

CHAPTER – 1

Methods of Irrigation

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LECTURE 2

Definition of Irrigation

Irrigation may be defined as the science of artificial application of water to the land, in accordance with the 'crop requirements' throughout the 'crop period' for full-fledged nourishment of the crops.



History

- ❑ Started in ancient civilizations in arid and semi-arid climatic zones – where the food shortage was acute.
- ❑ Old cities excavated in Asia and Africa have disclosed that more than 5000 years ago people in Mesopotamia, Lebanon, China, Indo-Pakistan, Egypt adopted a permanent irrigation canal system. They knew that without digging canals and taking water from rivers through canals, land cultivation was not possible.
- ❑ Chinese are known to have practiced irrigation since 2627 BC. Has the longest irrigation canal, known as Grand Canal of 1285 miles, constructed originally by the Sui Empire during 589 to 618 AD and completed 1300 AD. This oldest and longest canal links Beijing and Hanchow by crossing the Great Yangzi and Yellow rivers and still serving 159223 sq. km of area.
- ❑ One of the largest irrigation canal of North Kiangsu Province of China which is 170 km long and 127 m wide in bed was dug by 13,00,000 people in 80 days. 69.9 million cum earthwork was done only with shovels and baskets.

Importance of Irrigation

Following are the factors which govern the importance of irrigation:

- Insufficient rainfall
- Uneven distribution of rainfall
- Improvement of perennial crops
- Development of agriculture in desert area

Advantages of Irrigation

- Increase in food production
- Optimum benefits
- Elimination of mixed cropping
- Improvement of cash crops
- Source of revenue
- General prosperity
- Generation of hydroelectric power
- Domestic water supply
- Facilities of communications
- Inland navigation
- Afforestation

Disadvantages of Irrigation

- Rising of water table: water-logging
- Problem of water pollution (nitrates seepage into GW)
- Formation of marshy land
- Dampness in weather
- Loss of valuable lands

Types of Irrigation

Broadly classified into:

- Surface Irrigation, and
- Sub-surface irrigation

System of Irrigation

Surface Irrigation System

Lift irrigation

By man or
animal power

By mechanical or
electrical power

Open well

Shallow
Tube well

Deep Tube
well

Flow irrigation

Inundation
Irrigation

Perennial
Irrigation

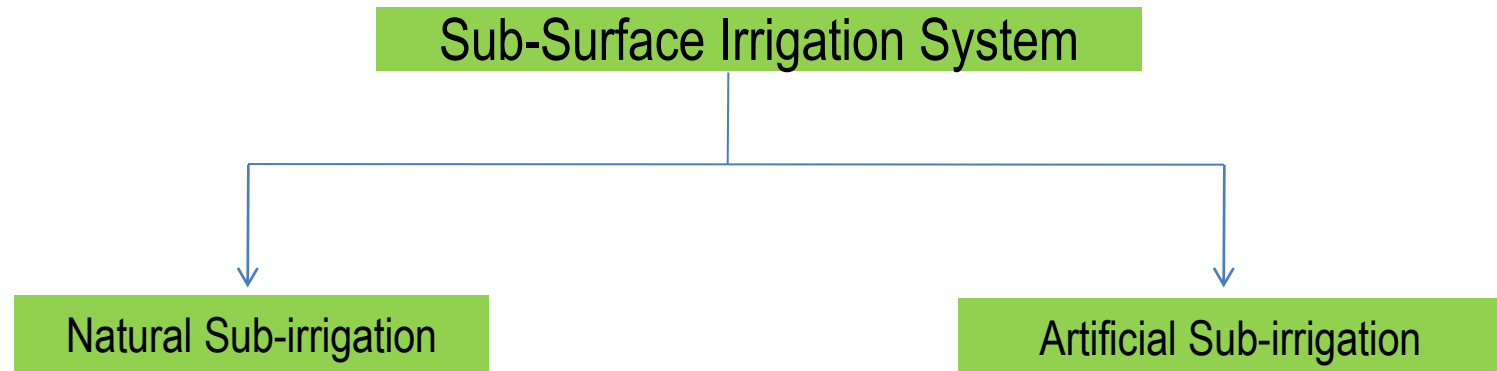
Direct
Irrigation

Storage
Irrigation

Lift Irrigation



Subsurface irrigation system



LECTURE 3

Methods of Irrigation

- Free Flooding
- Border Flooding
- Check Flooding
- Basin Flooding
- Furrow irrigation method
- Sprinkler irrigation method
- Drip irrigation method

