

## 2. METHODS AND DEPTH OF IRRIGATION WATER

### INTRODUCTION

Faulty method of irrigation leads to more wastage of costly irrigation water. Proper leveling and preparation of field help in even distribution of irrigation water. Application of larger quantities of irrigation water in excess of the soil moisture deficit of the field also adds to the wastage.

In this lesson we are going to study the proper method of irrigation and also the optimum quantity of irrigation water necessary for irrigation with minimum wastage.

### KEY CONCEPT

Preparation of land for application of water & gross irrigation requirement.



### OBJECTIVES

After studying this lesson you will be able to -

- *gather knowledge about different methods of irrigation.*
- *select suitable irrigation method for crop.*
- *determine the optimum depth of irrigation to be given in each irrigation.*

### 2.1 METHODS OF IRRIGATION

Irrigation water may be applied to crops by flooding it on the field surface (surface methods) by applying it beneath the soil surface (sub-surface irrigation), by spraying it under pressure (sprinkler method) or by applying it in drops to the root zone of the crop (drip method).

**(i) SURFACE METHODS :** Surface methods of irrigation are most widely practised for crops. In this system water is conveyed directly on to the soil surface. It may be of the following types:

Free flooding, Border strip, Check Basin, Ring Method & Farrow irrigation.

**(a) FREE FLOODING :** Water flows from the ditch directly to the field without much control on either side of the flow. It covers the entire field and moves almost unguarded. It is generally practised

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where topography is quite variable and poorly levelled. The land is somewhere deep causing waterlogging and somewhere very shallow leading to water scarcity. Uneven distribution of water and low water application efficiency are the common drawbacks of this method.

But this method is easy and inexpensive crops like rice, wheat, oilseeds and fodder crops are generally irrigated by this method.

**(b) BORDER STRIP:** This is a controlled method of irrigation. The area is divided into strips with bunds either side to check lateral movement of water (Fig. 1). In the strip water moves in an elongating thin sheet. The strips are level cross wise with gentle slope along the line of advance of front. Border strip needs through land grading and shaping. The width of the border usually varies from 3 to 15 meter. The length of the border depends on the infiltration rate of soil, slope of the land and the size of the irrigation stream. For moderate slopes and small to moderate size of irrigation stream, the following border strips are suggested.

Soil type	Border length (m)	Slope (%)
Sandy and sandy loam	60-120	0.25 - 0.60
Medium loam	100-180	0.20 - 0.40
Clay loam and clay	150-300	0.50 - 0.20

Its chief advantages are

- i) can be constructed with cheap farm equipment
- ii) irrigation labour requirement is greatly reduced.
- iii) uniform distribution of water and high water application efficiency (less wastages of water)
- iv) large irrigation streams can be efficiently used.

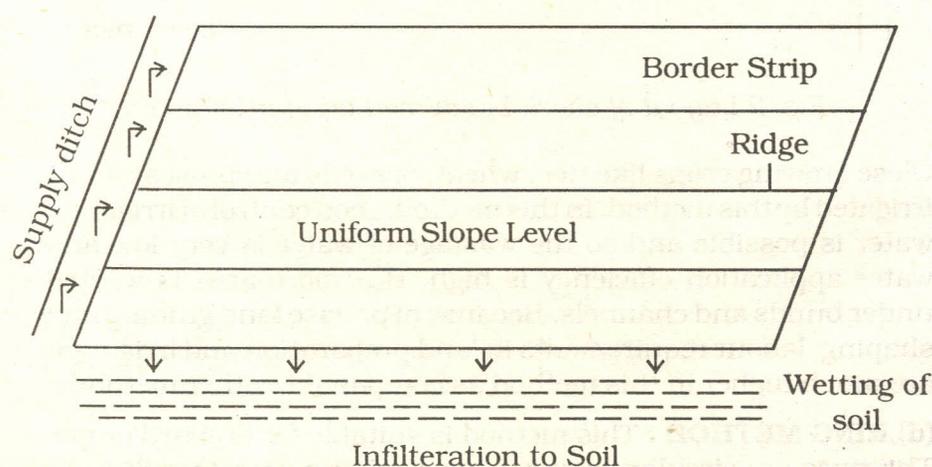


Fig. 1 Layout of border irrigation system.

