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Future Proofing the Grass-Fed Beef Value Chain (GFBVC): A Case Study in the Matatiele area of the uMzimvubu Water Source Area in the Eastern Cape Province, South Africa

Interim Report draft 2: September 2022

Future *impacts and threats* of *climate change* and *socio-economic conditions* on the *Grass Fed Beef Value Chain* in the Matatiele region of the Eastern Cape Province, SA

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Executive summary

The Matatiele district is a montane grassland region of South Africa that has been a major livestock producer for over 150 years. The regional vegetation is dominated by native grasslands as well as secondary grasslands that have re-established on abandoned cultivated lands. These two major land cover types comprise approximately 90% of the land surface and although highly productive, they are both vulnerable to soil erosion, changes in species composition (which affects forage quality) and invasion by undesirable/unpalatable woody shrubs. Climate change predictions for the region indicate that for the foreseeable future these grasslands will remain the dominant land cover type, with some small-scale increases in woody shrub biomass in the form of non-indigenous wattle along hill-slope seeps. The major impact of climate change expected for this region is an increase in the frequency and intensity of summer rainfall events, with an accompanying increase in soil erosion and silt loads in rivers. Heavier downpours, or storm-flow events, are due to the warming ocean and the increase in cyclonic conditions in the Indian Ocean off KwaZulu-Natal. These downpours will result in increased soil erosion which will be exacerbated by the relatively low grass cover associated with intensive grazing of abandoned arable lands, and the prevalence of large area with bare soil where un-controlled grazing continues to predominate.

Elevated CO_2 may also, through atmospheric fertilization of C3[1] trees and shrubs, lead to an increase in cover of native woody shrubs and trees in the region. There is evidence for this process already occurring as invasive alien plants have increased along the hill-slope seeps, adjacent to woodlots and windbreaks, but primarily into abandoned arable land. Although this land cover classes occupy relatively small areas (~10%) in relation to grass covered land, the accumulative effect of increased alien and indigenous trees and shrubs, and increased land area under settlement, will result in the decline of the land area available for grazing by domestic livestock.

[1] C3 plants undergo a process of photosynthesis which is characterised by photorespiration as opposed to C4 plants which avoid photorespiration during photosynthesis. See further: https://ripe.illinois.edu/blog/difference-between-c3-and-c4-plants

Fire is used annually in this region to provide early wet-season grazing[2]. Under the predicted climate scenario of increasing rainfall and temperature, fire frequency is likely to increase as farmers attempt to provide much-needed forage at the end of the dry season. The region has occasionally experienced lower than expected rainfall, leading to livestock losses with devastating implications for local livelihoods, but there is no evidence for increased drought frequency in the climate record[3]. Several NGOs have implemented initiatives to link the rangeland condition of areas under a common property regime to improved market access, and in so doing incentivize better rangeland management, which has been helpful in mitigating some of the effects associated with the described climate trends.

Women play an important role in the Matatiele community and in relation to the beef value chain however, this role is within a patriarchal framework as cattle ownership remains male dominated. Livestock in the homestead are often owned by non-resident individuals who live and work as professionals in cities. Importantly, cattle ownership has been linked with household poverty which underscores the relevance and importance of mobile auctions in these areas. The grass-fed beef value chain in Matatiele is characterised by 3 market systems in the form of auctions at which cattle are sold. These systems: old market, mobile auction and the formal auctions are underpinned by the community and rangeland conservation on which it is dependant. Overall, there is a steady local and international demand for South African beef and in terms of supply, through communal and commercial beef production, this meet is net.

Given the extensive overview of the grass-fed beef value chain (GFBVC) in Matatiele, there seems to be no immediate significant threat to the industry in the medium (20-30 years). On the other hand, synergies between decreasing land area for grazing, increased fire frequency and decline in overall forage quality, may result in a smaller regional herd, with higher animal fertility and more rapid turn-over of the production unit. Against this backdrop, it is important to continue and intensify NGO efforts at environmental improvements, including climate change effects. Mitigation efforts to ensure continued sustainability of the industry in the area, especially as it relates to the socioeconomic security and livelihoods of local communities,

[2] The effects of emissions of greenhouse gases on this are discussed in-depth in the report below.
[3] This is the case for increased frequency even though there is a record for the recent drought of 2015 to about 2016.

could consider several interventions. Using the grass-fed/free range beef value chain as an instrument, certification of those farmers demonstrating improved veld management should be further supported. In addition, the scheme which certifies the storing of more soil organic carbon should be considered. Following the current global discourse on limiting methane (CH_4) emissions from livestock, there are opportunities to certify farmers who practice GHG emission reduction by changing livestock feed quality, reducing herd size, mean herd age and increased herd fertility. Some of these debates are presented and reviewed in the report. For instance, while there are data presented on how Grass-fed units contribute more to CH_4 emissions given their longer general lifespan, these same animals still have a lower carbon footprint in their production compared to feedlot animals. This can be improved even further if communal livestock producers can be encouraged to sell more of their animals at a younger age, for example through the means of mobile auctions.

