KP11
Knowledge Product 11

CCARDESA
Centre for Coordination of Agricultural Research and Development for Southern Africa

# DECISION TOOL:
# Climate Smart Water Management Options for Rice

**CLIMATE SMART AGRICULTURE**
**KNOWLEDGE PRODUCTS FOR EXTENSION WORKERS**
Customised Information Tools for Agricultural Professionals

*Audience: Local Level Extension Staff (Government, NGO/Civil Society, Private Sector)*

Rice | Decision Point | Gender | Youth | Climate Smart | Practice | Technology

*APPSA, 2013*

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# WHAT IS CLIMATE SMART AGRICULTURE (CSA)?

CSA comprises three interlinked pillars, which need to be addressed to achieve the overall goals of food security and sustainable development:

1. **Productivity:** Sustainably increase productivity and incomes from agriculture, without negative impacts on the environment
2. **Adaptation:** Reduce exposure of farmers to short-term risks, while building capacity to adapt and prosper in the face of shocks and longer-term stresses (resilience). Attention is given to protecting ecosystem services, maintaining productivity and our ability to adapt to climate changes
3. **Mitigation:** Wherever and whenever possible, CSA should help to reduce and/or remove greenhouse gas (GHG) emissions. This implies that we reduce emissions for each unit of agricultural product (e.g., through decreasing use of fossil fuel, improving agricultural productivity and increasing vegetation cover).

**CSA = Sustainable Agriculture + Resilience – Emissions.**

## How is CSA Different?

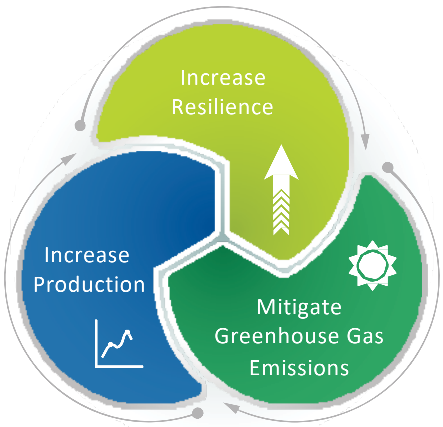
1. CSA places greater emphasis on **hazard and vulnerability assessments** and **emphasises weather forecasting** (short term) and **climate scenario modelling** (long term) in the decision-making process for new agricultural interventions
2. CSA promotes the **scaling up of approaches** that achieve **triple wins** (increase **production**, increase **resilience** and [if possible] **mitigate GHG emissions**), while at the same time **reducing poverty** and **enhancing ecosystem services**
3. CSA promotes a systematic approach to:
   a. Identifying **best bet** opportunities for agricultural investment
   b. Contextualising **best bet** options to make them **best fit** their specific context through learning and feedback loops
   c. Ensuring the **enabling environment** is in place so that farmers (and other stakeholders) can invest in CSA practices and technologies to catalyse adoption.

## Key Messages:

1. Climate smart management of available water resources can greatly increase resilience of rice to ever-changing rainfall patterns
2. To make climate smart decisions on water management options for rice, you need to consider:
   - Crop water requirements
   - Probable rainfall
   - The status of the soil
   - Farmers' priorities
   - Gender dynamics
3. Climate smart water management options for rice include:
   - Variety and crop selection
   - In-field water harvesting
   - Land preparation
   - Alternate wetting & drying
   - System of rice intensification.

## Entry Points for CSA

- CSA practices and technologies
- CSA systems approaches
- Enabling environments for CSA.



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# CLIMATE SMART WATER MANAGEMENT OPTIONS FOR RICE

This **Decision Tool** aims to help field-level extension staff make **climate smart decisions** on which water management option best suits their farmers' context. This tool is not designed as a technical guide to implementation. It is designed to assist extension staff in making climate smart decisions on improvements to their farming systems with their clients. Reference to technical guides relevant to the practices/technologies outlined are included at the end of the tool. The tool focuses on some of the **Best Bet Climate Smart Water Management Options** for rice production in the Southern African Development Community (SADC) region. These are just some of the many options available. In many cases multiple options might be selected. They are listed in no particular order and have been selected as best bet because:

- They are climate smart (see Table 1)
- They are applicable in multiple agro-ecological zones across the region
- They have high potential to address major constraints (water stress) to rice production in the region (Table 1).

These are best bet options. An understanding of the local context and farmers' priorities is required in order to make these options **Best Fit** to individual farmer's needs.

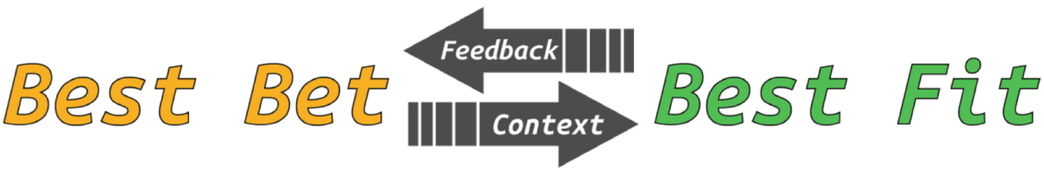



**Table 1: Best Bet Climate Smart Water Management Options for Rice that have potential to address climate risks across the SADC region.**

| Climate Smart Water Management Practice Option | What is it? | 3 Pillars of CSA | | |
|---|---|---|---|---|
| | | Increase Production | Resilience/ Adaptation | Mitigate GHG Emissions if possible |
| **Variety/Crop Selection** | Selecting early-maturing, drought-tolerant or flood-tolerant varieties. Suitable for irrigated lowland, rainfed lowland and rainfed upland rice systems | Varieties specifically bred for yield potential at lower water availability or for longer submergence | More predictable yields | N/A |
| **In-field Water Harvesting** | Practices to increase water infiltration and moisture retention in the soil<br>Predominantly used in rainfed upland systems | Water is available to plants when it is needed<br>Reduced nutrient leaching | Reduce dry spells | Can lock more carbon in the soil<br>Increase fertiliser-use efficiency |
| **Land Preparation** | Reduced use of water and water loss during land preparation and planting | Cost of production reduced through use of less water | Maintain production with reduced inputs<br>Predictable yields | May reduce GHG emissions from irrigation pumps |
| **Alternate Wetting and Drying** | Rice field (paddy) is not continuously kept with a layer of water covering the soil<br>Suitable only for irrigated rice | Cost of production reduced through less use of water | Maintain production with reduced inputs<br>Predictable yields | May reduce GHG emissions from irrigation pumps |
| **System of Rice Intensification** | An integrated system for growing rice that includes alternate wetting and drying<br>Suitable only for irrigated rice | Reduced inputs for greater yield | Predictable yields<br>Higher production equals increased food security/ income and resilience | May reduce GHG emissions from irrigation pumps |

