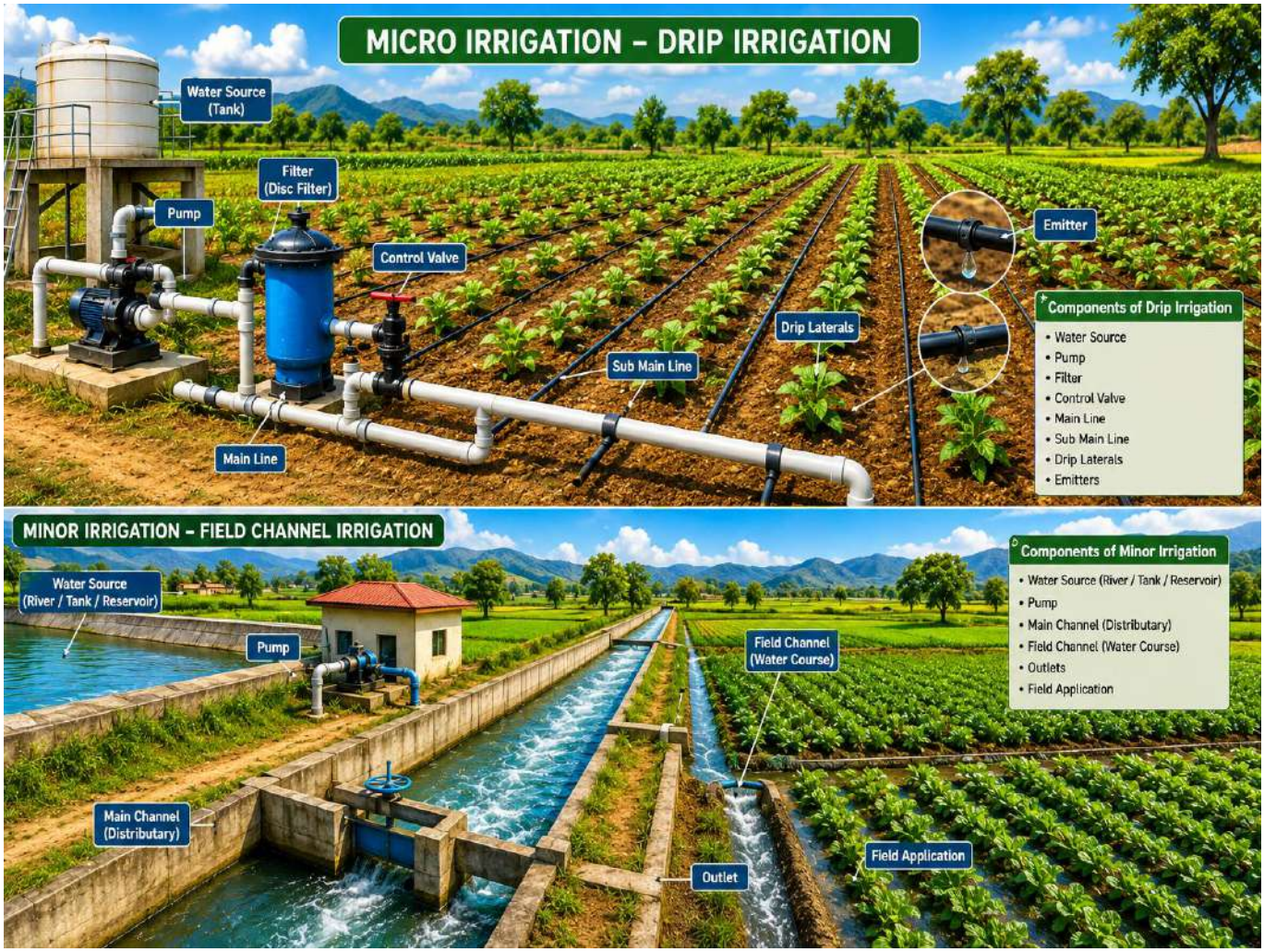
R.C.Patel College Of Engineering & Polytechnic, Shirpur

Department of Civil Engineering

Course Title- Water Resource Engineering **Course Code -** 315314

Programme Name -Civil Engineering **Semester-** Fifth

Unit	Title	COs	Learning hours	R Level	U Level	A Level	Total Marks
IV	Minor and Micro Irrigation	CO4	05	02	04	04	10



4. Minor and Micro Irrigation.

4.1 Bandhara Irrigation

Introduction → Bhandhara is a low-height structure constructed across a river or stream to raise the water level so that water can be diverted for irrigation.

OR A Bandhara (also called a weir or check dam) is a small barrier built across a river or stream to stop the flowing water, The stored water is used for irrigation, drinking, groundwater recharge etc.

