KP09
Knowledge Product 09

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

DECISION TOOL:
Climate Smart Seed Selection for Sorghum, Maize & 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)

Maize | Sorghum | Rice | Decision Point | Gender | Youth | Climate Smart | Practice

Johnson Siamachira, CIMMYT, 2016

german cooperation
DEUTSCHE ZUSAMMENARBEIT

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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.

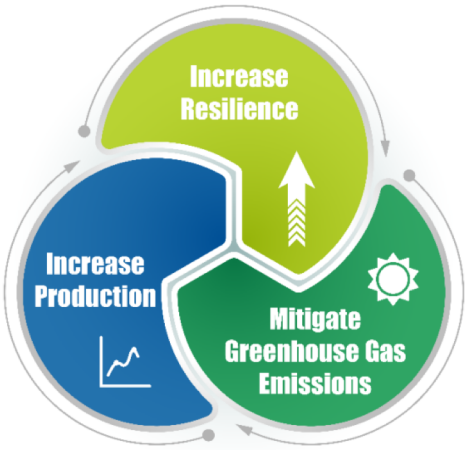
Key Messages:

1. To make climate smart decisions on which variety of maize, sorghum or rice best suits your farmers, you need to consider:
   - The farming system, including gender dynamics
   - The current status of the soil
   - Trends in rainfall and temperature
   - Farmers' priorities

2. There are four climate smart options to consider when deciding on which rice, maize or sorghum seed is most suited for your farmers:
   - Crop selection
   - Improved varieties
   - Saving own seed
   - Planting multiple varieties.

Entry Points for CSA

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



CLIMATE SMART SEED SELECTION FOR SORGHUM, MAIZE & RICE

This **Decision Tool** aims to help field-level extension staff make **climate smart decisions** on which seed 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 with their clients/farmers on improvements to their farming systems. 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 Seed Selection Options**. The tool is applicable for rice maize and sorghum.

The options 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 Southern African Development Community (SADC) region
- They have high potential to address major constraints to rice, 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 to make these options **Best Fit** to individual farmer's needs.

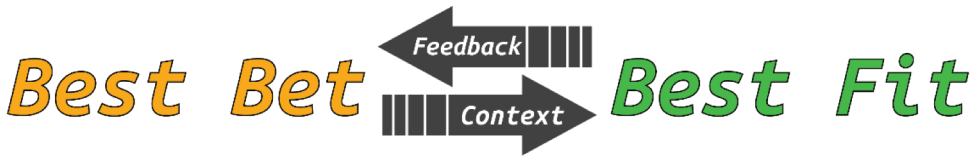


Table 1: Best Bet Climate Smart Seed Selection Options that have potential to address climate risks to maize, sorghum, and rice production across the SADC region.

Climate Smart Variety Selection Option	What is it?	3 Pillars of CSA		
		Increase Production	Resilience/ Adaptation	Mitigate GHG Emissions if possible
Crop Selection	Selecting an appropriate crop for the local conditions	Selecting the most suitable crop may increase production	Increases the likelihood of getting a return on investment	N/A
Improved Varieties	Drought/heat/salinity/ pH tolerance and/or pest/ disease resistance	Perform better in adverse conditions	Mitigate the effects of higher temperatures and lower/less predictable rainfall	Can result in better water-use efficiency and reducing energy inputs for irrigation
Saving Own Seed	Selecting the best of the farmer's own harvest for next year's seed. Not suitable with hybrid seeds	Higher germination and crop establishment	Healthier plants are less likely to be attacked by pests or diseases	N/A
Planting Multiple Varieties	Planting more than one variety in the same field.	Can reduce losses from pests and diseases	More predictable yields	N/A

Which seed is best suited to your farmers' situation?

The first step is to select the crop that best suits your farmers' situation. You can then assess if improved varieties are desired and are available/accessible. If these are not available or accessible, then selecting their own seed is the next consideration. There is also an option to plant multiple varieties if these are available and suitable to the farmers' context.

