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More Crop Per Drop

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Abstract

Agriculture utilizes the largest proportion of available water on the planet; however, only a pinch of this available proportion is sustainably and efficiently used in the cultivation of crops and production of other agricultural commodities and the remaining is squandered as a result of soil evapotranspiration, runoff and infiltration, and also absorbed by weeds. Water is more decisive to Indian agriculture than is commonly thought. India's water resources are under tremendous pressure as the gap between food production and population growth continues abate. With 4 percent of the world's water resources and nearly 18 percent of its population, the country is already under great pressure to fulfill the water requirements of the various growing sectors.

Among various approaches, water productivity or water use efficiency (WUE) is the most effective method. A plant with high WUE will have a higher yield as compared to a plant with low WUE (Meena *et al.*, 2013). Considering the shocking reality of the water crisis, there is a need for better water management to conserve this invaluable resource before things get out of hand.

Efficient Water Management

Water is a very important resource for agricultural production. Erratic and unpredictable monsoon conditions and dwindling water levels due to overuse have led to a shortage of suitable water for agricultural use, which mandates the efficient use of this resource. Strategies for managing water for agricultural use include water conservation, integrated water use, efficient water distribution and increased water efficiency in plants.

I. Conservation of Water

Local water conservation can be achieved by reducing and slowing down the water runoff thus allowing a maximum percentage of water to infiltrate into the ground indirectly reducing the loss of water by deep flow and direct evaporation from the ground. Runoff is reduced either by increasing the opportunity time or by infiltration rate of the soil or both. Opportunity time can be manipulated by land modifications, tillage, mechanical structures and vegetative barriers and infiltration rate can be increased using scientifically recommended crop rotations, application of amendments, tillage, mulching etc. Water loss by deep seepage can be prevented by increasing the soil water retention capacity by increasing the root zone of crops and increasing soil water retentively. Direct evaporation from soil can be controlled with shallow cultivation and mulching.

II. Efficient Use of Irrigation Water

The efficiency of irrigation water can be increased by using water-conserving technologies, such as optimum irrigation scheduling, laser land leveler, proper and scientific irrigation methods, mulching, intercropping and using improved varieties. Scheduling irrigation to rice based on of soil matric potential can save 25% irrigation water (Kukal *et al*. 2005) without any reduction in the yield of rice. Similarly, laser land levelers can save 25% of irrigation water in rice (Sidhu *et al*. 2007).

III. Rainwater Harvesting

Rainwater harvesting projects should be also be implemented in rural areas, especially in areas with high rainfall. This will abate the problems of flooding and stagnation of water and will ensure a continuous supply of water in draught periods. Traditional structures like Johads, Khadins, Isris, Bandhs should be promoted along with the latest research-based technological advancements thus ensuring maximum conservation of rainwater.

IV. Renovation of Village Ponds

It is estimated that single irrigation from a village pond can add 17.2 kg Nitrogen, 1.7 kg Phosphorous and 75.3 kg Potassium ha^{-1}. Such ponds also have sediment layers ranging from 1 to 1.5 meters in thickness, which acts as a rich source of nutrients and organic matter. The renovation of such ponds and facilitating the diversion of these sediments along with the water into the agricultural lands can serve as a good source of nutrients and will also result in increased replenishment of groundwater.

V. Optimal Allocation of Water

Judicious and optimal allocation of available water with appropriate irrigation schedule of application must be well planned at regions with limited water availability for irrigation and in rain-fed areas to maximize economic returns on available water meanwhile ensuring future availability of the same. Under conditions with sufficient availability of irrigation water optimal allocation involves a proper irrigation schedule so that crop yields are maintained at their highest potential, depending on the local climate. Meanwhile, under the condition of limited water supply irrigation water should be provided in such a way that periods of possible water deficits are likely to coincide with the most tolerant growth periods or during dormant stages.

VI. Agronomic Practices

a. **Selection of crops and cropping system**: Choice of species and planting systems for efficient use of water should be done based on the availability of water under rain-fed crops, limited and fully irrigated crops. For this purpose, timely knowledge of upcoming climate and weather conditions can be collected from various authentic sources and also recommendations and guidance must be sought from local Agricultural Research Stations (ARS) and Krishi Vigyan Kendras (KVKs).

b. **Conservation tillage**: Tillage affects the WUE by altering the hydrological features of the soil thus influencing the growth and development of above ground and below-ground biomass of the crops. Conservation tillage leaves behind about 30 % of crop residue on the fields itself which slow water movement thus reducing soil erosion and allowing more water to percolate into the soil. Conservation tillage also has many indirect benefits like soil compaction, benefitting predatory arthropods thus abating pest damages and also reducing fuel consumption.

