DECISION TOOL:
Climate Smart Water Management Options for Maize & Sorghum

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)

Maize  Sorghum  Decision Point  Gender  Youth  Climate Smart  Practice  Technology

Pivot Irrigation. Stock Image
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 maize and sorghum to ever changing rainfall patterns

2. To make climate smart decisions on which water management option for maize/sorghum best suits your farmers you need to understand:
   a. Crop water requirements
   b. Probable rainfall
   c. The current status of the soil
   d. Farmers’ priorities
   e. Gender dynamics

3. Climate smart water management options for maize and sorghum include:
   a. Variety/crop selection
   b. Solar irrigation
   c. Deficit irrigation
   d. In-field water harvesting
   e. Rainwater harvesting

Entry Points for CSA

- CSA practices and technologies
- CSA systems approaches
- Enabling environments for CSA approaches
CLIMATE SMART WATER MANAGEMENT OPTIONS FOR MAIZE & SORGHUM

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/farmers. 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 Maize and Sorghum 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 maize and sorghum production in the region (Table 1)

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

Table 1: Best Bet Climate Smart Land Preparation Options that have potential address climate risks across the SADC region.

<table>
<thead>
<tr>
<th>Climate Smart soil amendment practice</th>
<th>What is it?</th>
<th>3 pillars of CSA</th>
<th>Mitigate GHG emissions if possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety/crop selection</td>
<td>Selecting early maturing, drought-tolerant varieties, Or, selecting more drought tolerant crops (e.g., sorghum instead of maize)</td>
<td>Varieties specifically bred for yield potential at lower water availability</td>
<td>More predictable yields</td>
</tr>
<tr>
<td>Solar irrigation</td>
<td>Using solar technology to irrigate crops from either surface or sub-surface water sources</td>
<td>Plants get enough water. Potential for two or more cropping seasons per year</td>
<td>Predictable yields. Higher production equals increased food security/income and resilience</td>
</tr>
<tr>
<td>Deficit irrigation</td>
<td>Used when there is not enough water. Water is applied only during the most critical growth stages</td>
<td>Stabilises yield</td>
<td>Adapts to real time rainfall conditions</td>
</tr>
<tr>
<td>In-field water harvesting</td>
<td>Practices to increase water infiltration and moisture retention in the soil (e.g. Zai Pits, Contour Bunds, Integrated Soil Fertility Management, etc.)</td>
<td>Water is available to plants when it is needed Reduced nutrient leaching</td>
<td>Mitigate dry spells</td>
</tr>
<tr>
<td>Rainwater harvesting</td>
<td>The collection and storage of rainwater to reuse rather than letting it run off</td>
<td>More water available to plants when it is needed</td>
<td>Mitigate dry spells</td>
</tr>
</tbody>
</table>
WHICH CLIMATE SMART WATER MANAGEMENT OPTION IS BEST SUITED TO YOUR FARMERS?

To make climate smart decisions on the land preparation options best suited to your farmer(s), it is key to understand the local context:

- Crop water requirements
- Available (probable) rainfall
- What other sources of water are available, if any

The Decision Point figure illustrates the decision making process based on these three core criteria. Each one is then discussed in more detail below.

To make climate smart decisions on water management options for maize and sorghum an understanding of crop water requirements, expected rainfall and other potential sources of water is required.

DECISION POINT

Water requirements

How much water does maize/sorghum require and how much is available through rainfall?

Available rainfall

Not enough total rainfall

- Ground/surface water for irrigation not available/accessible.
- Variety/crop selection
- Irrigation (solar)

Enough rainfall, but not distributed when needed

- Ground/surface water source available for irrigation
- Zai pits
- Soil amendments

Enough rainfall and distributed when needed

- Improve soil moisture storage
- Consider rainwater harvesting
- Other land preparation

Other water sources

Possible Climate Smart water management options

Water is not the problem

Table 2: Water requirements and critical growth stages for water stress in maize and sorghum.

<table>
<thead>
<tr>
<th>Normal range (mm/total growing period)</th>
<th>Critical growth stages for water stress</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maize</strong></td>
<td>500-1,200</td>
</tr>
<tr>
<td><strong>Sorghum</strong></td>
<td>400-900</td>
</tr>
</tbody>
</table>

4/CLIMATE SMART WATER MANAGEMENT OPTIONS FOR MAIZE & SORGHUM
Figures 1 and 2 illustrate the daily water requirement (in mm) at the different growth stages of maize and sorghum (respectively) in different agro-ecological zones in the SADC region. The charts illustrate how humidity and temperature impact on water stress. Sorghum and maize grown in areas with high temperatures and low humidity will require significantly more water than those in humid areas with medium temperatures.