South Africa's current climate change mitigation policy does not consider the beef industry and thus, there are no guidelines governing the interplay between beef production and the emission of methane and other GHGs. This lack of policy is of concern as the agricultural sectors are particularly vulnerable to climate change and can therefore be expected to play a large role in advocating for emission reductions. Within the context of Matatiele, it would be difficult for community leaders to influence directly national and global policy. A more viable option would be for these leaders to interact with broader government and non-government organisations that can play a policy advocacy role.

Focusing on the development of human capabilities are also essential in dealing with the various threats and opportunities linked to climate change. Given this need, it is of concern that compared to the other provinces, the Eastern Cape continues to have the greatest basic education challenges. Another policy consideration is the readiness of the social grant system to mitigate for largely unanticipated climate related calamities such as droughts and floods. A key grant, in this regard is the Social Relief of Distress (SRD) benefit, which is specifically designed to deal with emergencies. It is in the interests of leaders in the Matatiele community to lend their voice to how this grant is used and aligned to climate-related contingencies.

Investment in carbon offset programs will aid conservation work in areas like Matatiele where, for example, groups in Matatiele being certified as having brought about higher levels of carbon sequestration through improved conservation efforts, and for this group to be paid through international mechanisms whereby rich countries pay developing countries. The last policy implication to take note of is the increasingly complex certification of beef as consumers (local and international) require clarity on the greenhouse gas emissions associated with products. A major challenge to this process is the scant research on the life cycle of different types of beef in the country.

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2.1.Introduction

This report provides an overview of the climate impacts on the future of beef value chain in Matatiele and South Africa overall. The effects of climate change on this value chain are the main concern as global warming and extreme weather events are increasingly experienced worldwide. The beef sector has been identified as the second fastest-growing commodity in South Africa's agricultural sector (DALRRD, 2021) and therefore, it is essential to future proof these interests.

Various sources of data are used in this report, including relevant reports and related studies, the 2016 Community Survey (StatsSA, 2016), field observations, personal communication and interviews with NGO representatives and various stakeholders in the Matatiele region. Drawing from these sources, this report shares findings on issues related to climate change in South Africa with a special focus on the availability of water and the effects on biomass and biodiversity in Matatiele. The biophysical changes linked to climate change are explored in detail and supplemented by a discussion of the key social and economic factors linked to the grass-fed beef value chain in Matatiele.

2.2. Future changes on the biophysical environment in Matatiele Region

2.2.1. General Climate Change effects

Climate change, although confidently supported by directional trends in global databases of atmospheric CO_2, temperature and numerous other variables (IPCC, 2021), is poorly understood by small-holder producers (Shackleton et al., 2015). This means that policy decisions, from a global level down to a local level, are often poorly understood. Moreover, uncertainty caused by an inadequate understanding can exacerbate community anxiety in relation to climate change. However, there is evidence that, although generally still low (Gandure et al. 2013)[4], understandings are improving. In a community such as Matatiele, activists, the youth

[4] "Generally, education and awareness levels about climate change impacts and therefore coping capacities were found to be very low among most farmers partly due to weak institutional coordination and support" (Gandure et al., 2013, 46).

and more educated individuals are likely to possess relatively good knowledge about the various scientific and policy complexities of climate change (Lee et al., 2015). Importantly, since around 2012, climate change has received a relatively strong emphasis across several subjects in the school curriculum (Gustafsson, 2021: 49).

a. Predicted climate change for South Africa

There are at least two major drivers of climate change that affect weather and climate patterns globally and on the continent. These are the increase in atmospheric concentrations of CO_2 and other greenhouse gasses (GHG's) such as methane and nitrous oxide. In addition, the increase in atmospheric CO_2 concentration leads to an increase in global air temperatures. It is the temperature increases that lead to weather fluctuations or changes. Data is provided to global circulation models that can simulate the effect of these drivers on global and local weather patterns. Following the predictions of several global circulation models (GCMs), there is general consensus that there are likely to be significant, rapid changes in atmospheric conditions throughout southern Africa. These changes are linked primarily to three large scale climate systems which affect the climate and weather patterns across the sub-continent.

The first system, which primarily affects the central and north-western parts of the country, is the **Inter-Tropical Convergence Zone (ITCZ)** that moves southwards during the southern hemisphere summer. The ITCZ brings the moist, warm air of the tropics further south, and delivers the country's classic Highveld thunderstorms. Most models predict that the ITCZ will strengthen, providing wetter summer months. The evidence for this has already been provided by recent climate records which show a shift towards greater summer seasonality of rainfall in the highveld and the central interior of the country (du Toit and O'Connor, 2014). The predictions from this system ***are that rainfall will be more extreme***, with more frequent, higher rainfall events. However, the increasing global air temperature will also result in greater evapotranspiration. This will mean that soil moisture will dry out more quickly, resulting in shorter growing seasons for crops and grasses. Trees and shrubs will generally not be as disadvantaged as these vegetation types tap into water at deeper levels in the soil profile. Trees and forest species mainly use C3 photosynthetic pathways, and they have been shown to benefit from

elevated CO_2, via so-called CO_2 fertilization (Bond and Midgley, 2000). The condition of elevated CO_2 and continued availability of deep soil water will therefore result in a more advantageous environment for all C3 trees and shrubs.