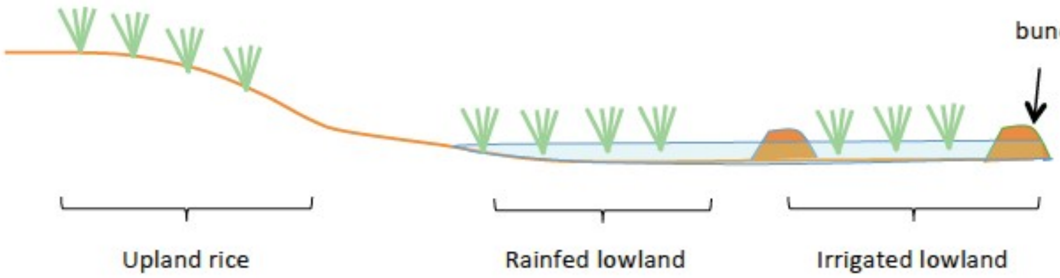
# WHICH CLIMATE SMART WATER MANAGEMENT OPTION IS BEST SUITED TO YOUR FARMERS?

There are three main types of rice production system:

- Irrigated lowland
- Rainfed lowland
- Rainfed upland.

The differences between these systems of production are outlined in Figure 1 and Table 2 below. There is a fourth system, the mangrove swamp. This represents only a very small portion (6%) of the rice growing area in Africa, and is not discussed further here. 'Lowland' refers to the production technique (rice grown on land that is flooded or irrigated), not altitude.

**Figure 1: Ecologies where rice is grown.**




*Source: ASHC, 2015.*

**Table 2: Descriptions of the three main rice growing systems in SADC.**

| Criteria | Rain-fed upland | Rain-fed lowland | Irrigated lowland |
|---|---|---|---|
| **Estimated % of rice production in Africa** | 20 | 47 | 33 |
| **Ecologies where used** | Uplands, from low lying valleys to steep slopes | Swampy, low lying areas that collect a lot of water | Flood plains, valley bottoms and terraced fields where there is sufficient water and water control infrastructure to allow irrigation |
| **Crops per year and yields** | 1 crop per year<br>Yields lower and more variable than lowland | 1–2 crops per year<br>One rice crop plus other diversified crops<br>Yields lower than irrigated | 1–2 crops per year<br>Highest yields |
| **Water** | Soil not covered with water for most of growing season | Soil submerged for part of cropping season, depending on rainfall and groundwater | Layer of water is controlled and covers soil for most of growing season<br>Active water management |
| **Main factors impacting yields** | High risk of drought.<br>Subsistence farming – low use of inputs | Competition from weeds and risk of drought can reduce yields | Reduced risk of crop failure gives farmers confidence to use fertilisers and other inputs |

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| Criteria | Rain-fed Upland | Rain-fed Lowland | Irrigated Lowland |
|---|---|---|---|
| **Current average yields (tonnes/ha)** | 1 | 2 | 5 |
| **Attainable yields with application of good management practices (tonnes/ha)** | 2 | 3–4 | 6–8 |
| **Key management practices** | No puddling or irrigation and soil not intentionally submerged<br><br>Seeds broadcast or dibbled in dry soil prior to or during rains | Soils ploughed after onset of rains. Bunds used to contain water, but no active management of water<br><br>Transplantation of seedlings or direct seeding in dry or puddled fields | Puddling, transplantation or direct seeding. Management of water levels throughout cropping season. Mechanical weed control |

The Decision Point below illustrates possible climate smart water management options for rice. It demonstrates how more than one option can be combined to make the most efficient use of water in rice production.

## DECISION POINT

| | | | |
|---|---|---|---|
| **Understand context** | What is the soil type, rainfall pattern and access to water for irrigation? | | |
| **Production system** | Rainfed upland | Rainfed lowland | Irrigated |
| **Farmer's goal** | Improve soil moisture retention | Improve soil moisture retention and water use efficiency | Increase water use efficiency, reduce irrigation costs |
| **Possible Climate Smart water management options** | In-field water harvesting<br><br>Variety selection | In-field water harvesting<br><br>Variety selection | Alternate wetting and drying<br><br>System of rice intensification (SRI)<br><br>Variety selection |

Understanding the context will assist you and your farmers in making climate smart water management decisions. To make **Climate Smart decisions** on water management options best suited to your farmer(s), it is key to understand:

**A.** The soil's physical and chemical properties

**B.** Crop water requirements

**C.** Available (probable) rainfall and distribution.

## A. Know your soil

Rice can be grown in a wide range of soil types. Soils with good water-retention capacities are best – clay soils with high organic matter content are ideal, but soils with high silt contents are also suitable. Sandy soils are not ideal for rice production. They tend to dry out quickly. Rice does best in soils with a near neutral pH (6–7).

- The pH value is most important in upland rice. If it is too low (i.e. too acidic) there is a risk of aluminium toxicity and low phosphorus availability (phosphorus is essential to promote good root growth and tillering)

- In rainfed lowland rice, iron toxicity is a major problem – limiting yields. Iron toxicity occurs in acidic soils and can be managed by applying lime and growing iron-tolerant rice varieties amongst other techniques

- In irrigated lowland rice systems where soils are submerged for extended periods, pH is not usually a problem. Submerged soils tend to become neutral, irrespective of whether they were originally acidic or alkaline.

