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**Q1a.** Define "Delta" and "Duty" and derive their relationship in MKS and FPS systems.

**Ans:** DELTA:

It is defined as the depth of water (cm or in) that is required for the crops through out the base period is known as delta of the crop.
Majorly, a crop needs specific volume of water in order to accommodate it's base period.

DUTY:

Duty of water is expressed as the number of hectare of land that can be irrigated for the full growth of the given crop by supplying 1 cumec water continuously during the entire base period of that crop.

RELANTIONSHIP B/W DUTY & DELTA IN MKS SYSTEM:

Let there be a crop of base period B days. Let one cumec ($m^3/sec$) of water be applied to this crop on the field for B days.

Now the volume of water applied to this crop during B days

$V = (24 \times 60 \times 60 \times B) m^3 = 86,400 m^3$

By defination of duty, $1 m^3$ of water supplied for B days matures D hectares of land. This quantity of water (V) matures D ha of land or $10^4 D\ m^2$ of area.

→ Total depth of water applied on this land =

$$\frac{\text{Volume}}{\text{Area}} = \frac{86400 B}{D(m)} = 864 B / D \text{ cm}$$

where $\Delta$ is in cm, B is in days.

D is duty in ha/cumec.

RELATIONSHIP B/W DUTY and DELTA IN FPS SYSTEM:

Let

$D$ = Duty (acres/cusec)

$\Delta$ = Delta

B = Days

One cusec of water flowing continuosly for "B" days gives a depth of water "Δ" over an "D" acres.

Volume of water ($ft^3$/sec) in one day = $1 \times 24 \times 60 \times 60 = 86400 ft^3/sec$

Volume of water ($ft^3$/sec) in B day = $1 \times 24 \times 60 \times 60 = 86400 B\ ft^3$ — (i)

∴ 1 Acre = $43560 ft^2$

putting in equ (i) = 86400B/43560

Vol of water ($ft^3$/sec) in B day = 1.983 B Acre-ft — (ii)

Depth of water required for crop $= \frac{1.983\, B\, A}{D}$

$$\boxed{\Delta = \frac{1.983\, B\, A}{D}}$$

b) If wheat requires about 9cm of water after every 35 days and the base period or crop period of wheat is 140days. Find out the delta for wheat?

Sol: Given data:

Water required for wheat = 9cm

No of days = 35 day

B = 140 days

Required:

$\Delta = ?$

By using ratio method

9cm : 35days

$\Delta$ : 140days

$35\Delta = 9 \times 140$days

$$\Delta = \frac{9cm \times 140days}{35 days}$$

$$\boxed{\Delta = 36cm}$$

c) Explain Indus Water treaty?

Ans: The Indus water treaty (IWT) is a water distribution treaty between India and Pakistan signed on 19 sept, 1960.

The treaty was signed by President Ayub Kham and P.M J.Nehru. It was brokered by the World Bank.

The Indus water treaty deals with river's Indus and it's five tributaries which are classified into two categories:

| EASTERN RIVERS | WESTERN RIVERS |
| --- | --- |
| 1) Sutlej | 1) Jhelum |
| 2) Beas | 2) Chenab |
| 3) Ravi | 3) Indus. |

- According to the treaty, all the water of eastern river shall be available for unrestricted use in India.
- India should let unrestricted flow of water from western rivers to Pakistan.
- The treaty says that india can use the water in western rivers in "non-consumptive" needs.
- The treaty allocates 80% of water from the six river Indus water system to Pakistan.
- A Permenant Indus Commission was set up as a bilateral Commission to implement and manage the treaty.

d) Write significance of duty of a crop.

Ans It helps in designing efficient canal irrigation system. If we know the overall duty of all the crops required to be irrigated in different seasons of the year and the total available water at the head of the main canal, the area which can be irrigated and can be worked out.

- If we know the crop area required to be irrigated along with their duties so we can work out the discharge required for designing the canal

$$Q = A/D \; ; \; A = QD$$

Q2 a) Explain the factors affecting consumptive use.

Ans: Following are the factors affecting consumptive use:

1- Temperature
2- Humidity in air
3- velocity of wind
4- Soil topography
5- Sunlight etc.

1- <u>TEMPERATURE:</u>

The rate of consumptive use of water by crops in any particular locality is probably affected more by temperature, which for long-term periods is a good measure of solar radiation, than by any other factor. Abnormally low temperatures retard plant growth and unusually high temperatures may produce dormancy. Consumptive use may vary widely even in years of equal accumulated temperatures because of deviations from the normal season distribution.

