KP13
Knowledge Product 13

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

DECISION TOOL:

Climate Smart Post-Harvest Management Options for Maize, Sorghum & 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 | Technology

Steward, 2015

Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
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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. **Resilience:** 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 climatic 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?

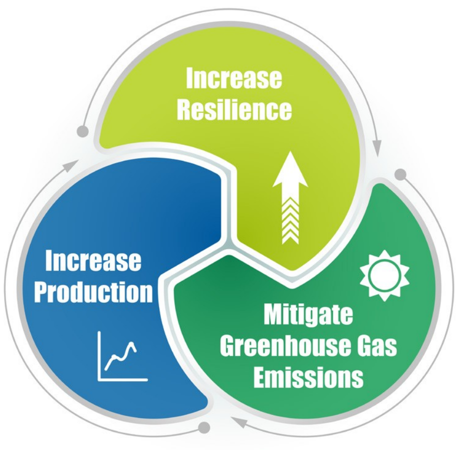
1. CSA places greater emphasis on **hazard and vulnerability assessments** and **emphasises weather forecasting** (short term) and **climate scenario modelling** (long term) in the decision-making process for new agricultural interventions
2. CSA promotes the **scaling up of approaches** that achieve **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. Post-harvest losses = wasted labour, expenditure and income.
2. To make climate smart decisions on post-harvest management options you need to analyse:
   - The farming system
   - The household context
   - Market requirements
   - Collect data on post-harvest losses
3. This Decision Tool outlines climate smart options for harvesting, drying, and storing your crops to minimise post-harvest wastage. These include:
   - Best practice harvesting techniques
   - Changing harvest time
   - Drying techniques
   - Physical storage options

Entry points for CSA

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



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CLIMATE SMART POST-HARVEST MANAGEMENT OPTIONS FOR MAIZE, SORGHUM & RICE

This **Decision Tool** aims to help field level extension staff make **climate smart decisions** on which post-harvest 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 post-harvest management options** for maize, sorghum and rice 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.

- They are climate smart (see Table 1)
- They are applicable in multiple agro-ecological zones across the region
- They have high potential to address the areas where the largest post-harvest losses occur.

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

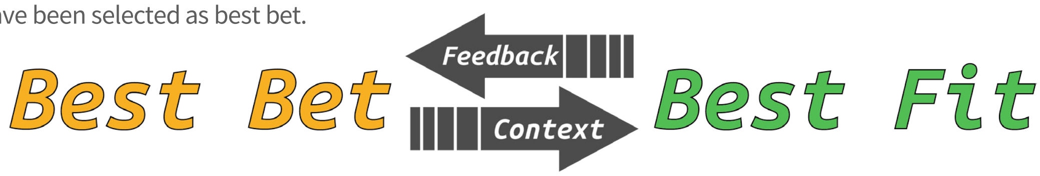


Table 1: Best Bet Climate Smart post-harvest management options for rice, sorghum and maize that have potential to address losses across the SADC region.

Climate Smart post-harvest practice	What is it?	3 pillars of CSA		
		Increase production	Increase resilience	Mitigate GHG emissions if possible
Best practice harvesting techniques	Proper harvesting techniques to reduce breakage and bruising	Reduces potential losses of ripened grain	More grain of a higher quality to consume and sell	More efficient use of resources
Changing harvest time	Harvesting at optimal moisture conditions to avoid losses due to mold and decay	Reduces potential losses of ripened grain	More grain of a higher quality to consume and sell	More efficient use of resources
Drying Techniques	Improved drying techniques to avoid mold and decay	Reduces potential losses of ripened grain	More grain of a higher quality to consume and sell	N/A
Physical storage options	Improved physical storage (off-ground storage, improved packaging, chilling)	Reduces losses during storage	Storage that is protected from flooding, extreme rain and heat will protect grain. Potential to store until prices are higher and increase income	More efficient use of resources

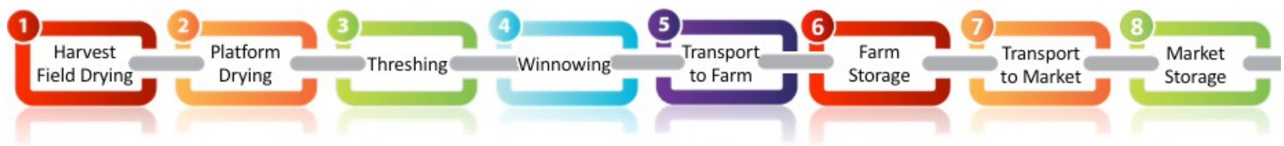
WHICH CLIMATE SMART POST-HARVEST MANAGEMENT OPTION IS BEST SUITED TO YOUR FARMERS?

Post-harvest losses of cereal grains commence when physiological maturity is reached in the field. This is followed by a chain of post-harvest activities, from the field to the consumer. This chain has at least eight links from harvest to marketplace (Figure 1).

At each link, there are usually some dry matter weight losses. This can be from the following:

- Grain being scattered or spilt
- Grain becoming rotten or consumed by pests

Figure 1: There are eight links in the post-harvest chain. Losses can occur at every link in the chain.



To make climate smart decisions requires actionable information. The Decision Point illustrates the importance of information in making decisions on post-harvest management options. However, obtaining accurate information on post-harvest losses is a resource intensive exercise. If there is no information available for your target region it may be worthwhile linking up with the **African Post-harvest Losses Information System (APHLIS)** and using their detailed guidelines to enable you to collect this information for your area. Another option is to use the **Rapid Loss Appraisal Tool (RLAT)** developed by GIZ. This tool is focused on maize losses but could also be used for sorghum and rice.