Free Flooding or Ordinary Flooding

- Ditches are excavated in the field
- Movement of water is not restricted, it is sometimes called "*wild flooding*"
- It is suitable for close growing crops, pastures etc.
- This method may be used on rolling land (topography irregular) where borders, checks, basins and furrows are not feasible.

Contd..... Free Flooding

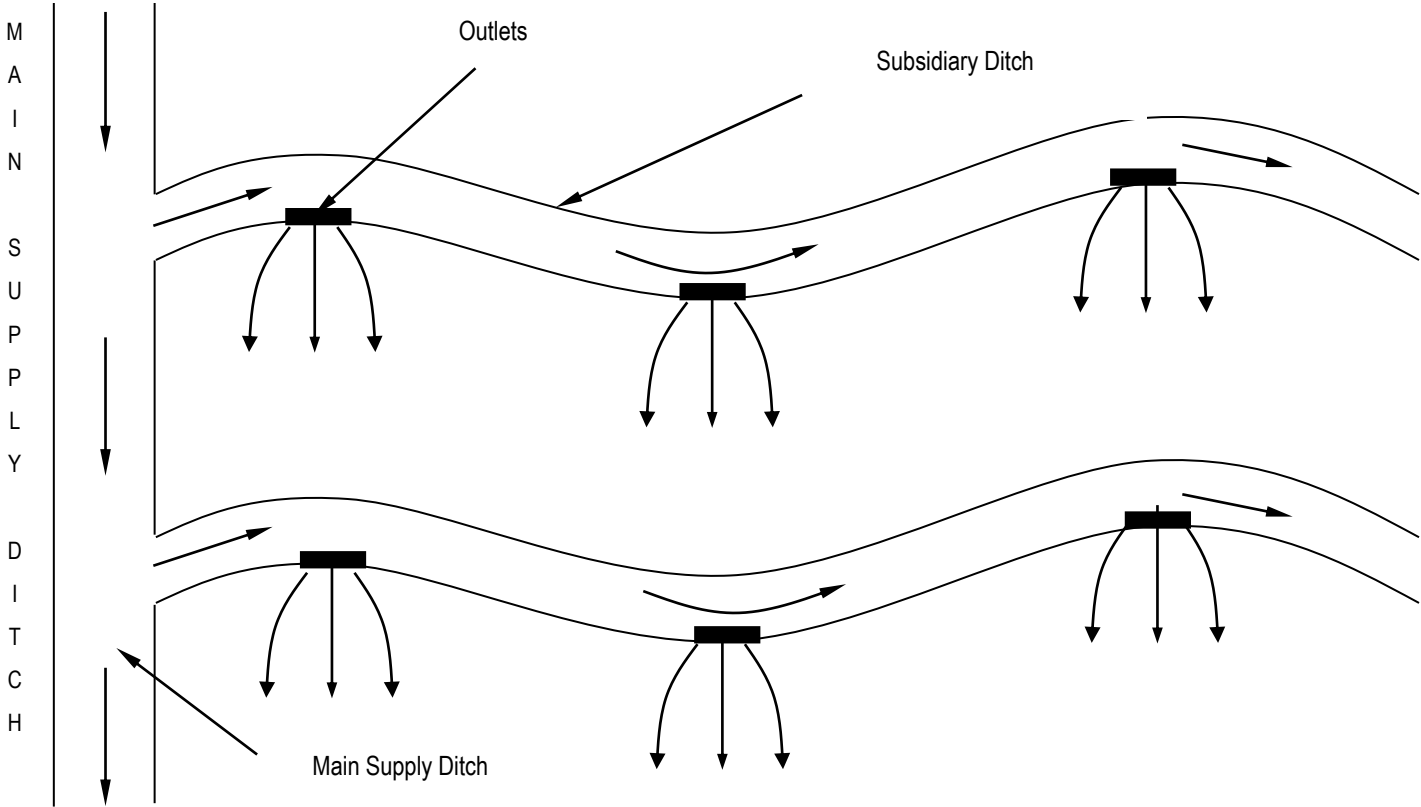


Fig: Free flooding (plan view)