Minor irrigation is classified in three different types:

1) Bandhara
2) Percolation tank and
3) Lift irrigation

Objectives →

1) Store river water
2) Supply irrigation water
3) Recharge groundwater
4) Increase water level in wells
5) Reduce soil erosion
6) Support fish farming
7) Provide drinking water

Advantages →

1) **Economical →**

The total cost for construction is much low as compared to dam and hence it can be constructed by finance managed by villages co-operatives.

2) Efficient →

In that length of canal is less and hence transit losses are less and irrigation efficiency is high.

3) Easy in construction →

Here the mode of construction is simple and hence highly modern machines, plants and designs are not required.

4) Maximum utilization of water and land

The site which is not suitable for dams can be utilized by constructing number of bandhara's on a single stream and thus maximum utilization of water and land is achieved.

5) Intensive irrigation

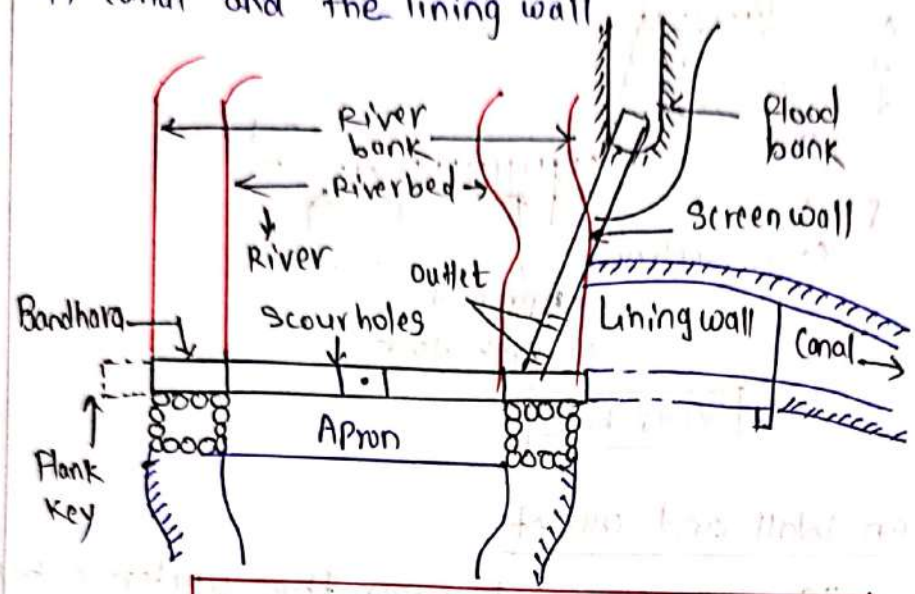
Because of small commanded area and local management the intensive irrigation is possible.

Disadvantages →

1) Limited storage capacity: It store only small quantity of water.
2) Depends on stream flow: It is useful only when sufficient water is available in the stream.
3) Silting problem: Sediment carried by the stream may accumulate behind the bandhara and reduce its storage capacity.
4) Flood damage: During heavy floods, the structure may be damaged if it is not properly designed.
5) Water losses: Some water may be lost through seepage and evaporation, depending on the site and storage conditions.

Component Parts and Layout

1) Bandhara and scour hole.
2) The screen walls and outlet.
3) The flood bank
4) Canal and the lining wall



Component parts of Bandhara

1) Bandhara Body

The bandhara body is the main barrier constructed across the stream or nala.

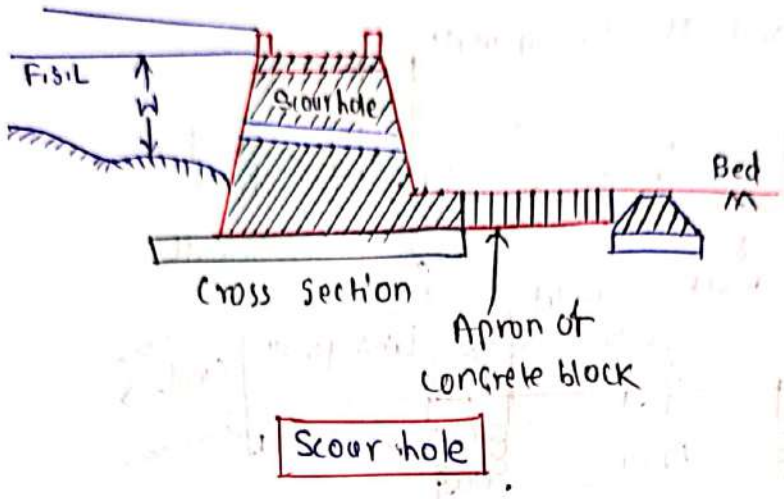
Functions →
i) Raises the water level on the upstream side.
ii) Helps divert water towards the irrigation canal.
iii) Allows excess water to pass safely over/through the structure, depending on its design.

