AIR-1 Notes

Pages: 123

IRRIGATION ENGINEERING

Handwritten notes by

Kartikay Kaushik

AIR-1 ESE 2021

IES Master classroom Student

IRRIGATION ENGINEERING

CONTENT

24/06/19

Irrigation Engineering

Syllabus

1) Introduction
2) Soil Plant Relationship
3) Water requirement of crops
4) Canal Design

} GATE

5) Sediment Transport
6) Lining of Canal
7) Reclaimation of water logged and saline soil
8) Design of gravity Dams → GATE
9) Theory of seepage
10) Miscellaneous Topics
    (a) River Draining
    (b) Cross Drainage work
    (c) Diversion Headwork
    (d) Modules
    (e) Canal fall

1. INTRODUCTION

→ Irrigation is artificial application of water to the agriculture field for the purpose of cultivation i.e. in accordance with crop requirement throughout the crop period for optimum growth of crops.

NOTE:
Crop period is time period from instant of sowing to the instant of harvesting.

⇒ Necessity of Irrigation

1) Inadequate Rainfall
2) Uneven distribution of Rainfall
3) Increasing yield of crops
4) Growing more than one crop in a year.
5) Growing perennial crops like sugarcane.
6) Prevention from drought and famine condition.

⇒ Advantages of Irrigation

(a) Direct advantages

1) Increasing yield of crops
2) Prevention from drought and famine condition
3) Elimination of mixed cropping.

NOTE:

Mixed cropping means growing 2 or more crops simultaneously in the field.

↳ Advantages

↳ Mixed cropping is found economical and necessary when irrigation facilities are lacking i.e if ~~the~~ weather conditions are not suitable for one of the crop, they may be suitable for other crop and hence farmer will get atleast some yield.

↳ Disadvantages

↳ Diff. crops require diff. types of field preparation, watering pattern, manuring etc. Since it would be difficult to satisfy need of both the crops simultaneously in the field hence, it will result in low yield.

↳ Also at the time of harvesting crops would get intermixed which reduces purity and value of crops in the market.

(b) Indirect Advantages

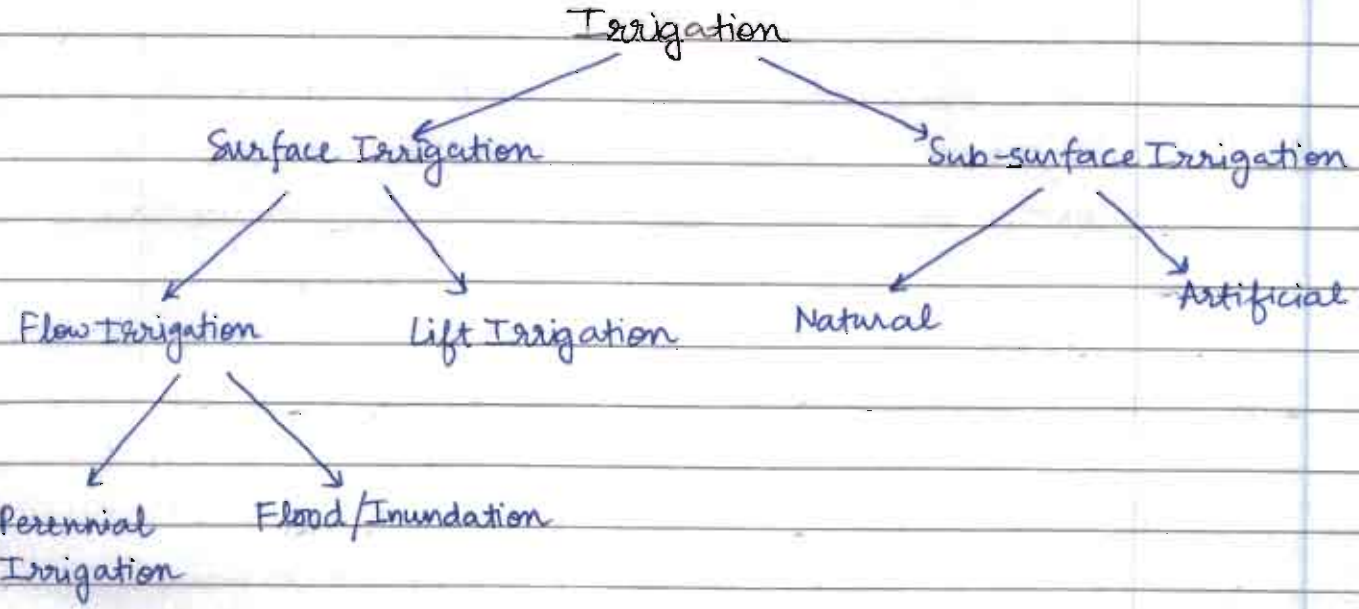
1) Power generation → Ganga Sharda Canal system generates 80 MW hydropower.
2) Flood control
3) Transportation → Inland Navigation and Roads
4) Ground water recharge (Percolation)
5) Industrial and domestic water supply
6) Employment generation.