SEED SELECTION OPTIONS FOR ADDRESSING CLIMATE RISKS IN RICE/MAIZE/SORGHUM PRODUCTION

Below are four steps in climate smart seed selection options for rice, sorghum, and maize. Decision making on seed variety is essentially a process of elimination. All four steps are broadly applicable across the SADC region. While these are recommended steps, they are not universally applicable. CSA is context specific, and selected seed varieties will need to be tested under local conditions to ensure they **Best Fit** the local context.

CROP SELECTION

The first step is to know the context. You need to have a good understanding of the following before making any recommendations:

A. Soil

B. Required and predicted rainfall and temperature ranges

C. Pests and diseases prevalent in the area.

Johnson Siamachira, CIMMYT, 2016

A. Know Your Soil

Different soils are better suited to different crops. The recommended soil types for each of the three crops are given below.

Table 2: Recommended soil types for each of the three crops.

	Sorghum	Maize	Rice
Recommended Soil Types	Fertile, well-drained soils are important to optimise yield Soils with clay loam or loamy texture, having good water retention capacity, are best suited for sorghum cultivation	Deep fertile soil that is well drained, with good water holding capacity and rich in organic matter. The soil can range from heavy clay to light sandy soil, but loam or sandy-loam soils are preferable	Soils with good water retention capacities are best – so clay soils with high organic matter content are ideal, but soils with high silt contents are also suitable
Ideal pH Range	6.0 – 7.5	5.6 – 7.5	6.0 – 7.0
Soils to Avoid	Soils with excessively high or low soil moisture levels, hardpan and/or compaction	Sandy with low organic matter and poor moisture retention	Sandy soils with poor moisture retention

Some varieties have been designed to tolerate pH outside the optimal ranges. Knowing the pH of your soil is critical. **Stunted roots** (Figure 1) in maize and sorghum are often an indication of acidic soils – low pH.

Some varieties will have high yield potential, but only if grown under optimal conditions – correct pH, fertile soil high in organic matter, and with optimal inorganic fertiliser applications. It may be better to choose a more robust variety with slightly lower yield potential if the soil is not as fertile, and if access to inputs is limited.

The amount of fertiliser applied that actually gets used by the plants is often very low, due to poor soil conditions. Very low pH (4.5) can mean that over 70% of the applied fertiliser is wasted. Soil moisture and organic matter content also have significant effects on fertiliser use efficiency **(See CCARDESA KP21 – Climate Smart Fertiliser Application Options)**.

Understanding your soil is critical in making decisions on which varieties are best suited to your farmers.

Plants that are deficient in any one of the main nutrients (or are exposed to toxic levels of) will be weaker and less able to fight off attacks from pests and diseases.

If you do not have access to a laboratory for testing soil, then field observations of growing plants is the next best thing – **See CCARDESA KP06 - Climate Smart Soil Amendments**.

Figure 1: Stunted roots of maize resulting from acidic soils.

B. Required and Predicted Rainfall Distribution

Knowing crop water requirements and matching them to predicted rainfall is critical in selecting climate smart varieties. This may even influence the choice of crops to grow, rather than just the variety that is most suitable. Maize is less drought tolerant than sorghum, for instance. Understanding rainfall patterns is also important for irrigated crops so that the area of cultivation can be maximised, and the amount of irrigation water used is minimised.

To understand the local context in terms of rainfall, you should consider:

- 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. PICSA helps you in supporting farmers to make more informed decisions – based on accurate, location-specific climate and weather information, as well as crop, livestock and livelihood options. Your local **Met Office and Disaster Management Office** should be able to provide you with some basic information to help your farmers make more informed and climate smart decisions.

In any case, ask farmers about their past observations on rainfall, seasons, access to water and extreme events.

You can consider collecting rainfall data with your farmers – especially documenting dates on which it rained, and the duration and intensity. 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 making climate smart decision, and reducing risks in hazardous situations.