2- HUMIDITY IN AIR:

Evaporation and transpiration are accelerated on days of low humidity and slowed during periods of high humidity. During periods of low relative humidity, greater rate of use of water by vegetation may be expected.

3- VELOCITY OF WIND:

Evaporation of water from land and plant surfaces takes place more rapidly when there is moving air than under calm air conditions. Hot, dry winds and other unusual wind conditions during the growing period will affect the amount of water consumptively used. However, there is a limit in the amount of water that can be utilized. As soon as the land surface is dry, evaporation practically stops and transpiration is limited by the ability of the plants to extract and convey the soil moisture through the plants.

4- SOIL TOPOGRAPHY:

The landscape of the soil is very important because a smooth surface or good-land topography is necessary to yield a good growth of Plant. Rugged landscape or bad land topography must lead to poor yielding. Crop growing techniques such as watering, contouring and by-passing etc. To the soil fertile manuers are being used such as cowdung.

5- SUNLIGHT:

The hours of daylight during the summer are much greater in northern latitudes than the Equator. Since the sun is the source of all energy used in crop growth and evaporation of water, this longer day may allow plant transpiration to continue for a longer period each day and to produce an effect similar to that of lengthening the growing season.

b) What is to be grown at certain place, the useful rainfall for the whole season is 10cm and it's cumulative consumptive use is 40cm. Determine consumptive irrigation requirements (CIR) and Field irrigation Requirement (FIR) if the water application efficiency is 80%

Sol: Given data:

Usefull Rainfall (cm) = 10

Water application Efficiency ($\eta_a$) = 80% = 0.8

Cumulative Consumptive Use ($C_u$) = 40cm

Required data:

Field Irrigation Requirement (FIR) = ?

Consumptive Irrigation Requirement (CIR) = ?

Formula;

→ Consumptive Irrigation Requirement (CIR) $= C_u - R_c$

$= 40 - 10$

$CIR = 30 cm$

→ Field Irrigation Requirement (FIR) $= \frac{CIR}{\eta a}$

$= \frac{30}{0.8}$

$FIR = 37.5 cm$

c) Explain Class A pan Evaporation (Ep) measurement with the help of a diagram.

Ans: Evaporation can be experimentally determined by directly measuring the quantity of water evaporated from this standard class A pan. This pan is 0.1m 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 water surface is at least 5cm and never more than 7.5cm, below the top of pan.

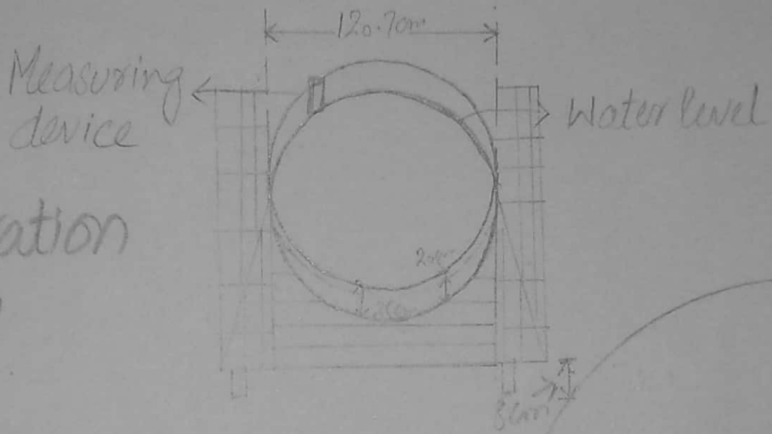
The pan evaporation can also be determined by using the Christiansen formula which states

