted in the developed nations channeling out the benefits of these natural resources.
- The developing countries are now demanding a higher share of the accrued economic benefits.
- The developed nations are also concerned by the unsustainable exploitation of natural wealth, particularly rainforests.
- develop national strategies for the conservation and sustainable use of biological resources;
- establish protected areas, restore degraded ecosystems, control alien species, and establish ex-situ conservation facilities;
- establish training and research programmes for the conservation and sustainable use of biodiversity and support such programmes in developing countries;
- encourage technology and biotechnology transfer particularly to developing countries;

The major cause for biodiversity loss

- Loss of biodiversity occurs when either the habitat essential for the survival of a species is destroyed, or particular species are destroyed.
- The former is more common as habitat destruction is a fallout of development.
- The latter reason is encountered when particular species are exploited for economical gain or hunted for sport or food.
- Extinction of species may also be due to environmental factors like ecological substitutions, biological factors and pathological causes which can be caused by nature or man.

Natural causes for the loss of biodiversity

Natural causes include floods, earthquakes, landslides, natural competition between species, lack of pollination and diseases.

Man-made causes for the loss of biodiversity

- Destruction of habitat in the wake of developmental activities like housing, agriculture, construction of dams, reservoirs, roads, railway tracks, etc.
- Pollution, a gift of the industrial revolution can be given the pride of place for driving a variety of species in air, water and land towards extinction.
- Motorcars, air-conditioners and refrigerators, the three symbols of a modern, affluent society, have been instrumental in global warming and ozone depletion. They have drastically altered the climate with disastrous effects on the various species.
- Factories and power stations spewing out poisonous gases and effluents have fouled up the environment bringing death and disease to many species. Oil spills and discharge of sewage have ravaged the oceans and coastal habitats.
- A large number of species are threatened by overhunting, poaching and illegal trade.
- Genetic erosion arises from the loss (due to commercial and anthropogenic pressures) of habitats rich in biodiversity and from the disappearance of the traditional conservation practices of wild species in their habitats by rural and tribal people.

Wildlife Management

Wildlife management is the manipulation of wild animal populations and their habitats in the context of an ecosystem.

Wildlife management includes activities such as:

- Managing parks and reserves
- Altering and rehabilitating wildlife habitats
- Providing education and extension programs for special interest groups
- Maintaining threatened populations and pests at a desirable level
- Protecting human life and property
- Managing harvests of wildlife.

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Genetically Modified or GM Crops

What is genetically Modified or GM Crops?

Genetically Modified or GM Crops are that type of plants who's DNA has been modified through genetic engineering for imbedding a new trait to the plant which does not occur naturally in the species. Foods produced from or using GM organisms are often referred to as GM foods.

Advantages of Genetically Modified or GM Crops

1. It improves production and raise farmer's income. Indian farmers are still practicing traditional process of seeding and cultivation, which required scientific moves for raising their production. Hence, it is one of the moves to enhance the farm production.
2. It reduces the use of pesticide and insecticide during farming that might be great moves for the betterment of the food supply.
3. It can feed a rapidly increasing population because it shows dramatically increased yields.
4. It can produce more in small area of land.
5. India introduced Bt cotton seeds in 2002. It has greatly reduced the use of toxic pesticides. Bt cotton produces a common soil bacterium, Bacillus Thuringiensis (Bt). It is a natural pest repelling bacteria that is toxic to many worms and pests that can harm the crop but is not hazardous to humans. Bt is widely sprayed on crops by organic farmers as a pesticide. As a result of the adoption of Bt cotton, India is now the largest cotton producer in the world.

Disadvantages of Genetically Modified or GM Crops

1. The production imposes high risks to the ecosystem and biodiversity because the "better" traits produced from engineering genes can result in the favoring of one organism. Hence, it can eventually disrupt the natural process of gene flow.
2. It increases the cost of cultivation and more inclined towards marketization of farming that work on immoral profits.
3. The transgenic crops endanger not only farmers but also the trade, and the environment as well.
4. It is biologically altered. Hence, biotech foods may pose a human health risk.
5. The excessive production of genetically modified foods will be rendered ineffective over time because the pests that these toxins used to deter might eventually develop resistance towards them.

Direct and indirect effects of genetically modified crops on environment

What direct effects could genetically modified crops have on the environment?

1.Gene flow

- Gene flow can affect the environment by creating a reduction of differentiation between populations as well as an increase in diversity between individuals within a population
- Gene flow from cultivated crops to wild relatives is expected to create hybrids with characteristics that are advantageous in agricultural environments, but that would not thrive in the wild.

2.Non-target species

- secondary effects of gene flow also need to be addressed including effects on non-target species, biodiversity disturbance, species displacement and extinction, disturbance in soil micro-environment and species of ecological concern
- When foreign genes are introduced into an organism, creating a transgenic organism (commonly called a genetically modified or genetically engineered organism), the results for the organism and its environment are almost always unpredictable. The intended result may or may not be achieved in any given case, but the one almost sure thing is that unintended results – nontarget effects – will also be achieved.

3.Biodiversity Loss:

Herbicide-tolerant crop systems have encouraged the use of herbicides that reduce overall plant diversity in agricultural systems and can limit habitat and food sources for other important organisms.

What indirect effects could genetically modified plants have on the environment?

