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Agriculture Water Management for Improving Crop Productivity

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Water is the most crucial input for agricultural production. Taking into consideration of the alarming fact of water crisis, there is a need to efficient management of water to conserve the precious input. Strategies for efficient management of water for agricultural use involves conservation of water, integrated water use, optimal allocation of water and enhancing water use efficiency by crops.

Introduction

Agriculture is the largest consumer of water. However, only a part of this agricultural water diverted is effectively used in the production of food or other agricultural commodities and the remaining does not reach the crop/plants because of losses through soil evaporation or infiltration, and used by weeds. Water is more crucial to Indian agriculture than is commonly perceived. India's water resources are under considerable stress as the race between food production and population growth surges relentlessly forward. With 4 per cent of the world's water resources and 18 per cent of its population, the country will be hard pressed to meet the water requirements of the various growing sectors.

Among different approaches water productivity or water use efficiency (WUE) is an efficient approach. A crop with high WUE should have greater yield than a crop with low WUE (Meena *et al.*, 2013). Taking into consideration of the alarming fact of water crisis, there is a need to efficient management of water to conserve the precious input.

Efficient Water Management

Water is the most crucial input for agricultural production. Vagaries of monsoon and declining water-table due to its overuse resulted in shortage of freshwater supplies for agricultural use, which calls for an efficient use of this resource. Strategies for efficient management of water for agricultural use involves conservation of water, integrated water use, optimal allocation of water and enhancing water use efficiency by crops.

I. Conservation of water

In-situ conservation of water can be achieved by reduction of runoff loss andenhancement of infiltrated water and reduction of water losses through deep seepage and direct evaporation from soil. Runoff is reduced either by increasing the opportunity time or by infiltrability of soil or both. Opportunity time can be manipulated by land shaping, tillage, mechanical structures and vegetative barriers of water flow and infiltrability can be increased through suitable crop rotations, application of amendments, tillage, mulching etc. Water loss by deep seepage can be reduced by increasing soil-water storage capacity through enlarging the root zone of crops and increasing soil-water retentively. Direct evaporation from soil can be controlled with shallow tillage and mulching.

II. Efficient use of irrigation water

The efficiency of irrigation water can be increased by using water-saving technologies, such as (i) optimum irrigation scheduling, (ii) laser land leveler, (iii) proper irrigation method, and (iv) mulching. Scheduling irrigation to rice on the basis of soil matric potential (which can be measured by simple farmer-friendly tensiometer developed by PAU as shown in the plate) can save 25% irrigation water (Kukal et al. 2005) without any reduction in yield of rice. Similarly, laser land leveler can save 25% of irrigation water in rice (Sidhu et al. 2007).

III. Rainwater harvesting in cities

Rainwater harvesting projects should be implemented in cities, especially in high rainfall areas. Three-tier strategies could be adopted. First, areas along the roadside and parking lots can be put under grass-paver tiles. Common grass can be planted in holes and it will allow the rainwater to percolate rapidly into the soil. This will help in reducing the sewage water load and avoiding the flooded conditions on the city roads during monsoon rains.

IV. Renovation of village ponds

It has been estimated that one irrigation from village-pond water (7.5 cm) adds 17.2 kg N, 1.7 kg P and 75.3 kg K ha^{-1}. These ponds also have a 4-5 foot thick layer of sediments, which are a rich source of nutrients and organic matter. Renovation of ponds, including diversion of the sediment and water to agricultural lands, will be a good source of nutrients and will result in an increase in the recharge of groundwater.

V. Optimal allocation of water

Optimal allocation of available water among the competing crops and optimum timing of application is to be decided under adequate and limited water supply situation so as to maximize economic returns from available water. Under adequate water supply situation optimal allocation involves timing of irrigations so that crop yields are maintained at their achievable potential, as per climatic conditions of the location. Under limited water supply situation irrigation water must be allocated so that periods of possible water deficits coincide with the least sensitive growth periods.

VI. Agronomic practices

a. **Selection of crops and cropping system**- Selection of crops and cropping systems for high water-use efficiency should be done on the basis of availability of water under rainfed crops, limited irrigated crops and fully irrigated crops.
b. **Tillage practices for moisture conservation**: Tillage affects the WUE by modifying the hydrological properties of the soil and influencing root growth and canopy development of crops. The principal effects of tillage are the preparation of seedbed conducive to the germination of seed and growth of seedling, conservation of soil moisture in unirrigated/rained areas that influence infiltration characteristics of the soil and providing adequate soil depth for optimum root growth, proper placement of seeds and fertilizers in the soil and inter-cultivation for weed control.
c. **Mulching and crop residue management:** About 69-70 per cent of the rainfall is lost through evaporation. Different types of mulches are stubble mulch, soil/dust mulch, straw mulch. Stubble mulching i s based on stirring the soil with implements that leave considerably effective part of the vegetative material, crop residues or vegetative litter on the surface as a protection against erosion and for conserving moisture by favoring infiltration and reducing evaporation (Rana et al, 2003).

