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Sustainable Water Management in Cereals

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Introduction

Sustainable water management implies using water in a way that meets current, ecological, social, and economic needs without compromising the ability to meet those needs in the future. It requires water managers to look beyond jurisdictional boundaries and their immediate supply operations, managing water collaboratively while seeking resilient regional solutions that minimize risks. The three most important cereals in India are rice, wheat, and maize. The three cereals directly contribute more than half of all calories consumed by human beings.

Globally, about 30 percent of total fresh groundwater is being utilized for rice cultivation (Bouman et al., 2007). About 800–5000 L (Mean - 2500 L) of water is used to produce one kg of rice (Bouman, 2003).

Wheat, a crucial cereal crop globally, water requirements vary depending on factors such as climate, soil type, and the stage of crop growth. Understanding these requirements are essential for efficient water management and ensuring optimal yields. Wheat generally requires between 450 to 650 millimetres (mm) of water throughout its growing season.

Maize is the third most important cereal crop produced globally after wheat. Maize performs better under the furrow and drip irrigation methods, and the range of water requirements is between 450–650 mm. Plastic and straw mulching has enhanced irrigation water use efficiency up to 34.0–47.2 and 15.3–24.1 kg ha^{-1} mm^{-1}, respectively.

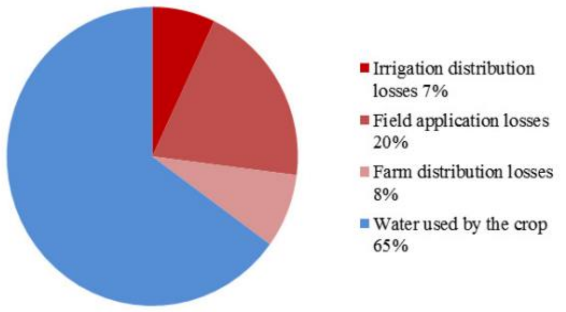

Fig 1 Water losses in agriculture

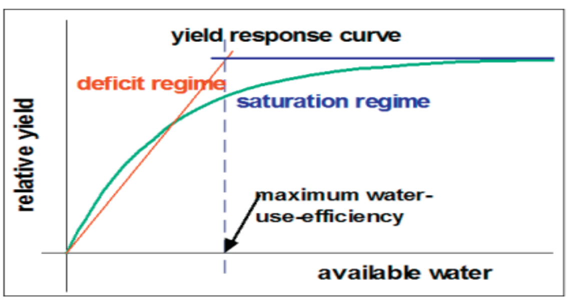

Fig. 2 Plant yield response to water

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Sustainable water management in rice

- Although a major part of irrigation water (45%) is directed to rice, yet it covers only 38% of total cultivated area under rice.
- Among cereals, rice has lowest productivity/unit of water (3.7. kg/ha mm).
- The main reason for growing rice in rainy season and irrigation is provided only during deficit period to make up the water requirement.
- Nursery management: For land preparation- 1.5-2cm
- For growth of rice in nursery- 2.5-4cm
- Main field: For land preparation-20-30cm
- For growth- 80-120cm
- Total water requirement- 104-156cm
- Average WR for Kharif paddy- 110-120cm
- Rabi paddy- 150-200cm
- Daily WR- 0.87cm/day
- WR for producing 1kg rice yield= 5000litre
- Critical stages for irrigation- PI,Boottng,Heading,Flowering and Grain development

Water saving techniques in rice

- **Dry-direct seeded rice** is an alternative rice establishment method which reduces the amount of water required to produce a crop (Mahajan et al., 2017). The crop is generally grown without standing water, and water savings of 35–57% compared to puddled transplanted rice have been reported across north-eastern India (Jat et al., 2019).
- **Alternate wetting and drying (AWD)** is an irrigation management technique to minimize the loss of unproductive water from rice fields by allowing standing water to disappear for a certain period before it is recharged (Bouman et al., 2007).
- **System of Rice intensification (SRI)**: It reduces water usage by 25-50% (Uphoff et al., 2016) Increases rice yields significantly and promotes better root growth and plant health.
- **Efficient irrigation technique:** According to Parthasarathi et al. drip irrigation improved the aerobic rice yield by 29%, increased water saving efficiency by 50%, and consequently increased water productivity, favoured the root oxidizing power, canopy photosynthesis and dry matter partitioning. According to Parfitt et al., water use

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efficacy (WUE) are high for sprinkler-irrigated rice than for rice grown in flood-irrigated lowland. Some other Water-Saving Agronomic Practices are using drought-tolerant rice variety, plastic mulching, straw mulching, organic matter application, minimum tillage, etc., to assess their influence on water saving in irrigated rice production.

Sustainable water management in wheat

- Highly responds to irrigation
- 4-6 irrigations are essential
- At 40-50% depletion of ASM
- Appropriate IW /CPE ratio for wheat 0.7-0.9
- On clay loam up to 80% depletion
- Critical phases for irrigation are

  CRI – (21-25 DAS)

Second most critical stage – flowering

Third important stage – jointing and milk stages

- **Mulching**: Applying organic or synthetic mulch around wheat plants helps retain soil moisture. Mulch acts as a protective layer, reducing evaporation and preventing weed growth. This practice contributes to better WUE.
- **Optimal irrigation amount**: Finding the right balance between irrigation and rainfall is essential. Research suggests that the optimal WUE occurs when the irrigation amount is around 80–160 mm or when irrigation is applied twice during the season. Additionally, the total seasonal irrigation amount plus precipitation should not exceed 240 mm[1].
- **Subsoiling and straw return**: Practices like subsoiling (deep tillage) and returning crop residues (straw) to the soil can improve yield, reduce evapotranspiration, and enhance WUE. These techniques contribute to sustainable agricultural development by conserving water and nutrients.

Sustainable water management in Maize

- Susceptible to excessive and deficiency of water
- Stagnation of water should be avoided
- Total WR is 50-60cm

- Wilting of plant due to water stress should be avoided.
- Critical stage of irrigation: Knee height stage, Tasselling stage, Silking and grain filling stage
- Moisture stress during these critical stage for 2days reduces the yield by 20% and 7 days by 50%.

- **Irrigation Scheduling:** Under conditions of limited irrigation water, irrigation scheduling should be based on avoiding water deficit during flowering followed by grain development period. If shortage of water is unavoidable, water may be saved by reducing the supply during vegetative stage as well as during grain filling stage.
- **Precision Irrigation Techniques:** Precision irrigation is a cornerstone of sustainable water management in maize farming. By using technology to deliver water more efficiently and precisely, farmers can reduce water waste and optimize crop yields.

Drip Irrigation:

It Maintain control over soil moisture and nutrient levels. Support increased plant populations. Increase the number of irrigated hectares which leads to a significant increase in annual yields. Save water and energy costs.

Sprinkler Systems:

Modern sprinkler systems, including centre pivots and lateral moves, provide uniform water distribution. These systems can be equipped with soil moisture sensors and automated controls to adjust irrigation schedules based on real-time data, ensuring that maize plants receive the optimal amount of water.

Conclusion

Keeping in this view in mind, the increased water demands worldwide by other users that have priority over irrigated agriculture and because significant improvements in the biological efficiency of the crop water use process are not possible, at least in the short run, and, it is evident that conservation of irrigation water is the most important new source of water for agriculture now and in the future. As we have seen, water saving technologies already exist to conserve irrigation water, however, technologies alone will not provide permanent solutions to the many problems of irrigated agriculture. The path towards a more sustainable irrigated agriculture requires multidisciplinary approaches to problem solving and user participation at all levels.

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