1.Agricultural practices

- Scientists agree that the use of conventional agricultural pesticides and herbicides has damaged habitats for farmland birds, wild plants and insects and has seriously reduced their numbers
- Because genetically engineering foods is a relatively new practice, little is known about the long-term effects and safety.
- Critics of GM recognize the terrible damage to the life forms surrounding the crops. The risk to beneficial insects such as pollinators, the residues left in the soil, and the runoff into fresh water sources such as rivers and streams.
- Cross pollination will not only contaminate wild plants, affecting their natural genetic makeup, but will seriously compromise any organic or non GM farming system

2.Pesticide use

- GM insect-resistant (Bt) crops are engineered to produce a toxin that makes the entire plant toxic to some insects, such as butterflies and beetles. However, the toxin produced by the plant may also have adverse environmental impacts.

3.Herbicide use

- The repeated use of one herbicide causes very pressure on selection weeds with resistant to the herbicides associated with trans-genic plants.
- When the herbicide is applied, it would improve the weeds' strength and could reduce the economic benefits of herbicide resistance.

4.Pest and weed resistance

- GM can promote the development of resistant insect pests and weeds
- One of the consequences of the increased use of specific herbicides with GM herbicide-tolerant crops has been the emergence and spread of herbicide-resistant (HR) weeds, or "superweeds".
- These are weeds that develop resistance to certain herbicides when they are widely and frequently applied.

5.Difficult agricultural conditions

- New transgenic crops with tolerance to various abiotic stresses (e.g. salt, drought, aluminium) are being developed that may allow farmers to cultivate soils that were previously not arable.
- Scientists agree that these crops may be environmentally beneficial or harmful depending on the particular crop, trait and environment

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Insects on agriculture

Role of Beneficial Insects,

1. **Pollinators:** Insect pollinators are flower visiting Insects that forage on flowering plants to obtain plant-provided food (nectar, pollen).

   Many crops depend on pollination for seed production and fruit set to achieve good yield. Globally, an estimated 35% of crop production is a result of insect pollination.
2. **Natural Enemies**: Insect predators and parasitoids that attack and feed on other insects, particularly on insect pests of plants are considered natural enemies.

Through this type of feeding, natural enemies contribute to a type of pest regulation referred to as natural biological control.

Natural enemies responsible nearby 33% of the natural pest control in cultivated systems.

3. **Weed Killers**: So many insects feed upon unwanted weeds just the same manner they do with the cultivated crops.

   In many cases the occurrence of these insects has contributed much towards eradication of the weeds.

4. **Soil Builders**: Insects which live in soil make tunnels, creating channels for smaller organisms, water, air, and roots to travel through.

   Insects improves soil aeration, and earthworm activity can enhance soil nutrient cycle, the soil physical properties, such as soil structure and tilth and activity of other beneficial soil organisms.

5. **Scavengers**: Insects which feed on dead and decaying matter of plants and animals are called as scavengers.

   Insects (scavengers and decomposers) help in the biochemical cycling of the nutrients.

   Examples: Bark beetle, water scavenger beetle, Termites, Ants etc.

Natural insects and their use

insects	Beneficial insect or Invertebrate	Pest attacked	Impact on pest
Beetles	Red and Blue beetles , Green carab beetles, Green soldier beetles	Aphids, mites, mealy bugs, moth eggs and larvae.	Able to handle a wide range of prey and are immediately effective.
Bugs	Pirate bug , Apple dimple bug , Spined predatory shield bug ,Broken backed bug	Aphids, Diamondback moth, and larvae cutworms	Depending on the species of predatory bug, adults, larvae or eggs may be attacked.
Spiders	Variety of species including wolfspiders, night stalking spiders, flower spiders, jumping spiders	A range of insect pests.	Pest species are consumed.
Caterpillar	Numerous parasitic wasps including Banded caterpillar parasite	Heliothis and other moth larvae	Female lays eggs in host pupae as the parisitoid larvae develop in the host it causes the death of the pupa.

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Pollinator crisis

What is the pollinator crisis?

Harmon-Threat is one of a growing group of scientists studying the evolving relationships between native bees and introduced plants. Their work is critical in a world where human actions have dramatically shifted the distributions of plants and are forcing a **pollinator crisis.**

Why are pollinators decreasing?

The intensive use of agro-chemicals including pesticides that may have a direct affect on insect pollinators, and herbicides that remove important floral resources.

Pests and diseases affecting domesticated pollinators such as honey bees and which may spread to wild populations.

Possible causes of pollinator crisis

1. The loss of basic habitat requirements in our landscapes such as floral resources other than flowering crops that provides food to pollinators. Flowering crops are usually in bloom for only a fraction of a pollinator's life cycle, so in order to survive and reproduce effectively they need alternative sources of nectar and pollen throughout their active season. The loss of other basic needs such as nesting sites and materials may also contribute to the problem.
2. The simplification of the landscape with the promotion of monocultural crops, larger fields and less traditional features such as hedgerows, set-aside land and wildflower rich grassland. This results in less of the food and nesting resources occuring in landscapes and the isolation of resource-rich semi-natural habitats..
3. The intensive use of agro-chemicals including pesticides that may have a direct affect on insect pollinators, and herbicides that remove important floral resources.
4. Pests and diseases affecting domesticated pollinators such as honey bees and which may spread to wild populations.
5. Over-reliance on domesticated honey bees for pollination which may compete with wild pollinators for scarce resources.
6. Honeybees, raised specifically to pollinate crops, have declined due to parasitic mites, disease and pesticides. Wild pollinators are also disappearing at alarming rates due to habitat loss, pesticide poisoning, diseases and pests.

