KP21
Knowledge Product 21

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

DECISION TOOL:
Climate Smart Fertiliser Application Options

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

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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/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 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?

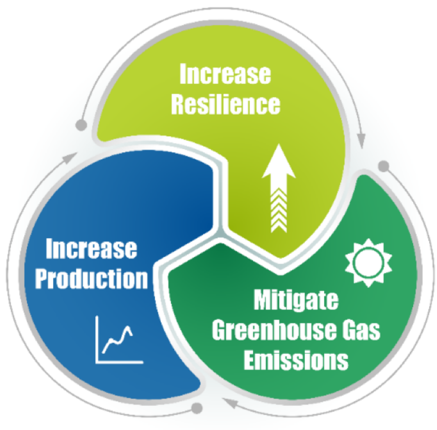
1. CSA places greater emphasis on **hazard and vulnerability assessments** and **emphasises weather forecasting** (short term) and **climate scenario modelling** (long term) in the decision-making process for new agricultural interventions
2. SA promotes the **scaling up of approaches** that achieve **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. **The 4Rs** or four 'rights' of fertiliser management are the:
   - **Right source** of nutrients
   - **Right rate** of application
   - **Right time** of application
   - **Right place** of application
2. To make climate smart decisions on fertiliser application you need to understand:
   - The farming system
   - Access to weather/climate data
   - The socio-economic context
3. Climate smart fertiliser application options include:
   - Banding
   - Microdosing
   - Sub-surface fertilisation.

Entry Points for CSA

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



CLIMATE SMART FERTILISER APPLICATION OPTIONS

This **Decision Tool** aims to help field-level extension staff make **climate smart decisions** on which fertiliser application 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 Fertiliser Application Options** for maize, sorghum and rice production in the Southern African Development Community (SADC) region. They are listed in no particular order and have been selected as best bet because:

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

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

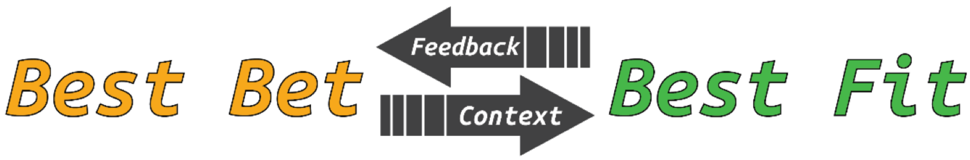


Table 1: Best Bet Climate Smart Fertiliser Application Options that have potential to address climate risks across the SADC region.

Climate Smart Fertiliser Application Option	What is it?	3 Pillars of CSA: Increase production	Resilience/ adaptation	Mitigate GHG emissions if possible
Banding	Placing fertiliser in a row (band) 5 – 8 cm below the soil surface, covering with soil, and planting seeds above the fertiliser			
Microdosing	Small amounts of fertiliser are placed in each planting station (usually measured in 'bottle caps')	Maintains or increases yields with less fertiliser used	Good nutrient management increases crop vigour, making plants less susceptible to diseases/pests	Greater fertiliser-use efficiency results in reduced emissions intensity. This is the quantity of greenhouse gas (GHG) emissions per kg of food produced
Sub-surface fertilisation	Placing fertiliser briquettes (compressed balls of fertiliser) 7 – 10 cm deep in the soil; almost always done in flooded fields			

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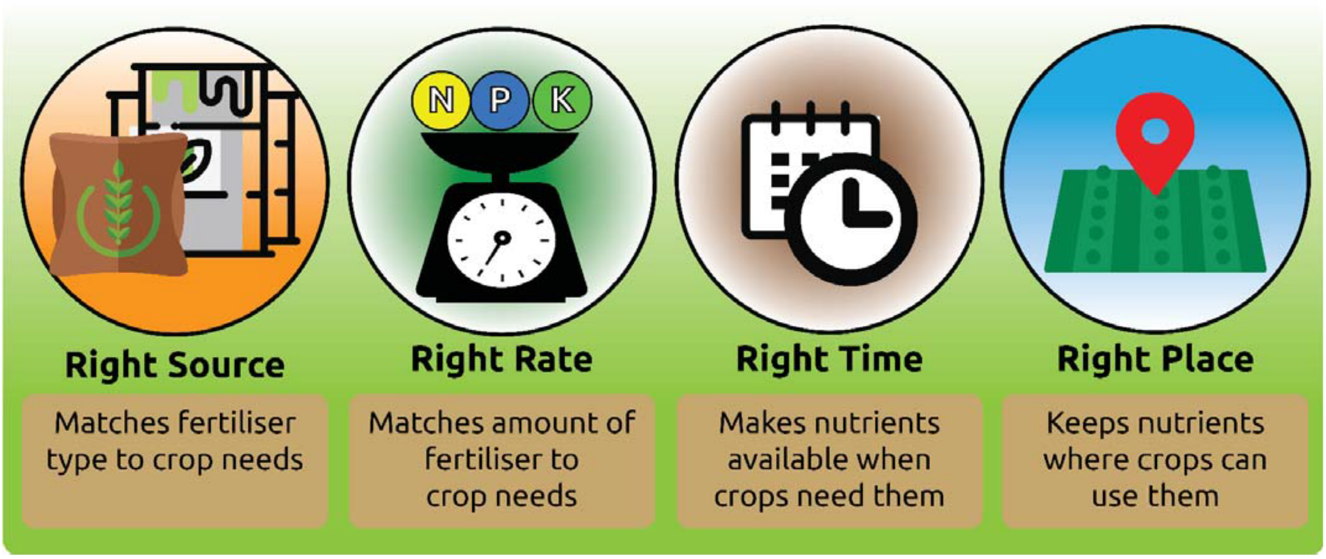
WHICH CLIMATE SMART FERTILISER APPLICATION OPTION IS BEST SUITED FOR YOUR FARMER(S)?

