Deliver & Supply both are
Same terms

2.) Water application efficiency (η_a)

- It is depends on the application method of water to the crops

- It is the ratio of water stored in root zone during irrigation to the water delivered in the farm

$$\eta_a = \frac{\text{stored water in root zone}}{\text{Delivered water in the farm}} \times 100$$

$$= \frac{W_s}{W_f} \times 100 \quad \left(\begin{array}{l} s = \text{store} \\ f = \text{farm} \end{array} \right)$$

Suppose, Stored water in root zone = 0.3 cm
Delivered water in the farm = 3.0 cm

So,

$$\eta_a = \frac{2.5}{3.0} \times 100 = 83.33\ \%$$

- when we applying water to the farm the there will be Surface runoff & deep-percolation losses are taken into consideration.

So,

stored water = apply water − (surface runoff + deep-percolation)

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3.) Water use efficiency (η_u)

- It is the ratio of water beneficially used including leaching water to the quantity of water delivered

$$\eta_u = \frac{W_u}{W_d} \times 100 \quad \left(\begin{array}{l} u = \text{used} \\ d = \text{delivered} \end{array} \right)$$

$$= \frac{\text{Water used including leaching}}{\text{Water delivered}} \times 100$$

Suppose

$$\eta_u = \frac{5 \text{ (cm)}}{8 \text{ (cm)}} \times 100 = 62.5\,\%$$

4.) Water storage efficiency (η_s)

- It is the ratio of water stored in the root zone to the water needed in the root zone prior to irrigation

$$\eta_s = \frac{W_s}{W_n} \times 100$$

$$= \frac{\text{stored water in root zone}}{\text{need water in root zone}} \times 100$$

Suppose,

$$\eta_s = \frac{3 \text{ (cm)}}{5 \text{ (cm)}} \times 100 = 60\,\%$$

5.) Water distribution efficiency (η_d)

- It evaluates (मूल्यांकन) the uniformly distribution of water throught the root zone
- It is given by

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

where,

y = Avg. numerical deviation in depth of water stored from averages depth stored by irrigation

d = Average depth of water stored by irrigation

Suppose $y = 0.5\,m$ & $d = 1\,m$

$$\eta_d = \left(1 - \frac{0.5}{1}\right) \times 100 = 50\%$$

6.) Consumptive use efficiency (η_{cu})

- It is given by

$$\eta_{cu} = \frac{W_{cu}}{W_d} \times 100$$

where W_{cu} = Consumptive use of water

W_d = Net amount of depleted (कम) water from root zone

Suppose

$$\eta_{cu} = \frac{12\,(mm)}{15\,(mm)} \times 100 = 80\%$$

Ex-2.4 Garg (30)

One Cumec of water is pumped into a farm distribution system. 0.8 Cumec is delivered to a turn-out, 0.9 Km from the well. Comp[ute] the Conveyance efficiency

- We know that

$$\eta_a = \frac{Output}{Input}$$

$$= \frac{\text{Water delivered into the farm}}{\text{water supply from well}}$$

$$= \frac{0.8}{1} \times 100$$

$$= 80\%$$

Ex-2.5 Garg (30)

10 Cumecs of water is delivered to a 32 ha field for 4-hours. Soil probing after the irrig[ation] indicates that 0.3 m of water has been stored in the root zone. Compute the water applica[tion] efficiency.

- We know that

$$\eta_a = \frac{\text{Stored water in root zone}}{\text{Delivered water in the field}} \times 1$$

Here, $Q = 10 \ m^3/s$
$A = 32 \ ha = 32 \times 10^4 \ m^2$
$d = 0.3 \ m$
$t = 4\text{-hrs} = 4 \times 60 \times 60 = 14,400 \ sec$

So,

Volume of water delivered in the field = Discharge × time

= ·10 (m^3/s) × 14,400 (seconds)

= 1,44,000 m^3

&

Volume of water stored in root zone = Area (A) × depth (d)

= 32 × 10^4 × 0.3

= 9.6 × 10^4

= 96,000 m^3

Therefore,

$$\eta_a = \frac{\text{Output}}{\text{Input}} \times 100 = \frac{96,000}{1,44,000} \times 100 = 66.67\%$$

Ex-2.6 Garg (31) The depths of penetrations along the length of a border strip at points 30-m apart were probed. Their observed values are 2.0, 1.9, 1.8, 1.6 & 1.5-meter. Compute the water distribution efficiency.

Soln: – We know that

$$\text{Water distribution efficiency } (\eta_d) = \left(1 - \frac{y}{d}\right) \times 100$$

Where y = Deviation (m)

d = Average depth (m)

Here,

Average depth (d) or Mean depth (d) $= \frac{\sum_{i=1}^{n} d}{n}$

$= \frac{2.0 + 1.9 + 1.8 + 1.6 + 1.5}{5}$

$= \frac{8.8}{5}$

$= 1.76$ m

Deviation (y) = ?