What you can do to help pollinators?

- Reduce the use of pesticides or, if possible, stop using them altogether.
- Plant gardens filled with nectar-producing flowers that are native to your area. Choose "straight species" as opposed to cultivated varieties (cultivars) for best benefits to pollinators.
- Provide habitat for birds, bats and other wildlife on your land.
- If you find a bee nest too close to your home, don't destroy it. Contact a local beekeeper or your state cooperative extension service for help in removing the nest without harming the bees.

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Ecological farming

Ecological Farming combines modern science and innovation with respect for nature and biodiversity. It ensures healthy farming and healthy food. It protects the soil, the water and the climate. It does not contaminate the environment with chemical inputs or use genetically engineered crops.

Benefits

- to support the ecological sustainability of the farm
- To create globally sustainable land management systems, and encourages review of the importance of maintaining biodiversity in food production and farming end products.
- to develop specialized automata to scan and respond to soil and plant situations relative to intensive care for the soil and the plants

Ecological Farming- Principles

1. **Food sovereignty** - Ecological Farming supports a world where producers and consumers, not corporations, control the food chain. Food sovereignty is about the way food is produced, and by whom.
2. **Benefitting farmers and rural communities** - Ecological Farming contributes to rural development and fighting poverty and hunger, by enabling livelihoods in rural communities that are safe, healthy, and economically viable.
3. **Smarter food production and yields** - To increase food availability globally, and to improve livelihoods in poorer regions, we must reduce the unsustainable use of what we grow at the moment and we must reduce food waste, decrease meat consumption, and minimize the use of land for bio-energy. We must also achieve higher yields where they are needed – through ecological means.

4. **Biodiversity -** Ecological Farming is about nature's diversity – from the seed to the plate, and across the entire agricultural landscape. It is about celebrating the flavour, nutrition, and culture of the food we eat, improving diets and health
5. **Sustainable soil health and cleaner water -** It is possible to increase soil fertility without the use of chemicals. Ecological Farming also protects soils from erosion, pollution, and acidification. By increasing soil organic matter where necessary, we can enhance water retention, and prevent land degradation.
6. **Ecological pest management -** Ecological Farming enables farmers to control pests and weeds – without the use of expensive chemical pesticides that can harm our soil, water and ecosystems, and the health of farmers and consumers.
7. **Resilient food systems -** Ecological Farming creates resilience: it strengthens our agriculture, and effectively adapts our food system to changing climatic conditions and economic realities.

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Forest fragmentation

Forest fragmentation is the breaking of large, contiguous, forested areas into smaller pieces of forest; typically these pieces are separated by roads, agriculture, utility corridors, subdivisions, or other human development.

Or

Forest fragmentation involves both the extent of forest and its spatial pattern, and is the degree to which forested areas are being broken into smaller patches and pierced or interspersed with non-forest cover.

Effects of forest fragmentation

- In general, by reducing forest health and degrading habitat, fragmentation leads to loss of biodiversity, increases in invasive plants, pests, and pathogens, and reduction in water quality.
- The former is typically much more damaging to forest health and habitat quality, usually with permanent negative effects
- Fragmentation increases isolation between forest communities and it increases so called edge effects. They alter growing conditions within the interior of forests through drastic changes in temperature, moisture, light, and wind.

- When a forest becomes isolated, the movement of plants and animals is inhibited. This restricts breeding and gene flow and results in long-term population decline.
- Fragmentation is a threat to natural resilience, and connectivity of forest habitats may be a key component of forest adaptation and response to climate change.
- ill effects on the health, growth, and survivability of trees, flowers, ferns, and lichens and an array of secondary effects on the animals
- Changes in the degree or patterns of fragmentation can affect habitat quality for the majority of mammal, reptile, bird, and amphibian species found in forest habitats.
- The effect of fragmentation on the flora and fauna of a forest patch depends on a) the size of the patch, and b) its degree of isolation

- Forest fragmentation is frequently caused by humans when native plants is cleared for human activities such as agriculture, rural development, urbanization, road construction, logging, mining and the creation of hydroelectric reservoirs
- Forest fragmentation reduces biodiversity by 13% to 75%, and the effects on ecosystems magnify with the passage of time. The scientists found that 70% of the world forest eco systems is degrade by human activities and non-forest species
- Evidence of forest destruction through natural processes such as volcanism, fire, and climate change
- **On Agriculture**

1.Genetic Risks-

- As the remaining habitat patches are smaller, they tend to support smaller populations of fewer species
- Adapting environmental change to survival
- Genetic drift is random changes to the genetic makeup of populations and always leads to reductions in genetic diversity.
- Because genetic drift is a random process, it does not allow species to become more adapted to their environment

2.Gene Flow and Inbreeding

- Gene flow occurs when individuals of the same species exchange genetic information through reproduction. Populations can maintain genetic diversity through migration
- When a habitat becomes fragmented and reduced in area, gene flow and migration is typically reduced.

- Reduced gene flow and reproductive isolation can result in inbreeding between related individuals.

