KP03
Knowledge Product 03

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

OPTIONS PAPER:

Best Bet Climate Smart Agriculture Options for Sorghum in SADC

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

Audience: Local Extension Staff

Sorghum | Options Paper | Gender | Youth | Climate Smart | Practice | Technology

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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.

Key Messages:

1. Sorghum is more drought and heat tolerant than maize, but production is particularly sensitive to **water stress** during the reproductive phases

2. This paper outlines some of your 'best bet' climate smart options for sorghum production in the SADC region

3. CSA is context specific – **Best Bet** options should take account of the farmer's own context and priorities and be adapted to become **Best Fit** CSA solutions.

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:

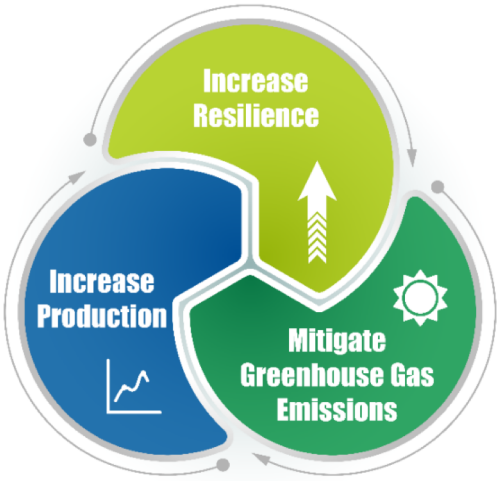
   a. Identifying **best bet** opportunities for agricultural investment

   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.

Entry Points for CSA

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



BEST BET CLIMATE SMART AGRICULTURE OPTIONS FOR SORGHUM IN SADC

This **Options Paper** focuses on some of the **Best Bet Climate Smart practices** and **technology** options for Sorghum production in the Southern African Development Community (SADC) region. These are just some of the many options available. They are listed in no particular order, and have been selected as best bet for the reasons shown:

- Each of them has been identified as a priority CSA option in the CSA country profiles completed so far for the SADC region (Mozambique, Zambia, Tanzania and [in draft] Malawi)
- They are widely applicable across the region
- They have high potential to address major constraints to sorghum production in the region (Table 1).

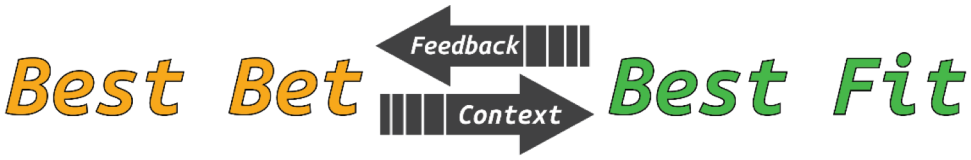


Table 1: Best Bet options for addressing climate risks to sorghum production with smallholder farmers, as they offer the most potential to mitigate production losses.

Best Bet Climate Smart Option for Sorghum	Risk to sorghum production
Integrated Soil Fertility Management (ISFM)	Nearly 40% of soils in sub-Saharan Africa are already low in nutrient capital reserves, 25% suffer from aluminium toxicity, and 18% have high leaching potential
Improved varieties	53% of world production is in sub-Saharan Africa, where sorghum is the second most important crop after maize. Less predictable rainfall patterns and longer dry spells pose significant risks to production across the region
Planting system options	In 2016, average yield was <1 tonne/hectare – but yields of 2 tonnes are achievable. Sorghum is less prone to drought than maize, and may be a viable alternative
Pest and disease control	Crop losses in African countries to insect pests are estimated at 49% of the expected total crop yield each year The effects of the changing climate are expected to increase the damage done by insects *Striga*, a parasitic weed, has already infested 40 million hectares of land in sub-Saharan Africa, resulting in yield losses of 20%–80%
Post-harvest management	The African Post Harvest Losses Information System (APHLIS) lists average annual losses for sorghum across Africa in 2017 as 17.1%.

