2019

Feasibility Study: Sustainable Sorghum production in Botswana and Lesotho

Report presented under the project: Climate Resilient Agriculture Production, funded by GIZ and implemented by the Rural Self-help Development Association (RSDA). With support from the Departments of Agricultural Research of Botswana and Lesotho

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

Rural Self-Help Development Association

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Acknowledgements:

GIZ

Nathaniel Mtunji

RSDA

RSDA Managing Director:	Mampho Thulo
Project Team Leader and report author:	Liesl Keam
Economic Assessment:	Kim Adonis
Communications support:	Christopher Muller

Technical Experts

Lesotho Ministry of Agriculture and Food Security, Department of Agricultural Research, particularly, Director Dr Lefulesele Lebesa, Rethabile Nchee and the DAR Lesotho working group.

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Disclaimer:

Our work is complemented by a synthesis of background documents that are already available in the public domain.

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Acronyms and Abbreviations

AF	Adaptation Fund
AGOA	African Growth and Opportunity Act
BUR1	First Biennial Updated Report
CA	Conservation Agriculture
CAADP	Comprehensive Africa Agriculture Development Plan
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CCARDESA	Centre for Coordination of Agricultural Research and Development for Southern Africa
CIAT	International Centre for Tropical Agriculture
CMA	Common Monetary Area
CRA	Climate Risk Assessment
CSA	Climate-smart agriculture
DAR	Department of Agricultural Research
EAC	East African Community
EFTA	European Free Trade Agreement
EIA	Environmental Impact Assessment
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	German Corporation for International Cooperation
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Country
NAIP	National Agriculture Investment Plan
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NCCP	National Climate Change Policy
NDC	Nationally Determined Contribution
NEPAD	New Partnership for Africa's Development
NSDP	National Strategic Development Plan
NSFP	National School Feeding Policy
RSDA	Rural Self-help Development Association
RSA	Republic of South Africa
SACU	Southern African Customs Union
SADC	Southern African Development Community
SDG	Sustainable Development Goal
SSA	Sub-Saharan Africa
TNC	Third National Communication
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
WFP	World Food Programme

Executive Summary

1 Introduction

1.1 Climate Resilient Agriculture Production Programme Context

The Climate Resilient Agriculture Production Programme is a collaboration between the Departments of Agricultural Research in Lesotho and Botswana to undertake a climate risk assessment (previously vulnerability assessment) of sustainable agriculture and climate-smart agriculture (CSA) best practice production in the countries, using the Sorghum value chain as a reference case where necessary. The Programme is funded by GIZ and its implementation led by the Rural Self-help Development Association (RSDA) in Lesotho. Based on available desktop information, a study of the feasibility of scaling up CSA production in Lesotho and Botswana will be undertaken to inform the development of a scaled investment proposal.

In rural Lesotho, agriculture is either the primary source of income or contributes supplementary income for more than 50% of the population (Agricultural Sector Strategy, 2003; Lesotho Bureau of Statistics, 2014). While the agricultural sector accounts for 41 percent of employment, it is estimated that about 80 percent of the country is reliant on agriculture either directly or indirectly for a livelihood, particularly in the rural areas (World Bank & CIAT 2018). Climate change impacts are already being experienced and climate change models indicate that Lesotho will experience higher temperatures and more erratic rainfall patterns in future. Current dependence on rain-fed agriculture makes the country highly vulnerable to such changes, which will exacerbate existing issues of environmental degradation, increase the risk of vector and water-borne diseases and have the potential to slow economic performance and threaten achievements in social development (National Strategic Development Plan - NSDPI). Climate change impacts compound existing economic, social and health challenges faced particularly by the rural population and limit the country's ability to establish and maintain sustainable livelihoods for vulnerable populations.

In Botswana, agriculture is an important sector in the economy because it provides food, income and employment for the majority of the rural populace (Statistics Botswana, 2013). The sector has a potential for growth and to alleviate poverty and hunger and develop a food secure Botswana. Although the agriculture sector accounts for only 1.9% of the national income, over 70% of Botswana's population resides in the rural areas, and the majority (70%) relies on traditional/subsistence agriculture for their livelihoods (UNDP, 2012). However, the performance of the sector has been unsatisfactory due to recurring droughts, pests, diseases and land degradation.

To achieve food security and agricultural development goals, CSA is necessary to support farmers to operate in the face of climate change impacts. Currently, Lesotho and Botswana are net importers of food and climate change is likely to exacerbate this. Agricultural production in Botswana is on a downward trend in terms of cereal production; maize and Sorghum are estimated to have declined on a yearly basis to 64 000 tonnes, down 32% from the high output of 2017 (FAO, 2018). Rainfall variability is one important factor that limits production and in many African countries, farmers may seek to replace maize with a drought-resistant crop in areas where rainfall declines due to climate change. As in many African countries, Lesotho is reliant on maize production which, though highly productive when rainfall is abundant, is very sensitive to drought. It is anticipated that the landrace varieties and more nutritious Sorghum may do better under erratic rainfall regimes. The work undertaken in this project will assist each country to quantify the climate risks and the components which, currently and under future projections, will have the most impact on sustainable production. Working with technical experts, best practice adaptation measures will be selected and documented to form a model of climate resilient production which can be scaled up.

1.2 Programme Description and Methodology

The scope of this work complements Sorghum pilot activities undertaken by DAR Lesotho and DAR Botswana. This project aims to better understand climate resilience agriculture (using Sorghum as a reference where necessary) and the risk climate change poses. The project also aims to specify the feasibility and scope of scaling up climate resilient production in Lesotho and Botswana for the objective of improving the climate resilience of smallholder farmers.

The four core components of this project feed into each other as per the representation below. This project is implemented in a collaborative manner working closely with key government counterparts. In addition, through the implementation there are key points of stakeholder engagement which feed into the outcomes. At these points broader groups of key stakeholders are convened to provide technical input into or validate the outcomes of each step.

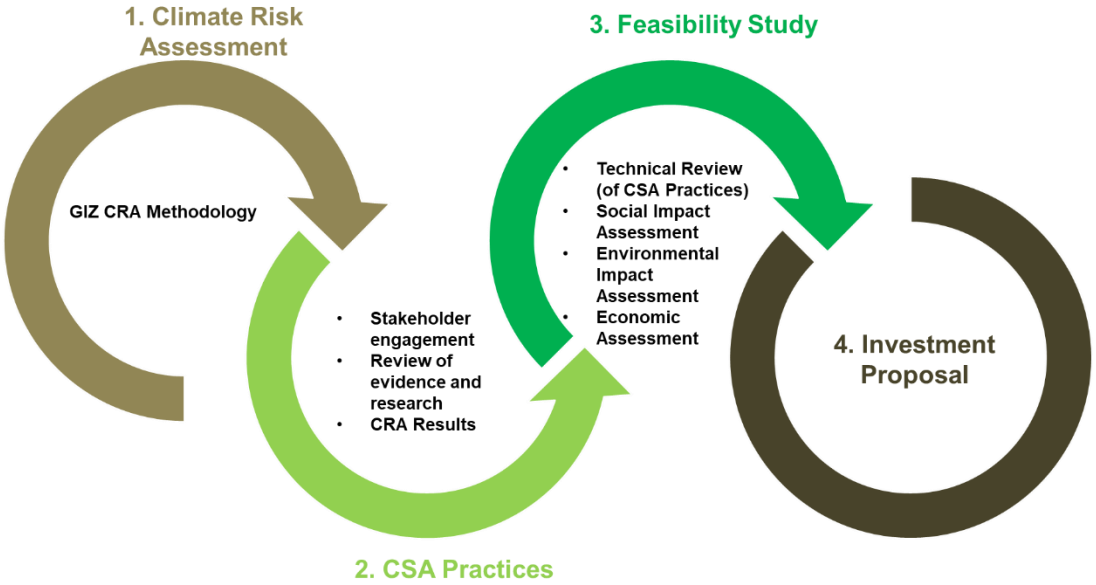
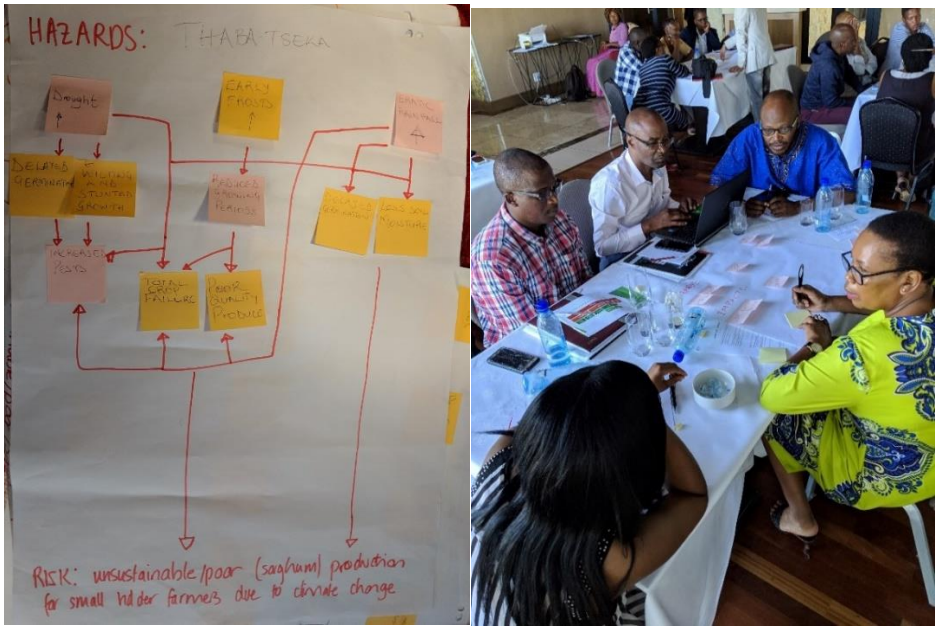


Figure 1 Climate Resilient Agriculture Programme Components

The CRA and CSA Practices phases are complete and outputs from that work are provided separate to this report. This report covers the outcomes of the Feasibility Study and is intended to provide information as to the technical, environmental, social and economic feasibility of scaling up Sorghum production.



Photos 1 Climate Risk Mapping Exercise in Phase 1 and 2

2 Technical Assessment

2.1 Climate Risk Assessment

The CRA undertaken in the first phase of this programme, analysed the context of the agriculture sector in each country, outlined the climate risks for current and future climate projections, mapped the hazards, risks and impacts of the risks and identified climate smart practices that farmers can utilise to reduce risk. The CRA report is a separate report but its key findings relevant to the feasibility of driving and scaling up the Sorghum value chain are summarised below.

The work undertaken in this analysis is consistent with the assessment frameworks outlined in the GIZ Vulnerability Sourcebook (2014) and the Risk Supplement to the Vulnerability Sourcebook (2017). These are aligned with the IPCC methodologies for conceptualising and analysing the impacts of climate change and aligned to the conceptual model specified in the Fifth Assessment Report of the IPPC (AR5). These materials were developed to provide a standardised approach to climate change assessments. These assessments were initially called Vulnerability Assessments; however, the terminology has now changed to Climate Risk Assessment to reflect the conceptual advancements in AR5.

2.1.1 Climate Threat: Lesotho

Global Circulation Models (GCMs) used by CCAFS and CIAT show climate projections for the country which suggest that temperatures are likely to increase by an average of 2°C by 2050 and up to 2.4°C by 2070 (World Bank & CIAT, 2018). Overall, Lesotho is likely to experience higher temperatures, increased climate variability, and an increased frequency and intensity of extreme weather events all with impacts on crop and livestock production, water security, and rural infrastructure. Changes in rainfall are expected to pose challenge to the country's food security and production since agriculture is largely rain-fed, and irrigation systems are not used at a large scale. Flooding may become more frequent and severe, which will challenge agricultural production, marketing infrastructure and rural livelihoods. Increased rainfall variability across the country can be expected to have impacts on water availability for crop and livestock production.

2.1.2 Climate Threat: Botswana

The World Bank Climate Knowledge Portal indicates that, compared to a 20-year interval (1986-2005), Botswana is expected to average temperature increases of between 2-3°C by 2059 and a decrease in monthly precipitation by 2059 in both median and extremes of range. Temperatures in this region are already close to or beyond thresholds at which already low yields and low farming productivity are encountered (FANRPAN, 2017).

2.1.3 Defining and Assessing Climate Risk

In a series of working sessions with stakeholders from Lesotho and Botswana, a Climate Risk Assessment Conceptual Framework was applied and each component mapped in order to identify linkages and define adaptation measures.

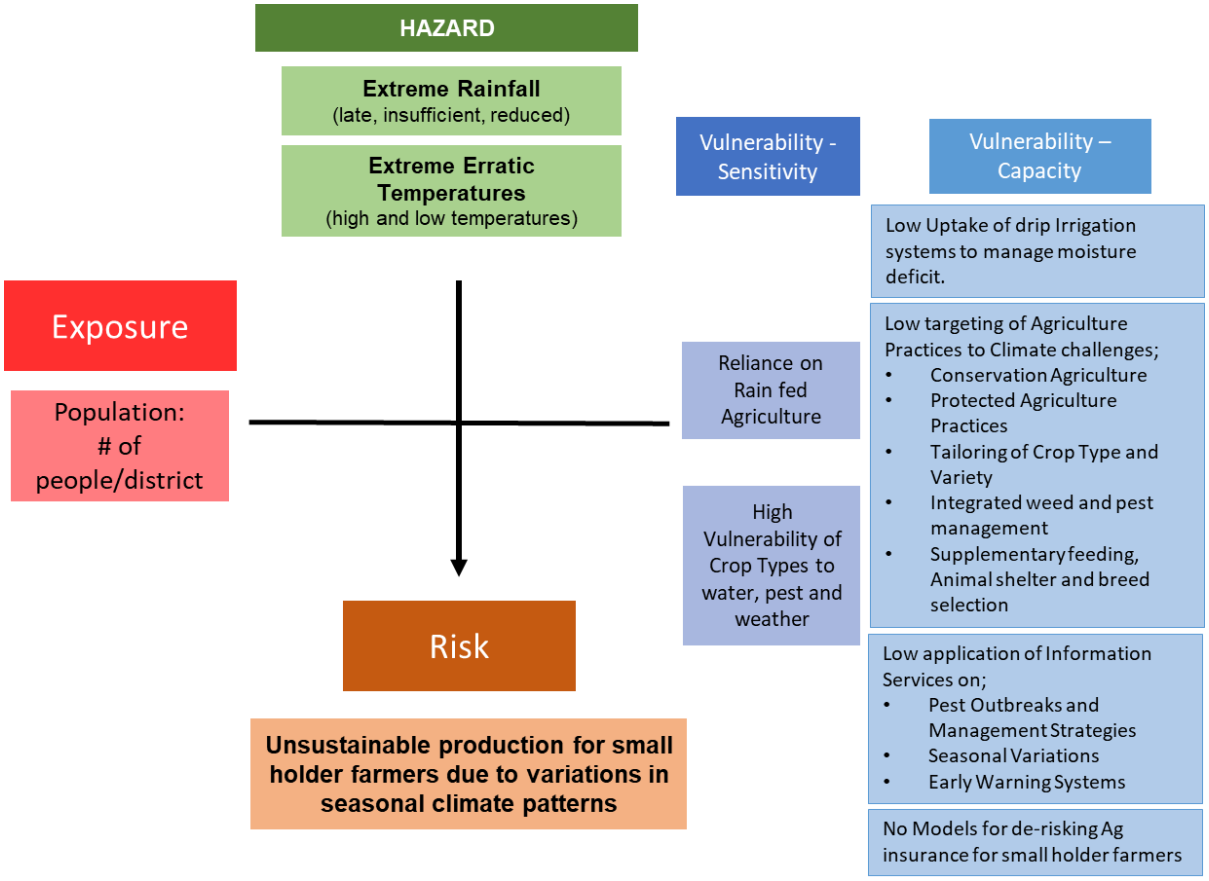


Figure 2 Final Climate Risk Analysis Framework

Changing extremities in weather patterns were the primary climate hazards identified for smallholder farming systems; particularly late onset and/or reduced rainfall and extreme lows and highs in temperature. These hazards led to a number of core critical impacts which significantly threaten the success of smallholder farmers;

- Poor germination
- Increase in pests and diseases
- Less maturation time
- Poor quality and quantity of output (failure, decreased yield)
- Poor soil quality
- Poor livestock health and productivity

According to the SADC Climate Proofing Tool (CCARDES/GIZ 2016) methodology, by mapping this system within a traditional risk framework, we can broadly classify risks and identify the associated adaptation measures which can target reducing the risk from these specific climate hazards., The following table represents the climate proofing analysis and risk classification.

The risk categorisation for all of these biophysical elements under the projected climate change will be high. These risks are exacerbated by the sensitivities of the farming systems, namely the high reliance on rain-fed agriculture and the use of crop types which are highly vulnerable to changes in water, pest occurrence and weather. The characteristics of the farming system limit the capacity of farmers to cope with the hazard impacts when they do occur. There is low uptake of irrigation systems that manage moisture deficit, limited targeting of agriculture practices to seasonal climate challenges, low utilisation of information services and lack of models to de-risk agriculture for smallholder farmers. Adaptation measures that target these gaps and build these capacities will be those that best mitigate the risk from the climate hazards.

Table 1 Climate Proofing Analysis: System Elements, Risk Classification & Adaptations

A* System of interest and development goal	D Climate hazard the system might be exposed to	E Sensitivity	F adaptive Capacity	G Bio-physical	H Socio-economic	Lesotho Current Risk	Lesotho Projected Future Risk	Botswana Current Risk	Botswana Projected Future Risk	L Adaptation options
Sustainable (Sorghum) production for small holder farmers in the face of climate change (in particular variations in seasonal climate patterns)	- Extreme Rainfall - Extreme Erratic Temperatures (including Drought and Frost)	- Reliance on Rain fed Agriculture - High Vulnerability of Crop Types to water, pest and weather	- Low Uptake of drip Irrigation systems to manage moisture deficit. - Low targeting of Agriculture Practices to Climate challenges; - Conservation Agriculture - Protected Agriculture Practices - Tailoring of Crop Type and Variety - Integrated weed and pest management - Supplementary feeding, Animal shelter and breed selection - Low application of Information Services on; - Pest Outbreaks - Seasonal Variations - Early Warning Systems - No Models for de-risking Ag insurance for small holder farmers	Poor germination	*Increased Production Costs* *Increased Labour Requirements* *Low Farm Outputs* *Low market price* *Reduced Household Savings*	Medium	High	Medium	High	Small scale, on farm, irrigation systems Climate Responsive Agriculture (Crop rotation, minimum tillage, protected agriculture, highly tailored crop types, targeted animal health and feeding) Better systems for accessing information services on (Pest, Seasonality, Early Warning) Identification of models to de-risk Ag insurance for small holder farmers
				Increase in pests and diseases		Medium	High	Medium	Medium	
				Less maturation time		High	High	Medium	High	
				Poor quality and quantity (crop failure, decreased yields)		Medium High	High	Medium	High	
				Poor Soil Quality		Medium	Medium	High	High	

*column lettering aligns to CCARDESA Climate Proofing Tool categories

2.1.4 Responding to Climate Risk

Working with DAR from Lesotho and Botswana, the climate risk was analysed and from a list of 25 relevant climate smart practices, eight highest priority practices for adaptation were identified for each country. These practices scored highest when assessed for effectiveness, cost, feasibility and speed of result.

Table 2 Climate smart practice priorities (in order of score, common practices bold)

Lesotho	Botswana
Sustainable Fodder Production	Use of local adaptive livestock breeds
Mixed farming (Crops and Livestock)	**Sustainable Fodder Production**
Provision and utilisation of climate Information services (weather, crop information etc)	**Mixed farming (Crops and Livestock)**
Implementation of Rainwater Harvesting	Supply (quantity and location) of improved seeds and breeds available.
Improvements in post-harvest storage and management	**Implementation of Rainwater Harvesting**
Systems which make access to inputs easy (seeds, fertiliser)	**Improvements in post-harvest storage and management**
Systems which link farmers to higher value crops	National Policy and Strategy providing guidance for sector
Phytosanitary legal framework	**Legal and phytosanitary frameworks**

These practices were selected by the representatives of Lesotho and Botswana as being highest priority for implementation. They are not meant to serve as a definitive list of practices (the CSA prioritisation work in the CRA report should be consulted for that purpose) but rather to assist to frame priorities for approaches to scaling up climate smart agricultural production in Lesotho and Botswana.