The four best management practices, commonly referred to as **the 4Rs** or four 'rights' of fertiliser management (Figure 1) are to apply the **right source** of nutrient at the **right rate**, at the **right time** and in the **right place** to meet crop demand. These 4Rs help to increase the proportion of applied fertiliser that is used by the crop, and therefore contribute to improved agronomic efficiency.

Figure 1: The 4Rs of fertiliser management.



Source: www.nutrientstewardship.org

To make decisions on each of the 4Rs, we need to have a detailed understanding of the local context. This includes:

- The farming system
    - Crops grown, soil type, integration of livestock, farmer priorities, etc.
    - Who does what activities on the farm?
        - » Is fertiliser application the role of women or men?
        - » Who buys the fertiliser?
        - » Is access equal for men and women?
- Access to markets
- Access to information (especially accurate climate/weather information).

The **farming system analysis** tool used for planning Integrated Soil Fertility Management (ISFM) practices is a very useful tool to help you gather this information. Please refer to the African Soil Health Consortium's (ASHC's) ISFM Manual for more details.

TIP

To be truly climate smart, fertiliser should be considered as one component of an **Integrated Soil Fertility Management** strategy on the farm.

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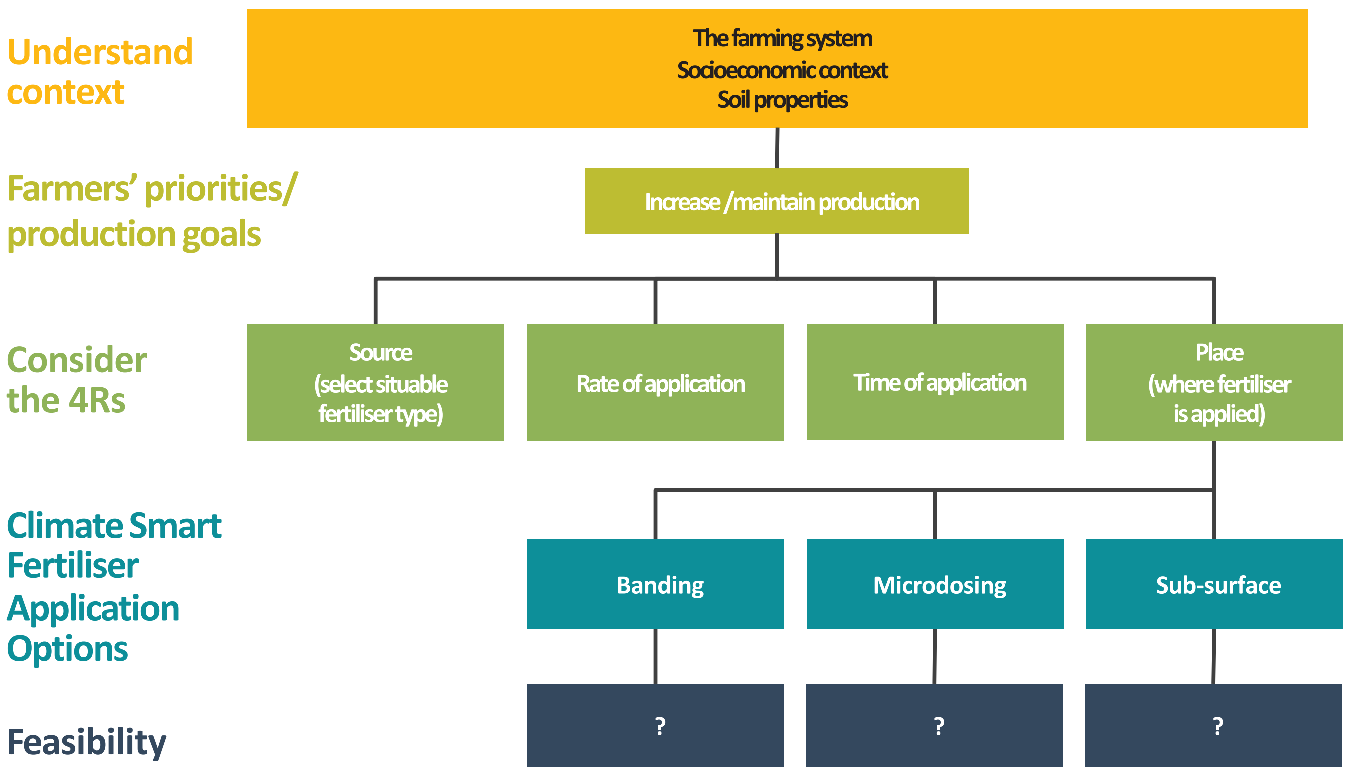
BEST BET FERTILISER APPLICATION OPTIONS FOR ADDRESSING CLIMATE RISKS IN MAIZE/SORGHUM/RICE PRODUCTION

The 4Rs are each described below – with emphasis on placement in this decision tool – as the focus is on climate smart fertiliser application options. While these are best bet options, they are not universally applicable. CSA is context specific and each of these options will need to be tested under local conditions and adapted to make it **Best Fit** the local context.

The **Decision Point** below illustrates how understanding the context can inform decision making on climate smart fertiliser application options.

DECISION POINT



RIGHT SOURCE

The right fertiliser product means matching the fertiliser source and product to the crop's needs, and the properties of the soil.

