UNACADEMY

Irrigation Engineering

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- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

IRRIGATION ENGINEERING

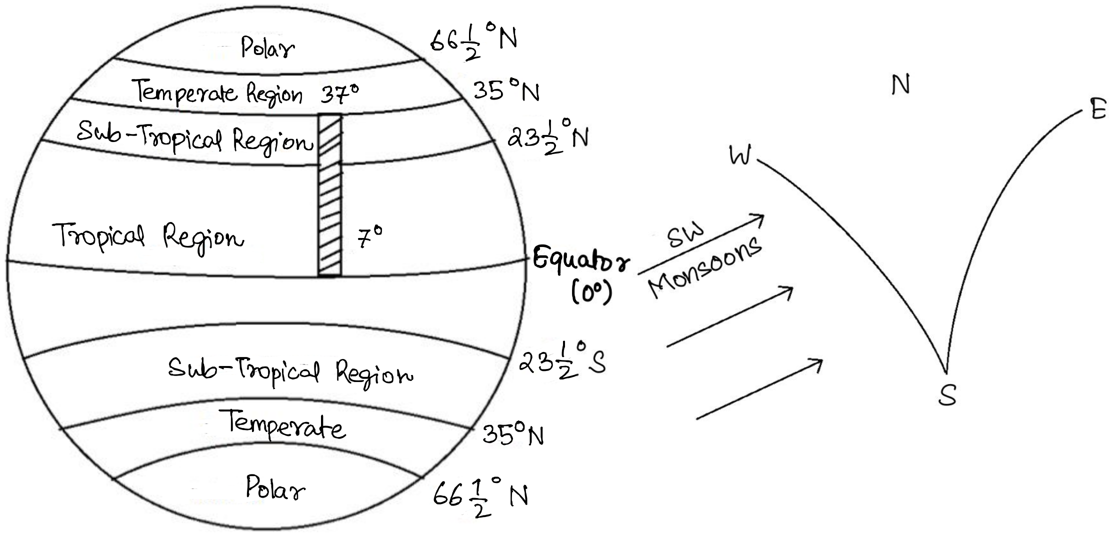
-JASPAL SINGH
(EX IES)

CONTENT

INTRODUCTION TO IRRIGATION

Q. Why Irrigation is Required in India.

Ans:



- Every Crop Requires certain amount of Water at Regular Interval throughout the growth period at desired time so that the Crop may attain Maturity.
- If in an area natural Rainfall is both timely and sufficient then irrigation facilities are not required to develop.
- In a tropical Count(r)y like India Rainfall is neither sufficient not timely therefore irrigation facilities are required to be developed
- Water Requirement of Crop may not be fulfilled by Natural rainfall, in such case also irrigation facilities are required to be developed, so that adequate amount of water may be supplied to the crops required for acheiving max. Cultivation.

RICE
(Kharif Monsoon)
(June – Sept)

↓↓↓↓↓↓↓↓↓↓

Sowing (June) — Cultivation (Sept)

WHEAT
(Rabi Winter)
(Nov – March)

↓↓↓↓↓↓↓↓↓↓

Sowing (Nov) — Cultivation (March)

Hence, Irrigation may be defined as artificial application of water at desired interval for specific duration throughout the Entire growth Period of Crop so as to attain full maturity.

Note: Classification of area Based on defficiency of Rainfall.

ARID (Dry)
- These are the area where for Cultivation of any type of crop irrigation is must

Semiaried {Semi-dry}
- These are the areas where Cultivation of inferior Crops can be done without Irrigation.

Ex :→ Thar, Kacchch
Leh and Ladakh

Ex → Telangana, Bundelkhund,
Vidharbha.

Note: Inferior Crops: These are those crops which can be cultivated in inferior condition. Here inferior conditions corresponds to
(a) Poor Quality of Soil
(b) less Availability of water
Example – Bajra, Jowar
– These inferior crop shows low yield and high suicide.

•• ADVANTAGES OF IRRIGATION

(i) Obtaining maximum yield since by developing irrigation facilities we can supply adequate amount of water which is required by the crop max. yield is obtained.

$$\text{Yield} : \text{Yield} = \frac{\text{Cultivation}}{\text{Area}} = \frac{(\text{tonnes})}{\text{Hectares}} \quad \{1 \text{ hec} = 10^4 \text{ m}^2\}$$

(ii) Elimination of mixed cropping
– Growing of 2 or more crops together in the same field in the same time is called mixed cropping
– Mixed cropping has following drawbacks
(a) Max Yield cannot be obtained from entire area, at any given time quantity is reduced.
(b) Therefore irrigation helps in eliminating mixed cropping, because adequate amount of water can be supplied to crop that is required for its max yield.

