Consumptive Use Or Evapotranspiration (Cu or Et)

- Consumptive use for a particular crop may be defined as the total amount of water used by the plant in transpiration (building of plant tissues etc..) and evaporation from adjacent soils or from plant leaves, in any specified time. The values of consumptive use (Cu) may be different for different crops and may be different for same crop at different times and places

- In fact, the consumptive use for a given crop at a given place may vary throughout the day, throughout the month and throughout the crop period. Values of daily consumptive use or monthly consumptive use are generally determined for a given crop and at a given place. Values of monthly consumptive use over the entire crop period, are then used to determine the irrigation requirement of the crop.

EFFECTIVE RAINFALL:- (Re)

- It is the rainfall falling during the growth period of a crop that is available to meet evapotranspiration needs of crop exclusive of the rainfall lost through deep peculation below the root zone or the water lost as surface runoff.

CONSUMPTIVE IRRIGATION REQUIREMENT (CIR)

- It is the amount of irrigation water required to meet the consumptive use of a crop during its growth period. It is same as the consumptive use exclusive of effective rainfall
- i.e. CIR=Cu-Re

NET IRRIGATION REQUIREMENT:- (NIR)

- It is the sum of CIR and the water lost in satisfying the other needs such as leaching of salts

NIR= Cu- Re + water lost in leaching

FIELD IRRIGATION REQUIREMENT:- (FIR)

- It is the amount of water required to meet NIR plus the water lost in deep percolation in field water course

$$FIR = \frac{NIR}{\eta_a}$$

where η_a is water application efficiency

GROSS IRRIGATION REQUIREMENT (GIR)

- it is the sum of water required to satisfy FIR and conveyance losses in distributaries up to the field

$$GIR = FIR / \eta_c$$

where η_c is water conveyance efficiency.

FACTOR AFFECTING CONSUMPTIVE USE:-

- Assignment
- TEMPERATURE
- HUMIDITY IN AIR
- VELOCITY OF WIND
- SOIL TOPOGRAPHY
- SUNLIGHT Etc

ESTIMATION OF CONSUMPTIVE USE:-

- The most commonly used and simple methods are

1. Blaney – Criddle Equation
2. Hargreaves class A pan evaporation method

BLANEY CRIDDLE FORMULA:-

- $Cu = \frac{k.p}{40}[1.8t + 32]$ in M.K.S units

where, Cu= Monthly consumptive use in cm.

k= crop factor , determined by experiments for each crop, under the environmental conditions of the particular area.

t= Mean monthly temperature in C.

p = Monthly percent of annual day light hours that occur during the period.

If $\frac{P}{40}[1.8t+32\}$ is represented by f, we get Cu=k.f

However it was found that the values of k based on seasonal determinations were low for the short periods between irrigations. This led to further developments and finally the formula was expressed as $Cu = k \Sigma f$

Where Cu= seasonal consumptive use i.e. consumptive use during the period of growth.

Example

Wheat is to be grown at a certain place, the useful climatological conditions of which are tabulated in the table. Determine the evapotranspiration and consumptive irrigation requirements of wheat crop. Also determine the field irrigation requirement if the water application efficiency is 80%. Make use of Blancy- Criddle equation and a crop factor equal is 0.8

NEGLECT WATER USED FOR LEACHING i.e CIR = NIR

MONTH	Monthly temp. in averaged over the last 5 years	Monthly % of day time hr. of the year computed from sunshine	Useful rainfall in cm, averaged over the last 5 years
November	18.0	7.20	1.7
December	15.0	7.15	1.42
January	13.5	7.30	3.01
February	14.5	7.10	2.25

SOLUTION

- Blaney Criddle equation is:-

$$Cu = k \Sigma f$$

Where

$$f = \frac{p}{40}(1.8t+32)$$

Values of f are worked out in column.

Month	T	P	Ro	$F=\frac{p(1.8t+32)}{40}$
November	18.00	7.20	1.70	9.8
December	15.00	7.15	1.42	10.5
January	13.50	7.30	3.01	10.3
February	14.50	7.10	2.25	10.3
			sum =8.38cm	sum=40.9cm

- $Cu = k \Sigma f = 0.8*40.9 = 32.72cm$

  hence consumptive use $Cu = 32.72cm$

  consumptive irrigation requirement

  $= Cu – Re = 32.72 - 8.38 = 24.34cm$

  field irrigation requirement = C.I.R/ η_a

$=24.34/0.8=30.43cm$

HARGREAVES, CLASS A PAN EVAPORATION METHOD:-

- In this method , evapotranspiration (Consumptive use) is related to pan evaporation by a constant k. called consumptive use coefficient.