The border strip method is suitable for irrigating most of the close growing crop like wheat, barley, pulses, oilseeds and fodder crops.

**(c) CHECK BASIN :** It consists of dividing the field into small units of plots, so that each has a nearly level surface. Such a small plot is called a basin. Water is conveyed to the field by a system of supply channels and lateral field channels. The supply channel is aligned on the upper side of the area and there is usually one lateral for every two rows of check basins (Fig. 2). Water from the laterals is turned into the beds and is cut off when sufficient water has been admitted to the basin. Water is retained in the basin until it soaks into the soil. This method can be adopted in heavy soils where water is absorbed very slowly and is required to stand for a relatively long time to ensure adequate irrigation. It is also suitable in very permeable soils which must be covered with water rapidly to prevent excessive deep percolation losses at the upstream end. In clay soils basins can be of 80 to 500 m<sup>2</sup> and in sandy soils these may be 50 to 100 m<sup>2</sup> plots.

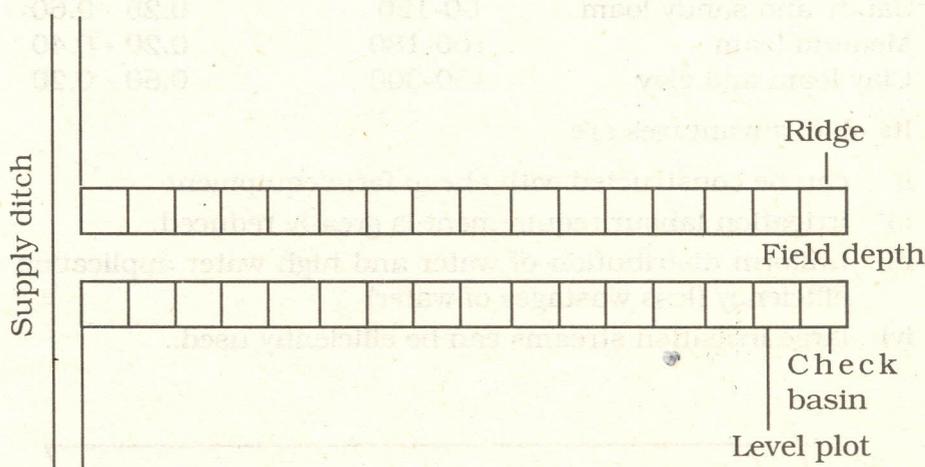


Fig. 2 Layout of check basin method of irrigation

Close growing crops like rice, wheat, oilseeds and pulses can be irrigated by this method. In this method, good control of irrigation water is possible and so the wastage of water is very low and water application efficiency is high. But more area is wasted under bunds and channels. Because of precise land grading and shaping, labour requirements in land preparation and irrigation are much higher in this method as compared to other methods.

**(d) RING METHOD :** This method is suitable for orchard crops. The rings are circular basins formed around each tree (Fig. 3). The ring basins are small when the plant is young. The size is

increased as the plant grows. Generally a small ring of 15-20 cm width is formed around the base of the tree. The depth of ring depends on the quantity of water to be irrigated. In this method, the entire area is not flooded, thus obtaining high water use efficiency. This method utilizes water most economically.

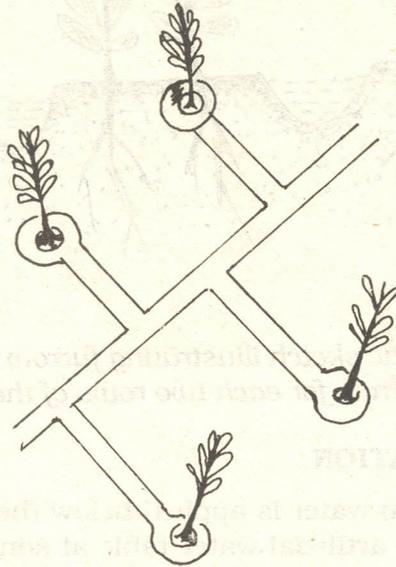
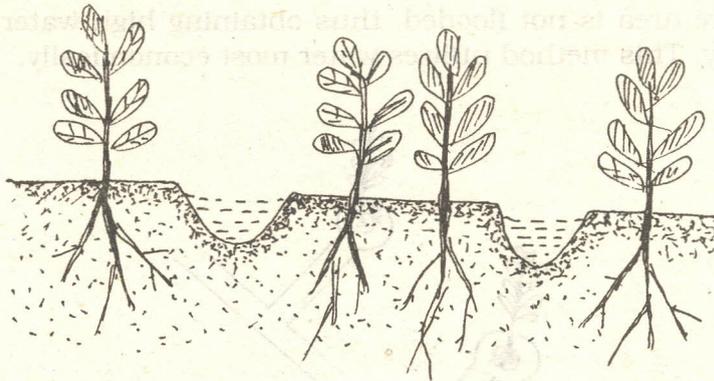


