GHG Mitigation through Climate-Smart Agriculture in Southern Africa: Scaling climate-smart livestock systems

brief

Abstract

This brief explains the contribution of livestock to GHG emissions in Southern Africa, how livestock development and adaptation practices have mitigation co-benefits, and the challenges and opportunities for upscaling climate smart livestock with mitigation co-benefits.

GHG Mitigation through Climate-Smart Agriculture in Southern Africa: Scaling climate-smart livestock systems

Key messages

• Livestock is a key source of greenhouse gas (GHG) emissions in the Southern African Development Community (SADC) region, but emissions have been decreasing in recent years due to the adverse effects of drought.
• Three ways to realise mitigation co-benefits of livestock development and adaptation are: (1) reducing absolute levels of GHG emissions, (2) increasing productivity to reduce the GHG emission intensity of livestock production (GHG emissions per unit of livestock product output), and (3) increasing carbon sequestration in rangeland soils and trees/shrubs to balance emissions from livestock.
• Some initiatives in the region are upscaling by valuing GHG mitigation co-benefits through carbon markets and climate finance.
• Capacities for quantification of livestock GHG emissions and rangeland soil carbon are required to strengthen the ability of stakeholders in the region to value GHG mitigation co-benefits of climate smart livestock practices and to better align livestock sector development and climate change adaptation with GHG mitigation.

About this document

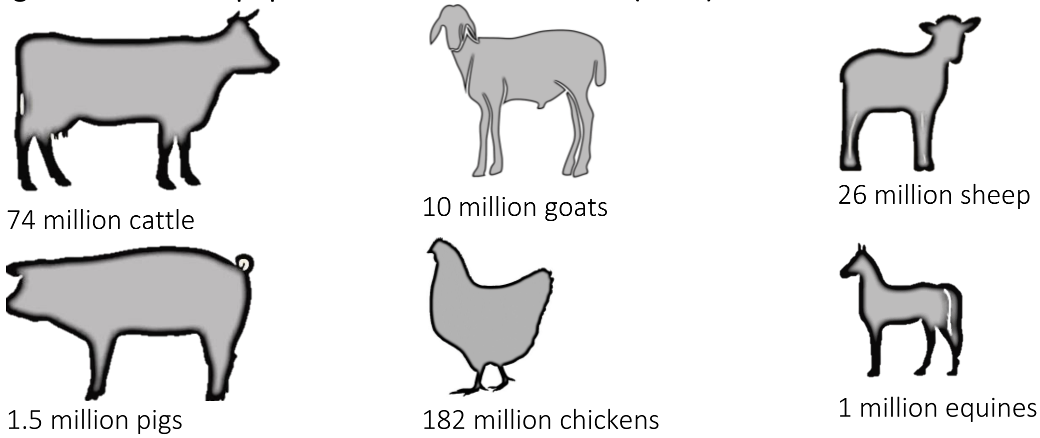
This information brief on mitigation co-benefits of Climate Smart Livestock is one of four information briefs that highlight the relevance of greenhouse gas (GHG) mitigation as a co-benefit of Climate Smart Agriculture (CSA) in Southern Africa. This brief explains
• the contribution of livestock to GHG emissions in Southern Africa
• how livestock development and adaptation practices have mitigation co-benefits, and
• the challenges and opportunities for upscaling climate smart livestock with mitigation co-benefits.

☑ Climate-smart livestock

Other briefs in this series:
☐ Climate Change Mitigation through CSA: Challenges & Opportunities
☐ Climate-smart crop production
☐ Climate-smart landscapes

Livestock production systems in Southern Africa

Figure 1: Livestock populations in southern Africa (2019)



Source: FAOSTAT

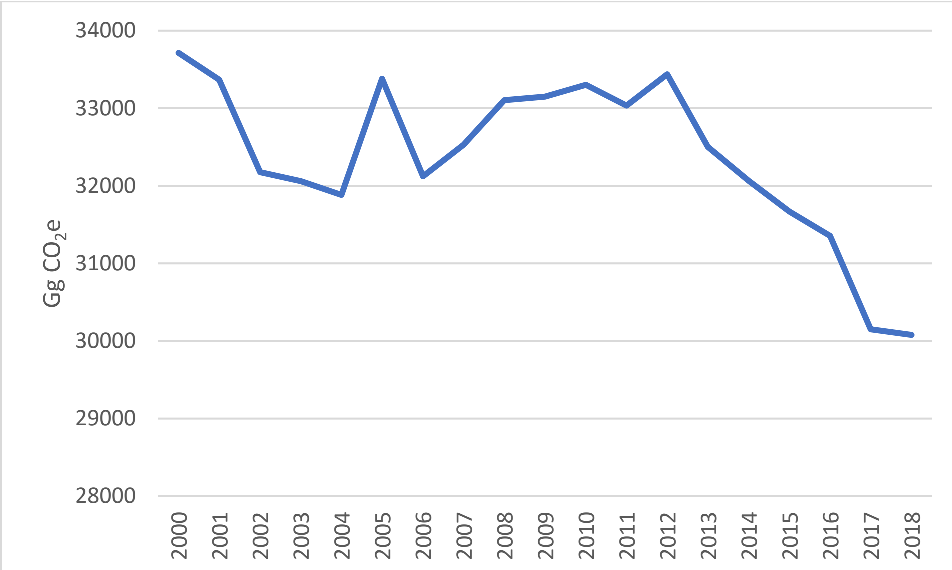
Livestock production is a major source of livelihoods in rural Southern Africa. More than 40% of the population is dependent on livestock for consumption of animal source foods and income from sale of live animals, meat and milk, fibers, and hides. Livestock also provide farmers with manure for crop cultivation, draught power and are an important asset that can be converted into cash in emergencies, as well as a symbol of social status.[1]