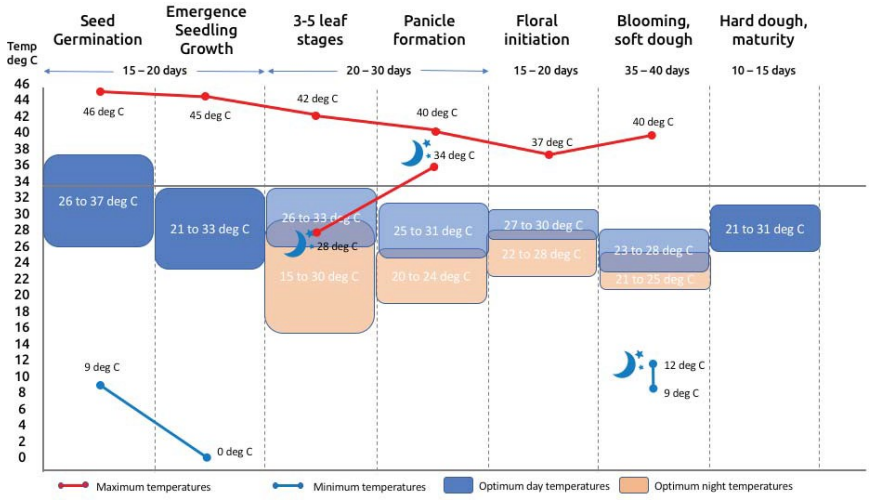
CLIMATE HAZARDS TO SORGHUM PRODUCTION

Sorghum productivity is affected by changes in **temperature** (air and soil), as well as variations in the **intensity** and **duration of rainfall**. While it is **much less vulnerable to climate variations than maize**, it has a much lower potential yield.

Sorghum requires 400 – 900 mm of rainfall over the whole growing season (500 – 1,200 mm for maize), and is drought tolerant, being able to remain dormant during prolonged dry spells. It is particularly susceptible to water stress during the reproductive stages, especially during flowering. A minimum accumulated rainfall of 20 mm is recommended for planting. Sorghum tolerates a wider range of temperatures and is particularly **resistant to elevated temperatures**.

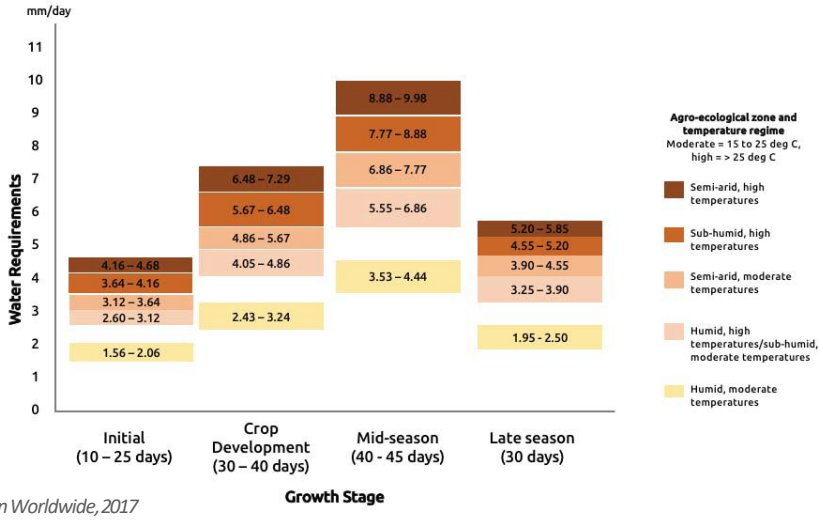
Figures 1 and 2 illustrate the rainfall and temperature requirements for the different growth stages of sorghum.

Figure 1: Sorghum temperature requirements by growth stage.



Source: Concern Worldwide, 2017

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



Source: Concern Worldwide, 2017

BEST BET OPTIONS FOR ADDRESSING RISKS IN SORGHUM PRODUCTION

Below are five of the best bet climate smart options for sorghum production. These are covered in more detail in a series of **Decision Tools** developed by CCARDESA for field-level extension staff.

Integrated Soil Fertility Management (ISFM)

ISFM is a set of soil fertility management practices:

- The use of fertiliser
- Organic inputs
- Improved germplasm (seeds) adapted to local conditions
- Cropping systems (rotations/intercropping/fallows, etc.)
- Water management (irrigation, moisture retention, etc.)
- Cultivation practices (minimum till, sub soiling, pit planting, etc.).

