

Experiment No. 14

Date-----

Calculation of Irrigation Efficiency

Aim

To study about different irrigation efficiencies parameter

Materials required

1. Pen
2. Pencil
3. Note book

Calculations on irrigation efficiencies

Irrigation efficiency indicates how efficiently the available water supply is being used, based on different methods of evaluation. The objective of efficiency concept is to show where improvements can be made, which will result in more efficient irrigation. Various efficiency terms are:

i) Water conveyance efficiency

This term is used to measure the efficiency of water conveyance systems associated with the canal network, water courses and field channels. It is also applicable where the water is conveyed in channels from the well to the individual fields. It is expressed as follows:

$$E_c = \frac{W_d}{W_f} \times 100$$

Where, E_c = Water conveyance efficiency, per cent

W_d = Water delivered to the irrigated plot (at the field supply channel)

W_f = Water diverted from the source

ii) Water application efficiency

After the water reaches the field supply channel, it is important to apply the water as efficiently as possible. A measure of how efficiently this is done is the water application efficiency, expressed as follows:

$$Ea = \frac{Ws}{Wd} \times 100$$

Where, Ea = Water application efficiency, per cent

Ws = Water stored in the root zone of the crop

Wd = Water diverted to the field (at the supply channel)

iii) Water storage efficiency

The water storage efficiency refers how completely the water needed prior to irrigation has been stored in the root zone during irrigation. It is expressed as :

$$Es = \frac{Ws}{Wn} \times 100$$

Where, Es = Water storage efficiency, per cent

Ws = Water stored in root zone during irrigation

Wn = Water needed in root zone prior to irrigation

iv) Water distribution efficiency

Water distribution efficiency indicates the extent to which water is uniformly distributed along the run. It is expressed as:

$$Ed = 100\left(1 - \frac{y}{d}\right)$$

Where, Ed = Water distribution efficiency, per cent

d = Average depth of water stored along the run during the irrigation

y = Average numerical deviation from d

v) Water use efficiency

It refers to the amount of marketable end product obtained per unit of water used by the crop.

$$WUE \text{ (kg ha}^{-1} \text{ mm}^{-1}\text{)} = \frac{\text{Total economic yield (kg ha}^{-1}\text{)}}{\text{Total consumptive use (mm)}}$$

(i) **Crop water use efficiency:** It is the ratio of crop yield (y) to the amount of water depleted by the crop in the process of evapotranspiration (ET).

$$\text{Crop water use efficiency} = \frac{Y}{ET}$$

(ii) **Field water use efficiency:** It is the ratio of crop yield (y) to the total amount of water used in the field (WR)

$$\text{Field water use efficiency} = \frac{Y}{WR}$$

vi) **Project efficiency**

Project efficiency indicates the effective use of the irrigation water source in crop production. It is the percentage of irrigation water that is stored in the soil and is available for consumptive use by crops. When the delivered water is measured at the farm head gate or well, it is called farm irrigation efficiency, when measured in the field, it is designated as field irrigation efficiency, and when measured at the point of diversion from the canal or the main source of supply it may be called project efficiency.

vii) **Operational efficiency**

Operational efficiency is the ratio of actual project efficiency compared to the operational efficiency of an ideally designed and managed system using the same irrigation method and facilities. Low operational efficiency indicates management or system design problems, or both.

viii) **Economic (irrigation) efficiency**

Economic efficiency is the ratio of the total production (net or gross profit) attained with the operating irrigation system, compared to the total production expected under ideal conditions. This parameter is a measure of the overall efficiency, because it relates the final output to input.

Significance of irrigation efficiencies

A low value of any of the irrigation efficiencies in general implies that the land, water and the crops are not being managed properly. A low conveyance efficiency implies that much of the

water released from the source is lost in transit from source to the field. A low application efficiency means wastage of water in the form of deep percolation or runoff losses. A poor storage efficiency means water has been applied inadequately. A poor distribution efficiency results due to uneven land surface. There are low patches where water will penetrate more and there are high patches where water cannot reach. A low water use efficiency also results due to over application of water or inability of the crops to utilize the applied water due to poor vegetative growth or adverse chemical properties of root zone soil and water. The net effects of poor irrigation efficiencies are crop loss and wastage of water and nutrients.