Border Flooding

- ❑ Land is divided into a number of strips
- ❑ Strips separated by low levees called “borders”
- ❑ Strip area: width 10 ~ 20 m and length 100 ~ 400 m
- ❑ Ridges between borders should be sufficiently high
- ❑ The land should be perpendicular to the flow to prevent water from concentrating on either side of the border

Contd.Border Flooding

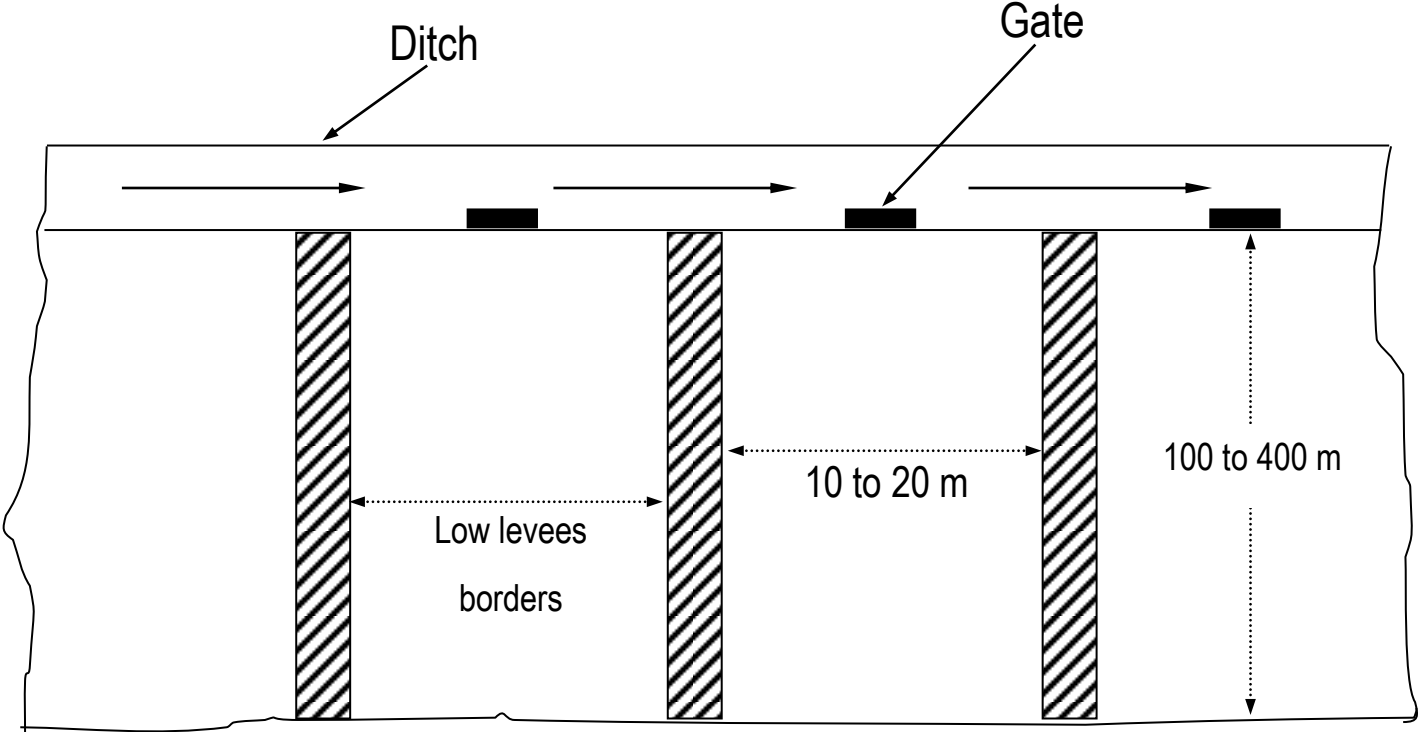
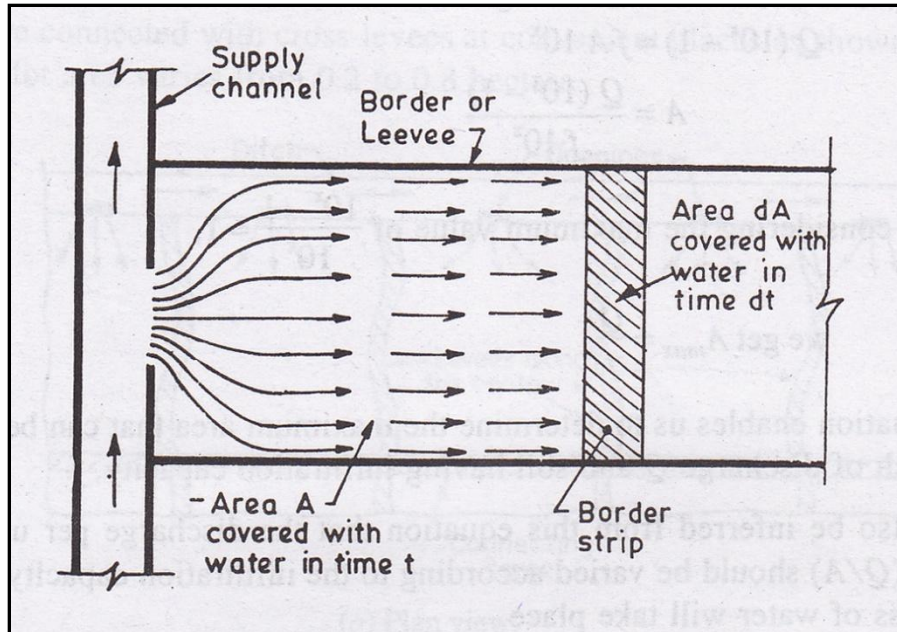