2.2 Sorghum Production Assessment

2.2.1 Sorghum

Sorghum is an annual grass similar in appearance to maize in its vegetative stage, although it has more stems (tillers) and more finely branched roots. *Sorghum bicolor* tends to be a tall plant (1.5-2.1 meters), though newer varieties now contain 2-3 dwarfing genes, resulting in plants that are easier to harvest because they stand from 0.6 to 1.2 meters tall. The waxy leaves that roll when moisture stressed, help the plant to be more tolerant to drought than other cereals, such as maize. (ICRISAT iexplore, accessed 2019)

It is considered a robust crop due to the fact that it:

- will grow over a wide range of temperatures and elevations;
- performs well in different soil types – from very porous, sandy soils that don't retain water to heavy clay-types that are prone to water logging;
- has tremendous resilience in the face of drought, and not only survives but still produces grain using only residual moisture;
- can be grown under a wider range of soil acidity than many other crops; and
- is resistant to grain mold, giving people and animals protection against the health dangers of contamination by mycotoxins.

The crop is also genetically diverse which a variety of panicle shapes, sizes, colours as well as purposes for human food as well as feed and forage for livestock.

Figure 3 Sorghum crop Mokhotlog district, Lesotho April 2019

Sorghum Facts and Figures

Sorghum is produced on about 42 million hectares worldwide; the area of production has decreased overall from a high of about 51 million hectares but has remained essentially constant since 2008.

Total Sorghum production has remained more or less stable over the past 30 years, although there are notable regional differences.

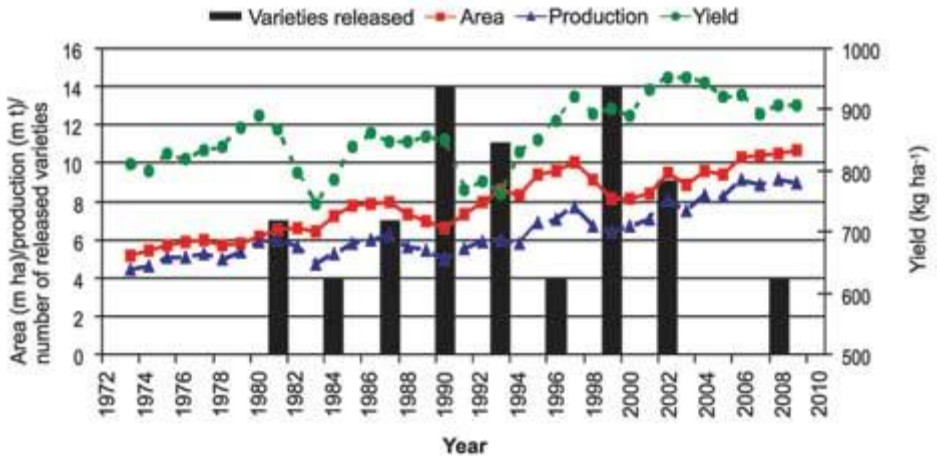
More recent global trends also show increases in both grain yield and production, gains that reflect an increased use of improved varieties and better crop management practices (such as fertilizer micro-dosing).

The cultivated species of Sorghum is diverse, with five major races identified, many of them with several subgroups – this reflects farmer selection pressure applied over millennia for adaptation to diverse production conditions;

Sorghum grain has moderately high levels of iron (> 40 ppm) and zinc (> 30 ppm) with considerable variability in landraces (iron > 70 ppm and zinc >50 ppm) and can complement on-going efforts on food fortification to reduce micronutrient malnutrition globally.

Sorghum is grown on 40 million hectares in 105 countries of Africa, Asia, Oceania and the Americas. Sorghum grain is used mostly as food (55%), in the form of flat breads and porridges (thick or thin) in Asia and Africa, and as feed (33%) in the Americas. Its stover is an increasingly important source of dry season fodder for livestock.

Area and production in Eastern and Southern Africa have increased significantly from the early 1970s to 2009, while there has been a marginal (18%) increase in productivity from 800 kg/ha to over 940 kg/ha during the same period.



Three-year moving average for Sorghum area, production, yield; and number of released varieties (3-year total) based on ICRISAT-bred material in ESA.

Source: http://exploreit.icrisat.org/profile/Sorghum/193

2.2.2 Sorghum and Climate Resilience

A number of characteristics make Sorghum a resilient crop. From their recent research Clara et al (2019) summarise that;

- Sorghum is able to withstand higher-than-average temperatures than most other cereal crops, after germination; average temperatures between 24 degrees C to 27 degrees C are ideal for best yields.
- Low temperatures can be limiting to Sorghum growth and most plants will die when exposed to below freezing temperatures.
- Sorghum is often grown in regions that receive between 350–700 mm of precipitation annually
- As a predominantly rain-fed crop, its yield depends largely on its drought resistance.
- The ideal soil moisture during germination ranges between 25% and 50% of field capacity and the Sorghum plant can survive flooding events as it is more tolerant of wet soils.
- Sorghum is often grown in shallow to medium deep or light to medium-textured soils and/or medium to deep soils of high-water capacity after the rainy reason.
- Sorghum has a short maturity period and the highest food production per unit of energy spent.
- Post-harvest: its versatility allows the whole plant to be consumed/utilised for a variety of uses (broom-making, firewood, animal feed, fuel, food) and prepared in a number of ways (boiled, cracked, malted, baked and popped)

Research in East Africa has found that there is an increase in Sorghum yields shown by almost all General Circulation Models (climate projections) studied, which may be attributed to [predicted] increase in temperatures and the slight changes in projected rainfall which appear to create conducive conditions for Sorghum growth, being more tolerant to heat and water stress (Canadian Center of Science and Education, 2015). The results are in agreement with the observations by Turner and Rao (2013) and Gwimbi, Thomas and Hachigonta (2013), which show Sorghum gaining in terms of grain yields from higher temperatures in specific regions with lower baseline temperatures (below 20ºC).

In modelling climate change impacts on Sorghum (and millet) in West Africa, Sultan et al (2013) concluded that simulations show that the photoperiod-sensitive traditional cultivars of millet and Sorghum used by local farmers for centuries seem more resilient to future climate conditions than modern cultivars bred for their high yield potential. However, given the large difference in mean yields of the modern versus traditional varieties, the modern varieties would yield more under optimal fertility conditions in a warmer world, even if they are more affected by climate change.

Whilst Sorghum appears to have significant potential as an adaptation response to predicted climate changes, there is insufficient data specific to Lesotho and Botswana. A limited number of regional research results (Sultan et al 2013, Rurinda et al., 2014) indicate that whilst there are potential benefits of Sorghum farming methodologies over other crops, variety choice and crop mix can influence production. Additionally, combining Sorghum/or millet with maize is more realistic than a total replacement of maize (primary) crop. Interventions promoting Sorghum production should incorporate research and in particular action learning research approaches to ensure that resilience assumptions are upheld by production and livelihood outcomes.

2.2.3 Challenges to sustainable Sorghum production

Despite the potential yield, production and livelihood benefits of Sorghum production as a response to climate variability, a number of challenges need to be addressed. Whilst these challenges are common across many crop types for smallholder farmers, interventions targeting Sorghum production need consideration.

A study in Kenya (Omoro, 2013) identified that traditional production methods, low technological adoption, environmental constraints and policy impediments are major reasons for low Sorghum production among small-scale famers, whilst Venya (2012) identified that for countries like Malawi, agricultural inputs such as fertilizer and post-harvest (residual) management can generate economic benefits even with increases in future climate variability. From a global review, Clara et al (2019) conclude that traditional inputs will not be a long-term solution for Sorghum food supply in low income countries if populations in those countries continue to grow rapidly, requiring technological advances.

In their background paper for the AfDB High level conference '*Feeding Africa - An Action Plan for African Agricultural Transformation'* ICRISAT (2015) identified that the following pragmatic approaches will have the potential for increasing productivity, creating impact and improving the livelihood of smallholder farmers when taking into account the challenges in the production of Sorghum and the opportunities that exist for its development and expansion.

Table 3 Summary of Conclusions from ICRISAT background paper on cereal crops (Sorghum and millet)

Enabling farmers' access to production inputs and markets:	A valid theory of change is that resource-poor smallholder farmers will adopt improved Sorghum and millet technologies if they are relevant and made available, accessible and can be utilized, and that they have access to reliable markets to dispose of surplus production. Existing use of improved inputs by smallholder farmers is limited both by inconsistent external demand on the output side, and lack of capacity to supply improved seed, fertilizer, finance, and know-how on the supply side. Efforts should be made to enable farmers to access both the inputs needed for production, and the markets for disposing of surplus farm produce.
Strengthen and sustain the technology delivery system:	There is need to formulate strong technology delivery programs and systems that ensure timely, accurate and location-specific information required by smallholder farmers for their decision-making process. Digital tools, such as the use of mobile phones and short text message (SMS) are helping to bridge this gap in some countries. But a great deal of work remains to reach remote farmers.
Mechanization: Adoption and use of small and medium scale mechanization:	High priority should be given to the participatory evaluation and dissemination of machines and tools for mechanization of small and medium scale production and processing to increase productivity and to reduce drudgery among women and youth. These operations should be used to increase job and income generation among youths and women as well as increase quality of postharvest grains and products.
Review of relevant agricultural policies:	In many countries in SSA, the policies governing many aspects that are central to agricultural production require considerable review. These include critical aspects such as seed certification, production and distribution, land ownership or tenure, gender relations and the rights of women to own property. Since some of these aspects have cultural roots, addressing them is a slow, long process which would need to go beyond the mere change of policies. However, it is evident that efforts towards reforming such aspects are necessary and urgent.
Restoring degraded soils and ensuring sustainability:	In millet and Sorghum based farming systems, soils are widely degraded and depleted of organic matter and plant nutrients. There is a need to empower farmers to enable them to manage their natural resource base in a sustainable manner using integrated soil fertility and crop-livestock systems management, crop rotation, minimum or conservation tillage systems. There is need for extension systems that enable farmers to continuously learn new ways of performing old tasks, as well as new tasks, to increase their production while sustaining the environment and their land's productive capacity.
Understanding farm livelihoods and the potential impacts of interventions:	Farm households are highly heterogeneous entities, with multiple constraints of labour, capital and access to resources and operating in environments of high climatic variability. The use of systems analysis – encompassing the biophysical and socio-economic makeup of farm households – can capture some of these complexities. Such methodologies, applied anticipatively with farmers and stakeholders, create robust intervention strategies.

Source: ICRISAT (2015)

2.2.4 Quelea bird and Sorghum in Botswana

Sorghum production in Botswana is subject to a unique constraint which provides a challenge for the sustainable production of Sorghum. The CABI Invasive Species Compendium (2018) summarises that;

> *The red-billed quelea is a small weaver bird native to sub-Saharan Africa and renowned for its attacks on small-grain crops within Africa. It is the most numerous bird species in the world, with peak post-breeding population estimated at 1,500,000,000. The red-billed quelea is mainly granivorous…and it relies on a supply of grass seeds to survive. When unable to find grass seeds or when opportunities arise, quelea will attack crops. It is a major pest throughout much of sub-Saharan Africa and can cause significant economical losses.*

The bird is inherently nomadic, following rain fronts, and this nomadism accounts for its invasions into areas where it was previously absent. The red-billed quelea has a substantial economic impact as a result of crop damage throughout sub-Saharan Africa (CABI, 2018). A single quelea can consume and/or destroy up to about 10g of grain in a day (Elliott, 1989). Thus, a flock of one million birds can ruin up to 10 tonnes of crops daily. When major invasions occur, crop damage can be as high as 50% of potential crop harvests and, locally, entire crops may be wiped out.

Fenthion, an organophosphate, is the main avicide used for controlling the Quelea bird pest but it is highly toxic to non-target organisms (Chekea et al, 2019). Apart from chemical avicides, the only rapid technique to reduce the numbers of quelea substantially is the use of explosives combined with fuel to create fire-bombs, but these also have negative effects on the environment, can be dangerous and have associated security issues. The technique is labour-intensive and in practice can only be deployed against small (< 5 ha) colonies and roosts (ibid). Chekea (et al 2019) identifies from research that an integrated pest management (IPM) approach is the most environmentally benign strategy but that most IPM activities only have realistic chances of succeeding in controlling quelea in small (< 10 ha) areas. The research recommends training of farmers on IPM principles and quelea biology through farmer field schools.

In Botswana, experiments have been conducted using lanner falcons (*Falco biarmicus*) to scare quelea away from Sorghum crops in the Pandamatenga area (Gaemengwe, 2014). The farmers reported that the method gave good results and they supported use of the method as it had led to good and high tonnages due to reduced bird damage (H.Modiakgotla, pers. comm., Oct 2016 reported in Chekea (et al, 2019)). The latter was estimated as 12.1% of Sorghum heads damaged on average in 13 fields where falcons were not deployed, but was about half this figure at 6.3% in 6 fields where the falcons were flown. However, use of falcons has only been tested in the commercial farms in the Pandamatenga area and has not been applied to protect crops grown by subsistence farmers. In Europe and elsewhere, machines that produce loud bangs at set intervals are available commercially for farmers, and it is also possible to purchase varieties that produce species-specific alarm calls or predator calls to scare bird pests. However, Chekea (ibid) reports that such devices are expensive, and the birds are likely to become habituated to them, as they will to other noises used for scaring such as drumbeats and tractor horns.

Trials of varieties of Sorghum developed to be resistant to the Quelea bird have been implemented in Botswana and supported by DAR. Anecdotal information suggests that they have had some challenges and although they have been somewhat successful, they have not been implemented beyond pilot studies. Staff in the Crop Department believe that there are substantial opportunities to develop approaches to managing the quelea bird risk and that further pilot studies and action research projects can continue to address the challenge.

Complementary CSA practices

Phase 1 of the Climate Resilient Agriculture Production programme identified a series of CSA practices which were determined by the stakeholders from Lesotho and Botswana to be the highest priority to support smallholder farmers. A series of visual information products were created for each of the highest priority practices for use by partners and stakeholders (refer to Annex 1). The purpose of the visual tools is to give farmers a high-level understanding of the practice and how it can relate to their farming operations thereby making them more resilient to climate variability.

These practices form a set of complementary practices which can be implemented as part of or alongside an intervention to promote sustainable Sorghum production. By combining and tailoring a set of these practices, with the value chain approach to Sorghum production (discussed in Section 6) outcomes for farmers are likely to be greatly improved.

Mixed farming (Crops and Livestock):

By combining crops and livestock, farmers diversify household diets, improve nutrition and mitigate risk of loss.

Mixed farming combines crop production with livestock rearing (FAO 2017). It presents not only a means to diversify food production and improve nutrition at household level, but also a way for farmers to fortify their income and to mitigate risk of loss of either crops or livestock if the farmer is entirely dependent on one or the other. It might include Integrating cattle farming or small ruminant farming with crop production.

Sanitary and Phytosanitary frameworks:

Protect local consumers by ensuring food is safe for consumption and protect local farmers by regulating trade and strengthening local production.

Effective phytosanitary frameworks can strengthen the trade and market opportunities for farmers by ensuring that produce is certified as necessary to meet both national use and export quality requirements. For the successful implementation of phytosanitary frameworks certification processes from the farm gate to off takers need to be efficiently and effectively operated. Systems need to be responsive to changing regional trade environments to respond quickly to risks and opportunities that could influence the agriculture sector and the value chain.

Sustainable Fodder Production:

Allows farmers to meet the demand of forage for their livestock.

Climate change threatens food and water supply globally, due to increase in temperatures, prolonged dry spells and changes in rainfall patterns. This, coupled with rangeland degradation and soil erosion compromise quality of pastures, making grazing for livestock increasingly difficult. Key Solutions include; Cereal grain sprouts in a controlled environment, Planting cover crops for forage, Intercropping crops for consumption with crops for livestock forage and fodder crop production on land suitable for crop production.

Implementation of Rainwater Harvesting:

Enables farmers to collect and use rainwater in times of drought, or as an irrigation mechanism.

One of the biggest challenges which climate change poses, is the predicted decrease in rainfall. Coupled with predicted higher temperatures and potential prolonged droughts, relying on rainwater for farming will be impractical and a high risk for farmers. It poses a risk to farmers when the onset of rains is later in the season, or when the rains are inconsistent. Key Solutions include: Rooftop rainwater harvesting and storage in tanks, runoff harvesting from open surfaces and paths and storage in pans and ponds, earth dams and conservation agriculture as a mechanism for minimum water usage and moisture retention

Improvements in post-harvest storage and management:

Helps farmers to reduce losses after harvesting, increasing their food supply and income.

In sub-Saharan Africa, 30-50% of food produced for human consumption is lost or wasted along the value chain every year. These losses equally affect nutrition, food security and income. Post-harvest losses exacerbate food insecurity and threats to livelihoods globally when combined with the pressures on future food systems which climate change is expected to bring. Key Solutions include**;** good agricultural practices and good veterinary practices can protect food, at the primary stages of production and improving storage conditions for preservation of quality.

3 Economic Assessment of Sorghum scale up & production

The purpose of the Economic Assessment is to **assess the economic viability** of increasing Sorghum production in Lesotho and Botswana as a means to reduce the vulnerability of small-scale farmers.

3.1 Status Quo for the Global Market

Sorghum is a major international crop that is grown all over the world. In 2015, global Sorghum production amounted to 63.5 million tons and was produced in over 60 countries (Mundia et al., 2019). The top ten Sorghum producers span across various continents including the North and South America, Africa and Asia.

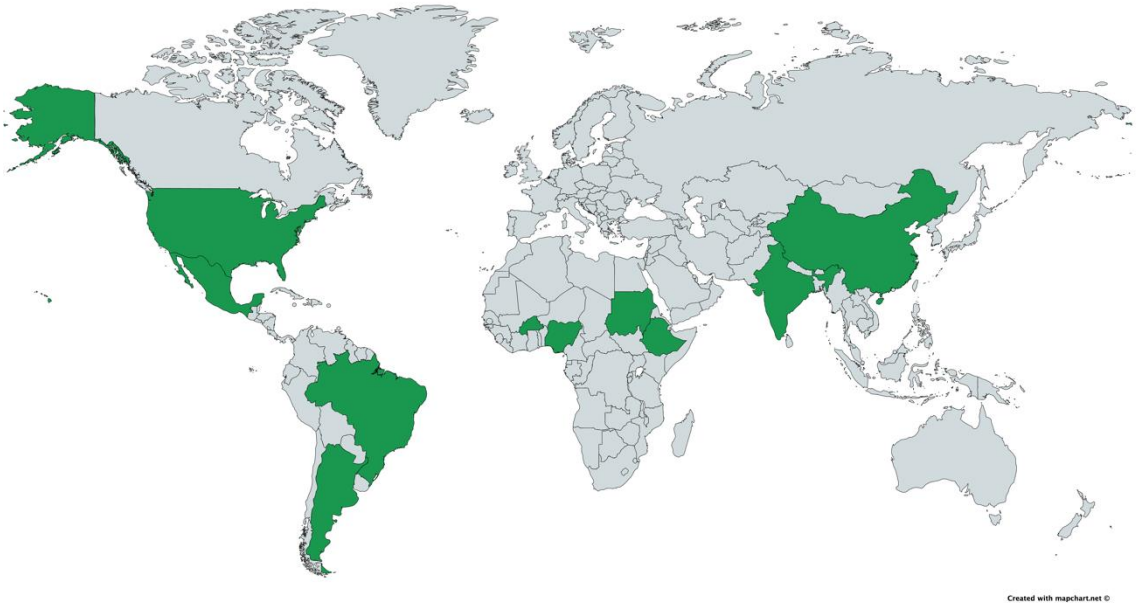


*Figure 4 Top 10 Sorghum Producing Countries, 2019**

Source: https://www.indexmundi.com/agriculture/?commodity=Sorghum&graph=production

The top 5 Sorghum producing countries include the United States, Nigeria, Ethiopia, Mexico and India. South Africa ranks as the 33rd largest producer in the world and Lesotho and Botswana ranked as 55th and 56th respectively, in terms of estimated production volumes for 2019, each producing 10,000 MT.

