KP17
Knowledge Product 17

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

DECISION TOOL:
Climate Smart Genetic Improvement Options for Livestock

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)

Livestock | Decision Point | Gender | Youth | Climate Smart | Practice


CCAFS, 2014

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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. 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. Contextualizing **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:

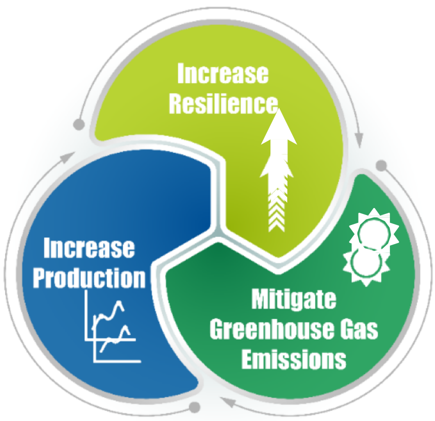
1. More productive animals can greatly increase the efficiency of the use of feed resources and reduce feed costs, while decreasing greenhouse gas emissions per unit product and thus improving resilience to diseases and heat stress

2. To make climate smart decisions on which genetic improvement option best suits your farmers, you need to analyse:
   - The farming system
   - How livestock are currently managed within the system
   - Farmers perceptions of problems and opportunities

3. Climate smart genetic improvement options include:
   - Cross-breeding exotic and indigenous breeds
   - Cross-breeding indigenous breeds
   - Assisted reproduction
   - Choosing alternative breeds
   - Diversifying species.

Entry Points for CSA

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



CLIMATE SMART GENETIC IMPROVEMENT OPTIONS FOR LIVESTOCK

This **Decision Tool** aims to help field-level extension staff make **climate smart decisions** on which genetic improvement option best suits the context of their farmers. 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 farming systems with their clients. Reference to technical guides relevant to the practices and technologies outlined are included at the end of the tool.

The tool focuses on some of the **Best Bet Climate Smart Genetic Improvement Options** for livestock 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 livestock 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.

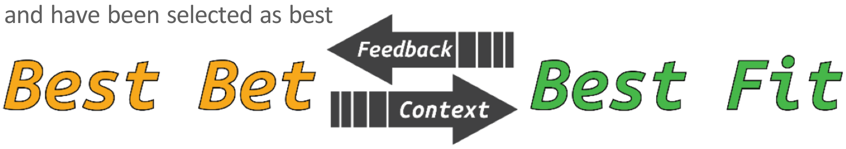


Table 1: Best Bet Climate Smart Genetic Improvement Options for livestock for the SADC region.

		3 Pillars of CSA		
Climate Smart Herd Improvement Option	**What is it?**	**Increase production**	**Adaptation/ resilience**	**Mitigate GHG emissions if possible**
Cross-breeding exotic and indigenous breeds	Cross breeding local breeds with introduced breeds, with the aim of increasing milk, meat and/or egg production	Increases milk or egg yield and/or weight gain of animals, thus increasing production per unit of input	Breeding for resilience to: • Heat and drought • Pests and diseases	Lower methane emissions: • Focus on increasing productivity per unit livestock, resulting in lower emissions per unit meat/dairy/eggs produced • Possibility of including methane as a specific selection objective
Cross-breeding indigenous breeds	Selecting indigenous breeds due to their adaptation to the local climate (heat tolerance, pest and/or disease resistance)			
Assisted reproduction	Artificial insemination, embryo transfer, semen quality assessment and/or genetic marker assisted breeding			
Choosing alternative breeds	Introducing new breeds with desired traits to replace existing breeds			
Diversifying species	Selecting different livestock species to minimise or diversify risk	Ensures production from species that are better adapted to the local climate	Expanded number of species reduces overall risk of production failure and pest and disease prevalence. Other species are better adapted to the changing climatic conditions	Increased productivity will reduce overall emissions per unit of production


Lim, 2010

Species selection and **breeding plans** can help maintain or increase production in livestock systems in the face of climate change. Genetics makes use of natural variation among animals; therefore, **selecting preferred animals** as parents can yield **permanent** and **cumulative improvements** in the population. More efficient animals can greatly reduce feed costs, while decreasing greenhouse gas emissions. Breeding, including cross-breeding between indigenous and imported species, can also improve resilience to diseases and heat-stress, and increase reproductive performance.