Fig: Border Flooding (plan view)

Time estimation for border flooding



Derivation of Equation:

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

Considering small area, dA of the border strip of area (A)

Depth of water, y over this area (A)

Assume that in time dt , water advances over this area (dA).

Now, the volume of water that flows to cover this area = $y \cdot dA$ ----- (1)

During the same time dt

The volume of water that percolates into the soil over the area (A)

$$A = f.A.dt \text{ ----- (2)}$$

The total quantity of water supplied to the strip during time (dt)

$$dt = Q.dt \text{ ----- (3)}$$

From equation (1), (2) & (3) \Rightarrow

$$\therefore Q .dt = y. dA + f. A. dt$$

$$\Rightarrow dt = \left(\frac{y.dA}{Q - f.A} \right)$$

For getting time required to irrigate the whole land, we have to integrate the above equation and considering y , f , and Q as constants

$$\int dt = \int \left(\frac{y.dA}{Q - f.A} \right)$$

After integrating the equation in the previous slide, we get.

$$t = \frac{y}{f} \ln\left(\frac{Q}{Q - f.A}\right) + C \text{ (Constant)} \quad \text{----- (4)}$$

But at, $t = 0, A = 0$

From equation (4) \Rightarrow

$$0 = \frac{y}{f} \ln\left(\frac{Q}{Q - f.0}\right) + C$$

$$\Rightarrow 0 = \frac{y}{f} \ln\left(\frac{Q}{Q}\right) + C = \frac{y}{f} \ln(1) + C = \frac{y}{f} \times 0 + C \quad \therefore C = 0$$

Finally,

$$\therefore t = \frac{y}{f} \ln\left(\frac{Q}{Q - fA}\right) = 2.3 \times \frac{y}{f} \log\left(\frac{Q}{Q - fA}\right)$$

This above equation can be further written as

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

$$\Rightarrow x = \log\left(\frac{Q}{Q - fA}\right)$$

$$\Rightarrow 10^x = \left(\frac{Q}{Q - fA}\right) \Rightarrow Q \cdot 10^x - f \cdot A \cdot 10^x = Q$$

$$\Rightarrow Q(10^x - 1) = f \cdot A \cdot 10^x$$

$$\Rightarrow A = \frac{Q(10^x - 1)}{f \cdot 10^x}$$

Further, considering the maximum value of $\frac{10^x - 1}{10^x} = 1$

We, get

$$A_{\max} = \frac{Q}{f}$$

Now, let $\frac{t.f}{2.3.y} = x$

Problem

Determine the time required to irrigate a strip of land of 0.04 hectares in area from a tube-well with a discharge of 0.02 cumec. The infiltration capacity of the soil may be taken as 5 cm/h and the average depth of flow on the field as 10 cm. Also determine the maximum area that can be irrigated from this tube well.