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, so the ranges indicated in Table 3 may change as new, early maturing, drought tolerant varieties are developed.

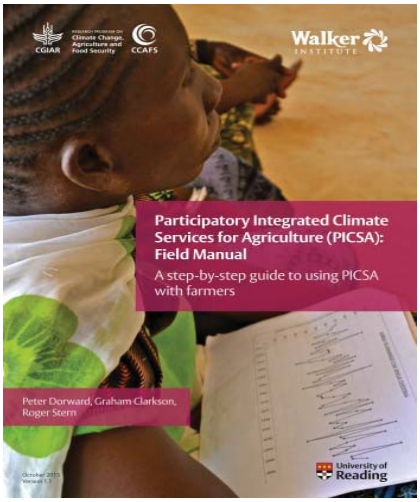


Table 3: Crop water requirements and critical growth stages.

Crop	Normal Range		Critical growth stages for water stress
Maize	500 – 1,200 mm total growing period		Flowering to late grain filling phase with a peak during the tasselling and silking phases
Sorghum	400 – 900 mm total growing period		Reproductive stages, especially flowering
Rice	**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) Reproductive stage is especially sensitive
	Irrigated	Rainfall not necessary if enough 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

C. Know What Pests and Diseases are Prevalent in Your Area

There is limited use in picking a crop that is resistant to a pest or disease that is not present in your area, unless there is potential for it to spread to your area in the next season. Information on potential outbreaks of pests and diseases is vital. Weather forecast information can sometimes be used to predict a probability of pest/disease outbreaks. Access to early warning information and continuous surveillance are critical tools for the extension officer.

There are many types of insect, weed, disease and other threats that can affect rice, maize and/or sorghum. Identifying them is not always easy, and not all are worth controlling. For example, there are over 100 different insects that can attack rice, but only about 20 that cause economic damage.

It is important to know exactly what pests and/or diseases are most common in the area, before selecting varieties that may have pest, disease or weed resistance. If you are not sure what the main pests and diseases in the target area are, the first thing you need to do is to find out. Fields should be visited regularly during the season so that any new infestations can be identified. There are several tools available to help you in identifying pests and diseases. These include early warning systems such as FEWSNET or Plantwise Pest and Disease Updates.

The *Rice Doctor* is a particularly useful app that you can use on your smartphone; only available in English.

Rice Doctor
LucidMobile
Free

The *Plantwise Factsheet Library* allows you to search for factsheets on various pests, diseases and nutrient deficiencies in multiple languages.