ISFM aims to support the efficient use of fertiliser and organic resources, coupled with other climate smart agronomic practices such as planting improved varieties with appropriate spacing and timing, and good control of weeds, insect pests and diseases. Good crop growth is associated with an extensive and vigorous root system, capable of efficient uptake of soil nutrients and water.

To achieve the highest levels of efficiency in terms of productivity, ISFM entails **continuous decision making for improvement of agronomic practices** on the farm.

This requires constant testing and assessment of which climate smart practices/technologies work best for a particular farmer. When promoting ISFM, a **longer-term perspective** should be taken with the farmer. Seemingly small incremental improvements can add up to significant and sustainable increases in production.

Small incremental improvements can add up to significant and sustainable increases in sorghum production over several years. Key decision points for climate smart ISFM selection include the following:

1. Understanding soil type and structure
2. Understanding local climatic conditions and changes over time
   - Assess probability of adequate rains in the coming season
3. Understand priorities
   - Are these the same for men and women farmers?
4. Understand the farmer's constraints
   - Are these the same for men and women (e.g., labour availability)?

See **CCARDESA KPs 06, 07, 08, 09, 12 and 21** for more details on making climate smart decisions on ISFM options for sorghum (and maize).

Table 2 illustrates the climate smart credentials of ISFM identified during CSA country profiling in Tanzania. ISFM for sorghum production was prioritised as a best bet CSA practice to be promoted.

Table 2: ISFM for sorghum was identified as a priority intervention to be supported/promoted in Tanzania.

CSA Practice	Region adoption rate	Predominant farm scale	Impact on CSA pillars		
			Productivity	Adaptation	Mitigation
Integrated Soil Fertility Management	Bahi 30% Songea 30% to 60%	Small to Medium Medium	Improves yield per unit area, hence increasing household incomes	Promotes soil and water conservation, hence less use of inputs such as fertilisers. Reduces incidence of soil-borne pests and diseases	Increases above and below-ground carbon storage. Reduces the need for synthetic fertilisers – and related GHG emissions

Source: CCAFSCSACountry Profile Tanzania.

Improved varieties

New varieties of sorghum are constantly being released across the SADC region and existing ones tested for their qualities. Improved varieties represent just 23% of the sorghum planted[1]. This means there is **huge untapped potential already on the market**.

It is vital that **farmers get access to new varieties and information on high quality existing varieties**, so they can make decisions on which ones might be best suited to their conditions. Sorghum is grown for human consumption, brewing (grain sorghum), for animal fodder, or for a combination of these. Different varieties are available for different uses. Farmers' objectives and their local context must be understood before an appropriate variety can be recommended. Deciding which variety is most suited to your farmers' context is crucial in maximising productivity.

Climate smart decisions on variety selection should include:

1. Understand **soil type and structure**
2. Understand local **climatic conditions**, and changes over time
   - In the long term, sorghum may no longer be a viable crop in the target area
3. Understand **farmers' goals**
   - Sale (brewing), consumption, fodder, combination (e.g., short-stemmed early maturing varieties will likely not be appropriate for a farmer who wants to harvest the grain for herself, but who also wants the leaves/stalks for animal fodder)
   - Food security – taste/colour may be an important consideration
4. Assess what **varieties** are currently available, and if others can be made available
5. Test different varieties under **local conditions** in on-farm trials, and promote the most viable options
   - Testing should always include a calculation of gross margins
6. Continue to test **new and existing varieties as they become available**.

See **CCARDESA KP09** for a **Decision Tool** to help you make climate smart decisions when selecting sorghum varieties. Table 3 illustrates the climate smart credentials of stress-tolerant varieties identified during CSA country profiling in Zambia, where the use of drought-tolerant varieties of sorghum was prioritised as a best bet CSA practice to be promoted.

[1] Data from 2010

Table 3: Use of drought-resistant varieties was identified as a priority intervention to be supported/promoted in Zambia.

CSA Practice	Region adoption rate	Predominant farm scale	Impact on CSA Pillars		
			Productivity	Adaptation	Mitigation
Use of drought-resistant varieties	Natural region 1 & Natural region 2a: 30% to 60%	Small	Promotes crop productivity and quality Reduces production costs, hence increases potential income	Reduces crop losses, even during abiotic stress conditions Promotes biodiversity conservation	Reduces GHG emissions (carbon footprint) by reducing use of synthetic pesticides

Source: CCAFSCSACountry ProfileZambia

Planting system options

There are multiple climate smart cropping options available for sorghum:

- **Crop rotation** – almost always includes at least one legume
  - Changes in the order or sequence of crops in a rotation
  - Changes to the types of crops in the rotation
- **Intercropping** with legumes
- **Crop diversity**
  - Cultivars – multiple sorghum varieties in same plot
  - Crops – grow more types of crops in the plot
  - Rotation – increase the number of crops in the rotation.

