

# Every drop counts

by Bas Bouman and Mia Aureus

*Water scarcity is crippling the world's food supply balance. So, IRRI has developed water-saving technologies to help farmers cope with the problem and, more importantly, to sustain global rice production*

**W**ater makes up 70% of our planet. But in spite of this vast availability, our fresh water reserve is finite. Over the years, improper use has led many to waste this precious natural resource, unaware of its dire crippling effects on the world's food supply balance, particularly for rice—the staple food of about 3 billion people around the world.

Like all other plants, rice needs water to survive. However, unlike most plants, it needs twice as much water to produce good yields. For 1 kg of rough rice, for example, an average of 2,500 liters of water needs to be supplied by rainfall and/or irrigation (see *How much water does rice use?* on pages 28-29 of *Rice Today* Vol. 8, No. 1). About 1,400 liters are used up in evaporation and transpiration, while the remaining 1,100 liters are lost by seepage and percolation. A farmer, then, constantly needs to ensure that sufficient irrigation water is provided (to complement rainfall if that is insufficient) to match all these outflows. Note that transpiration (the process by which the rice plant absorbs water, takes it up to bring essential nutrients from roots to leaves, then releases it to the atmosphere) is the only productive water use, as it helps the plant stay alive and healthy.

BAS BOUMAN (3)



AN IRRIGATION canal in northern China dries up because of water scarcity.

irrigation water and need to be managed in the most water-efficient way. The causes for increasing water scarcity are diverse and location-specific. They include falling groundwater tables, chemical pollution, malfunctioning of irrigation systems, and increased competition from other sectors such as urban and industrial users.

In the face of this troubling reality, the International Rice Research Institute (IRRI) has developed several water-saving technologies to help farmers cope better with water scarcity in their paddy fields. Farmers primarily need to reduce the nonproductive outflows (percolation, seepage, and evaporation), while maintaining transpiration flows. This can be done during land preparation, crop establishment, and the actual crop growth period.

## Growing water scarcity

Fresh water for agriculture around the world, however, is becoming increasingly scarce, thereby threatening rice productivity and, consequently, the world's food supply. In the next 25 years, some 15–20 million hectares of irrigated rice are projected to suffer some degree of water scarcity, particularly the wet-season irrigated rice regions of China, India, and Pakistan. Dry-season irrigated rice areas everywhere in Asia rely on expensive

## Get the basics right

In preparing the land—the foundation of the whole cropping season—it is crucial for farmers to “get the basics right.” To establish good water management early on, they need to properly build field channels, level the land, prepare solid bunds, and effectively implement tillage operations (puddling).

In most irrigation systems in Asia, water flows from one field into another and there are no *field*

channels to convey irrigation water to, and drainage water from, individual fields. So, farmers usually have a hard time controlling the flow of water in and out of the fields. Either the farm loses much of its water to other farms or it gets too flooded as water from other farms pours in. Water that continuously flows through the rice fields may also remove valuable nutrients. Constructing separate channels to convey water to and from each field will help improve individual control of water. This is the recommended practice in any type of irrigation system.

Another prerequisite for good water management is a *well-leveled field*. Logically, when fields are not even, water cannot be equally distributed. Some parts may suffer from water stagnation, while other sections may become dry. This results in uneven crop emergence, uneven early growth, uneven fertilizer distribution, and weed problems.

Most farmers puddle their fields to prepare the land for transplanting of seedlings. *Puddling* is the repeated harrowing of the soil under flooded conditions and it results in a muddy layer 15–20 cm thick. Before puddling takes place, farmers need to soak the land at the end of the previous fallow period. Sometimes, large and deep cracks are present in the soil and a lot of water is lost at soaking by water flowing down these cracks. A shallow tillage to fill the cracks before soaking can greatly reduce this water loss.

Puddling creates a so-called *plow layer* of some 5-cm thickness just below the muddy layer. This plow layer is very compact and it prevents water from percolating downward, where the roots of the rice plants cannot reach it anymore. Thorough puddling after soaking the field results in a more compacted soil. Puddling is especially effective in clay soils that form cracks during the fallow period.

*Good bunds* or *paddy dikes* also help limit water losses by seepage and underbund flows. Bunds should be well compacted. Any rat holes should be plastered with mud at the beginning of the crop

# Saving water: alternate wetting and drying

## Water scarcity

Worldwide, water for agriculture is becoming increasingly scarce. By 2025, 15 to 20 million hectares of irrigated rice may suffer some degree of water scarcity. Interventions to respond to water scarcity are called “water savings” and imply a reduced use of irrigation water.