⇒ Disadvantages of Irrigation

1) Water logging
2) Intense irrigation results in cold and damp climate which may cause spreading of disease like dengue and malaria.
3) Ground water pollution due to percolation of water.

> NOTE: Bad effect of irrigation can be overcome by economical and scientific use of water.

⇒ Types of Irrigation



⇒ Surface irrigation

→ Surface irrigation is a method in which water is directly applied to the soil surface either by gravity or pumping.

→ It is best suitable for soil with low to moderate infiltration capacities.

→ It is suitable in the area with rolling terrain. (gentle slope)

→ Surface irrigation can be further classified as:

1) Flow Irrigation - If water is available at higher elevation and it is supplied to the lower elevation under the action of gravity, it is called as flow irrigation.

2) Lift Irrigation - If water is lifted up by some mechanical means or some manual means and supplied to the agriculture field it is called as Lift Irrigation.
eg. - Pump, well and Tube well.
Lift Irrigation is costlier than flow Irrigation.

→ Flow Irrigation can be classified as:

1) Perennial Irrigation - If a constant and continuous water is supplied to the agriculture field as per the requirement of crops throughout the crop period it is called as perennial irrigation.
(a) Direct Irrigation - By diverting river run off into a canal with the help of weir or barrage. eg - Ganga canal system.
(b) Storage Irrigation - System of dam and channels
eg - Ram Ganga Dam Project.

2) Flood Irrigation / Inundation - In this system of irrigation a large quantity of water flowing in a river during the flood is allowed to flood or inundate the area which is to be cultivated which causes saturation of the area.

When excess water is drained off under the action of gravity, then cultivation can be practised eg- Sunderbans.

⇒ Sub-surface irrigation

→ In this type of irrigation system, water does not wet the soil surface rather it is directly supplied to the root zone of the plants.

→ It is classified into 2 types:

(a) Natural Sub-Surface Irrigation

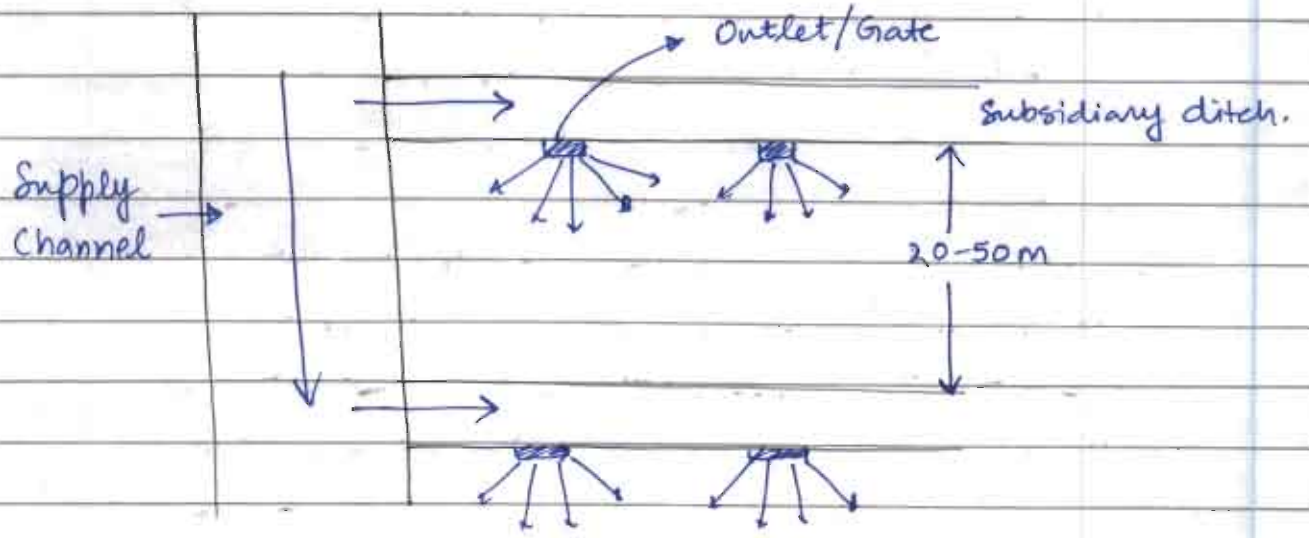
In this system, water seeping through channels and water bodies may irrigate crops grown on lower area by cappilarity.