2) Scour Hole

- A scour hole is a depression or protected area provided on the downstream side of the bandhara.
- When water passes over the bandhara, it has high velocity and energy. This can erode the river bed.

Functions →
i) Dissipates the energy of flowing water.
ii) Reduces the velocity of water.
iii) Prevents excessive erosion of the downstream bed.

There are the holes of diameter 20 to 50 cm at a height 30 to 50cm above river bed across solid wall.
- Those holes are closed after rainy season is over.



3) Screen Wall and outlet

- Screen walls are provided near the water entry arrangement to control the entry of water and reduce the entry of large debris, stones or unwanted material.
- The outlet provides a controlled passage for taking water from the bandhara / reservoir towards the irrigation system.

Functions → i) Helps control water entering the canal.
ii) Reduces entry of floating material.
iii) Allows irrigation water to be conveyed to the canal.
iv) Helps regulate the water supply.

4) Flood Bank

A flood bank is an embankment provided along the sides of the stream / channel near the bandhara to protect the surrounding land from floodwater.

Functions → i) Prevents floodwater from spreading into agricultural land.
ii) Protects nearby areas from flooding.

5) Canal → The canal carries water diverted by the bondhara from the stream towards the agricultural fields.

The system may consist of :

Main canal → Branch Canal → Distributary → field channel.

Functions → i) carries irrigation water
ii) Distributes water to the command areas.

6) Lining Wall → The lining wall is a protective wall / lining provided along the canal or important portions of the water conveyance arrangement.

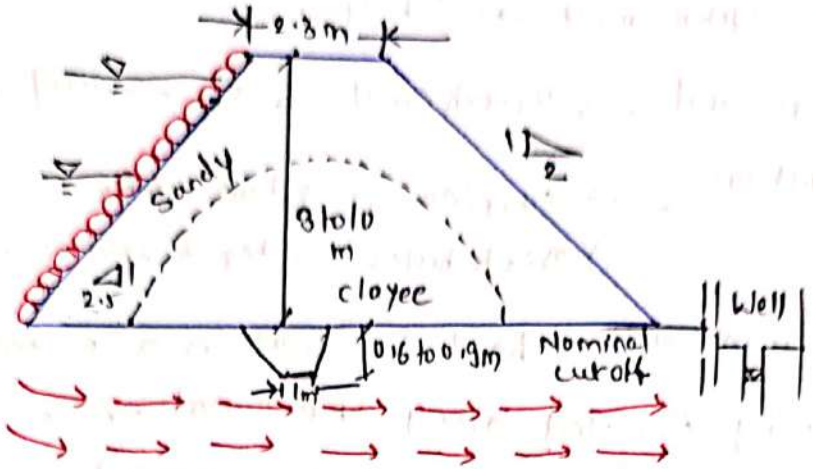
Functions → i) Prevents erosion of the canal sides.
ii) Reduces seepage losses.
iii) Maintains the shape and stability of canal.
iv) Improves the efficiency of water conveyance.

4.2 Percolation Tanks

Definition → A percolation tank is a small reservoir constructed across a natural stream or drainage line to store rainwater and allow it to slowly seep into the ground.

- The main purpose is to increase groundwater recharge and improve the water level in nearby wells.
- The percolation tank are constructed where soil is porous and it is not possible to construct the big retaining structures like dam but it is necessary to irrigation the area.
- The importance of percolation tanks are constructing small bunds water can be retained on upstream side and it percolates through the pores and joins the well downstream side thus water is made available for irrigation.

Components and construction



Percolation tank

Components

1. Catchment area
2. Reservoir/ Storage area
3. Earthen bund
4. Core/cut-off arrangement
5. Waste weir / spillway
6. Upstream and downstream slopes
7. Natural ground
8. Recharge/ percolation zone
9. Downstream drainage arrangement.

Construction

Step 1. site survey

First, a detailed survey of the selected location is carried out.
From which determined,

a) catchment area
b) storage area
c) contour levels
d) Bund alignment
e) Maximum water level
f) Spillway location

Step2 : Preparation of foundation

The area where the bund is to be constructed is cleared.

- Vegetation, roots and loose soil are removed.
- The foundation is excavated to suitable depth.

A cut off trench may be provided below the bund to reduce seepage through the foundation.

Step3: Construction of earthen bund

The main bund is generally constructed using Suitable locally available soil.

The bund consist of:

- Upstream slope
- Downstream slope
- crest
- core/cut off
- Toe area

The bund should be sufficiently stable against.

- sliding, seepage, Erosion, overtopping.

Step4: Construction of spillway /waste weir

A spillway is provided to safely pass excess water when the tank becomes full.

- It prevents uncontrolled overtopping of the earthen bund.

Step5: Protection of slopes

The upstream and downstream slopes are protected against erosion.