$E_p = 0.459 R . C_t . C_w . C_h . C_s . C_e$

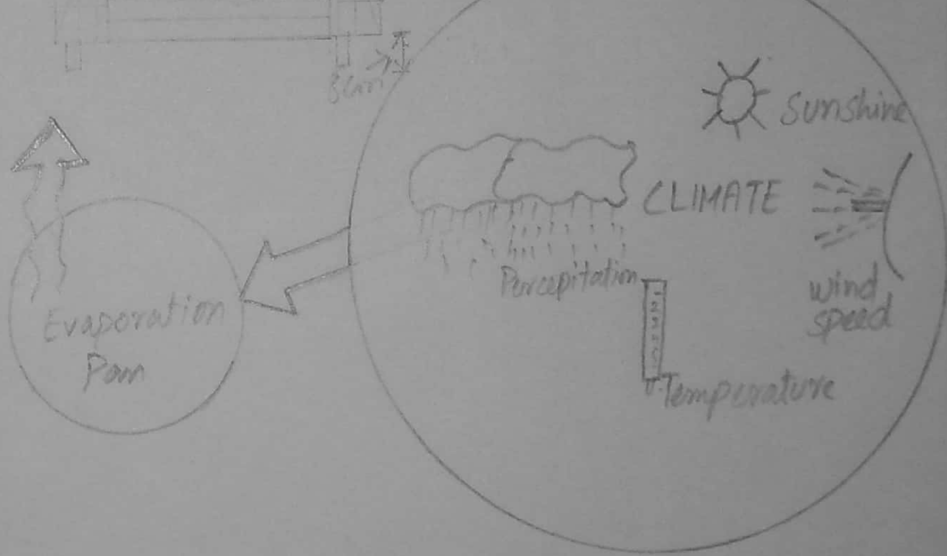
where

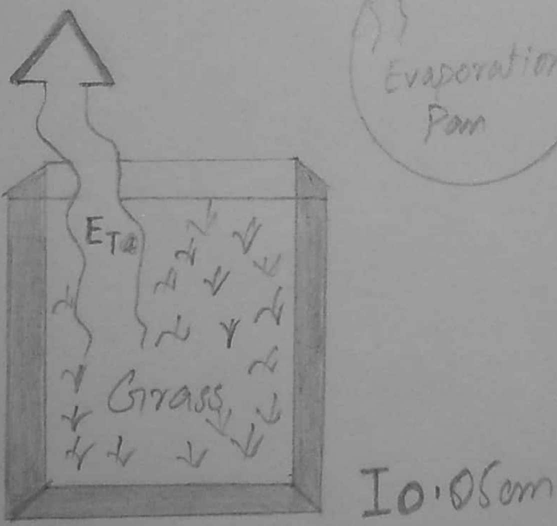
- $R$ = Terrestial radiation

- $E_p$ in cm or mm
- $C_t$ = Coefficient for temperature.
- $C_w$ = Coefficient for wind velocity.
- $C_h$ = Coefficient for relative humidity.
- $C_s$ = Coefficient for percent of possible sunshine
- $C_e$ = Coefficient for elevation.




Evaporation Pan



d) Explain Crop seasons (Rabi and kharif) and Kharif Rabi Ratio.

Ans: RABI CROP:

Those crops which are grown in the winter season, mainly from Oct end to April are called rabi crops. Examples:

Wheat, Barley, gram, mustard, potatoes etc

KHARIF CROPS:

Kharif crops are those which are grown in summer season, mainly between April and May. These crops are not effected by the rainfall.

Examples: rice, maize, cotton, jowar, bajra etc.

KHARIF-RABI RATIO:

Irrigated areas for rabi crop is generally more than kharif crop. The ratio of proposed areas of rabi to kharif season is called Kharif-rabi ratio. This ratio is generally 1:2 i.e kharif area is one half of Rabi area.

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Q3 Define and explain the following terms:

a) FIELD CAPACITY:

Field capacity is the amount of soil moisture or water content held in soil after excess water has drained away and the rate of downward movement has materially decreased, which usually takes place with in 2-3days after a rain or irrigation in pervious soils of uniform structure and texture.

b) PERMENANT WILTING POINT:

Permenant wilting point or wilting point is defined as the minimal point of soil moisture the plant requires not to wilt. If moisture decreases to this or any lower point a plant wilts & can no longer recover it's turgidity when placed in a saturated atmosphere for 12hours. The physical defination of the wilting point is defined as the water content at -1500 J/kg of suction pressure, or negative hydraulic head.

c) AVAILABLE AND READILY AVAILABLE MOISTURE CONTENT:

Available moisture content is the the portion of water that can be absorbed by plant roots. By defination It is the amount of water available, stored or released between field capacity and the permenant wilting point

→ Readily available moisture content:

Readily available water is the water that a plant can easily extract from the soil. RAW is the soil moisture held between field capacity and a nominated refill point for unrestricted growth. These values are presented in table 5 as mm of moisture available per cm of soil depth.

d) OPTIMUM UTILIZATION OF WATER:

The quantity of water at which the yield is maximum, is called optimum water depth. Therefore, optimum utilization of irrigation generally means, getting maximum yield with any amount of 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 and then falls down.