The formula can be written as

$$\frac{\text{Evapotranspiration (Et or Cu)}}{\text{Pan evaporation (Ep)}} = k$$

Et or Cu = k.Ep

- Consumptive use coefficient (k) is different for different crops and is different for the same crop at different places.
- The crop have been divided into 8 groups and the coefficients have been suggested for average conditions of soil , etc.

1) GROUP A. The important crops include: sugar, beat, maize, cotton, juwar, bean, peas, potatoes etc.,

GROUP B

- This group consists of deciduous fruits and some field crops. Important crops are: tomatoes , hybrid , walnuts , plumes , olives , and some group A crop that fail to produce max. vegetative cover & max. growth ratios
- **GROUP C**. Et / Ep ratios are of the order of 0.6. it includes crops like melons ,onions ,carrots ,hops, grapes.

GROUP D

- The maximum Et / Ep ratio is about 0.90 and usually occurs at about 75 to 80% completion of crop vegetative cycle. The important crops are:- wheat, Barley, Celery, Flax, and other small grains etc.
- **GROUP E**:- ratios of Et/ Ep ratio vary from 0.7 to 1.10. the model value being 0.90. the important crops are: pastures ,orchard with cover crop, plantain etc.

GROUP F

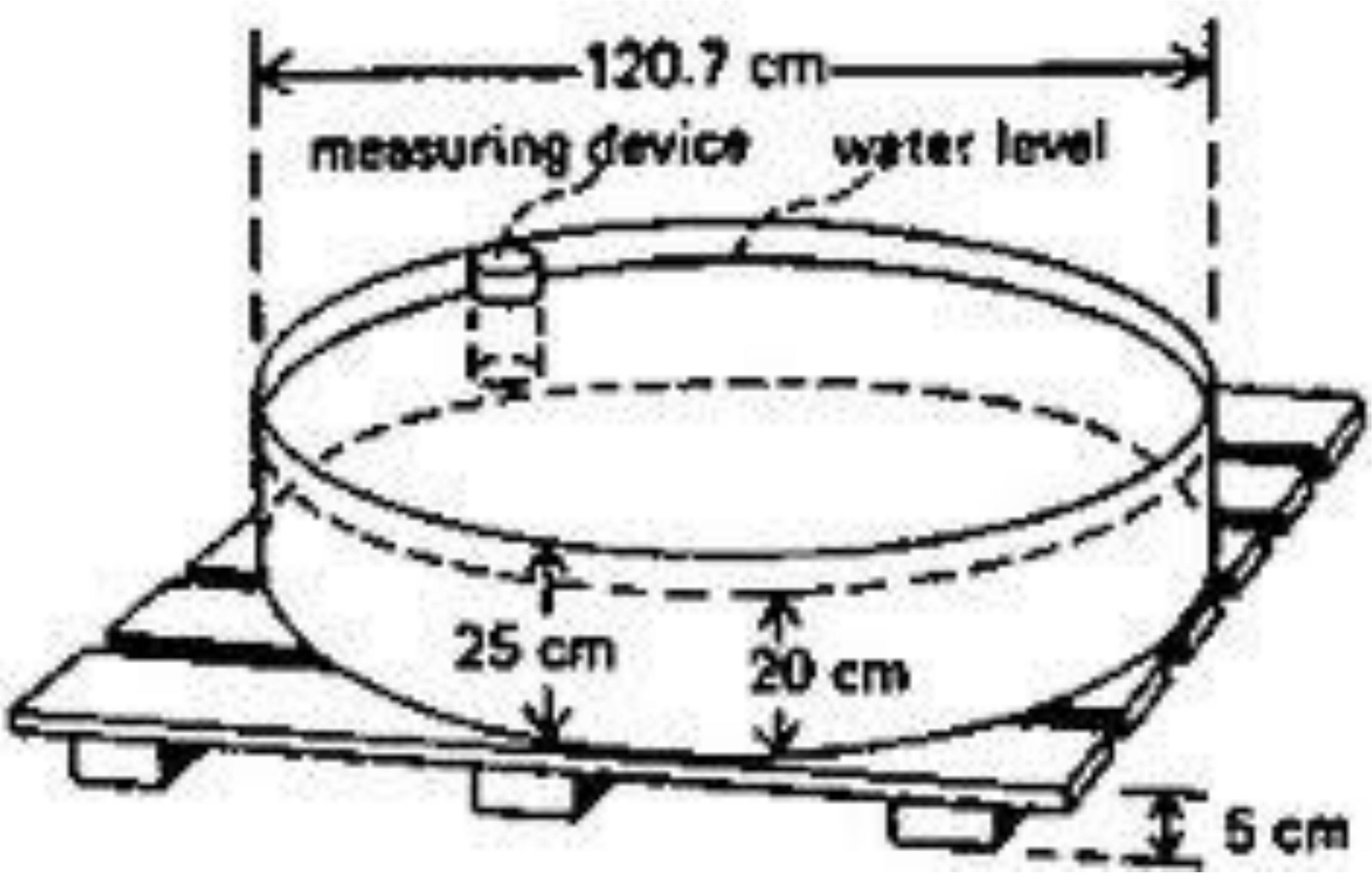
- It includes citrus crops such as oranges grape fruit etc. the Et / Ep ratios are fairly constant throughout the year and average to a value of about 0.60
- **GROUP G:-** Et /Ep values generally increase with crop and vary from 0.66 to 1.00. it includes sugarcane and alfalfa.
- **PADDY OR RICE:-** Et / Ep increases from 0.80 to 1.30