The upstream face particularly needs protection from wave action.

Step6 : Formation of storage area

The natural depression behind the bund acts as the storage area.

- Minor excavation or shaping may be carried out to obtain the required storage capacity.

Step 7 : Provision of drainage

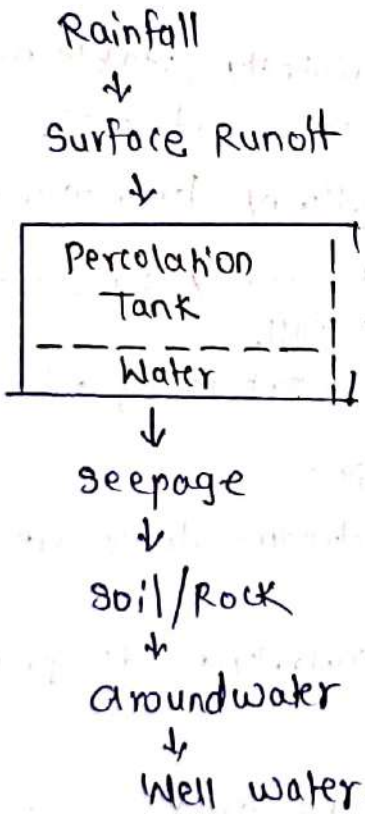
Proper drainage arrangements are provided on the d/s side to safely carry seepage water and surface runoff.

Step 8: Compaction and finishing

The completed bund is checked for:

- Proper dimensions
- Crest level
- Slopes
- Compaction
- Spillway level
- Seepage
- Erosion protection.

Rainfall → Runoff → Tank Storage - Infiltration → Groundwater recharge → Improvement in well water.



Needs [Percolation Tank]

Percolation tanks are mainly constructed for groundwater recharge.

1) Groundwater recharge:
- Stored water gradually infiltrates into the soil.
- It increases the groundwater tables.

2) Improves well water.
- Nearby open wells and bore wells receive more ground water.
- Their water level can remain higher for a longer period.

3) Stores rainwater
Rainwater flowing through small streams is temporarily stored.

4) Reduces surface runoff.
Instead of allowing rainwater to quickly flow away, the tank holds it.

5) Controls soil erosion.
Reduction in flow velocity helps reduce erosion of soil downstream.

6) Useful in drought prone areas
It helps maintain groundwater availability during dry periods.

Selection of site for percolation Tank

Selection of a suitable site is very important because the purpose is to make water percolate into the ground.

1) Suitable catchment areas
The site should have a sufficient catchment area so that adequate rainwater reaches the tank.

2) Permeable soil
The soil or fractured rock below and around the storage area should allow water to seep, downward.

Ex. Sandy soil, Gravelly soil, weathered / fractured rock.

3) Suitable geological condition
The underlying geological formation should have good capacity to absorb and transmit water.

4) Narrow valley
A relatively narrow valley or suitable natural depression is preferred because the length of the bund becomes smaller.

5) Suitable foundation
The foundation should have adequate strength and should be capable of supporting the earthen bund.

6) Nearby wells.
The site should preferably be located where ground water recharge can benefit existing wells in the surrounding area.

7) Avoid highly polluted areas.
The source water should not contain pollutants that could contaminate groundwater.

8) Availability of construction material.
Suitable soil for the bund and locally available construction materials should preferably be available nearby.

Advantages →

1) Low cost
2) Easy in construction
3) Better utilization of natural resources can be made.
4) Increases groundwater level
5) Helps control soil Erosion.

Disadvantages →

1) Compare to other irrigation low efficiency.
2) There is various test conducted in command area so, leads to costly investigation.
3) It has maximum percentage of maintenance compare to other. for slip of Bunds.
4) Storage capacity reduces due to sediment deposition.

4.3 Lift irrigation Scheme

Definition → Lift irrigation is a method of irrigation in which water is lifted from a lower level to a higher level by using mechanical energy, generally through Pumps, and supplied to agricultural area.

- When the source of water is lower than the area to be irrigated, then water is to be lifted by artificial means and process of lifting water from lower to higher level is called lift irrigation.

Advantages →

1) **Irrigates higher level land**

Water can be supplied to field that are at a higher elevation than the river, canal or reservoir.

2) **Useful in uneven areas**

It is suitable for hilly, undulating and uneven land where gravity flow is difficult.

3) **Prevents water logging**

Lifting of water from wells and tube wells helps to lower the ground water table and thus avoids waterlogging.

4) **Local control**

As it is operated manually farmers can utilized water in proper manner and thus optimum use of water is achieved.

5) **Utilization of recourses**

The water from much below ground is also utilized water for irrigation purposes and thus helps in proper utilization of resources is achieved.

