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Water management to tackle drought conditions

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An integrated approach involving water conservation, efficient water use, and climate-smart agricultural practices is essential for rainwater management in drought-prone areas. Rainwater can be collected and stored through rooftop harvesting, ponds, percolation tanks, and village-level reservoirs. Under watershed management, structures such as contour bunding, terracing, vegetative barriers, check dams, and gully plugging reduce surface runoff and enhance groundwater recharge. Recharge pits, recharge wells, infiltration trenches, and recharge shafts replenish groundwater reserves. Drip and sprinkler irrigation, deficit irrigation, precision irrigation, and scientific irrigation scheduling enhance water use efficiency. Practices such as mulching, conservation tillage, crop residue retention, cover cropping, and the use of raised beds aid in soil moisture conservation. Drought-tolerant and short-duration crop varieties, crop diversification, intercropping, and adjusting sowing times based on weather forecasts are also effective strategies. Multi-purpose water use systems promote irrigation, fisheries, and the conjunctive use of surface and groundwater. Additionally, seasonal forecasting, early warning systems, real-time drought monitoring, and irrigation decision-support systems provide enhanced preparedness and adaptive capacity.

Water management techniques

Water conservation-based measures in drought-prone areas aim to harvest rainwater, recharge groundwater, conserve soil moisture, and increase water availability for irrigation. By enhancing water security in rain-fed regions, these techniques improve agricultural productivity and farmers' incomes.

- 1. Check dam:** Check dams reduce the velocity of water flow in seasonal streams, thereby facilitating rainwater harvesting and enhancing groundwater recharge. They prevent soil erosion, improve water levels in nearby wells and handpumps, and maintain soil moisture in agricultural lands by providing irrigation water for *rabi* and summer crops.
- 2. Pond:** A farm pond collects rainwater and makes water available for irrigation as needed. It provides life-saving irrigation to crops during droughts, promotes fish farming and multi-purpose water use, and enhances water use efficiency when integrated with micro-irrigation systems like drip and sprinkler setups.
- 3. Percolation tank:** A percolation tank collects rainwater and allows it to gradually seep into the ground. This improves the groundwater level, increases water availability in wells and tube wells, and ensures long-term water sources for irrigation and drinking purposes.
- 4. Contour bunds and graded bunds:** These structures conserve soil and moisture by regulating rainwater runoff on sloping land. This leads to increased rainwater absorption, reduced soil erosion, and enhanced groundwater recharge, while also boosting the productivity and sustainability of rain-fed agriculture.

5. **Recharge pits and recharge wells:** Recharge pits and recharge wells enhance groundwater replenishment by directing rainwater directly to the groundwater level. This improves the water levels in borewells and wells, increases water availability, and creates long-term water sources for irrigation and drinking purposes.
6. **Gully plug:** A gully plug controls water flow in small streams and deep gullies, reducing the velocity of the runoff. This minimizes soil erosion, enhances rainwater absorption, retains soil moisture, and boosts groundwater recharge, thereby supporting agriculture and environmental conservation.
7. **Rooftop rainwater harvesting:** Rainwater collected from rooftops is either stored in tanks or directed into the groundwater via recharge structures. This provides water for domestic use, enhances groundwater recharge, offers relief during water crises, and ensures the sustainable and efficient management of water resources.
8. **Micro-irrigation system (drip and sprinkler):** This system offers high irrigation efficiency with low water usage. It saves 30–60% of water, boosts crop production and water productivity, and enables the efficient use of fertilizers. Consequently, costs decrease, while improves agricultural profitability and water use efficiency.
9. **Mulching:** In mulching, the soil surface is covered with crop residues or plastic, which reduces evaporation and helps retain soil moisture for a longer period. It aids in mitigating the impact of drought by controlling weeds, balancing soil temperature, conserving water, and improving crop growth.
10. **Raised and sunken bed system:** This system manages excess water in high-rainfall areas while making water available for irrigation during dry spells (**Figure 1**). Vegetables and pulses are cultivated on raised beds, whereas paddy and water-intensive crops are grown in sunken beds. This approach facilitates water harvesting, crop diversification, and multi-purpose farming, ultimately leading to increased farmers' income.



Figure 1: Drip irrigation system with raised and sunken bed system.

Conclusion: The integrated use of these technologies is considered as one of the most effective strategies for long-term water security and sustainable agriculture in drought-prone areas.