Once the information has been collected it can be used to predict post-harvest losses from samples of grain. The more information that becomes available the more accurate the predictions become.

The most significant post-harvest losses for sorghum, maize and rice occur during:

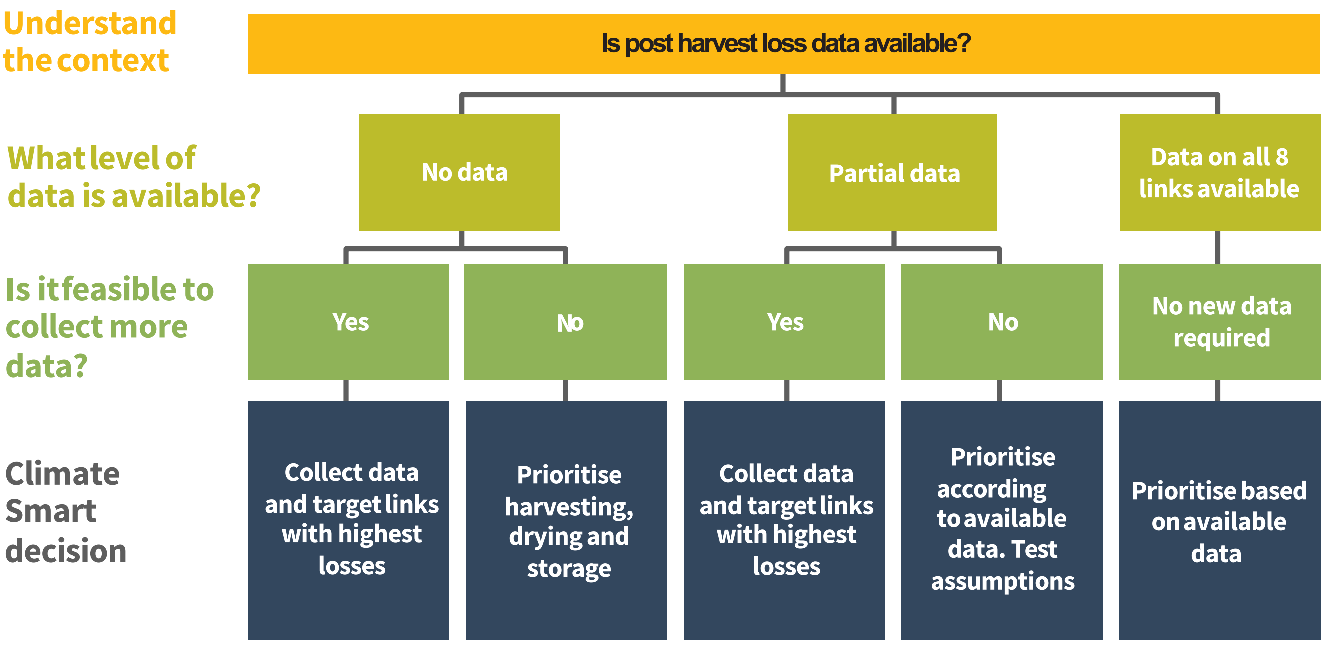
1. Harvesting and field drying
2. Drying
3. Farm storage

These three links in the post-harvest management chain are a good place to start when making decisions on which climate smart post-harvest options might best suit your farmers.

To make climate smart decisions on post-harvest management options it is important to have a detailed understanding of the following factors:

- The farming system
- The household context
- The climate related hazards (such as flooding or cyclone damage)
- The market requirements

DECISION POINT



A. The farming system

Different agronomic practices and farming preferences can affect post-harvest management options. Some considerations include:

- The planting date and days to maturity will determine harvesting date.
  - Is the variety prone to lodging?
- What type of grain has been sown?
  - Hybrid varieties are usually much more susceptible to post harvest losses than local varieties
  - Have multiple cultivars and/or varieties been sown in the same field?
- Is the sorghum or maize intercropped?
- The use of plant residues may impact on harvesting techniques.
  - Are the plant residues required to be cut at a certain height?
  - Are they left on the field as mulch or grazing?
  - Are they removed for fodder, fencing and/or fuel etc.?
  - Are they required to be left standing to support intercropped climbing beans?
- Is grain stored or sold immediately after harvest?
  - How much grain is stored (if any) and for how long?
  - How much grain is sold (if any) and when is it sold?
  - Is any grain kept for seed?
- Does the farming system include livestock?

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B. The household context

The availability of resources within the farming household will also impact on selection of climate smart post-harvest management options:

- Is the growing of maize, sorghum and/or rice a priority in the household?
  - Does most of the household income come from these crops or does it come from elsewhere?
  - Do men and women within the household have the same priorities in terms of maize, sorghum and/or rice production?
- Is the household labour constrained?
  - Is labour hired in and/or shared for specific tasks or do all tasks need to be completed by household members?
- Who in the household (men, women and children) is involved in each link of the post-harvest chain?
  - What tasks are predominantly done by women, men and children and how long do these usually take?
- Can the household afford to invest in improved technology and practices on post-harvest management?

C. Climate-related hazards

Climate change leads to more intense and at times more frequent extremes. These can typically be strong winds and cyclones, flooding and drought. In the context of post harvest management, following climate-related risks should be discussed with the farmers. Also the local disaster risk management office can provide information on risks.