CLASS A PAN EVAPORATION (EP) MEASUREMENT:

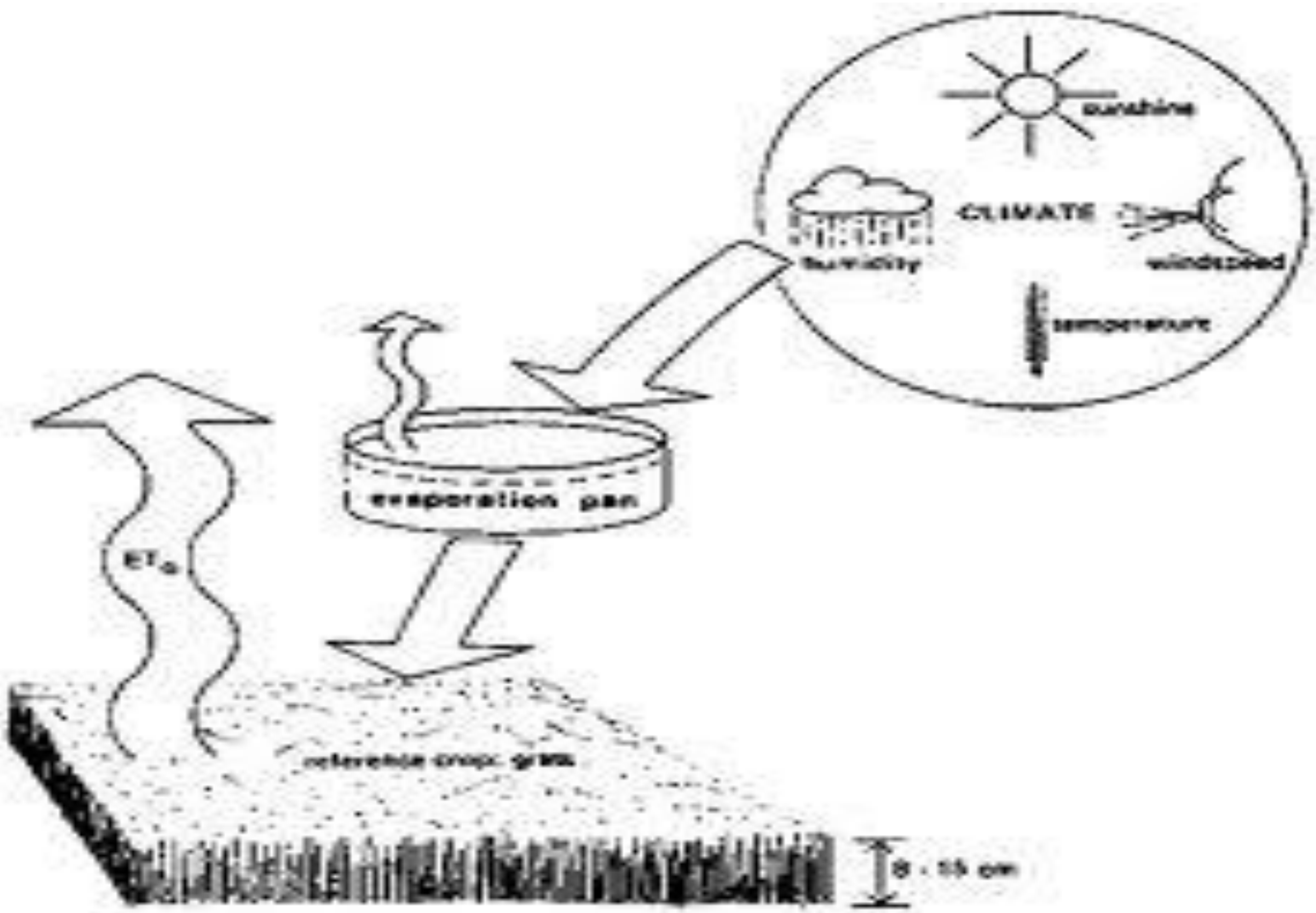
- Ep can be experimentally determined by directly measuring the quantity of water evaporated from this standard class a pan. This pan Is 1.0m in diameter , 25cm deep , and bottom is raised 15cm above the ground surface. The depth of water is to be kept in a fixed range such that the water surface is at least 5cm, and never more than 7.5cm, below the top of pan.

