

Water conservation methods in Agriculture

V. Santhosh

Assistant Professor in Agronomy, Nalanda College of Agriculture, Trichy- 621104.

Corresponding Author: santhoshvmsh2000@gmail.com

1. Soil Management Practices

1.1 Mulching:

Mulching involves covering the soil surface with organic materials such as straw, leaves, crop residues, and compost, or with inorganic materials like plastic sheets and biodegradable films. By reducing direct sunlight on the soil, mulches lower surface evaporation, moderate soil temperature, and suppress weed growth. This practice can conserve about 20–50% of soil moisture, enhance microbial activity, and improve nutrient retention, thereby supporting healthier crop growth under limited water conditions.

1.2 Conservation Tillage:

Conservation tillage includes practices such as no-till, reduced tillage, and strip-till, where soil disturbance is minimized and crop residues are left on the surface. This protective layer reduces erosion, enhances water infiltration, and helps maintain soil organic matter. Over time, it improves soil structure and water-holding capacity, making more moisture available to crops.

1.3 Organic Matter Addition:

The application of compost, farmyard manure, and green manure crops increases the organic matter content of soil. Organic matter improves soil porosity and aggregation, enabling the soil to retain more water. As a result, crops become more resilient to drought stress, and nutrient availability is enhanced, promoting sustained productivity.

2. Efficient Irrigation Techniques

2.1 Drip Irrigation:

Drip irrigation delivers small, precise amounts of water directly to the root zone through emitters. With a water-use efficiency of about 90–95%, it minimizes evaporation and runoff losses. This method is particularly suitable for vegetables, orchards, and row crops, ensuring that water is used effectively where it is most needed.

2.2 Sprinkler Irrigation:

Sprinkler systems spray water over crops in a manner similar to rainfall. With an efficiency of 70–80%, they can reduce runoff and provide uniform moisture distribution. This method is well suited for cereals, pulses, and horticultural crops, especially in areas with uneven terrain.

2.3 Subsurface Irrigation:

In subsurface irrigation, water is delivered below the soil surface through buried pipes, directly to the root zone. This reduces evaporation losses, limits weed growth, and

improves water-use efficiency, often resulting in higher crop yields.

2.4 Irrigation Scheduling:

Irrigation scheduling uses tools such as soil moisture sensors, tensiometers, and evapo-transpiration data to determine the optimal timing and quantity of water application. This approach prevents overwatering and waterlogging, conserving both water and energy while maintaining optimal soil moisture for crop growth.

3. Crop Selection and Management

3.1 Drought-Tolerant Varieties:

Crops such as pearl millet, sorghum, chickpea, and pigeon pea possess traits like deeper root systems, reduced leaf area, and efficient water-use physiology. These characteristics allow them to maintain yield even under water-limited conditions, making them ideal for dryland and semi-arid regions.

3.2 Crop Rotation:

Crop rotation involves alternating crops with different rooting depths and water requirements. This optimizes soil water use, improves soil structure, and enhances moisture retention, while also reducing pest and disease buildup.

3.3 Intercropping:

Intercropping combines shallow- and deep-rooted crops or complementary species in the same field. This system reduces evaporation from bare soil, improves ground cover, and ensures more efficient use of available soil moisture.

4. Water Harvesting and Storage

4.1 Rainwater Harvesting:

Rainwater harvesting methods such as rooftop catchments, check dams, and farm ponds capture and store rainfall for later use. This reduces dependence on groundwater and increases water availability for irrigation during dry periods.

4.2 Contour Bunding and Terracing:

Contour bunds and terraces are constructed along slopes to slow runoff and enhance water infiltration. These structures prevent soil erosion and help retain moisture within the root zone, improving crop performance on sloping lands.

5. Soil Moisture Conservation Practices

5.1 Cover Crops:

Cover crops are grown during the off-season to protect the soil. They reduce evaporation, prevent erosion, and add organic matter to the soil, thereby improving moisture retention and overall soil health.

5.2 Deep Tillage/Subsoiling:

Deep tillage or subsoiling breaks compacted soil layers, allowing better water penetration and root development. This enhances root access to moisture and nutrients, improving crop growth and drought tolerance.

6. Technology-Driven Approaches

6.1 Soil Moisture Sensors:

These sensors monitor soil water content in real time, enabling precise irrigation decisions. By applying water only when needed, they significantly reduce wastage and improve water-use efficiency.



Soil Moisture Sensors – Examples:

- Tensiometers used in paddy, sugarcane, and vegetable fields to decide irrigation time.
- Capacitance sensors installed in drip-irrigated tomato and chilli crops to automate watering.
- IoT-based soil moisture probes in greenhouses and polyhouses for cucumber and capsicum.