Consider the following factors when deciding which combination of crops to grow, and in which spatial arrangement:

1. **Understanding of the local soil** (texture, fertility), slope, area available and climatic (rainfall, temperature) conditions
2. **Current agronomic practices** – who is engaged in them (men/women/youth) when undertaking the following activities:
   a. Cultivation/land preparation/sowing
   b. Weeding/pest control
   c. Harvesting
3. An understanding of the **varieties of sorghum available**/desired and the farmer's production goals:
   a. Grain, Fodder, malting, or combination of these
   b. Pest/disease resistance
   c. Target tonnes per hectare
   d. Consumption or sale
4. Understanding of what the **farmer goals** are for the non-sorghum crop(s), recognising that farmers may have multiple goals:
   a. Cover crops/biomass production
   b. Pest/disease control
   c. Animal/human consumption
   d. Cash crop(s)
   e. Soil fertility management (nutrient availability, moisture retention)
5. **Understanding of legume types** available/desired, and what the main purpose is (legumes are almost always included in climate smart cropping options):
   a. Grain legume – consumption/sale, organic matter
   b. Fodder Legume – animal feed, organic matter
   c. Tree legume – fodder, wood, organic matter
6. **Understanding of the physical attributes** of the non-sorghum crop(s) to be introduced in the system:
   a. Root depth and plant spacing required
   b. Height at maturity and canopy spread
   c. Recommended plant spacing on different soil types
7. **Cost–benefit analysis** of option(s) tested.

See **CCARDESA KP07** for a **Decision Tool** to help make climate smart decisions when selecting planting systems for sorghum.

Table 4 (over) illustrates the climate smart credentials of crop associations identified during CSA country profiling in Mozambique. The use of crop associations in sorghum production was prioritised as a best bet CSA practice to be promoted.

Table 4: Crop associations for sorghum was identified as a priority intervention to be supported/promoted in Mozambique.

CSA Practice	Region adoption rate	Predominant farm scale	Impact on CSA Pillars		
			Productivity	Adaptation	Mitigation
Crop association	Central zone <30%	Small to Medium	Increases total production and productivity per unit of land. Harvests of multiple crops increase income and food security	Reduces the risk of total crop failure during unfavourable climatic conditions, due to a diversified production system	Improves soil structure, increases above-ground biomass, and when leguminous species are used reduces nitrogen-based fertilisers and related GHG emissions

Source: CCAFSCSACountry ProfileMozambique

Pest and disease control options

Crop losses in African countries due to pests and diseases are estimated at 49% of the expected total crop yield each year (CABI, 2018), driven by continuous monocropping of sorghum (and other crops), and poor pest/disease management practices.

Off-the-shelf pesticides, herbicides and insecticides can be effective control options, but are often not viable for smallholder farmers due to cost and availability. Men and women may also not have the same access to these inputs and/or to the information required to use them correctly (e.g., women's literacy rates are consistently lower than men across the region, meaning they are less likely to be able to read and understand instructions that come with the product). They can also have negative environmental effects, especially if not used correctly. Organic pesticides made from locally-available ingredients can also be used.

There are many climate smart options that can help minimise losses due to pests and disease in sorghum:

- **Crop rotations/intercropping/crop diversity**
  - Planting different crops, or varieties of the same crop, in rotation or on the same plot reduces risk, and can break pest and disease cycles
- **Resistant varieties**
  - Many sorghum varieties have built-in resistance to specific pests/diseases
- **Weeding**
  - Weeds themselves are pests, as they compete with sorghum and steal nutrients that could otherwise be used by the sorghum plant
  - Weeds can also host pests/diseases, which can then be transferred to the sorghum plants
- **Push–Pull**
  - These systems include plants within the sorghum plot that 'scare away' insect pests, and other plants around the edge of the plot that attract (trap) them, keeping them away from the sorghum
- **Dealing with infected plant material**
  - Depending on the type of pest/disease, it may be necessary to remove infected plant material and feed it to animals, burn it or compost it.