- What kind of climate-related hazards did the farmers experience in the past (flooding, storm damage, drought and/or fire)?
- How did these affect the post-harvest management steps (e.g. harvesting, drying, threshing, storage, transport)?
- What damages and losses were experienced?
  - If possible, damages and losses can be quantified.
  - How did these affect men, women and youth?
- What did the farmers (men, women and youth) do to reduce the damage and losses (e.g. postponing tasks, making storage facilitates safer, obtain a risk insurance)?
- What can be done in future to reduce the risk of damage and loss caused by extreme events?


Waddington, 2018

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D. Market requirements

If markets require certain standards of grain quality and are willing to pay a premium for high quality this can greatly incentivise farmers.

- Are quality standards set for maize, sorghum, and rice grains in the local market?
  - Who sets the standards?
  - Are standards communicated/known?
  - Do farmers know how to grade their grain?
- Who are the different actors in the maize, sorghum and rice post-harvest value chain?
- Do different markets have different requirements?
  - Do middlemen accept lesser quality grain than millers?
- Are there markets for by-products from harvesting, shelling and/or sorting grain?
- What was the price last year and does the price fluctuate over the course of the year?
- Are there companies or organisations or other opportunities to engage in bulk storage?
  - Are there community grain stores and/or rice banks?
  - Is anyone offering commercial storage facilities using a warehouse receipts system?
  - Who is responsible and takes care of these storages?

BEST BET POST-HARVEST MANAGEMENT OPTIONS FOR ADDRESSING LOSSES TO MAIZE, SORGHUM AND RICE

Below are three climate smart post-harvest management techniques for maize, sorghum and rice. They are listed in order of the links in the post-harvest chain and represent the links where the highest losses are most commonly found (Table 2). All are broadly applicable across the SADC region. To minimise losses all links in the post-harvest chain should be addressed, but these three are a good place to start. 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 to the local context.

Table 2: Typical post-harvest losses of cereal grains.

Stage	Percentage of crop (%)
Harvesting/field drying	4 – 8
Transport to homestead	2 - 4
Drying	1 – 2
Threshing	1 – 3
Winnowing	1 - 3
Farm Storage	2 – 5
Transport to Market	1 - 2
Market Storage	2 – 4
Cumulative loss from production	**10 – 23**

Source: WFP, 2012.

TIP

Mycotoxins are fungal growths in stored grain. They are very toxic to humans and can be a significant contributing factor to malnutrition. Storing at the correct moisture content helps control their growth, but limiting opportunities for contamination is also important.

BEST PRACTICE HARVESTING TECHNIQUES

Prior to the harvest it is important that farmers are already prepared for their post-harvest activities:

- The equipment needed for their harvest and post-harvest activities is available and in good shape
- They have decided where important activities will take place (allocating drying and threshing areas)
- Sufficient storage space for the crop is available
- The location and construction of the storage space is as safe as possible to protect the harvest from extremes (e.g. cyclone damage, flooding, extreme rain and heat)
- Grain stores and sacks and transport equipment have been thoroughly cleaned (and potentially disinfected) before the new harvest arrives so that the residues of the old harvest (last season's crop) are removed from all cracks and crevices and either burnt or fed to animals. Alternatively, they can be stored in a separate place, consumed quickly or processed.
  - New harvest should never be placed on, or with, grain from the previous season as this will encourage the movement of pests from the old to the new.
- Fields should be weed free at harvest time. This will prevent any weed seeds from being able to contaminate the harvest and be carried over into the following crop if using saved seed.

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Most smallholder farmers harvest their maize, sorghum and rice crops by hand and thresh them later. Maize cobs are plucked from the plant, while sorghum heads and paddy rice panicles are cut. Many farmers harvest their maize, sorghum and rice and place them directly onto the ground. When harvesting, best practices are to:

- Place the harvested crop directly onto clean mats, tarpaulins or directly into bags.
  - This avoids contact with the soil, which can lead to moisture uptake, soil contamination and the transfer of fungal spores that can lead to fungal growth and mycotoxin production.
  - This will also prevent contamination with tiny *Striga* (Witchweed) seeds that may be present. This is especially important if some of the harvested grains will be used as next season's seed.
- Leave the roots and at least 5-10 cm of the stalk in the soil when cutting stalks as this will help prevent erosion.
  - If the farmer is planning to leave the residues on the field for mulch then leaving the stalks slightly longer will reduce losses of mulch due to wind.
  - If the farmer is practicing minimum till (basin planting or zai pits) this practice will also enable easy locating of the planting stations for the next season.
- Avoid lodging as it can cause significant losses (in terms of time and grain) as well as contamination, especially in rice crops.
  - If this is a problem, consider using shorter varieties in the following season (see CCARDESA KP 09 – Climate Smart Variety Selection).
  - Also, for rice, missing the secondary tiller panicles when harvesting can result in significant losses (grain left in the field). This happens when harvesting is done by cutting the straw about 60 cm above the ground. It is more of an issue in lowland production.
- Keep the rice bundles standing upright, instead of laying them flat on the ground.

To implement these best practices, the following questions should be discussed with your farmers:

- Are tarpaulins, plastic sheets and/or concrete areas available to use during harvesting?
  - If farmers do not already use these, can they afford to invest in them?
  - If farmers do use them, are they big enough so they can be folded over (plastic & tarpaulins) if it rains and to ensure no spillage over the edges?
- Are the collection areas suitable and sited in the most convenient location?
  - Is the site accessible for transport (livestock, people, bicycles, trucks etc.)?
  - Is the site protected from livestock and cross-contamination from other fields?
  - Is it big enough so that grain does not spill onto the ground?
  - How are the crops transported from the field to the collection area and drying site?
- Are grains from different fields mixed at the harvesting site?
  - Are the grains from the different fields checked for quality, damage and infestation before being mixed?