**Figure 1: Maize water requirements by growth stage in the tropics and sub-tropics.**

**Figure 2: Sorghum water requirements by growth stage in the tropics and sub-tropics.**

Source: ASHC
If you have access to a rain gauge this will be even more accurate. Over time you can build up a picture of the trends locally. This will help you and your farmers in climate smart decision making.

Once you know the water requirements for maize and sorghum and have estimated probable rainfall you will be able to make decisions on whether or not it is likely that there will be enough rainfall to meet the crops’ needs in the coming season.

Figure below illustrates a decision tree where other water sources are both available and unavailable. Climate smart decisions on water management options for maize and sorghum should factor in what other water sources might be available to supplement rainfall if it is not expected to be enough to meet crop requirements.

**Understand context**

**Not enough total rainfall**

**Other water sources**

- Ground/surface water for irrigation not available/accessible
- Ground water/surface water source for irrigation available and accessible

**Climate Smart water management options**

- Variety/crop selection
- Irrigation (solar)
- Deficit irrigation
If the area does not receive enough total rainfall during the growing cycle, then the farmers’ options are limited. Irrigation may or may not be an option depending on a range of factors including:

- **Availability** of ground or surface water sources
- **Cost** of accessing these sources
  - Distance to field
  - Depth of water table
  - Cost of pumping equipment required
- **Access to credit**
- **Individual vs. group** schemes
- **Availability of labour**
  - Canals and distribution channels may need to be dug
  - Does the household have access to the labour required to do this?

### BEST BET WATER MANAGEMENT OPTIONS FOR ADDRESSING CLIMATE RISKS IN MAIZE/SORGHUM PRODUCTION

Below are five climate smart water management options for sorghum and maize. 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/CROP SELECTION

If rainfall is not sufficient and irrigation is not an option, then you need to work with your farmer to assess if it is viable to grow maize or sorghum at all:

- Are new short-season, drought-tolerant varieties available locally, and are these accessible/affordable?
- Early-maturing varieties tend to have lower yield potential than later maturing varieties

- Is labour availability the same for men and women farmers?

- **Land ownership** – owned vs rented

- **Gender and age** also need to be assessed
  - Women may not have the same access to credit and labour as men
  - Older farmers may be less interested in investing in something that will take several years to pay back
  - Young farmers might lack the finance to invest

- **Cost benefit analysis** – will the potential increase in yield offset the costs involved and over what time period?

- Does the farmer **plan to grow for sale** or **grow for consumption**?
  - If growing for **consumption**, it may be difficult to repay investment costs

- What effect will use of this water have on other users within the catchment?

- Is there potential to switch to sorghum instead of maize, as sorghum requires less water?
  - Is the crop for own consumption or sale?
  - Is sorghum an acceptable food locally and can it be sold on the market?
  - Is there local knowledge on how to grow sorghum or is it a new crop to the farmers?

For more information on how to make climate smart decisions on which crop and variety to plant, please see KP09 – Climate Smart Seed Selection.
SOLAR IRRIGATION

There are many different potential types of irrigation depending on the source of water to be used. **Gravity fed systems**, where water is diverted and collected at a higher level than the field to be irrigated, and channelled either through pipes or canals to the field, require the least amount of energy, and are a very climate smart option. All options should be considered before selecting the best option for your location.

**Solar Irrigation** uses solar energy to power irrigation systems that would otherwise use electricity from the national grid, or diesel-fuelled pumps. The benefits in terms of Green House Gas (GHG) emissions from two different projects are illustrated in Table 3.

### The cost of solar irrigation equipment is declining rapidly with new solar products continually entering the market. You should regularly visit your local agri-supplier to see what is on the market, so you can advise your farmers appropriately.