The second circulation pattern that exerts an influence on the sub-continent are the ***Circumpolar Westerlies*** that bring cool, moisture-laden air from the southern Ocean to the Western and Eastern Cape during the regional winter. This cool, moisture-laden air provides the winter rainfall which supports the grain, fruit and grape growing industries of the region. The climate predictions for this region indicate that ***rainfall is going to decrease in frequency***, with longer droughts. We have already witnessed the consequences of this with long droughts in the Western and Eastern Cape, south of the Great Escarpment, and the resultant water crises in Cape Town and Gqeberha (formerly Port Elizabeth). Long-term climate records for this region have already shown an increase in mean annual air temperature (Hoffman et al., 2011).

The third circulation pattern that will affect the region is the increase in sea surface temperature (SST) on the *east coast* which promotes ***cyclonic rainfall in the KZN region***. As the warmer sea surfaces move further south, so the strength of the cyclonic activity will increase. We have just experienced the consequences of the changes in this circulation pattern with the *extreme flooding events in eThekwini metropolitan region* and surrounding regions (April 2022). The increase in SST means that there is less energy needed to evaporate oceanic water and to get it up into the atmosphere. There is therefore *more water available for larger, cyclonic events that deposit larger quantities of rain* when the air cools as it arrives at the *Great Escarpment and the foothills of the Drakensberg*.

A fourth system, which is linked to the cyclonic rainfall in coastal KZN, is the mid-tropospheric closed-lows (cold-core cut-off lows and warm-core tropical lows) (Engelbrecht et al., 2013). Over South Africa, most wide-spread flood events are caused by these systems. It is therefore important to explore the potential impact of anthropogenic forcing on the occurrence of closed-lows and extreme rainfall events over the region. The climate science indicates a general increase in extreme rainfall events over southern Africa despite the projected decrease in closed-low frequencies. It is deduced that this increase in extreme rainfall events is driven by intense

convective rainfall events occurring within more frequently forming tropical-temperate cloud bands.

The predicted future climate for East Griqualand is principally dominated by the third and fourth of these sub-continental systems. In other words, there will be an increase in rainfall events, with a greater intensity, depositing larger amounts of rain during a shorter period. This will result in floods as the topography is steep, and the rivers narrow, short, steep and fast flowing. The recent rainfall record shows that there will continue to be an increase in summer seasonality in the central parts of the country, but this is unlikely to have an impact in the East Griqualand.

Climate change can be slowed down if humans reduce their release of greenhouse gasses, particularly *carbon dioxide and methane*. This is often referred to as climate change mitigation. However, climate change would not stop, even if we did what is clearly impossible and stopped releasing greenhouse gases immediately. Once gases such as carbon dioxide and methane have been released through human activities such as electricity generation and farming, these gases stay in the atmosphere for a long time. There are natural processes which remove greenhouse gasses from the atmosphere. The oceans are described as the most important sink for atmospheric carbon dioxide, or place to which CO_2 can be absorbed. Currently, around a quarter of the carbon dioxide released through human processes into the atmosphere finds its way into the oceans (IPCC, 2021). The problem is that this causes acidification of the oceans, which has a negative effect on marine life, including the seafood that humans eat. It is widely believed that forests remove carbon dioxide from the atmosphere. This is often, but not always true. In the case of mature forests, the amount of carbon dioxide that is released into the atmosphere after trees have died may be as large as the carbon dioxide removed from the atmosphere by trees that continue to grow (Luyssaert et al, 2008). On the other hand, newly planted forests are more likely to absorb more carbon dioxide than they release.

b. Mitigation and adaptation policy issues

Generally, and across the whole country, communities including in Matatiele, will in the next fifty years see their lives affected by climate change effects and related policy reactions.

Through taxation and prices instruments, policies will change which technologies are used more often than others. Any technology involving the burning of fossil fuels or the emission of GHGs will come with larger tax penalties. These policies will also direct education spending towards those skills which are needed to expand the use of technologies such as solar power generation. The expected shifts in the economy will affect jobs, incomes and potentially also have an impact on South Africa's vast inequalities. Several scenarios generated by analysts inside and outside of government have indicated that it is possible to respond to climate change effectively without worsening poverty or inequality. Some scenarios indicate that responding to climate change could assist in improving the lives of South Africans and reducing inequalities. The term *just transition* is often used, in South Africa and beyond, to describe the ideal whereby the challenge of climate change is used as an opportunity to correct past injustices (see, for example, Calland, 2023). Of course, a just transition is not guaranteed, as much of it depends on how effectively governments manage the transition over the coming years and decades. Policies that deal with climate change can be placed into two groups: mitigation policies are aimed at reducing the release of greenhouse gases, while adaptation policies aim to help communities and individuals deal with a changing climate.

Mitigation policies affect almost everyone because they change the way the entire economy works. Almost all countries in the world have signed the 2015 Paris Agreement[5], which commits countries to reducing their greenhouse gas emissions in order to ensure that the global average temperature increase by the year 2100 remains 'well below' 2.0 degrees Celsius, with a 1.5 degree increase being considered the ideal. These increases are relative to the start of the industrial revolution. As pointed out in Interim Report one, the average temperature has already increased by 0.8 degrees, suggesting that a target of 1.5 degrees means a further increase of just 0.7 degrees.