6.2 GIS and Remote Sensing:

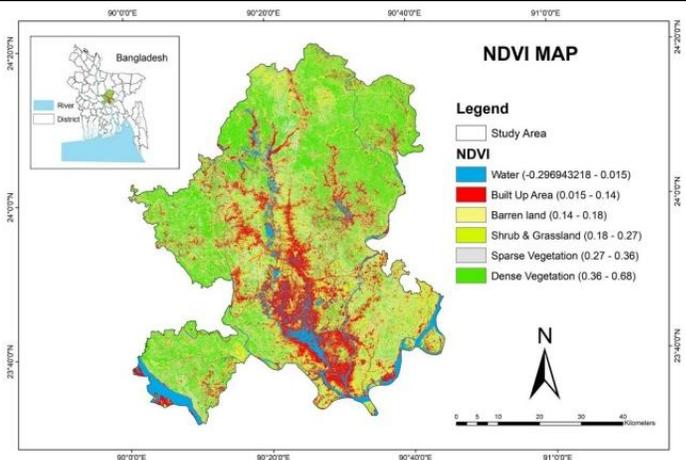
GIS and remote sensing technologies identify water-stress zones in large farms. They assist in planning targeted, water-efficient crop management practices.

GIS and Remote Sensing – Examples:

- Satellite images (NDVI maps) used in large sugarcane or cotton farms to locate dry and stressed zones.
- Drone-based field mapping in orchards (mango, banana) to detect moisture deficiency areas.
- GIS mapping in watershed projects to identify low-moisture patches for rainwater harvesting structures.

6.3 Precision Agriculture:

Precision agriculture tailors water application according to crop needs in different field zones. This reduces



unnecessary water use, improves yield, and enhances overall resource efficiency.

Precision Agriculture – Examples:

- Variable-rate drip irrigation in vineyards and orchards where different zones receive different water volumes.
- Smart irrigation systems in maize and vegetable farms that adjust watering based on soil and crop data.
- Zone-wise irrigation in large farms using GPS-guided systems for crops like cotton and sugarcane.

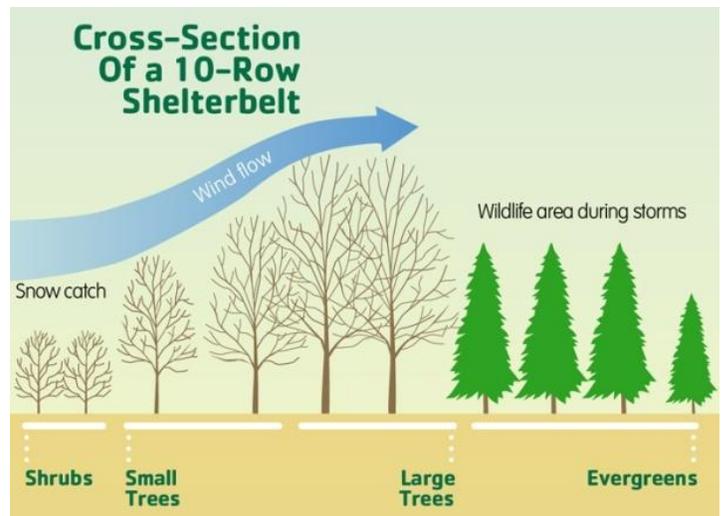
7. Agroforestry and Windbreaks

7.1 Trees and Hedgerows:

Trees and hedgerows reduce wind speed, lower evaporation, stabilize soil, and improve the microclimate. These effects enhance soil moisture retention and create favorable conditions for crop growth.

7.2 Shelterbelts:

Shelterbelts protect crops from moisture loss and soil erosion. By moderating wind and temperature extremes, they can significantly increase crop water-use efficiency.



Key Principles for Agronomic Water Conservation

Effective agronomic water conservation is based on reducing losses from evaporation, runoff, and deep percolation; increasing soil water retention through improved structure and rainwater capture; applying water efficiently only when and where it is needed; and adapting cropping systems using drought-tolerant varieties and resilient farming practices. Together, these principles ensure sustainable water use and stable crop production under changing climatic conditions.

References:

Unger, P. W., Kirkham, M. B., & Nielsen, D. C. (2010). Water conservation for agriculture. *Soil and water conservation advances in the United States*, 60, 1-45.

Ali, A., Hussain, T., & Zahid, A. (2025). Smart irrigation technologies and prospects for enhancing water use

efficiency for sustainable agriculture. *AgriEngineering*, 7(4), 106.

Kader, M. A., Nakamura, K., Senge, M., & Mojid, M. A. (2025). Enhancing Water Availability in Dryland Agriculture: A Review of the Role of Condensation Under Plastic Mulch. *Water Conservation Science and Engineering*, 10(3), 1-12.

Shah, S. S., van Dam, J., Singh, A., Kumar, S., Kumar, S., Bundela, D. S., & Ritsema, C. (2025). Impact of irrigation, fertilizer, and pesticide management practices on groundwater and soil health in the rice-wheat cropping system—a comparison of conventional, resource conservation technologies and conservation agriculture. *Environmental Science and Pollution Research*, 32(2), 533-558.
