Hydrology & Irrigation

For

Civil Engineering

By

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Syllabus for Hydrology & Irrigation

Irrigation: Duty, Delta, Estimation of Evapo-Transpiration; Crop Water Requirements; Design of Lined and Unlined Canals, Head Works, Gravity Dams and Spillways; Design of Weirs on Permeable Foundation; Types of Irrigation Systems, Irrigation Methods; Water Logging and Drainage; Canal Regulatory Works, Cross-Drainage Structures, Outlets and Escapes, Open Channel Flow (FM).

Hydrology: Hydrologic Cycle, Precipitation, Evaporation, Evapo-Transpiration, Watershed, Infiltration, Unit Hydrographs, Hydrograph Analysis, Flood Estimation and Routing, Reservoir Capacity, Reservoir and Channel Routing, Surface Run-off Models, Ground Water Hydrology - Steady State Well Hydraulics and Aquifers; Application of Darcy's Law.

Previous Year GATE Papers and Analysis

GATE Papers with answer key

thegateacademy.com/gate-papers

Subject wise Weightage Analysis

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Contents

"I would rather attempt something great and fail than attempt to do nothing and succeed."

... Robert Schuller

CHAPTER 1

Irrigation

Learning Objectives

After reading this chapter, you will know:

1. Types of Irrigation
2. Flow Irrigation
3. Techniques of water Distribution in farms
4. The condition Favoring the adoption of this Method
5. Drip Irrigation Method

Introduction

Science of artificial application of water to the land is according with the crop requirements through out the 'crop period' for full-fledged nourishment of crops.

- 70% of India populations depend on agriculture directly and 30% depend indirectly.
- Total geographical area of India = 328 million hec. Cultivable area = 184 million hec.

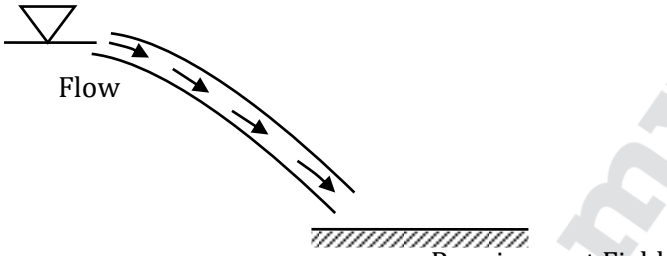
- **Advantage of Irrigation**
  1. Increase in food production.
  2. **Optimum Benefits:** Obtaining maximum crop yield with required amount of water.
  3. **In Mix Cropping:** More than two or two crops is the same field if the two or two crops is the same field if the weather conditions are not favorable to one of the crops, they may be suitable for other; and thus farmer may get some yield. But when irrigation is assured mixed cropping can be eliminated.
  4. **General Prosperity:** Revenue returns with well-developed irrigation, are sometimes, quite high, and help in all round development of country.
  5. **Generation of Hydroelectric Power:** cheaper power generation can be obtained from water development projects, primary designed for irrigation alone.

- **Disadvantages of Irrigation**
  1. Procuring and supplying irrigation water is complex and expensive.
  2. Irrigation may result is colder and damper climate, resulting in marshy lands and breeding of mosquitoes.
  3. Over irrigation may lead to water legging and may reduce crop yields.
  4. Loose productivity of soil.

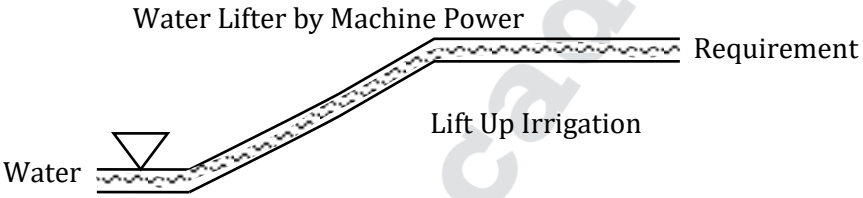
Types of Irrigation

1. Surface Irrigation
2. Sub Surface Irrigation

1. **Surface Irrigation**
   (a) Flow Irrigation
   (b) Lift Irrigation



Flow Irrigation



Lift Irrigation

Flow Irrigation

1. **Perennial Irrigation**
   Flood Irrigation
   - In perennial system, water is supplied through storage canal head works and canal distribution system.
   - When irrigation is done from direct runoff of a river, or by diverting the river runoff is called direct Irrigation.
   - Ganga canal system is an example of direct irrigation.
   - Storage irrigation → First water is storage then supply for irrigation.
   - Flood Irrigation also called inundation irrigation. In this method of Irrigation, soil is kept submerged and thoroughly flooded with water, so as to cause through saturation of land.