## What is AWD?

Alternate wetting and drying (AWD) is a water-saving technology that lowland (paddy) rice farmers can apply to reduce their water use in irrigated fields. In AWD, irrigation water is applied to flood the field after a certain number of days have passed following the disappearance of ponded water. Hence, the field is alternately flooded and not flooded. The number of days of nonflooded soil in AWD in between irrigations can vary from 1 day to more than 10 days.

## How to implement AWD?

A practical way to implement AWD is to monitor the depth of ponded water in a field using a field water tube. After irrigation, the depth of ponded water will gradually decrease. When ponded water drops to 15 cm below the soil surface, irrigation should be applied to re-flood the field up to 5 cm. From a week before until a week after flowering, ponded water should always be kept at 5-cm depth. After flowering and during grain filling and ripening, the water level can be allowed to drop again to 15 cm below the surface before re-irrigation.

A farmer can start AWD a few days after transplanting (or with a 10-cm-tall crop in direct seeding). If there are too many weeds, AWD can be postponed for 2–3 weeks, until the ponded water suppresses weed growth. Local fertilizer recommendations for flooded rice can

be used. Apply nitrogen fertilizer preferably on the dry soil just before irrigation.

## Safe AWD

The threshold of 15 cm is called *Safe AWD* as this will not reduce yields. In *Safe AWD*, water savings are on the order of 15–30%. Once farmers feel confident that *Safe AWD* will not reduce their yields, they can try to drop the threshold level for irrigation to 20 cm, 25 cm, 30 cm, or even lower. This will help save more water, although production may be slightly affected. This minor setback may be acceptable when the price of water is high or when water is very scarce.

## The field water tube

This tube can be made of a 40-cm-long plastic pipe or bamboo, with a diameter of 15 cm or more, to allow farmers to see and monitor the

water table. Put holes on all sides of the tube. Stick the tube into the soil, but leave 15 cm above the soil surface. Remove the soil inside the tube so that the bottom will be visible. Make sure that the water table inside the tube is the same as that on the outside. The tube can be placed in a flat part of the field close to a bund so that it is easy to monitor the depth of ponded water.

EDNA REYES (2)



A SAMPLE field water tube made from polyvinyl chloride. Note the holes on all sides.



THE SOIL inside the tube is removed after sticking it into the ground.

season. Farmers need to also check for, and repair, new rat holes, cracks, and pores dug by earthworms throughout the growing season. Plastic sheets can be used to fix permeable sections of the bunds.

During the crop growth period, farmers are best advised to keep their ponded water at a 5-cm depth to minimize the loss of water by seepage and percolation. This is also the advised level in another water-saving technology called alternate wetting and drying (AWD) (see *The big squeeze* on pages 26-31 of *Rice Today* Vol. 7, No. 2).

AWD, also known as controlled irrigation, does not require rice fields to be continuously flooded. Farmers flood the fields up to 5 cm for a few days, and then let them dry to a certain extent, before re-flooding them. This cycle goes on throughout the season, but with a period of continuous flooding during flowering to prevent sterility from occurring. In the practice of safe AWD, farmers use a field tube to monitor the underground water level in the field: when the ponded water has dropped to 15–20 cm below the surface of the soil, it is time to flood the field again. It was found that this technology reduced the amount of water required by a quarter and, more importantly, it did not reduce yields.

### Aerobic rice

When water is really very scarce, and there is not enough water to



FARMERS PUDDLE their fields to prepare the land for transplanting seedlings.



FARMERS MUST make sure that the bunds are well compacted to limit water loss.

even intermittently flood the field such as in AWD, the system of *aerobic rice* may be useful (see *High and dry* on pages 28-33 of *Rice Today* Vol. 7, No. 2). Aerobic rice is a production system in which especially developed “aerobic rice” varieties are grown in well-

drained, nonpuddled, and nonflooded soils. With good management, aerobic rice can produce up to 4–6 tons per hectare while using less than half the water required in flooded paddy rice.

### Every drop counts

Today’s problem of water scarcity reminds everyone of water’s finite nature. IRRI continues to further develop and refine water-saving technologies to help farmers cope. As water scarcity increases and climate change aggravates the problem, IRRI is also stepping up its efforts in disseminating these technologies to farmers. Outreach efforts include an array of training activities and the production of

information

materials such as leaflets, brochures, posters, manuals, and eventually e-learning courses to reach out to as many people as possible. New partnerships are being forged among scientists, extension agencies, irrigation system managers, and farmers to jointly tackle the problem of water scarcity and implement solutions. To help the fate of water-scarce farmers and to ensure global food security, every

drop of water counts. 🌱

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