Different practices can be used together to maximise benefits, and **no one solution works in every situation**. Combining pest management practices is known as **Integrated Pest Management (IPM)**.

To make climate smart decisions on which options are best suited to your farmers:

1. Be able to identify which pests are currently affecting the farmers' sorghum crop

2. Understand the pest life cycle so you can recommend control options

3. Understand farmer objectives in terms of production
   - This may affect investment of time and resources in pest control. Men are often more interested to invest in cash crops. Women may be more interested in food crops

4. Understand the farmers' ability to access/use inputs such as organic/inorganic pesticides/herbicides/ insecticides

5. Understand who does what and when in the crop calendar (men, women, youth)
   - Who is responsible for weeding?
   - What do they think about the costs/benefits of weed control options?

6. Assess the potential and actual benefits of any options recommended/implemented
   - Labour should always be included in an analysis of gross margins or agronomic efficiency
   - Men's and women's labour requirements and availability should always be assessed.

See KP19 for a Decision Tool to help you make climate smart decisions when selecting pest and disease control options for sorghum (and maize).

Table 5 illustrates the climate smart credentials of integrated pest and disease control options identified during CSA country profiling in Zambia.

Table 5: Integrated Pest Management (IPM) was identified as a priority intervention to be supported/promoted in Zambia.

CSA Practice	Region adoption rate	Predominant farm scale	Impact on CSA Pillars		
			Productivity	Adaptation	Mitigation
Integrated pest and diseases management	Natural Region 2a <30% Natural Region 1 <30%	Small Small	Ensures crop production and quality, Hence increasing potential in income	Reduces crop losses from pests and diseases, even when crops are under moisture stress conditions	Reduces GHG emissions by reducing use of synthetic pesticides

Source: CCAFS CSA Country Profile Zambia

Post-harvest management options

Reducing post-harvest losses in sorghum can be a more resource-efficient way of increasing grain availability – rather than expanding production – as it may not rely on increased use of agricultural inputs such as land, labour and fertiliser.

Addressing post-harvest losses may be a more viable alternative for labour-constrained households (e.g., single women-headed households) than trying to increase production.

Post-harvest losses of cereal grains commence when they have reached physiological maturity in the field. This is followed by a chain of post-harvest activities, from the field to the consumer. This chain has at least 8 links, from harvest to marketplace. At each link, there are usually some dry matter weight-losses when grain is scattered or spilt, or due to grain becoming rotten or consumed by pests. The typical magnitudes of such losses for sorghum are shown in Table 6 below, in comparison with maize and millet.

When making decisions on which post-harvest handling and storage options to advise farmers to adopt, the following steps should be followed:

1. Understand the principles of good management for each stage (harvesting, transport, drying, sorting, protecting and storing)
2. Understand the current farming practices to identify how they can be improved
3. Be able to recognise better quality grain
4. Understand the farmers' priorities and constraints to select the most appropriate climate smart solution for their situation
5. See the **CCARDESA KP13 Decision Tool** to help you make **climate smart decisions** when selecting **post-harvest management options** for **sorghum.**

See the **CCARDESA KP13 Decision Tool** to help you make **climate smart decisions** when selecting **post-harvest management options** for **sorghum.**

Table 6: Typical post-harvest losses – percentage weight-loss of harvest.

Crop	Maize	Maize	Sorghum	Millet
Scale of farming	**Small**	**Large**	**Small**	**Small**
Harvesting/field/drying	6.4	3.8	4.6	3.5
Platform drying	4	3.5	–	–
Threshing	1.3	2.3	3.6	2.0
Winnowing	–	–	–	0
Transport to farm	2.4	1.9	2.2	2.5
Farm storage	5.3	2.3	2.5	1.1
Transport to market	1.7	1	1	1
Market storage	2.7	2.7	2.7	2.7
Cumulative % weight loss	**21.6**	**16.3**	**15.5**	**12.2**

Source: APHLIS, 2013

FEASIBILITY ANALYSIS

Before you can decide which options are best suited for your farmers/clients, you need to assess if they are **feasible in the local context**. All the best climate smart CSA options listed have been proven to work; however, that does not mean that they are suitable for every farmer.

