Module 5

Irrigation: *Importance of Irrigation, Classification of Irrigation projects,* ***Irrigation system:*** *Types, Field water distribution, Multipurpose river valley projects,* ***Dams:*** *Purpose, types.*

Layout of canal Irrigation system: *components and definitions*

Irrigation

Irrigation is a critical practice in agriculture and land management that involves the **artificial application** of **water to soil or land** to assist in the **growth of crops** and vegetation. It plays a vital role in agriculture and has numerous important benefits, making it essential for food production, water resource management, and overall societal well-being.

Here are the key reasons why irrigation is important:

1. Increased Agricultural Productivity: Irrigation enables farmers to provide a consistent and reliable supply of water to their crops, regardless of natural rainfall patterns. This helps crops grow in areas with insufficient or irregular rainfall, leading to increased agricultural productivity and higher crop yields. As a result, it helps ensure food security and stabilizes food production.

2. Crop Diversification: Irrigation allows farmers to diversify their crops and grow a wider variety of crops throughout the year. This diversification can include cash crops, fruits, and vegetables, which can increase income and improve local diets by providing a variety of food options.

3. Water Resource Management: Irrigation systems can help manage and optimize the use of available water resources. Water can be stored in reservoirs during rainy seasons and used during dry periods, reducing water scarcity and ensuring a consistent water supply for agriculture.

4. Climate Resilience: In regions prone to droughts or erratic weather patterns, irrigation provides a means to adapt to climate change and maintain agricultural production. It acts as a buffer against the uncertainties of weather and climate fluctuations

5. Improved Soil Quality: Controlled irrigation allows for better management of soil moisture levels, preventing soil erosion and salinization. Proper irrigation practices can enhance soil quality, leading to sustainable land use.

6. Rural Employment: Irrigation projects often require labour for construction, operation, and maintenance, providing job opportunities in rural areas. This helps reduce rural unemployment and can contribute to economic development.

7. Energy Production: Some irrigation systems, such as hydroelectric irrigation, can generate renewable energy, benefiting both agriculture and the energy sector.

8. Stabilizing Agricultural Production: Irrigation can help stabilize agricultural production over time. It reduces the vulnerability of crops to sudden fluctuations in weather, which can lead to more predictable and reliable harvests.

9. Global Food Supply: Irrigation plays a significant role in ensuring a stable global food supply. In many parts of the world, irrigated agriculture contributes significantly to food production and the availability of food on the global market.

10. Economic Growth: Irrigation contributes to economic growth by increasing agricultural output, enabling agribusinesses to flourish, and improving food security. It also supports rural development, which can have a positive impact on the overall economy.

11. Environmental Conservation: Sustainable irrigation practices can help conserve natural water resources by ensuring efficient water use and reducing over-extraction of water from rivers and aquifers.

Classification of Irrigation projects

Major irrigation project:

Major irrigation projects are those which have a culturable command area (CCA) of **more than 10,000 ha**. The total area that can be irrigated using the water from the canal system assuming an unlimited quantity of water is available is called a gross command area (GCA) for the irrigation system. The culturable command area (CCA) is the area of the cultivable land within the GCA of an irrigation project. The major irrigation project usually consists of huge multipurpose storage reservoirs and flow diversion structures.

Medium irrigation project:

Medium irrigation projects are those which have a culturable command area (CCA) **of less than 10,000 ha** but **more than 2,000 ha**. Such projects include medium-sized storage reservoirs and diversion structures.

Minor irrigation project:

Minor irrigation projects are those which have a culturable command area (CCA) of **less than 2,000**. The source of water is either groundwater or surface water lifted by pumps or by gravity flow from tanks, ponds, or small canals.

Types of irrigation system

Irrigation systems are classified into various categories based on different criteria, including the source of water, project scale, distribution methods, and purpose. Here are common
classifications of irrigation projects:

1. **Source of Water:**

a. Surface Irrigation: In surface irrigation projects, water is taken from surface water sources like rivers, lakes, canals, and reservoirs and distributed over fields by flooding or gravity flow methods.

b. Groundwater Irrigation: Groundwater irrigation projects involve extracting water from underground aquifers using wells, tube wells, or pumps.