WHICH CLIMATE SMART GENETIC IMPROVEMENT OPTION IS BEST SUITED FOR YOUR FARMER(S)?

To make recommendations to your farmers on the most climate smart option for genetic improvements, you must analyse the following:

- The **farming system**
- **How are livestock currently managed** within the system?
  - Including breeding and selection practices
- **Constraints** to livestock production and marketing.

A deep understanding of the context will help you to develop **Best Fit** rather than just **Best Bet** options for genetic improvement.

THE FARMING SYSTEM

Farming systems are varied and complex across the SADC region. A farmer may only have one specific type of livestock as their sole source of income, or they may have several types of livestock and crops. Each part of the system may impact on another. Most smallholders will have a diverse farming system in which livestock play a key role. It is important to take the time to analyse the system, and what influences it in detail, before selecting climate smart genetic improvement options.

The following is a checklist of questions that may prove helpful when trying to analyse a farming system:

- Who owns the land, and how is it passed from one generation to the next?
  - Is land community or individually owned, or both?
  - Where is community land and where is individually owned land? A resource map may be useful here
  - Where is water sourced, and who has access to this water
    - » Is access equal for men and women?
    - » Are there some groups who have more access than others?
    - » What limits a farmer's access?
  - Is land owned by men or women, or both?
- If land is traditionally used by pastoralists, is this land being encroached by agropastoralists and/or cropping?
  - Have migration routes been demarcated?
  - Are there any conflict and dispute resolution structures?
    - » Do these structures work?
  - How many farmers and livestock are using the pastoral land, and how has this changed over time?

- What are the local rainfall and temperature patterns?
  - During which months does it rain, and how heavy is this rain?
  - Which months are hottest, and which coldest?
  - Have the farmers experienced extremes, such as droughts or flooding? And how did they cope?
  - Has this been changing over time?
- What is the status of the soil?
  - Slope, texture, organic matter content, soil moisture, etc.
  - Are there specific areas prone to erosion?
- When are the main cropping and grazing seasons?
  - Developing a detailed agricultural calendar is a smart way to understand changes throughout the year
- What livestock are included in the farming system(s)?
  - Does the farming system include more than one type of livestock (e.g., chickens, goats and cows)?
- What are the sources of credit?
  - Is credit equally accessible to all farmers (men, women, other subgroups)?
  - What are the repayment conditions?
- Where do farmers access agricultural inputs?
  - Is access equal for men, women and other subgroups?
  - What limits a farmer's access?
- Have there been changes in land use over the past number of years (lifetime of the farmers)?
  - Why or why not?
- Are there any agricultural projects in the target area?
  - Who are these targeting?
  - Can these projects be leveraged to help support climate smart genetic improvements?

HOW ARE LIVESTOCK CURRENTLY MANAGED WITHIN THE FARMING SYSTEM?

To make climate smart decisions on genetic improvement options, we need to understand current management practices for each type of livestock in the farming system. This includes:

- **Livestock holdings:**
  - What type of livestock and how many are kept (age and gender should be recorded)?
  - What type of breeds are kept? Record the local names and key characteristics of each breed.
- **Livestock housing:**
  - What housing structures are provided, if any?
  - What bedding is used, if any?
  - At what times is housing used – day, night, and/or seasonal changes?
  - Are animals all housed together, or are they separated by age, sex and/or species?
  - Are feeding troughs provided?
  - Where is manure collected if at all?
- **Watering points:**
  - Where are the watering points?
  - Is there enough water throughout the year?
  - Who 'waters' the livestock (men, women, children)?
  - How long does this take?
- **Crops grown on the farm:**
  - What are the main crops grown by the farmer on their land?
  - Why are these crops grown?
  - What is the typical yield
  - What is done with crop residues?

- **Livestock feeding:**
  - Is livestock stall-fed, tethered, open grazed, or a combination of these?
  - How does this change over the year?
  - How do feeding habits change throughout the year?
  - Does the farmer plant any fodder crops or collect fodder for their animals?
    - »If so, at what times of year is this available?
    - »Is any of this processed; how?
  - Does the farmer purchase any livestock feed?
    - »Is this equally possible for male and female farmers?