(iii) Improving Domestic water supply :→ Development of irrigation facilities in an area helps in increasing/supporting the water supply in nearby villages and towns where other sources of water is not available or there is scarcity of water.

(iv) Generation of Hydro – Electric power :→ Cheaper power generation can be obtained from water development project primarily design for irrigation.

(v) Facility of communication :→ Irrigation channels are primarily designed for embankments and inspections road which connect as the mode of communication also.

(vi) Afforestation :→ Trees are generally grown along the banks of the channel which increases the proportion of green cover and also helps in reducing the soil erosion.

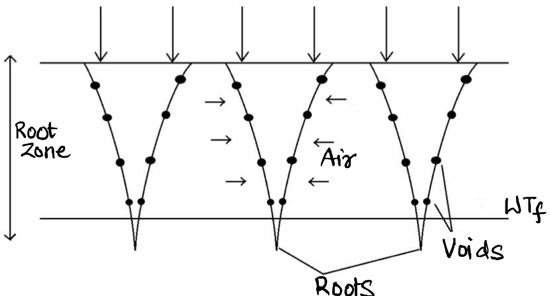
(vii) Optimum Benefits.

(viii) General prosperity.

•• DISADVANTAGES OF IRRIGATION

(i) Irrigation may lead to creation of wet climate condition, which results in ambient growth of mosquitos and micro-organisms that increases the risk of water-borne disease.

(ii) Intensive irrigation may lead to waterlogging if water is applied over a agricultural land or field than certain fraction get lost due to seepage and ultimately joins ground water.
– If the process continues for few successive years, then ground water table rises and if it reaches upto root zone, which will result in choking of pores present in the roots, that are responsible for Aeration, hence growth of crop reduce.



(iii) Since Indian soils are deficient in nitrogen, it is supplemented by addition of fertilizer (Urea, NH_2, $CONH_2$) which along with water seeps upto ground water level, thereby increases concentration of NO_3^- in it.
- If this ground water is used for domestic use, it may lead to mathemoglobinemia.

•• TYPES OF IRRIGATION

Irrigation is broadly classified into 2 types :→
(i) Surface Irrigation
(ii) Sub-Surface Irrigation

(i) SURFACE IRRIGATION: In this method water is applied over the surface and agricultural field remains in vet condition.
- It is further classified as :→
(a) Flow Irrigation (b) Lift Irrigation.

(a) FLOW IRRIGATION:→ When the water is available at higher level and it is supplied to the lower level by the action of gravity then it is termed as flow irrigation.

(b) LIFT IRRIGATION: If the water is lifted by some mechanical or manual mean and then supplied for irrigation, it is termed as lift irrigation.
- Use of tube well, open wells for supplying irrigation water falls in this category.

- Flow Irrigation is further classified as –
(A) Perennial irrigation (B) Flood irrigation.

(A) PERENNIAL IRRIGATION: In this system of irrigation constant and continuous water supply is assured to the crops in accordance with the requirement of the crop throughout the crop period in this system, water is supplied through canal distribution system, taking off from a reservoir and weir.

This Perennial Irrigation is further classified as :→
(1) Direct Irrigation (2) Storage Irrigation

- When Irrigation is done by derouting the river runoff into the main canal by using diversion headwork across the river it is termed as direct Irrigation.

- If the dam is constructed across a river to store the water during monsoon, so as to use in dry period is termed as storage irrigation.

(B) FLOOD IRRIGATION: This type of irrigation is also termed as Inundation irrigation.

- In this method soil is kept submerged and thoroughly flooded with water so as to cause saturation of the land.
- The moisture soaked by soil, is further used by the crops over the crop period for growth.
- It is usually adopted in areas near rivers in alluvial soil.
- This system of irrigation is also called uncontrolled irrigation.

(ii) **SUB-SURFACE IRRIGATION:** In this method water does not wet the soil surface as it is being applied in root zone below the ground surface.