While the Paris Agreement has been criticised, it is perhaps the best possible agreement that could have been reached given the global political context. One criticism made by many,

[5] Iran is the only major emitter (2%) which had not signed the agreement by early 2022. The United States signed, the application was then withdrawn under the Trump presidency, and the country agreed to continue with its commitments under the Biden presidency. Libya and Yemen have yet to ratify the agreement, and Eritrea was the latest country to sign in February 2023.

including South African scientists and politicians, is that the agreement does not place sufficient responsibility on those countries, largely rich, industrialised countries, which have caused most of the increase in greenhouse gases in the atmosphere (Gustafsson, 2021)[6]. A criticism that is especially relevant for South Africa is that the agreement does not consider greenhouse gases released by countries to produce goods that other countries need. In the case of South Africa, around a third of the greenhouse gases emitted are due to goods South Africa exports, especially minerals. South Africa has committed itself to ensuring that greenhouse gas emissions are between 21% to 34% lower in 2030 than they are currently, and that by 2050 there are net zero emissions **(**DFFE, 2021**)**. Currently, South Africa removes around 5% of the greenhouse gases it emits into the atmosphere. This 5% is mostly the result of the fact that forest coverage has increased slightly, which the United Nations (UN) considers as a credit in the accounting for emissions. Net zero emissions in 2050 might therefore allow South Africa to emit some greenhouse gases, but not more than what is removed from the atmosphere each year. Importantly, South Africa's emission reductions targets assume that rich countries will assist South Africa, technically and financially, to achieve this, in line with the Paris Agreement.

There has been less emphasis on adaptation policies than mitigation policies, as the most difficult adaptation is still several years into the future, while mitigation is urgently needed now. Having social support systems whereby the country provides income support to those living in the parts of the country which are hit worst by climate change helps society to adapt. Carbon offset projects can help local economies find new sources of income in the face of declines in other sectors. South Africa's climate change adaptation strategy pays considerable attention to human capacity. The country will need new researchers and experts to plan for adaptations to climate change; many more technicians will be needed in certain areas; and the population in general will need a better understanding of how to adapt to a changing environment. The one area in which there will be an especially large increase in the demand for technicians across the country is in photovoltaic (PV) electricity, or electricity generated from solar energy. It has been estimated that the number of technicians will have to increase

[6] Much of the remainder of this section draws from Gustafsson (2021), which summarizes South Africa's climate change policies.

from under 10 000 currently to around 60 000 by 2050 (Fourie, 2021: 24). The adaptation strategy also emphasises the need for better monitoring of weather and climate patterns, and better prediction of disasters such as droughts. Given South Africa's vulnerability to droughts, better water management systems are also required. Given this general overview of climate change and the mitigation and adaption policies on which South African scientists and policy developers are focusing, the next two sections throw the spotlight onto the Matatiele area of the Eastern Cape by focusing on the climate change effects on water, biodiversity and biomass in the area.

Summary

In general, climate change knowledge remains scant, however, recent evidence suggests that this is changing. Carbon dioxide (CO_2) and methane emissions remain the main contributors to greenhouse gasses which drive global climate change. Several global circulation models predict that there are likely to be significant, rapid changes in atmospheric conditions throughout southern Africa which are linked to three large scale climate systems which affect climate and weather patterns across the sub-continent. Climate change policies, in the form of adaption and mitigation policies, that come into effect will impact the lives of all South Africans. Mitigation policies are aimed at reducing the release of greenhouse gases, while adaptation policies aim to help communities and individuals deal with a changing climate.

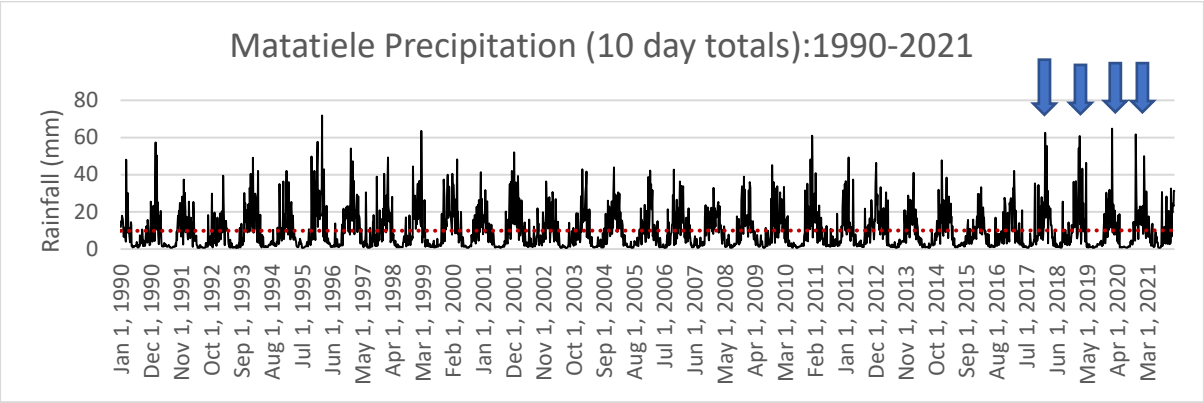
2.2.2. Climate change effects on water availability in Matatiele

a. Rainfall

Given the regional predictions above, *mean annual rainfall in the Matatiele region is likely to increase*, but this will take the form of heavier (i.e. more intense) downpours during the summer months (see Figure 1). The figure shows the increase in high intensity events over five (5) years (2018-2021) whilst the trendline shows a marginal increase in the magnitude of 10-day rainfall totals over the time series. These heavy downpours or storm events are more likely to be of shorter duration, resulting in wide-spread flooding. Shorter, more intense events also *increase soil erosion and reduce the quality of water* which is entering storage reservoirs, dams and rivers. We have already witnessed the consequences of high silt loads on the capacity of

dams that supply water to regional towns such as Mount Fletcher - where the dam is now completely silted up.[7]