(b) Artificial Sub-Surface Irrigation

In this system, water is directly supplied to the root zone of plants by a network of perforated pipes, which are laid below the soil surface.

⇒ Techniques of water distribution

1) Free flooding / ordinary Flooding.



25/06/19

→ In this method ditches are excavated in the field and water from these ditches flows across the field.

→ After water leaves the ditches, no attempt is made to control the flow, hence it is called as wild flooding.

→ Suitable for rolling terrain (gentle slope)

→ Field preparation is low.

→ Water application efficiency is low.

→ Suitable for close growing crop like pasture.

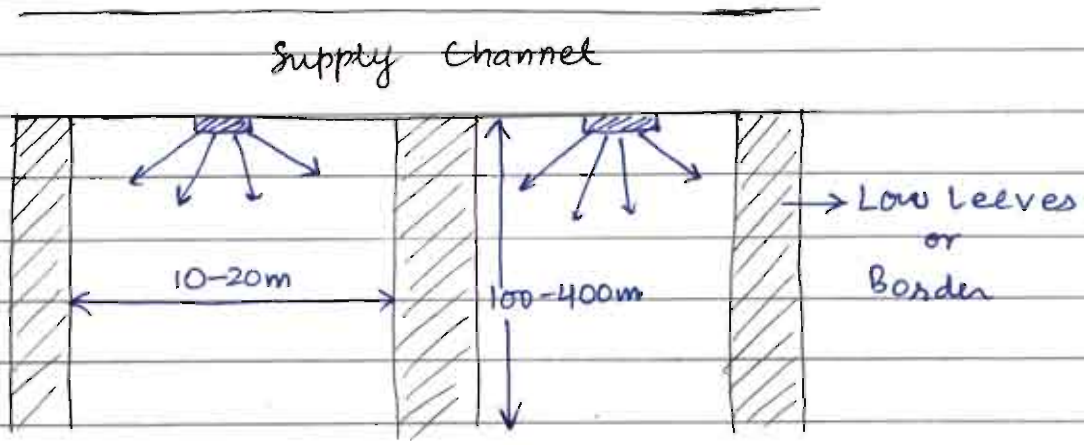
→ Subsidiary Ditch / Lateral Ditch are spaced 20–50 m apart depending on:

(a) Slope

(b) Type of Soil

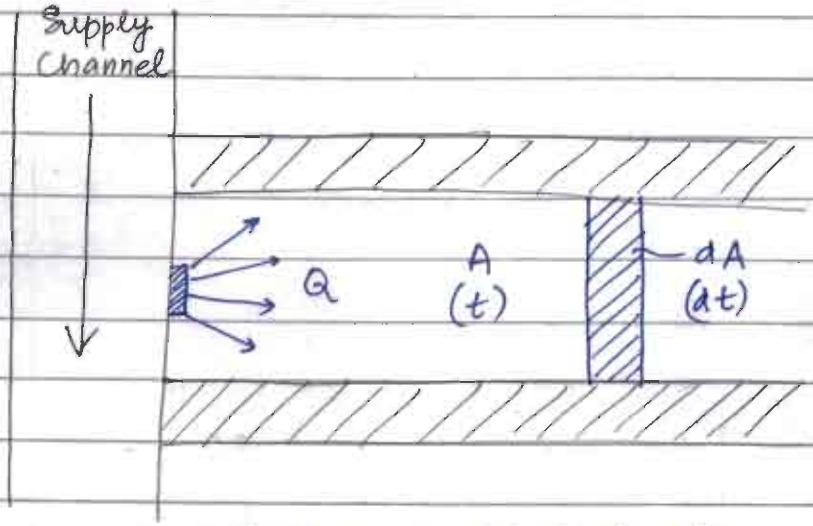
(c) Crop etc.