The essential components of Solar Irrigation Systems are illustrated in Figure 3. They include the following:

- **Solar generator**, i.e. a Photovoltaic (PV) panel or array of panels to produce electricity
- A **mounting structure** for PV panels, fixed or equipped with a solar tracking system to maximise the solar energy yield
- A **pump controller**
- A surface or submersible **water pump** (usually integrated in one unit with an electric motor)
- A **distribution system** and/or storage tank for irrigation water

### Table 3: GHG emission reductions due to use of solar pumping equipment in two separate projects.

<table>
<thead>
<tr>
<th>Project</th>
<th>Unit</th>
<th>Solar</th>
<th>Grid Electricity</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIZ 2016</td>
<td>gCO2-eq/kWh</td>
<td>16-32</td>
<td>600</td>
<td>1,000</td>
</tr>
<tr>
<td>POST 2011</td>
<td>gCO2-eq/kWh</td>
<td>75-116</td>
<td>488-990</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: GACSA 2017.

**Figure 3: The essential components of a solar irrigation system.**
Where can solar irrigation be practiced?

Solar irrigation can be practiced in any location where the following requirements are fulfilled:

- Sufficient solar irradiation – solar power received per unit area of land surface
- Land availability – sufficient un-shaded land to support the PV panels, and accommodate water infrastructure, such as storage tanks
- Water availability and legal permit/license to abstract water – sufficient water to satisfy the pre-determined irrigation water requirement of the crop(s)
- Appropriate water quality – sufficiently low levels of salinity or heavy metal concentrations

Factors to consider when deciding on the type of solar irrigation system

Availability and cost of the different systems are likely to be the most limiting factors in decision-making.

- Drip irrigation systems are highly efficient, but are more suited to high-value crop production on small land areas (e.g., vegetables), rather than for maize and sorghum
- Surface irrigation systems using earth channels are much less efficient, but require much lower investment costs

The irrigation efficiency of different systems is outlined in Table 4. Relative costs as well as some key resources required for the three main types of irrigation systems are outlined in Table 5.

Table 4: Irrigation efficiency of different types of systems.

<table>
<thead>
<tr>
<th>Application system</th>
<th>Irrigation efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drip systems</td>
<td>90%</td>
</tr>
<tr>
<td>Sprinkler systems</td>
<td>65% - 80% (depending on type)</td>
</tr>
<tr>
<td>Surface irrigation systems (piped supply)</td>
<td>80%</td>
</tr>
<tr>
<td>Surface irrigation systems (earth channel supply)</td>
<td>60%</td>
</tr>
</tbody>
</table>

Table 5: Relative comparison between various factors that commonly influence decision making on irrigation systems.

<table>
<thead>
<tr>
<th>Irrigation type</th>
<th>Initial costs</th>
<th>Land leveling</th>
<th>Efficiency</th>
<th>Adding of fertilisers</th>
<th>Labour requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Low</td>
<td>Required</td>
<td>Low</td>
<td>No</td>
<td>Intensive</td>
</tr>
<tr>
<td>Sprinkler</td>
<td>High</td>
<td>Not required</td>
<td>Middle</td>
<td>Economical</td>
<td>Low</td>
</tr>
<tr>
<td>Drip</td>
<td>High</td>
<td>Not required</td>
<td>High</td>
<td>Highly efficient</td>
<td>Low</td>
</tr>
</tbody>
</table>

Source: Energypedia.

Solar irrigation systems do require significant up-front investment. It is important that you discuss with your farmers if this investment is justified. These systems may only be viable for higher-value crops and may only be practical in group schemes rather than for individuals.

TIP

You should always calculate the total lifetime costs of the system as well as the payback period.

Consider entering into a service contract with the supplier/ installer to ensure minimal downtime.

Source: www.omafra.gov.on.ca
**DEFICIT IRRIGATION**

**Deficit Irrigation** involves irrigating plants with less than the optimal amount of water but applying this water during the most beneficial growth stages. This strategy can be applied using several types of irrigation systems. It is appropriate in the following contexts:

- Irrigation water is available, but is not sufficient to meet full crop needs
- Where it is more profitable for a farmer to maximise crop water productivity over harvest per unit area – saved water can be used to irrigate extra units of land or for other purposes, such as feeding livestock

The aim of deficit irrigation is to **stabilise rather than maximise yields**.

The correct application of deficit irrigation requires thorough understanding of the yield response to water - crop sensitivity to drought stress - and the economic impact of reductions in harvest. This climate smart option may become more important in the future in regions where rain-fed agriculture is important and where lower and more variable rainfall is predicted.

**Deficit Irrigation** is a responsive practice and cannot be scheduled in the same way as full irrigation. The best water delivery systems are those that can be used on demand; for instance, where farmers have access to wells, or nearby water sources.