Plantwise Factsheet Library
CABI
Free

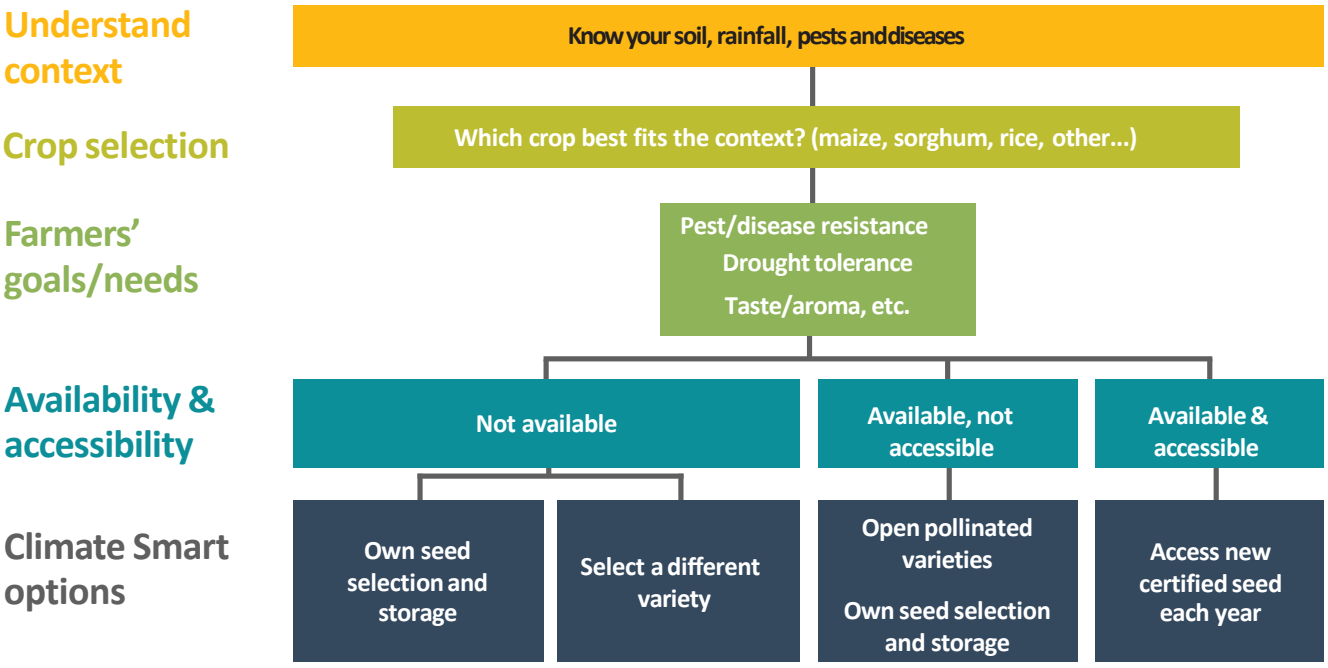
The above tools include resources on how to prevent and directly control various weeds, pests, and diseases.

Understanding the soil, climate, and pest/disease incidence in the target area, it is possible to make decisions on whether or not the crop the farmer wants to grow is suited to the target area. With rising temperatures and more erratic rainfall, crops like maize are becoming less suitable in many areas – there may be an option to replace maize with sorghum, or even millet. In most cases, the farmer will know best what crop fits their priorities and they will have good reasons for their choices. It is then necessary to find the most suitable variety of that crop to best fit the farmer's context.

Making climate smart decisions requires an understanding of probable local weather conditions (climate), access to water for irrigation, knowledge of the soil's physical and chemical properties, and prevalent pests and diseases. This understanding needs to be balanced with the availability and accessibility of seed varieties, as well as farmers' own priorities – which may not always be motivated by increases in production.


Jill Cairns, CIMMYT, 2014

DECISION POINT



Understanding the context will assist you and your clients/farmers in making decisions on which variety is the most appropriate. Issues to consider when assessing farmers' goals, defining desired traits, and assessing whether the desired seed is available and accessible, are outlined next.


Anne Wangalachi, CIMMYT, 2010

SELECTING IMPROVED VARIETIES

When selecting improved varieties, it is vital to consider the farmers' goals and priorities for production before assessing whether seed with desirable traits is available and accessible locally.

Understand the farmers' goals/needs

Farmers' goals/needs are not all the same. Never assume that one seed variety will suit all farmers in a target area. There are many factors to consider when assessing farmers' goals:

- **Producing for market or consumption**
  - Household vs market demands on quality and characteristics
  - Gender may be a significant factor here, so be sure to check on the different priorities for men and women
  - Biofortified varieties are available that can help address specific vitamin deficiencies in human diets
- **Taste, colour, aroma, ease of cooking, etc.**
  - Yellow maize has a higher potential yield than white maize, but white maize may be preferred for cooking
  - 'Stickyness' and aroma of rice can be a factor
  - Market demands, and own consumption demands can be very different
- **Irrigated or rainfed** production
  - Yellow maize might be selected if being sold on the cob from irrigated production
- **What is most important** to the farmer?
  - Yield potential/predictability/ease of management
- **Drought tolerance/disease/pest/weed resistance**
  - Some farmers may be able to afford pesticides/ herbicides, or practice cultural/biological control. Others may not (e.g., a farmer who has fenced fields and no livestock may be able to mulch their fields heavily, thereby suppressing weeds. Or, she might favour a drought tolerant variety with good yield potential over a weed resistant variety with lower yield potential)
- **Availability of labour** and other inputs
  - Some varieties only reach their potential under perfect growing conditions and correct fertiliser application
    - »Is the farmer likely to be able to commit the resources required?
    - »Is adequate rainfall predicted?
  - If not, it may be better to choose a more robust variety with lower yield potential
- Ability to **store surplus**
  - Does the farmer want to grow just enough for their own consumption, or do they need some extra to sell?