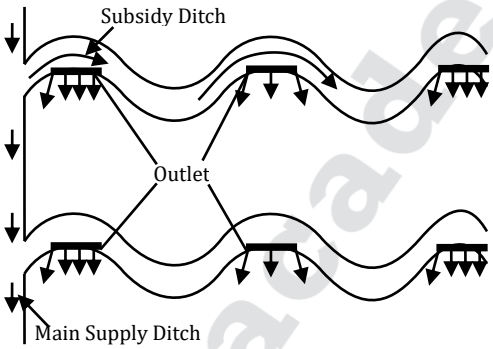
2. **Sab Surface Irrigation**
   (a) **Natural Sub Irrigation:** Leakage water from channels etc., goes under ground, and during passage through the sub soil, it may irrigate crops, sown on lower ends by capillary
   (b) **Artificial Sub Irrigation:** When a system of open jointed drains is artificially laid below the soil, so as to supply water to the crops by capillary, then it is known as artificial sub irrigation.

Techniques of Water Distribution in Farms

1. Free flooding
2. Border flooding
3. Check flooding
4. Basis flooding
5. Furrow irrigation method
6. Sprinkler irrigation method
7. Drip irrigation method

1. Free or Ordering Flooding

- Also called wild flooding
- Suitable for steep land
- Subsidy ditches are generally spaced at 20 to 50 meters
- Initial cost of land preparation is low and labour requirement are very usually high

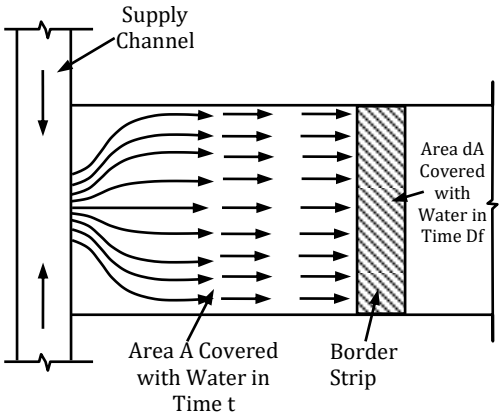


2. Border Flooding

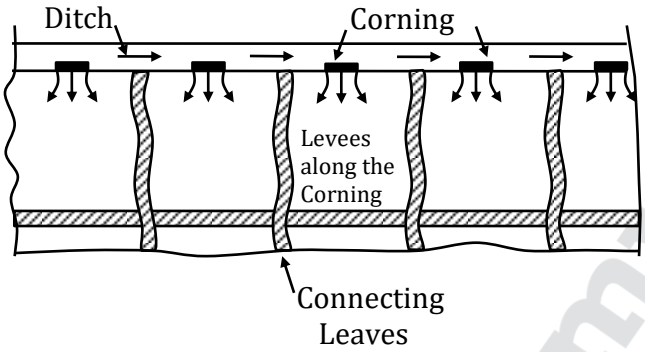
In this method, the land is divided into a number of strips, separated by low levees called borders

- The land areas confined in each strip of the order of 10 to 20 meters in width and 100 to 400 meters in length
- $t = 2.3\ y/f\ \log_{10}\left(\frac{Q}{Q - fA}\right)$

  Q = Discharge through supply ditch
  y = Depth of water flowing over border strip
  f = Rate of infiltration of soil
  A = Area of land strip to be irrigated
  t = Time required to cover the gives area

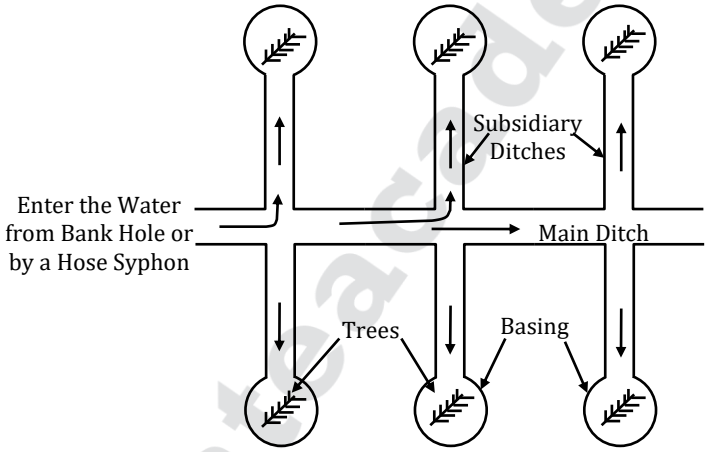


3. **Check Flooding**
   - Vertical interval of about 5 to 10 cm
   - The confined plot areas varies from 0.2 to 0.8 hectare
   - This method is suitable is suitable for more permeable soils as well as for less permeable soils