Stephen Morrison, 2009

CHANGING HARVEST TIME

Ensuring the correct timing of harvesting (and best practice harvesting techniques) can also help minimise losses during transport to the homestead. This is another area where losses are typically high.

Harvesting should be done as soon as the plants are physiologically mature and then transported to the homestead for immediate drying. On reaching physiological maturity, cereal grains are still too moist and soft to be threshed so most smallholder farmers leave them to dry naturally in the field for several weeks prior to harvest. They are sometimes left on the stalks to dry in the sunshine or the stems are cut and arranged into piles called 'stooks'.

- This approach is **not recommended** as the crop is more vulnerable to losses caused by:
    - Infestation by insect pests
    - Damage by birds or other wild animals
    - Losses due to theft

- Late harvesting should also be avoided, because
    - Insects that attack at crop maturity may be carried over into storage and cause severe damage
    - The grain may start to scatter, this is especially the case for paddy rice and sorghum

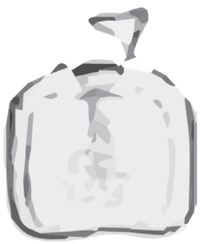
- The only **disadvantage** of harvesting and moving the harvest to a designated drying area as soon as the crop reaches physiological maturity is that the crop will be heavier than if left in the field to dry for longer, so it requires more effort to move it to the homestead.

It is important to be able to recognise when crops are mature in the field:

Maize – The crop is mature when the plant has become straw coloured (light brown) and the grain hard. Some of the cobs will droop downwards. Cob maturity can be tested by checking for the black layer that forms at the base of grains (where they connect with the cob). The layer can be seen by removing grains from the cob and scraping the base with your fingernail (see Figure 2).

If harvesting of maize is delayed due to wet weather, then entry of water into the cobs can be reduced by breaking the stem just below the cobs and turning the cobs so that their tips are pointing downwards.

Figure 2: Mature Maize.



Source: After WFP,2012.

Sorghum - Grains tend to reach physiological maturity while the stalks and most of the leaves are still green. Like maize the grains also develop a black layer at their base when mature. The grain tends to mature from the top of the seed head downwards. The bottom of the seed head lags behind the tip by about one week, so it is worth checking grain from the top and bottom of the seed head for signs of maturity.

Late harvesting can lead to spontaneous shedding of the grain from the panicles resulting in significant losses and grain deterioration due to rapid changes in temperature and humidity.

Rice – The crop should be harvested when nine out of ten grains on the panicle are straw coloured, when they typically have a moisture content of around 20-25%. Such grains are firm, but not brittle when squeezed between the teeth. Delay in harvesting can cause significant losses due to scattering (shattering) during harvesting, transporting, and handling of the harvested crop before threshing.

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Rain at harvest

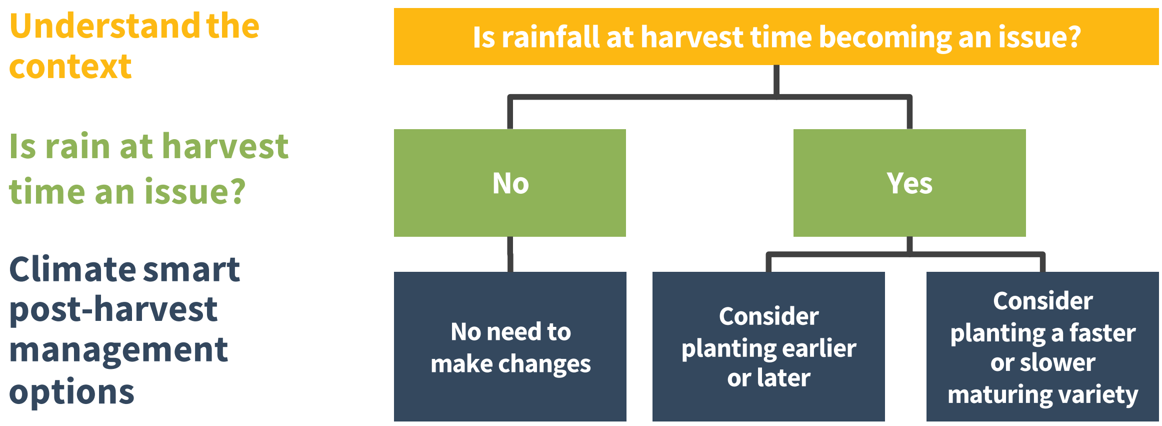
If rain is a recurring issue that delays or effects harvesting, then you should discuss with your farmers the option of either planting at a different time or selecting different varieties that are faster or slower maturing. This decision should be based on the following factors:

- A good understanding of trends in rainfall and evidence on which to base estimations moving forward. Discuss the following with your farmers
    - If they think that there will be enough rain in the next season?
    - How likely the rain is to come during the critical growth stages?
    - What information they are using to make these assumptions?

- An assessment of farm resources and the effect that changing planting and harvesting times might have on labour availability for crop management practices; including the effect on men, women and children throughout the cropping cycle.

Post-harvest management options if rain occurs during harvesting are presented in the Decision Point below.