2. Method of Water Distribution:

a. Canal Irrigation: Canal systems transport water from a source, such as a river or reservoir, to fields through a network of channels and canals. These canals can be classified into perennial (supplying water year-round) and non-perennial (seasonal) canals.

b. Drip Irrigation: Drip irrigation is a micro-irrigation system where water is delivered directly to the root zone of plants through a network of pipes, tubes, and emitters.

c. Sprinkler Irrigation: Sprinkler irrigation systems use pressurized pipes and nozzles to spray water over crops, similar to natural rainfall.

d. Furrow Irrigation: In furrow irrigation, water is directed into furrows or trenches between rows of crops, allowing gravity to distribute water along the rows.

e. Subsurface Irrigation: Subsurface irrigation systems deliver water below the ground surface, typically through buried pipes or tubes

3. Purpose of the Project:

a. Agricultural Irrigation: These projects are designed to supply water for crop cultivation, ensuring consistent and reliable water supply for farming.

b. Urban and Industrial Irrigation: Irrigation is used in urban areas and industries for landscaping, recreational areas, and cooling processes.

c. Hydropower Irrigation: Some irrigation projects are designed with the dual purpose of generating hydroelectric power and supplying water for irrigation.

4. Control Mechanism:

a. Gravity Flow Irrigation: In gravity flow systems, water is distributed through channels and pipes by taking advantage of the force of gravity.

b. Pump Irrigation: Pump irrigation projects use pumps to lift water from a source, such as a river or well, to a higher elevation, enabling distribution.

5. Extension of Irrigated Area:

a. Local Irrigation: Local irrigation projects serve a limited area and cater to the needs of specific regions or communities.

b. Command Area Development: These projects aim to expand the irrigated area by bringing more land under irrigation in a given region. They may include the development of canals, drainage systems, and infrastructure to maximize the utilization of available water resources.

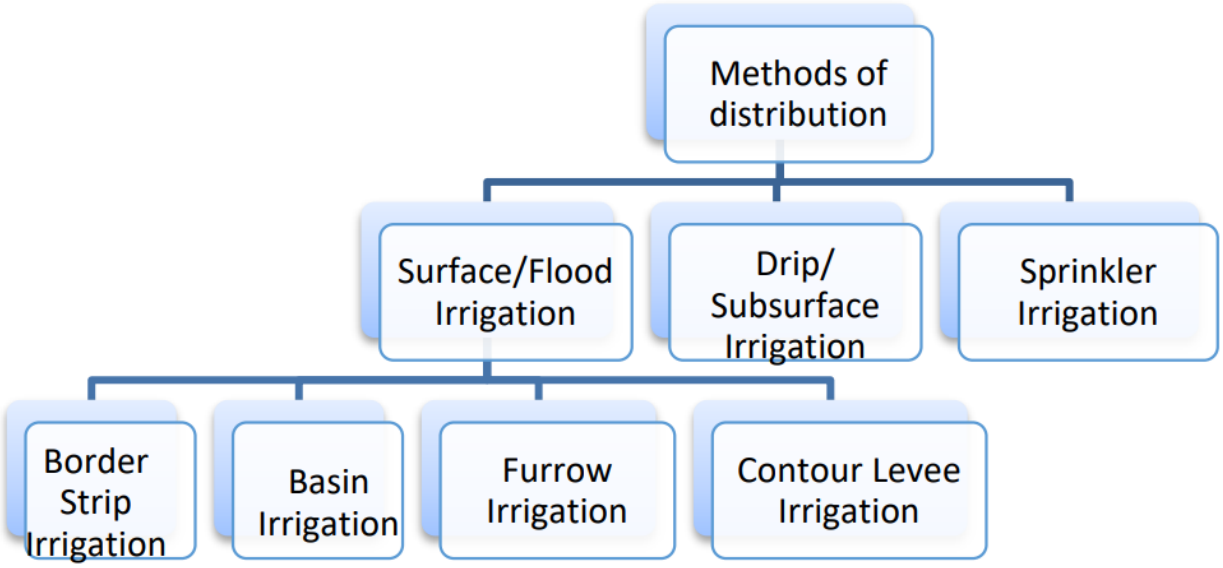
6. Multi-Purpose Projects:

a. Multi-Purpose Projects: Some irrigation projects are developed for multiple purposes, such as irrigation, flood control, hydropower generation, and navigation. These projects aim to address a combination of water resource management needs.