- **Grazing:**
- Do the animals spend any time grazing?
- Where do animals graze (if they do) and how long is this for?
  - What plants, residues, crops and/or trees do animals feed on?

- **Sources of household income:**
  - What are the main contributors to household income?
  - How much does income from livestock contribute to total household income?

- **Use of livestock within the farming system:**
  - Why does the farmer keep each type of livestock?
    - »For own consumption and/or sale (meat, dairy, eggs, hide, wool, etc.)
    - »As a coping strategy (sale in lean periods or during household shocks)
    - »As a status symbol
    - »As draught animals
    - »For transport
    - »For manure for crops and/or fuel
    - »A combination of reasons

- **Sale of livestock and livestock products:**
  - How many animals has the farmer sold over the past three years, and what were their weights (if known)?
  - How much did the farmer receive per head of livestock sold?
  - What is the overall milk and/or egg production from the farmer's animals?
  - How much did the farmer receive per litre of milk and/or number of eggs?
  - Who sells the livestock and products, and who decides upon sales and use of money (men, women or children)?
  - Were any of the sales a response to drought or over grazing on pasture and/or rangeland?

- **Labour:**
  - Who performs each animal husbandry task (men, women or children)?
  - How much time is spent on each task?
  - Do any tasks require hired labour and if so, how much does this cost?
  - Do labour requirements change throughout the year (for men, women, children)?

Current breeding and selection practices

- Do different households own various species and breeds?
  - **List all breeds of each species**
  - What are the reasons for the differences (if any)?
  - Does the wealth and/or poverty status determine who owns which species or breeds?

- **Identify traits** of importance to livestock keepers when selecting breeding animals and/or sourcing replacement animals. Table 2 illustrates how traits and preferred breeds can be identified using a simple ranking matrix. Ask your farmers which traits are important and list them.

» e.g., heat tolerance, number of kids per goat, resistance to disease, ability to cope with dry season, etc.

» Has the importance of any of these traits changed over the past five years?

- Rank the breeds that farmers keep (and others they know well) according to these traits
- Provide overall ranking for the breeds (see Table 2).

Other information important for breeding:

- How did the farmer learn about and get the breed/s he or she currently keeps?

»Historical reasons, availability, extension service advice, due to lack of information on available breeds, etc.

- What are the ways of acquiring animals in the area (breeding purchase, gift, exchange, etc.)?
- If the farmer purchases, why does he or she not rear their own? If they purchase:

»Where do they get the animals from?

»How do they choose which animal to buy (characteristics)?

»What information do they request from the seller?

› If parentage is not mentioned – ask if this is important

- If they reared their own – why did they not purchase?
- If given a choice, would farmers prefer keeping other breeds? If yes, which ones, and what hinders them from changing?

Breeding strategies:

- Is breeding **controlled** or **uncontrolled**?

»If controlled, discuss how?

› Are males selected from their own flock and/or herd, or others'? How are they selected, and how do farmers access them? Are there any costs, or payment received?

› Are females selected? If yes, how?

› Who are the main decision makers in relation to breeding (i.e. who selects the breeding animals)? Is advice obtained from others to make breeding decisions? If so, from whom?

› Does the farmer keep any breeding records?

»Are livestock herders used? If yes, what is the relationship between livestock owners and livestock herders?

› Are the herders paid?

› Are herders trained?

- What changes have taken place in terms of breeding practices in the last 5 years?

Table 2: Example of a trait ranking table. This should be completed for all the different breeds of livestock held by the farmer(s).

Traits	Breed 1 (rank 1–5)	Breed 2 (rank 1–5)	Breed 3 (rank 1–5)	Breed 4 (rank 1–5)
e.g., Daily milk production	1 (very poor)	5 (very good)		
Overall Ranking (Sum of scores: > = better)				

Source: Adapted from: FAnGR-Asia; Development and Application of Decision Support Tools to Conserve and Sustainably Use Genetic Diversity in Indigenous Livestock and Wild Relatives

- Are there any breeding and/or livestock projects in the target area?
  - Who are these projects targeting?
  - Can these be leveraged to help support climate smart genetic improvement?
  - If there are none currently, have there been any in the past?
    - »Were they successful or unsuccessful?