To make the most of this option, it should be used in conjunction with localised, accurate weather forecasting. In many communities, the available water supply is inadequate to irrigate all of the available land. In such cases, farmers might consider the communal benefits of allowing sub-optimal yields on their individual fields, by practicing Deficit Irrigation, so that the water saved might be used to irrigate additional land in the community.

The figure below illustrates how an understanding of farmers’ priorities and the local context can influence decisions on which water management option might be most suitable.

When there is enough rainfall but it is not distributed evenly farmers’ priorities and available resources will influence decision making on climate smart water management options.

**Improve Soil Moisture Storage**

The two remaining climate smart options for water management in maize and sorghum fall under the umbrella of improving soil moisture storage. There are many climate smart options for increasing the potential of the soil to retain more moisture. These include soil amendments, cropping systems and land preparation options, all of which are covered in more detail in other Knowledge Products (KPs 06, 07 and 08). These options are applicable where there is enough total rainfall, but the rainfall is not distributed evenly over the growing season.

**DEcision point**

**Figure 4: Understanding how farmer priorities and local context can influence water management decisions**

- Enough rainfall
  - Enough rainfall but not distributed when needed
    - Improve soil moisture storage
    - Consider rainwater harvesting
  - Farmer priorities & available resources
    - Climate Smart water management option
      - In field water harvesting practices
      - Soil amendments
      - Planting systems
      - Land preparation options

10 / CLIMATE SMART WATER MANAGEMENT OPTIONS FOR MAIZE & SORGHUM
IN-FIELD WATER HARVESTING

The focus of this section is on climate smart in-field water harvesting practices that aim to capture runoff water, and how to best choose the one most suited to your farmer(s).

- In-field water harvesting practices can be labour intensive and are best suited to arid and semi arid regions where other options are limited
- Climate smart soil amendments, planting systems and land preparation options can all be implemented as well as in-field water harvesting to maximise moisture retention

A water harvesting scheme will only be sustainable if it fits into the socio-economic context of the area and fulfils a number of basic criteria. These include:

**SLOPE:** The ground slope is a key limiting factor to water harvesting. Water harvesting is not recommended for areas where slopes are greater than 5% due to uneven distribution of run-off and significant quantities of earthwork required.

**SOILS:** Should have the main attributes of soils suitable for irrigation:

- Deep soils
- Not saline or sodic
- Ideally possess inherent fertility
- Soils with a sandy texture are a serious limitation as the infiltration rate may be higher than the rainfall intensity, no runoff will occur

**COSTS:** The quantities of earth and stonework involved in construction directly affects the cost of a scheme and indicates how labour intensive its construction will be.

This short video illustrates how to test infiltration rates of soils in a simple way

**Water Infiltration in No-Till vs Conventional Soil**

TAWC – Texas Alliance for Water Conservation

The figure below illustrates a decision tree that focuses on climate smart in-field water harvesting options for small scale maize and sorghum farmers. Other options are available for rangeland fodder and tree-based systems.

**Figure 4: Decision tree for climate smart in-field water harvesting options suitable for small scale maize/sorghum farmers**

**DECISION POINT**

<table>
<thead>
<tr>
<th>Region</th>
<th>Arid/semi arid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td></td>
</tr>
<tr>
<td>Deep loamy soils</td>
<td>Slope &lt;5 degrees</td>
</tr>
<tr>
<td>Sandy soils</td>
<td>Slope &gt;5 degrees</td>
</tr>
<tr>
<td>Not recommended</td>
<td>Not recommended</td>
</tr>
</tbody>
</table>

**Climate Smart in-field water harvesting options**

- Zai pits
- Half moons
- Contour ridges (stone/earth)
- Water spreading bunds
- Permeable rock dams
- Not recommended
Assuming the soil texture is suitable, deciding on which climate smart in-field water harvesting option to implement will depend on several factors:

- **Floodwater or runoff systems**
  - Is it possible to divert floodwater (Water spreading dams, permeable rock dams) or is it necessary to try to capture runoff (contour ridges, Zai pits, half-moons)

- **Availability of labour**
  - Individuals might choose to do half-moons, or Zai pits
  - Labour constrained farmers might choose other climate smart alternatives such as soil amendments, different field preparation practices or choosing alternate crops/varieties
  - Groups may choose more labour-intensive options

- **Availability of stones**
  - Limited availability will rule-out stone bunds, or permeable rock dams

- **Local topography** and catchment size

- **Cost benefit analysis**

### TIP

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

Ultimately, the farmers themselves should make the decision on which (if any) climate smart in field water harvesting practice they want to try out. To do this they need to understand the lifetime costs of each option, not just the initial costs.