2. Border Flooding



→ Area is divided into no. of strips separated by low levees called borders.

⇒ Relation between discharge through supply channel (Q), rate of Infiltration of soil (f), average depth of flow over strips (y), area to be irrigated (A) and time required to irrigate the area (t)



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

→ Assuming Q, y and f as constant.

$$(Q - fA)\,dt = y\,dA$$

$$\int dt = \int \frac{y}{Q - fA}\,dA$$

$$t = \frac{y}{-f}\left[\ln(Q - fA)\right] + c$$

→ If $t = 0$ then $A \to 0$.

$$c = \frac{y}{f}\ln Q$$

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

$$\Rightarrow \boxed{t = 2.303\,\frac{y}{f}\log\left(\frac{Q}{Q - Af}\right)}$$

⇒ Maximum area that can be irrigated with a particular amount of discharge

if $t \to \infty$ then $A \to A_{max}$

therefore, $Q - A_{max} f = 0$

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

→ Size of the strip will depend on discharge (Q), characteristic of soil (f) and slope of the area.

Q- For Border strip method of irrigation, time required to irrigate a strip of 0.04 hectare from a tubewell with a discharge of 0.02 cumec. Infiltration capacity of the soil is 5cm/hr and average depth of flow on the field is 10cm. Also determine maximum area that can be irrigated from this tubewell.

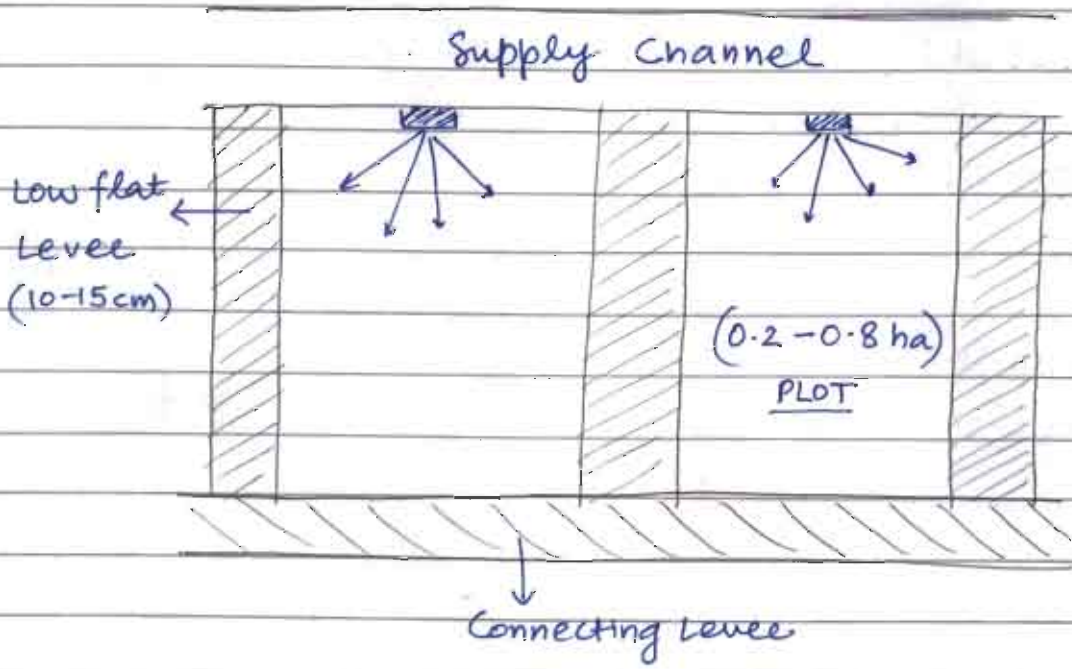
$$t = \frac{2.303y}{f} \log_{10}\left(\frac{Q}{Q - Af}\right)$$

$$t = 2.303 \times \frac{10}{5} \left(\log_{10} \left\{ \frac{0.02}{0.02 - 400 \times \frac{0.05}{3600}} \right\} \right)$$