3.Adaptation

- In order for populations to evolve in response to natural selection, they must be large enough that natural selection is a stronger evolutionary force than genetic drift.
- Reduces adaptation capacity because of small population size.

Agricultural biotechnology

Agricultural biotechnology, also known as agri-tech, is an area of **agricultural** science involving the use of scientific tools and techniques, including genetic engineering, molecular markers, molecular diagnostics, vaccines, and tissue culture, to modify living organisms: plants, animals, and microorganisms

What is the role of biotechnology in agriculture?

- Agricultural biotechnology is a collection of scientific techniques used to improve plants, animals and microorganisms.
- Based on its understanding scientists have developed solutions to increase agricultural productivity

What are some examples of agricultural biotechnology?

- Molecular diagnostics are used in agriculture to more accurately diagnose crop and livestock diseases.
- Vaccines: Biotechnology-derived vaccines are used in livestock and humans.
- Examples of crops produced using tissue culture include citrus, pineapples, avocados, mangoes, bananas, coffee and papaya

How does biotechnology help agriculture?

- Through biotechnology: Seeds yield more per acre, plants naturally resist specific insect pests and diseases, and farming techniques improve soil conservation.
- Farmers and ranchers can help plants and animals fight diseases and adapt to environmental stress and climate change

What are the benefits of agricultural biotechnology? Or **social and economic impacts of agricultural biotechnology**

- Farmers Benefit from Agricultural Biotechnology Seeds.
- Agricultural biotechnology is a safe and beneficial technology that contributes to both environmental and economic sustainability.
- Farmers choose biotech crops because they increase yield and **lower** production **costs**.

Uses of agricultural biotechnology

1. Genetic engineering:

- Scientists have learned how to move genes from one organism to another. This has been called genetic modification (GM), genetic engineering (GE) or genetic improvement (GI).
- The process allows the transfer of useful characteristics into a plant, animal or microorganism by inserting genes (DNA) from another organism

2. Molecular diagnostics:

- Molecular diagnostics are methods to detect genes or gene products that are very accurate and specific.
- Molecular diagnostics are used in agriculture to more accurately diagnose crop or livestock diseases.

3. **Vaccines**:

- Biotechnology-derived vaccines are used in livestock and humans.
- They may be cheaper, better and safer than traditional vaccines.
- They are also stable at room temperature, and do not need refrigerated storage

4. **Tissue culture**:

- Tissue culture is the regeneration of plants in the laboratory from disease-free plant parts.
- This technique allows for the reproduction of disease-free planting material for crops.

What are the social and ecological impacts on agricultural biotechnology? Or

What are the advantages and disadvantages of agricultural biotechnology?

Advantages or Benefits:

- Farmers have adopted no- and reduced-tillage systems which utilize herbicidal weed control rather than plowing.
- It is improved soil health and water retention, reduced runoff, fuel conservation, reduced greenhouse gas emissions and more efficient carbon storage in the soil.
- Increasing number of farmers is choosing to plant biotech seeds and produce higher crop yields.
- Less pesticide is needed to be used due to insect pest resistant plants.
- GMO crops last longer. This decreases the amount of wasted crops and foods.
- Reduced energy needs to produce GMO crops and higher resistance to diseases.
- Decrease in costs of growing and farming, due to the reduced use of pesticides.
- More economically friendly as pesticides do not go into the air, soil, and water.
- Reduction of sicknesses and illnesses, as GMO crops are more nutritious.
- Developments of new kinds of crops that can be grown at extreme climates, for example, dry or freezing environments (like deserts).

Disadvantages or negative impacts

Effect to human health

- **Human Breast Cancer:** GMOs in our food allows for greater herbicide and pesticide used over time many of which are known endocrine disruptors.
- **Lung cancer:** From the chemical-lined bag to the actual contents, microwave popcorn is at the center of lung cancer debates around the world.
- New allergy types may develop.

Ecological impacts

- In agriculture, there are concerns that genetically modified crops may transfer genetic material into natural, unmodified plants.
- Another concern about agricultural biotechnology centers on the uncertainty of genetically modified crops' long-term biological viability.
- Harm to other organisms. For example, genes and their effect included in a crop may turn out to be poisonous to insects

- Impacts from changes in **pesticide use, impacts on non-target species, and pest and virus**

Social issues

- Difficult to distinguish which crop field is organic, and which is not, posing a problem to the proper labeling of non-GMO food products.
- Widening corporate size gaps between food producing giants and smaller ones. Cause: fewer competitors increase and increase food prices.
- Larger companies might have more political power. They might be able to influence safety and health standards (example: less stringent regulations, standards and requirements).

1. Assess the challenges, goals of Global Environmental Governance and deduce the evidence of environmental degradation

Global Environmental Governance

Global environmental governance (GEG) is the sum of organizations, policy instruments, financing mechanisms, rules, procedures and norms that regulate the processes of global environmental protection. The efficacy of global environmental governance will ultimately depend on implementation at global and domestic levels.