7) **Uses water from nearby sources**

Water can be lifted from rivers, wells, ponds reservoir lakes etc.

Disadvantages

1) High initial cost.

Pumps, motors, pipelines, intake structures and other equipment require a large initial investment.

2) Requires electricity or fuel

The pump needs power to lift water, so electricity or fuel is continuously required during operation.

3) High operating cost

Electricity, diesel and regular maintenance increase the cost of irrigation.

4) Limited Service area

A lift scheme generally supplies limited command area depending on the pump capacity and pipeline arrangement.

5) skilled operation may be required

Proper operation of pumps and electrical equipment may require trained personnel.

6) Presence of harmful salt

If irrigation is from well it may contain harmful salt. is harmful for crops.

7) Less discharge

Discharge from well is less as compare to canal which is suitable only for small areas.

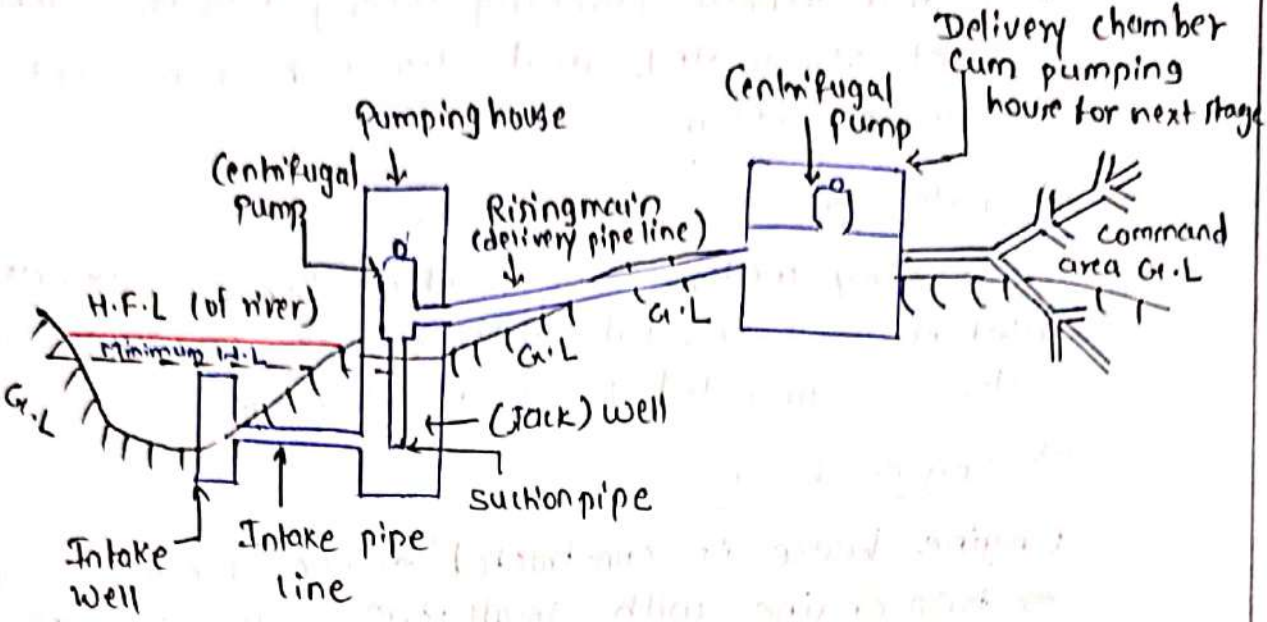
8) failure of pumps stops irrigation

If the pump or motor fails, water supply to the fields may stop completely.

9) Uneconomical

The pumping units may require frequent maintenance and thus increases cost of scheme and leads to scheme uneconomical.

Component Parts of Lift Irigation



Layout of Lift irigation system

1) Intake Channel

The intake constructed for water source and it to be delivered. It is properly designed as per consideration its top should be placed below the lowest water level.

River → Intake → Pumping system.

- Collect the water from source
- Allows water to enter the suction system
- Helps prevents excessive entry of floating materials.
- Maintains a suitable approach to the pump.

2) Inlet chamber

- This is generally Circular or rectangular chamber constructed just near the bank. It avoids silts and debris to enter into jackwell.
- It is provided with steel mesh, it has different opening at different level to allow entry of water.

3) Jack Well

It is location of an engine house above high flood level and allows pumping during floods. Jackwell is kept above HFL and diameter is in between 3.65 m to 4.55 m.

4) Inlet pipe

To convey water from inlet chamber to jackwell an inlet pipe is provided with proper gradient and a valve is provided to control discharge.

5) Engine house

Engine house is constructed either for one engine or two engine with small store rooms for storing fuels, spare parts, tools etc.

6) Rising Main / Delivery pipe

- After the water passes through the pump, it enters the rising main or delivery pipeline.
- It carries water from the lower elevation towards the higher elevation.