Up to 90% of the agricultural land in Southern Africa is classified as rangelands and the region is dominated by arid, semi-arid and sub-humid agro-ecological zones.[2] Pastoral or agro-pastoral grazing systems are the dominant production systems, but livestock are also raised in mixed crop-livestock smallholder farms, in the emerging farming sector, and in commercial farms. Most cattle are raised in extensive grazing systems and about three quarters of livestock are owned by smallholder farmers and raised using traditional methods. Women and children play important roles in raising livestock.[3]

Livestock GHG emissions

Agriculture is the third largest source of greenhouse gases in the SADC region, after the energy sector and land use change and forestry.[4] Considering agriculture, forestry and other land use (AFOLU) together, in 2018 livestock contributed about 30% of GHG emissions. Livestock emissions in the region have been decreasing in the last decade and are now about 10% lower than in 2008 (Figure 1). This is mainly due to a decrease in cattle populations across the region following the El Niño related droughts since 2015/16. In some countries, livestock keepers have been responding by increasing their stocks of goats, which are more resilient in drought conditions.

Figure 1: Total livestock GHG emissions in southern Africa (2000-2018)



Source: FAOSTAT

Box 1: The main livestock GHG emission sources

There are three main direct livestock emissions sources:

Enteric fermentation is a digestive process in ruminant animals (i.e., cattle, sheep, goats) which breaks down carbohydrates into simple, digestible molecules. Methane is produced as by-product of this process. Enteric methane contributes about 55% of livestock emissions in the SADC region, mostly from cattle.

Manure management, i.e., storage and processing of manure, results in methane and nitrous oxide emissions. The method (anaerobic or aerobic) and duration of storage influences the level of emissions. Manure management is a relatively small contributor in Southern Africa (about 3% of livestock emissions) because most livestock graze rangelands where their dung and urine is not managed.

Deposit of dung and urine on rangelands is responsible for about 42% of livestock emissions in southern Africa because most livestock are raised in extensive grazing systems.

In addition, the livestock sector requires production of feed, which causes emissions from fertilizers and crop production and processing, and energy is used in transport and processing of livestock products. Demand for grazing and feed resources can contribute to land use change. Rangeland degradation can also cause loss of soil and biomass carbon stocks. These emissions are not normally considered as part of livestock GHG emissions, but where livestock are fed on cultivated forages and feeds, feed-related emissions can significantly contribute to the overall carbon footprint of livestock production.[5]

Livestock GHG mitigation options

There are three main ways to reduce GHG emissions associated with livestock production:

- **Reducing absolute emissions from livestock.** Reducing livestock numbers reduces livestock emissions. In recent years, reductions in livestock numbers have been driven by climate-related disasters but reducing livestock numbers is rarely proposed as a policy option because it could reduce incomes, food and nutrition security for livestock keepers. Some specific technologies that reduce GHG emissions (e.g., biogas reduces emissions from manure management) are ready to deploy, but potential technologies such as feed additives or vaccinations to reduce methane emissions from enteric fermentation are some years away from widespread deployment.

- **Reducing GHG emission intensity:** Farmers' and policy makers' objectives of meeting growing demand for livestock products can be achieved by reducing GHG emissions per unit of livestock product. This can be achieved through changes in the structure of the livestock sector (e.g. increasing the scale of more efficient production systems or shifting towards lower emitting animal species) and by increasing production efficiency within each production system (Box 2).
- **Increasing carbon stocks in rangeland soils and in trees**: Although livestock emissions may increase due to increasing productivity, these emissions can be balanced against carbon sequestration in rangeland soils and trees.

Box 2: Producing more with less

The livestock sector makes important contributions to food and nutrition security and livelihoods for rural people. Growing demand for livestock products can be met not by increasing livestock numbers but by increasing the productivity of the sector. There are three main ways to achieve this:

(1) Change in the structure of the sector: More intensive livestock production systems tend to produce milk or meat with a lower carbon footprint than under extensive production. More rapid growth in intensive or semi-intensive production systems, or more rapid growth of animals with a lower carbon footprint (e.g., small ruminants, pigs, poultry) can increase total livestock product output while reducing GHG emissions per unit of livestock product.