Annual maintenance costs in terms of labour and/or capital investment should be calculated and planned for.

If the benefits are not well understood, then a pilot site might help convince farmers of the benefits. Different practices can be piloted over a season and farmers can then decide which are best.

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### RAINWATER HARVESTING

If there is enough rainfall but distribution is variable, another option is rainwater collection from run-off into tanks/ponds. The collected rainwater can be used in conjunction with either gravity fed or pumped (solar) irrigation systems. There are many types of rainwater harvesting systems available across the SADC region.

There are various factors your farmers should consider when making a decision on which option might best suit them:

- **Small systems often rely on water collected from roofs**
  - Metal/slate roofs work best
  - These limit the volume of water that can be collected due to surface area and because the tank must fit below the eaves (gutter) of the roof

- **Larger systems require significant investment in labour and/or money and generally are only viable as group schemes**
  - Technical experts will be required for larger systems

- **When considering rainwater harvesting it is always good to consider what else the water might be used for if it is made available. It is better to understand and plan for this at the start than to find capacity is not enough because water is being drawn down for other uses such as livestock or human consumption.**

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**Remember** when establishing farmer trials, keep all other variables (seed type, soil amendments added, time of planting, weeding, etc.) the exact same. The highest possible yield is not always the most profitable for the farmer. Gross Margins should always be calculated to assess the return on investment, so the most profitable option is clear.
Table 6 details the main advantages and disadvantages of some common water harvesting technologies used across the SADC region.

Table 6: Advantages and Disadvantages of different water harvesting technologies used across the SADC region.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Target Level</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Suitability for Maize/ Sorghum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic Water Tank (5 m³)</td>
<td>Individual</td>
<td>• Easy to install</td>
<td>• High Initial Cost</td>
<td>• Only suited to very small-scale production (e.g., home gardens)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Easy to move</td>
<td>• Difficult to repair</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No evaporation</td>
<td>• Relatively short lifespan – 10yrs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No pump required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plastic Water Tank (1 m³ – 10 m³)</td>
<td>Individual</td>
<td>• Easy to install</td>
<td>• High Cost</td>
<td>• Only suited to very small-scale production (e.g., home gardens)</td>
</tr>
<tr>
<td>with Drip Irrigation Kit (100 m²</td>
<td></td>
<td>• Easy to move</td>
<td>• Difficult to repair</td>
<td></td>
</tr>
<tr>
<td>– 200 m²)</td>
<td></td>
<td>• No evaporation</td>
<td>• Relatively short lifespan – 10yrs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No pump required</td>
<td>• Drip system requires constant maintenance and has a short lifespan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Drip irrigation has 80%+ water use efficiency compared to 35% with a watering can</td>
<td>• Sustainability of access to replacement parts for drip system</td>
<td></td>
</tr>
<tr>
<td>Bamboo Water Tank (5 m³ – 8 m³)</td>
<td>Individual</td>
<td>• Made from locally available materials.</td>
<td>• Cannot be modified once installed.</td>
<td>• Only feasible where bamboo is easily and cheaply available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Easily repaired</td>
<td>• Requires skilled labour to construct (trained technician)</td>
<td>• Only suited to very small-scale production (e.g., home gardens)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 30-year lifespan</td>
<td>• Takes a minimum of 3 weeks to construct.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Low evaporation</td>
<td>• Limited maximum capacity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No pump required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi Underground Tank (SUT) (6 m³</td>
<td>Individual</td>
<td>• Low cost</td>
<td>• Requires a pump to lift water (labour requirement)</td>
<td>• Only suited to very small scale production (e.g., home gardens)</td>
</tr>
<tr>
<td>– 10 m³)</td>
<td></td>
<td>• Locally available materials</td>
<td>• Higher level of water impurities/germs than other solutions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Does not require skilled labour</td>
<td>• Short lifespan of just 10 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Volume can be increased after installation</td>
<td>• Sourcing the correct specification of plastic for the 10 m³ tanks is a challenge</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Easy to repair (replace plastic liner or re-plaster)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Low evaporation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>Target Level</td>
<td>Advantages</td>
<td>Disadvantages</td>
<td>Suitability for Maize/Sorghum</td>
</tr>
<tr>
<td>-------------------------------</td>
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<tr>
<td>Run-Off Water Pond (250 m³ and 480 m³)</td>
<td>Groups</td>
<td>• Large capacity</td>
<td>• Requires pump to lift water</td>
<td>• Multiple ponds are required to irrigate a significant area of land</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Easy to construct</td>
<td>• Too expensive for individual households</td>
<td>• Requires detailed feasibility studies</td>
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<tr>
<td></td>
<td></td>
<td>• Locally available labour and materials</td>
<td>• Requires a strong group/committee to maintain/manage</td>
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<tr>
<td></td>
<td></td>
<td>• Potential for integration of small scale fish production</td>
<td>• Requires a large piece of land</td>
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<tr>
<td>Solar Irrigation Systems (1-5 ha)</td>
<td>Groups</td>
<td>• Can irrigate a large area of land for a long period</td>
<td>• High initial cost (but coming down all the time)</td>
<td>• High cost but also high impact if established effectively</td>
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<td></td>
<td></td>
<td>• Minimum labour requirement once operational</td>
<td>• Only suitable where groundwater can be accessed</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Low running costs</td>
<td>• Sustainability: – Requires a motivated committee to manage the system</td>
<td></td>
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<tr>
<td>Night Storage Reservoir (NSR) (700 m³)</td>
<td>Groups</td>
<td>• Filling at night reduces conflict with downstream communities</td>
<td>• High potential for theft of solar panels</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• High capacity</td>
<td>• Low output on cloudy days</td>
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<td></td>
<td></td>
<td>• Easy to construct using local skills</td>
<td>• Not replicable without external support</td>
<td></td>
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<tr>
<td>Small Earth Dams</td>
<td>Groups</td>
<td>• Potentially very high volume</td>
<td>• Requires an expert to conduct feasibility study and oversee construction</td>
<td>• If the geography is right, this can be a viable option, but downstream users must be consulted</td>
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<td></td>
<td></td>
<td>• Construction costs can be kept down using local labour</td>
<td>• Silitation – catchment area may need to be rehabilitated as well</td>
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<td></td>
<td></td>
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<td>• Only applicable in specific sites</td>
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<td></td>
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<td></td>
<td>• Requires a large piece of land</td>
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</tbody>
</table>