TIP

There is no 'one-size-fits-all' solution. Each farmer has their own priorities. Never assume you know what is best for a farmer.

Select seeds for Desirable characteristics

Once you understand the local context and farmers' needs, you can assess what type of seeds are available on the local market. The **ideal** seed variety may have multiple resistances/tolerances, e.g., high yielding, drought tolerant, and resistant to certain pests.

Work with your farmers to define what this ideal seed would look like for them. You then need to compare this with what is available on the market, and determine the best match.

- **Drought/heat tolerance**
  - If total rainfall is an issue, select a variety with a shorter time to maturity
  - These varieties tend to have lower yield potential than medium and longer time to maturity varieties, but are more likely to attain their yield potential
  - These varieties are often shorter in height (especially for maize/sorghum), which may be a factor to consider – depending on what the plant residues are used for
  - Some varieties are better suited to short dry spells, common in some regions after the initial rains have started
  - When selecting for drought tolerance, always check if the variety also has good heat tolerance. A variety that is drought tolerant, but does not have good heat tolerance, will not perform well in hot dry conditions
- **Salt tolerance**
  - This characteristic is usually associated with crops grown under irrigation, where there can be an accumulation of salts
- **pH tolerance**
  - Applying lime can be expensive due to the volumes required. If pH is marginally low, a variety with higher tolerance may suit
- **Pest and/or disease resistance**
  - There are multiple varieties available with resistance to various pests and/or diseases. Knowing the common pests/diseases in your area will help you to select the most beneficial ones.
  - ***Striga*** (or **witchweed**) is a huge problem across the SADC region, and selecting for resistance to this particular weed pest is highly advisable
- **Resistance to lodging**
  - Shorter plants that do not blow over, or are not flattened as easily by heavy rain. This is more likely to be a characteristic of rice varieties. Consider the harvesting technique, and what the rice straw/stover is used for when selecting these varieties
- **Biofortification**
  - In recent years, some varieties have been released which have been biofortified with specific vitamins that are known to be deficient in human diets in the region. Biofortified maize with Vitamin A is one example.

Many varieties have multiple resistance characteristics, so selecting the variety most suited to your farmer is not always easy. Most farmers tend to use the same varieties every year, even though new and improved varieties are being released all the time.

Encourage farmers to test new varieties in small areas to assess if they are better than older varieties. If possible, engage with representatives of the seed supply companies/ research stations to discuss the pros and cons of the different varieties available. It is advisable to test new varieties on a portion of the farmers land for at least one or two seasons before committing to planting whole fields.

TIP

When testing new varieties, they should be grown under the same conditions as the older varieties. If fertilizer is not normally used, then it should not be applied to the new variety. This will give a more accurate comparison

Availability and accessibility

The type of seeds you want may or may not be available and/or accessible:

- **Not available** – A seed variety with the resistance/ tolerance you are looking for may not exist
  - If the seed type you want is not available, then the farmer can either **select a different variety** that closely matches their requirements, or **use their own seed**