- **Supply nutrients** in plant-available forms
  - The nutrient applied is plant-available, or is in a form that converts timely into a plant-available form in the soil

- **Suit soil** physical and chemical properties.
  - Examples include avoiding nitrate application to flooded soils, surface applications of urea on high-pH soils, etc.
  - Is **adequate rain** expected – intensity and duration of rainfall events?
  - Several methods can be used to **identify which nutrients are deficient** in the soil. These include soil analysis, nutrient omission trials, and nutrient deficiency symptoms observed on crops (For more on assessing soil conditions, see **KP06 – Climate Smart Soil Amendment Options**)

- Recognise synergies among nutrient elements and sources
  - Examples include fertiliser-complementing manure, the phosphorus(P)-zinc interaction, nitrogen (N) increasing P availability, etc.
  - Have manure/compost/plant residues been applied in the past, when, and at what rate?

- Recognise blend compatibility
  - Certain combinations of sources attract moisture when mixed, limiting uniformity of application of the blended material; granule size should be similar to avoid product segregation, etc.

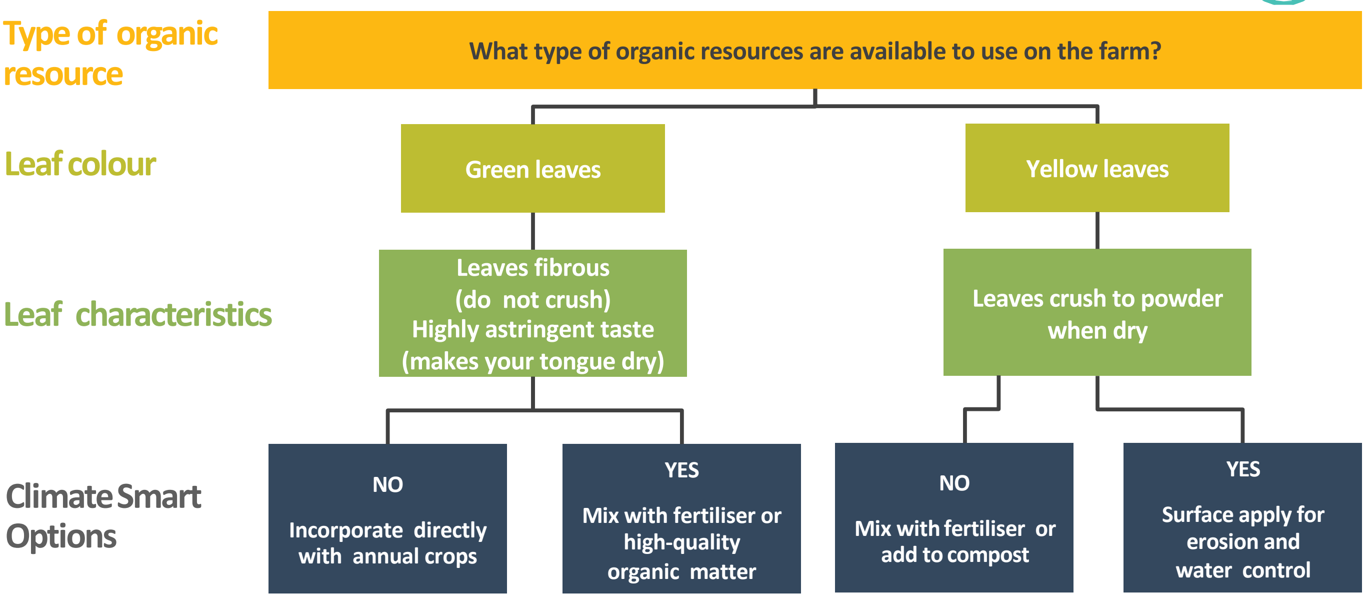
- What is the crop's fertiliser/nutrient needs?
  - Leguminous crops may not need N fertiliser.

The **Decision Point** below illustrates a decision tree that can help you make decisions with your farmers on the combination of nutrient sources that might be required, depending on what type of organic matter is available to use as a soil amendment.

TIP

Fertiliser is **not a substitute** for organic matter. Organic matter in the soil makes applied fertiliser more efficient. **Both are required** to obtain maximum yield.

DECISION POINT



RIGHT RATE

The right fertiliser rate means matching the amount of fertiliser applied to the crop's needs.

- Fertiliser rates are site and crop-system specific and are estimated after considering:
  - The nutrient requirements of the crop
  - The soil's capacity to supply nutrients (measured by soil analysis and omission plots)
  - The amount of nutrients applied in crop residues and farmyard manure. Table 2 describes the typical nutrient content of different sources of organic matter
  - The amount of nutrients applied to previous crops
  - The amount of nutrients removed in previous crops. Table 3 illustrates the amount of nutrients in kilograms removed from the soil per tonne of production. E.g., if one tonne of hybrid maize is produced, 15.6 kg of nitrogen will be removed
  - The target yield
  - The attainable yield under local climatic conditions
    - » It may be advisable not to apply any fertiliser when/if adequate rain is not predicted
  - The cost of fertilisers and the value of crop products
- Applying too much fertiliser leads to waste of nutrients not taken up by the crop and possible contamination of the environment. However, applying too little fertiliser results in decreased yield and crop quality, and less crop residues to protect and build the soil or for use as animal fodder
- In many areas in s-SA, published fertiliser rates for a locality are out of date and are geared towards maximising yield rather than the farmer's economic returns. It is very important to **assess the farmer's goals and attitude to risk** before recommending fertiliser application rates.

Table 2: Nutrient content (%) of manures and residues commonly available in sub-Saharan Africa (C = carbon, N = nitrogen, P = phosphorus, K = potassium, Ca = calcium).