14 / CLIMATE SMART WATER MANAGEMENT OPTIONS FOR MAIZE & SORGHUM
TO SUMMARISE

STEP 1: Consider your crop water requirements
- Different varieties and crops require different amounts of water

STEP 2: Know what sources of water are available
- Enough/not enough
- Rainfall – probable
- Surface
- Sub surface

STEP 3: Consider the local context
- Availability & Accessibility of different varieties
- Geography/topography
- Farmers’ needs/priorities

STEP 4: Cost benefit analysis
- Which option is financially viable
- Consider alternatives

Climate smart soil water management is just one component of Integrated Soil Fertility Management (ISFM).

The benefits from adopting multiple climate smart practices are much greater and more sustainable than from adopting just one.

Irrigation Kit
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, 12, 16 & 19 for more detail on specific climate smart practices and technologies included within Integrated Soil Fertility Management.

  - An excellent resource that every extension officer should have access to

- ASHC – Sorghum and Millet Nutrient Management
  - A very practical resource for anyone growing Sorghum or Millet

- ASHC – Maize-Legume Cropping Systems
  - A practical guide to growing maize and legumes. Excellent resource for extension staff in the field

- International Centre for Tropical Agriculture (CIAT) – Impact of Conservation Agriculture on Soil Health
  - Aimed more at policy level, but a useful overview of the climate smart credentials of solar irrigation

  - A useful and comprehensive guide on SPIS

- Food and Agriculture Organisation of the United Nations (FAO) – Green manure cover crops and crop rotation in conservation agriculture on small farms: Integrated Crop management Vol 12, 2010
  - Focused on Paraguay and a bit scientific in places, but covers all the principles behind the practices

- FAO – Soil and water requirements:
  - Quite technical, but a useful guide on how to calculate/estimate the water requirements of different crops

- Global Alliance for Climate Smart Agriculture (GACSA) Practice Brief – Solar Powered Irrigation Systems: A clean energy, low emission option for irrigation development and modernisation
  - A very useful infographic/poster that relates to soil health in general, not just conservation agriculture

Citation: CCARDESA and GIZ 2019. Knowledge Product 10: Climate smart water management options for maize & sorghum. CCARDESA Secretariat, Gaborone, Botswana.