LECTURE 04

CROP WATER REQUIREMENT

- Water requirements of specific crops
- Crop period
- Base period
- Duty and Delta of a Crop
- Factors affecting Duty
- Methods of improving Duty
- Consumptive use of water
- Irrigation Efficiencies
- Irrigation requirement of crops
- Wastewater with treatment and its consequences.

Crop Water Requirement

- In irrigation, it is essential to know the amount of water needed by crops.
- This determines the quantity of water to be added by irrigation

Factors Affecting Water Requirement

- Water table: High water table less requirement, vice versa.
- Climate: In hot climate evaporation loss is more, hence requirement more, vice versa.
- Ground slope: If ground is steep, the water flows down very quickly and soil gets little time to absorb, so requirement more. If ground is flat less requirement.

- Intensity of irrigation: If intensity of irrigation for a particular crop is high, then more area comes under the irrigation system and requirement is more, vice versa.
- Type of soil: Sandy soil water percolates very quickly, so requirement is more. Clay soil retention capacity is more, so less requirement.
- Method of application of water: surface method more water is required to meet up evaporation. In sub surface and sprinkler method less water required.

- Method of ploughing: In deep ploughing less water required, because soil can retain moisture for longer period. In shallow ploughing more water required.

Definations related to irrigation

- **CROP PERIOD:-**It is the time in days, that a crop takes from The instant of its sowing to that of its harvesting.
- **BASE PERIOD:-** The base period is the relation between he First watering and the last watering supplied to the land.
- **PALEO:-** It is defined as the first watering before sowing the Crop.
- **GROSS COMMAND AREA(G.C.A):-**It is defined as the total Area lying between drainage boundaries which can be commanded or irrigated by a canal.
- **CUTURABLE COMMAND AREA(C.C.A):-** It is that portion of G.C.A which is cultivable or cultivable.
- **CROP RATIO:-** It is defined as the ratio of the land irrigated During the two main crop season rabi and kharif.
- **TIME FACTOR:-** It is the ratio of number of days the canal has actually run to the number of days of irrigation Period.
- **CAPACITY FACTOR:-** It is the ratio of mean supply to the Full supply of a canal.

Base

- Base is defined as the period from the first to the last watering of the crop just before its maturity.
- Also known as base period.
- Denoted as "B" and expressed in no of days.

Crop	Base in days
Rice	120
Wheat	120
Maize	100
Cotton	200
Sugarcane	320

Delta

- Each crop requires certain amount of water per hectare for its maturity.
- If the total of amount of water supplied to the crop is stored on the land without any loss, then there will be a thick of water standing on the land.
- This depth of water layer is known as Delta for the crop.
- Donated by "Δ" expressed on cm.

KHARIF CROP	DELTA IN CM
Rice	125
Maize	45
Ground nut	30
Millet	30

RABI CROP	DELTA IN CM
Wheat	40
Mustard	45
Gram	30
Potato	75

Duty

- Duty of water is defined as no of hectares that can be irrigated by constant supply of water at the rate of one cumec throughout the base period.
- Denoted as “D” and expressed in hectares/cumec.
- Varies with soil condition, method of ploughing, method of application of water.
- 1 cumec-day = 1 m3/sec for one day

Types of duty

- There are four types of duty:

1) **GROSS DUTY:-**It is the duty of water measured at the head of main canal.

2) **NOMINAL DUTY:-**It is the duty sanctioned as per schedule of an irrigation department.

3) **ECONOMIC WATER DUTY:-**It is the duty of water which results in the maximum crop yield.

4) **DESIGNATED DUTY:-** It is the duty of water assumed in an irrigation project for designing capacities of the channel.

Factors Affecting Duty

- Soil characteristics: If soil of the canal bed is porous and coarse grained, it leads to more seepage loss and low duty. If soil is compact and close grained, seepage loss will less and high duty.
- Climatic condition: When atmospheric temp. of command area becomes high, the evaporation loss is more and duty becomes low and vice versa.

- Rainfall: If rainfall is sufficient during crop period, less quantity of irrigation water shall be required and duty will more and vice versa.
- Base period: When base period is longer, the water requirement will be more and duty will low and vice versa.
- Type of crop: Water requirement of various crops are different. So the duty also varies.
- Topography of agricultural land: If land has slight slope duty will high as water requirement optimum. As slope increases duty increases because there is wastage of water.
- Method of ploughing: Deep ploughing by tractor requires less quantity of water, duty is high. Shallow ploughing by bullocks requires more quantity of water, duty is low.
- Methods of irrigation: Duty is high in case of perennial irrigation system as compared to inundation irrigation system. Because in perennial system head regulator is used.
- Water tax: If some tax is imposed on the basis of volume of water consumption, the farmer will use the water economically, duty will be high.

Methods Of Improving Duty

- Proper ploughing: Ploughing should be done properly and deeply, so that moisture retaining capacity of soil is increased.
- Methods of supplying water: This should be decided according to the field and soil conditions.
- Furrow method – crops shown in row
- Contour method – hilly area
- Basin method – for orchards
- Flooding method – plain lands
- Canal lining: To reduce percolation loss the canals should be lined according to site condition.
- Transmission loss: To reduce this canals should be taken close to the irrigable land as far as possible.
- Crop rotation: Crop rotation should be adopted to increase the moisture retaining capacity and fertility of the soil.
- Implementation of tax: The water tax should be imposed on the basis of volume of water consumption.