Class A Pan Evaporation

Class A Pan Evaporation



Class A Pan Evaporation



Class A Pan Evaporation

- The pan evaporation Ep can also determined by using the Christiansen formula which states

$$Ep = 0.459\ R.Ct.Cw.Ch.Cs.Ce$$

R = extra . Terrestrial radiation in the same units as Ep in cm or mm

Ct = Coefficient for temperature.

Cw = Coefficient for wind velocity

Ch = Coefficient for relative humidity

Cs = Coefficient for percent of possible sunshine

Ce = Coefficient for elevation

CROPING SEASONS

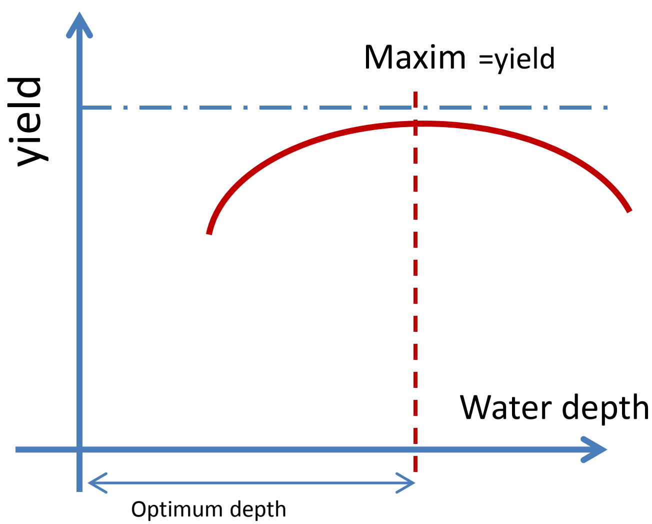
1. **RABI** – 1^{ST} October to 31^{st} March – winter.
2. **KHARIF** – 1^{ST} April to 30st September – summer.

   Kharif crops: Rice Bajra Jawar Maize cotton

   Rabi crops: Wheat, Barley, Gram, Mustard Potatoes. KHARIF RABI RATIO:- The area to be irrigated for rabi crops generally more than that for kharif crops. This ratio of proposed areas, to be irrigated in kharif season to that in Rabi season Is called, kharif Rabi ratio. This ratio is generally 1:2. i.e. kharif area is one half of Rabi area.

OPTIMUM UTILIZATION OF IRRIGATION WATER

- If a crop is sown and produced under absolutely identical conditions using different amounts of water depths, the yield is found to vary. The yield increases with water, reaches a certain maximum value & then falls down as shown in following fig.



The quantity of water at which the yield is maximum is called **optimum water depth**.

Irrigation Efficiencies:- Efficiency is the ratio of water output of water to the water input and is usually expressed as percentage.

Efficiency of Water conveyance

- Efficiency of Water conveyance: It is the ratio of the water delivered to the fields from outlet point of the channel to the water pumped into the channel at the starting point. It may be represented by $^{\eta}c$. It takes the Conveyance or transit losses into account.

Efficiency of water Application

- It is the ratio of quantity of water stored into root zone of the crops to the quantity of water actually delivered into the field. It may be represented by η_a. It may also may be termed as the farm efficiency as it takes into account the water lost in the farm.

Efficiency of water Storage

- It is the ratio of the water stored in the root zone during irrigation to the water needed in the root zone prior to irrigation (i.e. Field capacity – existing moisture content). It may be represented by η_s.


Thanks!