(2) Increasing productivity in each production system: At low levels of productivity, a large proportion of feed intake is used to maintain an animal's basic energy levels. More productive animals use a greater proportion of intake to support growth or lactation. More productive animals therefore produce fewer GHG emissions per unit of product. At the herd level, reducing age at first calving or calving intervals, or maintaining fewer unproductive animals in the herd, can reduce GHG emissions per unit of product.

(3) Reducing food loss and waste: Even if livestock are produced efficiently, there are often losses in supply chains, such as when milk is unable to be transported to cooling plants on time, or when meat is discarded due to disease. Studies suggest up to 13% of milk produced is wasted in Sub-Saharan Africa.[6] Reducing loss and waste increases efficiency of the supply chain and can reduce GHG emission intensity.

There are many measures that can reduce GHG emissions throughout livestock value chains. Some measures are widely applicable in extensive production systems, some are more specific to the mixed crop-livestock system and others are most appropriate in intensive production systems. Because farmers in each production system face different constraints and opportunities, different practices may be more suitable in different contexts. Table 1 lists a number of widely relevant practices, indicating their applicability in different production systems and the likely effects on GHG emissions. Each practice is then discussed in the sections that follow.

Table 1: Climate smart livestock practices

Climate smart practices	Production system	How the practice affects GHG emissions

Forage, feed and water		
• Rangeland management	EXT, CL	Sequesters soil carbon; can improve rangeland forage supply and quality, which could reduce enteric fermentation emissions
• Fodder cultivation and storage	CL, INT	Improves fodder and feed supply and quality which most likely increases productivity and reduces GHG emission intensity, but not absolute GHG emissions. Protein content above animals' needs could increase manure management emissions
• Feed purchased fodder or feeds	CL, INT	
• Fodder tree cultivation	EXT, CL	Improves supply of protein-rich fodder, which likely increases productivity and reduces GHG emission intensity of livestock production, and sequesters carbon in trees and soils.
• Improved water supply	EXT, CL, INT	For lactating cows, can increase emissions per head but reduce GHG emission intensity if milk yield increases
• Improved feeding practices (e.g., balanced rations)	EXT, CL, INT	Improves diet quality, matching nutrients with animals' needs.
Animal and herd management		
• Breeding and animal selection	EXT, CL, INT	Higher yielding breeds may increase GHG emissions but decrease GHG emission intensity. Selection for locally adapted breeds could increase or decrease GHG emissions, depending on breed characteristics
• Improved reproduction	CL, INT	
• Improved animal health	EXT, CL, INT	
Manure management		
• Application to fields	CL, INT	Application to fields on a daily basis has the lowest GHG emissions of all manure management options
• Composting	CL, INT	Reduces GHG emissions from manure
• Biogas	CL, INT	Reduces GHG emissions from manure, also has can reduce fuel wood and fertilizer emissions
Marketing		
• Increasing off-take rates	EXT, CL, INT	Reduces GHG emission intensity, can also reduce absolute emissions if animals are sold at younger age
• Preventing waste	EXT, CL, INT	Reduces GHG emission intensity by increasing milk marketed
• Reducing consumption	EXT, CL, INT	Could contribute to lower GHG emissions if herd sizes decrease

Extensive ("EXT"), mixed crop – livestock ("CL") and intensive ("INT")

Livestock forage and feed

Rangeland management: Rangelands provide the majority of animal feed intake in extensive systems and grass growth is very sensitive to rainfall and drought. Improved rangeland management is a key adaptation measure given rainfall variability and increasing temperatures which increase moisture evaporation from rangeland soils.[7] Rangeland management can also sequester carbon in soils and in trees or shrubs. Bush encroachment is an issue in many areas of Southern Africa and control of bush encroachment may be required to maintain important rangeland ecosystem services. Because shrubs can sequester carbon in soils and in woody biomass, so bush control may decrease the benefits of carbon sequestration.[8] In more intensive grass-based systems, cultivation of high-yielding pasture, including legumes, can increase the digestibility of feed, reducing GHG emissions per unit of feed intake. CCARDESA's Knowledge Product 15 provides more information on rangeland and pasture management.

Box 3: Rangeland management, carbon sequestration and carbon credits[9]

In 2017, the Northern Rangelands Trust, a Kenyan NGO whose 14 member conservancies manage 2 million ha of rangeland, registered a first-of-its-kind carbon credit project. In each conservancy, grazing management plans are developed and supported by grazing coordinators to ensure that rotational grazing practices are adopted. The carbon sequestered in soils was estimated using a model developed for savannahs in Kenya, and the project will monitor the change in soil carbon stocks over time. Initial estimates suggest that improved grazing can sequester just under 1 tCO_2 per ha, and the project could generate 1.85 million tCO_2 per year. When stock changes have been verified, carbon credits can be issued, which will provide an additional income stream for pastoralist communities to invest in activities identified by the communities, such as health care or paying school fees.