DECISION POINT



DRYING TECHNIQUES

Drying the crop at the homestead is a better option than drying it in the field. During drying at the homestead, consider the following factors:

- Never place the crop in direct contact with the soil
- Keep the crop away from farm animals, otherwise the grain may be contaminated, damaged or eaten
  - This may be done by tethering animals or fencing in the area where grain is drying.

For drying, sorghum is usually left on the seed head and maize grain is left to dry on the cob. The reason for this is that in the un-threshed form, air can circulate more easily around the grain and so drying is quicker. By contrast, rice is usually threshed before drying.

In the case of maize, cobs may be dried either with **or** without husk cover. The following considerations can help you to take a decision with your farmers:

1. **De-husk maize cobs if:**
   a. Rapid drying is required
   b. There is no danger of cobs getting wet due to rainfall during drying (the husk would provide some protection from rainfall)
   c. Storage period after drying will be short or the cobs will be shelled soon after drying
2. **Retain husk cover if:**
   a. Rapid drying is not essential
   b. There is a danger of cobs getting wet due to rainfall during drying;
   c. Storage after drying will be at least 3 months (complete husk cover i.e. including the tip of the cob, provides some protection against insect infestation)

There are two main drying techniques on the farm:

1. Drying outside on a flat surface
2. Using a drying crib

Drying outside on a flat surface

For drying, the crop can be placed directly in the sunshine on a drying floor. This can be a cement area, a tarpaulin, layer of sacks or woven mats. In many contexts there can be cloudy weather and some rainfall at the time of drying so it is important to keep watch on the drying crop and cover it with a tarpaulin prior to any rainfall. To make the process of drying quicker the rice, cobs or seed heads should be placed in a single layer and turned at intervals of every hour. If they are placed in a deeper layer then drying will be slower. If loose grain is to be dried, which is usually the case with rice, then it should be at a depth of 2-4 cm and should also be turned at intervals of one hour or less.

Drying cribs

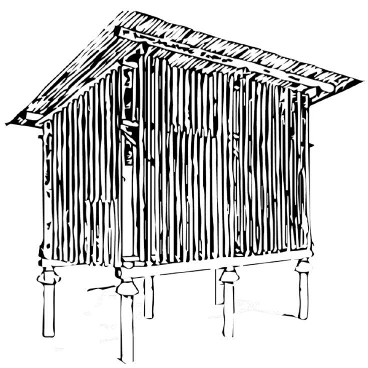
Drying cribs (Figure 3) are commonly used for drying maize but may be used for other crops such as sorghum as well. The cribs recommended for drying are long and narrow, with wooden slats or chicken wire sides that allow free ventilation and a roof that protects against rain. The legs should be fitted with rat guards that keep rodents from climbing and accessing the crop. The cribs are built across the prevailing wind to promote drying.

Ideally drying cribs are rectangular with a framework of wooden poles, erected in the open with the long side across the prevailing wind. This will ensure good ventilation for drying. Grain dries better in a narrow crib because air passes through it more easily. The maximum width of a crib is determined by the prevailing climatic conditions.

To ensure that maize dries sufficiently and mold spoilage is avoided the maximum width should be:

- 0.6 m in humid areas where maize is harvested at high moisture content (30-35%);
- 1.0 m in drier zones with a single rainy season where maize is harvested at about 25% moisture content
- 1.5 m in very dry places

Figure 3: A drying crib.



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The walls of the crib can be made of raffia, bamboo, poles, sawn timber, or chicken wire. At least half of the wall area should be open to ensure good ventilation. Roofs can be of thatch or corrugated iron sheet. To further protect from rodent attack the floor of the crib should be at least 1 m above ground level, beyond the maximum distance that rodents can jump. It is important to ensure there are no trees, plants, or structures close enough to the crib that would allow rodents to jump across and into the crib. Cribs are multi-functional:

- They are primarily used for drying and have the advantage that if used to hold early harvested maize cobs then losses during field drying will be lower and the land can be cleared and prepared earlier for a new crop
- They can be used to store shelled grain in sacks if the walls of the crib are covered with mats to protect grain from driving rain

The open structure allows for easy cleaning and for periodic inspection of grain quality. Loading and emptying is relatively easy through the open framework or through a door in the end wall. Farmers should clean the crib very well prior to each harvest season and should check to ensure none of the timbers are infested by storage insects, especially the larger grain borer. If so then those timbers should be replaced, otherwise the pests will just move directly into the freshly harvested drying grain.

Artificial drying facilities

A third option is to organise collective grain drying or to have a service provider who can do this. In this case, artificial drying facilities such as forced air ventilation or hot air dryers could be used to give rapid and reliable drying. These facilities require considerable investment and have maintenance and energy costs.

Before embarking on this type of drying the economic feasibility needs to be established. The advantages and disadvantages of the different drying options are detailed in Table 3.

Table 3: Advantages and disadvantages of the different crop drying systems.

Drying system	Advantages	Disadvantages
Outside on a flat surface	Low cost Technology well understood by most farmers	High labour demand Contamination by animals, dirt etc. as grain needs to be left in the sun for several days Rain or intense heat can damage grains, especially if being kept for seed
Drying crib	Good for drying maize cobs or sorghum heads that have been harvested at higher moisture content and brought directly from the field after harvesting Roof keeps rain off if it occurs after harvest Roof also shades so grains do not overheat – this is important for saved seed Can be reused for many years	Some financial and labour costs for construction Requires ongoing maintenance every year
Forced air or hot air dryers	Can dry grains to specific moisture content – very accurate Maintains the maximum amount of high quality grains May be cost effective for larger groups of farmers. Is not weather dependent	Initial capital investment is high Running costs may also be high Only suitable where an entrepreneur shows interest and a feasibility study has been completed

When is grain dry enough for storage?