Figure 1: Rainfall at Matatiele for the period 1990-2021



Source: Extracted from the CHIRPS database

b. Energy and evapotranspiration

The increase in air temperature in the region will contribute to greater evapotranspiration. Although this usually means greater plant growth, this growth can favour the woody components of the ecosystem over the grasses. The differences are unlikely to be significant in the short term but could potentially lead to changes in rangeland quality that would affect livestock grazing.

c. Run-off

The increase in the intensity and shorter duration of storm flow events will result in greater water yields to rivers and dams. As the region has few large dams, most of the increased flow will be discharged through the uMmzimvubu River which reaches the sea at the town of Port Saint Johns. The uMmzimvubu river is deeply incised into the sandstone and shale regions it flows through and therefore is especially fast flowing following storm events.

[7] C.f. tenders for de-siltating of dams in Matatiele – e.g. https://tenderbulletins.co.za/tender-bulletin/the-rehabilitation-de-silting-of-earth-dams-at-matatiele-local-municipality-alfred-nzo-district/

Summary

Heavier downpours are predicted for the summer months in the Matatiele region resulting in an increase in rainfall over the area. These short bursts of heavy rainfall will lead to widespread flooding and increased soil erosion. The increase in air temperature in the region will contribute to greater evapotranspiration and lastly, the storms will lead to greater water yields in rivers and dams. Siltation is a major issue in the Matatiele area and this needs to be considered in future planning.

2.2.3. Climate change effects on key ecosystem services

a. Grassland production

Under the predicted climate scenario for the Matatiele region, grass production is predicted to increase in the short-term as the stronger summer seasonality with marginally heavier rain favors grasses that dominate this ecosystem. Currently grass production is approximately 3.5 tons ha^{-1} $annum^{-1}$. *This equates to a livestock carrying capacity of 1-2 ha per large stock unit (LSU*$^{-1}$*).* There are very few locations in South Africa where the carrying capacity of natural veld exceeds 1 ha LSU^{-1} (Meissner et al., 2016), **so the current livestock carrying capacity is likely to hold for decades into the future.** In terms of the availability of healthy grassland, there is no threat to the grass-fed beef value chain however, this low risk is influenced by other factors like the negative effects of flooding in the area.Grasslands themselves are increasingly recognized as vital biomes for both biodiversity conservation and carbon conversion needs, with research advocating strongly for grassland conservation and restoration (Carbutt and Kirkman, 2022).