Material	Water	C	N	P	K	Ca
Human faeces	–	–	1.0	0.2	0.3	–
Cattle faeces	–	–	0.3	0.1	0.1	–
Pig faeces	–	–	0.5	0.2	0.4	–
Fresh cattle manure	60	8–10	04–0.6	0.1–0.2	0.4–0.6	0.2–0.4
Composted cattle manure	35	30–35	1.5	1.2	2.1	2
Farmyard manure	50	–	1.0	0.8	1.2	0.8
Goat manure	50	–	0.8	0.7	1.5	0.8
Sheep manure	50	–	1.0	0.7	1.5	1.7
Pig manure	80	5–10	0.7–1.0	0.2–0.3	0.5–0.7	1.2
Poultry manure	55	15	1.4–1.6	0.25–0.8	0.7–0.8	2.3
Garbage compost	40	16	0.6	0.2	2.3	1.1
Sewage sludge	50	17	1.6	0.8	10.2	1.6
Sugarcane filter cake	75–80	8	0.3	0.2	0.06	0.5
Castor bean cake	10	45	4.5	0.7	1.1	1.8

Source: ASHC, Integrated Soil Fertility Management Handbook

Table 3: Nutrient removal (grams per tonne) in selected cereals, root crops, food legumes and fodder crops (N = nitrogen, P = phosphorus, K = potassium, Mg = magnesium, Ca = calcium, S = sulphur).

Crop	Product	Removal (g/t crop product)					
		N	P	K	Mg	Ca	S
Cereal							
Maize hybrid	Grain	15.6	2.9	3.8	0.4	0.9	1.3
Maize local	Grain	16.0	2.8	4.0	0.4	0.8	1.2
Rice improved	Grain	15.0	2.8	3.8	0.3	1.0	0.8
Rice local	Grain	15.0	2.5	2.5	0.5	1.0	0.5
Sorghum	Grain	16.5	3.5	3.8	1.9	0.4	1.2–1.6
Millet	Grain	26.6	3.5	4.4	1.4	0.1	1.2

Source: ASHC, Integrated Soil Fertility Management Handbook.

Fertiliser responses

Crops may not always respond as expected to fertiliser application. There may be several reasons for this. Fertiliser responses are most commonly classified in the following terms:

- **Poor responses** on fertile soils with large nutrient reserves (often the fields lying close by the farmer's house where fertilisers, animal manures and crop residues have been applied regularly in the past)
- **Large responses** to fertiliser on nutrient-deficient, but responsive soils (often the fields more distant from the farmer's house where fertilisers, manures and crop residues are not applied)
- **Very poor responses** to fertiliser application on degraded soils where fertilisers must be applied in combination with substantial amounts of organic inputs (crop residues, animal manures) to obtain satisfactory responses to mineral fertiliser.

Approaches to address these include:

- Applying smaller amounts of fertiliser and/or manure on fertile soils can sustain soil fertility
- Resource-poor farmers can invest limited cash most effectively by prioritising fertiliser use in their most responsive fields, and using moderate amounts that achieve a large return in yield per kilogram of fertiliser applied (i.e. high agronomic efficiency)
- Application of organic resources may be required to rehabilitate non-responsive soils before a response to mineral fertiliser is obtained
- In some non-responsive soils, the application of organic resources may not result in a response to mineral fertilisers, and other techniques may be required (e.g., tillage or application of micronutrients).

The following **Decision Point** outlines a decision tree to illustrate how an understanding of the local context and crop responses to fertiliser application in the past can lead to the selection of climate smart option rates, and source (organic and chemical) of nutrients to be applied.

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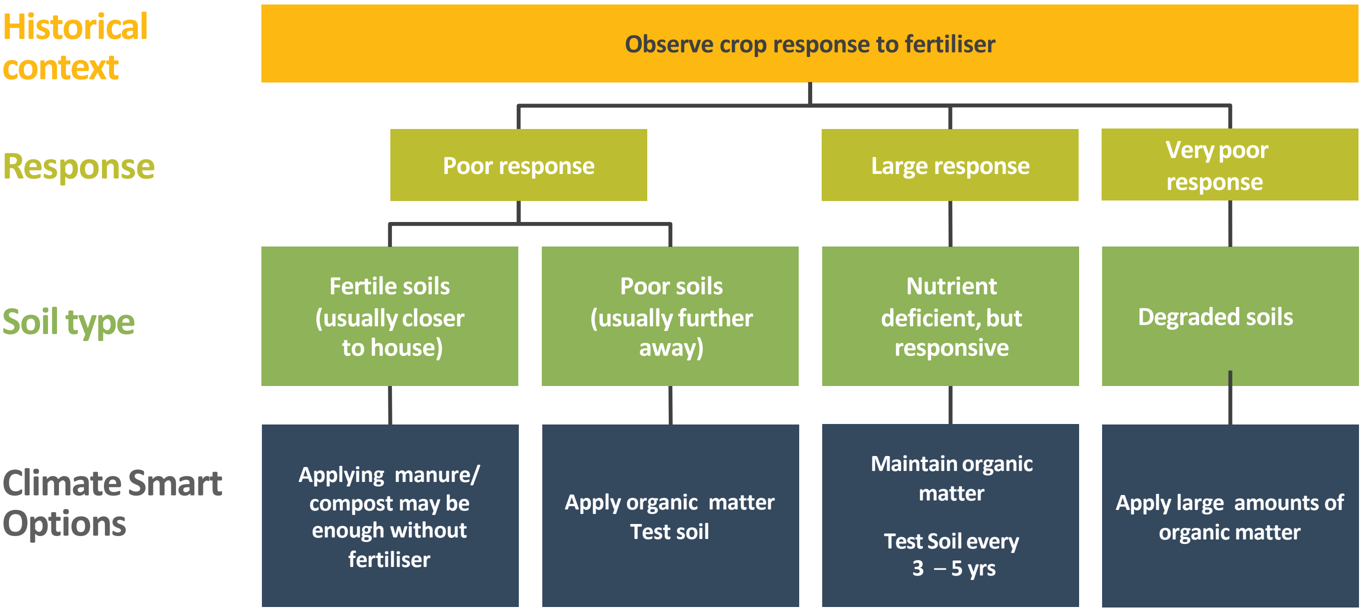
DECISION POINT



