

2. Principles of Water Efficient Irrigation

Water Efficient Irrigation is based on scientific principles that ensure optimum use of water while meeting the actual needs of crops. These principles focus on applying water precisely and avoiding unnecessary losses.

1. Right Amount of Water

Crops should receive only the quantity of water that they require for healthy growth. Excess irrigation leads to water loss through deep percolation and nutrient leaching, while insufficient irrigation causes water stress. The required amount of water depends on the crop growth stage, as water demand varies from germination to flowering and grain filling stages. It also depends on soil type, since sandy soils require frequent but light irrigation, whereas clay soils can hold water for longer periods. Climatic conditions such as temperature, humidity, wind, and rainfall also influence crop water needs.

2. Right Time of Irrigation

Timely irrigation is as important as the quantity of water applied. Irrigation should be given when soil moisture falls below the optimum level for crop growth. Special attention should be given to critical growth stages of crops, such as tillering in cereals, flowering in pulses and oilseeds, and fruit development in horticultural crops, as water stress during these stages can cause severe yield losses.

3. Right Method of Application

The method of irrigation should ensure that water is delivered directly to the root zone, where it can be effectively used by plants. Modern methods like drip and micro-irrigation reduce evaporation, runoff, and weed growth, thereby improving water use efficiency.

4. Uniform Distribution

Water must be distributed uniformly across the field to avoid water stress in dry areas and waterlogging in wet areas. Uneven distribution leads to poor crop growth and reduces overall productivity.

5. Monitoring and Scheduling

Irrigation scheduling should be based on soil moisture sensors, weather data, and crop water requirements. Scientific monitoring helps farmers decide when and how much to irrigate, preventing both over-irrigation and under-irrigation.

3. Methods of Water Efficient Irrigation

Several modern irrigation methods are used to improve water use efficiency by delivering water precisely to the crop root zone and reducing losses due to evaporation and runoff.

1. Drip Irrigation

In drip irrigation, water is delivered directly to the plant roots through a network of pipes and emitters. This system supplies water slowly and continuously, maintaining optimum soil moisture around the root zone. It saves about 30-60% of water compared to traditional methods and significantly reduces weed growth since only the cropped area is wetted. Drip irrigation also allows the application of fertilizers along with water, known as fertigation, which improves fertilizer use efficiency and crop yield. It is highly suitable for vegetables, fruits, and plantation crops.



Source: <https://www.linkedin.com/>

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INTRODUCTION

Water is the most critical input for agricultural production, and its efficient management is essential for ensuring food security and sustainable farming. With increasing pressure on freshwater resources due to population growth, climate change, and over-extraction of groundwater, agriculture must adopt practices that use water more wisely. Traditional irrigation methods often result in significant water losses through evaporation, runoff, and deep percolation, reducing overall irrigation efficiency. Therefore, the concept of Water Efficient Irrigation has gained importance as a practical solution to conserve water while maintaining or increasing crop productivity.

2. What is Water Efficient Irrigation?

Water Efficient Irrigation (WEI) refers to the application of water to crops in a manner that minimizes losses and maximizes crop water use efficiency, ensuring that plants receive the right amount of water at the right time and at the right place, mainly in the root zone. It focuses on matching irrigation supply with actual crop water requirements and soil conditions, thereby avoiding both over-irrigation and under-irrigation.



Source: <https://www.agrivi.com/>

Why is Water Efficiency Important?

Agriculture consumes about 70% of global freshwater resources, making it the largest user of water worldwide. Rapid urbanization, industrial demand, and irregular rainfall patterns further reduce the availability of water for farming. Efficient irrigation helps in conserving scarce water resources, improving resilience to drought, and ensuring sustainable agricultural production under changing climatic conditions.

Objectives of Water Efficient Irrigation

- Reduce wastage of water
- Improve crop productivity and quality
- Save energy and labor inputs
- Maintain soil health and structure
- Promote sustainable and climate-smart agriculture

Major Causes of Water Loss in Traditional Irrigation

- Evaporation from soil and water surfaces
- Deep percolation beyond the root zone
- Surface runoff due to uneven fields
- Uneven distribution of water in fields

Efficient irrigation systems are designed to minimize these losses and improve overall water use efficiency in agriculture.

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क्रमांक: COOP/2023/KOTA/201080/25/63

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Water Efficient Irrigation

संकलन

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2. Sprinkler Irrigation

Sprinkler irrigation sprays water over crops in the form of artificial rainfall. It is suitable for uneven and sandy lands where surface irrigation is difficult. This method saves about 20–40% water and helps in reducing soil erosion. It also ensures better uniformity of water distribution, making it useful for cereals, pulses, and fodder crops.

3. Micro-Sprinklers

Micro-sprinklers are mainly used in orchards and horticultural crops. They apply water gently over a small area, maintaining uniform soil moisture and improving fruit size and quality. This system is more efficient than conventional sprinklers.

4. Subsurface Irrigation

In subsurface irrigation, water is supplied below the soil surface through buried pipes or tubes. This method results in very low evaporation losses and is suitable for high-value crops where precise moisture control is required.

4. Modern Technologies for Water Saving

Modern technologies play a vital role in improving irrigation efficiency by ensuring precise and timely application of water according to crop needs and environmental conditions.

1. Smart Irrigation Systems

Smart irrigation systems use sensors, mobile applications, and automated control valves to manage irrigation efficiently. These systems collect real-time data on soil moisture and weather conditions and automatically apply water only when required. This reduces human error, saves water, and ensures optimal crop growth. Smart systems are especially useful for large farms and commercial horticulture.