Relation between Duty and Delta

- Let,

D=duty in hectares
Δ = total depth of water supplied in meters
B = base period in days

1) If we take a field of area D hectares, water supplied to the field corresponding to the water depth Δ meters will be,

= D x Δ hectares – meters
=D x Δ x 104 cubic meters

2) For the same field of area D hectares , water is supplied at the rate of 1 cumec for the entire base period of B days , then the total quantity of water supplied to the field,

=1 x b x 24 x 60 x 60 cubic meter
=8.64 x 104 B cubic meter

D = 8.64 B/ D meters

Consumptive Use of Water

- It is defined as total quantity of water used for the growth of plants by transpiration and the amount of lost by evaporation.
- It is also known as evapo-transpiration.
- Expressed in hectare-meter or as depth of water in m.
- The value of consumptive use of water is vary from crop to crop, time to time, place to place.

Evapotranspiration

- Evaporation: The process by which water is changed from the liquid or solid state into the gaseous state through the transfer of heat energy.
- Transpiration: The evaporation of water absorbed by the crop which is used directly in the building of plant tissue in a specified time. It does not include soil evaporation.
- Evapotranspiration, ET: It is the sum of the amount of water transpired by plants during the growth process and that amount that is evaporated from soil and vegetation in the domain occupied by the growing crop. ET is normally expressed in mm/day.

Evaporation

- Phase change of water from a liquid to a gas

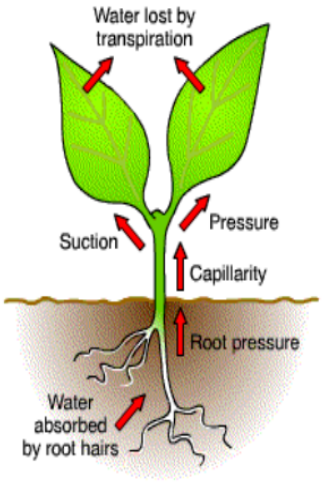
- Rate of evaporation is driven by the **vapor pressure deficit**. Function of:
  1. The ability of air to hold water based on air temperature and relative humidity.

  1. The energy in the water largely based on temperature.

- Net evaporation ceases when the air has reached the **saturation vapor pressure.**

Transpiration

- **Transpiration** is the loss of water in the form of vapor from plants

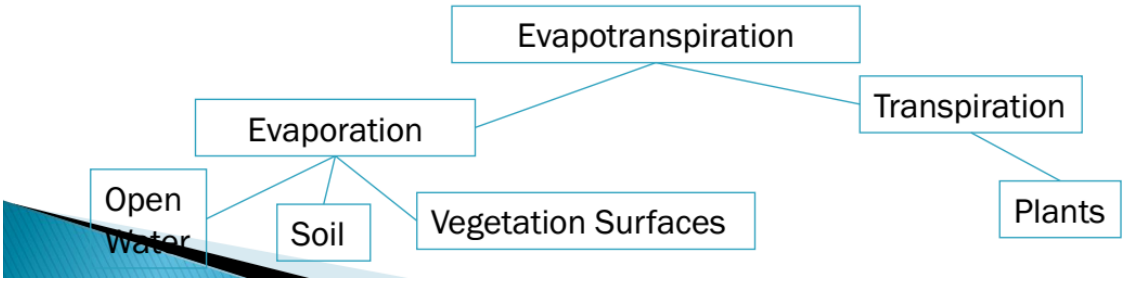


- Factors that affect transpiration rates
  - Type of plant
  - Wind
  - **Plant Available Water**: the portion of water in a soil that can readily be absorbed by plant roots. Amount of water released between **field capacity** (amount of water remaining in the soil after gravitation flow has stopped) and **wilting point** (amount of water in the soil at 15 bars of suction).

Evapotranspiration

- Composed of two sub processes:-
  - **Evaporation** occurs on surfaces of open water or from vegetation and ground surfaces.
  - **Transpiration** is the removal of water from the soil by plant roots, transported through the plant into the leaves and evaporated from the leaf's stomata.

- Typically combined in mass balance equations because the components are difficult to partition.



Factors that affect evapotranspiration

- Weather parameters
- Crop Characteristics
- Management and Environmental aspects are factors affecting ET

Weather Parameters:

- The principal weather conditions affecting Evapotranspiration are:
- Radiation
- Air temperature
- Humidity and
- Wind speed.

Crop characteristics that affect ET :

- Crop Type
- Variety of Crop
- Development Stage
- Crop Height
- Crop Roughness
- Ground Cover
- Crop Rooting Depth

Management and Environmental Factors :

- Factors such as soil salinity,
- Poor land fertility,
- Limited application of fertilizers,
- Absence of control of diseases and
- Pests and poor soil management
- May limit the crop development and reduce soil Evapotranspiration.
- Other factors that affect ET are ground cover, plant density and soil water content.
- The effect of soil water content on ET is conditioned primarily by the magnitude of the water deficit and the type of soil.
- □oo much water will result in water logging which might damage the root and limit root water uptake by inhibiting respiration.

Determination of ET

- Evapotranspiration is not easy to measure.
- Specific devices and accurate measurements of various physical parameters or the soil water balance in lysimeters are required to determine ET.
- The methods are expensive, demanding and used for research purposes.
- They remain important for evaluating ET estimates obtained by more indirect methods.

Measurement of Consumptive Use of Water

- There are two method for the measurement :

➢ **Direct measurement method**

1. Tank and lysimeter method
2. Field experiment method
3. Soil moisture study
4. Integration method
5. Inflow and outflow studies

➢ **Use of empirical formula**

1. Penman method
2. Jensen –Haise method
3. Blanley Criddle method
4. Hargreaves method
5. Thornthwait method