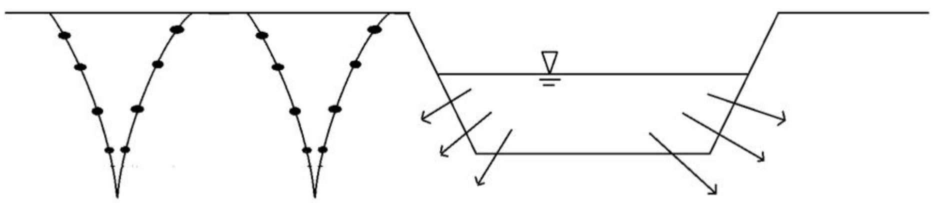
- In this case, roots of plants utilizes the water by capillarity.

It is further classified into :-

(a) Natural

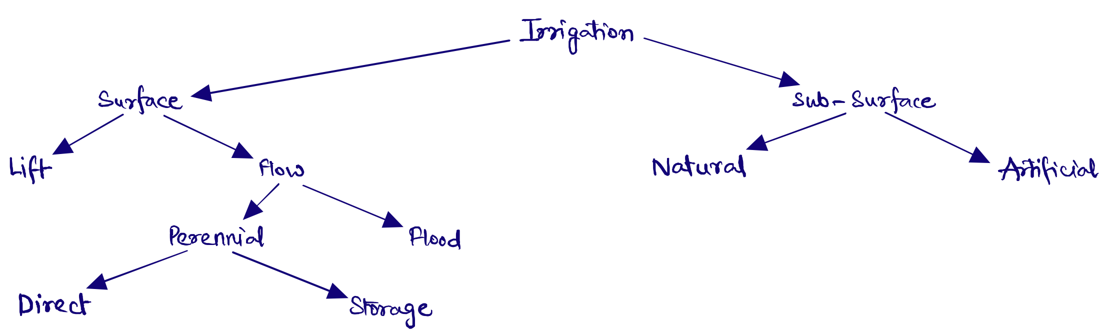
(b) Artificial

leakage water from channel goes underground and during passage through the sub soil it may irrigate the crops by capillarity.



In this method (Artificial) water is supplied artificially direct into the rootzone with the help of network of pipe and drains it is termed as artificial sub-surface irrigation.

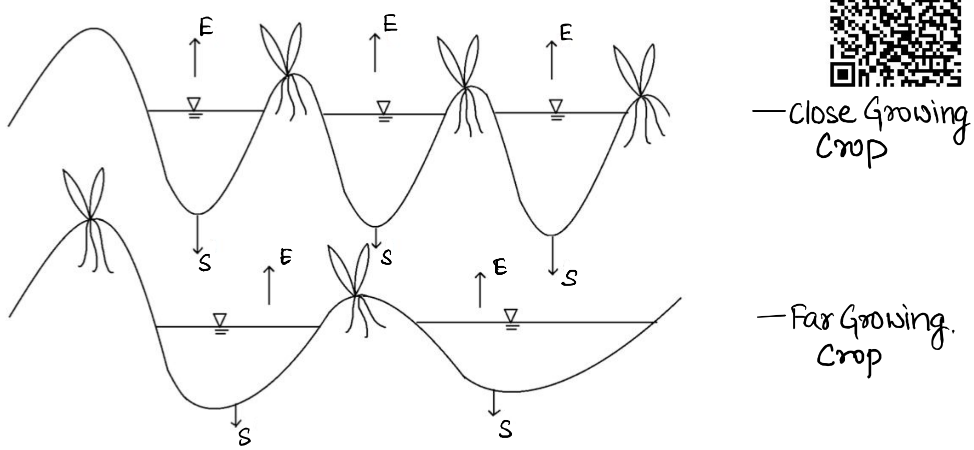
- Since in this case, cost is very high, it is not used in India.