CCAFS, 2014

CONSTRAINTS TO LIVESTOCK PRODUCTION AND MARKETING

To select the best fit climate smart genetic improvement options for livestock with your farmers, it is always good to ask farmers about the main problems and opportunities they face:

- List the major problems faced by farmers in livestock production and marketing
  - Do not limit this to breeding, as systems can be complex. For example, issues in relation to sorghum production may impact on availability of crop residues as supplementary feed – which in turn affects the condition of breeding males and/or females at critical times of the year

- Define the cause of each problem:
  - Take time to tease out the root cause of the problem by asking: 'Why is that?' (several times if necessary)
  - Once a list of problems has been developed, these can be prioritised using a simple pairwise ranking tool (Table 3)
    - » Changes in climate might be resulting in animals suffering from heat stress, for example

- Which breed is most affected?
  - Compare how the different breeds are affected by each problem identified

- How do farmers currently cope with each situation?
  - If there is a drought, do they sell off important breeding livestock or do they select the animals with less desired traits to sell?

- What do farmers view as potential solutions to these identified problems?
  - It is always best to start with a discussion of local solutions, as these are much more likely to be adopted than external ideas
  - In the above example, making silage in the rainy season would enable the farmer to maintain key breeding stock in good condition on the farm throughout the dry season.

Table 3: Example of a pairwise ranking table for five identified problems. A matrix can be developed to rank as many problems as are identified.

Pair	Problem considered more important
Problem 1 vs Problem 2	
Problem 1 vs Problem 3	
Problem 1 vs Problem 4	
Problem 1 vs Problem 5	
Problem 2 vs Problem 3	
Problem 2 vs Problem 4	
Problem 2 vs Problem 5	
Problem 3 vs Problem 4	
Problem 3 vs Problem 5	
Problem 4 vs Problem 5	

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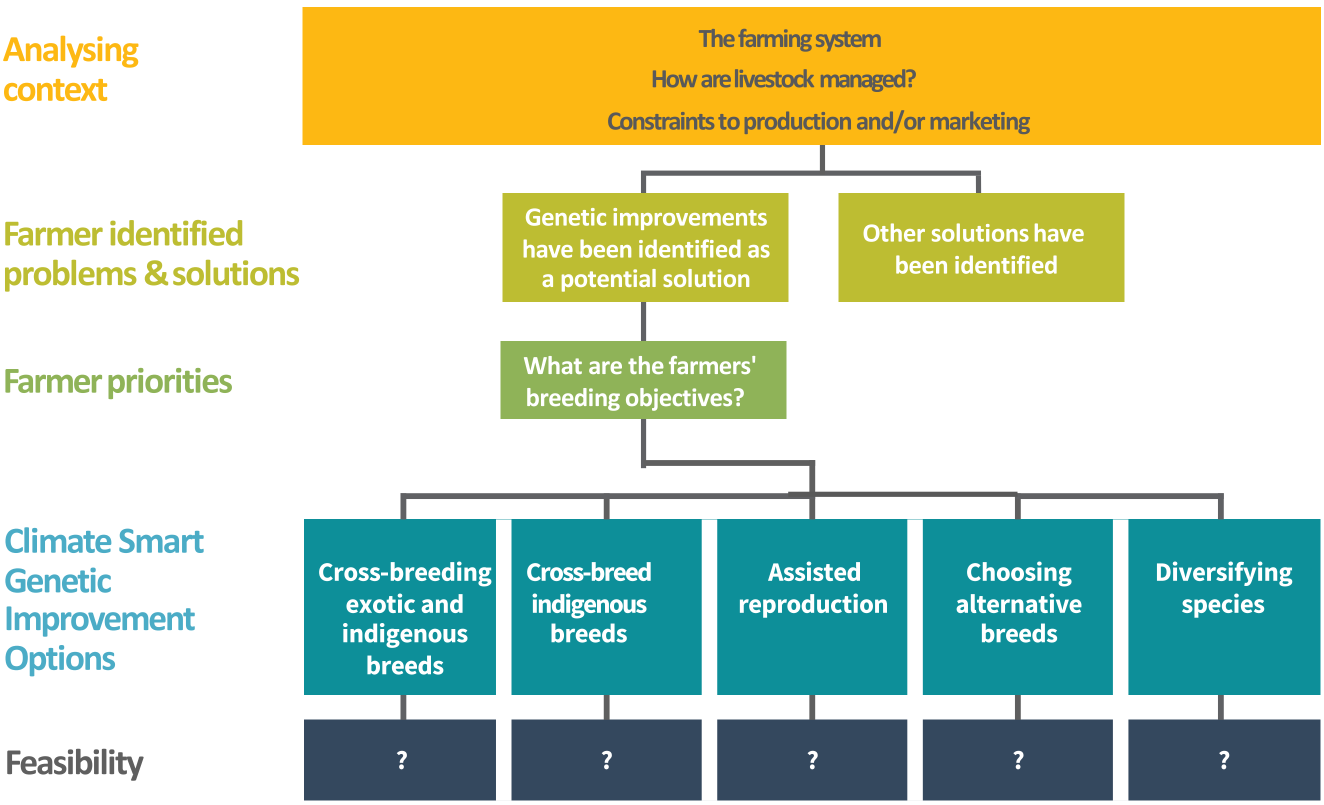
Table 4: Example of a table that can be used to summarise priority issues, explain how they impact farmers, and propose climate smart solutions.