Farmers need to know when their grain is dry enough for safe storage. The following humidity levels are recommended:

- Maize – 13.5%
- Sorghum – 14%
- Rice – 14%

The grain gets harder as it gets drier so that with experience farmers can tell by biting or pinching it, or by the different sound it makes when pouring or rattling it. These methods are subjective and of no use if the farmer is not experienced. A more objective approach is to use the 'salt method' (see Box 1). This is quick and easy but will only indicate that grain is above or below 15% moisture content. Otherwise the only alternative is to ask someone with access to a moisture meter and who has been trained in how to use it, to test grain moisture content.

Box 1: The Salt Method

Dry salt will absorb moisture from grain. This principle can be used to help determine whether a grain sample has a moisture content of **above or below 15%**.

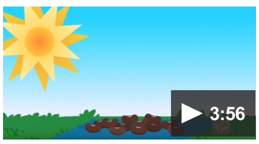
Materials required:

- A clean dry glass bottle of about 750ml capacity, with a cap that makes it airtight; and
- Some common salt.

How to do it

1. First of all it is important to ensure the salt is dry. Confirm that salt is dry enough for use in test by placing salt in empty bottle and shaking. Dry salt does not cling to sides of the bottle.
2. If the salt does stick to the side then place the salt in hot sun in a thin layer on some plastic sheeting, until the salt is hard at least 3 or 4 hours. Turn the salt at intervals during this time. Alternatively this can be done for a much shorter period in an oven. Store the dry salt in a sealed container.
3. Fill one third of the dry bottle with the grain sample (250g to 300g).
4. Add 2 or 3 table spoons of salt (20g or 30g)
5. Close the bottle tightly with its cap.
6. Shake the bottle vigorously for 1 minute.
7. Leave the bottle to rest for 15 minutes.
8. If after 15 minutes the salt sticks to the side of the bottle then the moisture content of the grain is above 15% and so is not safe for storage.

   If the salt does not stick to the bottle then the moisture content is below 15% and so is safe for storage.



Sawbo: Postharvest Loss: Salt Testing for Grain Moisture Levels

SAWBO™ Scientific Animations Without Borders

Mar 19, 2015

PHYSICAL STORAGE OPTIONS

There are many climate smart storage options, but not all will be available to your farmers. Before deciding on a climate smart storage option, you must understand what the grain will be used for and what the farmers priorities are.

- Will the grain be used for seed, own consumption, sale, or a combination of all of these?
- How long will the grain need to be stored?
- How much grain needs to be stored?
- What are the current storage practices?
- What other storage solutions are available locally?
  - Can the farmers afford these?
- Are insecticides available locally and are these affordable?
  - If insecticides are not affordable and/or available what are the alternative storage solutions?

Physical storage facilities and locations should always be as safe as possible in terms of protecting the grain from loss and damage caused by extremes such as flooding (a high enough location) and cyclone damage (solid structures).

The Decision Point below outlines the decision making process when selecting climate smart storage options for maize, sorghum and rice.

TIP

No matter what the stored grain will be used for or how long it will be stored, it must be stored at the correct moisture content.