Problem 1:

A stream of 135 liters/sec. was diverted from a canal and 100 litres /sec. were delivered to the field. An area of 1.6 ha was irrigated in 8 hours. The effective depth of root zone was 1.8 m. The run off loss in the field was 432 m³. The depth of water penetration varied linearly from 1.8 m at the head end of the field to 1.2 m at the tail end. Available moisture holding capacity of the soil is 20 cm/m depth of soil. Calculate water conveyance efficiency, water application efficiency, water storage efficiency and water distribution efficiency, irrigation was started at a moisture depletion level of 50 per cent of the available moisture.

Solution

$$W_f$$

(i) **Water conveyance efficiency, $E_c = \frac{W_d}{W_s} \times 100$**

$$W_d$$

$$100$$

$$= \frac{100}{135} \times 100 = 74\%$$

$$135$$

$$W_s$$

(ii) **Water application efficiency, $E_a = \frac{W_d}{W_s} \times 100$**

$$W_d$$

$$100 \times 60 \times 60 \times 8$$

Water delivered to the plot = $\frac{100 \times 60 \times 60 \times 8}{1000} = 2880$ cu. m

$$1000$$

Water stored in the root zone = 2880 - 432 = 2448 cu.m

$$\text{Water application efficiency, } E_s = \frac{2448}{2880} \times 100 = 85\%$$

Ws

(iii) **Water storage efficiency, $E_s = \frac{\text{Ws}}{\text{Wn}} \times 100$**

Water holding capacity of root zone = 20 x 1.8 = 36 cm

$$36 \times 50$$

Moisture required in the root zone = 36 - $\frac{18 \times 1.6 \times 10,000}{100}$ = 18 cm

$$100$$

$$18 \times 1.6 \times 10,000$$

$$= \frac{288000}{100} = 2880 \text{ cu.m}$$

$$100$$

$$2448$$

Water storage efficiency = $\frac{2448}{2880} \times 100 = 85\%$

$$2880$$

v) **Water distribution efficiency, $E_d = 100(1 - \frac{y}{d})$**

$$1.8 + 1.2$$

$$d = \frac{1.8 + 1.2}{2} = 1.5 \text{ m}$$

$$2$$

Numerical deviation from depth of penetration:

$$\text{At upper end} = 1.8 - 1.5 = 0.3$$

$$\text{At lower end} = 1.2 - 1.5 = (-0.3) = 0.3$$

$$0.3 + 0.3$$

$$\text{Average numerical deviation} = \frac{0.3 + 0.3}{2} = 0.3$$

$$E_d = 100\left(1 - \frac{0.3}{1.5}\right) = 80\%$$

Question

A stream of 140 lps was diverted from a canal and 110 lps was delivered to the field. An area of 1.5 ha was irrigated in 8 hrs. The effective depth of root zone was 1.6 m and run off during irrigation was 430 m³. The depth of water penetration varied linearly from 1.6 m at head end to 1.2 m at tail end. AMHC of soil is 25 cm/m depth of soil. Irrigation was started at 50% depletion of available moisture. Calculate water conveyance, water application, water storage and water distribution efficiencies.

Solution:

Significance of irrigation efficiencies

A low value of any of the irrigation efficiencies in general implies that the land, water and the crops are not being managed properly. Low conveyance efficiency implies that much of the water released from the source is lost in transit from source to the field. Low application efficiency means wastage of water in the form of deep percolation or runoff losses. Poor storage efficiency means water has been applied inadequately. A poor distribution efficiency results due to uneven land surface. There are low patches where water will penetrate more and there are high

patches where water cannot reach. Low water use efficiency also results due to over application of water or inability of the crops to utilize the applied water due to poor vegetative growth or adverse chemical properties of root zone soil and water. The net effects of poor irrigation efficiencies are crop loss and wastage of water and nutrients.

Conclusion

Signature of Faculty In-charge