It is **vital to understand how different solutions might impact men, women, and youth differently**. For example, a recommendation to plant a new drought-tolerant variety of sorghum that is available five kilometres away in a farm supply store might be a simple solution for an adult male farmer with access to transport, but might not be suitable for a single female-headed household with a small child that is still being breast-fed.

If malnutrition is an issue, are their available drought-tolerant seed varieties that are bio-fortified, and/or is there potential for intercropping with legumes?

Farmers' priorities will also change with the time of year. During the growing season, they may be more concerned with pest and disease control, but potential climate smart solutions to this problem may start with the choice of varieties and the cultivation practices, which happen much earlier in the season. It is vital to understand the problems faced throughout the agricultural calendar.

A **checklist** of questions to help guide you in understanding the farmer's context is provided at the end of this knowledge product.

1 What do farmers need/ demand?

- Are the demands of male and female farmers the same?
- To develop effective climate smart solutions, they must address an identified need

2 Is the proposed solution accessible?

- Is the solution equally accessible to men and women?
- Is the technology locally available (e.g., improved seed)?
- Will the practice require extensive training or changes to existing practices?

3 Labour requirements

- If the solution requires increases in labour, who will do this (men/women/children), and do they have the time to do this?

HOW TO CHOOSE THE BEST BET CLIMATE SMART OPTIONS FOR YOUR FARMER(S)

Once you have worked with your farmer(s) to determine if proposed climate smart solutions are feasible, you will have a list of practical options – different practices will be appropriate at various stages in the sorghum cropping cycle.

The next step is to pick the option(s) best suited to meeting the demands of the farmer(s).

Trials should be established with the farmers to test feasible solutions, to see which are the most effective. These can be done with individual farmers, with lead farmers, or through **farmer field schools (FFS)**.

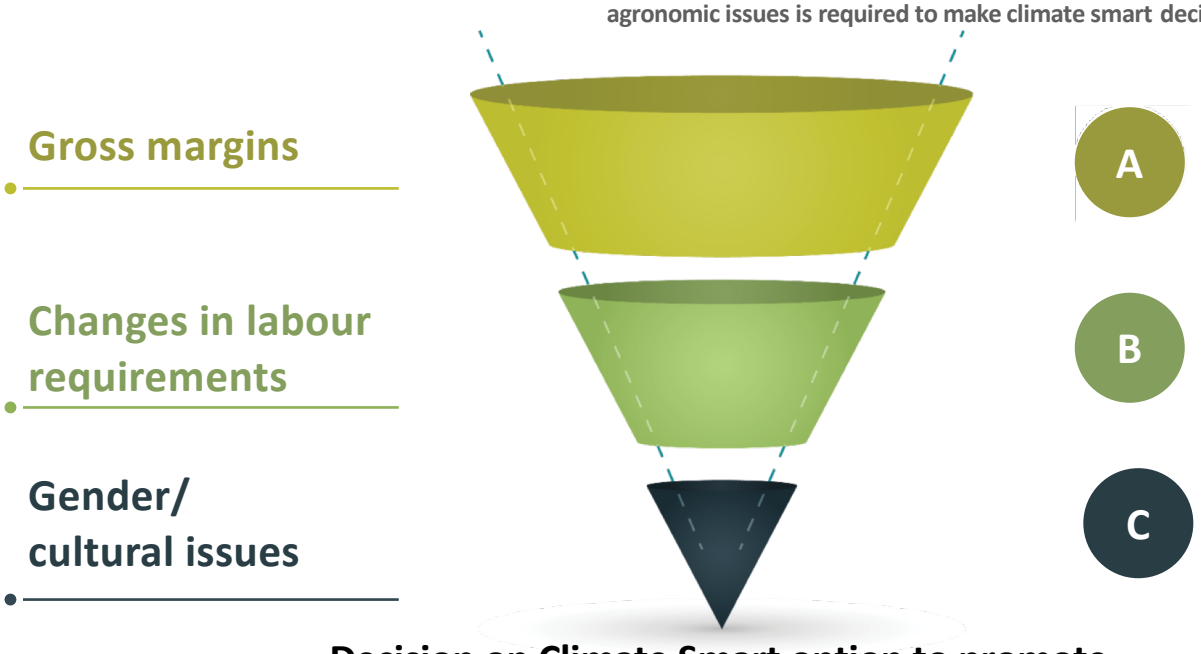
Gross margins should always be calculated to assess the return on investment as compared to other farm practices. This will result in the most profitable option emerging. Cost of own labour must be included in any **gross margin analysis**, along with all other inputs. A decision on a cultivation practice might have positive or negative effects on labour/input requirements later in the growing cycle. It is important to understand who does what and when within the whole growing cycle, and to assess input costs all the way through the season, even if the solution being tested is in relation to a different cultivation practice.