Solution:

Time required for irrigating the strip of land,

$$t = 2.3 \frac{y}{f} \log \left(\frac{Q}{Q - fA} \right)$$
$$= 2.3 \times \frac{0.10}{0.05} \times \log \left(\frac{72}{72 - 0.05 \times 400} \right)$$

$$= 0.65 \text{ hrs}$$

$$= 39 \text{ minutes}$$

Here,

$$A = 0.04 \text{ hectares}$$

$$= 0.04 \times 10^4 \text{ m}^2 = 400 \text{ m}^2$$

$$Q = 0.02 \text{ cumec} = 0.02 \text{ m}^3/\text{s}$$

$$= 0.02 \times 60 \times 60 \text{ m}^3/\text{hr}$$

$$= 72 \text{ m}^3/\text{hr}$$

$$f = 5 \text{ cm/hr} = 0.05 \text{ m/hr}$$

$$y = 10 \text{ cm} = 0.10 \text{ m}$$

Maximum area that can be irrigated is given by the equation:

$$\begin{aligned}A_{\max} &= 72/0.05 \text{ m}^2 \\ &= 1440 \text{ m}^2 \\ &= 1440/10^4 \text{ hectares} \\ &= 0.144 \text{ hectares}\end{aligned}$$

LECTURE 4

Cheek Flooding

- ❑ Similar to Ordinary flooding
- ❑ Water is controlled by surrounding the **check** area with low and flat levees
- ❑ The check is filled with water at a fairly high rate and allowed to stand until the water infiltrates
- ❑ The confined plot area varies from 0.2 to 0.8 hectares