Practical steps to improve fertiliser application rates

Soil testing, omission plots, crop nutrient budgets, tissue testing, plant analysis, applicator calibration, crop scouting, record keeping, and nutrient management planning are tools that will help determine the right rate of fertiliser to apply. Some practical steps to help farmers improve the application rates of fertilisers:

- Collect any information available from fertiliser trials (particularly if they were carried out in farmers' fields) in the locality in which you are working
    - Which nutrients improved yield?
    - Did fertiliser use increase farm profits as well as yields?
    - How much of each nutrient was required to achieve economic increases in yield?
- Supplement this information (if it is available) from trials by finding out how much and what kind of fertilisers farmers are presently using, and what response in terms of yield increases has been obtained
    - Draw up a table listing each farmer, the amount of nutrients applied, the field history (i.e. whether fertilisers have been applied consistently in past cropping seasons) and the yield achieved
- You should spend as much time as possible walking the fields, looking at crops for **nutrient deficiency symptoms** and crop stunting development (often due to phosphorus (P) deficiency)
- Identify farmers that are currently achieving high yields and profits
    - Find out how much fertiliser they are using and what yields they are achieving. Make an inventory of all the soil fertility practices they are using that may be applicable to other farmers
- If possible, carry out soil sampling and analysis to assess soil fertility, particularly the amount of available phosphorus (P) and exchangeable potassium (K) and magnesium (Mg)
- Work with farmers to test fertiliser recommendations, starting with low application rates
- Record the results of your work in a field book to build up a knowledge base of reliable information on fertiliser use and crop responses for your locality

- You should also record weather data (date, duration and intensity of rainfall in particular). Excessive rain can leach fertiliser nutrients from the soil, and not enough soil moisture can make fertiliser less available to plants
- After a few years it may be possible to assess the risk of crop failure so that farmers can be informed about the economic risks of applying fertiliser, e.g., if drought is highly likely, then applying fertiliser might be a waste of resources.

TIP

Fertiliser should be applied soon after weeding. If weeds are germinating/ growing when fertiliser is applied, some of the fertiliser will be 'stolen' by them from the crop.

RIGHT TIME

The right time for fertiliser application means making nutrients available when the crop needs them.

- Nutrients are used most efficiently when their availability is synchronised with crop demand
  - Basal fertiliser application is done at or just after planting, to supply N, P, K and other nutrients required for early crop growth
- Nitrogen fertiliser is highly mobile and easily lost from the soil due to leaching, so some N fertiliser should be applied as a 'top dressing' at key stages during crop development – usually when the crop is growing fastest
  - Top-dressed N fertiliser can be applied as several split applications to improve fertiliser-use efficiency
  - Top-dressing rates can be adjusted according to how well the crop is developing, and the expected price of crop products
- Top dressings produce good agronomic results if the crop is developing well under **favourable climatic conditions**, and if high crop prices are expected

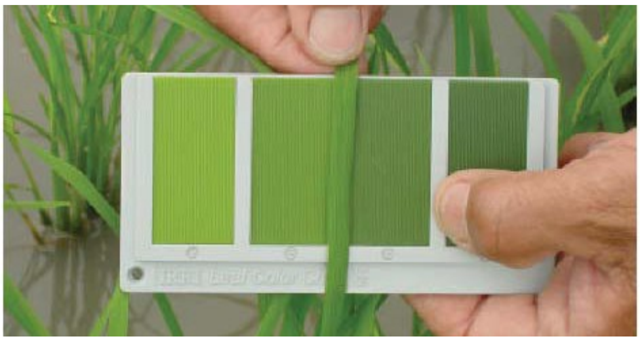
If you are unsure what type of nutrient deficiency your crop might have, check out these apps:

Crop Nutrient Removal Calculator
International Plant Nutrition Institute
Free

Crop Nutrient Deficiency Photo Library
International Plant Nutrition Institute
Free

  - If the crop has developed poorly because of poor rainfall and the price of crop outputs is expected to be low, top dressings can be cancelled and the fertiliser set aside for the next planting season
- Application timing (pre-plant or split applications), controlled release technologies, stabilisers, inhibitors, and product choice are examples of practices that influence the timing of nutrient availability
- Leaf colour charts (Figure 2) or chlorophyll meters are available on the market to guide the application of N, based on crop demand
- Slow-release N fertilisers and deep placement of N fertiliser improve the match between nutrient release and crop demand (sometimes referred to as synchrony).

Figure 2: A leaf colour chart for rice.



Source: IR.

RIGHT PLACE

The right placement of fertiliser means applying fertiliser where the crop can access the nutrients contained in the fertiliser. The choice of application method by the farmer will depend on the **labour required**. Application methods should be selected based on the crop or cropping system, and soil properties. It is usually best to incorporate basal fertiliser in the soil at or before planting to achieve efficient fertiliser use.

Broadcasting is the practice of applying fertilisers uniformly across the soil surface. This is done either before sowing, or in the standing crop. This method is easy to implement and has low labour requirements. N fertiliser top dressings are usually broadcast in irrigated rice fields. Climate smart fertiliser application options are detailed below.