Goals of GEG

1. Leadership - The GEG system should grasp the attention and visible support of high-profile political leaders. The key institutions within the system should be managed by leaders of the highest professional calibre and international repute; all working together towards the best interests of the GEG system as a whole.
2. Knowledge - Science should be the authoritative basis of sound environmental policy. The GEG system should be seen as a knowledge-based and knowledge-producing system.
3. Coherence - GEG should operate as a coherent "system" with reasonable coordination, regular communication and a shared sense of direction among its various elements.
4. Performance -The institutions that make up the GEG system should be well-managed; they should have the resources they need and should use these resources efficiently; and they should be effective in implementation. The ultimate purpose of the GEG system is to improve the global environmental condition.
5. Mainstreaming - The GEG system should seek to incorporate environmental concerns and actions within other areas of international policy and action, and particularly so in the context of sustainable development

Challenges facing environmental governance include:

The crisis by the impact of human activities on nature calls for governance, Which includes responses by international institutions, governments and citizens, who should meet this crisis by pooling the experience and knowledge of each of the agents and institutions concerned

- Inadequate continental and global agreements

- Unresolved tensions between maximum development, sustainable development and maximum protection, limiting funding, damaging links with the economy and limiting application of Multilateral Environment Agreements (MEAs).
- Environmental funding is not self-sustaining, diverting resources from problem-solving into funding battles.
- Lack of integration of sector policies and Inadequate institutional capacities and Unclear objectives
- International imbalance between environmental governance and trade and finance programs, e.g., World Trade Organization (WTO).
- Limited credit for organizations running projects within the Global Environment Facility (GEF)
- Inability to influence public opinion
- Time lag between human action and environmental effect, sometimes as long as a generation
- Environmental problems being embedded in very complex systems, of which our understanding is still quite weak

Environmental governance issues

1. **Soil deterioration**

Soil and land deterioration reduces its capacity for capturing, storing and recycling water, energy and food

- include soil rehabilitation as part of conventional and popular education
- involve all stakeholders, including policymakers and authorities, producers and land users, the scientific community and civil society to manage incentives and enforce regulations and laws
- establish a set of binding rules, such as an international convention
- set up mechanisms and incentives to facilitate transformations
- gather and share knowledge;
- mobilize funds nationally and internationally

2. **Climate change**

climate change can include - Changes in solar irradiance - Changes in atmospheric trace gas and aerosol concentrations Evidence of climate change can be identified by examining -

Atmospheric concentrations of Green House Gases (GHGs) such as carbon dioxide (CO2) - Land and sea surface temperatures - Atmospheric water vapor

3. **Biodiversity**

Biodiversity is fragile because it is threatened by almost all human actions.

To promote conservation of biodiversity, agreements and laws have to be created to regulate agricultural activities, urban growth, industrialization of countries, use of natural resources, control of invasive species, the correct use of water and protection of air quality.

4. **Ozone layer**

The use of chlorofluorocarbons (industrial refrigerants and aerosols) and farming fungicides such as methyl bromide has mostly been eliminated, although other damaging gases are still in use.

5. **Nuclear risk**

The Nuclear non-proliferation treaty is the primary multilateral agreement governing nuclear activity.

6. **Transgenic organisms**

Genetically modified organisms are not the subject of any major multilateral agreements. They are the subject of various restrictions at other levels of governance. GMOs are in widespread use in the US, but are heavily restricted in many other jurisdictions.

7. **Socio-environmental conflicts**

The effect of environmental degradation such as water scarcity, deforestation and soil erosion, air pollution and, climate change effects such as rising sea levels.

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2. What is alternative culture system? And explain the process and benefits of Alternative culture system

Alternative culture system

- Conventional agriculture has relied heavily on chemical inputs that have negatively impacted the environment and increased production costs.

- The alternative systems approach based on enhancing biological interactions to sustain and enhance production agriculture has had some success.
- This approach has innovatively reduced off-farm chemical inputs, and put emphasis on improved farm management and conservation of soil, water, energy, and biological resources
- Biological alternative to commercial fertilizer that reduces soil erosion and loss of nutrients, enhances water infiltration, reduces runoff, and creates a "natural" pest–predator relationship

The benefits of alternative farming methods

Agro ecology, a farming approach that mimics natural ecosystems, is an alternative method that can produce more food using fewer resources.

Farmers also use agro ecology to improve soil fertility, adapt to climate change, and reduce farming input costs.

Conventional farming threatens future food production by reducing biodiversity, and contributing to environmental degradation and climate change which lower yields.

Farming system

Farming system is an approach for developing farm- household systems, built on the principles of productivity, profitability, stability and sustainability.

The farming system approach emphasizes understanding of farm household, community inter linkages, reviews constraints and assesses potentials.

4. Explain the pros and problems of mega farming and vertical farming

Mega farms or factory farming

Purpose of Mega farms or factory farming - with modern factory farming methods, however, the conditions of growth for animals are difficult. Its purpose is to indicate as far as possible where meat has been produced by factory farming methods.

Mega farming is bad- why?

Mega or Factory farms can create other health hazards because they are over-crowded and stressful to animals, making it easy for disease to spread. When thousands of beef cattle are

packed into feedlots full of manure, bacteria can get on their hides and then into the slaughterhouses.

How much pollution does mega farming produce?

Large-scale animal factories often give animals antibiotics to promote growth, or to compensate for illness resulting from crowded conditions. These antibiotics enter the environment and the food chain. Mega farms contribute to air pollution by releasing compounds such as hydrogen sulfide, ammonia, and methane.