Contd..... Check Flooding

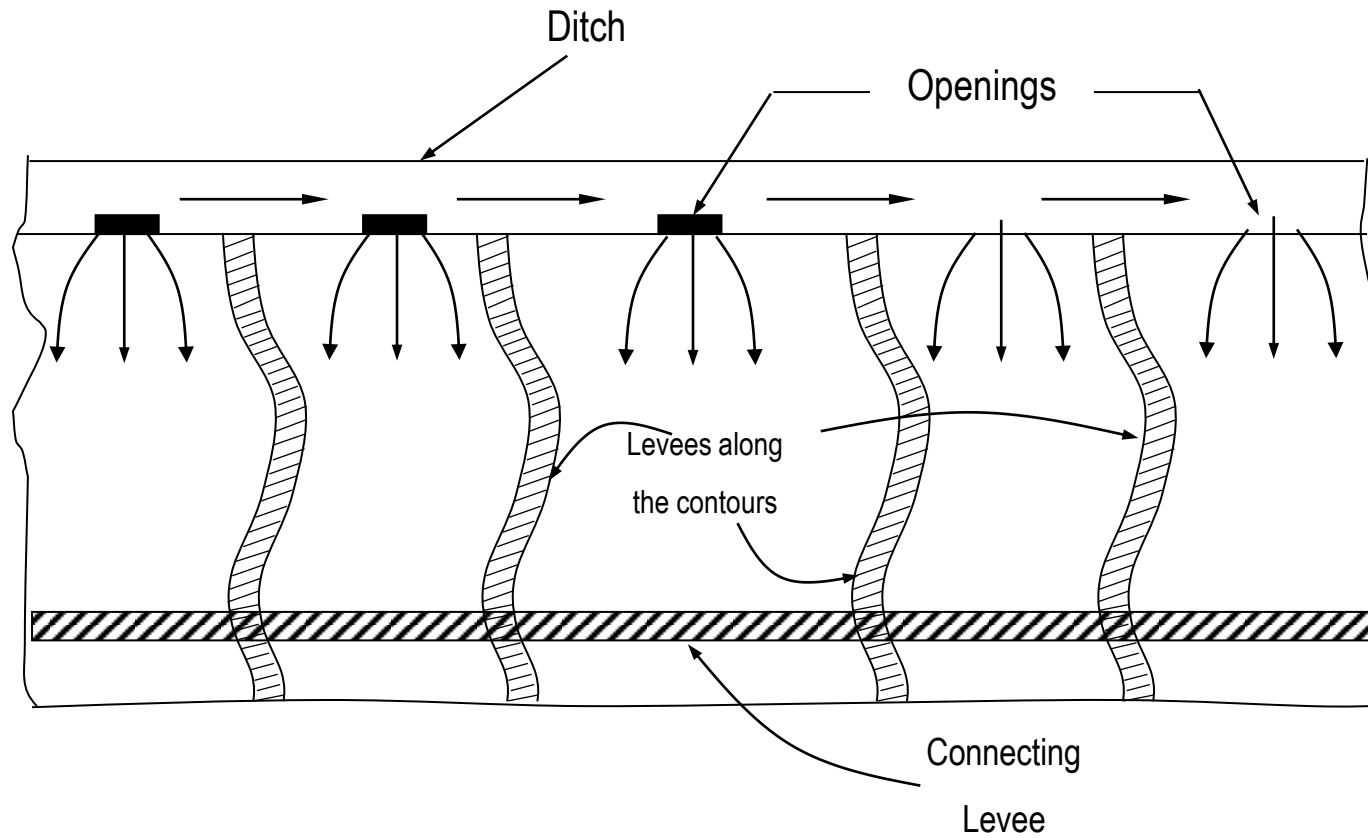


Fig: Check Flooding (plan view)

Basin Flooding

- Special type of check flooding
- Adopted specially for “Orchard trees”
- One or more trees are generally placed in the basin
- Surface is flooded as in check method by ditch water