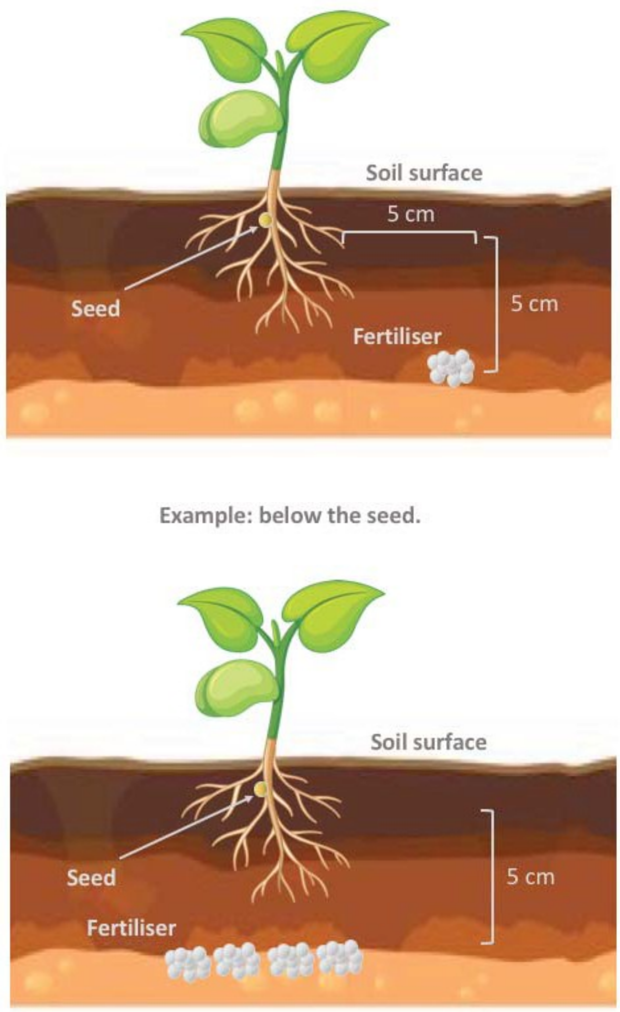
Banding

Figure 3 illustrates two different methods for the banding application of fertilisers. The fertilisers are placed in a band at a depth of 5 – 8 cm below the soil surface and covered by the soil. Seeds are planted above the covered fertiliser. Banding is the most common method of placement for basal fertiliser applications.

- The seed should not be allowed to touch the basal fertiliser, as this might 'burn' the seed and it may not germinate
- Planting below (and to the side) of the seed encourages root growth
- This practice uses less fertiliser, as it is applied only in rows and not across the whole field
- If this is being done by hand, a 'narrow' hoe should be used to minimise workload and soil disturbance
- If draught power is available (oxen/buffalo), a ripper can be used instead of a plough to minimise soil disturbance (**see CCARDESA KP08 - Climate Smart Land Preparation Options**).

Figure 3: Two different methods of fertiliser banding.

Example: below and beside the seed.



Source: after Yara

Microdosing

Fertilisers are applied in small amounts: either at planting in each planting station together with the seed, or close to each plant station during the crop growing season. Figure 4 illustrates the amount of fertiliser usually placed in each planting station when using the 'microdosing' technique.

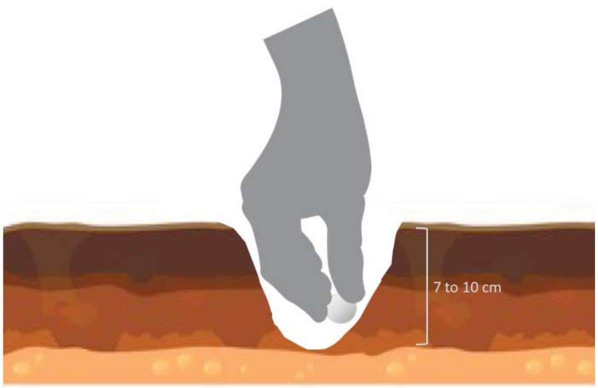
- Microdosing is preferred where plants are widely spaced, and where soil and climate conditions increase the risk of nutrient losses due to leaching

- Microdosing is becoming popular among farmers because it is more cost effective than broadcasting
- Microdosing is particularly effective where planting basins or 'zai' pits are used, as organic inputs and fertiliser can be applied and incorporated in each planting station at the same time
    - This method includes the advantages of banding by placing the fertiliser below the seed, but at a single point instead of in a band (row) – thus using less fertiliser.

Figure 4: A bottle cap contains about 6 g of fertiliser.

Source: ASHC, Integrated Soil Fertility Management Handbook

Figure 5: Sub-surface fertilisation or, fertiliser deep-placement.



Source: After International Fertiliser Development Centre – IFDC

Sub-surface fertilisation

Slow-release N fertilisers are placed in the soil in flooded fields (Figure 5). This technology was first developed in Bangladesh before being introduced in Africa. It consists of two key components:

- The first is a **fertiliser 'briquette'** produced by compacting commercially available solid fertilisers. Briquetting machines suitable to operating conditions in the SADC region are available
    - The machine produces 1 to 3-gram briquettes that are much larger than conventional fertiliser granules. These can be produced by local entrepreneurs with small-scale briquetting machines
- The second key component is the **placement of briquettes** below the soil surface. When used to fertilise irrigated rice, briquettes are centred between four plants at a depth of 7 – 10 cm within seven days after transplanting. Placement is done either by hand, or with a mechanical applicator.

The briquette releases nitrogen (N) gradually, coinciding with the crop's requirements during the growing season. While this technology has predominantly been used for urea application in irrigated rice (due to ease of application in a flooded paddy), it can be used with other fertiliser types and for other crops.

