Digitized Content Package on Sustainable Water Management in Paddy Rice Production

Sustainable Water Management in Paddy Rice Production and Alternate Wetting and Drying (AWD)Techniques for Sustainable Rice Production

1.0 Introduction: The Critical Role of Water in Rice Production

Rice cultivation in Nigeria falls into two main categories: Upland rice, grown without flooding on hillsides, sloppy terrain, and higher elevated regions, and Lowland rice (Paddy Rice), grown in fields that can be flooded through rain-fed, irrigated, or floodplain systems. Rice requires 3,000–5,000 liters/kg, far exceeding other grains (e.g., wheat: 900–1,200 liters/kg), traditional CF wastes 30–50% of water and emits methane (CH_4). Traditional water management in Nigeria's irrigated rice systems often involves continuous flooding, which is believed to control weeds. However, this practice has significant limitations, including high water wastage, increased methane emissions, and potential for shallow rooting and inefficient nutrient uptake, ultimately affecting the sustainability and productivity of rice production. Nigerian rice production faces several critical water management challenges:

- Increasing water scarcity affecting agricultural productivity
- Climate change impacts on rainfall patterns and water availability
- Environmental concerns about greenhouse gas emissions from traditional practices
- Need for more efficient water use to support growing food demand
- Economic pressures to reduce production costs while maintaining yields

Efficient water management enhances productivity, reduces costs, and supports sustainability.

In AWD, the rice field is periodically dried and re-flooded, creating alternating aerobic and anaerobic conditions in the soil. This drying period breaks the cycle of methane production by methanogenic microbes. AWD offers a climate-smart, water-saving alternative.

Principles of AWD (Alternate Wetting and Drying)
In Alternate Wetting and Drying (AWD), the water table is allowed to lower into the soil to some predetermined depth. Thereafter, the fields are flooded again. Thus, AWD is defined by the periodic drying and re-flooding of the rice field, creating alternating aerobic and anaerobic conditions in the field.

Scientific Rationale: Since CH_4 production in rice fields is enhanced by anaerobic conditions resulting from standing water over the rice field, the few days the field surface is dried of water breaks the cycle of methane production while maintaining adequate conditions for rice growth.

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Step-by-Step AWD Practice in Farmer Fields

1. Install a 30 cm perforated PVC tube in a representative section of the rice field.

2. Drying Period: After initial crop establishment, allow water to recede naturally. Allow the water to completely dry up from the soil surface. This will take a few days, depending on evapotranspiration (ET) rates.

3. Water Table Monitoring: Monitor the water level inside the tube.

4. When it drops 15 cm below the surface, irrigate to 5 cm depth.

5. Re-flooding: Flood the field again to the initial depth. Repeat until flowering; maintain standing water from flowering to grain filling stages.

The Standard Safe AWD Protocol involves irrigating the field when the water level drops to 15 cm below the soil surface. For a more conservative approach, especially for first-time users, irrigation can be triggered at 10 cm below the surface. The safe AWD range is between 10-15 cm depth below the soil surface.

Monitoring Tools and Techniques (PVC Pipe Method, Field Indicators)

Tool: Insert a perforated PVC pipe (7.5 to 10 cm diameter, 30-35 cm length, perforated from base to 20-25 cm height) into the field. A plastic bottle can also be used.

Placement: One pipe can monitor 0.1 to 0.2 hectares of a well-leveled field.

Measurement: Observe and measure the water depth in the pipe daily using a measuring tape or calibrated stick/ruler. The water level in the pipe will reflect the water level on/in the soil.

Field Indicators: Field indicators such as soil cracks, leaf curling, and changes in soil texture can signal moisture stress. These indicators can be effectively used with farmer-friendly guidelines and mobile apps to send alerts and support informed irrigation decisions

Benefits and Limitations of AWD

Water Conservation Benefits: The Alternate Wetting and Drying (AWD) method offers significant water conservation benefits, including a 30-50% reduction in irrigation frequency and water savings of around 38% without compromising rice yields. AWD also improves irrigation scheduling, reducing frequency from twice a week to once every 5-7 days, and increases water productivity by 16.9% compared to continuous flooding.

Economic and productivity benefits: This includes direct cost savings from reduced labor requirements, lower energy consumption, and extended irrigation equipment life.

Additionally, AWD promotes input efficiency, enabling better utilization of fertilizers and pesticides, thereby enhancing overall productivity.

Yield and Quality Improvements: The Alternate Wetting and Drying (AWD) technique maintains high yields in rice varieties bred for continuous flooding, with some cases reporting yield increases of 7-12%. Additionally, AWD helps maintain or even improve grain quality parameters, ensuring stable performance and potential benefits for rice production.

AWD offers several environmental and climate benefits, including a 14-18% reduction in global warming potential and substantial decreases in methane emissions, resulting in a lower carbon footprint. It also improves soil health by enhancing nutrient availability, organic matter cycling, soil aeration, and beneficial microbial activity. Additionally, AWD promotes crop health by reducing pests and diseases, improving root development, and increasing stress tolerance, ultimately contributing to a more sustainable rice production system

Limitations and Implementation Challenges

Infrastructure Requirements: Effective implementation of AWD requires controlled irrigation access, reliable water supply, and initial investment in monitoring equipment and field modifications. Additionally, farmers need technical knowledge and water management skills to successfully adopt AWD, which can be a challenge for some users.

Management Complexity: AWD implementation faces limitations and challenges, including management complexity that requires increased attention to monitoring and decision-making, risk management to prevent water stress and yield reduction, and a learning curve that necessitates technical support and capacity building for farmers to successfully adopt the practice.

Synergy with Good Agronomic Practices (GAP):

The success of AWD greatly depends on integrating it with other Good Agronomic Practices (GAP) and Good Irrigation Management Practices (GIMP). These include:

- Properly prepared land.
- Planting adapted high-yield rice varieties.
- Observing appropriate transplanting age and plant spacing.
- Observing appropriate crop growing period.
- Fertilizer application based on the

4Rs: Right rate, Right amount, Right time, Right nutrient.

- Effective weeding, disease, and pest control.
- Using high-quality water for irrigation.
- Selecting irrigation methods and tools that suit the terrain and farmer's technical know-how.