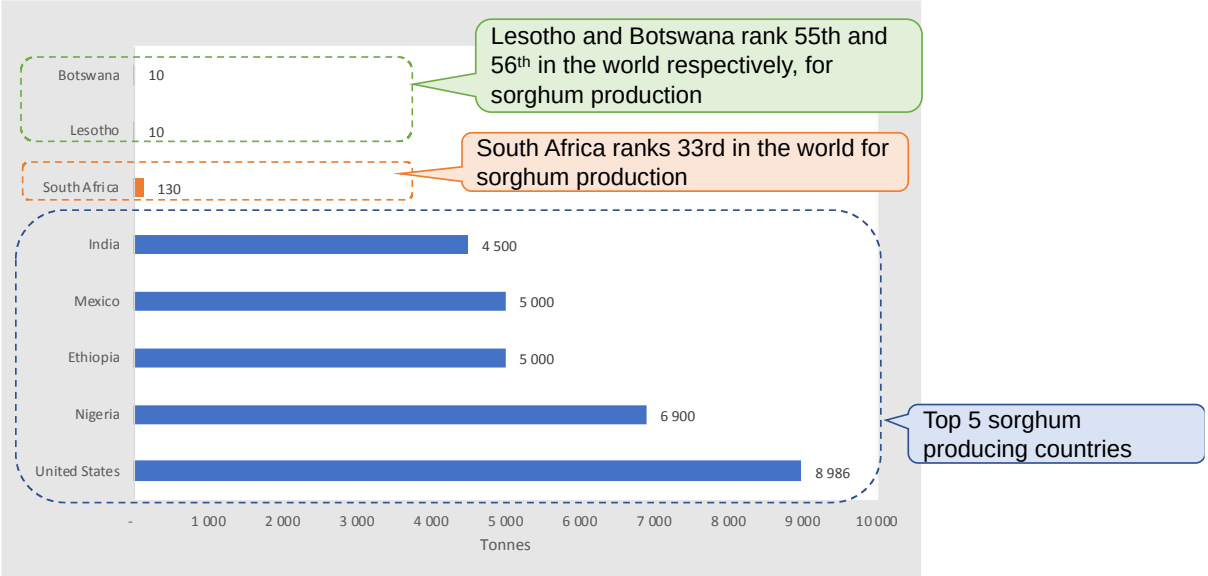


*Figure 5 Global production volumes for the top 5 Sorghum producing countries relative to production in Botswana and Lesotho, thousand Metric Tonnes (MT), 2019**

Source: *https://www.indexmundi.com/agriculture/?commodity=Sorghum&graph=production*

**Figures for 2019 are estimates*

A generic structure of the Sorghum market value chain is provided below. It outlines the various stages of production, beginning with sources of supply i.e. smallholder and commercial farmers and imports that supply traders and off-takers. Some of this supply is channelled towards the wholesale and retail market as well as for direct consumption by households. It is important to note that a large share of Sorghum in Botswana and Lesotho is produced for subsistence which contributes to food security.

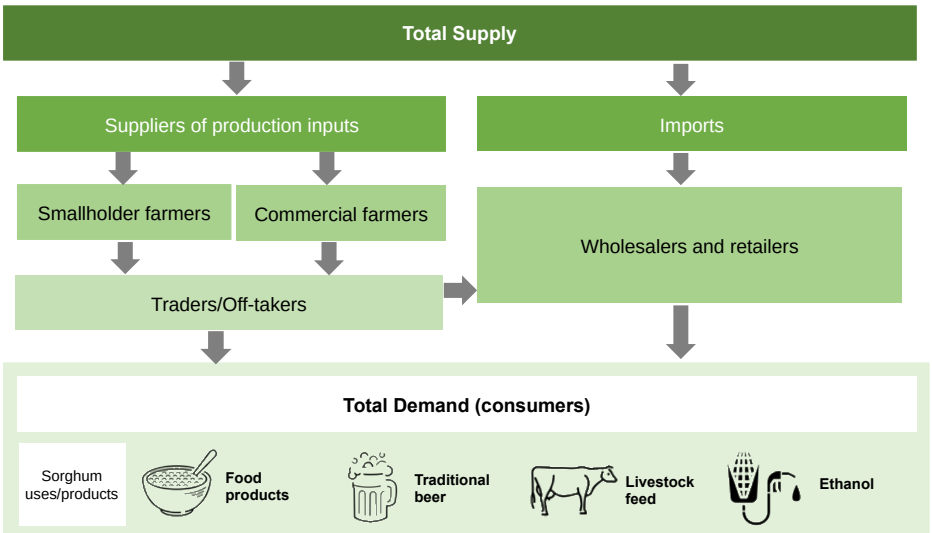


Figure 6 Generic structure of market value chain for Sorghum

Source: Mokitimi, N. 1990. Analysis of the Performance of the Lesotho Grain Marketing System. Research Report No. 27. Institute of Southern African Studies, National University of Lesotho

3.2 Status Quo for Botswana

Production volumes in Botswana have displayed considerable volatility over the last five decades, ranging between 74,000 MT in 1972 and 4,000 MT in 1979. Volatility in production volumes has reduced significantly since the early 2000s indicating more stability in production.

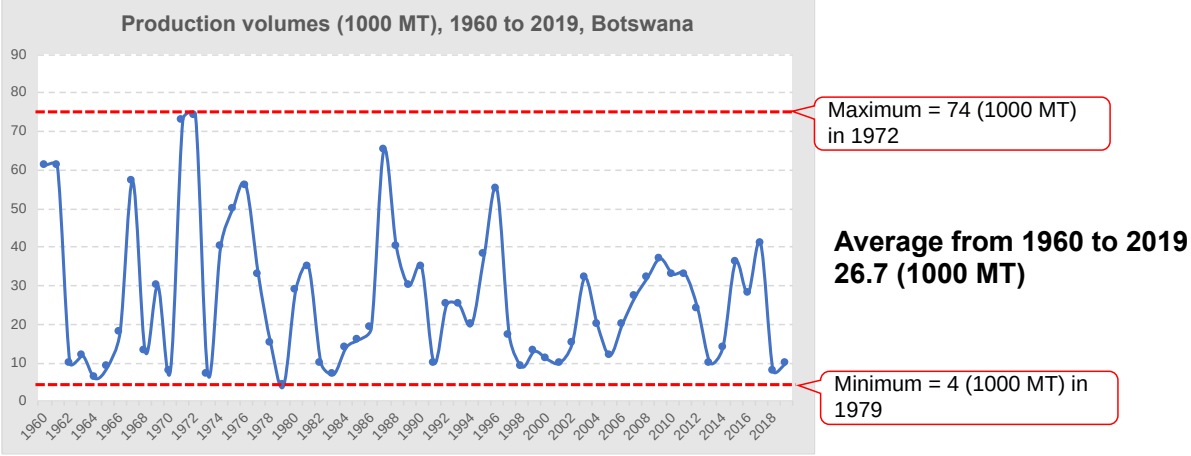
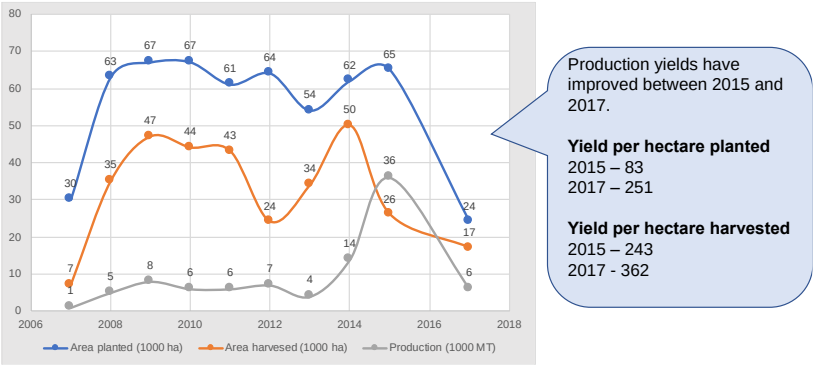


Figure 7 Sorghum production volumes in Botswana, 1000 MT, 1960 to 2019

Source: https://www.indexmundi.com/agriculture/?commodity=Sorghum&graph=production

**Figures for 2019 are estimates*

Figure 8 provides an overview of Sorghum areas planted, harvested and produced in Botswana from 2006 to 2017, as well as a closer look at the general production trend between 2010 and 2019. Although production yields per hectare have improved between 2015 and 2017, there has been a downward trend in production volumes over the last decade.



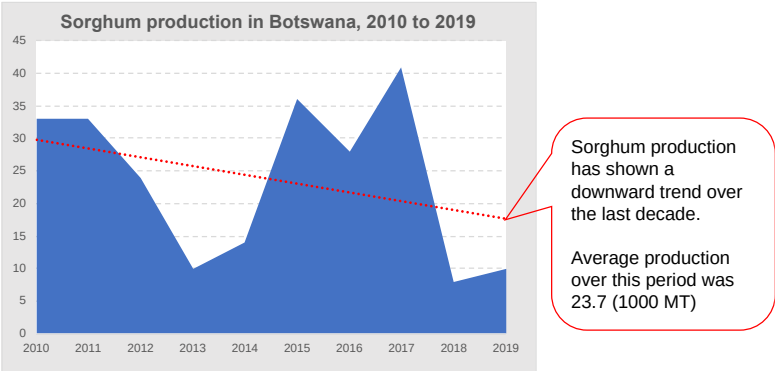


Figure 8 Sorghum areas planted, harvested and produced in Botswana, 2006 to 2017

Source: Botswana Annual Agricultural Survey, 2017

Despite the downward trend in production volumes, Sorghum remains the second largest crop in Botswana, amounting to close to 6,000 MT in 2017/18; 25% of production of the four major crops produced.

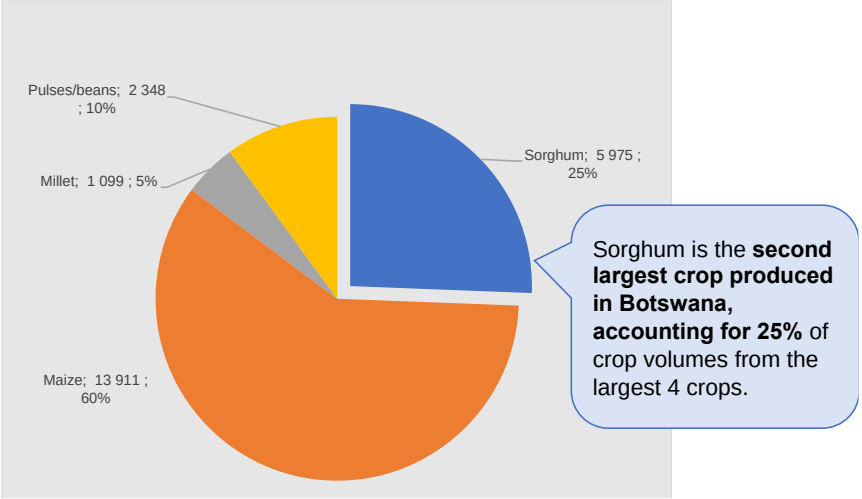


Figure 9 Production of major crops in Botswana, MT, 2017/18

Source: Botswana Annual Agricultural Survey, 2017

Sorghum production takes place in most districts in Botswana. However, production is currently geographically concentrated in four districts (Chobe, North East, Barolong and Central Tutume) which account for over 70% of total production.

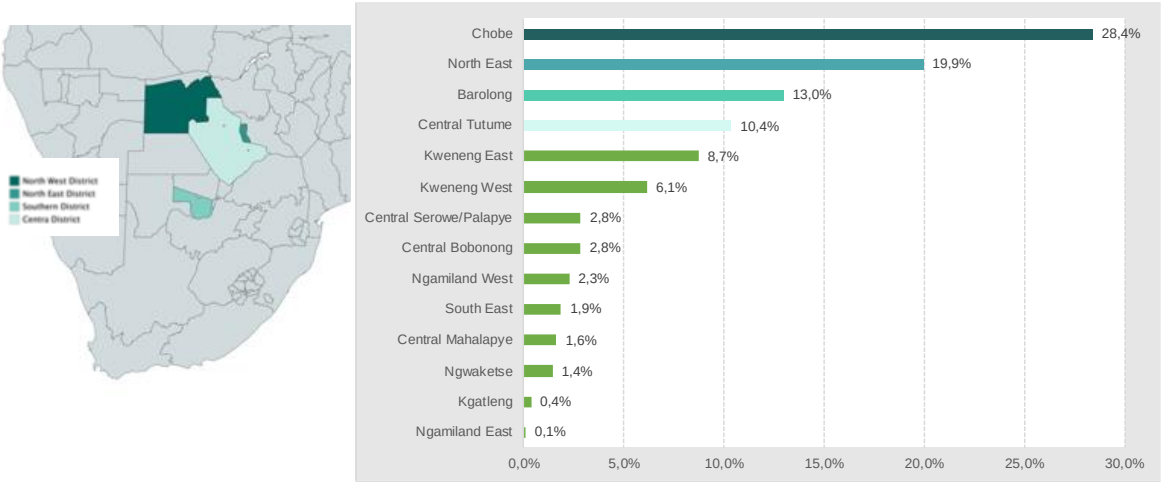


Figure 10 Sorghum production by district in Botswana, MT, 2017/18

Source: Botswana Annual Agricultural Survey, 2017

Uses / disposal of Sorghum in Botswana is dominated by Sorghum that is stored. This accounted for 42% of production volumes - unsurprising given the large variability in volumes on an annual basis. 16% of production is consumed for subsistence with 36% being traded / sold. In 2017, approximately 2.5 million kilograms of Sorghum was sold at an average price of 20 US cents per kilogram, amounting to revenue of about $501,185.

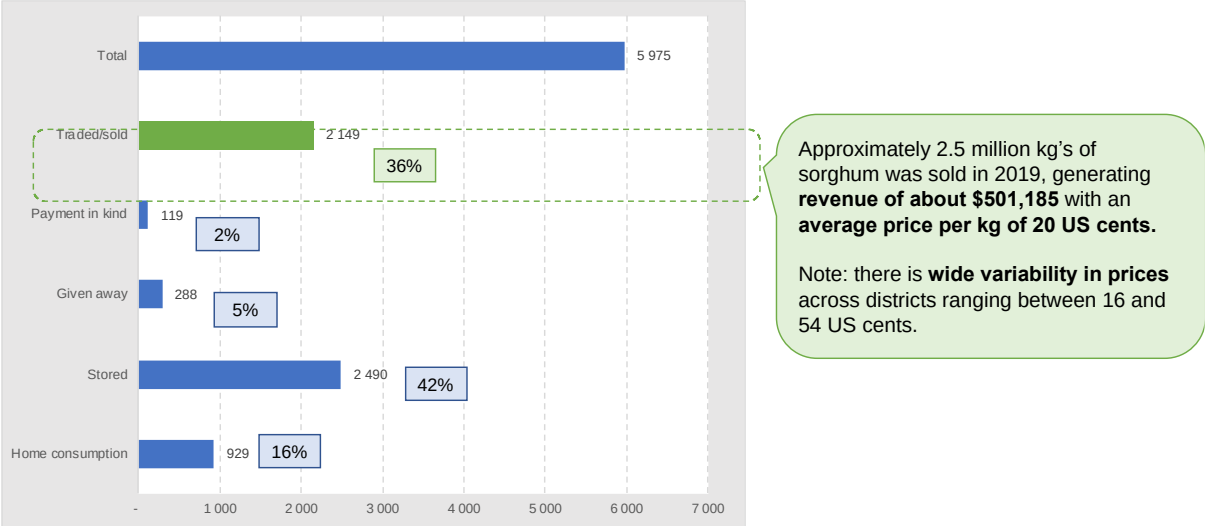


Figure 11 Uses of Sorghum in Botswana, 2017

Source: Botswana Annual Agricultural Survey, 2017

3.3 Status Quo for Lesotho

Production volumes in Lesotho have displayed considerable volatility over the last five decades, as well as a general downward trend, ranging from a maximum of 86,000 MT in 1978 to a minimum of 1,000 MT in 2016. Low production volumes have been displayed repeatedly since 2002.

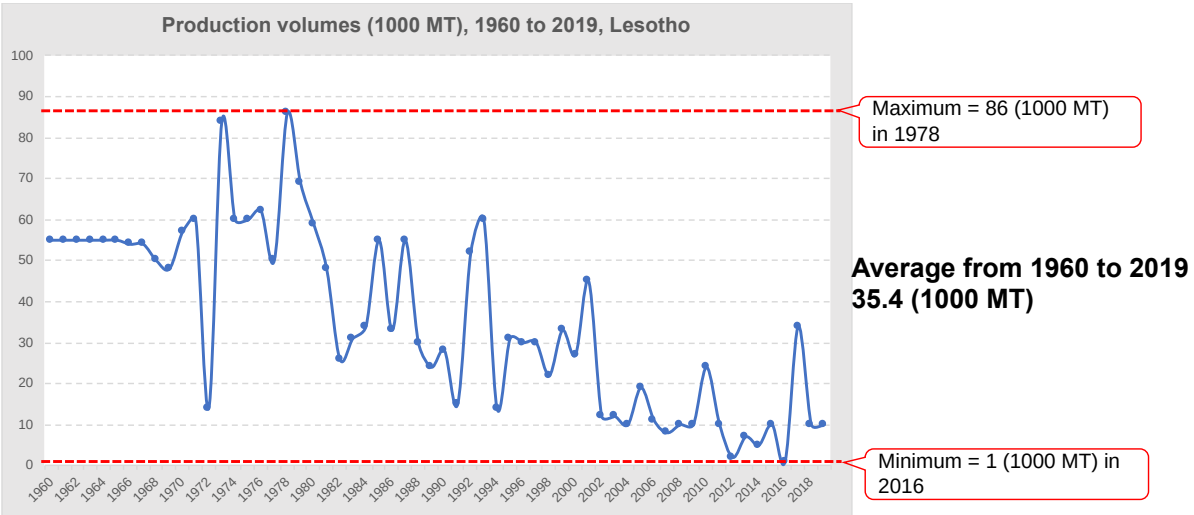
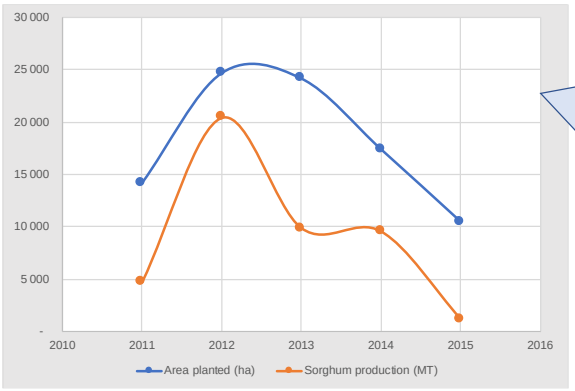


Figure 12 Sorghum production volumes in Lesotho, 1000 MT, 1960 to 2019

Source: https://www.indexmundi.com/agriculture/?commodity=Sorghum&graph=production

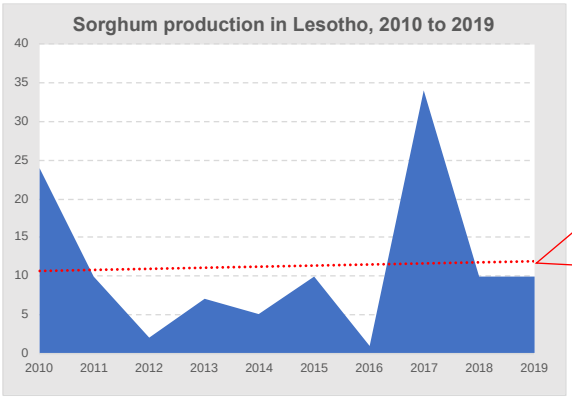
**Figures for 2019 are estimates*

Although production volumes have displayed a general downward trend over the long term (since 1960), over the last decade, volumes have stagnated with an average volume of 11,300 MT over this period. Yields have also shown significant variability ranging between 0.11 and 0.89 MT per hectare per year.



Yields per year (MT per hectare):

2011 – 0.41
2012 – 0.89
2013 – 0.45
2014 – 0.60
2015 – 0.11



Sorghum production has shown a stagnant trend over the last decade.

Average production over this period was 11.3 (1000 MT)

Figure 13 Sorghum areas planted, harvested and produced in Lesotho, 2006 to 2017

Source: Bureau of Statistics, Kingdom of Lesotho, 2017/2018 and 2015/2016 Agricultural Production Survey Crops

Despite the stagnant trend in production volumes, Sorghum is Lesotho's second largest crop, accounting for 25% of crop production out of the five major crops in the country. In addition, in 2017/18, Sorghum had the third highest yield of 0.52 MT per hectare.

Sorghum is the **second largest crop produced in Lesotho, accounting for 25%** of crop volumes from the largest 5 crops.

Average yield per hectare for sorghum is 0.52 MT per hectare, this is the **3rd highest yield** after, wheat (0.93) and maize (0.87).