c. **Mulching and crop residue management:** Approximately 69-70 percent of the rain is lost due to evaporation which can be abated by mulching which is one of the simplest and most beneficial practices for water conservation that can be done simply by spreading a protective layer of material on top of the soil to prevent it from blowing and being washed away. Mulch can either be organic in nature such as grass clippings, straw, bark and similar materials or inorganic such as stones, brick chips and plastic. Racial coverage is based on compacting the soil with materials that leave a well-functioning component of plant material, plant residues, or plant waste in the area as protection against erosion and moisture retention by allowing penetration and reducing evaporation (Rana *et al*, 2003).

d. **More Crop per Drop:** Generation between the output unit and the input unit. Here, the term water production is used specifically to describe the amount or value of a product in addition to the volume or quantity of depleted or diverted water. Product value can be expressed by different names (biomass, grain, currency). For example, a method called 'drip yield' focuses on the value of the product per unit of water. One approach looks at differences in the nutritional value of different plants, or whether the same amount of one crop feeds more people than the same amount of another crop. When it comes to food safety, it is important to look at those methods (Renault and Wallender, 2000)

e. **Laser land leveling:** A major chunk of water (20-25%) is lost during irrigation as a result of inefficient and unscientific farm planning and unevenness of the fields especially in the case of rice fields. This also ultimately leads to an unequal crop stand. This can be abated by using laser land leveling equipment using which a constant slope of 0 to 0.2 percent can be maintained.

f. **Fertilization:** Fertilizer input management is essential for high productivity under dry farming especially under limited availability of irrigation, where excess nutrient loading can lead to decreased productivity and can make the land infertile too if used for a longer period. Under such circumstances Integrated Nutrient Management technique should be taken up by using organic sources of fertilizers such as farmyard manure (FYM), Compost, Biofertilizers etc. along with technologically advanced inorganic fertilizers like Nano-Urea by IFFCO, in recommended doses.

g. **Improved Varieties:** Genetic Improvement can prove to be the most effective tool to increase water use capacity by selecting species having characteristics like fast-growing and hardy (i.e., heat, cold, salt, insects and pests resistant, drought, short growing seasons, early flowering, and optimal nutrient utilization) that are appropriate and location-specific.

h. **Intercropping:** In this practice two or more crops are grown in the same field at a time. This technique provides multiple benefits with various end uses like food and fodder production at the same time, Insurance against failure of one crop or market/price drop of one crop, security against insect and pest infestation etc. but care should be taken while planning of cultivation of two or more crops at the same time as both the crops should not compete with each other for the same resources.

i. **Agro-forestry:** Agroforestry is a land-use management system in which perennial trees or shrubs are grown on farmlands and rural landscapes along with annual agricultural crops solely or in combination with livestock like cattle, aquaculture etc. under common management. Agroforestry can help to strengthen the socio-economic status of farmers and can also conserve the local environment and biodiversity through shelterbelts and windbreaks, live fencing, providing fuelwood, timber and fodder and can also help in achieving zero budget natural farming as the biomass obtained from upper storey and livestock can be used for various purposes like making compost, panchgavya, mulch etc.

VII. Mechanical Measures

j. **Contour Farming:** Contour farming involves plowing, cultivating and weeding along the contour, i.e., across the slope rather than along the slope up to down. Contour ridges are widely used in semi-arid areas to conserve and harvest water, and in higher rainfall areas. Experiments showed that contour farming alone can reduce soil erosion by as much as 50% on mild slopes. However, for slopes steeper than 10%, other measures should be combined with contour farming to enhance effectiveness and overall productivity.

k. **Terracing:** Terraces are used in farming to cultivate sloped land. Graduated terrace steps are commonly used to farm on hilly or mountainous terrain. Terraced fields decrease erosion and surface runoff; thus, conserving water and soil, and are effective for growing crops requiring more water, such as rice.

Conclusion

Irrigation should be applied at the optimum time, in optimum amount, with correct and scientifically proven methods to get higher water use efficiency from the water applied as well as for better yield. There is an urgent need to adopt water conservation technologies to get higher returns per unit of money invested. These technologies help conserve our precious gift of nature (water) and at the same time uplifting the socio-economic status of the farmers. Therefore, it is necessary to improve WUE in rain-fed eco-systems to increase the economic crop production per unit of water and this goal cannot be achieved without implementation in the field the different technologies for increasing water use efficiency.

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