Gross margins, labour requirements, gender, and cultural issues, as well as multiple other context specific issues need to be understood and trade-offs made when deciding which CSA practice/technology is the best fit for a particular farmer (Figure 3).

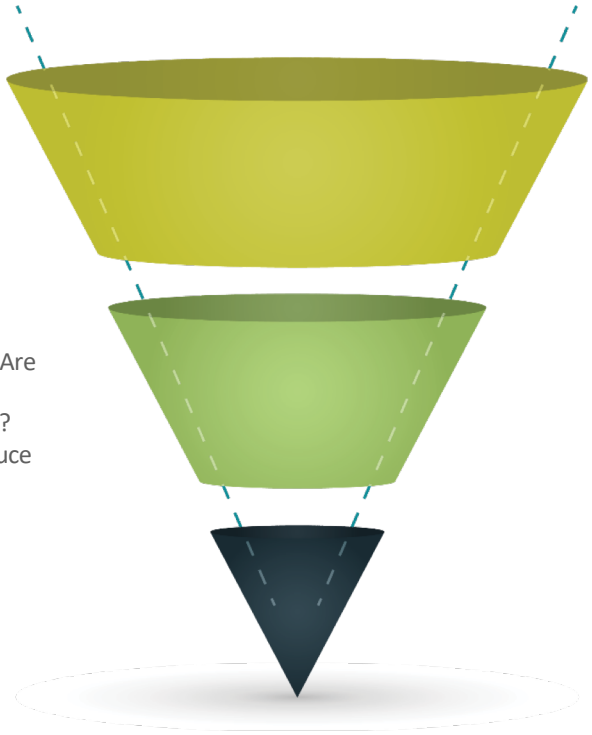
TIP

Remember, when establishing farmer trials – keep all other variables except the one you are testing (seed type, time of planting, weeding, etc.) – the exact same.

Figure 3: A deep understanding of the context and the interplay between multiple social, environmental, and agronomic issues is required to make climate smart decisions.



TO SUMMARISE



STEP 1: Identify options

- What is the current situation
- What happens if nothing is done?
- What is the potential if climate smart options are introduced?

STEP 2: Analyse feasibility

- What is being demanded by farmers? What are their requirements? Are requirements of men and women the same?
- Is the technology/practice, available/accessible to the target farmers?
- Will the proposed climate smart practice/technology increase or reduce labour requirements?

STEP 3: Select option

- Test different options with farmers
- Assess cost effectiveness using gross margins analysis
- Assess any gender/cultural constraints.

Union Square Farmer's Market_Sorghum bicolor, 2015

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. Translations of this Knowledge Product to French and Portuguese was achieved using machine translation tools, and the results were checked by an accredited translator.

- **CCARDESA website:** http://www.ccardesa.org
- **Food and Agriculture Organisation of the United Nations (FAO)** – The Climate Smart Agriculture Sourcebook
- The Research Programme for **Climate Change Agriculture and Food Security (CCAFS)** – the CSA Guide https://csa.guide/

Integrated Soil Fertility Management

- See also **CCARDESA Knowledge Products 7, 8, 9, 10, 12, 16 & 19** for more detail on specific climate smart practices and technologies included within
- **African Soil Health Consortium (ASHC)** – Handbook for Integrated Soil Fertility Management
  - An excellent resource for every extension officer
- **ASHC** – Sorghum- Millet Nutrient Management Guide
  - A practical guide to growing sorghum (and millet). Excellent resource for extension staff in the field

Improved varieties

- **FAO** – Training Manual for Post-Harvest Management and Storage
  - Sections on seed selection and storage are important here
- **ASHC** – Handbook for Integrated Soil Fertility Management
  - An excellent resource for every extension officer
- **ASHC** – Sorghum-Millet Nutrient Management Guide
  - A practical guide to growing sorghum (and millet). Excellent resource for extension staff in the field