## B. Crop water requirements

To make climate smart decisions it is important to know not just **how much** water is needed, but **when** it is needed. New varieties are constantly being developed, or already-existing varieties tested for their tolerance levels; the ranges indicated in Table 3 below may change as new or other, early maturing, drought-tolerant varieties are developed or identified.

**Table 3: Water requirements and critical growth stages for water stress in rice.**

| | Normal rainfall range (mm/total growing period) | Critical growth stages for water stress |
|---|---|---|
| **Rainfed upland** | 100 mm per month | Sensitive to drought before tillering and during flowering stages (mid-season) |
| **Rainfed lowland** | 200 mm per month | Sensitive to drought before tillering and during flowering stages (mid-season)<br>Reproductive stage is especially sensitive |
| **Irrigated** | Rainfall not necessary if sufficient irrigation available, but can reduce costs | Sensitive to drought before tillering and during flowering stages (mid-season). Water requirements do not change much across growth stages, remaining constantly high |



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Figures 2 and 3 illustrate the daily water requirement (in mm) during the different growth stages of irrigated and upland rice respectively in different agro-ecological zones in the SADC region. The charts illustrate how humidity and temperature play important roles in water stress.

Rice grown in areas with elevated temperatures and low humidity will require significantly more water than those in humid areas with medium temperatures.

**Figure 2: Irrigated rice water requirements by growth stage.**

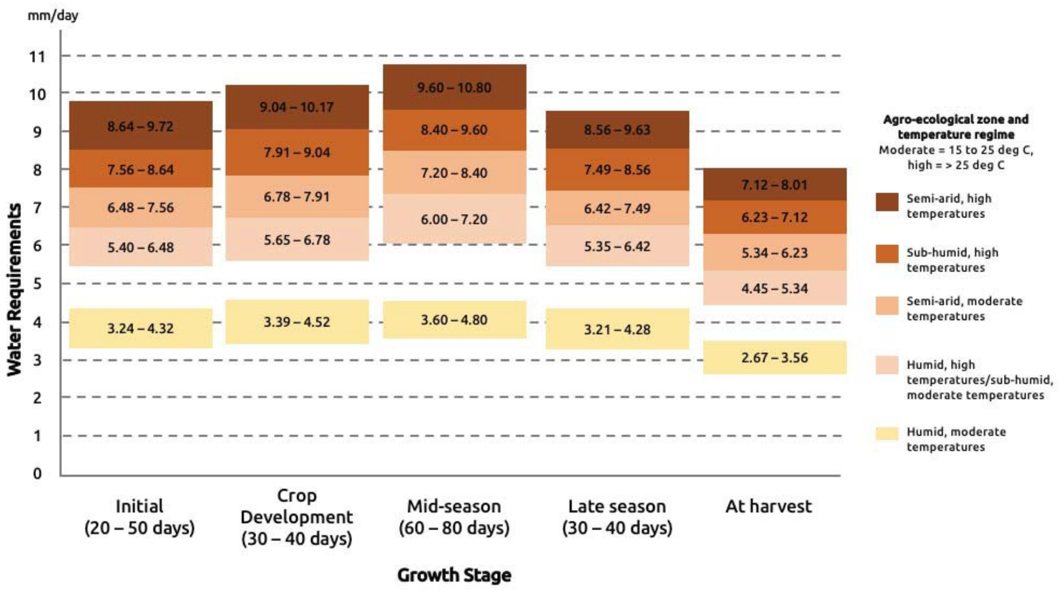
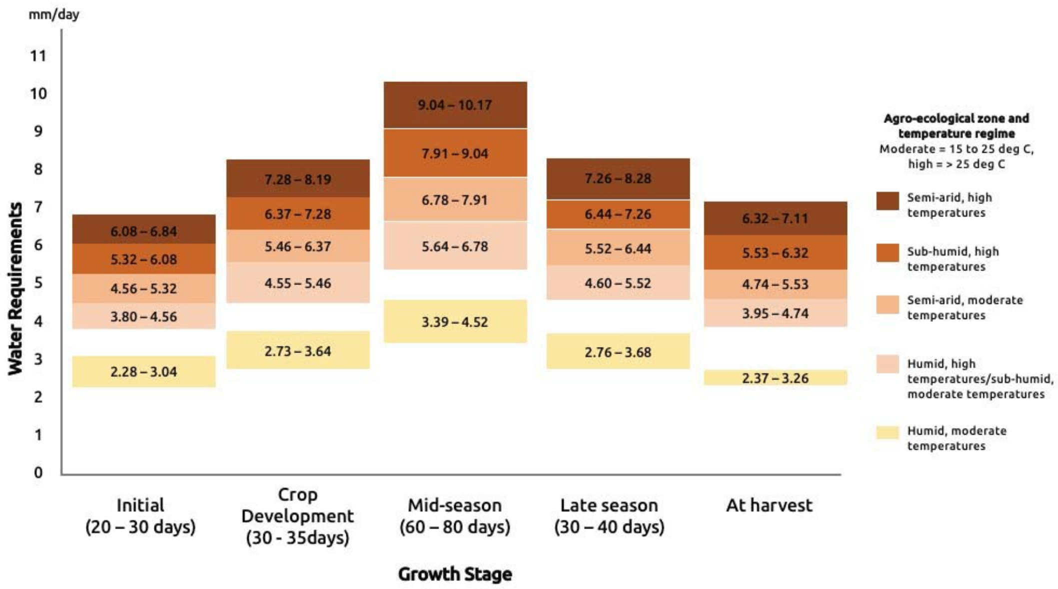



**Figure 3: Upland rice water requirements by growth stage.**




*Source: Concern Worldwide, 2017*

## C. Available (probable) rainfall and rainfall distribution

The next step is to understand the local context in terms of rainfall. This is less important for irrigated lowland production, but rainfall can have significant impact on irrigation costs.