7) Delivery chamber

- The water from rising main is collected in delivery chamber and then it is allowed to flow in field.
- This chamber brakes high velocity and turbulent action of water.
- Chamber dimension 3m x 1.5m x 1m.

function →
- Receives lifted water
- Provides temporary storage / surge control where designed for that purpose.
- Distributes water into the main distribution system.
- Helps regulate water supply to different areas.

8) Water distribution system

The irrigation is to be completed within 10-12 hours in a day, instead of 24hours. and hence canals are designed according to that to take up double discharge.

9) Main distribution pipe

From the delivery chamber, water is conveyed towards the command area.

- depends upon; open channel, closed pipeline etc.
- To carry water from delivery chamber to different parts of the command area.

10) Branch distribution pipe.

To carry water from the main line to individual sections of the command area.

- Main pipe → Branch pipe → Field.

11) Field outlet

-To control and supply water to the required agricultural field.

Working →

Step 1: Collection of water
Step 2: Entry through intake
Step 3: Removal of debris
Step 4: Suction
Step 5: Pumping
Step 6: Lifting
Step 7: Delivery
Step 8: Distribution
Step 9: Field application.

4.4 Drip and sprinkler Irrigation

1) Drip Irrigation:

Defination → Drip irrigation is a method in which water is supplied to plants at a slow and controlled rate, generally near the root zone, through small outlets called emitters or drippers.

Principle of drip Irrigation

Water Source → Pump → Filter → Main pipe → Sub main → Lateral → Dripper → Plant root zone.

- only the required quantity of water is supplied near the plant.

Components of Drip Irrigation

Following are the various components of drip irrigation system along with their function.

1) Pump unit →

The pump takes water from the source and supplies it to the pipe system at the required pressure.

function → To provide the required pressure and flow of water.

2) Control head or control valves

- The control head is an important part of a drip system.
- It controls and manages the water before it enters the pipe network.
- It may contain → - filter, Pressure regulator,
  - fertilizer injector,
  - valves
  - pressure gauge
  - flow meter.

3) Filter

The water passes through a filter before entering the small drip pipes because dripper openings are very small and can easily become blaked.

Filters remove → sand, soil particles, suspended particles, other impurities.

4) Fertilizer injector / fertilizer tank

Fertilizer can be mixed with irrigation water and supplied directly to the plants.

- This process is commonly called ferhigation.
- Fertilizer reaches the root zone along with water.

5) Main line

The main line carries water from the pump/control head towards different parts of the field.

- To transport water to the submain lines.

6) Sub main line

The sub main receives water from the main line and distributes it to several lateral lines.

Main line → Sub main → Laterals.

7) Lateral

A lateral is a small diameter pipe laid along the crop row.

Drippers are attached to the lateral.

8) Dripper / Emitter

This is the most important component.

It releases water slowly near the plant.

function → To control the discharge of water.

9) valves

Valves are provided for:

- start or stop water flow.
- control different sections of the field.
- Isolate a particular section for maintenance.

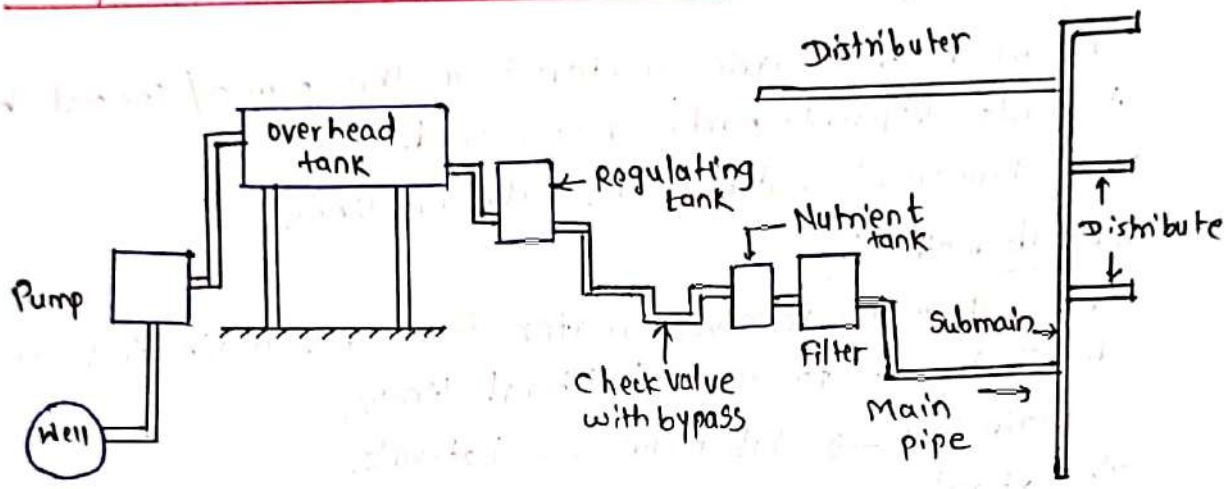
10) Pressure regulator

- Pressure should be controlled because excessive or insufficient pressure can affect uniform water distribution.
- The pressure regulator maintains suitable pressure in the system.