DECISION POINT

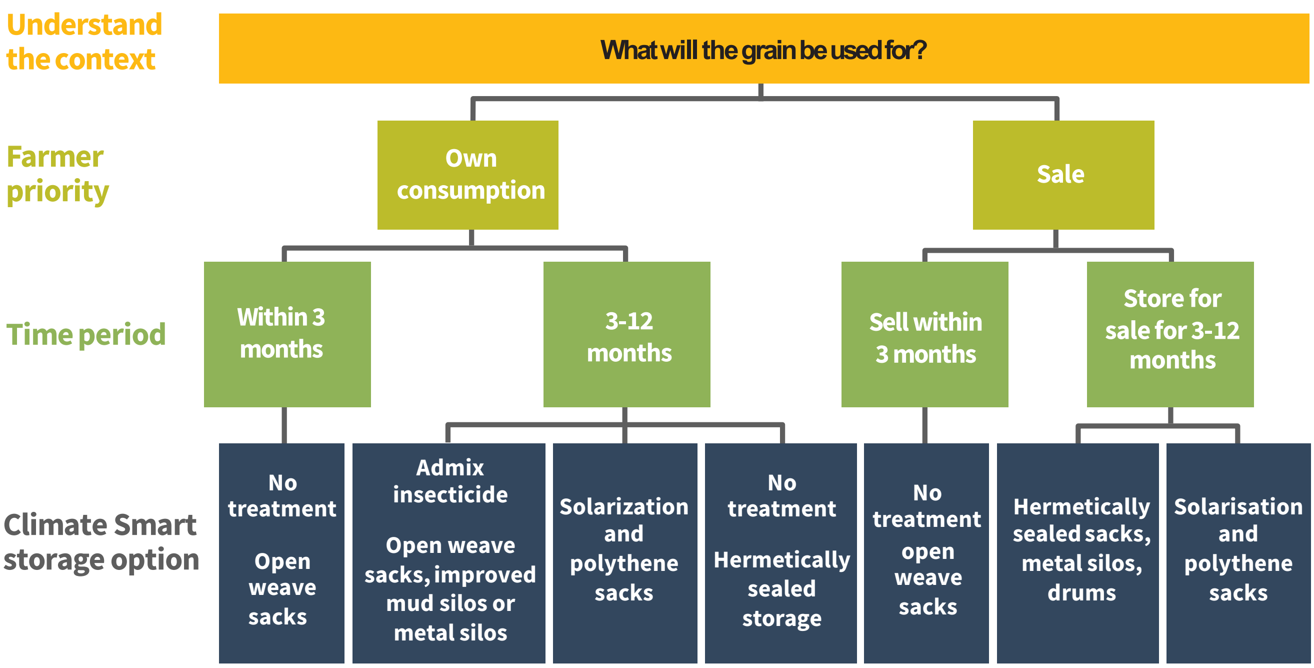


Table 4 details the characteristics of some of the most commonly available storage solutions used across the SADC region

Table 4: Characteristics of different storage options for maize, sorghum or rice.

Store Type		Storage Period	Pest Control	Weaknesses	Lifespan	Costs /tonne /year (USD)
Open weave sacks (jute, sisal, polypropylene)		0-6 months	If >3 months storage then admix insecticide	If used >6 months, grain quality declines more rapidly than in other store types	3 years	US$10 (+ pest control costs)
Improved mud silos		3-12 months		Shorter life than metal silo, very heavy so can't be moved to new location, takes up fixed space in house whether empty of full	5 years	US$20 (+ pest control costs)
Metal silos			1. Make hermetic then use lighted candle, *or* 2. Admix insecticide	Extra sealing required to make hermetic, then no access for 2 weeks	15 years	US$27.4 (+ pest control costs) US$12.4 (+pest control costs)
Polythene bags (1 liner + sack)			1. Solarisation if grain not for seed 2. Admix insecticide	Best for small quantities, susceptible to sharp objects and rodent attack	2 years	US$22.5
Metal or plastic drums			Hermetic seal kills pests	Drum to be nearly full and no access for first 6 weeks of storage	20 years	US$13.4
Triple bags (2 liners + 1 sack)				Susceptible to sharp objects and rodent attack. No access for the first 6 weeks of storage	3 years	US$20
SuperGrain bags (1 liner + sack)					2 years	US$32.5

Store Types	Unprotected	Insect Proof	Insect Proof and Hermetic

Source: FAO, Training Manual for Improving Grain Post-Harvest Handling and Storage.

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Humidity and insect infestation as the two main risks

Stored grain needs to be regularly monitored to ensure it is in good condition. Humidity and insect infestation are the two main risks to stored grain.

Humidity leads to mold and mycotoxins, which cannot only damage the grain, but also be very harmful to human health. Humidity levels get too high when the grain was not dried enough before storage or when moisture from the atmosphere (rain, humidity) or environment (flooding) gets into the storage facility.

To avoid insect infestation you need to ensure there are no insects in the grain when it is being stored and avoid the grain is being re-infested by insects after storage.

- **Insect proof** storage requires that the store shuts tightly enough that insects can not enter. If the grain is not already infested when it is put into this type of store then the grain will remain free of insect infestation during the period of storage.

Possible solutions to **reduce or avoid humidity include the following**:

- Careful drying (see drying techniques described above)
- Ensuring roofs, containers or silos are in a good state (no holes, drips, etc.)
- If storing in a humid climate, making sure the grain is stored in sealed containers that do not allow moisture to pass through (i.e. not woven sacks or single skin polythene bags)

Hermetic storage and solarisation are recommended as best practices to keep low levels of humidity and to avoid and kill insects.

Hermetic Storage requires that the store shuts so tightly that neither insects, moisture nor air can enter. When hermetic stores are filled with grain and closed, the oxygen in the store is gradually depleted and the concentration of carbon dioxide increases. This happens due to the biological activity of the grain. Any insect pests that are present will be killed.

This is very convenient since pest control can be achieved without the use of insecticides that might otherwise have to be purchased. Also humidity will not increase in hermetic storage. Note:

- Hermetic storage is a good option if the costs can be born (storage that is hermetic is more expensive and must be kept in a good state over the years)
- Single layer polyethylene (no weave plastic) sacks **are not hermetic** as moisture can pass through the single skin;
- As a less costly but efficient alternative consider a ‘triple bag’ or a ‘super grain bag’
- Hermetic storage only works with grain that is well dried, otherwise there is a risk of fermentation or other damages

Solarisation – this is a process of heating the grain to about 50°C using the sun with a solar heater. This will kill all insects and ensure the grain is dry. It is usually done with relatively small quantities of grain because it is labour intensive. The process can reduce the viability of seed so it is better only to use it for food grain. The simplest type of solar heater consists of:

- An insulating layer (usually plastic or tarpaulin) on which grain is laid to a maximum depth of about 2-3 cm
- A sheet of translucent plastic to cover the grain. The edges of the sheet are weighed down with stones or other heavy items

The solar heater should be kept in the sun for at least 5 hours.

After solarisation the grain should be allowed to cool before it is placed in store. If the grain is placed in an insect-proof container it will remain free of infestation. If there is free access for insects (e.g. in an open weave sack) then after two to three months the grain may become re-infested. To avoid this, the grain should be retreated every three months.