- Do your farmers think that there will be enough rain in the next season?
- How likely is the rain to come during the critical growth stages?
- What information are they using to make these assumptions?

The Participatory Integrated Climate Services for Agriculture (PICSA) field manual is an excellent resource to help you work with your farmers to estimate the probability of certain levels of rainfall in your area over the coming season, using the most locally available data. Also your local **Met Office** should be able to provide you with some basic information that may help your farmers make more informed climate smart decisions.

Once you have determined soil type and water requirements, and have estimated total rainfall and timing, you should work with your farmers to develop a crop calendar for rice. An example of a crop calendar is available available in Annex A or on the Knowledge Bank International Rice Research Institute (IRRI) website. Cross-check the water requirements during the various stages of growth (Figure 4) with the crop calendar and expected rainfall distribution.

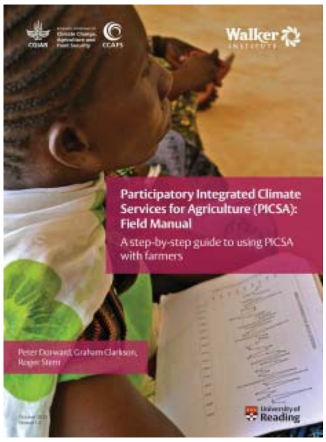
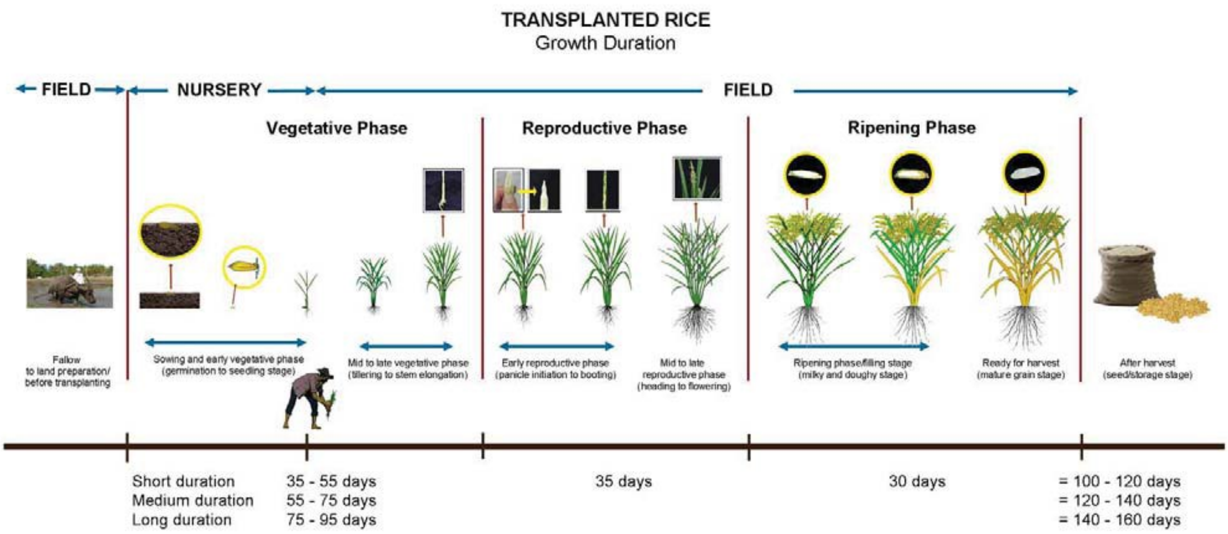



**Figure 4: Stages in rice growth and management for transplanted rice.**




*Source: IRRI, 2018*



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# BEST BET WATER MANAGEMENT OPTIONS FOR ADDRESSING CLIMATE RISKS IN RICE PRODUCTION

Below are five climate smart water management options for rice. They are listed in no particular order. All are broadly applicable across the SADC region. In many instances, a combination of these options will give optimum results in terms of water management. While these are best bet options, they are not universally applicable. CSA is context specific, and each of these options will need to be tested under local conditions and adapted to make it **Best Fit** the local context.

## VARIETY SELECTION

Regardless of which of the three rice production systems is being practised, variety selection is crucial. You should select locally adapted varieties where possible. This will ensure good crop establishment and high yield, with acceptable grain quality.

Table 4 outlines the key considerations that need to be understood when choosing a rice variety. Farmers' priorities must always be considered. It is also important to consider the different priorities of male and female farmers.

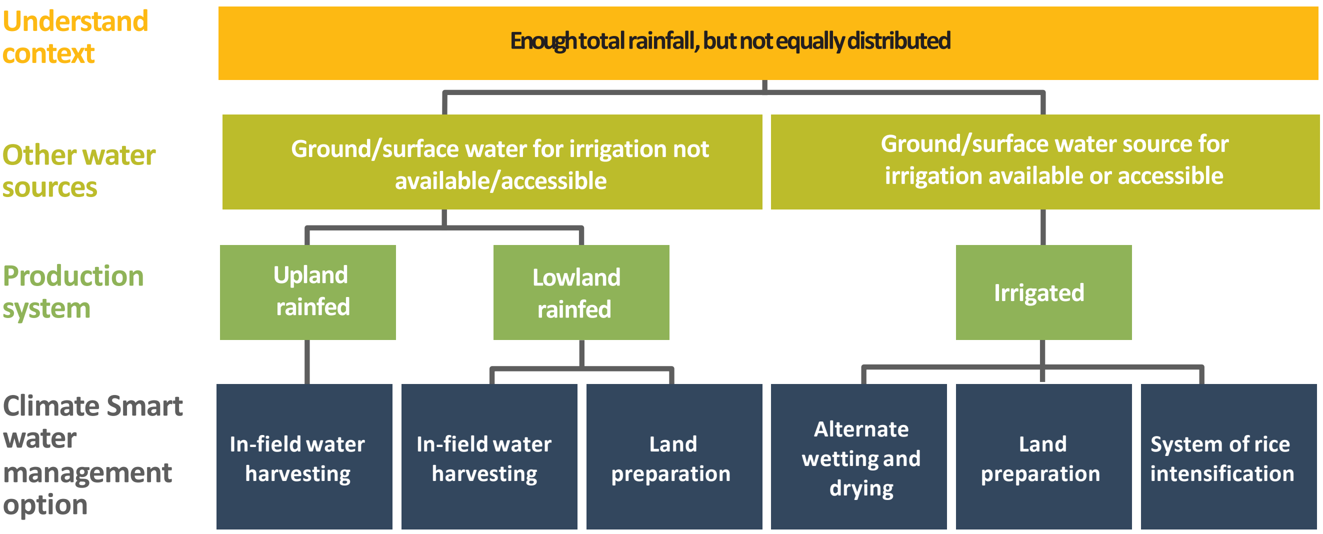
**Table 4: Different considerations that affect rice variety choice.**