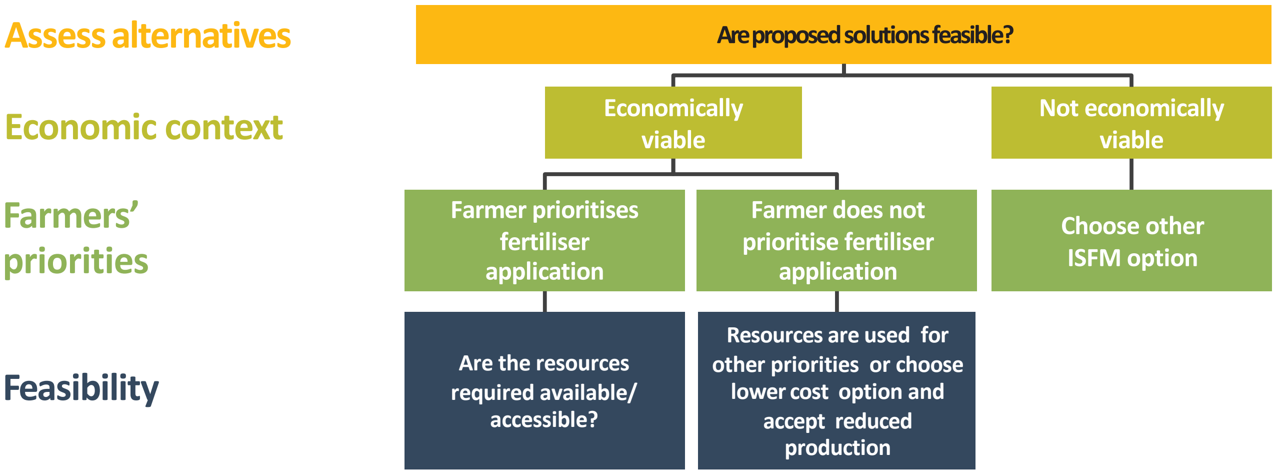
When urea is broadcast in flooded rice fields, a substantial portion of the N is wasted – lost through runoff, volatilisation (atmospheric evaporation) and nitrification/denitrification. Additional amounts of N are converted to nitrates, which are mobile in the soil and can contaminate groundwater. With sub-surface fertilisation, urea is deep-placed into the soil where the majority remains in the form of ammonium – which is much less mobile than nitrates. Therefore, more N is available to the crop throughout its growth cycle. Losses to the atmosphere, groundwater and waterways are drastically reduced.

Only about 4 percent of the N is lost to the environment, compared with about 35 percent when N is applied via broadcasting. The practice also dramatically improves a crop's absorption of N – two-thirds is absorbed by the rice grain and straw (post-harvest residue), compared with one-third when the broadcast application method is used.

Feasibility

The **Decision Point** below outlines a decision tree that can be used to help make decisions on whether climate smart fertiliser application options identified and selected are actually feasible in the individual farmers' context.

DECISION POINT



ECONOMIC VIABILITY (THE 'FIFTH R')

This is sometimes known as the **'Fifth R' (remunerative options)**. Because smallholder farmers in the SADC region often have limited cash resources and buy smaller amounts of fertiliser, it is important to identify the part of the farming system where fertiliser inputs will deliver the greatest return. When used with care, fertiliser can become the key to unlocking the potential of the farm. Soil fertility varies among the farmer's different fields (fields closer to the home are usually more fertile) so it is important to know which fields will deliver the greatest return on fertiliser use.

A second point is to consider the cropping system rather than a single crop when planning fertiliser use. For example, in a maize–grain legume rotation, fertilisers (particularly N) applied to the maize crop will provide a residual benefit in terms of nutrient supply to the legume crop that follows, which may therefore not need to be fertilised. Fertilisers should be provided to the main crop in intercropped systems. In a field of intercropped maize and beans, for example, N fertiliser should be applied to the maize crop because the beans are able to provide much of their N requirements through biological N2-fixation.

The 'fifth R', then, is to consider the **opportunity cost** of fertiliser, and to make sure that scarce fertiliser resources are delivered to the part of the cropping system that delivers the maximum economic benefit to the farmer. **Labour** is a key factor that must be assessed in terms of economic viability. Farmers rarely account for the cost of their own/family labour but will consider wage labour costs. Understanding who is responsible for key crop management tasks is critical in assessing if there are opportunity costs associated with the option proposed. Extra labour may be required for all three of the climate smart options proposed.

- Who will do the 'extra' work?
  - Men, women, children?

- What would they be doing if they are not doing this task?
  - Will children need to miss school?
  - Will women still be able to go to the market?
  - These are known as opportunity costs and must be factored in.

Seasonal calendars are an excellent tool to help define what resources are required (and available) when. The seasonal calendar should include all components of the farming system so that accurate projections for labour and cash resources are plotted. It may then be possible to **forecast** the potential costs associated with changes to more climate smart practices. This should be done by:

- Developing a **cashflow** forecast for the year

- Include cost of **labour** in the forecast (this can be in time or monetary units)
- Test the **assumptions** in the forecast:
  - Will money, labour be available when it is needed?

Throughout the year, the farmer should be supported to collect accurate data on the following:

- Inputs
- Rainfall – duration and intensity (affects fertiliser-use efficiency)
- Temperatures – can stress plants if too high or too low
- Costs
- Labour (who and how much)
- Management practices (e.g., date of planting, field preparation, compost application, weeding, pest/ disease outbreaks, etc.)
- Yield
- Revenue generated.

This will enable you to develop accurate gross margins at the end of the season. The farmers can use these to make decisions on how to improve farming practices to make them even smarter, so they are the best fit to their local context.

Accurate economic forecasting and analysis is not always easy as there are many factors that need to be considered.

Discussing issues with your farmers can help identify major factors that might help you decide on economic viability at this stage. Collecting accurate data on costs incurred, production attained and externalities such as climatic conditions throughout the year and reflecting on these, will help you and your farmers make more informed decisions in the following season.

Farmers' priorities

If crop production is a primary source of income on the farm, fertiliser application is likely to be a higher priority as it directly affects income and household economic status. While fertiliser use is recommended as part of a climate smart integrated soil fertility management approach, you should always consider alternative practices/technologies that might either:

- Result in similar improvements in yield/income generation
- Complement the use of the fertiliser application option chosen to further increase yields and make production more efficient.