Box 4: Herding 4 Health seeks to link with carbon markets[10]

Herding 4 Health (H4H) is an initiative of Conservation International and Peace Parks Foundation to transform livestock production for communities and nature conservation in five peace parks across Southern Africa. The H4H model uses herding and livestock management to regenerate rangeland ecosystems and enhance climate change resilience of the communities dependent on them. The H4H model is based on conservation agreements with affected communities that agree to site-specific good practice defined by scientific and traditional knowledge. In most cases, this involves collective grazing and/or corralling that is managed by professional herders called "eco-rangers"[1]. Restoration and wildlife protection elements of the agreement can be further incentivised by livestock production, training and access to markets for livestock products. Market access is a key component of the model to ensure income flows to participating farmers.

The H4H programme partners with universities and research institutes to ensure that programme activities are based on locally relevant scientific knowledge. Topics researched include climate resilience, commodity-based trade, wildlife-livestock coexistence and biodiversity conservation. The carbon sequestration impacts of the programme are another focal topic. The programme intends to link communities participating in H4H with carbon markets, and also to undertake assessments of the mitigation benefits at the national and landscape scale to inform policy engagements.

[1] Interested individuals such as community leaders can become qualified eco-rangers through the Basic Eco-ranger or advanced courses at the Southern African Wildlife College (https://www.bing.com/search?q=Ecoranger%20programme%20SAWC&qs=n&form=QBRE&sp=-1&pq=ecoranger%20programme%20sawc&sc=0-24&sk=&cvid=FFE4719D3EC54A04B4425D2327E90FB0) or the Herding Academy, both in South Africa (https://www.herdingacademy.co.za)

Fodder cultivation, timely harvesting and storage: In mixed farming systems, cultivated fodder can be an important feed source all year round, especially. Fodder production can be optimized by the use of organic or chemical fertilizer. Storage methods, such as making silage from maize or grass, enables cultivated forages to be preserved until the dry season when other sources are unavailable. In dairy systems, dietary supplements and concentrate feed as part of a balanced diet together with roughages can increase productivity.

Box 5: Improved dairy cattle feeding practices in Tanzania

In Tanzania, as part of the research for development project MilkIT (2012-2014), smallholder dairy farmers were trained on improved feeding practices. After having learned how to adequately feed dairy cattle for maintenance and milk production, milk yields significantly increased from 6.6 to 13.6 liters of milk per cow per day. A good market outlet, high demand for dairy and high milk prices significantly contributed to farmers interest and willingness to adopt improved feeding practices
Source: Lukuyu et al. 2015

Water infrastructure: Wells and ponds allow livestock to make better use of the rangeland and fodder resources available. Access to water is a critical adaptation measure in areas prone to droughts. If sufficient water is available, irrigation in can further increase the quality and quantity fodder produced.[11]

Animal and herd management

Improved feeding: Feeding according to the animal's requirements for maintenance, reproduction and growth can significantly increase animal production efficiency, and reduce GHG emission intensity. By feeding protein close to the animal's requirement, ammonia and nitrous oxide emissions from manure can be reduced.[12]

Breeding: Small-framed cattle are generally more resilient to climate risks such as drought, while large-framed breeds can be more productive when feeding conditions are good. Selection of higher yielding animals within the herd can further contribute to improving animal and herd production efficiency. Traits to be improved are overall productivity (in terms of meat and milk production), fertility, efficiency (e.g., low residual feed intake), and resilience to diseases and climatic stress. Crossbreeding of productive with indigenous species, the deliberate selection of males for reproduction and avoiding inbreeding are relatively simple but effective measures, especially in extensive and mixed crop-livestock smallholder systems.[13] In mixed farming and intensive systems, artificial insemination can be an option to increase the genetic potential of animals. More productive breeds generally have a lower GHG emission intensity, even though emissions per head may be higher, and breeding males can be replaced with productive females, which also reduces GHG emission intensity at the herd level.

Improving animal health: Disease prevention and control measures (e.g., tick control, vaccinations, hygiene) can lower morbidity and mortality of livestock and increase their productivity, especially with regard to widespread diseases such as Foot-and-Mouth Disease (FMD) or Brucellosis.[14] Animal health is a critical issue in the Southern Africa region because veterinary control measures limit farmers' access to markets and thus their incentives for adopting climate-smart practices (Box 6). CCARDESA's Knowledge Product 18 provides more information on animal disease management.

Box 6: Animal health and market access[15]

Several countries in southern Africa control contagious livestock diseases, such as FMD, through geographical zoning. FMD-free zones of a country are able to access export markets, while zones with endemic FMD are not. The two zones are separated by a veterinary fence and other restrictions on animal transport. In areas outside the veterinary cordon, commercial ranching and be profitable, while farmers in communal areas under veterinary restrictions are unable to market their livestock. Commodity-based trade (CBT) is emerging as an approach to address phytosanitary management in beef trade. CBT relies on ensuring that each specific supply chain is disease-free, rather than whole geographical areas. CBT was endorsed by SADC in the Phakalane Declaration in 2012. After several years of preparation, CBT activities are beginning to get off the ground in Ngamiland, Botswana, and show potential to greatly increase farmers' access to markets.