Intensive animal farming or **factory farming**,

- ✓ It is a production approach towards farm animals in order to maximize production output, while minimizing production costs. The main products of this industry are meat, milk and eggs for human consumption.
- ✓ Factory farms hold large numbers of animals, typically cows, pigs, turkeys, or chickens, often indoors, typically at high densities.
- ✓ The aim of the operation is to produce large quantities of meat, eggs, or milk at the lowest possible cost.
- ✓ Food is supplied in place.
- ✓ Methods employed to maintain health and improve production may include some combination of disinfectants, antimicrobial agents, hormones and vaccines; protein, mineral and vitamin supplements; frequent health inspections; bio-security; climate-controlled facilities and other measures

Modern animal farming

The competition to produce inexpensive meat, eggs, and dairy products has led animal agribusiness to treat animals as objects and commodities.

Chickens raised for Meat:

- ✓ densely populated sheds, vast amounts of waste accumulate.
- ✓ ammonia levels cause painful burns to the birds' skin, eyes, and respiratory tracts.
- ✓ high incidence of conditions that cause suffering, such as ascites and painful skeletal deformities.

Dairy Cows :

- ✓ For many people, dairy farming conjures up images of small herds of cows leisurely grazing on open pastures.
- ✓ Although scenes like this still exist in the world, most milk is produced by cows raised in intensive production systems.
- ✓ Some cows are housed indoors year-round, and lactating cows are often kept restrained in tie stalls or stanchions.

Fish:

- ✓ The fastest growing food-producing sector is aquaculture; one of two fish eaten is now raised on a farm rather than caught in the wild.
- ✓ fish farmers are designed to increase profitability but can reduce the well-being of the fish.

Welfare concerns include:

Poor water quality, aggression, injuries, and disease associated with inappropriate stocking densities; health problems due to selection for fast growth; handling and removal from water during routine husbandry procedures.

Vertical farming

- Vertical farming is the practice of producing food and medicine in vertically stacked layers, vertically inclined surfaces and/or integrated in other structures (such as in a skyscraper, used warehouse, or shipping container).
- The modern ideas of vertical farming use indoor farming techniques and controlled-environment agriculture (CEA) technology.
- These facilities utilize artificial control of light, environmental control (humidity, temperature, gases...) and fertigation.

Problems

1. Economics : Its economic and environmental benefits rest partly on the concept of minimizing food miles, the distance that food travels from farm to consumer
2. Energy use : The Vertical Farm" proposes a controlled environment, heating and cooling costs will resemble those of any other tower. Plumbing and elevator systems are necessary to distribute nutrients and water.
3. Pollution: Depending on the method of electricity generation used, greenhouse produce can create more greenhouse gases than field produce,[46] largely due to higher energy use per kilogram

Advantages

1. **Preparation for the future**: Vertical farms have the potential to reduce or eliminate the need to create additional farmland.
2. **Increased crop production**: Unlike traditional farming in non-tropical areas, indoor farming can produce crops year-round. All-season farming multiplies the productivity of the farmed surface by a factor of 4 to 6 depending on the crop.
3. **Weather disruption**: Crops grown in traditional outdoor farming depend on supportive weather, and suffer from undesirable temperatures rain, monsoon, hailstorm, flooding, wildfires and drought.
4. **Conservation**: Vertical farming would thus reduce the amount of farmland, thus saving many natural resources.[Deforestation and desertification caused by agricultural encroachment on natural biomes could be avoided. Producing food indoors reduces or eliminates conventional plowing, planting, and harvesting by farm machinery, protecting soil and reducing emissions.
5. **Resource scarcity**: The scarcity of fertilizer components like phosphorus poses a threat to industrial agriculture. The closed-cycle design of vertical farm systems minimizes the loss of nutrients, while traditional field agriculture loses nutrients to runoff and leeching.
6. **Mass extinction**: Withdrawing human activity from large areas of the Earth's land surface may be necessary to address anthropogenic mass extinctions.
7. **Human health**: Traditional farming is a hazardous occupation that often affects the health of farmers. Such risks include: exposure to infectious agents such as malaria, as well as soil-borne microbes, exposure to toxic pesticides and fungicides.
8. **Poverty and culture**: Food insecurity is one of the primary factors leading to absolute poverty. Constructing farms will allow basic needs, which can be significant to the recovery of a society from poverty.
9. **Urban growth**: Vertical farming, used in conjunction with other technologies and socioeconomic practices, could allow cities to expand while remaining substantially self-sufficient in food. This would allow large urban centers to grow without food constraints.[50]
10. **Energy sustainability**: Vertical farms could exploit methane digesters to generate energy. Methane digesters could be built on site to transform the organic waste generated at the farm into biogas that is generally composed of 65% methane along with other gases. This biogas could then be burned to generate electricity for the greenhouse.

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4. Explain Virtual water trade and its impacts on local environment.

What is virtual water trade?