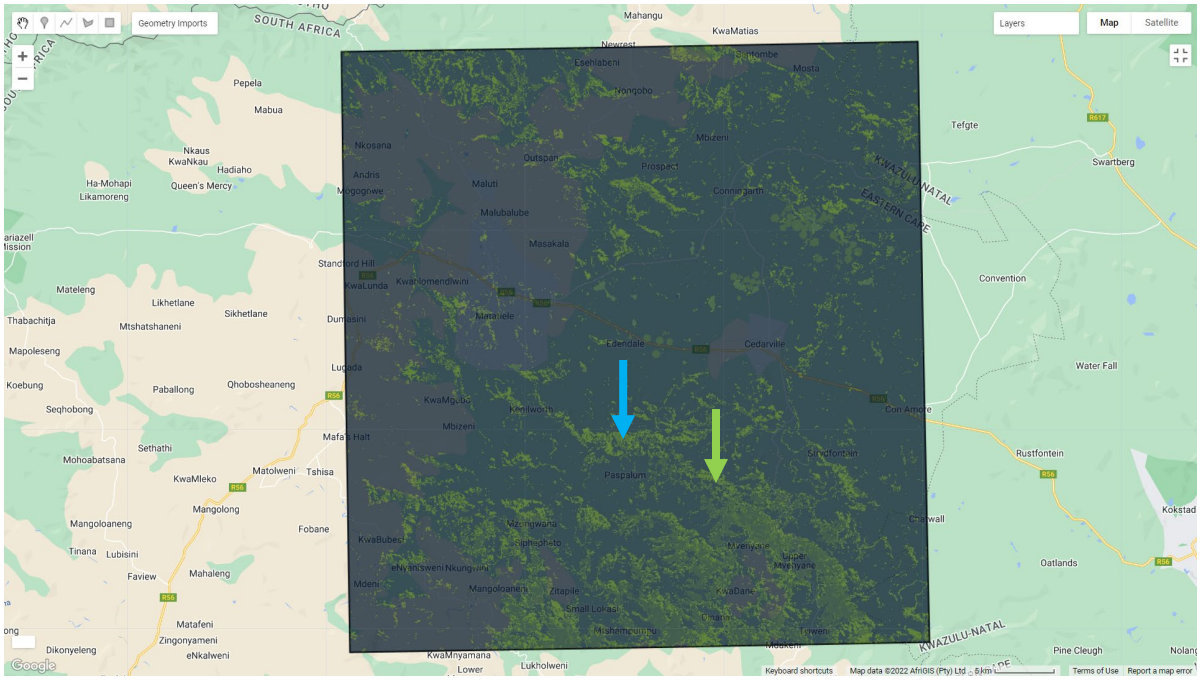
b. Woody biomass production

Wattle

Black wattle (*Acacia mearnsii*) and silver wattle (*A. dealbata*) occur throughout the region, and currently occupy about 274 km^2 of a 2500 km^2 geographic window around Cedarville and Matatiele (Figure 2). This is *>10% of the land surface area* and this window is generally representative of the land cover categories within this region. The light green colours in Figure 2 highlight the distribution of these two invasive alien plants. Unfortunately, satellite imagery

does not allow us to discriminate between the two species, so they have been grouped together into two categories representing 'old' established growth (green arrow in Figure 2) and 'young' growth (blue arrow). The light green colours represent the distribution of both wattle species and were mapped using 2019 using Landsat 8 satellite imagery (Palmer et al., In press). Wattle has been increasing in distribution since being planted as woodlots and wind breaks in the 1950s (Scorer et al., 2019). The silver wattle trees mainly occur along the seep-lines of the lower sandstone slopes. This is a weedy invasive with a high-water use (more than double that of the grassland that they replace) (Palmer et al., In press). Their presence results in the drying up of springs that provided clean, high quality household water, and this ecosystem service has been lost in heavily invaded areas. The stems of this species are slender and provide poor quality timber as fuel wood. This is in contrast to black wattle, which is more valuable and is currently being harvested as a so-called 'white wood' for exporting to Japan and for making of very high-quality paper. Black wattle was historically grown as woodlots around settlements during the Betterment Planning of the late 1950s (McAllister, 1991, 1992). Black wattle that was planted during that time has unfortunately invaded many abandoned arable lands and the riparian zone, and currently has standing biomass in excess of 400 tons ha^{-1} (Scorer, 2016; Scorer et al., 2019) in older (>50 yr) plantations. This poses a risk to grass-fed beef production.

Figure 2: The distribution of black (Acacia mearnsii) and silver wattle (A. dealbata)



Indigenous forests and plantation forestry

There is a small area (<1%) of indigenous Afro-montane forest on the southern aspect of several valleys in the region. These forests are rich in tree species that are highly valued in the traditional medicine trade. Several small commercial plantations (both pine and gum) on community (leasehold) and freehold land also occur in the region. These plantations are part of regulated forestry activities, and their catchment-scale water use is governed by Water Use Licenses awarded by the Department of Water and Sanitation.

c. Soil carbon storage

Since Betterment Planning occurred in this region in the late 1950s, soil carbon levels have been depleted as a result of the regular cultivation which was encouraged without the addition of fertilizers. A reduction in soil organic carbon (SOC) is a well-known consequence of cultivation, with resultant decrease in soil fertility and erosion risk (Wu et al., 2004). The reduction results from the regular stimulation, through annual ploughing, of soil microbes which respire and used the SOC store. The resultant low soil carbon levels therefore have the potential to be used to store significant amounts of atmospheric carbon, but this will require a change in land use practice. The potential for storing more carbon in the impoverished soils of the region has been reported recently (Momberg et al., 2023), but it would require significant sustainable changes in land management (i.e. kraaling of animals in mobile kraals, longer periods of veld resting, reduction in fire frequency) and to livestock ownership (i.e. a reduction in total livestock numbers).

d. Biodiversity

Although relatively little research has been conducted in southern Africa on species loss due to CO_2 fertilization, experimental work on grasslands across 59 global locations (Ladoucer et al., 2022) shows that under CO_2 fertilisation (i.e. increased atmospheric CO_2), the decline in species richness resulted from increased species loss and decreases in species gained. Biomass increase under fertilisation resulted mostly from species that persist and to a lesser extent from species gained. Seath and Shackleton (2022) have found that the invasion of A. dealbata has added to the habitat diversity of the north Eastern Cape, thereby facilitating increased avifaunal

diversity, if it continues to spread, then the populations and perhaps richness of grassland birds are likely to be negatively affected.