Another possible practice to avoid insect infestation is to **admix insecticide** in the form of a powder. Contact insecticides are applied in a thin layer on the grain to kill pest or keep them at bay. This practice is only recommend if no other option such as solarisation and hermetic storage is feasible (see above). Insecticides are mostly used for grain that will be sold. Note:

» This must be done with care

» It will protect grain for short durations (check after 3 months and monthly thereafter)

» Grain needs to be cleaned before consumption

If the grain is aggregated in large quantities of stored bulk grain to be sold, the best form of insecticide treatment is **fumigation**. Please note the following:

- If done properly, all insects will be killed and virtually no residues will be left
- It **must be** done by a professional, because the fumigation gas is **lethal**, and **must not** be used by individuals who are not correctly trained and do not have the appropriate equipment:
  - Farmers often buy the fumigation tablets and stick them in their bags. This is both dangerous and a waste of money as the gas escapes immediately and poisons them and their families, not the insects.


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FORECASTING AND ANALYSIS

Climate Smart decisions are based on information on the current farming practices, the household socio-economic context and the broader market system. The more accurate the information, the easier it will be to make climate smart decisions. It is not always possible to have accurate information on actual post-harvest management losses at the individual farm level so predicting and forecasting reductions in losses is not easy.

Decisions should be based on detailed seasonal calendars that define who does what, when and what other inputs are required (financial costs). This will enable your farmers to plan for the year ahead and to assess best where scarce resources can be most effectively used.

It is vital that after any climate smart post-harvest management option has been implemented, time is taken to reflect on it with your farmers:

- Do farmers feel it was worthwhile?
  - Why/why not?
- Will they continue to practice this option?
  - If not, why not?
- Is there anything that can be done to improve the climate smart post-harvest management practice?
- Can other improvements be made to post harvest management practices?

TO SUMMARISE

STEP 1: Understand the context

- Farming system
- Household context
- Market requirements
- Climate/weather

STEP 2: Understand current post-harvest practices

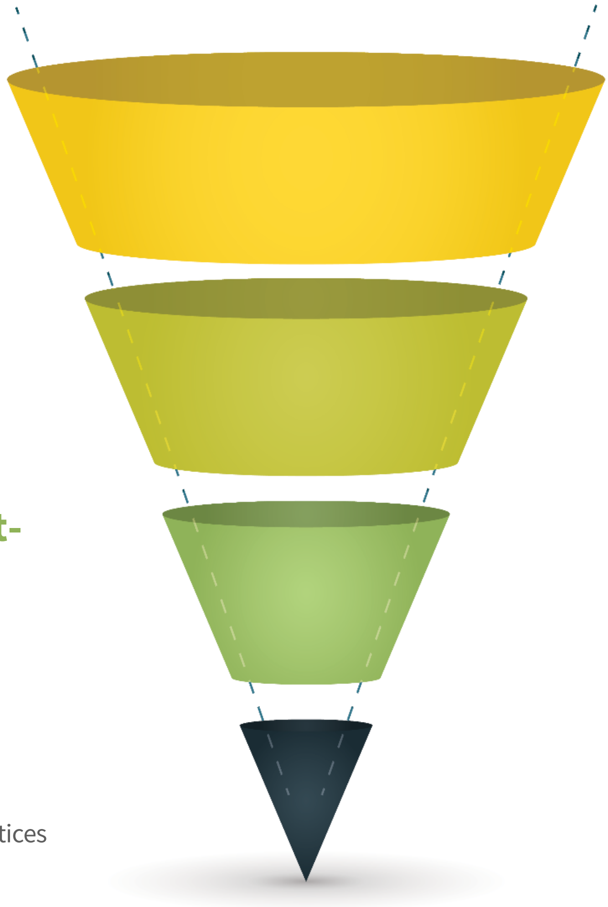
- 8 links in the post harvest chain
- Assess priority areas for loss reduction

STEP 3: Select Climate Smart Post-harvest management options

- ID what is available locally
- Crosscheck with farmer priorities
- Select the best fit

STEP 4: Analyse and improve

- Assess if it has been worthwhile
- Suggest improvements to post harvest management practices



WHERE CAN I GET 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 KP 09** on Climate Smart Variety Selection
- **African Post harvest Loss Information System (APHLIS)** (managed by NRI) – Loss Assessment Manual
  - Detailed guidelines on how to collect and analyse data on post harvest losses at each link in the post-harvest chain
- **Food and Agriculture Organisation of the United Nations (FAO)** Information on Post-Harvest Operations (INPhO)
  - Details on post harvest management practices for maize, sorghum, rice and other crops.
- **GIZ** – Rapid Loss Appraisal Tool (RLAT): For Agribusiness Value Chains – A user guide for Maize
  - A useful guide to assist practitioners in designing and implementing an assessment of where in the value chain losses are most significant, measuring these and designing interventions to address these.
- **International Rice Research Institute (IRRI)** – The Rice Knowledge Bank
- **National Rice Institute (NRI; India)** Post-Harvest Loss Reduction Centre
  - This website has lots of practical resources on managing post-harvest losses. Its 'Granary Selector Tool' is a useful guide for extension staff
- **World Food Programme (WFP), University of Greenwich, Natural Resources Institute (NRI)** – Training Manual for Improving Grain Post-harvest Handling and Storage
  - An excellent resource for extension staff. Covers every aspect of post-harvest management in detail while still being very user friendly.
  - Also includes posters that can be customised by adding text in the local language.

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Citation: CCARDESA and GIZ 2019. Knowledge Product 13: Climate smart post-harvest management options for maize, sorghum, and rice. CCARDESA Secretariat, Gaborone, Botswana.