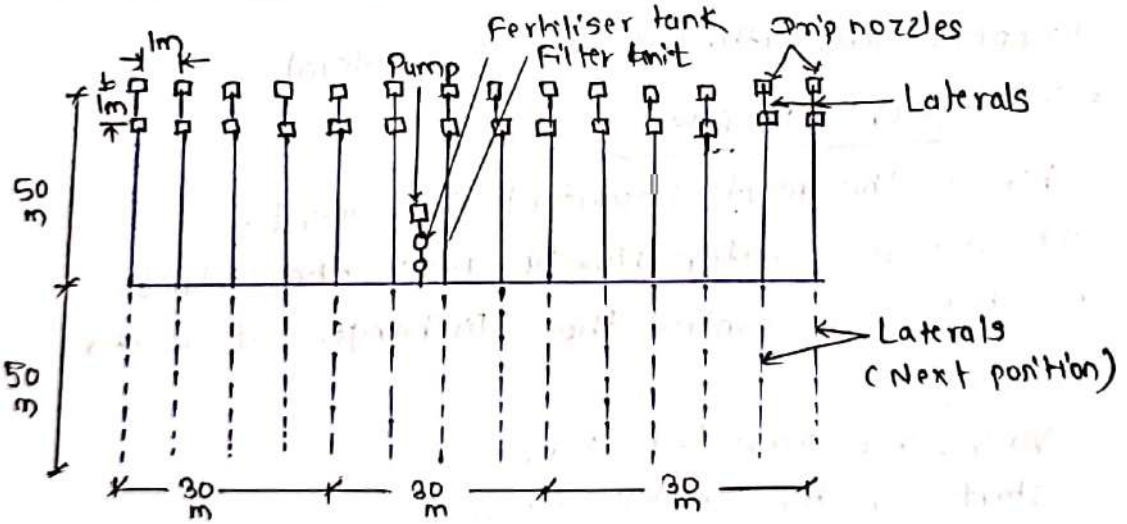
11) End cap / Flush valve

The ends of laterals are closed using end caps or flush valves.
They are also used to flush out:
- Dirt, sediments, deposits.

Layout of Drip Irrigation



Layout of field drip irrigation system



Suitability of Drip Irrigation

1) Suitable crops →

Drip irrigation is especially suitable for:
- Fruit crops
- Vegetable crops
- Grapes
- Sugarcane
- Cotton
- Orchards

It is particularly useful where individual plants or rows can be supplied by emitters.

2) Suitable soil →

a) Sandy soil : Water moves quickly through sandy soil, so water may need to be supplied more frequently.

b) Clay soil : Water should be supplied slowly to avoid, - Ponding, Runoff.

3) Suitable land → Drip irrigation can be used on, Level land, sloping land, undulating land.

- Proper layout and pressure control are important on sloping land.

4) Suitable where water is scarce

Drip irrigation is highly useful in areas where,
- Water availability is low
- Water is costly
- Water conservation is important.

Sprinkler Irrigation

Defination → Sprinkler irrigation is a method in which water is supplied through pipes and sprayed into the air through sprinkler nozzles.

- The water falls on the field in the form of small drops, similar to natural rainfall.

Principle of Sprinkler irrigation

Water source → Pump → main pipe → Lateral → sprinkler → Water droplets → crop.

Components of sprinkler Irrigation

following are various components of sprinkler Irrigation system.

1) Pumping unit
2) Tubings (main, submains & laterals)
3) Couplers
4) sprinkler head
5) Accessories like valves, bends, plugs, risers etc.

1) Pumping unit

The pump supplies water at the pressure required for the sprinkler system.

Function → Lift water, create required pressure
- Supply water through the pipe network.

2) Tubings

It consist of mainline, sublines and laterals main line carry water from the source and distributes it to the submains which further convey water to the laterals. laterals turn the water supply to the sprinklers.

3) Couplers

Couplers can be used for connecting two pipes and uncoupling rapidly and easily.

