Unit:1 Irrigation and Its Methods

Agriculture: This is the broad practice of cultivating soil, growing crops, raising animals, and producing food, fiber, medicinal plants, and other products used to sustain and enhance human life. It includes various aspects such as crop cultivation, livestock management, soil health, pest control, and more.

Irrigation: This is a specific agricultural practice that involves artificially applying water to crops or land to support their growth. It is a method used to supplement natural rainfall to ensure plants receive adequate water, especially in areas where water availability is limited or inconsistent.

1. Need and Classification of Irrigation

Need for Irrigation

1. **Insufficient Rainfall**: Regions with unpredictable and insufficient rainfall patterns require irrigation systems to ensure a steady water supply for crops.
2. **Crop Rotation**: Irrigation facilitates multiple cropping systems by providing the necessary water for different crop cycles throughout the year.
3. **Mitigating Droughts**: Irrigation becomes essential in mitigating the effects of droughts, especially in arid and semi-arid regions, by ensuring water availability.
4. **Enhancing Yields**: Proper irrigation systems significantly enhance crop yields by maintaining optimum soil moisture levels for plant growth.
5. **Boosting Cash Crops**: Water-intensive crops like rice, sugarcane, and cotton require efficient irrigation methods for their cultivation and profitability.
6. **Livestock Development**: Ensures the growth of fodder crops and grasslands, thereby supporting the livestock industry.

Classification of Irrigation

1. **Surface Irrigation**:
    - **Flooding Method**: Water spreads across the field; it is further categorized into uncontrolled (wild flooding) and controlled (border or check flooding) systems.
    - **Furrow Irrigation**: Water is distributed along small channels or furrows between crop rows.
    - **Basin Irrigation**: Applied to fields divided into basins, commonly used for orchards and trees.
2. **Subsurface Irrigation**:
    - Delivers water through underground pipes or channels directly to the root zone of plants, reducing evaporation losses.
3. **Pressurized Irrigation**:
    - **Sprinkler Systems**: Water is distributed in droplets resembling rainfall through sprinkler heads.
    - **Drip Systems**: Provides water in small quantities directly to the root zone using perforated pipes, ensuring minimal water wastage.
4. **Localized Irrigation**:
    - Focuses water supply to specific areas of the field, employing tools like micro-sprayers, emitters, and bubblers.

2. Merits and Demerits of Irrigation

Merits

1. **Increase in Crop Production**: Ensures a steady water supply, enhancing crop yields by preventing water stress during critical growth stages. (Santosh Kumar Garg highlights this as a key driver for sustainable agriculture.)
2. **Soil Fertility Maintenance**: Regular irrigation dilutes soil salinity and maintains optimal moisture levels, critical for nutrient absorption.
3. **Boosts Rural Employment**: Irrigation projects and related agricultural activities generate significant employment opportunities, a point emphasized by Santosh Kumar Garg.

4. **Economic Upliftment**: The consistent agricultural output contributes to regional and national economic growth, enhancing food security.
5. **Reduction in Crop Failures**: By mitigating reliance on unpredictable rainfall, irrigation reduces the risks associated with droughts and dry spells, ensuring stable agricultural outputs.
6. **Increase in Crop Production**: Provides regular water supply and increases yields.
7. **Soil Fertility**: Enhances fertility by controlling salinity and maintaining moisture levels.
8. **Employment Opportunities**: Promotes jobs in agriculture and related activities.
9. **Economic Growth**: Contributes to the rural economy and food security.
10. **Control over Droughts**: Acts as a safeguard against unpredictable weather conditions.

Demerits

1. **Waterlogging and Salinization**: Poorly managed systems can lead to soil degradation.
2. **Over-Exploitation**: Excessive extraction can deplete groundwater resources.
3. **Expensive Infrastructure**: High initial cost for setting up canals, wells, or pumps.
4. **Environmental Issues**: Alters natural water flow and may affect ecosystems.
5. **Health Concerns**: Stagnant water can breed mosquitoes and cause diseases like malaria.

3. Types of Crops and Crop Seasons

Types of Crops

1. **Food Crops**: Wheat, rice, maize, millet.
2. **Cash Crops**: Cotton, sugarcane, tobacco.
3. **Horticultural Crops**: Fruits and vegetables.
4. **Forage Crops**: Grass, alfalfa, clover.

Crop Seasons

1. **Kharif Season**: Crops (e.g., rice, maize) sown in the monsoon (June-September).
2. **Rabi Season**: Crops (e.g., wheat, barley) sown in winter (October-February).
3. **Zaid Season**: Short-duration crops (e.g., cucumbers, watermelon) grown in summer (March-June).

4. Duty, Delta, and Base Period

Duty:

The area irrigated (in hectares) by a unit discharge of water (1 cumec) over the entire growing period of a crop.

Delta:

The total depth of water (in meters) required to grow a crop during its entire base period. Formula: $\delta = (8.64 \times B \times D) \times 10^{-4}$ Where:

- δ = Delta in meters
- B = Base period in days
- D = Duty in hectares/cumec

Base Period:

The total duration (in days) from the first watering at sowing to the last watering before harvest.

5. Consumptive Use of Crops

Definition: Total water used by the crop for transpiration and evaporation during its growth period. Formula:

Where:

- **ETc**: Crop evapotranspiration (consumptive use).
- **S**: Soil water contribution.
- **I**: Irrigation water applied.
- **D**: Water lost due to drainage or percolation.

Case Study

Project: Bhakra Nangal Irrigation System, India

1. **Region**: North India (Punjab, Haryana, Rajasthan).
2. **Crops Supported**: Wheat, rice, sugarcane.
3. **Delta and Duty Analysis**:
    - Wheat: Base period = 120 days, Duty = 1640 hectares/cumec.
    - Rice: Base period = 150 days, Duty = 875 hectares/cumec.
    - Total water requirement = 50 billion cubic meters annually.
4. **Outcomes**:
    - Increased productivity by 30% in the last decade.
    - Supports over 10 million farmers directly.
    - Reduced dependency on monsoons.