

Strategies for water management under limited water supply

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Irregular or insufficient rainfall can be a serious limitation to agricultural production, causing low yields and even crop failure. This is particularly true in drylands, where productivity levels are generally low. Irrigation water may be inadequate due to drought, lost well capacity, or changes in operation or administration of project water. When irrigation water is not available to meet crop demand, strategies are needed to achieve the highest possible economic return with limited water.

Key words: Evapotranspiration, Partial Root-Zone Drying, Sprinklers, Subsurface Drip Irrigation

WHILE REDUCING irrigated acreage or purchasing additional equipment are ways to manage limited water supplies, they may not maintain or improve economic return. Alternate strategies requiring minimal capital and equipment investment include fine tuning irrigation scheduling to optimize crop water use efficiency, taking steps to capture and store precipitation, and growing crops well suited to limited irrigation. While the way one deals with limited water supplies differs depending on whether the shortage is temporary or permanent, the following list provides some strategies for dealing with limited irrigation water in either case.

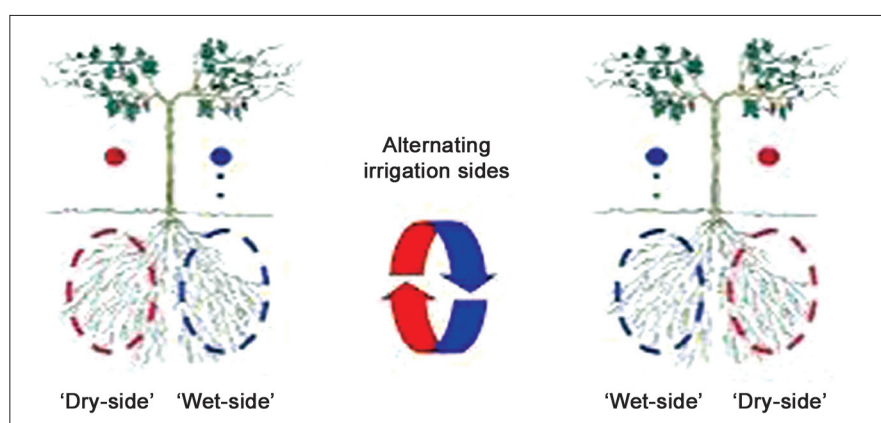
- Reduce irrigation during non-critical growth stages.
- Use soil moisture and evapotranspiration (ET) measurements to schedule irrigations. Do not rely on crop appearance. Understand ET and how seasonal water use requirements vary by crop type, elevation, short-term weather and length of growing season.
- Adopting regulated deficit irrigation approach (RDI): In RDI, the entire root zone is

irrigated with an amount of water less than the potential evapotranspiration during specific periods of the crop cycle. The principle of the RDI technique is to irrigate during critical crop growth stages.

- Using partial root-zone drying (PRD) strategy: RDI is a method where water application is manipulated over time, while PRD is a method where water is manipulated over space. PRD is designed to maintain half of the root system in a dry or drying state, while the other half is irrigated. The treatment is then reversed, allowing the previously well-watered side of

the root system to dry down while fully irrigating the previously dry side. During PRD irrigation, water must be switched regularly for every 10-15 days.

- Sprinklers and micro-sprinklers are most suitable for narrow spacing crops (wheat, mustard, barley, spices etc.). This system helps in saving sufficient amount of water (at least 20%) and gives 33 and 37% higher yield as compared to check basin and border strip methods of irrigation, respectively. However, high wind speed and use of saline water may restrict its application in arid regions.
- Drip irrigation is more suitable for



Partial root-zone drying.

wider spacing crops and orchards and yield increases by 40-50% are common for different crops. Daily irrigation by drip forces the salts to the side and below the root zone, thereby allowing gainful utilization of water having a relatively high salt content.