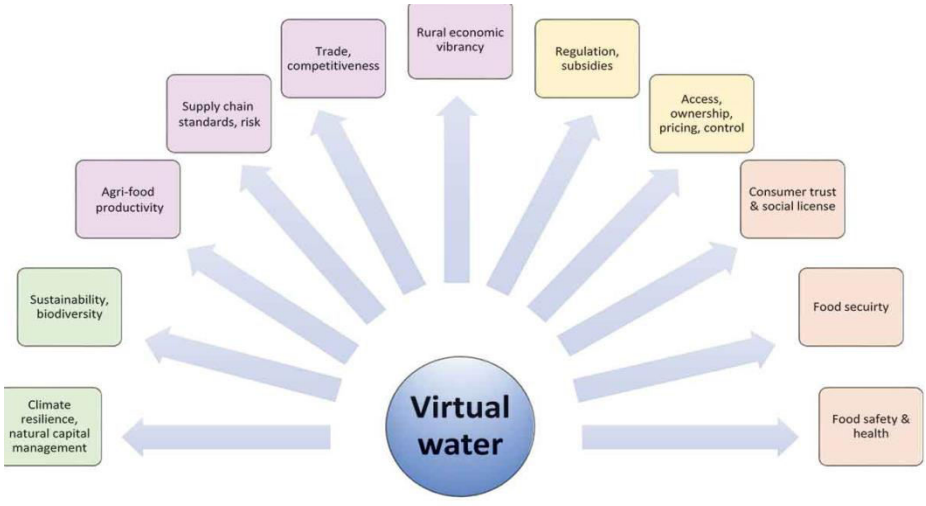
Virtual water trade (also known as trade in embedded or embodied water) refers to the hidden flow of water if food or other commodities are traded from one place to another.

What is the difference between direct and virtual water use?

- ✓ People use water for direct and indirect purposes.
- ✓ Direct purposes include bathing, drinking and cooking.
- ✓ Indirect water (also called "virtual water") use refers to the water used to produce the goods and services others need and enjoy.

Why is it important to measure virtual water trade?

- ✓ This is one of the water saving methodology in product production.
- ✓ It refers, in the context of trade, to the water used in the production of a good or service.
- ✓ The concept of virtual water helps us realize how much water is needed to produce different goods and services.



Environmental, economic, regulatory & consumer issues are inter-connected

Limitations & Objections

- Virtual water and water footprints have been important in highlighting the role of water resources in international trade.

- International trade is complex and involves many issues that are not captured in the notion of virtual water.
- Water use and allocation involve many more issues and implications than are captured in estimates of water footprints.
- Water foot-printing analysis has been used to suggest that water-short countries should not produce and export water-intensive crops.
- This could encourage policymakers to promote production and trade strategies that reduce social net benefits.
- Those activities generate substantial revenue for the producers, while enhancing the collection of goods and services available in both the exporting and importing countries.
- Proposals to re-arrange international trading patterns based only on consideration of water endowments could impose substantial harm on individuals who earn their living in agriculture, particularly in poor countries.

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5. Explain the Impacts of virtual water on local environment

Water Footprint

- Knowing the virtual water content of products creates awareness of the water volumes needed to produce the various goods, thus providing an idea of which goods impact most on the water system and where water savings could be made.
- The sum of national water use and net virtual water import is defined as the 'water footprint' of a country.

Impacts of virtual water on local environment

- Virtual water trade as a policy option requires a thorough understanding of its impacts not only related to international trade regimes and dependencies but also on the local, social, environmental, economic and cultural situation.
- It should contribute to local, national and regional food security requiring appropriate trade agreements which respect nation's right to decide on their way to achieve food security and ensuring access to food.

1) **Food security, food self-sufficiency, food safety and food sovereignty**

- Food security is the capability of a nation to provide access to everyone in the country to adequate, nutritious and safe food now and in the future.
- This can be achieved by striving for food self-sufficiency where all food is grown domestically or a combination of domestic production and food imports.
- Food security is necessary for planning the future of a country and it involves larger policy decisions that the country takes in the context of infrastructure development and international relations. Especially the more populous countries like China, India and Indonesia would like to be self-sufficient in food.
- This means that all food is produced domestically to prevent dependence on foreign entities for their staple food supplies.

2) **Environment**

- Poverty is the root of many environmental problems.
- Many developing countries need to encourage economic growth to provide even a basic quality of life for its citizens and luxury life minimal environmental flows this water.

3) **Employment and Poverty**

- Making water available for different purposes by reducing local food production and importing virtual water through food imports may result in loss of employment in agriculture and quality of livelihoods.

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Agriculture and the Environment

- Agriculture has close and complex links with the environment. The natural environment supplies the resources (i.e., soil, water and air) for agricultural production.
- The impact of agricultural production on the environment may be both beneficial and harmful. It may change the quality and quantity of local resources, which are also the basis of natural habitats, biodiversity and landscape.

The major environmental impacts of agriculture

- These include changes in soil quality, water quality, air quality and biodiversity.
- Farming systems can help maintain the traditional landscape, preserve habitats and biodiversity, and contribute to the sustainable management of water and soil resources.
- On the other hand, agricultural production activities can also lead to pollution or contamination of surface and ground water, the degradation of habitats, the loss of biodiversity and natural landscapes, and soil erosion.

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6. Integrate Agricultural and Environmental Policies and explain the environmental impacts

Agricultural Policies and Environmental Quality

What is agricultural policy?

Agricultural policy describes a set of laws relating to domestic agriculture and imports of foreign agricultural products. Governments usually implement agricultural policies with the goal of achieving a specific outcome in the domestic agricultural product markets.

What are the objectives of agricultural policy?

The first objective of the Common Agricultural Policy should be to maintain or enhance the European Union's capacity to produce safe and high-quality food.