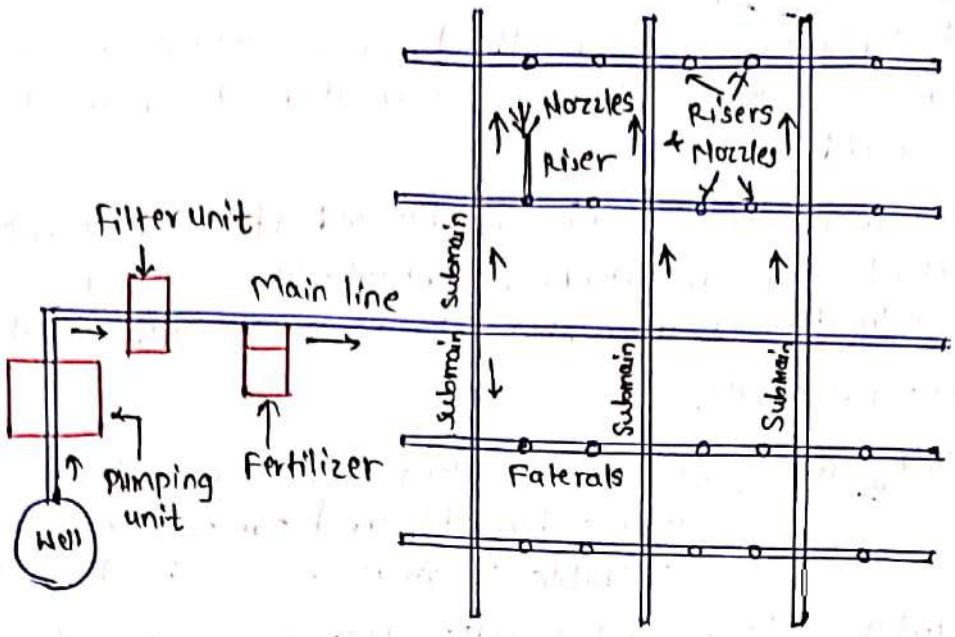
4) Sprinkler head

It is the must important component. It distribute the water uniformly over the field without runoff or excessive loss due to percolation at higher depth.

5) Fittings and Accessories

i) Water meter: It measure the volume of water delivered.
ii) Flange, couplings and nipple: There are used for the proper connection to the pump, Suction & delivery.
iii) Pressure gauge: It controls water pressure.

Layout of Sprinkler Imigation



Suitability of Sprinkler Imigation

1) Suitable crops →

- Sprinkler imigation can be used for:
  - Wheat, maize, vegetables, Groundnut, pulses, fodder crops, many field crops, Tree crops.

2) Suitable soil →

It is particularly useful for sandy soils having high infiltration rates.

- Because water enters sandy soil quickly.

3) Suitable land →

Sprinkler imigation is suitable for:

- Level land
- sloping land
- Undulating land

Therefore, it is useful where proper land leveling for surface imigation would be difficult.

4.5 Well Irrigation

1. Introduction →

Well irrigation is a method of irrigation in which ground water is taken out from a well and supplied to agricultural fields.

- Well irrigation is one of the oldest and most common methods of irrigation, particularly in areas where groundwater is available at a reasonable depth.

Types of wells.

i) Dug wells - Wells are dug manually water is drawn using buckets and pumps this method is suitable in areas having high water table.

ii) Tube wells - Tube wells deep bores are done using drilling machine and water is lifted using pumps.

iii) Artesian wells : These are natural pressurised well in which water flows without pumping.

Advantages →

1) Independent source of Irrigation
2) Water is available when required
3) Low initial cost for some shallow wells.
4) No major land acquisition.
5) Groundwater is generally available even when surface water is low.
6) Suitable for any irrigation method i.e. drip, sprinkler etc.

Disadvantages →

1) Water level may fall if groundwater is pumped faster than it is naturally recharged.
2) Limited water supply.
3) Pumping requires energy
4) Water quality problem.
5) Maintenance is required.
6) Not economical for every deep groundwater.

References →

1) Punmia B.C. ⟶ Irrigation and Water power Engineering.

2) Sharma R.K ⟶ Irrigation Engineering

3) Textbook ⟶ diagrams.

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ASSIGNMENT QUESTIONS

1. State the site selection criteria for percolation tank.
2. State the advantages and disadvantages of well irrigation system.
3. State any four requirements for an ideal site for bandhara.
4. Draw a layout of a Bandhara irrigation scheme showing different components.
5. State any two advantages of Bandhara Irrigation.
6. Draw a layout of lift irrigation scheme. Explain its function with component parts.
7. Differentiate between sprinkler irrigation and drip irrigation.
8. Explain how percolation tank differ from irrigation tank.
9. Describe drip Irrigation system showing field layout of system.
10. State the Advantages and Disadvantages of Bandhara irrigation.
11. Explain the Drip irrigation with neat sketch and describe components of each.
12. Discuss sprinkler irrigation system w.r.t. merits, demerits, sketch and trouble shooting of it.
13. state advantages of drip irrigation over sprinkler irrigation.
14. Write the need and suitability of site for construction of percolation tanks.
15. Explain well irrigation system.