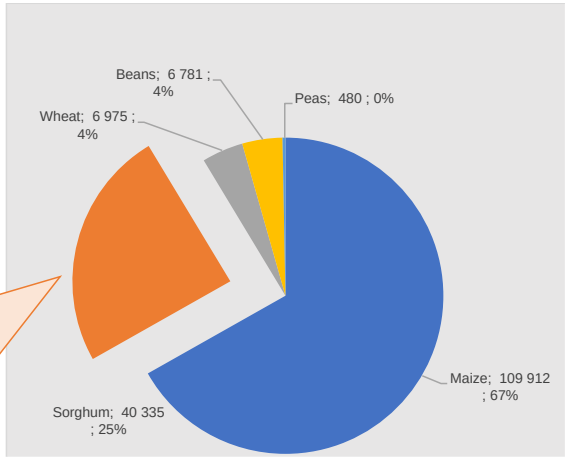


Figure 14 Production of major crops in Lesotho, MT, 2017/18

Source: Bureau of Statistics, Kingdom of Lesotho, 2017/2018 Agricultural Production Survey Crops

Sorghum production occurs in all districts in Lesotho, but 62.7% of production occurs within Maseru, followed by Leribe and Mohale's Hoek. Together, production in these three districts account for 83% of Sorghum production in Lesotho.

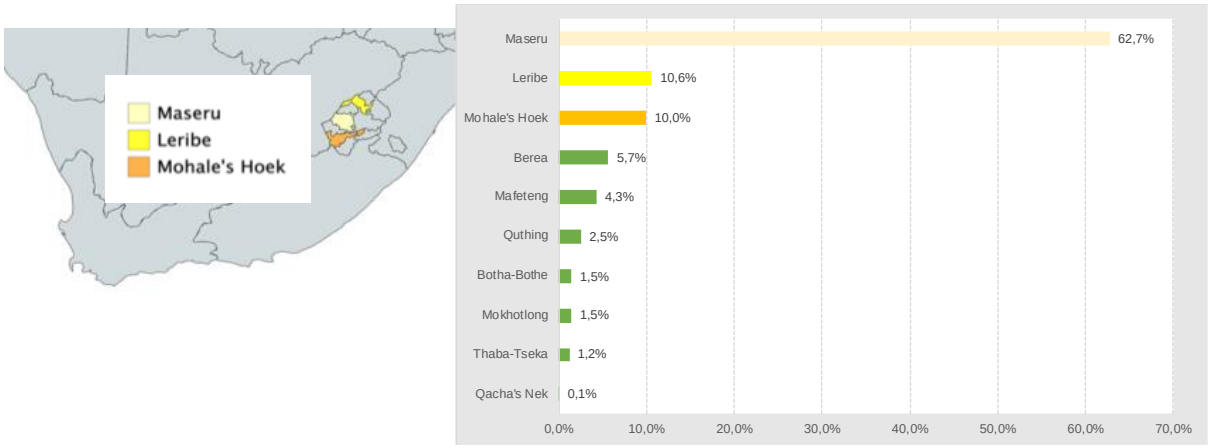


Figure 15 Sorghum production by district in Lesotho, MT, 2017/18

Source: Bureau of Statistics, Kingdom of Lesotho, 2017/2018 Agricultural Production Survey Crops

3.4 Economic Viability Assessment

Economic viability of upscaling Sorghum production should be considered through the lens of creating sustainable income streams for smallholders, as well as the potential for Sorghum production to contribute towards enhancing food security. **Error! Reference source not found.** presents a model of potential cost items for Sorghum production per hectare. Given a lack of costing information for each country, this data has been leveraged from a study on Nigerian Sorghum production, undertaken by the Food and Agriculture Organization (FAO) of the United Nations. However, for the purpose of our analysis, this costing has been reviewed and revised for Lesotho and Botswana contexts.

Table 4 Costs of Sorghum production per hectare, USD, 2019

Items	Quantity	Unit price (USD)
Ploughing (ha)	1	$ 16,74
Harrowing (ha)	1	$ 8,37
Ridging (ha)	1	$ 8,37
Seed (kg's)	8	$ 0,33
Planting (man days)	5	$ 1,67
First weeding/thinning (man days)	20	$ 1,67
Fertiliser (bags)	4	$ 18,42
Fertiliser application (man days)	10	$ 1,67
Harvesting (man days)	10	$ 1,67
Threshing (man days)	20	$ 1,34
Bags & labour for handling (bags)	20	$ 0,27
Total cost per ha		**$ 60,54**

Source: Food, M. A. Agricultural Policies (MAFAP) (2013). Analysis of Incentives and Disincentives for Sorghum in Nigeria. Exchange rate data: https://www.x-rates.com. Inflation data: http://www.in2013dollars.com/

The[LK1] table below presents the potential for revenue generation for Botswana and Lesotho based on the cost model described above, updated for national contexts. Revenue generation is dependent on the production yield per hectare planted, as well as the price at which Sorghum can be sold. Production yields are sourced from official country documents and two pricing scenarios are presented below.

Scenario 1: For Botswana, this pricing scenario is based on the average price per kilogram of Sorghum and for Lesotho, the prices are based on the average SAFEX traded prices for 2019. Given the cost per hectare of xxx, both countries would…….

Scenario 2: For both countries, this pricing scenario uses the maximum price per kilogram as traded in Botswana (54 US cents). It is important to note that pricing in Botswana varies widely between districts ranging between 16 and 54 US cents per kilogram. Based on this pricing scenario, both countries would…..

Table 5 Revenue-generating potential from Sorghum production per hectare, USD, 2019

Revenue Scenarios	Botswana		Lesotho	
Scenario 1	**Average price**		**SAFEX price**	
Kg per ha		250		112
Price per kg	$	0,20	$	0,22
Revenue per kg	$	50,00	$	25,21
Cost per ha	$	60,54	$	60,54
Profit per ha	**$**	**(10,54)**	**$**	**(35,33)**
Scenario 2	**Highest price**		**Highest price**	
Kg per ha		250		112
Price per kg	$	0,54	$	0,54
Revenue per kg	$	135,00	$	60,67
Cost per ha	$	60,54	$	60,54
Profit per ha	**$**	**74,46**	**$**	**0,13**

Source: *Exchange rate data: https://www.x-rates.com. Inflation data: http://www.in2013dollars.com/. Bureau of Statistics, Kingdom of Lesotho, 2017/2018 and 2015/2016 Agricultural Production Survey Crops. Botswana Annual Agricultural Survey, 2017. Sorghum prices: https://www.sagis.org.za/safex_historic.html*

3.5 Key Findings and Recommendations of Economic Assessment

Sorghum production for both countries is highly variable on an annual basis and has shown either a downward trend over time or stagnation in terms of production volumes. Despite this trend, Sorghum remains one of the most significant crops in both countries, accounting for 25% of production volumes of the other major crops.

Although a large share of production is consumed at subsistence level or stored, there is revenue-generating potential for the local sale of Sorghum. For example, in Botswana in 2017, 36% of the product was sold, generating approximately $501,000 in revenue for farmers. However, it is important to note that there is large variance in prices across the different regions of the country. It should be noted that there is limited information on pricing per district and revenue generation in Lesotho.

Production of Sorghum in both countries is geographically concentrated across three to four regions which account for over 70% and 60% of production for Botswana and Lesotho respectively. In upscaling production, it is important to identify the geographic focus of such a programme that takes into consideration the market structures and pricing within each district as this will influence the probability of success of upscaling.

The economic viability of upscaling Sorghum production is significantly dependent on the following aspects:

- Operating costs for production per hectare;
- Yields per hectare;
- Prices per kilogram at which Sorghum can be traded;
- The potential to enhance food security (this is a qualitative benefit that has not been quantified in this study).

Some key recommendations are as follows:

- The cost of the programme design should factor in the revenue-generating potential of the interventions. However, the interventions should also be designed with food security in mind; there should be focus on upscaling for selling and on enhancing food security at both farmer and national level.
- Interventions should be designed with pricing in mind as this will impact the revenue-generating possibilities in both countries.
- There is currently very limited information on the Sorghum off-takers and mills and therefore a gap in information on the scope for mills to increase their intake of additional production. Before detailed programme / intervention design can commence, additional primary research would be required which would need to include interviews with mills in both countries to get detailed information on their ability to increase their intake, as well as any key constraints they might face.
- Intervention design details should include capital and operating costs together with information on the extension services, training requirements and institutional implementation arrangements within national and local governments responsible for implementation; identification of the scope of upscaling and a quantification of the potential revenue on an annual basis. With further data, quantification of the economic benefits that can be unlocked as a result of enhanced food security and overall net economic benefits / costs of the programme over a predefined time period, would be useful.

4 Environmental and Social Assessment

4.1 Community Engagement Results

A series of community engagement workshops were held in Botswana (76 attendees) and Lesotho (58 attendees) to better understand the perspective of the farmers across the Agro-Ecological zones. The purpose was to receive their opinions on Sorghum production and interest in opportunities for scaling to validate the intervention basis. Additionally, it provided an opportunity to feed the real-life situation into the assessment work of this Feasibility Study. Workshops were extremely productive with all participants well engaged and a significant amount of information on boarded by the team.

The table below summarises some of the key data collected from the farmers with full notes from the workshops included in Annex 2.

Photos 2 Community Engagement in South East District, Botswana

Photos 3 Community Engagement and local environment in Thaba Tseka District, Lesotho

4.1.1 Characteristics of Agriculture in the Botswana communities

Table 6 Summary of issues from Botswana communities

Topic	Responses	Additional Comments
Primary Crops	Sorghum (local and hybrid), legumes (cowpeas), melons and maize	The community primarily produce Sorghum although they lately shifted to Maize. The problem with maize is its inability to withstand drought, forcing farmers to slowly go back to Sorghum. Farmers are also growing speckled cowpeas because of its drought resistance.
Varieties	**Sorghum** – Sekgaolane, Nkoroane (Sekgohloane), *Tsabatsie,* Sekgohloane (Milo), Mabaitse, Kanye and hybrid by government. **Maize –** SA 513, SC 506 and ZM and local maize varieties, Kalahari Early Pearl **Legumes –** speckeled cowpeas(Tsiloane) and local varieties (Tsioana) and blackeyed . **Pearl millet**	There is preference for local varieties as farmers are convinced that hybrid varieties need more management. Sekgohloane (Milo) is thought to be more tolerant than Sekgaolane but less reliable than other varieties. The hybrid by government is not planted more than other varieties. Hybrid maize take less days than local varieties, Local maize varieties are planted although most have disappeared.
Source of inputs	Government subsidies, from own silos and, to a lesser extent, agro-dealers.	
When do you plant?	November – January, but commonly December	The rains are usually expected from October to December, but now falls in December and January. Early planting helped farmers avoid the quelea bird, but as of late, the birds are around from January when farmers are planting at which time the grains are not toughened yet, resulting in lower yields.
Primary cash crop	Legumes, Maize Sorghum and cowpeas and its leaves for vegetables	
Crops of future interest	Groundnuts. Tepary beans which are drought resistant. Lablab for livestock. Finger millet. Mung beans.	Technological knowledge for groundnut production (i.e. how to thresh them) is lacking Finger millet is thought to be drought resistant but not very popular in this region. It is considered better than Sorghum in productivity although it is even more vulnerable to quelea birds.
Techniques Utilised	Planting in 3x6 Furrows Top dressing Coating seed before planting Some mixed farming No till, potholes – however, needs use of herbicides.	Ripping preferred to conventional ploughing, but subsidies to tractor owners by government mean they are pushed to use conventional disking.
Livestock	Sheep, goats and cattle, broiler chicken Farmers prefer to invest in livestock rather than in crop production, although some farmers claimed that they sell livestock to invest in crop production, make repairs and maintenance of equipment. One farmer stated that he bought a tractor with sales from livestock. Chickens are not kept in large number due to the New Castle outbreaks. Government is no longer assisting and farmers resort to traditional medicines for treatment. The community used to keep pigs but have discontinued because of health issues and because they claim pigs require more care and give diseases to cattle.	
Fodder Production	The biggest challenges are: • Processing • Fodder seed prices are high, a 10kg bag costs a P1,000.00. • Some fodder varieties require plenty of water. • Lucerne bales in the shops have significantly reduced in size but not in price. • There is not enough fodder processing infrastructure available for farmers. • Trade-offs between crops and fodder production.	There is limited knowledge on fodder production. Animal feed is still expensive. Although it remains subsidised by government at 50%, farmers are reluctant to buy. The farmers believe that producing own fodder could reduce costs for animal feed Most of the farmers have not seen fodder Sorghum (limited varieties) Sorghum production for human consumption is prioritised over Sorghum for fodder.

Climate Challenges	The most challenging weather-related issues: - Drought - Late Rains - Pest and Disease Rain comes in November, but not enough for planting until January. Frost used to be from mid June-July but now comes in May. Delayed rains lead to delayed planting and leaves crops susceptible to frost attack.	
Water Challenges	There is no water in the region, even for drilling. Farmers spend most time collecting water. Some water is too salty and pH between 4.5-11.5. Irrigation is not an option due to limited supply but there is significant interest in irrigation. Water is supplied by trucks, but farms compete with households and schools for supply.	
Soil Quality Challenges	• They mainly have 2 types of soils, loam and sandy soil. • They mainly plant maize on the loamy soil and legumes on the sandy soils. The loam soil is generally able to retain moisture unlike the sandy soil which is considered not good for crops. • Farmers suspect that the fertilizers destroy the soils especially if it does not rain (burn crops). • There are limited soil testing facilities, some have waited 4-5 years for the results. • Wind erosion is one of the bigger challenges and the nutrients move with the top soil.	Practices to improve soil quality: • Farmers use crop rotation to improve fertility and have realised that rotating beans makes consecutive crops perform better. • There is also a common use of manure (kraal and chickens) as well as compost and planting back the crop residues. • There is not much soil erosion in the region due to the flat terrain. But occasional floods do erode the soil and compaction is due to overgrazing. • They also minimize tillage to avoid wind erosion • According to one farmer, his soil is good, but he struggles with weeds. The farmers expressed the concern that they belief the weeds come with the government fertilizers since they used those they experience different types of weeds. • They would prefer to use the crop residues but they feed them to livestock, that could reduce soil erosion. • They believe ripping is important as well. • The use of organic matter is more important than chemical fertilizers especially because they do not have the soil test results. They use crop residues and crop rotation.
Pests	Quelea birds, Francolin birds, Ground squirrel, Springhare, Bagrada bugs, Worms (yellow/green/army), Witch weeds, Aphids, Stock borer, Army worm, Jackals, Locusts ('stotojane'). Chemicals are mostly used to control pests.	
Storage	There are no silos; the harvest is kept outside and unable to withstand heat and rain. In some cases, it is kept in the house, but there is high spoilage of product. They also buy chemicals, keep in cold storage and use smelling herbs/trees to get rid of pests. Because there is no access to markets, the grain ends up spoiled in storage.	To control weevils, farmers dry the grains and use some local knowledge of coating the grain with goat faeces. In the past, they made use of some chemicals in storage, but these are no longer on the market. They also buy chemicals, keep in cold storage and use smelling herbs/trees to get rid of pests.
Transport Challenges	They transport in small vans, which is not value for money. They hire transport to collect produce, which is to do and which reduces profit. There are poor access roads to the fields; these limit marketing of the products especially Sorghum.	

Photos 4 Community Engagement in Kweneng District, Botswana

Table 7 Summary of Experiences and Opinions on Sorghum from Botswana Communities

Sorghum Production
Sorghum is produced in **high volumes in the communities for both personal use and for external sales.** **Sorghum performs better than maize in the communities in terms of drought resilience and is preferred for consumption.** **They are interested to increase production but the quelea birds are a big problem. Farmers believe that the greater area of land (and number of farmers) planted with Sorghum, the more the impact of the bird would be spread and risk of failure to any one farmer reduced.** **Additionally**, farmers **are concerned by** the **reoccurr**ence of **drought which makes them unable to increase Sorghum production**.

4.1.2 Characteristics of Agriculture in the Lesotho communities

Table 8 Summary of issues from communities in Lesotho

Topic	Responses
Primary Crops	Maize, Sorghum and Beans
Varieties	For Sorghum communities use: Macia and Pan 870 For maize: SNK 2778, 4410, PAN 12 and Sahara For beans, pinto and sugar beans: silver king and NUA 45 (although it's a new variety to them), and some open pollinated varieties.
Source of inputs	The inputs are purchased from a government store in the form of a subsidy and from retail shops.
When do you plant?	They used to plough and plant from October to December but due to the changing climate and farmers' dependancy on rain, they wait until early-December.
Primary cash crop	Thaba Tseka - Wheat and Beans Berea - Currently there is no commodity sold for cash due lack of market.
Crops of interest	Whilst one community was interested in Sorghum, potatoes and beans, the other community did not want to change from wheat and beans which they see as performing well with the current climate.
Techniques Utilised	The most popular technique used is conventional ploughing, even though not all of them are able to plough due to high costs. Farmers are aware of other methodologies but prefer the conventional.
Livestock	The most popular livestock are cattle, sheep and goats. However, wool and mohair perform better than the dairy sector because they have Sesotho breeds which do not produce more milk as opposed to dairy breeds like Holstein Friesland. The quality of the wool and mohair produced at the high altitude is very high. However, there are some challenges brought on by government in terms of selling these commodities (wool and mohair).
Fodder Production	The only challenge they have is seed availability and lack of information, but if there is support for the process and for seed, they can produce fodder. The little seed that is available from others is very expensive. They do not purchase fodder, but they use crop residues after harvesting grain and sometimes they plant English giant for feeding their animals. Additionally, they graze their animals in rangelands. They don't plant specific crops like oats, barley and fodder sorghum for the purpose of feeding livestock.
Climate Challenges	Climate change brought many changes that affect farmers; for instance, severe drought, heavy rainfall which sometimes causes erosion. At times they experience early frost in mid-March which they never experienced. There are several consequences they are suffering from as a result of climate change for instance: experiencing severe drought, rain does not come at the usual time and when comes it comes it is often in the form of hail storms, which washes away top soil (the most fertile), leading to severe soil erosion.
Water Challenges	In one community, the challenge related to the community tap not working and requiring maintenance. The other community had access to water which could be used for irrigation and for domestic purposes, but unfortunately, they do not have irrigation systems.
Soil Quality Challenges	Farmers stated that production differs depending on the type of soil. On the river side, where there is black soil, the yield is high due to high nutrient content. There are also areas with soils that are shallow with low nutrients, where production is not as high. The production has decreased due to poor soil conditions (in terms of fertility). Therefore, topsoil has been washed away by floods, resulting in low yield during harvesting. They are adding kraal manure after harvesting to improve soil structure and retain its quality for improved production. However, they state that kraal manure takes up to three years for improvements while fertilizer takes one year. The yield is slightly higher than on the plot where they have used fertilizers.
Pests	Cut worm, Beetles, Bagradabug, Aphids and Ladybird. If not taken seriously, they can lead to reduced crop performance and yield decreases.
Storage	Farmers store their produce in their houses, and this is a challenge because they do not have enough space. It is difficult for them to fumigate while they live in the house, therefore pests (mice/rodent) take advantage. The additional challenge is the issue of theft prior to harvest.
Transport Challenges	There were different opinions raised among farmers as some said there is no market for their produce and pointed out that in 2016 they produced more Sorghum which were destroyed by weevil in their storage due to lack of market despite the fact that the government announced it will buy their produce. While others see a market of beans to WFP for school feeding program.

	Roads are available although transport is not easy; therefore difficulties exist in accessing markets.

Photos 5 Community Engagement in Thaba Tseka District, Lesotho

Photos 6 Community Engagement in Berea District, Lesotho

Table 9 Summary of Experiences and Opinions on Sorghum from Lesotho Communities

Sorghum Production
Communities **currently produce Sorghum**, **although last year (2018) less land was planted due to drought**. T**his year (2019) they struggled to access inputs.** **Whilst** m**aize is mostly used for consumption**, **Sorghum is highly** preferred **for business purposes. Sorghum has** lower **risk of attack by pests**. Given the choices, the community **would choose Sorghum.** **Currently they are producing** Sorghum **for home consumption**, **but** they are interested **to produce and commercialise** the **production. They would prefer to continue producing Sorghum because they are aware** of its **drought toleran**ce and the fact that it **can still be produced under** changing **climate condition**s. They also believe that **Sorghum is easily marketed because** of its multiple uses, i.e. as **soft porridge,** in the **brewing of beer, etc**. **The communities are interested to increase production provided there is a stable market where they can sell their produce.** The remaining **fear is operating on** a **larger scale without knowing the buyer**. I**f there is access to the market**, **they can increase production**. **According to their understanding**, **subsidy is only given to traders and as farmers** they **are not allowed to buy** directly **from the** g**overnment store**. T**his is a barrier because the inputs are expensive. The incidence of severe drought affects their planting times**, **leading to low production. However, funding that could** assist **in** the purchase of **inputs** would be an aid**.**

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4.2 The Gender Gap in Agricultural Productivity

The difference between the agricultural productivity - measured by the value of agricultural produce per unit of cultivated land - of female and male farmers is referred to as the gender agricultural productivity gap. Across sub-Saharan Africa this gap is found to range from 4-25% to the disadvantage of women (UN Women, UNDP, UNEP, and the World Bank Group, 2015).