	Problem	Importance (ranking)	Cause (describe)	Breed most/ least affected	Current coping mechanisms	Solution
1						
2						
3						
4						
5						

Once the problems and potential local solutions have been identified and ranked, you should spend time with your farmers to discuss the proposed solutions in more detail and consider if other solutions might be an option – that the farmers have not thought about.

The **Decision Point** below outlines how an analysis of the context, an identification of problems and viable solutions, and an assessment of farmers' priorities can lead to climate smart decisions on genetic improvement options.

DECISION POINT



BEST BET!

BEST BET GENETIC IMPROVEMENT OPTIONS FOR ADDRESSING CLIMATE RISKS IN LIVESTOCK PRODUCTION

Below are five climate smart management options for livestock, listed in no particular order. All are broadly applicable across the SADC region. In many instances, a combination of these options will give optimum results; however, 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 achieve **Best Fit** the local context.

Once problems and potential solutions have been identified, the problems that can be addressed through genetic improvement can be identified. It is vital at this stage to understand exactly what farmer priorities are in terms of breeding objectives.

Define breeding objectives

Genetic improvements are long-term solutions to production and/or marketing problems. A decision to breed two cattle with specific traits today may take three years before it can be assessed (the time it takes a dairy cow to calve, the calf to grow up, and have a calf of its own before it starts milking). This is especially the case where detailed data on the traits of each breed are not documented and the farmer may have to start from scratch. The farmer needs to be clear on what her or his objectives are before they select one particular direction.

It will be useful to collect the following information:

- The priority traits
- Which breeds have these traits and which do not?
- The main production and marketing problems.

Each farmer may have different breeding objectives for the same species, so a **one-size-fits-all approach should be avoided**. Amongst a group of farmers that own goats, some may place more emphasis on milk production because they see that as a key income source; others may focus on the speed in reaching maturity and target weights for sale and/or slaughter.

Breeding priorities might include the following:

- Disease resistance
- Heat tolerance
- Better weight at slaughter
- More efficient feed conversion
- Higher milk yield
- Faster weight gain
- Higher egg production
- Higher number of off-spring per reproduction cycle.

Understanding the farming context and the production system will enable you to make climate smart decisions on how best the farmer can address their breeding priorities.

Some climate smart genetic improvement options are outlined below:

CROSS-BREEDING EXOTIC AND INDIGENOUS BREEDS

This is simply the crossing of one breed with another to obtain desired traits in the offspring. This is done by crossing local breeds with more productive, exotic breeds; or vice versa.

Crossing local with exotic breeds usually results in larger animals that can put on weight more quickly, or which can produce greater volumes of milk. Caution needs to be observed when choosing this method as:

- The offspring may be less tolerant of heat or other environmental stresses
- Disease resistance may be reduced
- Expected productivity improvements may only be observed if investments are also made in higher levels of management (e.g., higher quantity and quality of feed, and regular worming)

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Cross-breeding exotic with local breeds should be done to increase resistance against environmental stresses (e.g., heat or drought tolerance, or pest and disease resistance).

