International Water Management Institute

Fact Sheet

Field water management and irrigation practices in rice production in West Africa

Introduction

Efficient water management in rice cultivation is essential for improving crop yields, conserving water resources, and ensuring the sustainability of the production system. There are different components of field water management and irrigation practices in irrigated rice production. This fact sheet provides basic guides in efficient water management and irrigation for better productivity in rice production.

Water use and productivity

Rice is highly water-intensive, requiring around 3,000 to 6,000 liters per kilogram of grain produced. Improved irrigation techniques can reduce water use by 30-40% without compromising yield.

Irrigation method

Basin and check basin

- Basin irrigation is practiced where land is relatively flat.
- The flatter the surface of the land, the easier it is to construct basins. Some leveling may be required on uneven lands to ensure uniform water distribution.
- Basins can also be built on terraced slopes.
- The construction of structures for surface irrigation — basins and check basins — is done after the land preparation, including land leveling (Figure 1).

These structures require labor cost, depending on the prevailing costs within the farm environment.

Field leveling:

Field leveling using essential tools (hoes, planks and lines) and, where available, efficient modern technology such as laser guided leveler technology is a critical practice for lowland rice prodution. Leveling improves water distribution efficiency, reducing water use by 20-30%. It ensures uniform water depth and prevents waterlogging in the field areas. Land leveling is critical for efficient irrigation in lowland rice production.

Saturated Soil Culture (SSC)

Instead of continuously flooding the fields, maintaining the soil in a saturated state can save water, improve oxygen availability to the roots and tillering, and boost rice yields by up to 10-15%.

Irrigation scheduling

- A proper irrigation schedule based on the crop's growth stage and soil moisture levels can enhance water use efficiency by 15-20%.
- Real-time data from alternate wetting and drying tubes can guide more precise irrigation.

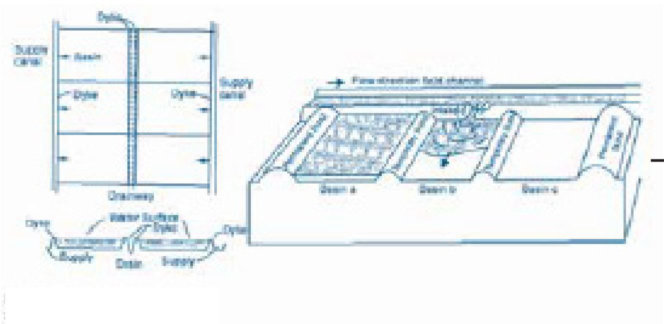


Figure 1. Typical basin layout. *Source:* FAO

Photo: Adebayo Oke

Water application

Water application in rice production must be adequate throughout the crop cycle, especially at the critical stages of development.

i. Irrigation water is released in the basin for puddling and leveling, which is essential to provide a suitable environment for rice transplanting.
ii. After transplanting, water levels should be around 3 cm initially, gradually increasing to 5-10 cm (with increasing plant height), and remain there until the field is drained 7-10 days before harvest.
iii. For direct wet-seeded rice, the field should be flooded only when the plants are large enough to withstand shallow flooding (3-4 leaf stage).
iv. The number of drainages and days the field is non-flooded will vary based on the soil type and climate realities.
v. Excess water may need to be drained from the field shortly before applying fertilizer.

Best practices for water management

1. **Alternate Wetting and Drying (AWD):** AWD is a proven water-saving technique that allows fields to dry for a few days before irrigation. This method can reduce water consumption by up to 25% and improve nitrogen uptake, resulting in higher yields, and reduce the emission of greenhouse gases such as methane.
2. **Field preparation:** Bund management - well-constructed and maintained bunds (field boundaries) prevent water seepage and allowing water retention.
3. **Weed control:** Effective weed management reduces competition for water, ensuring that more water is available for rice crops.

1. Make a simple AWD water tube (Figure 2) from a 30cm-4 inches diameter pipe.
2. Drill holes (perforation) at uniform intervals (0.5mm with a distance of 2cm away from one another) across 15cm of the pipe,leaving the upper 15cm unperforated
3. After, the tube can be placed in the field, Close to the ound. not less than 1m away from the bund. Farmers can monitor the tube when it is placed nearer to the bunds.
4. Bury the field water tube vertically up to 20cm, with the end allahore end protruding above the soil surface; after dipping, remove the soil/mud present in the tube so that the bottom of the tube is visible (Figure 3).
5. Observe the water level in the tube. When the water level falls below 15cm, the field is reflooded up to 5cm above the soil Surface. The threshold limit of 15cm will not cause any yield declines and is thus considered safe AWD

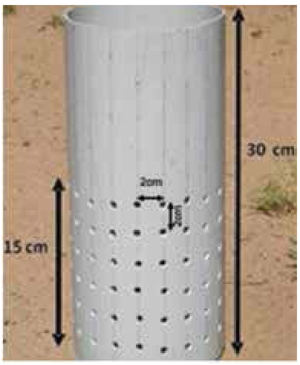


Figure 2. AWD Tube.


Figure 3. Installation of AWD Tube.

Environmental and economic benefits

1. Reduction in methane emissions: Improved water management practices such as AWD can lower methane emissions by up to 48% by reducing the continuous flooding of rice paddies, contributing to climate change mitigation.
2. Cost savings: Farmers can reduce irrigation costs by 10-30% through improved practices, lowering energy use for pumping water and reducing input costs.
3. Improved crop resilience: Proper water management enhances rice crops' resilience to droughts and other water-related stresses, leading to more consistent yields.