Studies suggested that patriarchy and culture contribute to significant gaps in power, control, choice and agency which is evident in decisions on land and income use, household division of labour and market access. Decision making is largely in the hands of men while women's roles are mostly associated with production whether for the market or the table (ibid). In addition, environmental hazards - especially climate variability - affect the productivity of male and female farmers both collectively and individually.

Whilst all farmers experience the impacts of climate variability, gender gaps in agriculture influence how women and men access, participate in, adopt and benefit from climate-smart agriculture practices for reduced vulnerability to climate variability. Studies have found a range of underlying factors that contributed to the gender gap, specifically that:

- females had lower levels of access to water, improved seeds, fertilisers, insecticides and agricultural tools needed for their farming livelihoods;
- female-managed farms were smaller than farms managed by men;
- female farm managers spent less on fertilisers and insecticides than farms managed by males;
- female-managed farmers had a higher household size and a higher dependency ratio resulting in more unpaid care and domestic work, reducing the amount of labour available;

These findings indicate that female and male farmers experience different agriculture production conditions and make different production decisions which results in differing levels of agricultural productivity.

4.3 Gender Inequality Issues

Women make significant economic and social contributions in paid and unpaid work, in the family, community and workforce and their large presence in agriculture in Lesotho and Botswana indicates that they are a key factor in transforming agriculture and the lives of rural households. Lesotho and Botswana have a large number of rural households, whose agriculture production remains predominantly subsistence for reasons such as reliance on traditional farming methods, farm plots that are too small to support commercial production and gender inequalities in access to and utilisation of inputs and technology. The diagram below represents key gender inequality issues in the agricultural sector both from analyses and stakeholder consultations. The arrows indicate that these issues feed into each other and are therefore mutually reinforcing. An inequality issue can at once be a cause and an effect. An example is the issue of lower inclusion levels which can be an effect from, or a cause for, increased vulnerability, demonstrating the multiplicity of issues at play when examining inequality. The inequalities may be perceived at the household, institutional or systemic levels.

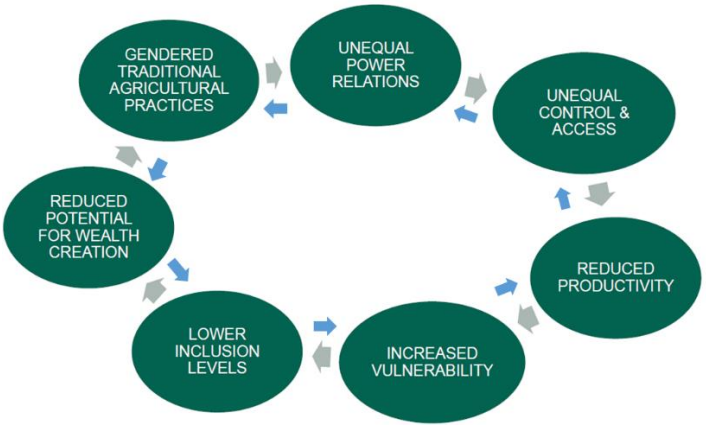


Figure 16 Inequality Cycle in Agriculture (Odera and Keam in AMS, 2019)[1]

4.4 Botswana Gender and Youth Issues

During the engagement exercise, communities shared the challenges women face and the opportunities they see for the future.

In the Botswana communities the challenges included:

- Animals being grazed on women's field (men owned animals)
- Limitations in mobility for herding their cattle
- Cultural issues such as high prevalence of single parenthood and associated social isolation
- Unequal labour burden with primary responsibility for care of the fields
- High physical labour demand of the physical tasks as well as ploughing operations.
- Double labour burden with primary responsibility for childcare as well as farm work
- There are safety issues when moving around on their own (both wildlife and crime)

The communities identified the Sorghum production opportunity as having good potential for women due to the reliability of Sorghum sales. They also believe that there are advantages to working collectively to pursue this opportunity due to the unity and strength in collectively tackling labour and marketing issues.

It was identified that youth are not interested in agriculture due to a number of reasons, including having adapted to a luxurious city life, not liking physical work and having a poor opinion of the manual labour of farmer as opposed to 'educated' jobs. This is a common trend across Sub-Saharan African as aging farming populations are not being sustained by youth entering the sector. Farmers themselves identify the engagement of youth as a priority and are concerned that they have not raised the children in a way that continually exposes them to the farm operations. The Youth Fund under the Ministry of Agriculture is an opportunity to support the engagement of youth in the agricultural sector particularly in more productive, poverty-reducing jobs including off farm within the value chains.

4.5 Lesotho Gender and Youth Issues

In the Lesotho communities the challenges included:

- Unequal decision-making power in farm operations, which contributes to;
- Lack of motivation to fully participate in field activities
- High physical labour demand of some of the tasks including loading and unloading and hoeing fields
- Lack of labour for support in wedding and hoeing

[1] National Gender and Youth Mainstreaming Strategy, MINAGRI, Rwanda, May 2019.

The cultural division of labour could be an ongoing issue with Sorghum production as women's roles traditionally do not include threshing. However, overall the Sorghum production is appealing because of the number of different options for sales in different forms: brewing beer, grain and mealie-meal for motoho. Accessing these markets will also require overcoming the limitations relating to finding intermediaries and resolving transportation issues.

Similar limitations to Botswana were identified relating to lack of youth engagement in the agriculture sector. Historically, youth were punished for misdeeds by having to plough so they do not have interest in farming. The youth are mobile and are focussed on pursuing employment in regional hubs and the capital. There is also lack of inputs and farming equipment for youth, as well as suffering security challenges for their produce as they are normally grazed by the village livestock. Whilst Sorghum production has potential, there remains concern about the protection of crops from birds and the recent experience with fast growing weeds impacting production.

The communities see opportunities to sell their produce to nearby schools but require support to form groups or associations so that it will be easy to access funding from Smallholder Agricultural Development Project (SADP) from government. The youth who have graduated could be trained on how to write business proposals to support this process.

4.6 Environmental and Social Screening

The previous sections have provided background context to the Social and Environmental issues relating to the scale up of Sorghum production. In this section, a formal screening tool is applied to ensure outstanding issues are addressed through mitigation. Due to the alignment of the proposed work to Climate Smart and Rural Development principles, no significant issues are anticipated such as the kind which may be found with infrastructure works etc. The screening tool has been tailored to the nature of the project.

The guiding principles of environment and social assessment is to ensure that interventions are designed to be environmentally and socially sustainable.

The two main objectives of the screening assessment tool are:

- **Identify and exploit environmental and social opportunities and benefits** of a proposed intervention. For example, a screening note might identify the need to include environmental services (waste management etc.) in a programme that is providing veterinary services to livestock farmers;
- **Identify and manage environmental and social risks associated with the intervention** and ensure that appropriate action is taken. For example, constructing small earth dams can have many economic benefits (e.g. water for irrigation), but the risks (e.g. dam failure and flooding) need to be managed;

At first glance, interventions developed from the results of this feasibility study pose little threat to the environment and social systems in the target countries. However, the core likely activities will have some (albeit small) negative environmental and social impacts, which will need to be avoided or mitigated. It is not possible to state precisely which exact activities will eventually be implemented, given that the actual shape of any future programme is currently unknown. It may be necessary at a future date, to revisit the analysis of this Strategic Environmental and Social Screening Report, in light of more detailed knowledge of the intended activities. It seems unlikely at this stage of understanding, that project-level Environmental Impact assessments (EIAs) will be required for individual projects, though some more in depth assessment may be required (for example if there were elements of irrigation infrastructure incorporated into the intervention). Once activities are implemented, environmental and social performance will need be monitored and evaluated, alongside the evaluation of other project related criteria. Thus, the implementation of environmental and social safeguards needs to be continuous, albeit at low intensity.

Table 10 Screening Assessment of likely Activities

PRIMARY ACTIVITY 1: RAINFED SORGHUM CROPPING			
In summary: Scaling up Sorghum production with promotion of sustainable farming practices (soil management, minimum disturbance, intercro pping, fodder production). Support to farmers to ensure linkages with markets and processes as relevant.			
Synergies – within and between sectors: Lesotho and Botswana both have a significant national production gap that is currently filled via imports. Demand for food Sorghum is high in Botswana and medium in Lesotho, however fodder Sorghum has potential livestock industry crossover in both countries (discussed further under Activity 2)			
Antagonisms - within and between sectors: Lesotho - formal market and processing capacity is low, smallholder farmers remain isolated from sales opportunities. Botswana - farmers are facing production challenges from Quelea bird.			
Assumptions & risks: Sorghum produced nationally can fill market gap currently met with importation. Farmers in Botswana can overcome the Quelea bird challenge and sustain production levels.			
Economic* and employment	**Social**	**Environment**	**Governance, safety & security**
Positive impacts • Better yields (and income) during periods of climatic variation such as late onset rainfall, than from other crops (i.e. Maize). *How to enhance* • Ensure farmers are supported to be well linked with relevant market players and intermediaries where needed. • Support farmers with weather and climate information to allow strong farm operation decision making.	*Positive impacts* • Better yields and thus improved livelihoods/ reduced poverty. *How to enhance* • Promote community-based initiatives that enable youth involvement, equal opportunities for men and women, and for people with disabilities.	*Positive impacts* • Less vulnerability to climate variations particularly drought and late on set rains. *When incorporated with core CSA techniques, compared to conventional agriculture:* • Less pressure on water resources because of more efficient water use. • Requires less land per unit of production, • Less soil degradation *How to enhance* • Utilise farmer field schools and other extension services to support farmers to undertake sustainable Sorghum production.	*Positive impacts* • Potential for farmer groups to emerge to fill gaps in value chains. *How to enhance* • Support capacity development of farmer groups through farmer field schools or other methodologies to upskill as necessary.

Negative impacts • Risk of expanding into a different staple crop than farmers are used to. • Crop risk during transition process due to inadequate knowledge of large-scale production issues *How to mitigate* • Support farmers with on farm practices to ensure most effective output. • Extension and sector level support to scale up.	*Negative impacts* • Risk of additional labor burden for women if there are social values around Sorghum as a women's crop (Botswana) *How to mitigate* • Ensure gender dynamics are targeted intervention design and development.	*Negative impacts* • Ongoing soil and water degradation risks if traditional agricultural practices are pursued for Sorghum scale up. *How to mitigate* • Ensure that intervention is built around CSA principles incorporating practices (see CSA prioritization documentation) targeted to local environment.	*Negative impacts* • None obvious.

*Note that there is a separate, more comprehensive, economic assessment.

5 Institutional Capacity and Coordination

5.1 Institutional Capacity for CSA and Sorghum production

Scaling up the climate resilient production of Sorghum in Lesotho and Botswana will require institutional capacity and coordination. Where these functions are not operating sufficiently currently interventions should support and address these gaps to ensure more sustainable outcomes.

FANRPAN (2017) identifies that, from studies of policies and practices across 15 African countries, four key areas of action are needed to promote climate-smart agriculture, namely (i) increased investment in material and human resources, (ii) the design a of coherent, integrated policies, (iii) a focus on evidence-based, context-specific plans, that include the promotion of strategies to ensure equitable participation in governance, and (iv) capitalising on innovation as a pathway to promote CSA.

They further identify that coherence in policy is key:

- As CSA contributes to a cross-cutting range of development goals, it needs to be implemented using an integrated, cross-sectoral approach to agriculture and food security that links it to other aspects of sustainable development, poverty reduction and economic growth.
- CSA policies and programmes, as with all cross-sectoral development programmes, need to be developed so that they are aligned among all levels of government.
- In the 15 cases studies, although the impacts of climate change are generally recognized, there is poor policy coherence
- From the 15 studies, there is a clear lack of adequate economic or regulatory incentives to stimulate CSA even when climate change adaptation and agricultural development are enshrined in public policy and recognized as national or regional priorities.
- Current policies generally provide an umbrella and overall goals, but often without specific policy instruments to realize them.
- There is insufficient cross-sectoral coordination, and sometimes conflicts, for instance, normally different ministries or departments handle climate and agricultural policies, and they are usually not synergistic or streamlined.

The issues outlined above align to anecdotal reports of experiences in Lesotho and Botswana and the national context is explored below along with the challenges and opportunities.

5.1.1 Lesotho

Lack of sustained coordination between government departments and disjointed approaches to programming have long caused confusion for those seeking to drive sustainable approaches to agriculture in Lesotho.

Climate policy in Lesotho is formulated and implemented by the Ministry of Energy and Meteorology, which also acts as the country's National Designated Authority (NDA) for the Green Climate Fund (GCF). Within this ministry, the Lesotho Meteorological Service (LESMET) is responsible for the day-to-day climate change related activities. The Ministry of Tourism, Environment and Culture is the focal point for the United Nations Framework Convention on Climate Change (UNFCCC) including the Global Environment Fund (GEF). MAFS is a key institution for CSA and is involved in many of the CSA-related initiatives in the country. (CIAT; World Bank. 2018). This decentralised approach creates obvious challenges to advancing sustainable agriculture and climate finance pursuits.

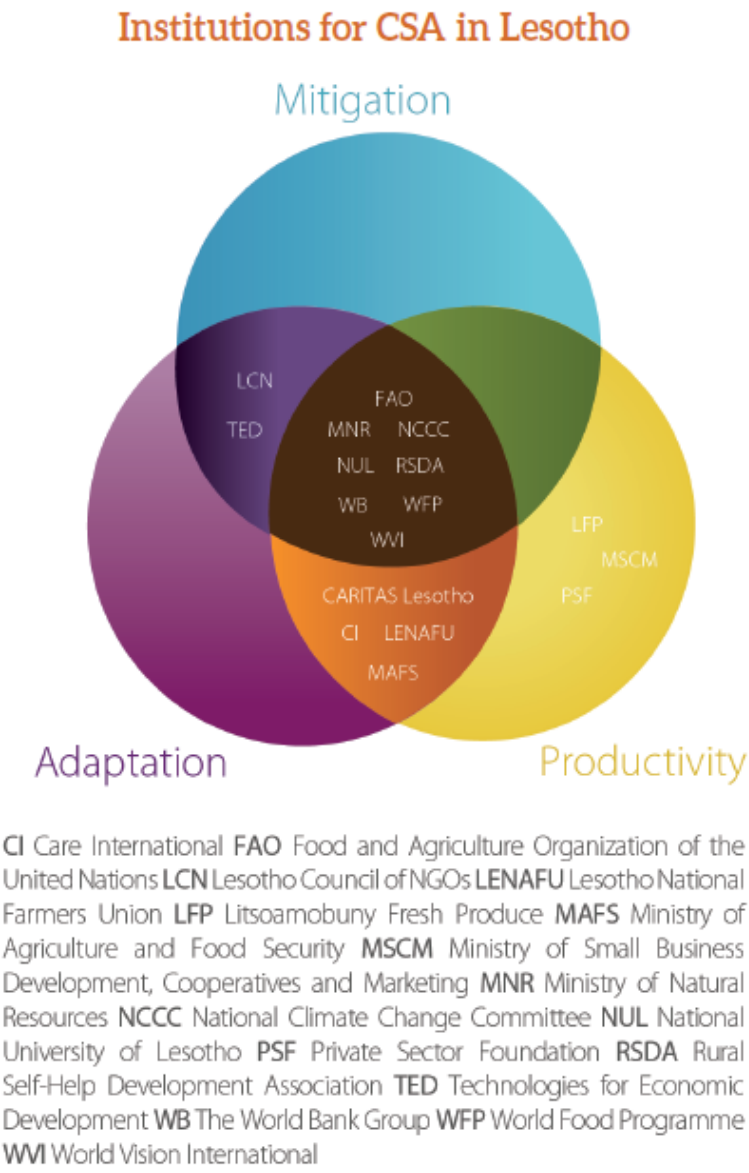


Figure 17 Organisations involved in CSA in Lesotho, and their focus areas (source: CIAT, World Bank 2018)

Although the tenets of CSA are embedded in the country's food security policies and programs, Lesotho has few policies directly related to or mentioning CSA. Even though there are many climate-resilient practices mentioned in various policies, a greater effort is required to ensure that CSA is better mainstreamed in all national policies (CIAT; World Bank. 2018).

FANRPAN country-level study for Lesotho (2017) concluded that there were opportunities to work towards;

- Institutional coordination between private and public agriculture and climate-related institutions at national, regional, and international levels to enable increased investment from diverse sources.
- Closely monitoring the impact and success of CSA projects in Lesotho to understand the potential of initiatives to contribute to agricultural transformation and livelihoods, and attract increased investment.
- Women who play a key role in the agriculture sector, need to be provided with knowledge and training opportunities and be actively involved in the planning and implementation of CSA

5.1.2 Botswana

The existing policies in Botswana do create some incentives for adoption (FANRPAN 2017a):

Table 11 CSA policies and incentives for adoption in Botswana

	Climate-smart agriculture Policy	Incentives for adoption
Botswana	CSA Framework Programme National Master Plan for Arable Agriculture and Dairy Development Integrated Support Programme for Arable Agriculture Development Livestock Management and Infrastructure Development programme	Capacity development and technology support Tax exemption for agricultural products and farming inputs A Young Farmers Fund issues loans at lower interest rates and longer repayment periods to encourage youth participation in agriculture.

Source: FANRPAN 2017a

However, some perverse incentives have been identified that undermine a CSA approach, such as the Integrated Support Programme for Arable Agriculture Development which pays P500.00 per hectare for minimum tillage but P800.00 for conventional tillage, although minimum tillage has the potential to increase yield through soil moisture conservation, while at the same time increasing soil carbon (FANRPAN 2017c). This was verified by community engagements where farmers reported that tractor owners who received subsidies, pressured them not to use minimum tillage despite their preference for it. A minor alteration to the programme such that minimum tillage receives the same payment as conventional tillage, supported by technical knowledge such as a demonstration sites could significantly impact on uptake.

When it comes to implementing national policy, Botswana also struggles with diverged responsibilities and silo operations, particularly between Departments within Ministry of Agriculture. The newly formed Department of Agribusiness is not well understood by other departments and there is scope to increase the feedback mechanisms for outputs from DAR so that they can be utilised in the work of the other departments, creating evidence-based approaches.

5.1.3 Challenges and Opportunities

Table 12 Challenges and opportunities related to institutional implementation[LK2]

Institution	Challenges	Opportunities
MAFS/MoA		
Department of Research		
Extension Department		
Crops Department		
Livestock Department		
Planning Department (Lesotho)		
Nutrition Department (Lesotho)		
Innovation Lab* (Ministry of Dev Planning Lesotho) *mandated (and holds budget) for driving jobs in Agribusiness		
Research, Statistics and M&E (Botswana)		
Department of Agribusiness (Botswana)		
BAMP (Botswana)		

6 Implementation Methodology

There is a broad scope of learnings from this feasibility study which inform the development of an intervention to sustainably scale up Sorghum production. The business case has been built around a value chain approach and this forms the basis for considering mechanisms and methodologies for potential interventions. The value chain approach was selected in collaboration with the working groups of Lesotho and Botswana to ensure that this intervention is situated solidly within the market space and has a sound basis both economically and technically. In this way the best outcomes can be achieved to ensure the climate resilience of small holder farmers. The value chain map below outlines the key components of this approach.

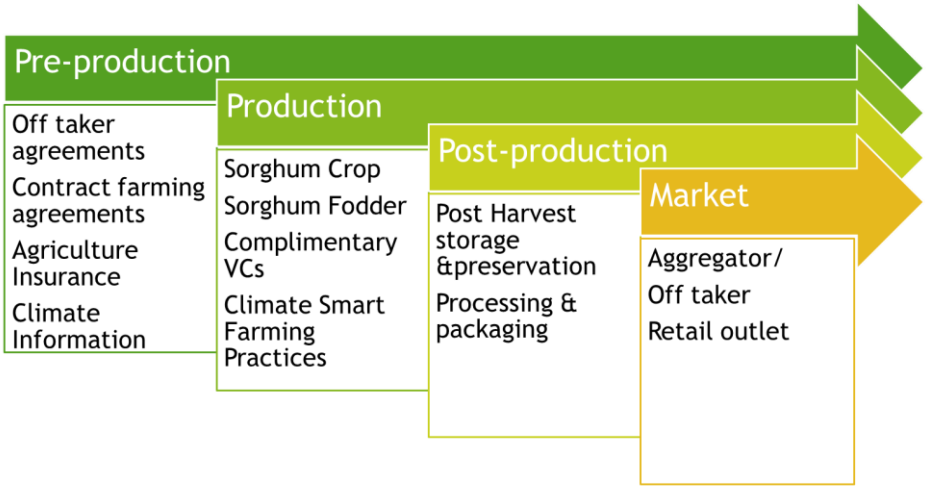


Figure 18 Simple Value Chain Map

To successfully drive and scale up Sorghum production along the value chain, implementation mechanisms are required to provide the technical and institutional support needed to elevate the current Sorghum production by smallholder farmers. These interventions need to provide technical support to farmers for farm practices and approaches that increase the resilience and productivity of Sorghum farming, action learning cycles to ensure that results based approaches can be quickly scaled by farmers, platforms to create partnerships between market players and institutional support and coordination to ensure consistency with national priorities. The way these core implementation mechanisms align to and support the value chain is shown below.