Application of fertiliser can increase grain plant biomass. It is important to consider the farmers priorities for use of plant residues. Returning larger volumes of plant residues to the soil or feeding them to livestock and returning the manure to the soil, will help to recycle nutrients within the farm system and make the entire system more efficient.

Feasibility

Finally, you need to work with your farmers to assess if the preferred options are feasible in terms of accessibility/ availability.

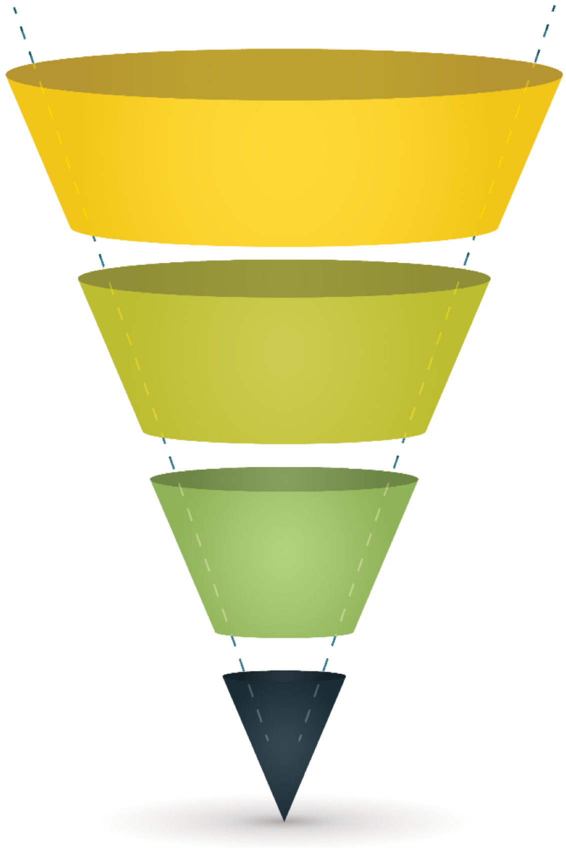
- Are the required inputs (including labour) available?
  - What is the current means of cultivation/land preparation?
    - » Will this need to be adapted a lot to facilitate banding/microdosing/sub-surface fertilisation?
    - » Who does this work, and will they be able/willing to do the extra work (if there is extra)?
  - Where can fertiliser be sourced?
  - Is fertiliser available in small packages, or is it only available in 50 kg bags?
  - What type of fertiliser is available?
    - » Compound or straight fertilisers?
    - » What is the quality of fertiliser available?
  - Is credit available and affordable?
  - Is there a subsidy scheme for fertiliser?
- If available, are the required inputs accessible?
  - Will the farmer be able to access the required resources?
  - Are they close by?
  - Will she/he be able to transport them?
  - Do men and women have equal access to inputs (including credit)?

TIP

Fertiliser should only be used where it gives a good return on investment. Crops like maize and rice usually respond well to fertiliser, but sorghum might not. Assessing **agronomic efficiency (AE)** (kg increase in yield per kg fertiliser added) is a key step to understand where scarce resources should be prioritised.

CCARDESA german cooperation DEUTSCHE ZUSAMMENARBEIT giz

TO SUMMARISE



STEP 1: Understand the context

- What is the farming system?
- Socioeconomic context
- Access to markets
- Access to information (especially climate info)

STEP 2: The '4Rs'

- Right Source
- Right Rate
- Right Time
- Right Place – select an option

STEP 3: Assess feasibility

- The fifth R – Remuneration: Assess economic viability
- Access to and availability of fertiliser/labour – gender issues

STEP 4: Test and improve

- Assess response rates
- Collect data and reflect on possible improvements.

IITA, 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.

- **The CCARDESA Knowledge Hub** – for more detail on specific climate smart practices and technologies included within Integrated Soil Fertility Management, specifically the following:
  - Knowledge Product 07 – Climate Smart Planting System Options
  - Knowledge Product 08 – Climate Smart Land Preparation Options
  - Knowledge Product 09 – Climate Smart Variety Selection
  - Knowledge Product 10 – Climate Smart Water Management for Maize and Sorghum
  - Knowledge Product 12 – Climate Smart Agroforestry Options
  - Knowledge Product 16 – Climate Smart Manure Management Options
  - Knowledge Product 19 - Identifying Pests & Diseases of Maize & Sorghum and selecting control options

- **ASHC** – Handbook for Integrated Soil Fertility Management
  - An excellent resource that every extension officer should have access to, clearly articulating how fertiliser can be used effectively within the farming system

- **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

- **FAO** – On-Farm Composting Methods; Land and Water Discussion Paper 2
  - A detailed guide on how to make several types of compost. Chapter 2 is especially relevant to smallholders

- **FAO** – Green manure cover crops and crop rotation in conservation agriculture on small farms: Integrated Crop management Vol 12, 2010
  - Focused on Paraguay and technical in nature, but covers all the principles behind the practices

- **International Fertiliser Development Centre (IFDC)** – Fertiliser Deep Placement
  - The website has a lot of potentially useful resources, including national fertiliser market studies for several SADC countries

- **International Plant Nutrition Institute (IPNI)** – Nutrient Stewardship 4R Pocket Guide
  - A handy guide to the 4Rs but targeted more at western/northern audiences
  - IPNI's website has a host of resources in different languages, but some (such as the 4R Plant Nutrition Manual) are not free and they are aimed at the North American market

- **Institute for Sustainable Development (ISD)** – How to Make and Use Compost
  - A detailed practical guide on compost making and use.

Citation: CCARDESA and GIZ 2019. Knowledge Product 21 Climate Smart Fertiliser Application Options. CCARDESA Secretariat, Gaborone, Botswana.