If data is not available on the traits of the off-spring produced, it is recommended to proceed with caution – especially with extremely poor smallholders.

Cross-breeding with other African breeds is an option that should be considered, depending on availability and accessibility.

CROSS-BREEDING INDIGENOUS BREEDS

This is the process of cross-breeding between indigenous traditional breeds, or with specific individuals with desired traits within the indigenous breed to achieve breeding objectives. Cross-breeding indigenous breeds has the advantage of the farmer knowing that the offspring will be well adapted to local conditions, including the following traits:

- Better heat tolerance
- Higher rates of survival on poor fodder
- Greater resistance to local pests/diseases.

The major constraint here is the lack of data available on the traits of indigenous breeds. This means that the traits the farmer is selecting for are observed rather than being scientifically documented, making a breeding programme less predictable.

ASSISTED REPRODUCTION

Assisted reproduction includes artificial insemination (AI), embryo transfer, semen quality assessment, and genetic marker assisted breeding.

It can be targeted at increasing productivity and resistance. It has the advantage that specific genetic traits can be selected. Cost–benefit analysis should be conducted to compare assisted reproduction with other options to help the farmer decide. Mostly, assisted reproduction is expensive – and in many parts of Africa, farmers have questioned the quality control.

It is likely only an option for intensive dairy and/or beef farmers. It may be an option for smallholder farmers, where there is funding available through an NGO or another organisation in some countries. Importing frozen semen and/or embryos comes with significant paperwork, so investment costs can be high.

CHOOSING ALTERNATIVE BREEDS

A farmer can choose to change the breed she or he has previously reared for another breed with traits that better match their priorities and circumstances. This might be in response to more extreme temperatures causing heat stress, or because another breed requires less water or lower quality feed to maintain it. This may mean changing from beef to dairy cows, or from a breed that does not have disease resistance to one that does. The change can be initiated over a period of time by changing a few animals initially, and then breeding these to replace the existing animals over several years.

The greater the number of the new breed that is brought in initially, the quicker the transition will likely be. For example: many farmers in Malawi have introduced the Black Australorp breed of chicken through NGO projects, and have used this to either cross-breed with local chickens or have replaced the local chicken altogether. This breed has much more meat, as well as being able to lay more eggs than local breeds. However, many people prefer the taste of 'local' chickens.

DIVERSIFYING SPECIES

The farmer may decide that the livestock she or he has on their farm is no longer suitable, and may decide to add on new species or change to different species altogether. Decisions can be influenced by the following factors :

- Changes in climate
    - Temperatures causing heat stress in current species
    - Reduced access to water
    - Fodder availability reduction due to changes in weather patterns
- Population growth
- Shrinking of available grazing areas
- Market demands.