| | |
|---|---|
| **Variety Considerations** | A variety should have:<br>• Good quality grain (especially cooking characteristics, colour, shape, taste and aroma, and head rice yield) that should meet a farmer's expectations in the context of its marketability or consumption<br>  ◦ You should ensure both male and female views are considered<br>• Adequate yield potential and stability over seasons<br>• Resistance or tolerance to major diseases, insects and/or abiotic stresses (e.g., drought, flood) of the area<br>  ◦ The right duration of growth to match the season. Do not choose varieties that need to be planted or harvested early or late, relative to other rice fields in the surrounding area, to avoid increased attack from pests (e.g., birds during maturation) or growth problems during times of adverse environmental conditions (e.g., late maturing varieties running out of water)<br>• Adequate tillering capacity to shade out weeds, and to produce a sufficient number of tillers for optimum yields<br>• Resistance to lodging under normal farmer management<br>• It should be available in the local market and affordable to the farmers<br>  ◦ Gender in particular should always be considered in terms of availability and access to seed varieties. Women in single-headed households may not have the same access to markets as men or two-parent households |

| | |
|---|---|
| **Management Considerations** | • Ensure variety is suited to the method of crop establishment and farmer management practices – e.g., some varieties are more suited to direct seeding than others<br>• Use 'good' seed to maximise yields<br>• Ensure sufficient seed amounts are available to meet local demand<br>• Plant a variety of seeds in regions to maintain biodiversity, in order to slow the spread of pests and to avoid the breakdown of varietal resistance |
| **Evaluating New Varieties** | • A variety should be tested over at least three seasons in farmers' fields to ensure suitability in terms of stability of yield and resistance to local pests, and adaptation to local conditions<br>• Evaluate new varieties by practising crop management that is similar to the farmers' practice. For example, if farmers apply very little fertiliser, new varieties should not be evaluated under very high levels of fertilisation. If farmers direct-seed, evaluation should not be done under transplanted conditions<br>• Consult with farmers to ensure variety suitability before releasing a new variety<br>• Grain quality, market demand and price need to be acceptable<br>• Farmers should lower the risk of new varieties by testing in just part of their fields<br>• When evaluating new varieties, both men's and women's views should be considered. Depending on who in the household performs what management tasks, it might also be relevant to assess youth views. |

The **Decision Point** below illustrates the factors that influence decision making when there is enough total rainfall, but when this is not equally distributed across the growing season.

## DECISION POINT



## IN-FIELD WATER HARVESTING

There are many climate smart options for increasing the potential of the soil to retain more moisture. The type of practice(s) chosen will depend on the following:

- The type of soil
- The depth of the water table – is the water table shallow enough for roots to access it for part or all of the growing season?
- The production system (rainfed upland, rainfed lowland or irrigated).

In-field water harvesting techniques aim to increase the ability of the soil to retain moisture. In-field water harvesting practices can be labour intensive, and farmers should consider if rice is the most suitable crop to grow in the location before moving ahead. The climate smart practices that can be applied in upland systems are very similar to those listed for sorghum and maize in KP10. These include:

- Contour ridges
- Water spreading bunds
- Permeable rock dams.

Climate smart soil amendments (KP06), planting systems (KP07) and land preparation options (KP08) can also be implemented, as well as in-field water harvesting to maximise moisture retention:

- Addition of organic matter
- Crop rotations
- Mulching
- Green manure/cover crops.

Some in-field water harvesting techniques, such as addition of organic matter, crop rotations and cover crops, are also appropriate for rainfed lowland and irrigated rice systems as part of an **Integrated Soil Fertility Management (ISFM)** approach.

**TIP** To maximise results of in-field water harvesting, it should always be implemented as part of a broader **Integrated Soil Fertility Management** approach.

## LAND PREPARATION

**Rainfed lowland** and **irrigated** rice are both usually planted in levelled fields with earth bunds to retain water. In the case of rainfed lowland rice, the water being retained is floodwater; while for irrigated rice (also called paddy rice), the water being retained is irrigation water. The following climate smart water management practices apply to both systems.

### Dry land preparation

Wet land preparation can consume up to a third of the total water required for growing rice in an irrigated production system. If water cost or availability at the time of crop establishment is a concern, consider dry land preparation, which uses considerably less water than wet land preparation.

Dry land preparation is typically practised for upland rice, but can also be practised in lowland fields. With this method, the soils are not puddled, and there is no freestanding water in the field. It requires less water and is effective for soil aeration, and in controlling golden apple snails. It also helps to obtain a smooth and firm seedbed, control weeds, and incorporate organic materials and fertiliser into the soil. Table 5 outlines when wet and dry land preparation should be selected.