$$t = 39.05 \text{ mins.}$$

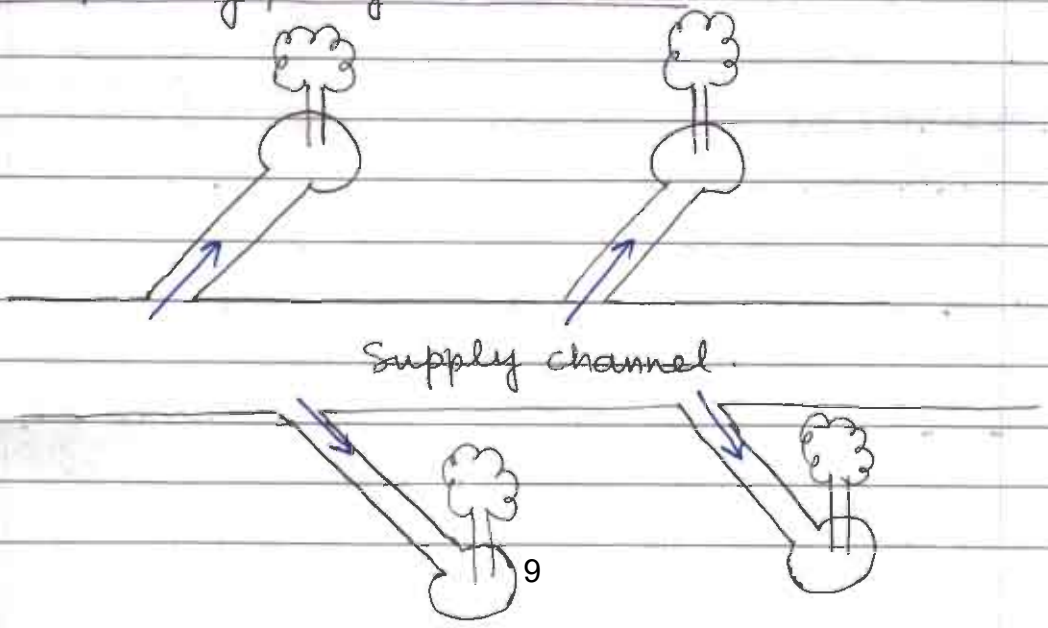
$$A_{max} = \frac{Q}{f} = \frac{0.02 \times 3600}{0.05} = 1440 m^2 = 0.144 ha$$

3) Check Flooding / Method of irrigation by plots (Paddy)



→ In this method, the area to be irrigated is divided into small plots of area 0.2-0.8 hectares with low flat levees.
→ Each plot has a nearly fair level surface.
→ Irrigation water is applied by filling the plots with water upto desired depth without overtoppling the levees and water is retained there to allow it to infiltrate into the soil.

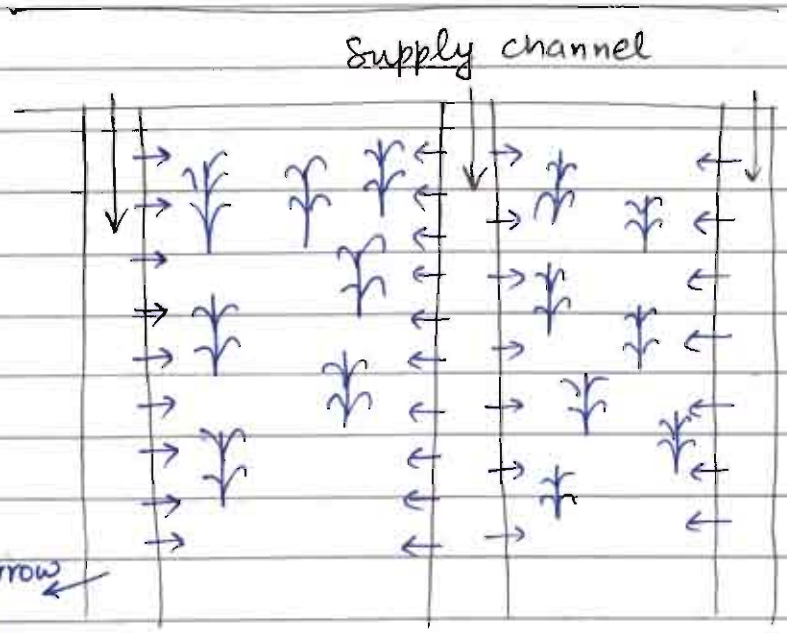
4) Basin flooding / Ring Basin Method



→ This method is a special form of check basin method which is used for irrigation of orchards [enclosure of fruit trees].