e. Fire frequency and intensity

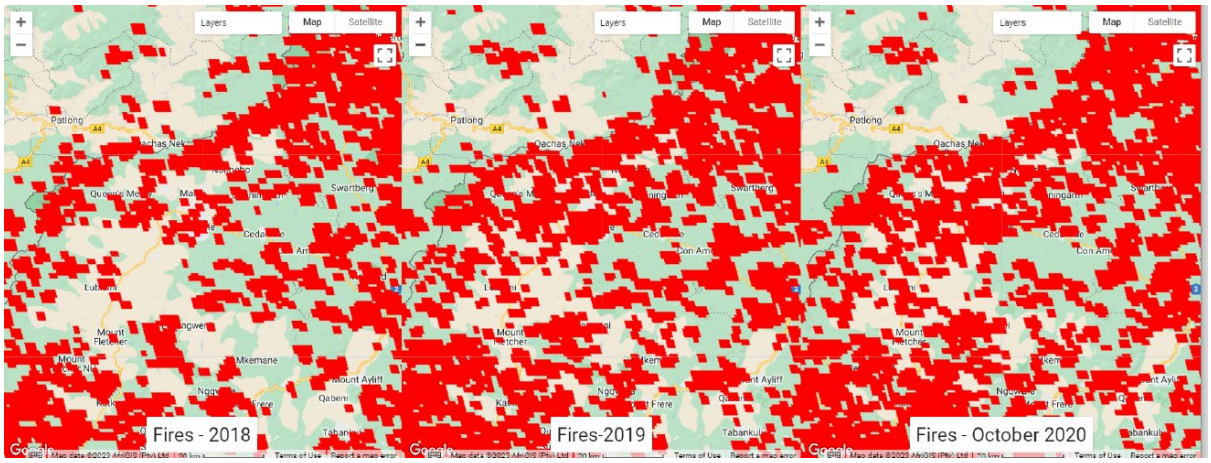
The use of fire to provide late season grazing has been a feature of grazing practices in sourveld on both freehold and leasehold land for over a century. Sourveld occurs in areas with high water supply and where parent material gives rise to soils with a low base status (Ellery et al., 1995). The sourveld of this region is the consequence of three major environmental drivers. Firstly, moderate to high rainfall (>700 mm per annum) that promotes the success of ligneous grass species that are generally less palatable to livestock outside of the growing season. These grasses are low in nitrogen (N) and high in ligneous material (mainly cellulose) that provides support structures for the rapidly growing grasses. Sourveld grasses generally have a low N:C ratio (Ellery et al., 1995) and livestock have to consume large quantities of poor-quality forage to maintain weight during the dry season.

Secondly, the strong summer seasonality of the rainfall further promotes the success of hardy grasses, and results in a bottleneck of very poor forage quality for several months at the end of winter. In order to capitalize on the green flush after the first spring rains, farmers tend to burn the excess grass in September and October. It is this practice which reduces both the standing grass biomass and provides fresh green flush for grazers. Thirdly, the underlying geology comprises sandstones which give rise to acidic soils, promoting the success of acid tolerant plants. These three factors are predicted to change in the following manner under the climate prediction: rainfall will increase, pH will decrease (soils become more acidic) and there will be a stronger rainfall summer seasonality. These effects are noteworthy as it will result in a greater abundance of less nutritious and less palatable grass biomass.

Currently, fire frequency in the region is highest during October (Figure 3), and this pattern will continue and be accelerated under the combined effect of elevated CO_2 and stronger summer rainfall seasonality as these two factors results in increased accumulated grass biomass

(i.e. fuel load for fires) at the end of the growing season. Figure 3, derived from the MODIS FIRMS product, shows the high frequency of fire in this region, with a distinct increasing trend from 2018-2020. As the 2019/20 growing season was a wetter year than the 2017/18 season, and there is a greater fire frequency in the former, it is likely that the increasing rainfall predicted for the region will also result in higher fire frequency.

Figure 3. Map of fire frequency in the Matatiele region for October 2018-2020



f. Invasion by indigenous woody shrubs

There is a suite of indigenous woody species which are known to increase in this region under continuous grazing by cattle and sheep. These species include kakerlakbos (*Leucosidea sericea*), bitterkaroo (*Chryscoma ciliata*), bakbos (*Felicia filifolia)*, sweet-thorn (*Vachelia karroo*) and bankrotbos (*Seriphium plumosum).* With the exception of *Vachelia karroo*, all these species are unpalatable to cattle and sheep, and their presence in increasing numbers has a deleterious impact on livestock production. *Felicia filifolia* is also toxic to sheep. Snyman (2012) showed a significant relationship between the loss of aboveground phytomass production of the grass sward and *S. plumosum* density. These results confirm the threat posed by *S. plumosum* in semiarid grasslands in general. Once again, it is unwise to speculate about the extent of this threat to the region without any data on the current distribution of *S. plumosum*. With any increase in their cover associated with grazing mal practices, all of these indigenous species have a negative impact on the area of grassland available for cattle and

sheep to graze. A trend of increasing occurrence of all these species is evident in the Matatiele region, but the magnitude of the change is uncertain.

Bond and Midgley (2000) suggest that the elevated atmospheric CO_2 will fertilize C3 shrubs differentially over C4 grasses. This is a possible explanation for the increase in woody biomass in many grassland systems in the world. Ladoucer et al., (2022) conclude in their global experiment at 59 grassland sites that woody biomass increases under fertilisation resulted mostly from species that persist in the landscape and to a lesser extent from species gained.

