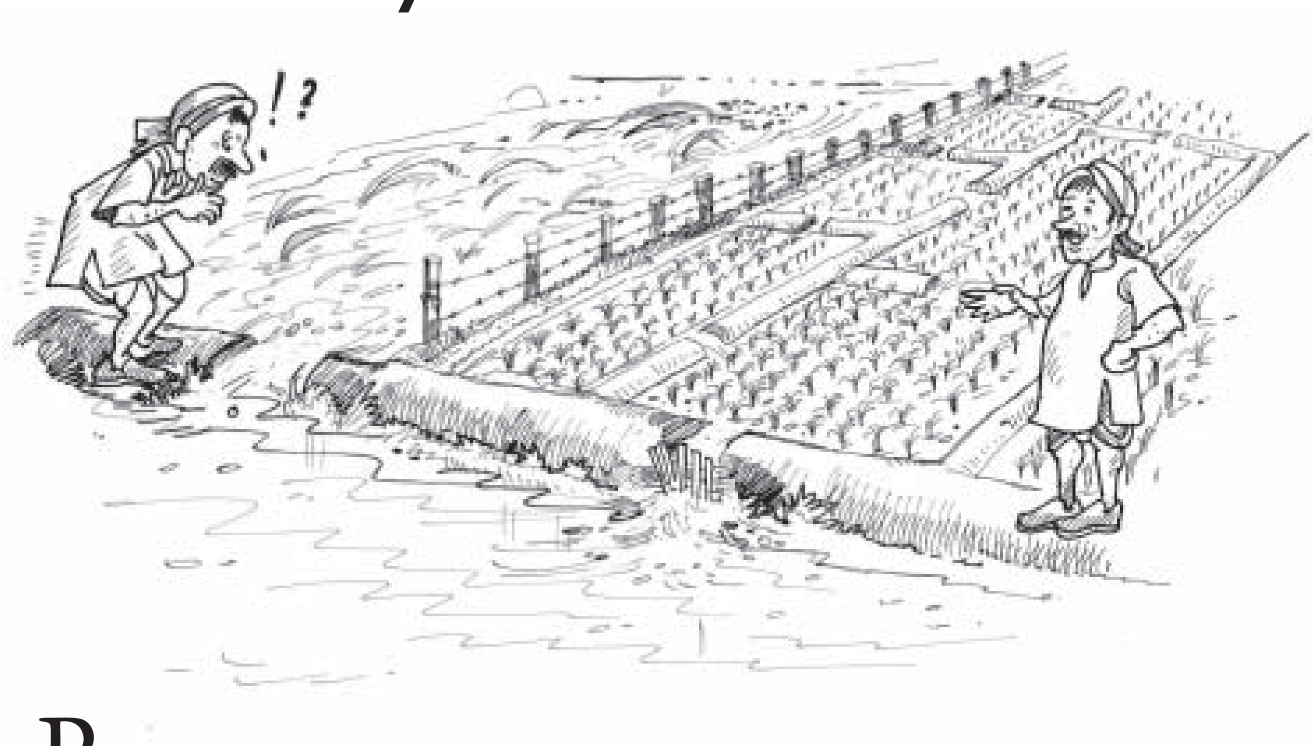
# Strategies and Practices for Increasing On-farm Water Productivity