**Table 5: Key factors in deciding on wet or dry preparation of rice fields.**

| Wet preparation may be appropriate if: | Dry preparation may be appropriate if: |
|---|---|
| • The farm has access to irrigation<br>• The field is surrounded by bunds that enable flooding<br>• The farm has a loamy to clay type of soil<br>• Equipment for primary tillage, secondary tillage, and levelling is available. | • There is no access to irrigation, and water supply is limited<br>• Machinery equipment is available for tillage, and/or labour is a limiting factor<br>• The farm has a coarse, sandy type of soil<br>• The field has a well-established hardpan; rice has been planted on it many times, and weeds can be controlled with methods other than flooding. |

## Repair or construct bunds

Good bunds are a prerequisite to limit water losses. Bunds should be well compacted, and cracks or rat holes should be plastered with mud at the beginning of the crop season to limit water loss. Bunds should be high enough (at least 20 cm for irrigated and 30 cm for rainfed) to avoid overflowing during heavy rainfall. Lower levees of 5–10 cm in the height of the bunds can be used to keep the ponded water depth at that height. These levees can be heightened with soil when more stored water is needed.

## Level the field

A well-levelled field is crucial for good water management. An unlevelled field requires an extra 80–100 mm of water to give complete water coverage. This is nearly an extra 10% of the total water requirement to grow the crop. Most fields need to be ploughed twice before you can level. In wet land preparation, the second ploughing should be done with standing water in the field to define high and low areas.

## Till the soil to fill cracks

Substantial amounts of water can be lost during land soaking prior to puddling when large and deep cracks are present, as water drains down the cracks beyond the root zone. Perform shallow tillage operations before land soaking. This fills in the cracks and can greatly reduce the amount of water used in land preparation. Despite reducing water loss, the action of puddling itself consumes water. There is a trade-off between the amount of water used for puddling and the amount of water 'saved' during the crop growth period, because of a compact hard pan.

**Figure 5: Cracks in soil should be filled before flooding. This will reduce water loss through the cracks.**

*Source: IRRI*

## Minimise time between operations to reduce water use

In some canal irrigation systems, the period between land soaking for land preparation and planting can be up to 40 days. To minimise time between operations:

- Install field channels so that each field can be irrigated on its own
- Use common or community seed beds so that whole fields do not have to be flooded, while only a small portion is being used to produce seedlings
- Plant nearby fields at the same time
- Practise **direct seeding** – Direct seeded crops require less labour and tend to mature faster than transplanted crops. In this method, plants are not subjected to stresses such as being pulled from the soil and then needing to re-establish fine rootlets when they then have more competition from weeds. Depending on the land preparation method used, direct seeding can be done in two ways:
  - **Direct wet seeding**
    - In wet fields, direct seeding can be done either through broadcasting or drilling seeds into the mud with a drum-seeder
  - **Direct dry seeding**
    - This method is usually practised for rainfed ecosystems. Farmers sow onto a dry soil surface and then incorporate the seed either by ploughing, or harrowing
    - Minimum and/or reduced tillage can also be practised, making this option more climate smart (See **KP08 – Climate Smart Land Preparation Options**)

## ALTERNATE WETTING AND DRYING

This practice is only applicable for irrigated rice systems. In irrigated systems, the rice is typically grown in bunded fields that are continuously flooded for up to 7–10 days before harvest. Safe alternate wetting and drying (AWD) is a water-saving technology that farmers can apply to reduce their irrigation water consumption without decreasing yield. In safe AWD, irrigation water is applied a few days after the disappearance of the ponded water. Hence, the field gets alternately flooded and non-flooded. The number of days of non-flooded soil between irrigations can vary from one to more than ten days, depending on a number of factors such as soil type, weather and crop growth stage.

A practical way to implement AWD safely is by using a 'field water tube' ('pani pipe') to monitor the water depth on the field (Figure 6). After irrigation, the water depth will gradually decrease. When the water level has dropped to about 15 cm below the surface of the soil, irrigation should be applied to re-flood the field to a depth of about 5 cm. From one week before to a week after flowering, the field should be kept flooded, topping up to a depth of 5 cm as needed. After flowering, during grain filling and ripening, the water level can be allowed to drop again to 15 cm below the soil surface before re-irrigation.

AWD can be started a few weeks (one to two weeks) after transplanting. When many weeds are present, AWD should be postponed for two to three weeks to assist suppression of the weeds by the ponded water, and to improve the efficacy of herbicide. Local fertiliser recommendations, as for flooded rice, can be used. Apply fertiliser N, preferably on the dry soil just before irrigation.

The field water tube can be made of a 30 cm long plastic pipe or bamboo, and should have a diameter of 10–15 cm so that the water table is easily visible and it is easy to remove soil inside. Perforate the tube with many holes on all sides, so that water can flow readily in and out of the tube. Hammer the tube into the soil so that 15 cm protrudes above the soil surface. Take care not to penetrate through the bottom of the plough pan. Remove the soil from inside the tube so that the bottom of the tube is visible. When water is at 15 cm below the soil surface, it is time to irrigate the field again (Figure 7).

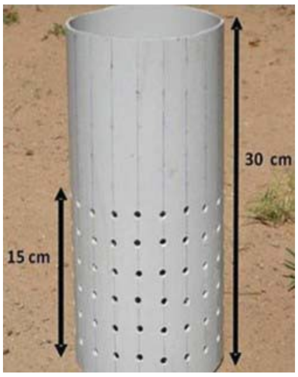



**Figure 6: A typical field water tube or 'pani pipe'.**

*Source: IRRI*

When the field is flooded, check that the water level inside the tube is the same as outside the tube. If it is not the same after a few hours, the holes are probably blocked with compacted soil and the tube needs to be carefully re-installed. The tube should be placed in a readily accessible part of the field close to a bund, so it is easy to monitor the ponded water depth. The location should be representative of the average water depth in the field (i.e. it should not be in a high spot or a low spot).