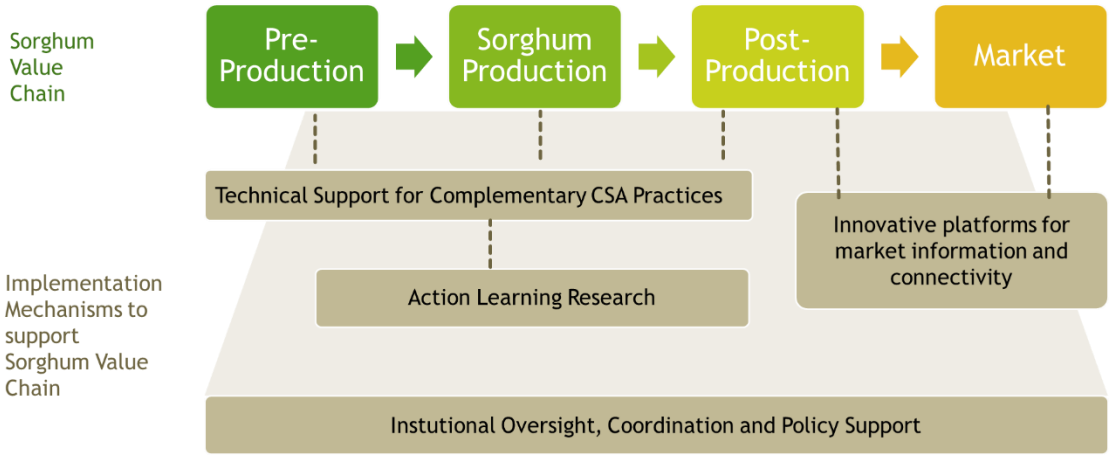
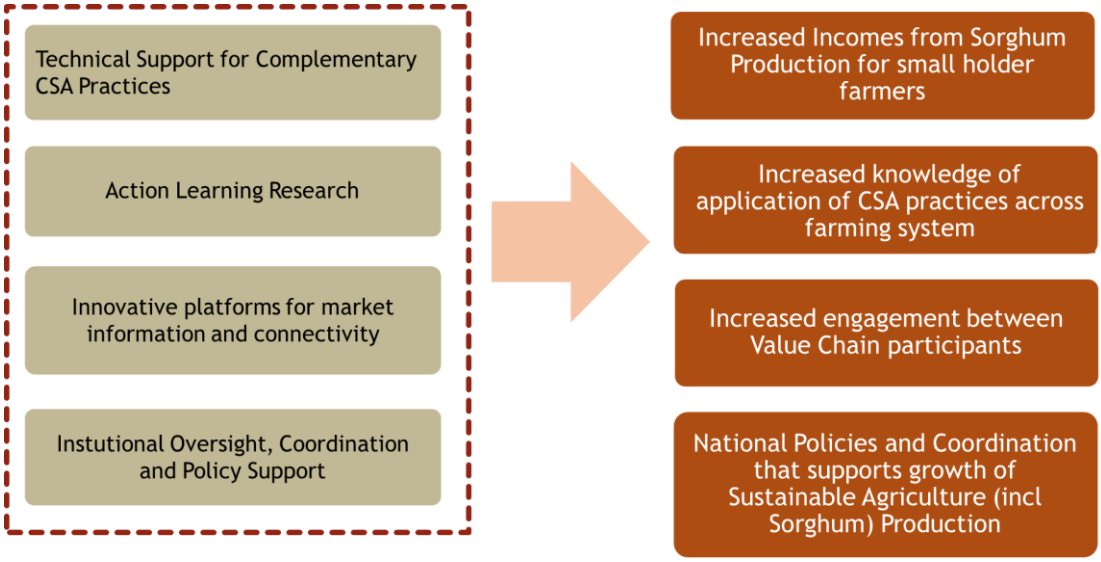


Figure 19 Implementation Mechanisms for Sorghum Value Chain

This implementation mechanism targets a clear set of impacts which support the climate resilience of smallholder farmers as shown below.



The results of this feasibility study and the previous work on CRA and CSA practices allow us to comprehensively scope each mechanism. Summaries of these scopes are provided below with more information to be contained in the Concept Notes under development with Lesotho and Botswana.

7 Conclusions

Technical Assessment

Changing extremities in weather patterns were the primary climate hazards identified for smallholder farming systems particularly, extreme rainfall patterns (late, insufficient, reduced) and erratic temperatures (more extreme highs and lows). These hazards led to a number of core critical impacts which significant threaten the success of small holder farmers; Poor germination, Increase in pests and diseases, Less maturation time, Poor quality and quantity of output (failure, decreased yield), Poor soil quality, Poor livestock health and productivity.

The CRA concluded that the risk categorisation for all of these biophysical elements under the projected climate change will be high. These risks are exacerbated by the sensitivities of the farming systems, namely the high reliance on rain fed agriculture and the use of crop types which are highly vulnerable to changes in water, pest and weather. The characteristics of the farming system limit the capacity of farmers to cope with the hazard impacts when they do occur; there is low uptake of irrigation systems that manage moisture deficit and limited targeting of agriculture practices to seasonal climate challenges, low utilisation of information services and lack of models to de-risk agriculture for smallholder farmers. Adaptation measures and CSA practices that best target these gaps and build these capacities will be those that best mitigate the risk from the climate hazards. Of particular interest to the stakeholders in Lesotho and Botswana are the practices of: Sustainable Fodder Production, Mixed farming (Crops and Livestock), Implementation of Rainwater Harvesting, Improvements in post-harvest storage and management, Legal and phytosanitary frameworks

A number of characteristics make Sorghum a resilient crop, including; its ability to withstand higher average temperatures after germination than most other cereal crops, its ability to survive as a rain-fed crop, tolerance for relatively low soil moisture during germination, ability to survive flooding events due to tolerance of wet soils, short maturity period and the highest food production per unit of energy spent and its versatility post harvest allowing the whole plant to be consumed / utilised for a variety of uses (broom-making, firewood, animal feed, fuel, food) and prepared in a number of ways (boiled, cracked, malted, baked and popped).

Whilst Sorghum appears to have significant potential as an adaptation response to predicted climate changes, there is insufficient data specific to Lesotho and Botswana. Results from regional research indicate that combining Sorghum in mixed systems and careful selection of variety choice is the most realistic approach. Interventions promoting Sorghum production should incorporate research and in particular action learning research approaches to ensure that resilience assumptions are upheld by production and livelihood outcomes.

To increase Sorghum productivity, create impact and improve the livelihood of smallholder farmers in the face of climate changes the following approaches are needed to support on farm production;

- Enabling farmers' access to production inputs and markets:
- Strengthen and sustain the technology delivery system
- Mechanisation: Adoption and use of small and medium scale mechanisation:
- Review of relevant agricultural policies:
- Restoring degraded soils and ensuring sustainability
- Understanding farm livelihoods and the potential impacts of interventions:

Sorghum production in Botswana is subject to a constraint in the form of the Quelea bird which provides a challenge for the sustainable production of Sorghum. Chemical avicides and firebombs have previously been used to control them but these have negative outcomes for the environment and non-target organisms. In small (< 10 ha) areas, IMP approach is the most environmentally benign strategy however training in these principles would need to be incorporated into FFS. Whilst some Quelea tolerant varieties have been trialled, there are still further opportunities to address this challenge that require additional exploration. Further pilot studies and action research projects can continue to address the challenge.

Business Case

Sorghum production for both countries is highly variable on an annual basis and has shown either a downward trend over time or stagnation in terms of production volumes. Despite this trend, Sorghum remains one of the most significant crops in both countries, accounting for 25% of production volumes of the other major crops. Although a large share of production is consumed at subsistence level or stored, there is revenue-generating potential for the local sale of Sorghum e.g. in Botswana in 2017, 36% of product was sold generating about $501,000 in revenue for farmers. However, it is important to note that there is large variance in prices across the different regions of the country. Production of Sorghum in both countries is geographically concentrated across three to four regions which account for over 70% and 60% of production for Botswana and Lesotho respectively. In upscaling production, it is important to identify the geographic focus of such a programme that takes into consideration the market structures and pricing within each district as this will influence the probability of success of upscaling. The economic viability of upscaling Sorghum production is significantly dependent on the following aspects:

- Operating costs for production per hectare
- Yields per hectare
- Prices per kilogram at which Sorghum can be traded

The profit per hectare of Sorghum production in Botswana and Lesotho is estimated to be approx. xxxx and xxxx respectively making Sorghum a viable revenue generating activity for smallholder farmers.

Some key recommendations going forward with intervention development are as follows:

- The cost of the programme design should factor in the revenue-generating potential of the interventions. However, the interventions should also be designed with food security in mind; there should be focus on upscaling for selling and on enhancing food security of smallholders.
- Interventions should be designed with pricing in mind as this will impact the revenue-generating possibilities in both countries.
- There is currently very limited information on the Sorghum off-takers and mills and therefore a gap in information on the scope for mills to increase their intake of additional production. Before detailed programme / intervention design can commence, additional primary research would be required which would need to include interviews with mills in both countries to get detailed information on their ability to increase their intake, as well as any key constraints they might face.
- Intervention design details should include capital and operating costs together with information on the extension services, training requirements and institutional implementation arrangements within national and local governments responsible for implementation; identification of the scope of upscaling and a quantification of the potential revenue on an annual basis. With further data, quantification of the economic benefits that can be unlocked as a result of enhanced food security and overall net economic benefits / costs of the programme over a predefined time period, would be useful.

Environmental and Social Assessment

Communities in both Lesotho and Botswana face a range of social and technical issues in their operations, but all indicated that they currently produce Sorghum for personal use (both countries) and external sales (Botswana) and are interested to further increase their production. Whilst drought incidents sometimes limit production in both countries, they still see Sorghum as a more drought-tolerant option than other crops. In Botswana, communities are concerned about the challenge the Quelea bird presents to their productivity, whilst in Lesotho farmers are concerned about the lack of stable markets for selling produce.

Patriarchy and culture contribute to significant gender gaps in power, control, choice and agency which is evident in decisions on land and income use, household division of labour, physical labour demands and market access. Whilst all farmers experience the impacts of climate variability, gender gaps in agriculture influence how women and men access, participate in, adopt and benefit from climate-smart agriculture practices for reduced vulnerability to climate variability. Women make significant economic and social contributions in paid and unpaid work, in the family, community and workforce and their large

presence in agriculture in Lesotho and Botswana indicates that they are a key factor in transforming agriculture and the lives of rural households.

In both countries it was identified that youth are not engaged or interested in agriculture due to pursuing employment in regional hubs and the capitals and having a poor opinion of the manual labour of farming. This is a common trend across Sub-Saharan African as aging farming populations are not being sustained by youth entering the sector. Farmers themselves identify the engagement of youth as a priority and are concerned that they are disengaging form the sector. In Botswana, the Youth Fund under the Ministry of Agriculture is an opportunity to support the engagement of youth in the agricultural sector particularly in more productive, poverty-reducing jobs including off farm within the value chains. In Lesotho there is reported to be a lack of inputs and farming equipment for youth, as well as security challenges for crops.

Interventions developed from the results of this feasibility study appear to pose little threat to the environment and social systems in the target countries. It is not possible to state precisely which exact activities will eventually be implemented, given that the actual shape of any future investment is currently unknown. It may be necessary at a future date, to revisit the analysis of this Environmental and Social Screening, in light of more detailed knowledge of the intended activities. It seems unlikely at this stage of understanding, that a project-level EIA will be required for individual projects. Once activities are implemented, environmental and social performance will need be monitored and evaluated, alongside the evaluation of other project related criteria.

Institutional and Coordination

Lack of sustained coordination between government departments and disjointed approaches to programming are challenges in both countries. In Lesotho, there are opportunities for coordination between private and public agriculture and climate-related institutions at national, regional, and international levels to enable increased investment from diverse sources, as well as targeting women in the approaches to programming. In Botswana, silo approach to operations is a challenge and there is an opportunity for better collaboration with the Department of Agribusiness for evidence take up, as well as ensuring negative incentives for sustainable approaches are eliminated.

Implementation Mechanisms

There is a broad scope of learnings from this feasibility study which inform the development of an intervention to sustainably scale up Sorghum production. To successfully drive and scale up Sorghum production along the value chain, implementation mechanisms are required to provide the technical and institutional support needed to elevate the current Sorghum production by smallholder farmers. These interventions need to provide technical support to farmers for farm practices and approaches that increase the resilience and productivity of Sorghum farming, action learning cycles to ensure that results based approaches can be quickly scaled by farmers, platforms to create partnerships between market players and institutional support and coordination to ensure consistency with national priorities. The way these core implementation mechanisms align to and support the value chain is shown below.

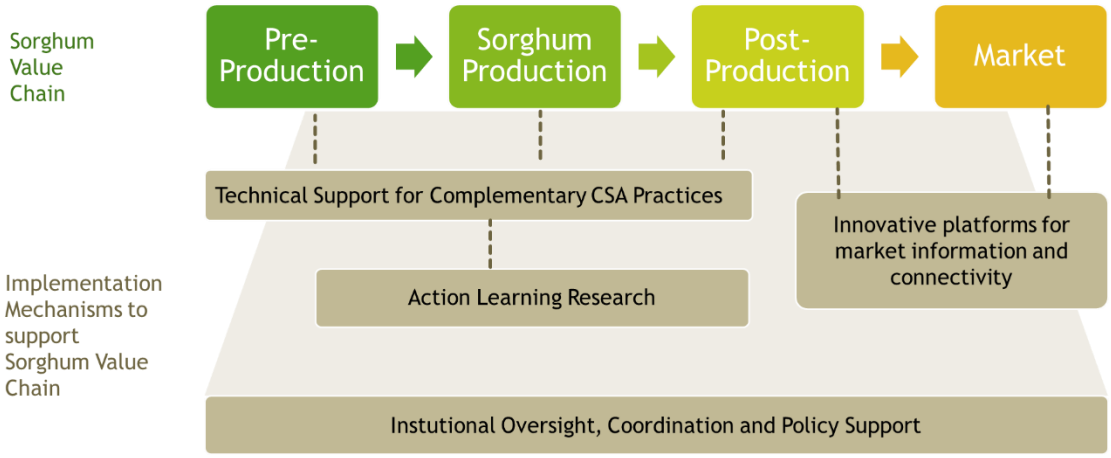


Figure 20 Implementation Mechanisms for Sorghum Value Chain

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Annex 1 Priority Climate Smart Practices[LK3]

Mixed farming (Crops and Livestock): by combining crops and livestock, farmers diversify household diets, improve nutrition and mitigate risk of loss.

Climate change is expected to include erratic weather patterns, primarily: increasing temperatures and decreasing rainfall. These climatic changes impact on farming and can pose challenges to sustainable production, income and food security. If a farmer is entirely dependent on one value chain, their resilience is compromised, and they may have difficulty coping and adapting in cases of extreme weather events.

Mixed farming combines crop production with livestock rearing (FAO 2017). It presents not only a means to diversify food production and improve nutrition at household level, but also a way for farmers to fortify their income and to mitigate risk of loss of either crops or livestock if the farmer is entirely dependent on one or the other.

Key Solutions:

Integrating cattle farming with crop production

In Botswana and Lesotho, cattle farming accounts for a large percentage of the agriculture sub-sector. In mixed systems in these countries, livestock can consume crop residues and by-products and in turn their manure can be used to fertilise crops (FAO 2017).

Integrating small ruminant farming with crop production

In Lesotho in particular, goats and sheep are reared on a large scale to produce wool and mohair. By integrating crops, farmers can also grow fodder for small ruminants and poultry

Sanitary and Phytosanitary frameworks: protect local consumers by ensuring food is safe for consumption and protect local farmers by regulating trade and strengthening local production.

Due to differences in climate, existing pests and diseases, or food safety conditions, the sanitary (human and animal health) and phytosanitary (plant health) requirements on food, animal or plant products coming from different countries need to be contextual. Climate variability in future also means a variability in diseases, pests etc. and changing pressures on food systems regionally, which require us to adapt these frameworks.

Key Challenges

Diseases and pests differ per value chain, per region

Food safety conditions differ per region

All countries maintain measures to ensure that food is safe for consumers, and to prevent the spread of pests or diseases among animals and plants. These sanitary (human and animal health) and phytosanitary (plant health) measures can take many forms (i.e. requiring products to come from a disease-free area, inspection of products, specific treatment or processing of products, setting of allowable maximum levels of pesticide residues or permitted use of only certain additives in food). These measures apply to domestically produced food or local animal and plant diseases, as well as to products coming from other countries.

Key Solutions

By adopting International Sanitary and Phytosanitary (SPS) processes, countries can protect their population by requiring that food should come from a pest/disease free area or require in-depth inspection or specific treatment or processing to ensure only safe levels of chemicals in the food – protecting both producer and the consumer.

By introducing border inspection, plants and plant-related consignments can be examined (checking relevant import/export documentation) and visually inspected.

Sustainable Fodder Production: allows farmers to meet the demand of forage for their livestock.

Climate change threatens food and water supply globally, due to increase in temperatures, prolonged dry spells and changes in rainfall patterns. This, coupled with rangeland degradation and soil erosion compromise quality of pastures, making grazing for livestock increasingly difficult.

Key Challenges

Overgrazing, poor land management and increased water shortages make pastures highly vulnerable and compromise grazing sources.

If underfed, animals may become emaciated and potentially unmarketable

Animals may be subject to reduced fertility which will affect the farmer's ability to breed their animals

Animals may be prone to disease, pests and less resilient to hazards

Beef, wool & mohair, milk quality and quantity may be compromised

Livestock population numbers reduce and as a result so too beef, wool and mohair production. By producing fodder, farmers are able to supplement livestock grazing and provide a more nutrient-rich addition to animal diets.

Key Solutions

Cereal grain sprouts in a controlled environment

Growing fodder by sprouting cereal grains in a controlled environment hydroponically, is an effective and time-saving way of producing feed for livestock which are known to be highly nutritious. Hydroponic fodder growth requires minimal labour, provides a high yield in a small area, year-round production and gives one control over feed quality for livestock. With simple installation, vegetation like barley, oats, wheat and maize can be grown, requiring no additional land for planting.

Planting cover crops for forage

After harvesting principal crops, farmers can opt to plant crops that, when harvested, serve as forage for livestock. In planting cover crops, farmers can supplement existing grazing, but also contribute to protection against soil erosion, inhibit weed growth and promote moisture conservation as mulch material.

Intercropping crops for consumption with crops for livestock forage

Intercropping crops for consumption with crops for livestock forage can help farmers maximise limited land space, while concentrating the labour of planting. Recent studies have shown an important added benefit of intercropping, for example, maize with drought-resistant greenleaf desmodium and planting Brachiaria grass on the farm's edge: it helps curb fall armyworms. Desmodium and Brachiaria grass are high quality animal fodder plants.

Fodder crop production on land suitable for crop production

This provides control of soil erosion by protecting soil surface from erosion. Similar to cover crops, fodder crops provide effective ground cover (more so compared to row crops). In addition, growing fodder on marginal fields results in the conversion of degraded land into quality forage (fodder) production fields as well as an increase in the prospects for their rehabilitation into viable crop production units.

Implementation of Rainwater Harvesting: enables farmers to collect and use rainwater in times of drought, or as an irrigation mechanism.

One of the biggest challenges which climate change poses, is the predicted decrease in rainfall. This, coupled with predicted higher temperatures and potential prolonged droughts, mean that relying on rainwater for farming will be impractical and a high risk for farmers. Overreliance on rain-fed agriculture is known to be one of the key challenges in Lesotho and Botswana. It poses a risk to farmers when the onset of rains is later in the season, or when the rains are inconsistent.

Key Challenges:

If reliant only on rains, crop farmers may face a delayed planting season if there is late onset of rains.

Limited availability of rains may also threaten livestock production as drinking water is reduced as well as water required for growing feed.