Water quality of irrigation water sources

- Water quality is a critical factor in managing irrigation systems for rice production.
- Rice is a water-intensive crop, and the quality of water used for irrigation directly affects yield and soil health.
- Understanding critical water quality parameters helps ensure sustainable rice cultivation, minimize environmental impacts, and maintain soil fertility.

Sources of water for irrigation

Surface water (rivers, lakes, reservoirs)	Groundwater (wells, boreholes)	Recycled or wastewater
	ADVANTAGES	
Generally low in salt and toxins, rich in dissolved oxygen, and easy to manage for rice paddies.	Consistent supply and availabilty during dry periods.	Reduces pressure on freshwater sources and conserves water in water-scare regions.
	CHALLENGES	
Vulnerable to seasonal fluctuation and contamination from agricultural runoff and industrial pollutants.	Risk of high salinity, elevated SAR, and contamination with toxic elements such as arsenic and flouride, especially in regions with shallow acuifers.	Requires careful treatment to avoid salinity isuues, pathogen contamination, or the presence of harmful chemicals (e.g., heavy metals).

Key water quality parameters in rice irrigation

1. Salinity (Electrical Conductivity, EC): Optimal range: < 0.75 dS/m for rice

Impact: High salinity causes osmotic stress, which leads to reduced water uptake, stunted growth, and lower yields. Prolonged use of saline water can degrade soil structure and lead to field salinization.

Management: Flushing fields with good-quality water, selecting salt-tolerant rice varieties, and improving drainage systems.

2. Sodium Adsorption Ratio (SAR): Optimal range: SAR < 6 for good water quality

Impact: High salinity causes osmotic stress, which leads to reduced water uptake, stunted growth, and lower yields. Prolonged use of saline water can degrade soil structure and lead to field salinization.

Management: SAR is an index of sodium, calcium and magnesium levels in irrigation water. High SAR indicates the possibility of sodium accumulation in soil, affecting soil structure and permeability. This can cause poor water infiltration and drainage issues in rice paddies.

3. pH levels: Optimal range: 5.5-7.5.

Impact: Extremely acidic (< 4-5) or alkaline (> 8.5) water can affect nutrient availability, microbial activity, and root function. Acidic water leads to toxicities (e.g., aluminum), while alkaline water can cause micronutrient deficiencies such as zinc and iron.

Management: Liming to raise pH if too acidic or applying sulfur or acidifying fertilizers to lower pH if too alkaline.

4. Dissolved Oxygen (DO): Optimal range: > 5 mg/L for healthy crop growth

Impact: Low dissolved oxygen levels, especially in stagnant or poorly managed fields, can lead to anaerobic conditions, affecting root respiration and microbial activities in the soil.

Management: To restore oxygen levels, aerate water or allow drying periods (alternate wetting and drying methods.

5. Nutrient content.

Impact: Nitrogen, phosphorus, and potassium: Adequate levels are essential for healthy crop growth, but excessive nutrients, especially nitrogen, can lead to lodging (weak stems), poor grain filling, and environmental pollution.

Management: Monitor nutrient levels in irrigation water and adjust fertilization practices to avoid nutrient imbalances.

6. Toxic elements: Common toxins: Arsenic (As), Boron (B), Iron (Fe), Manganese (Mn), Aluminum (Al)

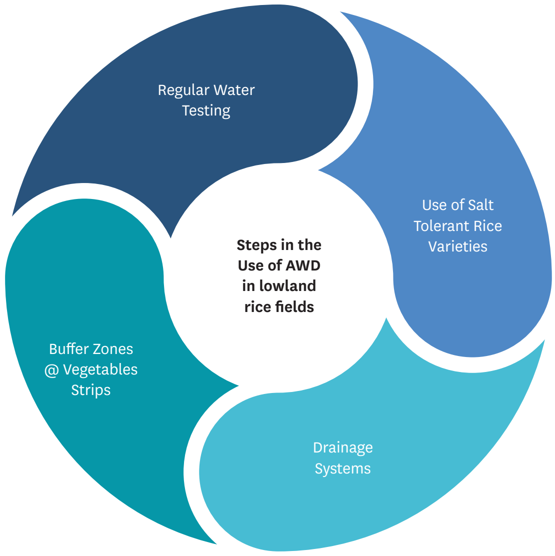
Impact: These elements, particularly arsenic, are toxic to rice plants at elevated levels. Arsenic contamination, often associated with groundwater, can accumulate in rice grains and pose health risks to consumers.

Management: Adopt the following measures: Soil and water testing, use of organic amendments, alternative irrigation practices, phytoremediation, crop rotation and soil management, and breeding and selection of varieties.

Best Practices for Water Quality Management in Rice Irrigation

Test water sources for salinity, pH, SAR, nutrient levels, toxic elements before & during the growing season to adjust management strategies accordingly.

In areas prone to salinity issues, use rice varieties that are genetically adapted to tolerate higher salt levels,reducing yield losses.



Establish buffer zones along irrigationchannels or paddies to filter runoff and prevent the entry of pollutants into water systems used for irrigation.

Ensure effective field drainage to prevent the accumulation of salts, toxins, or excess water that can negatively impact plant growth.

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For more information on water management in rice systems, visit: http://www.iwmi.org and http://www.knowledgebank.irri.org/org/step-by-step-production/growth/water-management or contact: Dr. Adebayo Oke; Email: a.oke@cgiar.org

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