Planting system options

- **FAO** – Green manure cover crops and crop rotation in conservation agriculture on small farms: Integrated Crop management Vol 12, 2010
  - Focused on Paraguay and quite scientific in places, but covers all the principles behind the practices
- **ASHC** – Sorghum-Millet Nutrient Management Guide
  - A practical guide to growing sorghum (and millet). Excellent resource for extension staff in the field
- **FAO/TECA** – Cover crop species with a special focus on legumes
- **FAO/TECA** – Crop Rotation in Conservation Agriculture

Pest and disease control options

- **Plantwise** – Factsheets for farmers
  - 100s of fact sheets available. Each one dedicated to a specific pest/disease. You will need to be able to identify the problem so you can find the correct factsheet, supported by a mobile App. Excellent resources
- **Centre for Tropical Agriculture (CTA)** – Practical Guide Series 2: How to Control Striga and Stemborer in Maize
  - Equally relevant for sorghum. A short, practical guide comparing different and joint control measures for both pests
- **ASHC** – Sorghum-Millet Nutrient Management Guide
  - A practical guide to growing sorghum (and millet). Excellent resource for extension staff in the field

- **ASHC** – Crop Pests and Diseases; A manual of the most important pests and diseases of the major food crops grown by smallholder farmers in Africa
  - A useful guide to identifying and controlling the main pests and diseases of the most important food crops. Every Extension Officer should download a copy
- **Crop-life International** – Trainee Manual; Introduction to Integrated Pest Management
  - A comprehensive guide to Integrated Pest Management, but quite verbose, and with few diagrams
- **Global Alliance for Climate Smart Agriculture (GACSA)** – Climate Smart Pest Management; Implementation Guidance for Policymakers and Investors
  - Targeted towards policy makers, not field staff. Worth reading to get the bigger picture

Post-harvest management

- **World Food Programme**, University of Greenwich, **NRI** – Training Manual for Improving Grain Postharvest 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
- **Natural Resources Institute's** (**NRI's**) Post-harvest Loss Reduction Centre – **https://postharvest.nri.org/**
  - This website has lots of practical resources on managing post-harvest losses. Its 'Granary Selector Tool' is a useful guide for extension staff
- **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
- **FAO Information on Postharvest Operations** (INPhO)
  - Details on post-harvest management practices for sorghum and other crops.

ANNEX A: CHECKLIST OF QUESTIONS TO HELP UNDERSTAND THE LOCAL CONTEXT

Understanding the farmer's context and the challenges they face is key to coming up with climate smart solutions to their problems. Different people within the household will often perform different tasks and thus a problem faced by a male farmer (e.g., in land preparation) might not be understood or mentioned by his wife/children (who might face different challenges in weeding) or vice versa.

The questions below are a good starting point for understanding the farming system and problems within it.

1. **Is this location suitable for sorghum – temperature and rainfall?**
   - If no, what alternatives are there?

2. **What is the sorghum being used for (sale/ consumption/both, etc.) and what varieties are available locally?**
   - What variety do they use and why? Who decides on this?
   - How much is required?

3. **What other inputs are used and how available and accessible are these?**
   - Is access/availability of these inputs different for men and women?

4. **What challenges to sorghum production are currently being faced by the farmer?**
   - Are these challenges the same for women and men?
   - You need to consider which jobs are done by men, women and children to ensure the different problems faced during different tasks are addressed

5. **What is the condition of the soil?**
   - Texture, structure, pH, slope, etc.

6. **What is the current farming system?**
   a. Irrigated or rain-fed production?
   b. How and when is land prepared, and who prepares it?
   c. Does the farm have a mixed cropping system and/or are animals integrated in the system?
   d. Where does the seed come from?
   e. How is the seed planted and who plants it?
   f. Is compost/manure applied, at what rate and by whom?
   g. Is fertiliser used? What type, when, how and by whom?
   h. If irrigated, how is water managed?
   i. How are weeds/pests managed and by who?
   j. How is harvesting done and by whom? (Timing/ drying/grading, etc.)

7. **How and where is the sorghum stored? What losses are normally expected in storage?**