d. **Direct Seeded Rice (DSR):** It is an efficient method of water saving in rice. Puddled transplanted rice (PuTPR) requires about 20 % more water than DSR and water requirement is more in PuTPR at establishment & vegetative phase. Several problems of PuTPR which are minimized in DSR are Puddling-ponding, frequent irrigation, cracks in puddled soil (Jat *et al*., 2006).
e. **Weed Management:** Productivity is a ratio between a unit of output and a unit of input. Here, the term water productivity is used exclusively to denote the amount or value of product over volume or value of water depleted or diverted. The value of the product might be expressed in different terms (biomass, grain, money). For example, the so-called 'crop per drop' approach focuses on the amount of product per unit of water. Another approach considers differences in the nutritional values of different crops, or that the same quantity of one crop feeds more people than the same quantity of another crop. When speaking of food security, it is important to account for such criteria (Renault and Wallender, 2000)
f. **Laser land leveling:** A significant 20-25% amount of irrigation water is lost during application at the farm during poor farm designing and unevenness of the field. This problem is more pronounced at the rice field. Unevenness of the field in efficient of irrigation water and also delays irrigation and crop establishment options. Field that are not level have uneven crop stand**.**
g. **Fertilization:** Nutrient management is the major factors to attain higher productivity under dry farming particularly under limited water supply, where the use of higher dose of inorganic fertilizer is restricted. Under such condition organic sources of nitrogenous fertilizer such farm yard manures (FYM) and biofertilizer are more appropriate (Sushila and Giri, 2000).
h. **Varieties:** Genetic approaches to raising water use efficiencies focus on the selection of varieties with growth characteristics and tolerances (i.e., heat, cold, salinity, pests, drought, shorter growing seasons, earlier flowering, and more efficient nutrient use) matched to relatively location-specific conditions. Crop breeding will have greatest impact on increasing water use efficiency by selecting for optimal growing season lengths and harvest dates that take maximum advantage of rainfall timing at critical growth stages for each region.
i. **Intercropping:** In this practice two or more crops are grown in the same field at a particular time. Some of the benefits of inter cropping are better and continuous cover of the land, good protection against the beating action of rain.
j. **Mulching:** Mulching is one of the simplest and beneficial practices for water conservation. Mulch is simply a protective layer of material that is spread on top of the soil to prevent it from blowing and being washed away. Mulch can either be organic such as grass clippings, straw, bark and similar materials or inorganic such as stones, brick chips and plastic.

VII. Mechanical Measures

a. Contour Farming: Contour farming involves ploughing, planting and weeding along the contour, i.e., across the slope rather than up and down. Contour ridges are used mainly in semi-arid areas to harvest water, and in higher rainfall areas for growing potatoes. Experiments shows that contour farming alone can reduce soil erosion by as much as 50% on moderate slopes. However, for slopes steeper than 10%, other measures should be combined with contour farming to enhance its effectiveness.

b. 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, and are effective for growing crops requiring much water, such as rice.

VIII. Chemical management

Antitranspirants are the materials or chemicals which decrease the water loss from plant leaves by reducing the size and number of stomata. Nearly 99 per cent of the water absorbed by the plant is lost in transpiration. Antiranspirants and is any natural applied to transpiring plant surfaces for reducing water loss from the plant. There are of four types.

1. **Stomatal closing type:** Most of the Tran spirants occur through the stomata on the leaf surface. Some fungicides like phenyl mercuric acetate (PMA) and herbicides like Atrazine in low concentration serve as antitranspirants by inducing stomatal closing. These might reduce the photosynthesis. PMA was found to decrease transpiration than photosynthesis.
2. **Film forming type:** Plastic and waxy material which form a thin film on the leaf surface and result into physical barrier. For example, ethyl alcohol. It reduces photosynthesis eg. Tag 9; S - 789 foliate.
3. **Reflectance type:** They are white materials which form a coating on the leaves and increase the leaf reflectance (albedo). By reflecting the radiation, vapour pressure gradient and thus reduce transpiration. Application of 5 percent kaolin spray reduces transpiration losses. eg. Diatomaceous earth product (Celite), hydrated lime, calcium carbonate, magnesium carbonate, zincs sulphate etc.
4. **Growth retardant:** These chemicals reduce shoot growth and increase root growth and thus enable the plants to resist drought. They may also induce stomatal closure. Cycocel is useful for improving water status of the plant.

Conclusion

Irrigation should be applied at optimum time, in optimum amount, with right methods to get higher water use efficiency from the water applied as well for better yield. There is an urgent need to adopt water conservation technologies to get higher returns per unit of money invested. These technologies are helpful in conserving our precious gift of nature (water) and at the same time uplift the economic standard of the farmers. Therefore, it is necessary to improve WUE in rainfed eco-systems to increase the economic crop production per unit of water and this goal cannot be achieved without implementation in field the different technologies for increasing water use efficiency in collaboration

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