Rainwater harvesting allows farmers to hedge against the risk of low/late/no rainfall, providing water for crops and livestock in water shortage emergencies or, with proper planning, providing an irrigation mechanism as part of farming. The practice of rainwater harvesting generally refers to the installation (or identification) of a catchment area and the collection and storage of rainwater into natural reservoirs or tanks, as well as the infiltration of water on the surface into subsurface aquifers (before surface water is lost as runoff, or before it is lost due to evaporation, transpiration or becomes contaminated).

Key Solutions:

Rooftop rainwater harvesting and storage in tanks

Catchment areas are on rooftops (usually constructed of corrugated iron sheets, corrugated plastic or tiles, aluminium) and water runs downward into gutter pipes ending in tanks. Tanks are constructed from a wide range of materials and should be watertight, durable and affordable and should not contaminate the water. For usage of the collected water, a tap is usually installed at the base of the tank.

Runoff harvesting from open surfaces and paths and storage in pans and ponds

Pans and ponds are dug to collect and store surface runoff water (i.e. from hillsides, roads, rocky areas and open rangelands). When well designed, pans can collect significant amounts of water for livestock and for irrigating crops to augment rainfall. But pans have relatively small capacities and can lose water through seepage.

Earth dams

A dam can be constructed to collect water from less than 20 km^2 for a steep catchment and 70 km^2 for a flat catchment. Dams can serve as reservoirs to collect and store flash floods, or for more larger quantities. However, it requires an adequate spillway to avoid collapse since the damage (in case of collapse) would be excessive. Additionally, conveyance systems (gutters, pipes or channels) should be planned and carefully executed to transport water from the catchment to the storage device and eventually to the end-use.

Conservation Agriculture as a mechanism for minimum water usage and moisture retention

In Conservation Agricultural practices (minimum tillage, crop rotation, cover cropping), rainwater is caught in-situ (rainwater is taken up in soils through the soil surface, rooting system and groundwater. The soil acts as the storage agent, improving water holding capacity, reducing risks of soil erosion). Water is caught, conveyed, stored and used within the same soil. The soil is conditioned to conserve moisture for ideal crop growth. Water is only harvested elsewhere for irrigation only if the moisture is insufficient from crops.

Improvements in post-harvest storage and management: helps farmers to reduce losses after harvesting, increasing their food supply and income.

In sub-Saharan Africa, 30-50% of food produced for human consumption is lost or wasted along the value chain every year[2]. This is an example of quantitative loss. But foods can also be lost qualitatively: nutrition value, safety and grade. These losses equally affect nutrition, food security and income. Post-harvest losses exacerbate food insecurity and threats to livelihoods globally when combined with the pressures on future food systems which climate change is expected to bring.

Key Challenges:

Losses can be incurred at various stages of the value chain. The FAO [CM4]explains these stages:

Production & Pre-harvest losses (damage in the field before harvest, due to biological and biotic factors such as weeds, insect, pests and diseases. Pre-harvest conditions and actions in the field can indirectly lead to losses at later stages in the chain, as differences in production and agronomic practices can result in different quality at harvest, different suitability for transport and shipping, different storage stability and different shelf-life after harvest).

Harvest and handling (Poor harvest scheduling and timing, as well as rough, careless handling of the produce, are key contributors to food loss and waste along the chain. Farmers often leave cereals (i.e. maize) in the field upon maturity to dry because they lack facilities for drying. However, when the harvest season coincides with the second rains, as is the case in some countries, there is increased rotting and aflatoxin contamination).

Storage (lack of proper storage facilities is a major cause of post-harvest losses. Highly perishable produce requires adequate storage facilities with well-maintained conditions, mainly temperature, relative humidity and gas composition. If infrastructure for initial storage is lacking, perishable produce can spoil within hours.)

Transport (transport introduces an element of longer time span between production and consumption, of particular importance for fresh products, as well as additional risks of mechanical and heat injury. Lack of proper transportation vehicles, poor roads and poor/inefficient logistical management hinder proper conservation of perishable commodities during transport).

Processing and packaging (Food losses at the processing stage are mainly due to technical malfunctions and inefficiencies. Errors during processing often lead to defects in the end product, such as wrong size, weight, shape, appearance or damaged packaging. Although these defects have no bearing on the safety or quality of the product, processed food can be discarded for not adhering to set standards.)

Retail (retailers influence the activities of supply chains as they dictate the quality of the produce to be supplied and displayed in their outlets. Conditions within the retail outlet (temperature, relative humidity, lighting, gas composition, etc.) and handling practices have an effect on quality, shelf-life and acceptability of the product. High losses at the retail stage occur in perishable commodities such as fruits and vegetables, fish and seafood, meat, dairy products, baked foods and cooked foods)

Consumption (The consumer waste problem was mainly an issue in developed countries. But emerging economies increasingly face a similar challenge: income growth and demographic changes over the past 20 years have brought a change of eating habits with an explosion in the consumption of processed foods, together with a relative convergence of diets (consumption of meat, chicken and dairy per capita), the emergence of obesity problems, rising rapidly even in some cases among the poorest part of the population, and average level of consumer waste increasing with household wealth).

Post-harvest storage and management encompass a wide range of activities, influenced by a wide range of actors and factors along any value chain. And as every value chain is unique, so too are suggested approaches and strategies to curb or reduce losses. In Lesotho and Botswana, cereal production (maize, Sorghum and wheat) is critical and smallholder farmers account for a large percentage of farming activities; therefore, introducing strategies for smallholder farmers in the post-harvest storage and management of cereals will be crucial.

Key Solutions

[2] https://www2.deloitte.com/content/dam/Deloitte/za/Documents/consumer-business/ZA_FL1_ReducingFoodLossAlongAfricanAgriculturalValueChains.pdf

When appropriately applied, good agricultural practices and good veterinary practices can protect food, at the primary stages of production, from damage or physical contamination by extraneous materials, pests, insects or vermin, and from biological contamination by mould, pathogenic bacteria or viruses – any of which can cause spoilage, crop damage and food-borne illness or even lead to chronic health consequences in humans.

A key intervention all along food chains is to improve storage conditions. For preservation of quality of harvested perishable foods, the most important issue is temperature control.

Technical solutions in transport, processing and packaging need to be adapted to local situations, including the level of infrastructures, economic and human resources, as well as conditions along the rest of the food chain.

Annex 2 Community Engagement Notes and Attendance

Community Engagement Field Tool

Project: Climate Resilience Agriculture Production and Scale Up

Purpose of Project: To better understand climate impacts on agriculture production and to understand and prioritise practices which help make agriculture resilient to climate change, so that these considerations can be incorporated into National Strategy and Plans and Programming. The project primarily considers Sorghum and associated value chains (ie Crop Sorghum, Fodder Sorghum, Livestock) but is not restrictive. Other considerations and priorities can be captured in the reporting processes for consideration.

Purpose of Discussion: The project is primarily based on desktop analysis so these community engagements are important to 'ground truth' the teams understanding of key issues and the response and experience of farmers. The engagement should aim to draw out issues from farmers and to capture a broad understanding of the situation. The facilitators should try and balance letting the conversation flow to identify the unique characteristics of each community and keeping the focus within the context of Sorghum production for Crop and Fodder and the linkages between those processes and livestock production.

It is suggested that one person facilitates the discussion and another takes notes directly as the session is running.

Berea Community, Lesotho

Climate Resilience Stakeholder Engagement	
Community/Communities Represented	Malimong, Ha Ntsekhe
District	Berea
Number of Participants	11
Agro-ecological Zone	Foothills
Characteristics of Ag Crop	*What is primary crop grown?* Maize, Sorghum and Beans *What varieties do you use?* For Sorghum they use Macia and Pan 8703 For maize, SNK 2778, 4410, PAN 12 and Sahara For beans, pinto and sugar beans and NUA 45 though it's a new variety to them. *Where do you get inputs from?* We purchase them from government store in a form of subsidy. *When do you plant?* They used to plough from october to december but due to climate change things have now changed because they depend on rain fed and they wait until early december. *What is primary commodity sold for cash?* Currently there is no commodity sold for cash due lack of market. *What is crop they would like to produce? (if different from current)* Intereted in Sorghum, potatoes and beans *What techniques are you using?* (ie. CA, mechanised) The most popular technique used is conventional ploughing, even though not all of them are able to plough due to high costs.
Charcteristics of Ag. Livestock	*What livestock are kept? (which most popular)* *For production (ie Milk, Wool, Mohair) or consumption/sale (Meat)?* The most popular livestock kept are cattle, sheep and goats. However wool and mohair perform better than dairy sector because they have Sesotho breeds which do not produce more milk as opposed to dairy breeds like Holstein Friesland.
Climate Challenge	*What is the weather related issue that causes them the most challenges?* Climate change brought many changes that affect farmers, for instance, severe drought,heavy rain fall which sometimes cause

	erosion, at times they experience early frost in mid March which they never experienced. *When does first rains come?* Earlier on, they used to have first rain in September but lately first rains came by the end of November to early December. *When does frost come?* Normally frost come in April but due to climate change it varies at times it came in mid March sometimes in May like this year in some areas it came in June.
Water Challenges	*What is the water related issue that causes them the most challenges?* *there is access of water but chllenge is the community tap are not working thus need maintanence.* *Do you have access to water?* There is access to water which could be used for irrigation and for domestic purposes but unfortunately we do not have irrigation systems.
Soil Challenges	*What is the soil related issue that causes them the most challenges?* Ie .erosions, soil quality, soil fertility Farmers stated that production differs depending on the type of soil. On the river side where there is black soil the yield is high due to high nutrients content. On the other hand there is also areas with soils that are shallow with low nutrients therefore the production is not high in such areas. *What measures/practices do you use to improve your soil fertility?* *(e.g. crop rotation, kraal manure, green manure, CA)* They use manure and fertilizers to improve their soil fertility, however they said kraal manure only takes up to three years while fertilizer takes one year but the yield is slightly higher than on the plot where they have used fertilizers.
Pests challenges	*What pests attack your crops?* There are few pests that are available in that area especially cut worm, bettles, bagradabug.
Storage	*What are the issues related to storage and post harvest management which cause them the most challenges?* Farmers store their produce in their houses and this turn to be a challenge because they do not have enough space for storing their produce. Again it is difficult for them to fumigate as they use their houses therefore pest takes an advantage.The other challenge is that there is an issues of theft while they are still preparing for harvest.
Transport	*What are the issues related transport and market access which cause them the most challenges?* There were different opions raised among farmers during our discussion others said there is no market for their produce and point out that in 2016 they produced more Sorghum but destroyed by weevil in their storage due to lack of market; even though the Government announced that it will buy their produce. While others view things in a different way whereby they see market of beans to WFP.
Sales Challenges	*What are the issues related to sales which cause them the most challenges?*

	(if not covered under previous question) Assumed in the previous response
Opportunities	*What do they see as the biggest opportunties for them in Agriculture?* • For beans there is a possibility of selling to the schools as compensation for school fees. • The other opportunities they are seeing is selling their produce to the institution like hospital, army, police services
Challenges/Opportunties for women (directed to women in the room)	*What are the issues that cause them the most challenges?* Generally women stated that their voice is not heard in the families concerning agricultural activities,in other words they do not have a saying men decision is enough so there is no motivation for them to fully participate in field activities.The other challenge is manpower for loading and offloading the truck which require power. Thirdly,the issue of hoeing is a challenge because they work on large scales of 2-3 acres on average. *What are the issues related to Sorghum farming?* Women said their norm sometimes tend to be barriers because when it comes to threshing men do not allow them to do such work, their role is winnowing. *What are the opportunities they are seeing in Agriculture?* According to them, sorhgum can reduce poverty as it can be sold in several forms for instance,it is used to brew beer,can also be sold as a grain, thirdly, it can be used as mealie-meal to companies producing soft porridge(motoho).
Challenges/Opportunties for youth (directed to youth in the room, but others can give opinions if none present, just note that opinion is from others)	*What are the issues that cause them the most challenges?* Thought there were no youth, farmers believe that most youth don't see opportunities in agriculture because some years back it was used as a punishment to them when they came late to school, they would be given a big plot to plough upon their arrival therefore they lost interest. *What are the issues related to Sorghum farming?* Sorghum is a good crop that is tolerant to drought, it requires a lot of time especially at its vegetative stage because this is when different birds eat it therefore farmers must take full monitoring. *What are the opportunities they are seeing in Agriculture?* There are schools arround their communities where they can sell their produce the only thing they need to do is to form groups or associations so that it will be easy to get funding from Smallholder Agricultural Development Project (SADP) from government. Again most of youth when they graduate they can easily be trained on how to write business proposals.
Sorghum Related	*Do they produce currently?* Yes they produced it though the production scale in terms of acreage is smaller than last year due to drought.

	For sale or personal supply? Currently they are producing for home consumption but in future they want to commercialise agriculture. *How does it perform compared with Maize? (production and sales)* Maize is mostly used for personal consumption but Sorghum is highly prefferable for business purposes. Soghum is also not mostly attacked by pests compared to maize therefore, if they were to choose between the two they would go for Sorghum. *Are they interested to increase production?* They can increase production provided that there is a stable market where they can sell their produce. So now their fear is operating on larger scale without knowing the buyer but if there is access to the market they can increase production because they have access to land. *What is preventing them?* According to them subsidy is only given to the traders as farmers are not allowed to go straight and buy from the Government store therefore, this turn to be a barrier because they say the inputs are still expensive.
Fodder Management/ Crop & Livestock systems	*What is the biggest challenges related to fodder?* The only challenge they have is seed availability but if there can be a funding they can plough fodder *Do they purchase fodder?* No they do not purchase but they use crop residues after harvesting grain and sometimes they plant English giant for feeding their animals. *Do they produce their own fodder? If not why not?* Yes they produce their own fodder. *Would they change from Crop Sorghum to fodder Sorghum?* It is not easy for them to change from Sorghum to fodder because they have seen that there is a greater opportunities in Sorghum than in fodder production.
Any other general comments	
Local/District extension staff key thoughts	If relevant
DAR/National government staff key thoughts	If relevant

Thaba Tseka Community, Lesotho

Climate Resilience Stakeholder Engagement	
Community/Communities Represented	Ha-Shoaepane
District	Thaba-Tseka
Number of Participants	47
Agro-ecological Zone	Highlands
Characteristics of Ag Crop	*What is primary crop grown?* Maize, Sorghum and Beans *What varieties do you use* They use pinto,sugar beans,silver king and open pollinated varieties. *Where do you get inputs from?* They purchase them from government store and retail shops *When do you plant?* *October - November* *What is primary commodity sold for cash?* Wheat & Beans *What is crop they would like to produce? (if different from current)* They would not want to change from these crops as they see their performance keeping well with the current climate condition therefore wheat and beans are their priority. *What techniques are you using?* (ie. CA, mechanised) Farmers are using one technique being conventional ploughing however they are aware of other techniques
Charcteristics of Ag. Livestock	*What livestock are kept? (which most popular)* *For production (ie Milk, Wool, Mohair) or consumption/sale (Meat)?* The most popular animals they rear are sheep,goats and cattles. They even mentioned that they invest so much in sheep and goat because of quality wool and mohair produced due to their high altitude thus,minimum pest and diseases which are not favoured by the cool temperature. However, there are some challenges brought by Government in terms of selling these commodity(wool and mohair).
Climate Challenge	*What is the weather related issue that causes them the most challenges?* There are several consequences they are suffering from as a result of climate change for instance: experiencing severe drought,rain does not come at the normal time than before and when comes it comes it

	as hail storm and washes away top soil which is the most fertile one hence severe soil erosion. *When does first rains come?* The first rain used to come around September to November but currently it even starts in February. *When does frost come?* In the past it used to come in April but currently they experiencing it in March.
Water Challenges	*What is the water related issue that causes them the most challenges? Ie shortage, lateness, flood etc* There is a lot of water due to many streams and wells available in the area but also the pressure in the pipes has reduced supply to other nearby villages and they think there is a need for maintenance. *Do you have access to water?* Yes there is access to water
Soil Challenges	*What is the soil related issue that causes them the most challenges?* Ie .erosions, soil quality, soil fertility There are several challenges related to soil encountered by farmers. The production has decreased due to poor soil condition in terms of fertility, therefore top soil has been washed away by flood and resulting in low yield during harvesting. *What measures/practices do you use to improve your soil fertility? (e.g. crop rotation, kraal manure, green manure, CA)* They are adding kraal manure after harvesting to improve soil structure and retain its quality for better production.
Pests challenges	*What pests attack your crops?* Pests that attack their crops are aphids,cut worm and ladybird. These if not seriously taken into consideration reduce crop performance and yield decreases.
Storage	*What are the issues related to storage and post harvest management which cause them the most challenges?* There is no storage as farmers stay in their houses with their produce. There is a lot of mice/rodents that destroy their produce.
Transport	*What are the issues related transport and market access which cause them the most challenges?* Roads are available though transport is not easy therefore it is not easy to access the market.
Sales Challenges	*What are the issues related to sales which cause them the most challenges?* *(if not covered under previous question)* Assumed in the previous response
Opportunities	*What do they see as the biggest opportunties for them in Agriculture?* Currently farmers said they do not see any market opportunities as there is no linkage between them and the market.

Challenges/Opportunties for women (directed to women in the room)	*What are the issues that cause them the most challenges?* Their vulnerability and lack of physical power make things difficult as they need more manpower for issues like loading and offloading of manure. Donkeys bieng their mode of transport. They experience a lot of weeds and for hoeing there is need for more manpower *What are the issues related to Sorghum farming?* Sorghum require a lot of time epsecially during vegetative stage because this is when species of birds fully depend on it for food. Therefore the field owners have to be there from morning till afternoon for mornitoring. *What are the opportunities they are seeing in Agriculture?* According to farmers present there is no opportunities because of lack of market.
Challenges/Opportunties for youth (directed to youth in the room, but others can give opinions if none present, just note that opinion is from others)	*What are the issues that cause them the most challenges?* Youth are mobile,they don't stay for long time in one area, they are in search for jobs therefore, they don't fully participate in agriculture as they did not realise any opportunity in it. There is also lack of inputs and farming equipment. Youth are also experiencing security challenges for their produce as they are normally grazed by the village livestock *What are the issues related to Sorghum farming?* Lately,there is a kind of weed that is growing at a suprising rate that compete with their crops and where it is grown crops do not survive and this reduce productivity. *What are the opportunities they are seeing in Agriculture?* Farmers do not see any opportunities in agriculture because their challenge is that there is no market access.
Sorghum Related	*Do they produce currently?* Yes Sorghum is still planted this year though acreage reduced due to lack of inputs, it is not easy for farmers to access them. *For sale or personal supply*? Firstly soghum is for personal consumption secondly for sale to companies that use it for making soft porridge and also for brewing beer. *How does it perform compared with Maize? (production and sales)* Maize is mostly used for personal consumption but Soghum is highly prefferable for business purposes. Soghum is also drought and disease tolerant crop compared to maize. *Are they interested to increase production?* Yes they are interested in increasing production as they are aware that they can not afford to buy everything they need, even the ones that they do have potential to plant for themselves.