Fig. 3. Ring method of irrigation

**(e) FURROW METHOD :** Furrow method of irrigation is used in the irrigation of row crops with furrows developed between the crop rows in the planting and cultivating processes. The size and shape of the furrow depends on the crop grown and spacing between crop rows. Water is applied by running small streams in furrows between the crop rows. Water infiltrates into the soil and speeds laterally to irrigate the areas between the furrows (Fig. 4). Furrow irrigation needs proper land grading to avoid ponding. It is suitable in loamy and clay soils but not in sandy soils due to high infiltration and poor lateral movement of water.

This method is suitable for irrigating potato, brinjal, lady finger, chillies, groundnut, cabbage, cauliflower, maize, tobacco, sugarcane, sugarbeet, cotton etc. The furrow method has several distinct advantages

- i) water in the furrows contacts only one-half to one-fifth of the land surface, thereby reducing puddling, crusting of the soil and evaporation losses.
- ii) earlier cultivation is possible which is a distinct advantage in heavy soils and
- iii) economic use of irrigation water and increased water use efficiency.



*Fig. 4 Schematic sketch illustrating furrow irrigation with one furrow for each two rows of the crop.*

#### **ii) SUB-IRRIGATION**

In sub-irrigation water is applied below the ground surface by maintaining an artificial water table at some depth depending upon the soil texture and the depth of the plant roots. Since the method requires an unusual combination of natural conditions, it can be used only a few areas.

#### **iii) SPRINKLER IRRIGATION**

In this method, water is sprayed into the air and allowed to fall on the ground surface somewhat resembling rainfall. The spray is developed by the flow of water under pressure through small orifices or nozzles. The pressure is usually obtained by pumping. With careful selection of nozzle sizes, operating pressures and sprinkler spacings the amount of irrigation water required to fill the crop root zone can be applied nearly uniformly at a rate to suit the infiltration rate of the soil, thereby obtaining efficient irrigation. The essential parts of a sprinkler system are

- (i) water pump
- (ii) main pipes
- (iii) laterals
- (iv) risers and
- (v) sprinkler nozzles.

The main pipe is coupled with the water supply pump; to the main pipe are attached the laterals and to the laterals the risers.

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At the top, the risers have the nozzle fitted. Water supplied to the main by force gets distributed to laterals and risers and get sprinkled through the perforations of the nozzles.

Soluble chemical fertilizers can be injected into the sprinkler system and applied to the crop at the desired depth in a soluble and readily available form to plants, without any danger of being leached away. Irrigation and fertilizer application are done simultaneously, thus it saves the labour required for fertilizers application.

Sprinkler irrigation can be used for almost all crops (except rice and jute) and on most soils. It is, however, not usually suitable in very fine textural soils (heavy clay soils). Crops like tea and coffee grown in plains and hill slopes can be effectively irrigated by this method.

Sprinkler can be used in uneven or rolling or irregular topography without any land levelling, where no other method is feasible. Exact quantity of water can be applied uniformly, so there is no deep percolation and run-off loss. No land is wasted for bunds and channels. Main disadvantages are high initial cost, necessary of technical guidance and constant water supply.

#### **iv) DRIP IRRIGATION**

Drip or trickle irrigation is one of the latest methods of irrigation which is becoming increasingly popular in areas with water scarcity and salt problems. In this method water is supplied in continuous or discontinuous small drops (trickles) to the root zone of the crops with a volume of water approaching the consumptive use of the plants, thereby minimising such conventional losses as deep percolation, run off and soil water evaporation.

The trickle irrigation system consists of main line, submain, laterals and tricklers (emitters). Like in sprinkler system, the main line fed by a pump feeds the submain, the submain to the laterals and the laterals to the tricklers.