7. Rainfed Agriculture Enhancement:

a. Rainwater Harvesting: In rainfed areas with irregular rainfall, rainwater harvesting systems capture and store rainwater for agricultural use.

Field water distribution



1. Surface Irrigation

In this method, water is applied to the soil surface and distributed across the field by gravity. It is the most traditional and widely used irrigation technique.

Types of Surface Irrigation:

1. Border Strip Irrigation:

1. Fields are divided into long, rectangular strips (known as borders) separated by levees.
2. Water is released at the upper end of the strip and flows along the length of the field.
3. Suitable for uniform fields with a gentle slope.
4. Low capital cost.

Disadvantages:

Uneven water distribution if the slope is irregular.
Requires more water compared to other methods.

Border Strip

2. Basin Irrigation:

1. Fields are divided into flat basins surrounded by bunds (small walls).
2. Water is applied to flood the basins.
3. Commonly used for paddy/rice fields.
4. High water application efficiency.
5. Effective in controlling weeds due to prolonged waterlogging.

Disadvantages:

Not suitable for crops that are sensitive to waterlogging.
Requires a level field.

Check Basin

Ring Basin

3. Furrow Irrigation:

1. Water is applied in shallow channels (furrows) dug between crop rows.
2. Suitable for row crops like maize, sugarcane, and potatoes.
3. Reduces water contact with plant foliage, preventing fungal diseases.
4. Less water is lost to evaporation.

Disadvantages:

Requires precise field leveling.

May lead to uneven water distribution if furrows are not properly designed.

4. Contour Levee Irrigation:

1. Levees (raised barriers) are constructed along the contours of sloping fields.
2. Water is distributed along the levees, reducing soil erosion.
3. Suitable for hilly or uneven terrain.
4. Conserves soil and water.

Disadvantages:

Requires significant labor and cost for construction.

Not effective in sandy soils.

2. Drip Irrigation (Micro-Irrigation)

In drip irrigation, water is supplied directly to the root zone of plants through a network of pipes, emitters, or drippers.

Key Features:

•Water is applied drop by drop.
•Emitters are placed near the base of the plants.
•Highly efficient, saving up to 90% of water.
•Minimizes evaporation, runoff, and deep percolation losses.
•Promotes healthy plant growth by delivering water directly to the roots.
•Reduces weed growth since only the root zone is irrigated.
•Suitable for water-scarce areas and high-value crops like fruits, vegetables, and flowers.

Disadvantages:

•High initial installation cost.
•Requires regular maintenance to prevent clogging of emitters.
•Not suitable for all crops, particularly those grown densely.

3. Subsurface Irrigation

In this method, water is applied below the soil surface through underground pipes or channels.

Key Features:

•The water table is artificially raised to ensure moisture availability in the root zone.

•Ideal for sandy soils with high infiltration rates.

•Reduces evaporation and runoff losses.

•Keeps the soil surface dry, minimizing weed growth and fungal diseases.

•Efficient use of water.

Disadvantages:

•High installation and maintenance costs.

•Requires careful soil and crop management.

4. Sprinkler Irrigation

Water is sprayed into the air using sprinklers, and it falls on the crops like rainfall. This method ensures uniform water distribution.

Types of Sprinklers:

•**Fixed Sprinklers**: Stationary sprinklers that spray water in a specific pattern.

•**Movable Sprinklers**: Can be moved to cover larger areas.

•**Center Pivot Systems**: Rotate around a central pivot, covering circular areas.

Advantages:

•Suitable for all types of soils (except heavy clay).

•Can be used for various crops, including cereals, vegetables, and fruits.

•Reduces soil erosion and water wastage.

•Can cover large areas with less labor.

Disadvantages:

•High installation and operational costs.

•Water loss due to wind drift and evaporation.

•Not suitable for areas with strong winds.

Lift Irrigation

Water is lifted from a lower source (e.g., river, reservoir, or well) to a higher elevation using pumps or other mechanical devices. Water is transported to fields using canals or pipelines.