When water for irrigation is particularly scarce, AWD can be applied only at critical times in the rice growth cycle. This is similar to deficit irrigation and will lead to a reduced yield from the crop. Note that in this practice, the word 'safe' has been removed from 'safe AWD', as crop yields will be reduced.
More videos on Rice Management are available on the IRRI YouTube Channel: https://www.youtube.com/irrivideo/

**Figure 7: Water at 15 cm below the field surface. Time to irrigate the field again.**

*Source: IRRI*


Alternate wetting and drying (AWD)--using less water to grow rice

*International Rice Research Institute*

Nov 6, 2009

# KP11

CIFOR, 2017

## SYSTEM OF RICE INTENSIFICATION

Alternate Wetting and Drying (AWD) is the water management technique used in the **system of rice intensification (SRI)**. This system was developed in Madagascar, and is an integrated crop management technology. It is characterised by:

- Transplanting 8–12-day-old seedlings very carefully (root tip down)
- Transplanting single seedlings
- Spacing the plants widely apart in a square pattern (25 × 25 cm or wider)
- Controlling weeds by weeding with a rotating hoe, which aerates the soil
- Applying compost to increase soil organic matter content (optional)
- No continuous flooding during the crop growth period
- Applying small amounts of water regularly, or AWD field conditions to maintain a mix of aerobic and anaerobic soil conditions.

After flowering, a thin layer of water should be kept on the field, although some farmers find AWD of fields throughout the crop cycle to be feasible and even beneficial.


SRI Introduction: The spread of SRI in East Africa

*Flooded Cellar*

Nov 18, 2012

## Other factors to consider:

- The choice of which climate smart water management practice is used will often be influenced by the prevalence of pests and diseases, some of which can be effectively controlled through flooding. This trade-off will need to be considered when deciding on which practices are most appropriate for your farmers (see KP20 – Climate Smart Pest and Disease Control in Rice)
- Availability of labour is a further limiting factor. Practices such as AWD and SRI may require more labour than traditional systems. It is vital that gross margins are calculated to assess the real and perceived benefits of implementing new practices in any new context. The amount and cost of labour must be factored into these calculations
- You must also understand who does what and when throughout the rice calendar. Different household members will often be involved in different management tasks. To make climate smart decisions that will result in wider adoption of these practices, it is important to understand the constraints of men, women, and youth in performing their specific tasks so that practical solutions can be proposed
- Your job as an extension agent is to propose climate smart solutions that best fit within the farmers' own specific context, and to assist farmers in testing these. Gross margins should always be calculated to determine the returns (benefits) to farmers from any new practices proposed. Not everything will work the first time round. Time should be made during regular visits to assess what is and what is not working, and why.

Many factors, not just water management, can influence returns on investment; so it is important that adequate time is set aside to reflect with farmers on what they have implemented, and how this might be improved going forward.



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## TO SUMMARISE

In rainfed lowland and upland production, water management is often a trade-off between available water and yield reductions. To make climate smart decisions on water management in upland/lowland rainfed rice production, you need to:

- Analyse the soil type and water table
  - Can moisture retention be increased sufficiently through soil amendments?
- Find out typical rainfall distribution over the growing season
  - Timing of planting to ensure adequate soil moisture and sunshine at critical growth stages
- Determine the main pests and diseases in the growing area
  - This will influence the choice of variety and control options, which may be related to water use
- Determine labour availability for land preparation, weeding and harvesting
  - Heavy levels of mulch can help retain moisture, but can also significantly reduce labour in weeding
- Determine what varieties are available on the local market.

### STEP 1: Know your context

- Rice water requirements
- Observed and predicted volume and distribution of rainfall
- Soil type
- Production system

### STEP 2: What sources of water are available?

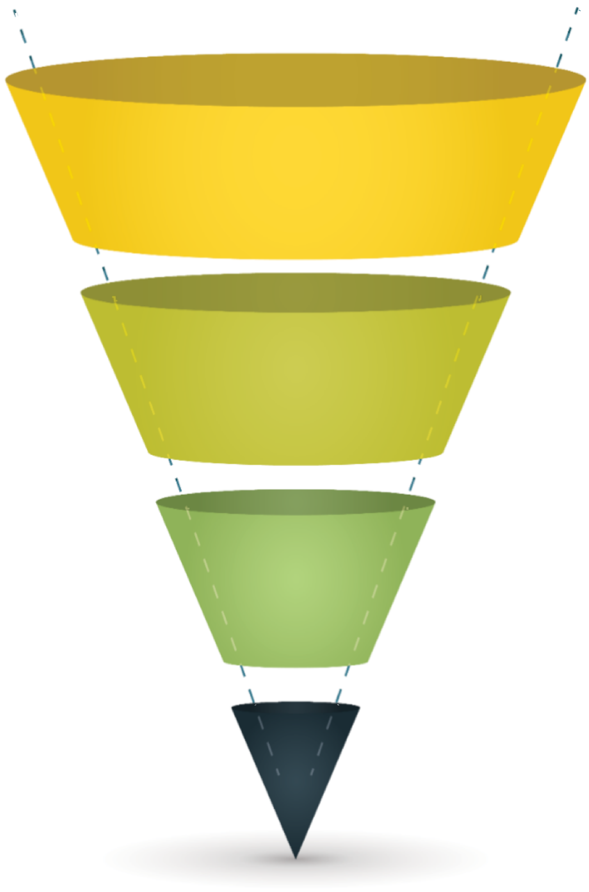
- Enough/not enough
- Rainfall probability
- Surface
- Sub-surface

### STEP 3: Consider the local context

- Availability & accessibility of different varieties
- Farmers' needs and priorities
- Availability of labour
- Needs and priorities of men, women and youth
- Pests and diseases

### STEP 4: Cost benefit analysis

- Which option is financially viable
- Consider alternatives.



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# WHERE CAN I FIND MORE INFORMATION?