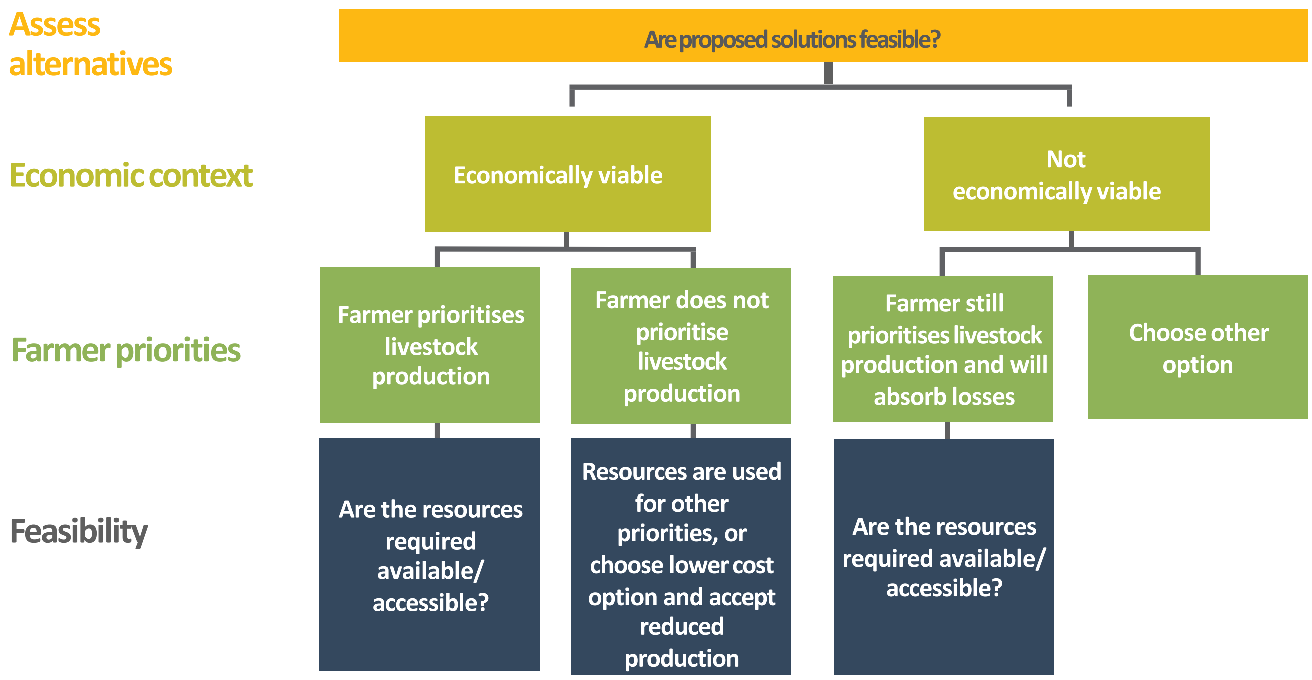
In some regions, pastoralists have slowly replaced their indigenous cattle herds with camels – with their ability to survive on less water and lower feed requirements. Switching from larger to smaller ruminants (cattle to goats) is an option where the quality of fodder available is not good enough to sustain cattle production.

When diversifying the species in the farming system, the risks of climate extremes (e.g., droughts and heat stress) having an impact on all species is reduced.

FEASIBILITY

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

DECISION POINT



Economic viability

Are the investments in climate smart genetic improvement options economically sustainable? In some cases, farmers may lose out in the short-term (high initial) costs, but benefit in the longer term.

Labour is a key factor that must be assessed in terms of economic viability. Farmers rarely account for the cost of their own and family labour, but will consider wage labour costs. Understanding who is responsible for key livestock management tasks is critical in assessing if there are opportunity costs associated with the proposed option. Extra labour may be required to milk cows, build livestock pens, keep priority breeding animals separate from other animals, or to cut and carry fodder crops.

- Who will do the work?
  - Men, women, children, youths?
- 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 market to sell milk?
  - These are known as opportunity costs, and must be factored in.

Where livestock are being managed in intensive systems, such as dairy cows with cut and carry fodder and/or silage, it may be possible to forecast the potential costs associated with improving genetics. This should be done through the following steps:

- Developing a cashflow forecast for the year
- Identify labour requirements in the forecast
- 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 factors:

- Inputs
- Heat
- Rainfall – duration and intensity
- Extremes (e.g., droughts and floods) – duration, frequency and intensity
- Costs
- Labour (who and how much?)
- Management practices (e.g., worm dose, communal grazing, repairs to sheds) and timing
- Productivity (milk per day, live weight gain, etc.)
  - This is especially important in genetic improvements, as the positive changes can be small and incremental
  - The information can be used when selecting which animals to breed for the next generation
- Revenue generated.

This will enable you to develop accurate **gross margins** at the end of the lifecycle. The farmers can use gross margins to make decisions on how to improve their farming practices to make them even smarter, so they **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. This is especially the case in more complicated farming systems where livestock are part of agropastoral systems and there are more external factors to consider. 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 and/or pest and disease outbreaks throughout the year and reflecting on these will help you and your farmers make much more informed decisions in the following season. Remember that for breeding programmes the results can take many years.

Farmer Priorities

If meat, dairy and egg production is a primary source of income on the farm, or livestock are a key source of draught power, genetic improvement is likely to be a higher priority as it directly affects household economic status. Livestock are often kept in mixed systems as a coping strategy, to be sold if cash is needed or as a status symbol. In these systems, simply keeping the livestock alive may be more important to the farmer than ensuring optimum weight gain and productivity, and genetic improvements may be less of a priority.