Comparison of Distribution Methods:

Method	Efficiency	Cost	Water Use	Best for
Surface Irrigation	Moderate	Low	High	Large flat fields
Drip Irrigation	High	High (installation)	Low	High-value crops
Subsurface Irrigation	High	High	Very Low	Sandy soils, orchards
Sprinkler Irrigation	Moderate	Moderate to High	Moderate	Undulating terrain
Lift Irrigation	Moderate	High	Moderate	Uneven terrains

Multipurpose River Valley Projects

Multipurpose river valley projects are large-scale infrastructure projects designed to utilize river water for multiple purposes simultaneously. They aim to maximize the utility of water resources for various needs like irrigation, electricity generation, and flood control while also addressing other societal and economic needs.

Objectives of Multipurpose River Valley Projects

- Irrigation: These projects provide water to arid and semi-arid regions, enabling agricultural growth and food security.
- Electricity Generation: By constructing hydroelectric dams, these projects generate renewable energy, which is essential for industrial and domestic use.
- Water Supply: They cater to the water requirements of domestic households and industries.
- Flood Control: Dams and reservoirs help regulate river flow, mitigating the impact of seasonal floods.
- Inland Navigation: By creating reservoirs and canals, these projects facilitate transportation and trade through waterways.
- Fish Breeding: The creation of reservoirs supports fish farming, enhancing food resources and employment.

Examples of Multipurpose River Valley Projects

Bhakra Nangal Project: Satluj River in Himachal Pradesh and Punjab.

Purposes: Irrigation for Punjab, Haryana, and Rajasthan, Hydropower generation, Flood control.

Hirakud Project: Mahanadi River in Odisha.

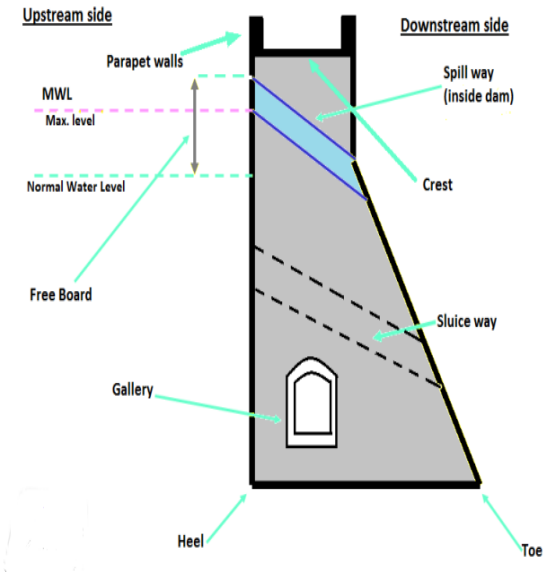
Purposes: Flood control in the delta region, Irrigation for Odisha and Chhattisgarh, Power generation.

Dam

A dam is a hydraulic structure of fairly impervious material built across a river to create a reservoir on its upstream side for impounding water for various purposes. These purposes may be Irrigation, Hydropower, Water-supply, Flood Control, Navigation, Fishing and Recreation. Dams may be built to meet the one of the above purposes or they may be constructed fulfilling more than one. As such, Dam can be classified as: Single-purpose and Multipurpose Dam.

Different parts & terminologies of Dams:

- **Crest:** The top of the Dam. These may in some cases be used for providing a roadway or walkway over the dam.
- **Parapet walls:** Low Protective walls on either side of the roadway or walkway on the crest.
- **Heel:** Portion of Dam in contact with ground or river bed at the upstream side.
- **Toe:** Portion of the dam in contact with the ground or river bed at the downstream side.
- **Spillway:** It is the arrangement made (kind of passage) near the top of the dam for the passage of surplus/ excessive water from the reservoir.



• **Abutments:** The valley slopes on either side of the dam wall to which the left & right end of the dam are fixed.

• **Gallery:** Level or gently sloping tunnel-like passage (small room-like space) at transverse or longitudinal within the dam with a drain on the floor for seepage water. These are generally provided for having space for drilling grout holes and drainage holes. These may also be used to accommodate the instrumentation for studying the performance of the dam.

• **Sluice way:** Opening in the dam near the base, provided to clear the silt accumulation in the reservoir.

• **Free Board:** The space between the highest level of water in the reservoir and the top of the dam.

• **Dead Storage level:** Level of permanent storage below which the water will not be withdrawn.

• **Diversion Tunnel:** Tunnel constructed to divert or change the direction of water to bypass the dam construction site. The dam is built while the river flows through the diversion tunnel.