Chapter 37: Water Requirement of Crops – Crops and Crop Seasons in India

Introduction

Water is one of the most essential inputs for agricultural production. In a country like India, where agriculture forms the backbone of the economy, understanding the **water requirement of crops** is vital for efficient irrigation planning, design of irrigation structures, and sustainable water resource management. This chapter deals with the concepts related to water needs of various crops, classification of crops based on seasons, and the cropping patterns observed in India. It also covers the terminologies and calculations used in determining irrigation needs and crop consumptive use.

37.1 Crop Water Requirement (WR)

Crop Water Requirement (WR) is defined as the total quantity of water required by a crop during its entire growth period.

Factors Affecting Water Requirement

- **Climatic factors**: Temperature, humidity, wind velocity, sunshine hours, and rainfall.
- **Crop factors**: Type of crop, root depth, crop duration, growth stage.
- **Soil factors**: Soil texture, infiltration rate, water-holding capacity.
- **Agronomic practices**: Irrigation method, mulching, planting density, etc.

37.2 Components of Water Requirement

Water requirement includes the following components:

1. **Consumptive Use (Cu)** – Includes evapotranspiration (ET).
2. **Percolation losses** – Especially in paddy fields.
3. **Application losses** – Due to irrigation inefficiencies.
4. **Leaching requirement** – For salinity control in soils.

5. **Special needs** – Water used for seedbed preparation, transplanting, and other pre-sowing operations.

37.3 Evapotranspiration (ET)

Evapotranspiration is the sum of:

- **Evaporation (E)** from soil surface and water bodies.
- **Transpiration (T)** by the plant leaves.

Types of ET:

- **Potential Evapotranspiration (PET)** – When water supply is unlimited.
- **Actual Evapotranspiration (AET)** – Under actual field conditions with limited water.

37.4 Methods for Estimating Water Requirement

1. Blaney-Criddle Method

- Empirical method using mean monthly temperature and percentage of daytime hours.
- $WR = K \times (P/100) \times (T \times 1.8 + 32)$

Where: K = Crop coefficient T = Mean monthly temperature (°C) P = Percentage of annual daytime hours

2. Penman-Monteith Method

- A more accurate and physically-based method.
- Considers net radiation, wind speed, temperature, and humidity.

3. FAO Modified Penman Method

- Widely used for international irrigation planning.
- Adopted by FAO for crop water requirement studies.

37.5 Duty, Delta, and Base Period

1. Duty (D)

The area irrigated per unit discharge of water. **D = A / Q** (in hectares/cumec)

2. Delta (Δ)

The total depth of water required by a crop during its base period. **Δ = (8.64 × B) / D** Where B = Base period (days)

3. Base Period (B)

The time between the first watering to the last watering before harvest.

37.6 Irrigation Requirement (IR)

The quantity of water that must be supplied through irrigation to meet the WR.

IR = WR – ER

Where ER is Effective Rainfall (portion of rainfall usable by crops).

37.7 Effective Rainfall (ER)

Not all rainfall is effective. Runoff, deep percolation, and water lost before it reaches the root zone are excluded.

Methods to Estimate ER:

- USDA method
- Empirical formulas
- Soil moisture balance method

37.8 Cropping Seasons in India

India has three primary cropping seasons:

1. Kharif Season (June–October)

- Starts with the onset of monsoon.
- Crops: Rice, maize, jowar, bajra, cotton, groundnut, soybean.

2. Rabi Season (October–March)

- Grown in winter, harvested in spring.
- Crops: Wheat, barley, mustard, peas, gram.

3. Zaid Season (March–June)

- Short-duration crops grown between rabi and kharif.
- Crops: Watermelon, cucumber, moong, vegetables.

37.9 Classification of Crops Based on Water Needs

Type	Examples	Water Requirement (mm)
High WR	Paddy, Sugarcane	>1200
Moderate WR	Wheat, Maize, Cotton	500–800
Low WR	Bajra, Gram, Mustard	<500

37.10 Crop Coefficient (Kc)

A dimensionless factor representing the relationship between ET of a particular crop and reference ET.

ETcrop = Kc × ETo

Where:

- ETo = Reference evapotranspiration
- Kc = Varies with crop type and growth stage

37.11 Root Zone Depth and Soil Moisture Depletion

- Different crops have different root zone depths.
- Water should be applied when depletion reaches the allowable limit to avoid stress.

Crop	Root Zone Depth (m)
Paddy	0.2 – 0.3
Wheat	0.6 – 1.2
Cotton	1.2 – 1.5
Sugarcane	1.5 – 2.0

37.12 Cropping Pattern and Water Allocation

Cropping pattern is the yearly sequence and spatial arrangement of crops on a farm.

Important considerations:

- Water availability from source.
- Soil fertility and type.
- Crop compatibility.
- Seasonal variations.

37.13 Command Area Development (CAD) and Crop Planning

To improve water-use efficiency, irrigation planning should be crop-based:

- Align irrigation supply with crop calendar.
- Avoid over-irrigation (waterlogging) or under-irrigation (stress).
- Promote crop diversification in water-scarce regions.

37.14 Water Use Efficiency (WUE)

WUE is defined as the ratio of crop yield to the water used.

WUE = Yield (kg) / Water Used (m^3)

High WUE means optimal usage of water with minimal loss. Techniques like **drip irrigation**, **sprinkler irrigation**, and **mulching** improve WUE.

37.15 Special Case: Paddy Fields

Paddy requires standing water during most of its growth stage.

- Percolation losses are significant (up to 5 mm/day).
- Needs bunds and leveling.
- Alternate Wetting and Drying (AWD) can reduce water usage without yield loss.

37.16 Modern Techniques to Reduce Water Requirement

- Use of **sensor-based irrigation**.
- **Laser land leveling** to avoid runoff.
- Use of **drought-resistant crop varieties**.
- Promotion of **micro-irrigation systems** (drip/sprinkler).
- **Soil moisture monitoring**.