*The following resources, which were used as reference for the development of this Knowledge Product, provide valuable additional reading on this subject. Please also refer to the CCARDESA website (www.ccardesa.org), the full series of Knowledge Products, and associated Technical Briefs.*

- See also **CCARDESA KPs 6, 7, 8, 9, 10, 12, 16 & 19** for more detail on specific climate smart practices and technologies included within Integrated Soil Fertility Management.
- **Africa Rice Centre (WARDA)** – Growing Upland Rice, A Production Handbook
  - Useful tool to guide you through all the stages of lowland rice production
- **International Rice Research Institute (IRRI)** – Steps to Successful Rice Production (13 Steps)
  - Very basic, but a good overview of the steps a farmer should follow
- **IRRI YouTube Channel** – **https://www.youtube.com/irrivideo/**
- **IRRI** – Water Management in Irrigated Rice: Coping with Water Scarcity
  - While detailed, and focused on Asia as a region, this is a comprehensive guide to water management in irrigated rice that is applicable in most contexts
- **IRRI** - The Rice Knowledge Bank
  - This is an outstanding resource for anyone working with rice producers. Links to technical guides and videos on all aspects of production. Every extension officer working with rice farmers should have this on their phone
- **NERICA** – NERICA Rice Crop Management
  - Covers all steps of production from land selection to weed control.

*Enking, 2000*



**Citation:** CCARDESA and GIZ 2019. Knowledge Product 11: Climate smart water management options for rice. CCARDESA Secretariat, Gaborone, Botswana.

# ANNEX A: CROP CALENDAR – EXAMPLE

Use this calendar to plan out your cropping season. Here is a list of some possible activities you do during the season, however feel free to add/delete as required.

Name: Field 2 Size: 1500 sq m Seed Variety: NSIC Rc218 Dry seeding ____ Transplanting X (please tick)

| Activity | Timing<br>DAS=Days after sowing; DAT=Days after transplanting; DAP=Days after planting (nursery) | Anticipated date | Species Selection and Action |
|---|---|---|---|
| Variety Selection | | 30 Nov | NSIC Rc 218 |
| Plan sowing method: transplant (manual v. machine) or direct (dry seed drill v. drum seed v. broadcast) | | 30 Nov | Manual Transplanting |
| Planning of fertiliser application using Nutrient Manager | | 30 Nov | 14-14-14 20kg at 0-14 DAT<br>Urea 12kg at 26-32 DAT<br>Urea 15kg at 43-47 DAT |
| Planning of weed management | | 30 Nov | 1) Wet land preparation with deep cultivation and puddling<br>2) Continuous flooding 2 to 4 cm depth<br>3) clean bunds |
| Planning of pest and disease management | | 30 Nov | Snails – Hand picking and bait leaves<br>Rats – bait traps and clean bunds Insects and disease – To be determined |
| Planning of field preparation | | 30 Nov | wet preparation |
| Fallow (glyphosate spray if applicable) | ~-30 DAS/DAT | 3 Dec | |
| Fallow (plough stubble if applicable) | ~-30 DAS/DAT | 13 Dec | 4wheel tractor with disc plow 2 x |
| Bund – maintenance and repair | -20 to 0 DAS/DAT | 13 Dec | Clean bunds, fill holes |
| Nursery Soil Preparation | -7 to -1 DAP | 15 Dec | Prepare wet bed nursery |
| Breaking seed dormancy | -2 DAP | 20 Dec | Soak seeds for 24hrs, then dry for 24hrs |
| Seeding Nursery/Sowing field | 0 DAP | 22 Dec | Sow seeds in wet bed nursery |
| Wet prep: Land soaking | -30 to -14 DAT | 13 Dec – 27 Dec | 14-days of flooding to decompose stubble and soften soil |

*Source: IRRI*

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| Activity | Timing<br>DAS=Days after sowing; DAT=Days after transplanting; DAP=Days after planting (nursery) | Anticipated date | Comments |
|---|---|---|---|
| Wet prep - Puddling, harrowing, levelling: apply water, puddle 2-3x, harrow 2-3x, level | -14 to -4 DAT | 27 Dec – 4 Jan | 27 Dec – 2 wheel power tiller with rotavator 2x<br>30 Dec – 2 wheel power tiller with harrow 2x<br>4 Jan – Third harrow with plank leveler |
| Dry prep: sufficient time for drying is needed if machine sowing | -5DAT | | |
| Herbicide – apply Pretilachlor/Butachlor (if applicable) | -2 to 2 DAS/DAT | | No need – managing weeds with water |
| Transplant | 14-20 DAP | 10 Jan | Transplant 19 day old seedlings |
| Apply water | ~ DAS/DAT | 10 Jan – 25 Jan | Maintain water at 2-5 cm |
| Basal fertilizer | 0-14 DAS/DAT | 15 Jan | 20kg 14-14-14 |
| Golden Apple Snail – check control | 0-30 DAS/DAP | 10 Jan – 21 Jan | Hand pick until seedlings are 30 days old |
| Water Management 3–10 cm | 0 DAS to 10-14 days before harvest | 25 Jan – 28 Apr | Maintain 3-10 cm water |
| Post emergent weed control | 14 to 21 DAS/DAT | 24–31 Jan | If weeds, apply post emergent herbicide |
| Pest and disease monitoring and control | Early tillering to harvest | 25 Jan – 10 May | monitor |
| Nitrogen topdressing, Nutrient Manager | Tillering | 10 Feb | 12 kg of urea at 30 DAT |
| Weeds check – no weeds | 30-40 DAS/DAP | 10–20 Feb | Hand weed if any weeds |
| Fertilizer – Panicle initiation | 40-50 DAT | 25 Feb | 15 kg urea at 45 DAT |
| Drain water | 10-14 days before harvest | 26 Apr – 1 May | Drain |
| Harvest | 22-24% moisture | 10 May | Combine harvest at 22% MC |
| Drying | Post harvest | 10 May – 12 May | Flatbed dryer |
| Storage | Post harvest | 12 May – 20 Sep | Superbag storage |
| Milling | Post harvest | 20 Sep | Mill as brown rice |
| Marketing | Post harvest | 20 Sep | Higher value for brown rice |
| Sale | Post harvest | 20 Sep | Higher value because off-season and brown rice |

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