CBT can also have benefits for wildlife and biodiversity conservation. The Peace Parks Foundation's Herding for Health programme is partnering with Meat Naturally, a South Africa based beef producer, to implement CBT measures in biodiversity hotspots, so that livestock production can be compatible with conservation goals.

Manure management

Manure management, storage and application: Different methods of manure management, storage and use can significantly reduce GHG emissions. Methane production is reduced under aerobic conditions so it is preferable to leave manure on the pasture in grazing systems. In grazing systems, emissions can be further reduced by aiming for a uniform distribution of manure and urine and by restricting grazing when conditions for nitrous oxide formations are favorable. If manure is stored, measures to limit emissions are to reduce nitrogen content in manure, reduce storage time and to create aerobic conditions during storage. Nitrogen content can be reduced by ensuring that protein content of feed is matched to animals' protein requirements. When manure is applied to soils, mitigation measures include applying it when crop nutrient demands are high, and avoiding application immediately before rainfall. In mixed farming systems, composting is a relatively low-cost method to reduce methane emissions. [16] Another method is biogas production. Apart from producing heat and electricity, the by-product of biogas, digestate, is an excellent fertilizer.[17] CCARDESA's Knowledge Product 16 provides more information on manure management.

Box 7: Biogas from intensive cattle production in South Africa[18]

Connected to the grid in 2015, the Bronkhorstspruit Biogas Plant was the first commercially viable biogas plant in South Africa. Its location has been chosen in proximity to one of the country's largest beef production sites. The manure from the feedlots represents the biggest part of the plant's feedstock, complemented by waste from the abattoirs located in the same area. The electricity produced is sold to BMW which runs a production plant nearby and pays a premium price as part of their sustainability plan to promote clean energy sources. The project has been met with high interest domestically and regionally and has already been replicated in the country at the Cape Dairy Biogas Plant.

Livestock product marketing

Since GHG emission intensity is measured as GHG emissions per unit of livestock product output, increasing marketing rates can reduce GHG emission intensity. Access to markets and incentives are essential for increasing off-take rates. If off-take rates are higher, the average age of animals in a herd is younger, and young animals convert forage and feed into body weight faster than older animals. Market-oriented production systems can therefore be more resource efficient. However, from an adaptation perspective, producers consider many other factors that influence their marketing behaviour (Box 8).

Box 8: Oxen vs Weaners: a climate vulnerability perspective

GHG emissions from oxen are higher than from young animals, and oxen typically take 2 years to reach marketable weight. Also, young animals gain weight faster than older animals, so they make more efficient use of limited pasture resources. At first glance, it would seem like specializing in selling young animals is preferable to selling oxen. However, livestock keepers have other considerations, which may lead them not to adopt the lowest-emission option.

The traditional cattle system in communal areas of Namibia produces oxen, but some farmers sell weaners, calves that have finished suckling at 6-7 months old, or tollies, calves less than 1 year old. Weaners and tollies are exported live and are sold to feedlots in RSA that are vertically integrated with slaughter, processing and wholesale enterprises. By contrast, in the oxen system weaned calves are retained and raised to two or more years of age, by which time they should have reached abattoir’s requirements for carcass weight (i.e., 230-260 kg). In weaner systems, most cattle are cows and replacement heifers – so a greater proportion of GHG emissions are from productive animals – while in oxen systems, there are more growing males and fewer productive cows.

Cattle producers’ decisions on whether to raise weaners or oxen are affected by a number of factors. For Namibian producers, the choice to produce weaners rather than oxen depends on the whether the Meatco B2 carcass price is sufficiently higher than the domestic weaner price to justify the extra costs of raising a weaner into an ox. However, the ratio of Namibian weaner and carcass prices is highly variable over time. One reason for this is large volatility in RSA demand for Namibian weaners, which is driven largely by the ratio of RSA maize prices to beef prices and factors affecting RSA weaner supply (e.g., outbreaks of disease). Beef producers do not know the price of oxen at the eventual time of sale two years later, so they mostly use current information to guide their decisions, but better-informed farmers also observe factors affecting maize and beef supply in RSA to form an expectation of future prices.

The weaner system has the following advantages for producers:

- when prices are good, a weaner system can be profitable;
- weaners give a return with much lower financial input, so are favoured by poor households with cash constraints;
- because calves convert forage and feed to weight gain more efficiently than older animals, in years of normal precipitation, maintaining a higher proportion of younger animals in the herd can increase the efficiency with which limited forage resources are used. Because climate change is likely to constrain the availability of good quality forage and water resources, increasing feed use efficiency will become increasingly important.