Contd..... Basin Flooding

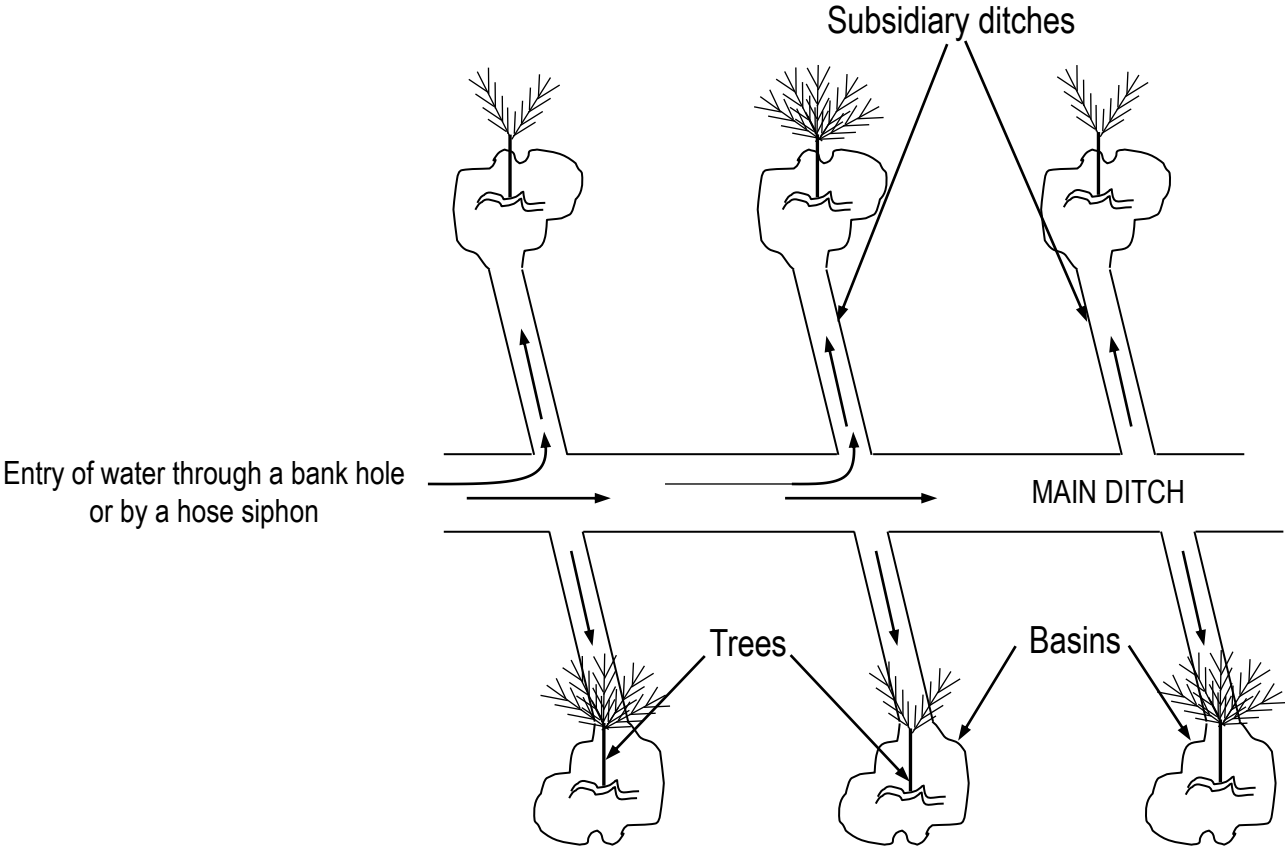
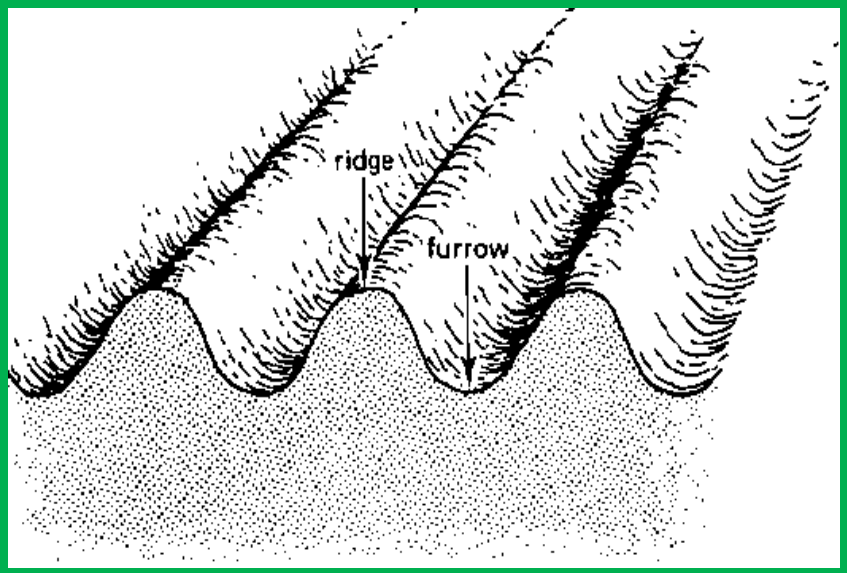


Fig: Basin Flooding (plan view)

Furrow Irrigation Method



Contd..... Furrow irrigation method



Sprinkler Irrigation Method



Contd..... Sprinkler irrigation method



Drip Irrigation Method



Irrigation Project Surveying

- Availability of Irrigation Water
- Selection of probable site for Barrage or Dam
- Discharge observation for the river
- Marking of GCA and Cultivable area
- Marking alignment of main canal
- Preliminary location survey
- Final Survey: Final location of Barrage or Dam, Route survey, Longitudinal leveling, Cross-sectional leveling, Data for cross drainage works, soil survey and well observation
- Preparation of drawings
- Office works
- Justification of the selection of final alignment
- Final location survey

Irrigation Project Report

- Introduction: Aim of the project, location, Area, population to be benefited, cost of the project etc.
- Necessity and economic justification
- Report on land acquisition and compensation
- Details of design and drawing of hydraulic structures
- Detailed estimate
- Specification
- Availability of materials and laborers
- Communication
- Maps
- Conclusion and recommendation

End of Chapter – 1