- **Available**, but **not accessible** – The seed variety you want is available, but not locally accessible
  - This may be due to the farmers' inability to buy the seed, or to get access to the market where it is sold
    - » Gender is an important consideration here, especially for women/child (single) headed households, who may not be able to leave home to go to markets as they must look after small children and/or elderly relatives
  - Organising farmers to buy in bulk may be an option. If the volume is high enough, the supplier may come to the location or a community member can be sent to buy for everyone
  - The size of the seed packet may be a limiting factor. If seed is only sold in 50 kg sacks and a farmer only needs 5 kg, it may not be feasible to buy the large sack and transport it home
  - An **Open Pollinated Variety (OPV)** of maize or sorghum might be an option here, as the seed can be reused for up to four years. This reduces the number of trips to market
  - **Selecting own seed** is an option for rice and for maize and sorghum, but **only** if the seed is an OPV
    - » This is not an option for hybrid seeds as they are not designed to be reused

- **Available and accessible**
  - This means that the required seed is available locally in a packet size that suits the farmer and that she/he has the resources to access it
  - In this case, the farmer is recommended to purchase certified seed on an annual basis as the purity, germination rate and crop establishment (and thus yield) will be much better than reused own seed. This can be of hybrid or open pollinated varieties, depending on the characteristics the farmer desires.

Biodiversity International, 2013

OWN SEED SELECTION

The preference should be to obtain certified seed each year (or every 3–4 years for OPV), as this will have high germination rates and will produce vigorous plants. If farmers cannot afford certified seed or it is unavailable, the next best option is 'good' seed – purchased from other farmers who have grown it especially for seed. This is sometimes called 'quality assured' seed. If this is not available or affordable, farmers can select the best of their own seed for the following crop.

Hybrid maize or sorghum seed is not suitable for saving and replanting, as it is designed only to last one growing season. Investing in land preparation for saved hybrid seed is not viable. Open pollinated varieties also have drastically reduced yield potential after three or four years, depending on variety.

Selecting seed for the following year:

- **Rogue off-types** (by plant height, appearance, flowering time, etc.) and poor, diseased or insect-damaged plants, or plants with discoloured panicles/ cobs/heads
  - Only select the very best performing plants to source seeds for the next year

Winnowing Rice, FAOALC, 2011

- **Winnowing** – Harvested seed includes seed of varying sizes and non-seed matter (e.g., weeds and trash). Full, plump (heavier) seed can be selected by winnowing with natural wind or an electric fan
  - Pour seed slowly from a height of 1 – 1.5 m
  - Repeat winnowing, if necessary. Select heavier seed closer to the side from which the wind blows. This procedure will also remove lighter weed seed and non-seed matter
- **Selection** – be careful to remove insect-damaged grain, mouldy grain and chaff, and burn it. Other damaged grain may be fed to animals. Only select the very best grains to keep for seed
- **Storage** – Store seed separately from other harvest. Dry seed to 12%–14% moisture content. Store the seed in sealed airtight containers until ready for planting (seed is good for up to one year if stored properly). Seed in non-airtight containers absorbs moisture and loses viability over time.

TIP

Hybrid seeds cannot be saved for the following season.

PLANTING MULTIPLE VARIETIES

Planting multiple varieties with **different resistances** and **tolerances** is an option, but varieties with the same total growing period should be selected if this is to be practised. Otherwise, losses of ripe seed can be incurred while other varieties are still not ready for harvest. Varieties should also be of similar height to make harvesting easier (especially for rice). The advantage of having multiple varieties is the **reduced risk of total crop failure** in the event of an outbreak of a specific pest or disease. Decisions on intercropping, alley-cropping and rotations may also affect choice of varieties. This topic is covered in **CCARDESA KP07 – Climate Smart Planting System Options**.

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TO SUMMARISE

When trying a new variety in local conditions, it should always be compared to:

- The potential according to the seed producer
- Existing local varieties.

To do this effectively, gross margins or a cost benefit analysis should be calculated to compare the existing and new varieties. All inputs, including labour, should be factored into these calculations to ensure they are realistic. These calculations should be done with your farmer(s), and discussions held on the results and if/how things could be improved. Accurate information is key in these calculations. Records should be kept throughout the season. It is best not to rely solely on memory.