The weaner system has the following disadvantage for producers:

- a larger proportion of the herd is productive females, which farmers are reluctant to sell and cows achieve a lower price when sold. So some farmers perceive that the oxen system enables them to be more flexible in responding proactively to drought warnings by managing herd size to track forage availability.

Avoiding losses and waste of offtake reduces the overall emissions from the sector, since there is more marketed produce for all the livestock raised. Loss and waste can occur on-farm, after the farm-gate, or during the processing or retail stages. Addressing loss and waste requires collaboration across the supply chain. For example, dairy farmers need to know how to meet processors' quality requirements and have access to storage and transport to be able to deliver milk in a timely way; chilling plants and processors need access to regular energy supplies to avoid interrupting production, and so on.

Challenges to scaling livestock GHG mitigation

CCARDESA has previously assessed constraints and options for upscaling adoption of CSA in Southern Africa.[19] Since options with GHG co-benefits also have benefits for adaptation and productivity, the challenges in scaling climate-smart livestock production are the same for GHG mitigation options. However, there are also some challenges that are specific to the livestock sector (Box 9) and some challenges specific to the potential benefits of CSA practices for GHG mitigation.

Box 9: Challenges in scaling climate-smart livestock in Southern Africa

Hardware barriers

• **Access to equipment, inputs and services** Adoption of climate smart livestock practices requires the use of certain machinery or equipment, e.g. for land preparation for fodder cultivation. Access to inputs such as equipment for fodder production, seed and fertilizer, or breeding services (e.g., artificial insemination) is often insufficient, unreliable and/or expensive. The reach of veterinary services is often insufficient, and a lack of proper extension services hinders farmers from making the best use of inputs.

• **Poor infrastructure** The lack of infrastructure in rural areas is considered one of the most important barriers to the development of the agricultural sector in Southern Africa. Poor infrastructure has implications for the entire value chain, including the lack of access and high cost of inputs, post-harvest losses, and higher prices for consumers. This makes it hard for local industries to compete with imported products. In relation to the risk of increasing drought frequency, water points are an important infrastructure for adaptation.

Software barriers

•**Technical knowledge and skills** Many farmers are unaware of climate smart livestock practices. Limited access to extension services, especially for women, is common in the Southern African region. Extension workers have received little training on climate change, climate smart agriculture or livestock, and a lack of funding for extension services limits the ability of technicians to work directly with livestock keepers.

• **Cultural practices** Culture can provide opportunities as well as barriers for the adoption of climate smart livestock practices. In some countries in the region, significant numbers of cattle are owned by people living and working in urban areas, who have no interest in the productivity or environmental impacts of their herds. Gender issues often remain a significant barrier to the adoption of climate smart livestock practices. Women often have less access to resources such as land or inputs, lack ownership of cattle and have limited access to extension services. The labour burden of reproductive activities (e.g., childcare, cooking, fuel wood provision) further limit women from engaging in training activities.

Orgware barriers

• **Land tenure** In mixed crop-livestock systems, small farm sizes and diversified activities can make investments in improved technologies or practices economically inviable. In communal land tenure systems, there can be high transaction costs to establishing and implementing improved grazing management systems. Customary land tenure laws and norms can be especially unfavorable for women, limiting their access to credit and extension services.[20]

• **Access to credit and insurance mechanisms** Intensification, sustainable land management and efficient processing technologies often require considerable up-front investments. Many farmers lack access to financial resources and are unable or unwilling to seek credit to finance otherwise profitable investments.[21] Investing financial, labour and natural resources in new technologies and practices always implies risks, which are often too significant for resource poor producers. Insurance against natural disasters affecting livestock could alleviate this barrier, but there are few such schemes in the region.

• **Policy support** Livestock sector policies in the region both provide support to and constrain development opportunities for livestock keepers. In particular, Foot and Mouth Disease (FMD) management policies and marketing policies have particularly strong impacts on producers' access to markets, and thus on the incentives they have for improving rangeland and livestock management.

Specific to GHG mitigation, additional constraints include:

• **Challenges in quantifying GHG benefits:** To harness climate finance for investment to support adoption of mitigation options, GHG benefits need to be quantified. Except for South Africa and Namibia, all other countries in the SADC region have national GHG inventories that use the relatively simple GHG IPCC Tier 1 method to estimate livestock GHG emissions. This method simply multiplies animal numbers by a fixed emission factor per head which does not vary over time or by production system.[22] To reflect the effects of changes in feed or management on livestock GHG emissions, a more advanced Tier 2 method is required. Tier 2 approaches could enable countries, institutions and projects to assess the effects of interventions on livestock GHG emissions and to set targets that explicitly consider synergies between productivity, adaptation and GHG mitigation co-benefits. There are similar knowledge and capacity gaps regarding rangeland soil carbon stocks. As a result of these challenges, policies in the Southern Africa region often recognize the relevance of GHG co-benefits of CSA, or state commitments to achieving mitigation outcomes, but practical measures and systems for measuring their outcomes still need to be developed.