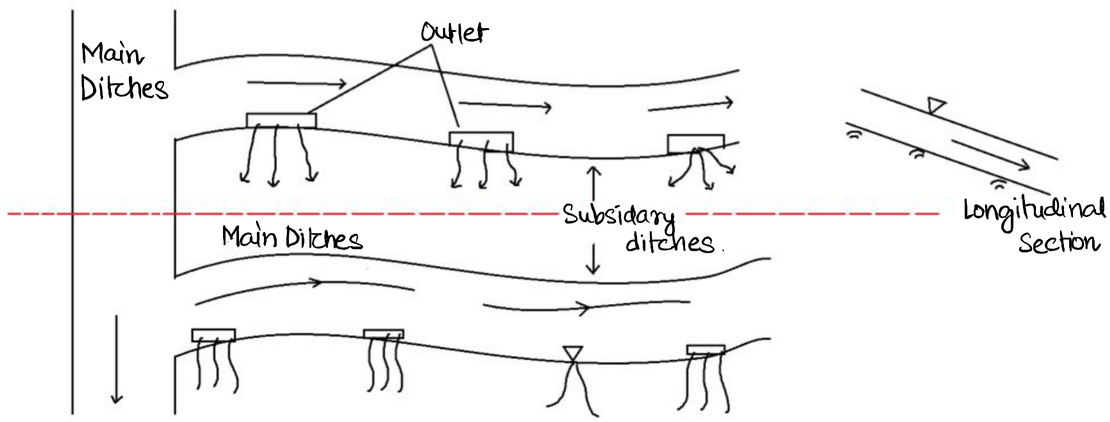


•• METHOD OF WATER DISTRIBUTION

(I) **FREE FLOODING:** It is also termed as ordinary or wild flooding.

- In this method ditches are excavated into the field and they may be either on contour side or up and down the slope.
- Water from these ditches flow across the field.
- After the water leaves the ditches no attempt is made to control, hence it flows freely
- Land preparation is low, labour requirement is adequate.
- It adequate and water application efficiency is low.
- It is suitable for close growing crops as losses in this case are comparatively less or where land is steep.
- The lateral or subsidiary ditches in this case are spaced about 20 to 50 m apart depending upon the slope, texture of soil and type of crop.
- It is suitable for rolling terrain where other method are not suitable.





② **BORDER FLOODING:** In this method, land is divided into no. of Strips, seperated by low levees {Note :→ levees are small embankment, which don't permit the flow of water across it} that are termed as Borders.

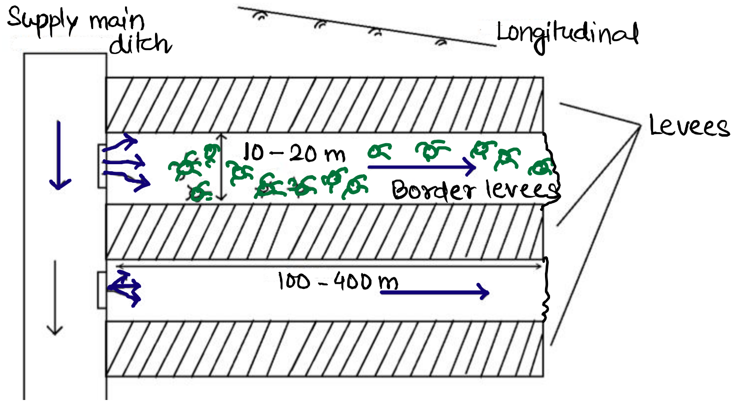
- The area confined in each Strips is of the order of 10 – 20 m in width and 100 – 400 m in length.
- To Prevent water from concentrating on either side of the Border, the land is levelled Perpendicular to flow.
- Water is made to flow from supply channel at regular interval.

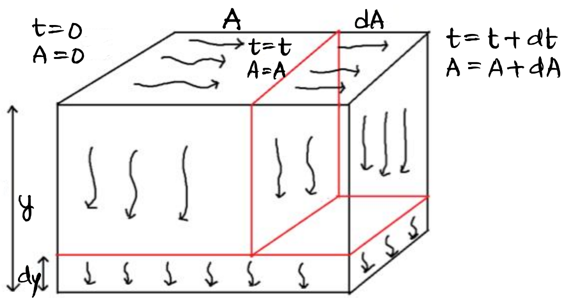
Note: The size of supply ditch depends upon type of soil, coarse grained soil with high infiltration will require high discharge rate to cover the entire field therefore, size of supply ditch should be comparatively bigger.

- for fine grained soil, where infiltration rate is low smaller ditches are required to avoid losses due to runoff at lower Reaches.

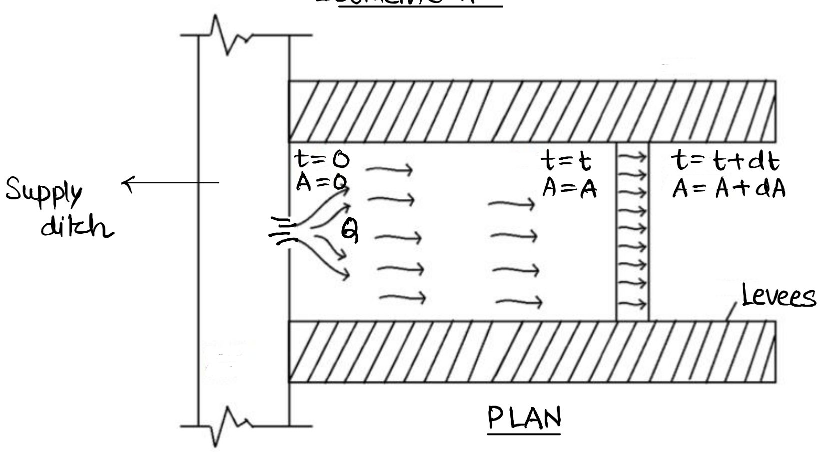
This method is very Popular among the other methods which are available.