→ A separate circular basin is provided for each tree.

5) Furrow Irrigation



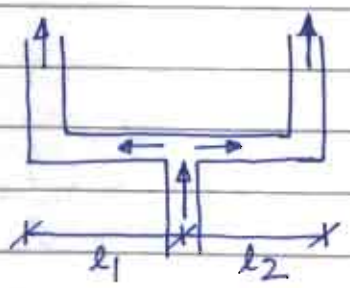
→ In this method water applied to the field to be irrigated by a series of long narrow field chamels which are calleed as furrows, are excavated at regular interval.

→ water entering into these furrows infiltrates into the soil and spreads laterally to irrigate the area between the furrows.

→ In this method, 20–50% area is wetted which results in less evaporation

→ It is suitable for Row crops, cotton, maize, potato, groundnut etc.

6) Sprinkler irrigation



→ In sprinkler irrigation method, water is applied to the land in the form of spray through the network of pipes and pumps.

→ Advantages

(a) It is simlar to rain, hence uniform application of water is possible.

(b) It can be used for wide range of topography, soil and crops i.e. irregular topography, steep slope and area in which soil is easily erodable.

(c) No field preparation is required.

(d) Surface runoff and percolation losses are eliminated.

(e) Field application efficiency increases close to 80%.

(f) Fertilizer, insecticide and pesticide can be mixed with water and supplied.

(g) It can be used even when infiltration capacity of soil is high or low.

(h) It can be used even when water table is high.

(i) About 15-20% crop area is increased because no area is lost in ditches and furrows.

→ Disadvantages

(a) Evaporation loss is high.

(b) It causses interference in farming operation due to network system.

(c) Wind may disturb sprinkler pattern which results in non-uniform application of water.
(d) High initial cost.
(e) Requires large electrical power and constant water supply.
(f) Cannot be used for crops requiring large and frequent depth of water. ex - paddy.
(g) Water shall be cleaned from sand and silt because it may cause choking of the system.

7) Drip Irrigation / Trickle Irrigation

→ In this method water is directly and slowly applied to the root zone of the plants by using small diameter plastic pipes with drip nozzles, commonly called as emitters or drippers
→ Water is applied at very low rate (2-10 ℓ/hr) to keep the soil moisture within the desired range of plant growth.
→ Irrigation application efficiency = 90%
→ Evaporation loss, surface run off and percolation loss can be eliminated.
→ Fertilizer can be mixed with water and supplied.
→ Cost of whole system is very high but it is useful ~~for it~~ in the areas where availability of water is less.
→ It is very useful for fruits and vegetables.

⇒ Quality of Irrigation water

1) Sediment

(a) Effect of sediment on quality of irrigation water depends on nature of sediment and characteristic of soil receiving that water.

→ If sediment contains large content of plant nutrients and/or it comes from fertile area then it is quite beneficial particularly for the soil which has low content of plant nutrient and very low water holding capacity.

→ If sediment is not rich in plant nutrients and it is deposited on the surface of fertile area, then it will make area infertile.

2) Concentration of Soluble Salts

→ When salts present in irrigation water are in excess quantity they increase osmotic pressure of soil solution, which causes high soil moisture stress in the root zone and it affects growth of plants and yield of the crops.

→ Bad effect of salts on the plant growth depends on the concentration of salts left in the soil.

→ Concentration of salts in the water may not appear to be harmful initially but with the passage of time the salt concentration in the soil may increase to harmful level as soil solution gets concentrated by evaporation.

→ Salinity concentration of soil solution (C_s) after consumptive use (C_u) is given by:

$$C_s = \frac{C\,Q}{Q - (C_u - R_{eff})} \quad \text{PPM or mg/L}$$

Where, C → Concentration of salts in applied water

Q → Quantity of water applied.

C_u → Consumptive use of water i.e. total quantity of water used by crop for its growth.

R_{eff} → effective rainfall that is stored in the root zone