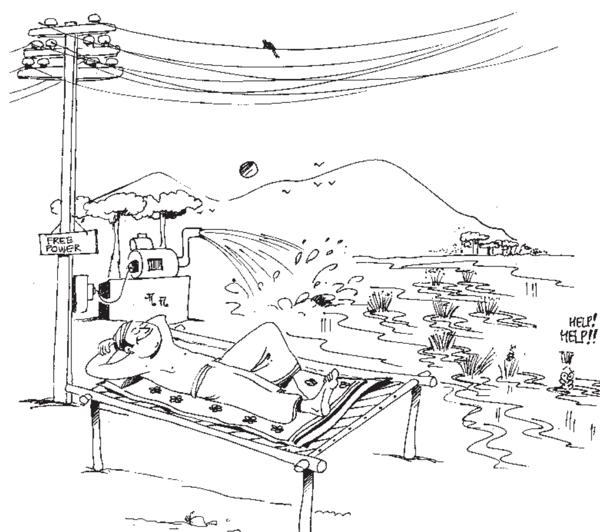



Rice flourishes in an abundant water environment that best differentiates it from all other important crops. This unique environmental adaptation, however, could lead to this crop facing the fate of the dinosaurs in an era where water is increasingly becoming scarce and there is competition from other sectors. Since 1980, the irrigated area per person has declined in a quick reversal of the trend in most of contemporary history when growth of irrigated area had outpaced population growth rates. Agriculture's share of water will decline at an even faster rate because of the increasing competition for available water from urban and industrial sectors (Tuong and Bhuiyan, 1994).

## Potential Changes

Some strategies that can be adopted to increase the water productivity on-farm are:

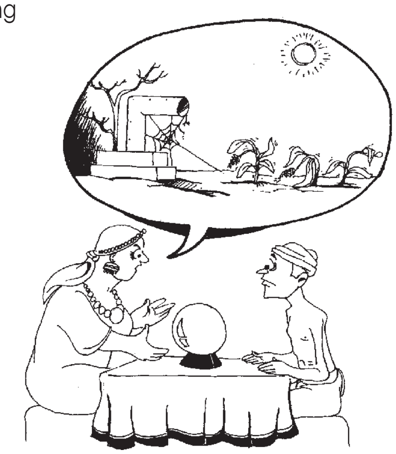
- Reduction of seepage and percolation losses of water during land preparation and crop growth periods.
- Reduction of water loss during land preparation.
- Reduction of surface runoff of irrigation water.
- Increase in crop yield per unit of evapo-transpiration during crop growth.

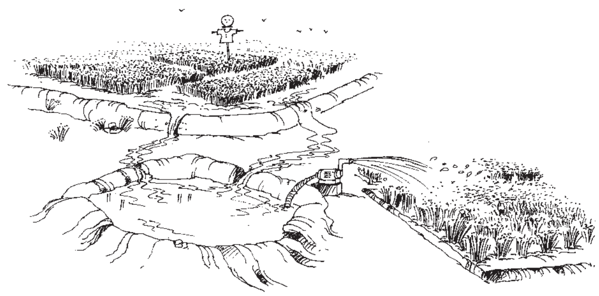


**Irrigation Efficiency**

The formulation of an action plan to achieve the objective of maximizing rice production with minimum water use raises a battery of pertinent questions to define who should do what, how it should be done, when and why. Some of the relevant questions are:

- What are the current levels of efficiency/productivity?
- What are the potential gains through adoption of infrastructural and management technologies and practices?
- Who should have the primary responsibility? What are the appropriate rules for farmer–users and systems managers that will minimize transaction costs and management requirements?
- What is the probability of water savings at the farm level being translated into net gains for the irrigation system and the entire basin?
- How should appropriate actions or interventions be identified?
- How should actions and interventions be evaluated for successful achievement of the objectives?





On-farm water savings by reduction of seepage or drainage outflow may also reduce the recharge of groundwater aquifers and availability of water downstream. The effects on such interdependent systems within a basin must be considered while assessing the water productivity. In some cases it may be more worthwhile to focus on re-use of drainage water rather than improving management of water delivery and application systems.

## Seepage and Percolation Reduction

Puddling or wet tillage creates a semipermeable hardpan that decreases percolation rate and can reduce input water requirement of rice crop by 40%-60% (Dayanand and Singh, 1980). Even if 1% of the area is left unpuddled over permeable subsoil, then the percolation rate could increase by a factor of five (Tuong, *et. al.,* 1994). Bunds can be sealed with clay taken from the plow layer to minimize lateral infiltration and underbund percolation. (Tuong *et al.,* 1994). Field bunds can also be lined with plastic sheets to reduce seepage losses.