Depth at 1st point − Avg. depth = $|2 - 1.76| = 0.24$
Depth at 2nd point − Avg. depth = $|1.9 - 1.76| = 0.14$
" " 3rd " − " $= 1.8 - 1.76 = 0.04$
" " 4th " − " $= 1.6 - 1.76 = -0.16$
" " 5th " − " $= 1.5 - 1.76 = -0.26$

Neglect the negative sign & Sum (Add) all the values & take the average value of it

Deviation (y) $= \frac{0.24 + 0.14 + 0.04 + 0.16 + 0.26}{5}$

$= 0.168$ m

So,

$\eta_d = \left(1 - y/d\right) \times 100 = \left(1 - \frac{0.168}{1.76}\right) \times 100 = 90.5\%$

Note :- It is useful for Practical examination because of the long procedure & content

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Ex-2.7 Gary (32) Same table in Michael (526)

A stream of 130 litres per second (lps) was diverted from a canal & 100 lps were delivered to the field. An area of 1.6 ha was irrigated in 8-hr. The effective depth of root zone was 1.7-m. The runoff loss in the field was 420 m³. The depth of water penetration varied linearly from 1.7-m at the head end of the field to 1.1-m at the tail end. Available moisture holding capacity of the soil is 20 per metre depth of soil. It is required to determine the water conveyance efficiency, water application efficiency, water storage efficiency & water distribution efficiency. Irrigation was started at a moisture extraction level of 50% of the available moisture.

Solⁿ:- Given data;

$Q_{canal} = 130$ lps

$Q_{field} = 100$ lps

Area (A) = 1.6 ha $= 1.6 \times 10^4\ m^2$

Time (t) = 8-hrs

d = 1.7-m = Root Zone depth

Runoff (R) = $420\ m^3$

M.C. depth @ head = 1.7-m } In field
M.C. depth @ tail = 1.1 m

Available m.c. of the soil = 20 cm/m

So,

Available m.c. of the soil in 1.7 m depth = 20 × 1 ... = 34-...

1-m → 20-cm
1.7 m → ?
$= 1.7 \times 20 = 34$-cm

$\eta_c = ?$
$\eta_a = ?$
$\eta_s = ?$
$\eta_d = ?$

Irrigation started when available m.c. falls upto 50% $= 34 \times \frac{50}{100} = 17$-cm a.) Water Conveyance efficiency (η_c)

$$\eta_c = \frac{\text{water delivered to farm}}{\text{water supplied from Canal}} \times 100$$

Here,

Q_{field} or $Q_{farm} = 100$ lps

$Q_{canal} = 130$ lps

So,

$$\eta_c = \frac{100}{130} \times 100 = 77\%$$

b.) Water application efficiency (η_a)

$$\eta_a = \frac{\text{Water stored in root zone}}{\text{water delivered to farm}} \times 100$$

⇒ To find the depth of water stored in root zone

Given that

$Q_{field} = 100$ lit/s

Time (t) = 8 hr

Area (A) = 1.6×10^4 m^2

Runoff (R) = 420 m^3

Volume of water = Discharge × time

= Q_{field} × ~~t~~

= 100 (lit/s) × 8 (hrs)

= 100 × 8 × 60 × 60 (lit/s) × (sec)

= 2880×10^3 lit

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Volume of water = 2880 m^3

So,
Depth of water = $\frac{Volume}{Area} = \frac{2880}{1.6 \times 10^4} = 0.18\ m$

Therefore

Water delivered to farm = 2880 m^3 or 0.18 m

⇒ To find the water stored in root zone

Utilize water by roots as per volume = Total water − Runoff

= 2880 − 420

= 2460 m^3

or

Utilize water by roots as per depth = $\frac{Volume}{Area}$

= $\frac{2460}{1.6 \times 10^4} = 0.153$

Therefore,

water stored in root zone = 2460 m^3 or 0.153

So,

$\eta_a = \frac{2460}{2880} \times 100 = 85.4\ \%$

or

$\eta_a = \frac{0.1537}{0.18} \times 100 = 85.38\ \%$

c.) Water storage efficiency (η_s)

$$\eta_s = \frac{\text{Wates stored in root Zone}}{\text{Water required/need in root zone}}$$

Given that, the available moisture holding capacity is 20cm per metre it means in 1-metre depth the 20-cm water is available

but here root zone depth = 1.7-m

So,

1-m 20-cm
1.7-m ?

= 1.7 × 20

Available moisture Capacity = 34-cm

Now, the irrigation was started when 50% of available water is falls down, it means when the 50% moisture rest in the field then irrigation should be given.

So, how much actual amount of water is ~~required~~ in the root

$$= \frac{50}{100} \times 34$$

$$= 17\text{-cm}$$

∴

Amount of water required in the root-Zone = 34 - 17 = 17-cm