- Short and narrow Strips are found to be more Efficient.
- Entry of Water into Strips generally Controlled by placing a gate in supply ditches.





Isometric View



PLAN

A relationship between the discharge through the Supply ditch, the average depth of water flowing over the Strip (y), the rate of infiltration of Soil (f), the area of the Land irrigated (A) and the approximate time required to Cover the given area is Given by –

$$t = 2.303 \cdot \frac{y}{t} \cdot \log_{10} \left\{ \frac{Q}{Q - fA} \right\}$$

Volume of Soil getting irrigate in the time dt.

$= dA(y - dy) + (A + dA)\,dy$

$= dA \cdot y - dA \cdot dy + A \cdot dy + dA \cdot dy$

$= dA \cdot y + A \cdot dy$ — (i)

Volume of water Supplied to the field in time dt.

$= Q \cdot dt$ — (ii)

Assuming losses = 0

Volume of water Stored = Volume Supplied.

$$dA \cdot y + A \cdot dy = Q \cdot dt$$

If rate of infiltration is f, then depth of water dy infiltrated in time $dt = f \cdot dt$

$$dA \cdot y + A \cdot f\,dt = Q \cdot dt$$

$$y\,dA = Q \cdot dt - A \cdot f \cdot dt$$

$$y\,dA = (Q - A \cdot f)\,dt$$

$$\frac{y\,dA}{Q - A \cdot f} = \int_0^t dt$$

$$y \int_{A=0}^{A} \frac{dA}{(Q - A \cdot f)} = \int_{t=0}^{t} dt$$

$$y \left| \frac{\ln(Q - Af)}{-f} \right|_0^A = [t]_0^t$$

$$-\frac{y}{f} \left| \ln(Q - Af) - \ln Q \right| = t$$

$$\frac{y}{f} \ln\left(\frac{Q}{Q - Af}\right) = t$$

$$\frac{tf}{2.303 \cdot y} = \log_{10}\left(\frac{Q}{Q - Af}\right)$$

let $\frac{tf}{2.303\,y} = x$ then, $\Rightarrow x = \log_{10}\left(\frac{Q}{Q - Af}\right)$

$$\Rightarrow 10^x = \frac{Q}{Q - Af}$$

$$\Rightarrow 10^x (Q - Af) = Q \Rightarrow 10^x . Q - 10^x . Af = Q$$

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

$$A = \frac{Q}{f} \left\{ \frac{10^x - 1}{10^x} \right\}$$

Max. value which can be attained by $\frac{10^x - 1}{10^x} = 1$

Hence, max Area of field that can be irrigated as given by $\boxed{A_{max} = \frac{Q}{f}}$

it can also be concluded that after this max. area is irrigated, losses will take place.

- The discharge per unit Area of the border strip (Q/A) should be varried accordingly to the infiltration capacity of the field (f), or else excess water would be lost or entire area would not be irrigated.

$$\frac{Q}{A} = f \left\{ \frac{10^x}{10^x - 1} \right\}$$

Q. Find the time required to irrigate a strip of land whose Area is 0.04 hactare from a tube well having a discharge of 0.02 m^3/sec. The infiltration capacity of the soil can be taken as 5 cm/hr and avg. depth of flow in the field is 10 cm. Also compute the max area which can be irrigated for the given discharge.

Ans: $t = 2.303 . \frac{y}{f} \log_{10}\left(\frac{Q}{Q - Af}\right)$

$$= 2.303 \times \frac{10}{5} \log\left(\frac{0.02}{0.02 - \frac{0.04 \times 10^4 \times 5 \times 10^{-2}}{60 \times 60}}\right)$$

$$t = 0.64 \text{ hr} = 39 \text{ min}$$

(ii) $A_{max} = \frac{Q}{f} = \frac{0.02}{5 \times 10^{-2}} \times 3600 \times 10^{-4}$