The objectives of the agricultural policy

- ✓ Encourages the development and use of land-saving agricultural technologies, including fertilizers and pesticides.
- ✓ Environmental regulations offer environmental subsidies, while extension programs attempt to promote environmentally friendly production technologies.
- ✓ Each mechanism employed to support commodity prices, farm incomes and control the supply goals has secondary and unintentional, effects on environmental quality.
- ✓ Agricultural policies may include trade barriers, subsidies for inputs and direct payments to farmers.
- ✓ to stabilise markets;

- ✓ to assure the availability of supplies;
- ✓ to ensure that supplies reach consumers at reasonable prices.
- ✓ In particular, agricultural policies influence farming activities through changes in:

    a. The relative prices of inputs and outputs;
    b. Direct and indicate restrictions on the use of inputs and outputs;
    c. Incentives (or disincentives) for adopting new practices;
    d. Impediments to resource movement; *and*
    e. Agricultural and rural infrastructure (OECD 1998b).

Integrate Agricultural and Environmental Policies

Goals

- An environmental policy to control non-point source pollution in agriculture must consider the effects on farm incomes and water quality.
- Agricultural policies designed to raise farm incomes must be assessed in terms of their effect on the environment.
- An integrated approach requires that we consider simultaneously the potential impact of environmental policy on agricultural production, incomes and prices.
- Integrating agricultural and environmental policies requires a clear understanding of the fundamental concepts underlying sustainable development.
- Sustainability is to maintain a certain environmental stock, or its equivalent, for current and future generations.
- To achieve sustainability, the public decision processes must incorporate the shadow prices of environmental quantity and quality.
- Conservation of the natural resource base has emerged as a goal of environmental policy. This is critical, because agricultural production relies heavily on the quality and quantity of the natural resource base.

Principles of agricultural and environmental policies

- View rural countryside assets as a source of agricultural products and environmental services;
- Promote comprehensive resource use efficiency by directly or indirectly including environmental shadow prices;

- Alter agricultural commodity program provisions that cause distortions in inputs, or crop and livestock outputs, which result in environmental degradation;
- Encourage farmers to recognize that it is in there and society's best interests to maintain and enhance their asset base;
- Promote pollution prevention rather than waste management;
- Target specific environmental objectives rather than use broad agricultural and environmental initiatives;
- Apply the principle "The polluter pays";
- Create an administrative framework which can promote integration.

This principle states that the polluter should be held responsible for any environmental damage he causes, and bear the expenses of preventing pollution.

Instruments of Policy Integration

Integrating agricultural and environmental policies has three dimensions.

1) First, there is institutional integration- the development of administrative structures designed to ensure greater co-operation among the ministries and various agencies responsible for agriculture and the environment.
2) Second, there is the need for integrative procedures, including the development of agreed objectives. The need to integrate agricultural and environmental policies has now become formally recognized by most countries. This has led to the revision of procedures for policy formulation.
3) Third, there is a whole set of integrative instruments. These are subdivided into three broad categories: regulatory instruments, economic instruments and moral suasion.

They influence the environmental performance of polluters directly, by regulating the processes or products used, or by abandoning or limiting the use of potential pollutants through licensing, standards and zoning.

Regulatory approach

- Regulatory action may restrict the availability of environmentally hazardous agricultural inputs, or prohibit the use of environmentally damaging production practices.

- It can be applied uniformly to all farmers, or may target specific farming operations or particularly vulnerable production areas.
- Other effects include an increase in the cost of agricultural production, with the possibility of higher consumer prices and decreased trade competitiveness.
- In practice, the regulatory approach has only been employed if the perceived environmental costs are high.

Economic incentive approach

- The use of economic instruments to complement regulatory instruments for environmental management.
- These include taxes on farm inputs which are sources of pollution, on farm emissions, or taxing farmers for their failure to meet required levels of environmental quality.
- The use of input taxes to reduce the use of agricultural chemicals.
- A subsidy program might pay farmers who use environmentally friendly production practices such as sound nutrient management or integrated pest management (IPM).

Cross-compliance

- Cross-compliance means that a farm's operations must meet certain requirements in order for the farmer to be eligible for assistance under government support schemes.
- It has increased the uniformity between farm commodity programs and environmental objectives, yielding significant environmental gains. For example, participants in some programs have been appreciative to use fertilizer and pesticides in stipulated ways.
- Point systems or package systems are a more flexible approach, as they enable farmers to select the options that fit in best with the actual situation on their farms. This is important, because certain options may be feasible in some areas but not in others.

Advisory approach

- Farmers must take into account all the economic conditions faced.
- Problems have been encountered if advisory methods alone are used, to try and persuade farmers to adopt environmentally friendly farming practices.
- Education and technical assistance help farmers to adopt environmentally benign practices.

- Assistance may include providing data on soil quality, disseminating information about new sustainable practices, and helping farmers prepare conservation plans.
- Providing the public with information may increase the use of conservation practices by farmers.
- Training, education and demonstration projects spread information and make farmers aware of the environmental effects of alternative farming practices.

Difference between hydroponics and aeroponics and aquaponics

Hydroponics: Hydroponics refers to the cultivation of plants in water.

Aquaponics: Aquaponics refers to a branch of hydroponics in which a combination of fish and plants is used in a looped system.

Aeroponic : Aeroponic plants receive nutrients from a mist that is sprayed onto their roots several times an hour.