STEP 1: Know Your context

- Soil type and soil health
- Water requirements of crop
- Predicted rainfall
- Prevalent pests & diseases

STEP 2: What are the farmers' goals/needs?

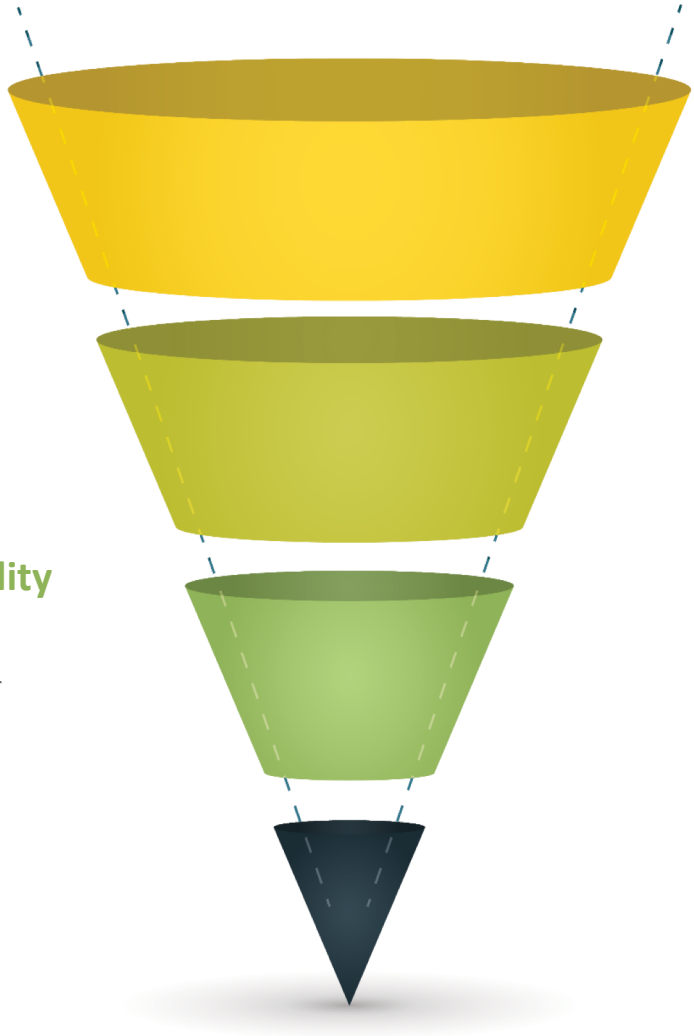
- Consumption or market
- Taste, colour, aroma, etc.
- Labour availability
- Drought tolerance/disease resistance, etc.

STEP 3: Availability and accessibility

- Not available – use own seed
- Available, not accessible – own seed or OPV
- Available and accessible – use certified seed each year

STEP 4: Reflect

- Cost/benefit analysis
- What can be done better?



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, 10, 12, 16 & 19** for more detail on specific climate smart practices and technologies included within Integrated Soil Fertility Management
- **African Soil Health Consortium (ASHC)** – Handbook for 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
- **ASHC** – Sorghum-Legume and Millet-Legume Cropping Systems
  - A practical guide to growing maize and legumes. Excellent resource for extension staff in the field
- **Climate Change, Agriculture and Food Security (CCAFS)** – Participatory Integrated Climate Services for Agriculture (PICSA) Field Manual: A step-by-step guide to using PICSA with farmers
- **Food and Agriculture Organisation of the United Nations (FAO)** - Training Manual for Post-Harvest Management and Storage
  - Sections on seed selection and storage are important here
- **International Maize and Wheat Improvement Center (CIMMYT)/International Institute for Tropical Agriculture (IITA)** - Drought Tolerant Maize for Africa
  - Access the different varieties that have been released over the past number of years, and useful contacts
- **International Rice Research Institute (IRRI)** – The Rice Knowledge Bank
  - An excellent resource for all extension staff working with rice.

CIAT, 2010

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