Box 10: Protocols for a Tier 2 approach to generate region-specific emission factors

Within the Programme for Climate-Smart Livestock Systems (PCSL), the International Livestock Research Institute (ILRI) supports Kenia, Ethiopia and Uganda in shifting their measuring, reporting and verification (MRV) systems to Tier 2 approaches in the livestock sector, and thus to better set their NDC mitigation targets for the livestock sector. Two protocols have been developed that provide guidance on how to generate region-specific emission factors. One protocol is focusing on enteric methane (CH_4) emission factors for cattle kept in smallholder systems and accounts for seasonal differences in feed availability, feed quality and related liveweight fluxes as often found in sub-Saharan Africa.[23] The second protocol is targeting methane and nitrous oxide (N_2O) emissions from cattle manure. Both protocols are designed for data from cattle production.[24]

Scaling livestock GHG mitigation co-benefits

Various success factors have been identified that contribute to effective and sustainable scaling of climate smart agriculture and livestock practices,[25] including:

1. Promotion of climate smart livestock practices that have **clear and tangible benefits** (i.e., addressing direct problems such as declining yields or livestock diseases), and that require **low upfront capital and/or labour investment**;
2. **Peer learning** by engaging farmers in an interactive, facilitative environment, enabling exchange of farmer experiences with climate smart livestock practices;
3. **Stakeholder participation and support** from government, civil society, local institutions and the private sector;
4. **Access to credit, inputs, land, markets and information**;
5. **Consideration of socioeconomic diversity including culture** so as to engage community members – including women – in active participation; and
6. **Supportive policies**.

The integration of climate change concerns, including adaptation and mitigation co-benefits, is on the agenda of many countries in the SADC region. Some have included climate-smart livestock in both the adaptation and mitigation components of their Nationally Determined Contributions towards the goals of the Paris Agreement. Concerted efforts will be required to build capacities to quantify the GHG co-benefits of livestock development and adaptation policies and measures, and to link with sources of carbon or climate finance to bring tangible value to GHG mitigation co-benefits in the sector.

Box 10: Subtropical Thicket Rehabilitation[26]

In Eastern Cape, South Africa, subtropical thickets (dominated by *Portulacaria afra*) have degraded due to long-term browsing by goats. Nutrient cycles, water infiltration, and water-use efficiency have suffered, causing desertification. In 2011, a carbon sequestration project was registered by the Department of Environmental Affairs in partnership with the Development Bank of South Africa, Eastern Cape Parks Tourism Authority, and South African National Parks. The project is targeting restoration of 2.5 million ha of thicket. Developing and implementing the project has benefitted from the following:

1. Knowledge building: Studies by universities and other researchers has provided the scientific basis for effective thicket restoration. Stakeholders have learned together how to link the restoration initiative with carbon markets.

2. Inclusive community participation: Community participation is incentivised through the Working-for-Woodlands Programme implemented by the Department of Water Affairs. Through the programme, unemployed people gain skills in nursery management and restoration activities. These workers include the poor, women and disabled individuals.

3. Political ownership and collaboration: The government strongly supports the project because of its alignment with poverty alleviation and skills development policies and its environmental benefits. These environmental benefits include restoration of ecosystem services and climate resilience, and the project provides tangible evidence of the government's climate change commitments.

4. Financial sustainability: The long-term plan is to generate verified carbon credits through thicket restoration and to generate revenue from the sale of credits to corporate buyers. This revenue can then be used to fund further phases of the project.

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References and further reading

CCARDESA Knowledge Products on CSA, which includes KP 15 on rangeland and pasture management, KP 16 on manure management, KP 17 on genetic improvement and KP 18 on livestock disease management.

The MRV Platform for Agriculture, which provides a range of materials on measurement and reporting of livestock GHG emissions.

Intergovernmental Panel on Climate Change (IPCC) National GHG Inventory Guidelines

Investing in sustainable livestock guide.

[1] SADC. 2012. Livestock Production. https://www.sadc.int/themes/agriculture-food-security/livestock-production/

[2] FAO. 2002. Cattle and small ruminant production systems in sub-Saharan Africa - A systematic review. http://www.fao.org/3/y4176e/y4176e.pdf

[3] Dzama. K. 2016. Is the Livestock Sector in Southern Africa Prepared for Climate Change? South African Institute of International Affairs. https://saiia.org.za/research/is-the-livestock-sector-in-southern-africa-prepared-for-climate-change/

[4] WRI CAIT database, http://cait.wri.org/

[5] Gerber, P. J. 2013. Mitigation of Greenhouse Gas Emissions in Livestock Production - A review of technical options for non-CO2 emissions. FAO. http://www.fao.org/3/i3288e/i3288e.pdf

[6] Affognon, H., et al. 2015. Unpacking postharvest losses in sub-Saharan Africa: a meta-analysis. *World Development*, 66: 49-68.

