IRRI

Rice science for a better world

Overview of AWD

Alternate wetting and drying (AWD) is a management practice in irrigated lowland rice that saves water and reduces greenhouse gas (GHG) emissions while maintaining yields.

Under the best management practice developed by IRRI water scientists, the AWD water regime starts two weeks after transplanting. The rice field is left to dry, but only to a point when there is still sufficient water in the soil for sustained plant growth. The soil water content can easily be monitored, so that the farmer can re-flood the field once a certain water level (e.g. 15 cm below the soil surface) is reached. Then, the field is re-flooded to a water depth of about 3-5 cm before draining again. This cycle is done repeatedly except during flowering stage of crop growth when the plants are very sensitive to dry conditions and field is kept in flooded conditions.

IRRI has been promoting AWD as a smart water-saving method for rice cultivation. Through the national agricultural research and extension systems, farmers are now being trained and the use of AWD being spread in Bangladesh, the Philippines, and Vietnam.

Aside from its water-saving feature, a large potential exists for GHG reductions from rice paddies through the use of systematically introduced AWD, optimized for GHG mitigation. At present, AWD is widely accepted as the most promising practice for reducing GHG emissions from irrigated rice for its large methane reductions and multiple benefits.

What are the benefits of AWD?

Reduced water use. By reducing the number of irrigation events required, AWD can reduce water use by up to 30%. It can help farmers cope with water scarcity and increase reliability of downstream irrigation water supply.

Greenhouse gas mitigation potential. In the 2006 IPCC methodology, AWD is assumed to reduce methane (CH_4) emissions by an average of 48% compared to continuous flooding. Combining AWD with nitrogen-use efficiency and management of organic inputs can further reduce greenhouse gas emissions. This suite of practices can be referred to as AWD+.

Increased net return for farmers. AWD+ does not reduce yields compared to continuous flooding, and may in fact increase yields by promoting more effective tillering and stronger root growth of rice plants. Farmers who use pump irrigation can save money on irrigation costs and see a higher net return from using AWD. AWD may reduce labor costs by improving field conditions (soil stability) at harvest, allowing for mechanical harvesting.

Where can AWD be practiced?

In general, lowland rice-growing areas where soils can be drained in weekly intervals are suitable for AWD. High rainfall may impede AWD. If rainfall exceeds water lost to evapotranspiration and seepage, the field will be unable to dry during the rice-growing period.

Farmers must have control over irrigation of their fields and know that they will have access to water once fields have drained. AWD in rainfed rice is not recommended due to uncertain water availability when fields have to be re-flooded.

Mitigation potential of AWD

Flooded rice systems (comprising irrigated, rainfed, and deepwater rice) emit significant amounts of CH_4. Although estimates vary and have high uncertainty, recent work suggests that flooded rice contributes about 10–12% of anthropogenic emissions from the agriculture sector globally.

CH_4 emissions from rice fields have been intensively studied, with more than 300 peer-reviewed scientific journal articles since the 1990s documenting the factors that affect CH_4 and nitrous oxide (N_2O) emissions. The vast majority of this work has taken place in China, Japan, and the US and, to a lesser extent, in India and Southeast Asia. Water regime and organic inputs are the primary determinants of CH_4 emissions in rice systems but soil type, weather/ climate, tillage management, residue, fertilizers, and rice cultivars also play a role.

Research has consistently found that non-continuous water regimes such as AWD produce significantly lower CH_4 emissions than continuous flooding. According to empirical models, 10-15% of the benefit gained by decreasing CH_4 emission is offset by the increase in N_2O emissions. However, net global warming potential is still significantly lower under AWD than in continuously flooded fields.

The mitigation potential of AWD depends strongly on its proper execution. Incomplete drainage (not allowing the water table to drop to 15 cm below soil surface) can result in negligible reductions in GHG emissions.

How does AWD reduce GHG emissions?

CH_4 in wet or "paddy" rice soil is produced by the anaerobic decomposition of organic material after the flooding of rice fields. Allowing the field to drain halts CH_4 production, which happens in anaerobic condition, thus reducing the total quantity of CH_4 released during the growing season.

The production of N_2O is also regulated by the presence of oxygen. In contrast to CH_4 however, the recurring shift between aerobic and anaerobic conditions favors bacterial conversion of other nitrogen compounds to N_2O and its release from the soil. The production of N_2O is also strongly influenced by the availability of nitrogen in the soil. Thus, N_2O emissions increase with the amount of nitrogen fertilizer applied to rice paddies.

BY THE NUMBERS: GHG REDUCTION BY AWD

Flooded rice produces approximately 20–40 Mt of CH4 per year, or about 10–12% of anthropogenic emissions from the agriculture sector globally.

In a review of on-station experiments in Asia, the CH4 emission reduction associated with multiple drying ranged from 14 to 80%, with a mean of 43%.

On-farm experiments with AWD have shown reductions in CH4 emissions by 20–70%.

IPCC 2006 Guidelines for National Greenhouse Gas Inventories estimate a 48% reduction inmethane emissions from AWD.

Using IPCC 2006 guidelines, it has been estimated that if all continuously flooded rice fields were drained at least once during the growing season, global CH4 emissions would be reduced by 4.1 Mt per year.

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