Different livestock are used for different purposes, and may be prioritised accordingly:

- Cattle may be more important as a status symbol, while goats may be more important for milk for home consumption and/or sale
- Farmers may decide to prioritise improvements in the genetics of one species over another.

Feasibility

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

- Are the required inputs (including labour) available?
  - Where can they be sourced?
  - Will they need to be sourced regularly or once off?
  - Is credit available and affordable?
- If available, are the required inputs accessible?
  - Are they close by?
  - Will she or he be able to transport, e.g., their nanny goats to the billy goat or vice versa?
    - »Is this affordable?
  - Do men and women have equal access to inputs (including credit)?
  - Are there any regulations governing the movement of livestock from one area to another?

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TO SUMMARISE

STEP 1: Analyse the context

- What is the farming system?
- How are livestock currently managed?
- What breeding strategies are currently used?

STEP 2: Select 'Best Fit' options

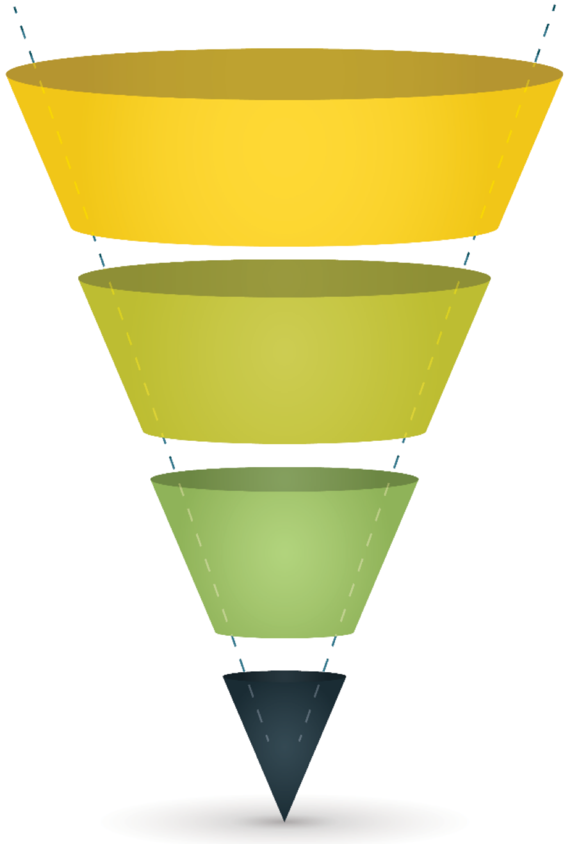
- What problems are identified by farmers?
- What local solutions are proposed?
- Are there other alternatives?

STEP 3: Assess feasibility

- Assess economic viability
- Cross-check with farmer priorities
- Are other options available?

STEP 4: Test and improve

- Try different options
- Collect data and reflect on possible improvements.



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** **www.ccardesa.org**
- **Food and Agriculture Organisation of the United Nations (FAO) –** Climate Smart Agriculture: Building Resilience to Climate Change – Section IV; A Qualitative Evaluation of CSA Options in Mixed Crop- Livestock Systems in Developing Countries
- **International Livestock Research Institute (ILRI)** – FEAST: https://www.ilri.org/feast
  - A useful tool to help make decisions on livestock interventions
- **ILRI** – The feasibility of low emissions development interventions for the East African livestock sector: Lessons from Kenya and Ethiopia
- **ILRI/United Nations Environment Programme (UNEP)/Global Environment Fund (GEF) – Farm Animal Genetic Resources** – Asia; Development and Application of Decision Support Tools to Conserve and Sustainably use Genetic Diversity in Indigenous Livestock and Wild Relatives
  - Gives guidance on what PRA tools to use for gathering information, but is less helpful in terms of explaining how to interpret/analyse information to make decisions
- **ILRI –** Smallholder dairy farmer training manual. ILRI Manual 24, 2016 – a useful resource for assessing body condition, heat detection, key performance indicators (traits), etc.
- **ILRI –** African Indigenous Cattle: Unique Genetic Resources in a Rapidly Changing World, 2015
  - Details the origins, distribution, and key characteristics of the main African cattle breeds.

Citation: CCARDESA and GIZ 2019. Knowledge Product 17 Climate Smart Genetic Improvement Options for Livestock CCARDESA Secretariat, Gaborone, Botswana.