2. Soil Moisture Sensors

Soil moisture sensors measure the amount of water present in the soil and indicate when irrigation is necessary. By using these sensors, farmers can avoid over-irrigation, which leads to water loss and nutrient leaching. They also help in accurate irrigation scheduling, improving water productivity and crop health.

3. Weather-Based Scheduling

Weather-based irrigation scheduling uses data on temperature, humidity, rainfall, and evapotranspiration (ET) to determine crop water requirements. Irrigation is applied only when climatic demand is high, preventing unnecessary watering after rainfall and reducing water wastage.

4. Fertigation

Fertigation refers to the application of fertilizers through drip irrigation systems. This method supplies nutrients directly to the root zone along with water. It reduces fertilizer loss, improves nutrient use efficiency, and enhances crop yield and quality. It also lowers labor and application costs.

5. Remote Monitoring

With remote monitoring, farmers can control and monitor irrigation systems using smartphones or computers. This technology allows timely decision-making, reduces labor requirements, and ensures efficient water management even from distant locations.

5. Agronomic Practices Supporting Water Efficiency

Efficient irrigation is not only about technology; proper agronomic practices play a crucial role in conserving water, improving soil health, and enhancing crop productivity.

1. Mulching

Mulching involves covering the soil surface with crop residues, straw, or plastic sheets. Mulching helps reduce water evaporation, keeps the soil moist for longer periods, and maintains a stable soil temperature. It also suppresses weed growth and protects soil structure, leading to more efficient use of irrigation water.

2. Crop Selection

Choosing the right crops can significantly improve water efficiency. Farmers should grow drought-tolerant crops and short-duration varieties that require less water and complete their growth cycle before peak water scarcity periods. This approach ensures higher water productivity and better adaptation to water-limited conditions.

3. Crop Rotation

Rotating crops with different water and nutrient requirements improves soil structure and enhances water retention capacity. Crop rotation also reduces pest and disease incidence, contributing indirectly to better water use and sustainable farming.

4. Land Leveling

Proper land leveling, especially using laser technology, ensures uniform water distribution across the field. It reduces ponding and runoff, allowing crops to receive water efficiently. Laser leveling can decrease water use by 15–25%, improving irrigation efficiency for cereals, pulses, and vegetables.

5. Conservation Agriculture

Conservation agriculture practices, such as minimum tillage and residue retention, improve soil organic matter and water-holding capacity. These practices reduce soil erosion, maintain soil moisture, and enhance crop resilience under water-limited conditions.

6. Benefits of Water-Efficient Irrigation

Water-efficient irrigation offers multiple benefits across economic, environmental, social, and agronomic dimensions, making it a key component of sustainable agriculture.

Economic Benefits:

Efficient irrigation methods such as drip and sprinkler systems significantly reduce water and electricity consumption by delivering water directly to the root zone and minimizing losses due to evaporation and runoff. This lowers input costs for farmers. At the same time, precise water application improves nutrient uptake and crop health, leading to higher yields and better-quality produce, which ultimately increases farm income and profitability.

Environmental Benefits:

Water-efficient irrigation helps conserve groundwater by reducing excessive pumping and promoting judicious water use. It also minimizes surface runoff, thereby reducing soil erosion and protecting soil structure. Furthermore, controlled irrigation limits nutrient leaching beyond the root zone, preventing contamination of groundwater and nearby water bodies, and supporting long-term soil fertility.

Social Benefits:

By ensuring reliable crop production even under limited water availability, efficient irrigation systems contribute to improved food security. They also support sustainable farming livelihoods by reducing production risks and stabilizing farm incomes, especially for small and marginal farmers.

Crop Productivity Benefits:

Uniform and timely water supply promotes better plant growth, stronger root development, and reduced stress, which lowers disease incidence. Crops produced under optimal moisture conditions show improved size, color, and overall quality, enhancing market value.

Climate Change Adaptation:

Water-efficient irrigation helps farmers cope with drought and irregular rainfall by maximizing water productivity and ensuring crop survival during dry spells, making farming systems more resilient to climate variability.

7. Government Schemes in India:

The Government of India actively promotes water-efficient irrigation through schemes such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), which aims to enhance water use efficiency at the farm level. The Per Drop More Crop (PDMC) component of PMKSY specifically supports micro-irrigation technologies like drip and sprinkler systems by providing financial assistance and technical support. Subsidies reduce the initial investment cost, making these technologies affordable for small and marginal farmers. These schemes play a crucial role in encouraging the adoption of water-saving practices and improving irrigation coverage in water-scarce regions.

Role of Farmers:

Farmers are key stakeholders in the success of water-efficient irrigation. They should adopt modern irrigation methods, regularly monitor soil moisture to avoid over- or under-irrigation, and ensure proper maintenance of irrigation systems for long-term efficiency. Timely repairs and correct operation help in maximizing water savings and crop productivity.

Role of Extension Agencies:

Agricultural extension agencies act as a bridge between technology and farmers. They organize training programs, field demonstrations, and provide technical guidance on system installation, operation, and crop-specific irrigation scheduling. Their support helps farmers gain confidence in new technologies and ensures effective implementation at the field level.

CONCLUSION

Water Efficient Irrigation is a key strategy for sustainable agriculture. By adopting scientific irrigation methods, modern technologies, and good agronomic practices, farmers can produce more food using less water, ensuring environmental protection and long-term agricultural productivity.

Slogan

"Save Water Today, Secure Food Tomorrow."