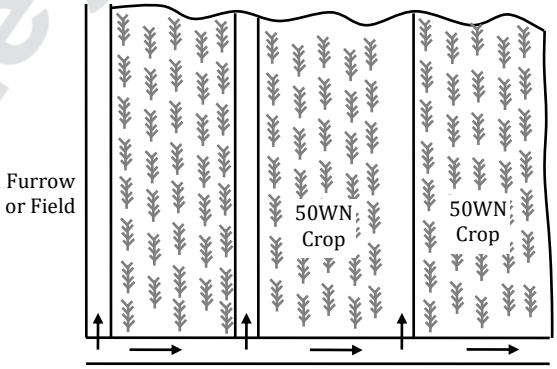


4. **Basin Flooding**

   This method is a special type of check flooding and is adopted specially for orchard tress



5. **Furrow Irrigation Method**
   - Furrows vary from 8 to 30 cm deep, and may be as much as 400 meters long
   - Deep furrows are widely used for row crops
   - Small shallow furrows called corrugations



6. **Sprinkler Irrigation Method**
   - Water is applied to the soil is form of a spray through a network of pipes and pumps
   - Used for all types of soil and for widely different topographies & slopes
   - This is very costly method

The Conditions Favoring the Adoption of this Method

1. Topography is irregular
2. Gradient is steeper
3. Soil is excessively permeable
4. Seasonal water requirement is low
5. When the water is available with difficulty

Types

1. Permanent System → piper are permanent buried
2. Semi – permanent system → not permanent
3. Portable system

- In semi-permanent system, the main lines are buried in ground, while laterals are portable
- In portable system the mains as well as laterals are portable.

Advantages of Sprinkler Irrigation

- Optimum quantity of water is used in this method
- Land leveling is not required
- Avoid surface runoff
- Upto 80% efficiency can be achieved
- Fertilizers can be uniformly applied, because they are mixed with irrigation water itself

Limitations

- High winds may distort sprinkler pattern
- In areas of high temperature and high wind velocity, considerable evaporation losses of water may takes place
- They are not suited to crops requiring frequent and larger depth of Irrigation, such as paddy
- Initial cost is very high
- It requires larger electrical power
- Constant supply of water is requires
- Heavy soil with poor intake cannot be irrigated efficiently

Drip Irrigation Method (or) Trickle Irrigation

- Latest field irrigation technique
- In this method water is slowly and directly applied to the root zone of plants thereby minimizing the losses by evaporation & percolation
- This system involves lying of a system of head, mains, sub mains, laterals and drop nozzles
- Water oozes out of there small drip nozzles uniformly and at a very small rate, directly into the plant roots area
- The head consists of a pump to lift water, So as to produce the desired pressure of about 2.5 atmospheres
- This method is however, being used for small nurseries, orchard, or gardens

Example: Determine the time required to irrigate a strip of land of 0.04 hectares is area from a tube well with a discharge of $0.02 m^3/s$. The infiltration capacity of the soil may be taken as 5 cm/hr and the average depth of flow on filed as 10 cm. Also determine the maximum area that can irrigate from this tube well?

Solution: Area $= 0.04$ hectares

$$= 0.04 \times 10^4 = 400 m^2$$

$Q = 0.02$ cumecs $= 0.02\ m^3/sec$

$$= 0.02 \times 60 \times 60 = 72 m^3/hr$$

$f = 5 cm/hr = 0.05\ m/hr$

$y = 10 cm = 0.1 m$

$$t = 2.3 \frac{y}{f} \log_{10}\left(\frac{Q}{Q - fA}\right)$$

$$= 2.3 \frac{0.10}{0.05} \log_{10}\left(\frac{72}{72 - 0.05 \times 400}\right)$$

$= 0.65$ hr $= 39$ minutes

Max. area that can be irrigated

$$A_{max} = \frac{Q}{f} = \frac{72}{0.05} = 1440\ m^2 = 0.144 \text{ hectares}$$

After irrigation this much of area, surface flow will stop, and deep percolation will start.