This system is more efficient and more specialised than sprinkler irrigation system. High cost of installation makes it prohibitive for general use. Emitter clogging, inadequate soil water movement, plant root development and operational technical difficulties are some of the disadvantages of this method. Crops like grapes, sugarcane, papayas, banana, guava and most other types of fruit trees and vegetables have been found to respond well to drip irrigation. There is considerable saving in water by adopting this method.

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## 2.2 OPTIMUM DEPTH OF IRRIGATION WATER

The amount of water to be replaced at each irrigation depends on the amount of available moisture the soil can hold in the moisture-extraction depth of soil and on the moisture level selected for the start of irrigation. If more water is applied than is needed to bring the moisture level up to field capacity the additional amount is lost by deep percolation. But if enough water is not supplied, crop yields are also reduced.

The following example shows how to estimate the net amount of moisture to be replaced in the soil.

- a) Sugarcane crop with its effective root zone depth of 90 cm requires irrigation at 65 per cent depletion of available soil moisture. Soil is silty loam with 12 cm available water per meter depth of soil.
- b) Available water in 90 cm root zone depth =  $\frac{12 \text{ cm} \times 90 \text{ cm}}{100 \text{ cm}}$   
= 10.8 cm
- c) Irrigation at 65 per cent depletion of available soil moisture, therefore, the net amount that must be added to the soil at each irrigation is  $\frac{10.8 \text{ cm}}{100} \times 65 = 7.02 \text{ cm}$

The gross amount of water to be applied at each irrigation is the amount that must be applied to the surface to be sure enough water enters and is held in the soil to meet the net requirement for each irrigation. Regardless of the method of irrigation used, no irrigation system is 100 per cent efficient and not all the water applied during an irrigation enters and is held in the root zone except drip method of irrigation. Unavoidable losses are caused by unequal distribution of water over a field, by percolation below the root zone, and by waste at the ends of borders and furrows. For a given irrigation method, field efficiency varies with the skill used in planning, laying out and operating the system and with the physical properties of the soil. To be sure that the net amount of moisture to be replaced at each irrigation enters and is retained in the rootzone, it is necessary to apply a larger amount of water to the soil surface to offset any losses. This gross amount to be applied, can be determined according to the following equation.

$$\text{Gross amount} = \frac{\text{Net amount to be replaced}}{\text{Efficiency of the system}}$$

In the example of net amount of irrigation (7.02 cm) if the efficiency of irrigation is 70 per cent, then the gross amount of water to be applied per irrigation is  $7.02 \text{ cm}/70 \times 100 = 10 \text{ cm}$ . The efficiency of the irrigation system is known as irrigation

efficiency. It is calculated as the water retained in root zone depth of soil ( $W_s$ ) divided by the water delivered to the field ( $W_f$ ) multiplied by 100 as follows

$$E_a = \frac{W_s}{W_f} \times 100 \text{ where } E_a = \text{Irrigation efficiency, percent.}$$

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### 2.1 INTEXT QUESTIONS

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1. What are the different methods of surface irrigation?
2. Give the Border length & slope percent for clay type of soil.
3. Give the size of check basin to be selected for clay soil.
4. What are the crops which are irrigated by furrow methods of irrigation?




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### WHAT YOU HAVE LEARNT

- Irrigation water may be applied on the soil surface, beneath the soil surface, by spraying or through drips.
- Suitable methods of irrigation for different crops and conditions suitable for their adoption.
- Optimum depth of irrigation water to be applied per irrigation.




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### TERMINAL QUESTIONS

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1. Describe borderstrip, check basin and furrow methods of irrigation.
2. Discuss sprinkler method of irrigation. Give its advantages.
3. Write short note on
  - a) Drip method of irrigation
  - b) Optimum depth of irrigation water.




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### 2.1 ANSWERS TO INTEXT QUESTIONS

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1. Free flooding, Border strip, check Basin, Ring method & Furrow irrigation.
  2. Length - 150 - 300 meter  
Slope % - 0.05 to 0.20
  3. 80 to 500 m<sup>2</sup>
  4. Potato, Brinjal, Ladies finger, Cillies, Groundnut, Cabbage, Cauliflower, Maize, Tobacco, Sugarcane, Sugarbeet, and Cotton.
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