	What is preventing them? There is severe drought and it affects their planting times leading to low production. However, if there can be funding that could help in terms of buying inputs. The other challenge is that their animals are being stolen by theives so it is a bit harder to work out the fields because they use them for all agricultural activities.
Fodder Management/ Crop & Livestock systems	*What is the biggest challenges related to fodder?* Their challenge regarding fodder production is that they do not know where to find seeds due to lack of information, even the little that is available from other others is very expensive so they could not afford to buy it. *Do they purchase fodder?* No they do not purchase it. What is actually happening is that their animals depend on grazing in rangelands. *Do they produce their own fodder? If not why not?* What they consider as their fodder is plant residues or remains after harvesting and this is used for feeding animals, they don't actually plant crops like oats,barley and fodder soghum for the purpose of feeding livestock. *Would they change from Crop Sorghum to fodder Sorghum?* They would rather stick to Sorghum because they are aware that it is drought tolerant therefore it can still be produced under climate change condition, besides that Sorghum is easily marketed because it does several things like soft porridge,brewing of beer,etc.
Any other general comments	
Local/District extension staff key thoughts	If relevant
DAR/National government staff key thoughts	If relevant

Kgatleng Community, Botswana

Climate Resilience Stakeholder Engagement	
Community/Communities Represented	Mochudi
District	Kgatleng
Number of Participants	20
Agro-ecological Zone	??
Charcteristics of Ag Crop	What is primary crop grown? The community primarly produce **Sorghum** though they lately shifted to **Maize**. But the problem with maize is that it is not able to withstand drought forcing them to slowly go back to Sorghum. They are also growing the speckeled **cowpeas** because of its drought resistance. They claimed they used to plant legumes at least twice a year. What varieties do you use? Sorghum(*sekgaolane, sekgohloane(koroane)-Tsabatsie* Pearl millet Maize – SA 513, SC 506 and ZM and local maize varieties though most have disappeared. Farmers believe that the hydrids varieties require more water and take longer to mature. Where do you get inputs from? They get the inputs from government susbisy and from own silos. When do you plant? Their planting depends on the rain which is normally between December and January, though it was initially in October to December. This would allow weeds to grow and be destroyed during planting. Again around that time quelea birds are not ready to attack by the time they are the grain is toughned. These birds attack from January. What is primary commodity sold for cash? Sorghum and legumes (Jugo beans) What is crop they would like to produce? (if different from current) Groundnuts, it is just that they don't know how to thresh them. Tappery beans which are drought resistant and lablab for livestock. What techniques are you using? (ie. CA, mechanised) They mainly use conventional ploughing with 3x6 furrows. They practice mixed farming, no till, potholes- though needs use of herbicides.
Charcteristics of Ag. Livestock	What livestock are kept? (which most popular) sheep and goats, broiler chicken, cattle For production (ie Milk, Wool, Mohair) or consumption/sale (Meat)?
Climate Challenge	What is the weather related issue that causes them the most challenges? New pests and weeds. Drought which causes poor germination When does first rains come? First rains come sprangly in January. When does frost come? Frost now starts around 25th May though used to come in 25th June.
Water Challenges	What is the water related issue that causes them the most challenges? Ie shortage, lateness, flood etc. There is shortage of water and mostly full of algae. Do you have access to water? There is generally no water and it is salty, only potable water is cleaned.
Soil Challenges	What is the soil related issue that causes them the most challenges? Ie .erosions, soil quality, soil fertility Farmers suspect that the fertilizers destroy the soils especially if it does not rain(burn crops). Soil testing is a challenge, maybe if government can change the way they are doing things will fast track the change What measures/practices do you use to improve your soil fertility?

	(e.g. crop rotation, kraal manure, green manure, CA) Farmers use decomposed kraal manure. They wish they could use the crop residues but they feed them to livestock, that could reduce soil erosion.They believe ripping is important as well.
Pests challenges	What pests attack your crops? Quelea birds are a mojor challenge, stock borer, aphids, army worm, squirrel, jackals eat melons and locusts ('stotojane'). Weeds are also a problem. They mostly use chemicals to control pests.
Storage	What are the issues related to storage and post harvest management which cause them the most challenges? Harvest is kept in the houses, there are no storage facilities. There is high spoilage of produce. They used to use some chemicals in storage but some are no longer in the market
Transport	What are the issues related transport and market access which cause them the most challenges? They hire transport to collect produce and it is expensive to do so while others have their own transport.
Sales Challenges	What are the issues related to sales which cause them the most challenges? (if not covered under previous question) The formal market prices are very low, Botswana Agricultural Marketing Board(BAMB) including butcheries. Farm gate prices are better, but challenge is all farmers produce. Farmers do barter system with one another.
Opportunities	What do they see as the biggest opportunties for them in Agriculture? The use and availability of ripper services and use of potholes. Introduction of silos for storage. Government need to make sure that the prices favour farmers. Price vs quality (storage)-cooperatives used to work for farmers but due to unreliability of farmers they are failing (aggregation)
Challenges/Opportunties for women (directed to women in the room)	What are the issues that cause them the most challenges? Women take more time taking care of fields than men, including taking care of children, 'we need each other'. Single parenthood is also a challnege in farming and for safety issues. Gender issues need to be balanced. What are the issues related to Sorghum farming? What are the opportunities they are seeing in Agriculture? Women collectively working together and collective marketing brings unity, that help them tackle labour issues in the farms. Government may need to consider using the Public works 'Ipeleng' for weeding in the fields.
Challenges/Opportunties for youth (directed to youth in the room, but others can give opinions if none present, just note that opinion is from others)	What are the issues that cause them the most challenges? Farmers reported that it is their fault that young people do not like farming, they leave them at home when going to the fields. This results in youth not loving and interested in agriculture. These young people are raised in the cities What are the issues related to Sorghum farming? What are the opportunities they are seeing in Agriculture? There is a youth fund under the Ministry of agricuture which supports young people in agriculture.
Sorghum Related	Do they produce currently? Sorghum is largely produced For sale or personal supply? For both personal use and sale How does it perform compared with Maize? (production and sales). It performs better than maize in terms of resistence to drought and consumption Are they interested to increase production? Yes What is preventing them? Drought and birds
Fodder Management/ Crop & Livestock systems	What is the biggest challenges related to fodder? Fodder seed prices are high, a 10kg bag costs a P1,000.00. There is also a limited knowledge on fodder production. Some fodder varieties need plenty of water. Do they purchase fodder? Do they produce their own fodder? If not why not? Yes, largely Lablab. Most of them have not seen fodder Sorghum(limited varieties)

	Would they change from Crop Sorghum to fodder Sorghum? There is is need to balance both, as farmers rely on livestock.
Any other general comments	Government is responsible for spraying and explosives to control birds. There is high demand for rippers and UN GEF SGP could assist if farmers make applications
Local/District extension staff key thoughts	If relevant
DAR/National government staff key thoughts	If relevant

South East Community, Botswana

Climate Resilience Stakeholder Engagement	
Community/Communities Represented	Ramotswa
District	South East, Botswana
Number of Participants	26
Agro-ecological Zone	South East
Charcteristics of Ag Crop	What is primary crop grown? Farmers primarly grow **legumes**(cowpeas). They moved to **maize** but lately coming back to **Sorghum,** because maize is not as tolerant as Sorghum. They realised that if they had planted maize and Sorghum, when it rains farmers with Sorghum get more yield. Sorghum does not require as much weeding and moisture as maize does. Cowpeas are also drought tolerant. What varieties do you use? **Sorghum** – Sekgaolane, Sekgohloane(Milo) more tolerant than Sekgaolane though reliable than other varieties, Mabaitse, Kanye and hybrid by government(but they don't plant it more than other varieties). **Maize –** Hybrid maize take less days than local varieties, Kalahari Early Pearl **Legumes –** speckeled cowpeas(Tsiloane) and local varieties (Tsioana) and blackeyed . There is preference of local varieties as farmers are convinced that hybrid varieties need more management. Where do you get inputs from? From government subsidy From own seed bank When do you plant? November – December, early planting help them avoid the birds(quelea). We plant late due to delayed rains which is now a trend and in turn result in low yields. What is primary commodity sold for cash? Sorghum, cowpeas and its leafs for vegetables What is crop they would like to produce? (if different from current) Finger millet-it is drought resistant but not very popular in this region. It is far better than Sorghum in productivty though mostly prefered by quelea birds. What techniques are you using? (ie. CA, mechanised)Ripping does not have equipment/facilities hence they have not yet seen the benefits. They understand that conventional does not preserve moisture. The tractor owners because they are paid by government for operations such as discing on their fields, just to get paid they force farmers to disc and yet farmers do not prefer discing. A farmer who refuses that is not prioritized by these operators.
Charcteristics of Ag. Livestock	What livestock are kept? (which most popular) Cows, sheep and goats For production (ie Milk, Wool, Mohair) or consumption/sale (Meat)? These animals are mostly kept for selling. Few use cows for ploughing the fields. The community used to keep pigs but because of health issues they are no longer kept. They claim pigs need more care and give diseases to cattle. Chickens as well are not kept in large number due to the New Castle outbreaks. Government is no longer helping and they resort to traditional medicines for treatment.
Climate Challenge	What is the weather related issue that causes them the most challenges? The most common climate change issue is severe drought since the country in general is already drought prone. This has brought a delay in planting season, as farmers have to wait for rains. This results in low productivity. There are also cases of floods for low laying areas. The drought also bring a lot of livestock mortalities

	When does first rains come? Rains used to come as early as September-October but lately they come as late as November to January hence delaying planting and leading to frost attack. When does frost come? Frost now comes as early as mid May instead of June-July. Late planting also make their crops prone to frost. They have to plant maize in December to avoid frost
Water Challenges	What is the water related issue that causes them the most challenges? Ie shortage, lateness, flood etc Drought is the main climate change issue experienced and occasional floods on the flat regions Do you have access to water? There is generally no access to water but only in dams for livestock. Some fields have wells and farmers use scotch-carts to collect it as there is no irrigation infrastructure. Potable water is collected from town not in the villages. Irrigation is not even an option in this region, though the community wish they could irrigate.
Soil Challenges	What is the soil related issue that causes them the most challenges? Ie .erosions, soil quality, soil fertility They mainy have 2 types of soils, the loam and sandy soil. They mainly plant maize on the loamy soil and legumes on the sandy soils. The loam soil is generally able to retain moisture unlike the sandy soil which is not good for the crops What measures/practices do you use to improve your soil fertility? (e.g. crop rotation, kraal manure, green manure, CA) They use crop rotation to improve fertility and have realised that rotating beans makes consecutive crops look good.There is also a common use of manure (kraal and chickens) as well as compost and planting back the crop residues. There is not much soil erosion in the region due to flat terrain. But occasional floods do erode the soil and compaction is due to overgrazing. Soil quality/fertility is checked by testing the soil. They also minimize tilage to avoid wind erosion" "My soil is good I am just struggling with weeds", one farmers mentioned. The farmers expressed the concern that they belief the weeds come with the government fertilizers since they used those they experience different types of weeds.
Pests challenges	What pests attack your crops? Termites, worms(cutworm and stock borer, ballworm), corn cricket and fall army worn(2017)are some of the common pests. For most of these pests farmers use the local knowledge. They struggle most with weeds, though they use herbicides like (Striker) they believe more in weeding. They believe that chemicals have after effects and they are good with significant amount of rain.
Storage	What are the issues related to storage and post harvest management which cause them the most challenges? The grain is mostly infested with the weevil at storage. The are no silos the grain is stored in the 'houses'. Because there is no access to markets the grain end up spoiled in storage.
Transport	What are the issues related transport and market access which cause them the most challenges? There are poor access roads to the fields, these limit marketing of the products especially Sorghum.
Sales Challenges	What are the issues related to sales which cause them the most challenges? (if not covered under previous question) The quality and price are the more determinants of the market. The feel like the formal market is taking their products for 'free'. The market mostly require the quality they do not have. They believe the low prices are due to the reference to the international markets(SAFEX), which may not be fair because they do not produce as much as RSA they are compared to. Farm gate sales make more money than formal market
Opportunities	What do they see as the biggest opportunties for them in Agriculture? They are able to produce enough to consume and sell. Small stock makes more money. The horticultural crops such as squash, melons and cowpeas leafs sell early therefore gives money.

Challenges/Opportunties for women (directed to women in the room)	What are the issues that cause them the most challenges? Duties such as weeding is mostly left to women and become more difficult if there are no equipment since women do not have as much man power as men. Ploughing operations are also labour intensive for women while at the same time expected to look after the children/households. There are also safety issues since women can not go out at night in the event of wild life damage and theft. Single parenthood is even more difficult for women to manage all operations and are mostly disregarded by communities. What are the issues related to Sorghum farming? What are the opportunities they are seeing in Agriculture?
Challenges/Opportunties for youth (directed to youth in the room, but others can give opinions if none present, just note that opinion is from others)	What are the issues that cause them the most challenges? Its worth noting that there were no youth in the room. The farmers claim that the young people are 'educated'and therefore donot practice farming. They also claim that these young ones are selling their fields instead and they treat going to the fields as abuse. Some believe it is their fault as parents because they leave the children at home when going to the fields, they have not introduced them to farming as business. They concluded that if they do not let the youth farm the land will be taken by the business people and make money out of it. What are the issues related to Sorghum farming? What are the opportunities they are seeing in Agriculture?
Sorghum Related	Do they produce currently? They largely produce Sorghum than any other crop For sale or personal supply? They produce for both sale and personal supply How does it perform compared with Maize? (production and sales). Sorghum is largely used in Batswana culture therefore it mostly sold than maize Are they interested to increase production? They are interested to increase Sorghum production What is preventing them? The issue of quelea birds as well as drought are the main factors preventing them to increase production
Fodder Management/ Crop & Livestock systems	What is the biggest challenges related to fodder? Animal feed is still expensive even though still subsidized by government at 50%, farmers are still reluctant to buy. Lucerne bales in the shops have signifcantly reduced in size though still the same price. Do they purchase fodder? The farmers believe that producing own fodder could reduce costs for animal feed Do they produce their own fodder? If not why not? There are not enough fodder processing infrustructure available for farmers. They claim their land holding is not enough for both crops and fodder production. Would they change from Crop Sorghum to fodder Sorghum? Some believe they already do not have enough to eat so cannot produce fodder for animals.
Any other general comments	
Local/District extension staff key thoughts	NB; The comments are by the extension staff and reflection of the entire country(3 regions visited) Sorghum production is high in Botswana, though farmers have experimented with maize. But now maize production has gone down. But apparently green mealies makes more money. Farmers believed Sorghum production was labour intensive; chasing the birds and threshing. Sorghum is mainly used in Batswana culture for brewing for funerals, weddings and other festivities. Hence why they cannot give up Sorghum for fodder. Women are mostly not the greatest fans of production of Sorghum because it is very itchy when threshing. But genereally they trying Sorghum again especially

	because government is supporting them, with explosives for quelea birds. Government has piloted the use of falcons for commercial settings. As for the uptake of CA, it is very low, and yet the soils are getting poorer and poorer. There is also no eqyuipment and farmers are still continuing to buy tractors and conventional ploughs. Government is advocating for adoption of conservation agriculture but the understanding of the Field Officers is very low hence slow uptake by farmers. Among the principles of CA only minimum tillage is understood than, rotation and use of cover crops. This is due to the fact that CA is not in the school curriculum. There is a need for standardised manual for Extension staff. Irrigation is not an option for Botswana agriculture, it is only used for irrigation of horticutural crops. Very few areas have water. Government subsidises the planting operations, though there is poor monitoring and the operations are not well done. There is a programme that supports youth within the Ministry of Agriculture. Adaptation measures on dealing with the quelea birds – introduction of the Sorghum variety that faces down, another one have grain inside…?, the peninicle flexes and the birds can not sit on and the promotion of bitter content varieties for birds but is used for brewing. Government also introducing the early maturing varieties. The local varieties do take long but DAR is working on short maturing varieties. Government is currently looking at the national climate change strategy which will ultimately deal with climate change issues.
DAR/National government staff key thoughts	DAR is considering exploring other breeding processes in response to assisting the farmers with the issue of birds on the Sorghum crop, ie, bring other traits in the Sorghum that can make it resillient to these birds.

Kweneng Community, Botswana

Climate Resilience Stakeholder Engagement	
Community/Communities Represented	Boatlaname Kgotla
District	Kweneng
Number of Participants	30
Agro-ecological Zone	?
Characteristics of Ag Crop	What is primary crop grown? **Sorghum** (local and hybrid varieties), **Legumes**-Lablab, **Melons** and **Maize** What varieties do you use?Sorghum (Sekgaolane, Nkoroane(Sekgohloane), black eye and Maize(506) Where do you get inputs from? Government subsidy, from own silos and agro dealers. When do you plant? In December or depends on when the rain comes. Ideally rains comes in November but now it rains in December - January What is primary commodity sold for cash? Legumes, Maize What is crop they would like to produce? (if different from current)Mung beans, Bambara groundnuts What techniques are you using? (ie. CA, mechanised) The most common technique used is planting in furrows. Top dressing is also very common as well as coating the seed before planting. Farmers believe more in ripping than conventional ploughing. They claim that they are forced to use conventional ploughing because the operations are subsidised.
Characteristics of Ag. Livestock	What livestock are kept? (which most popular)Sheep, goats and cattle. Farmers prefer to invest in livestock than in crop production. For production (ie Milk, Wool, Mohair) or consumption/sale (Meat)? Livestock is mainly kept for sale. They do not want to import milk goats due to foreign diseases, they prefer to breed locally. Some farmers claimed that they sell livestock to invest in crop production, make repairs and maintenace of equipment. One farmers testified that he bought a tractor with sales from Livestock. As for the chickens they supply youth projects with them. In this region people still do not prefer piggery production. I Missed something about feedlot –EU and Meat Board??
Climate Challenge	What is the weather related issue that causes them the most challenges? The main climate challenges are drought and late rains. There are many diseases claimed to be brought by climate change. When does first rains come? The first rains come in November and disappears. Then planting starts in January When does frost come? The frost comes in may though it depends on the regions. It used to come as late as Mid June to July. Late planting leads to attack by frost.
Water Challenges	What is the water related issue that causes them the most challenges? Ie shortage, lateness, flood etc There is no water in the region even for drilling. They spend most time collecting water. Some water is too salty and pH between 4.5-11.5. Irrigation is not even an option for them. Water is supplied by trucks and the households, schools compete with farms. Do you have access to water?
Soil Challenges	What is the soil related issue that causes them the most challenges? Ie .erosions, soil quality, soil fertility. There are limited soil testing facilities, some have waited 4-5 years for the results. Wind erosion is one of the bigger challenges and the nutrients move with the top soil. Their soils are mostly sandy and clay soils and are more difficult to manage than loam soils. Soils are regulated by the amount of rain.

	What measures/practices do you use to improve your soil fertility? (e.g. crop rotation, kraal manure, green manure, CA) The use of organic matter is more important than the chemical fertilizers especially because they do not have the soil test results. They use crop residues and crop rotation
Pests challenges	What pests attack your crops? The quelea birds are a major problem, francolin birds, ground squirrel and springhare though are more difficult to control than birds. Bagrada bugs are also a challenge, worms(yellow/green) witch weeds and aphids
Storage	What are the issues related to storage and post harvest management which cause them the most challenges? There are no silos, the harvest is kept outside and cannot withstand heat and rain. Weevils are also a big problem in storage – to control them they dry the grains and use some local knowledge of coating the grain with goat faeces. They also buy chemicals, keep in cold storage and use smelling herbs/trees to get rid of pests.
Transport	What are the issues related transport and market access which cause them the most challenges? They transport in small vans and this is not value for money.
Sales Challenges	What are the issues related to sales which cause them the most challenges? (if not covered under previous question) Low market prices from formal market like BAMB (Botswana Agricutural Marketing Board). There is low return on investment because of the middleman who makes more money than they do, especially when selling to schools. Farm gate prices are better. There are no aggregation points. They do not sell consistently every year. Milling companies do buy their products but a P270.00 bag for P150.00. Others buy at P110.00 for P300.00 per bag.
Opportunities	What do they see as the biggest opportunties for them in Agriculture? Government subsidy offers a great opportunity in agricultural production, it reduces production costs. There are drought interventions in place by government to support farmers. “we almost plant for nothing, we are blessed”. Though other people still don’t care and don’t take care of the fields despite planting for almost ‘free’. Government may need to consider not to spend money on the 5/15 ha?with no rain but rather 1ha with water(irrigation/wells) Agriculture create jobs and income for wealth.
Challenges/Opportunties for women (directed to women in the room)	What are the issues that cause them the most challenges? Men graze their animals on women’s fields. Women cannot herd after cattle. Single parenthood makes it even worse What are the issues related to Sorghum farming? What are the opportunities they are seeing in Agriculture? Sorghum makes income for women as is mostly sold.
Challenges/Opportunties for youth (directed to youth in the room, but others can give opinions if none present, just note that opinion is from others)	What are the issues that cause them the most challenges? Youth like money/nice cars, luxury and office work. They do not like the physical work, they are in towns, they leave animals and farms. Farmers understand that agriculture needs young people, as at least they can handle small animals. Very few young people work in the fields. What are the issues related to Sorghum farming? What are the opportunities they are seeing in Agriculture?
Sorghum Related	Do they produce currently? The Sorghum is highly produced in this region. For sale or personal supply? Both personal and sale How does it perform compared with Maize? (production and sales) Sorghum performs better than maize in this area. Are they interested to increase production? What is preventing them? Pests such as birds are a problem, farmers think its best to have a bigger acreage so that the birds would leave some for them

Fodder Management/ Crop & Livestock systems	What is the biggest challenges related to fodder? They would produce more if they had equipment to thresh fodder. Processing is a challenge Do they purchase fodder? Most farmers don't buy fodder, only one among the group buys fodder. Do they produce their own fodder? If not why not? They produce own fodder and its mainly Lablab legume for fodder, because it stands drought. Would they change from Crop Sorghum to fodder Sorghum? 'what would we eat', for them Sorghum is first.
Any other general comments	Government 'cash for work' activities make people to leave the fields to make quick money. These may need to be suspended for few months especially during planting season. They urged government to bring back ground water storages.
Local/District extension staff key thoughts	If relevant
DAR/National government staff key thoughts	If relevant