[7] CCARDESA and GIZ. 2019. Knowledge Product 15: Climate Smart Pasture and Rangeland Management Options for Livestock in the SADC region. CCARDESA Secretariat, Gaborone, Botswana. http://www.ccardesa.org/sites/default/files/ickm-documents/KP15_DecisionTool_Climate%20Smart%20Pasture%20Rangeland%20Management_V2_20190529.pdf

[8] Gxasheka M. et al. 2014. Integrated Plant Invasion and Bush Encroachment Management on Southern African Rangelands. In Andrew J. Price and Jessica A. Kelton (eds.) Herbicides - Current Research and Case Studies in Use. http://dx.doi.org/10.5772/56182

[9] Northern Rangelands Trust, 2017. Northern Kenya Grassland Carbon Project. https://verra.org/wp-content/uploads/2016/09/CCB_PROJ_DESC_1468_15AUG2016.pdf

[10] CI/PPF, 2019. Herding 4 Health Southern Africa 2019-2023

[11] Amede, T. et al. 2010. Improving water productivity in mixed crop–livestock farming systems of sub-Saharan Africa. Agricultural Water Management, 97(5): 579-586.

[12] Grossi G. et al. 2019. Livestock and climate change: impact of livestock on climate and mitigation strategies, Animal Frontiers, 9(1): 69–76

[13] Laker, M.C. et al. 2013. A South African per-spective on livestock production in relation to greenhouse gases and water usage. South African Journal of Animal Science 2013, 43(3). http://dx.doi.org/10.4314/sajas.v43i3.2

[14] FAO. 2017. Transboundary Threats to Food and Nutrition Security in Southern Africa. https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/transboundary_threats_to_food_and_nutrition_security_in_southern_africa_issue2_oct_dec_2017.pdf; FAO. 2017. Strengthening capacity to manage animal disease emergencies in Southern Africa. http://www.fao.org/emergencies/fao-in-action/stories/stories-detail/en/c/1029946/

[15] see https://www.peaceparks.org/h4h/

[16] Lindgren, J. 2019. Reducing Greenhouse Gas Emissions from Cattle Production. https://water.unl.edu/article/animal-manure-management/reducing-greenhouse-gas-emissions-cattle-production

[17] Bernues, A. et al. 2015. Reducing GHG Emissions from Traditional Livestock Systems to Mitigate Changing Climate and Biodiversity. Chapter 19 in R. Lal et al. (eds.). Sustainable Intensification to Advance Food Security and Enhance Climate Resilience in Africa. DOI 10.1007/978-3-319-09360-4_19

[18] BIO2WATT (2016). Bronkhorstspruit Biogas Plant (Pty) Ltd. https://www.bio2watt.com/bio2watt%E2%80%99s-bronkhorstspruit-biogas-plant-(pty)-ltd.html

[19] CCARDESA and GIZ, 2019. Knowledge Product 22. Options for Improving Adoption of Climate Smart Agriculture. https://www.ccardesa.org/sites/default/files/ickm-documents/KP22_2020_11_V3_OptionsPaperforImprovingAdoptionofCSA_EN.pdf

[20] Boly, A. 2018. Introduction: Understanding the Challenges of the Agricultural Sector in Sub-Saharan Africa. Chapter 1 in Building a Resilient and Sustainable Agriculture in Sub-Saharan Africa. https://doi.org/10.1007/978-3-319-76222-7_1

[21] Asfaw, S. et al. 2018. Climate Smart Agriculture Building Resilience to Climate Change. Natural Resource Management and Policy, Volume 52, Springer. FAO. DOI 10.1007/978-3-319-61194-5

[22] Wilkes, A. et al. 2017. Measurement, reporting and verification of livestock GHG emissions by developing countries in the UNFCCC: current practices and opportunities for improvement. https://cgspace.cgiar.org/handle/10568/89335

[23] Marquardt, S. et al. 2020. Protocol for a Tier 2 approach to generate region-specific enteric methane emission factors (EF) for cattle kept in smallholder systems. ILRI Manual 39. Nairobi, Kenya: ILRI. https://www.ilri.org/publications/protocol-tier-2-approach-generate-region-specific-enteric-methane-emission-factors-ef

[24] Leitner, S. et al. 2020. Protocol for generating region-specific Tier 2 emission factors for methane (CH4) and nitrous oxide (N2O) emissions from cattle manure. ILRI Manual 36. Nairobi, Kenya: ILRI. https://www.ilri.org/publications/protocol-generating-region-specific-tier-2-emission-factors-methane-ch4-and-nitrous

[25] Makate, C. 2019. Effective scaling of climate smart agriculture innovations in African smallholder agriculture: A review of approaches, policy and institutional strategy needs. Environmental Science & Policy. 96. 37-51. 10.1016/j.envsci.2019.01.014.

[26] Spekboom Carbon Sequestration and Rehabilitation Project in South Africa, https://www.weadapt.org/placemarks/maps/view/1224