- Subsurface drip irrigation (SDI) systems, which reduce surface evaporation, runoff, and deep percolation, work well for high value crops and fields too small or irregular for pivots.
- Make equipment upgrades to improve irrigation system efficiency and uniformity of application by shortening row length, increasing stream size and cutting back on set time, using optimum set time, packing furrows and surging rows.
- Under furrow irrigation, optimize row lengths and slope to shorten surface irrigation set times and increase uniformity. Use polyacrylamide (PAM) and surge valves to increase application rates.
- Increase residue and manage weeds with best available herbicide × crop technology and plant population reduction. These measures help capture and store precipitation, reduce runoff and evaporation and maximize water use efficiency.
- A limited root zone is a problem in water short situations. Avoid soil compaction by using no till, strip till, ridge till, conservation tillage, and chemical weed control.
- Manage soil water depletion carefully. Allow soil to reach its maximum allowable depletion (MAD) before completing the next irrigation.
- Preseason irrigation is a strategy that is often recommended under limited-irrigation. This strategy attempts to ensure that soil water storage is filled to near field capacity before the growing season.
- In situations where good quality water is unavailable, producers may consider using marginal quality water for irrigation. This is short-term strategy.
- If the only available water source is saline, consider reducing acreage and applying full irrigations to ensure leaching of salts through the root zone.



Raising of fodder crops.

- Revert some land to dryland crops or grass.
- Forage crops are a good way to take advantage of precipitation when it occurs and accommodate drought conditions, while high value or quality driven crops are not good choices for limited irrigation. Forage/livestock/grains integration and rotation can be done.
- When faced with limited water supplies, substitute with low water requirement crops, such as sunflower or winter wheat.
- Pre-monsoon sowing.
- Season length required by the crop is also an important consideration when water is limited. Short season crops use less water because they are harvested earlier.
- Indeterminate crops (tuber and root crops) generally require more water than determinate crops (grain, cereal, and oil crops) because of longer growing season of the former.
- Crop rotation can have major impact upon the total water needs by irrigation. Crop rotation with lower water use crops such as soybean or winter wheat can reduce irrigation needs. It spreads the irrigation season over a greater time period as compared to a single crop.
- Application of mulches reduces evaporation losses and results in additional benefits like soil conservation, moderation of temperature, reduction in soil salinity, weed control and



Rice straw mulch in potato.

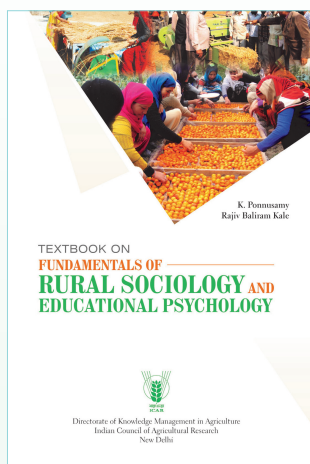
- improvement of soil structure.
- Vertical mulch is a technique which consists of digging suitable trenches across the slope, placing the straw or crop residues in these trenches. This helps in percolation of water in a trench and distribution of water in the profile.
 - Use of antitranspirants to reduce transpiration losses.
 - Growth retardant application reduces the shoot growth and increases root growth, thus enabling the plants to resist drought. They may also, induce stomatal closure. Cycocel is one such chemical useful for improving water status of the plant.
 - Osmopriming with chemicals such as 4% KCl solution and saturated CaHPO_4 in rice, KNO_3 in sunflower and hydropriming with water improved the germination and stand establishment under stress conditions.
 - Spraying nutrient solutions such as 2% urea and 1% KCl for immediate recovery from drought.
 - Use of superabsorbent polymers to increase the water holding capacity of soil.
 - Improved soil and water conservation practices and the associated reduced tillage systems.
 - Optimization of the fit between crop growth cycle and the available moisture.
 - Soil fertility management with respect to the water regime.
 - Control of soil biotic stress factors that inhibit root development.
 - Avoidance of mono cropping and enhancement of crop diversification.
 - Rain water harvesting or storage by *in-situ* and *ex-situ* measures.
 - Conjunctive use of water i.e., combined use of multiple sources that optimizes the beneficial characteristics of each source. For example, combining saline water with fresh water and canal water with groundwater.
 - Reuse of wastewater by discharging into a stream and later routing or diverting it for treatment as water supply.
 - Desalination, the process of removing salt from seawater or brackish water
 - Reuse of farm run-off.

SUMMARY

Crop yields and gross returns from limited irrigation will generally be less than a fully irrigated crop production system. However, changes in agronomic and irrigation management practices can help maintain respectable yields and net economic returns. A combination of management strategies such as rotations with lower water use crops, reduced tillage and residue management, irrigation timing and improved irrigation efficiency can help stretch limited water supplies in many situations and avoids zero yield.

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TECHNICAL SPECIFICATIONS

No. of pages : i-viii + 252 • Price : ₹ 450 • ISBN No. : 978-81-7164-181-9

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