In traditional transplanted rice, farmers prefer to maintain a relatively high depth of water. This leads to a high amount of seepage and percolation. However, continuous submergence is not essential for obtaining high rice yields. Water applied can be reduced by 40%-70% by maintaining saturated soil conditions or alternate wetting and drying of soil (Singh, *et al.,* 1996). The shallower the groundwater table, the longer the interval between irrigations (Mishra, *et al.,* 1990, 1997). In lighter soils, there is a greater reduction in water use. Soil nitrates and ammonium concentrations are not adversely affected by a saturated soil regime- instead of continuous flooding.

## Land Preparation

Excessive amount of water is often used for land preparation. Reducing the period of land preparation would lead to substantial saving of water lost through evaporation, seepage, percolation and surface run-off. Shallow, dry tillage soon after harvesting the previous crop can minimize the formation of soil cracks and loss of water through bypass flow. This can reduce water input by 31%-34% which corresponds to 108-117mm of water (Cabangon and Tuong, 2000).

## Surface Run-off

The shift from continuous submergence to a regime of saturated soil or alternate wetting and drying greatly reduces water loss due to surface run-off. More frequent application of smaller quantities of water, however, requires greater management capacity and more labor.

## Increased Crop Yield

Adoption of improved, early-maturing dwarf, high-yielding varieties (HYV) of rice started the Green Revolution and has more than doubled the average yield of irrigated rice from 2-3 tons per hectare to 5-6 tons per hectare. Simultaneously, the crop duration has decreased from about 140 days to about 110 days. This has increased the water productivity by 2.5 to 3.5 times with respect to evapotranspiration during the crop season per unit yield. The availability of hybrid rice varieties which have 15%-20% higher yield potential than inbred HYV rice of comparable crop duration, offers another opportunity to increase water productivity in rice culture.

Development of drought and salt-tolerant high-yielding varieties of rice through advances in biotechnology will further enhance water productivity. Better soil nutrient management can contribute by increasing yields at the same level of water use. Addition of 1kg nitrogen can increase rice yield by 10-15 kg (Peng, 1997, pers. comm). With on-farm water productivity at 0.5 kg rice per cubic meter of irrigation water, about 20-30 cubic meters of water is needed to obtain the same increase in yield.

## Direct Seeding

Direct seeding is a water-efficient method of rice establishment followed in several South and South East Asian Countries (Erguiza, *et al.,* 1990, Khan, *et al.,* 1992, Sattar and Bhuiyan, 1993). There are two forms: Wet Seeded Rice (WSR) and Dry Seeded Rice (DSR).

### Wet Seeded Rice (WSR)

In this form, pre-germinated rice seeds are broadcast on saturated, and usually puddled, soil. WSR systems use less water than transplanted rice for both land preparation and crop irrigation. The total irrigation water requirement is reduced by about 20%-25 % and the irrigation duration reduced from 140 to 105 days (Fuji and Cho, 1996). Less water is required because of shorter time for land preparation (Bhuiyan, *et al.,* 1995).

### Dry Seeded Rice (DSR)

Ungerminated rice seeds are sown on dry or moist, but unpuddled, soil. This form of planting uses rainfall more effectively and offers significant opportunity for conserving irrigation water. In DSR, early pre-monsoon rain is used effectively for crop establishment. Later, when the water reservoir is full, the crop can be irrigated as needed.

All methods for reducing water use in crop growth period by reducing losses and increasing yields help increase water productivity. Reduction of seepage and percolation in upstream farms may not improve the overall water use efficiency of the irrigation system if such water is normally re-used downstream. However, increases in yields due to use of HYV, efficient nutrient management, weed control, etc will improve both on-farm and system productivity.

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