g. Reduction in surface area of grassland

There has been a steady increase in traditional settlements of the area surrounding Matatiele including the establishment of the town of Maluti, and this has resulted in a rapid increase in the physical area occupied by both towns and traditional villages. This pattern of increasing residential occupation of prime agricultural land has been reported elsewhere in the former Transkei (Gibson et al., 2018). Gibson et al. (2018) show, using a futures modelling approach based on historical trends in the National Land Cover database, that grasslands under communal tenure arrangements will decline from 57% to 52% of a total catchment area from 2014-2030. These losses are likely to favour a gain in woody plants, cultivated land and an increase in traditional settlement. When combined, these three changes in land cover will further reduce the land available for livestock grazing, thereby decreasing the carrying capacity. There will need to be a trade-off between woody biomass accumulation due to increased above-ground woody biomass, grass production and residential cover (Bennett et al., 2023). The higher woody biomass will also lead to greater evapotranspiration, less surface water and corresponding surface air temperature will increase (albedo effect) (Palmer et al., In press). The decrease in run-off will specifically affect grass production in the favoured grazing areas or ‘meadows’ down-stream of hill-slope seeps (Gusha and Palmer, 2021; 2023).

h. Reduction in forage quality

Under the current land management regime, continuous selective grazing by cattle and sheep has led to a change in the species composition of the grasslands. Long-term trials at the Kokstad Experimental Farm (Hardy, 1994) have shown that continuous selective grazing by cattle and sheep shifts the species composition from one that is dominated by palatable, nutritious species such as *Themeda triandra, Tristachya leucothrix* and *Setaria sphacelata* to one dominated by unpalatable, disturbance tolerant grasses such as *Sporobolus africanus* and *Eragrostis plana*. *E. plana* is a very hardy perennial species which currently dominates the communal grasslands and thrives under disturbance regimes such as cultivation and trampling by livestock.

In an experimental study of the *E. plana*, Focht et al. (2012) showed that soil disturbance and poor grassland management regimes positively influenced the invasion by this species. Invasion was favoured by the lower grassland height (which accompanies continuous heavy grazing in an area such as Matatiele), lower forage mass, higher intensity of the soil disturbance (e.g. livestock hoof action), and higher photosynthetically active radiation intercepted (FARint) due to the continuous grazing. On the contrary, higher grassland height, higher forage mass, lower soil disturbance and lower FARint, associated with rotational grazing or exclusion, showed higher potential to control the invasion into the natural grassland. These conditions prevail in the grasslands under communal tenure in the Matatiele region. Forage quality has also been shown to decline under increasing air temperature (Lee et al., 2017). In general, forage quality on communal rangeland in the Matatiele region is currently very poor, with low nitrogen and high non-digestible fibre (NDF) and is likely to decline further given the local climate prediction of increased air temperature and continuous grazing. Poor forage quality has been shown to increase enteric CH4 production (Santander et al., 2023). Improving forage quality, either by improving veld condition or by supplementary feeding, can be a method to reduce enteric methane production. Value chain certification schemes, which quantify improvements in forage quality, could be introduced to further enhance the premium value of grass-fed beef.

Summary

The projected growth of the remaining native grasslands in the Matatiele area is still predicted to be able to cater for the region's livestock carrying capacity for at least short (5yr) and medium (15yr) terms. However, the growth of silver and black wattle which has dominated the area poses a threat as it dries up natural springs used by local communities and animals. In addition, the threat of reduced grassland area comes from several quarters, including indigenous woody invasion, increase in unpalatable species and clearing of land for residences. Furthermore, soil carbon stores have been depleted due to ploughing of the land without the use of fertilizers. This creates the environment for potential greater future soil carbon storage in these areas.

2.3. Key socioeconomic factors

Alongside the biophysical environment, the local socio-economic environment would also have an impact on the grass-fed beef value chain (GFBVC) and to this end, key socio-economic factors are discussed in this section of the report. A detailed account of the social and economic profile of the Matatiele area has been provided in report one so against that backdrop, the remainder of this section will outline the key social and economic underpinnings of the grass-fed beef value chain in the Matatiele area of the Eastern Cape.

2.3.1 Key social factors

Matatiele is composed of a fairly young population with females making up the majority in the population. Female-headed households are also found to be more common in Matatiele (68%). Results also show that 41% of inhabitants are in households which have at least one person aged 30 and above *and* where any such person is always female. In other words, there are no male household members aged 30 and above. All these indicators point to the vital role played by women in society and the economy, particularly in this region.

An overview of education shows that younger people are better educated than older people and that, over time, patterns have moved from a male advantage to a female advantage. Education

does not seem to contribute to participation rates in cattle livestock ownership where those with university education tended to own less cattle. In these instances, cattle ownership is associated with a lack of income or food insecurity and in a sense, cattle act more as a storage of wealth and a form of an insurance than as an income generating business activity. For many, livestock are seen as a livelihood security safety-net (Vetter, 2013, Twine, 2013, Coleman, 2019). If the food security situation is worse for households owning cattle then it is crucial and makes sense to ensure that these households participate in mobile auctions to make additional and supplementary incomes. This also signals a strong supply chain potential of cattle from these communal lands in the short to medium terms.

Gender dynamics to consider in this discussion include the fact that in many areas even when women and youth do the majority of the work in relation to livestock, they do so within patriarchal systems that still privilege male (elder) ownership and decision making. Such that in rural areas where women and youth are left to perform the daily activities of livestock production, they are still subject to older men being in charge of economic decisions such as the selling of livestock. In many cases their daily work would be seen as assisting in looking after livestock that 'belongs' to elders or migrant men. Historical data on cattle sales in the Matatiele region mobile auctions also present male dominated markets (Meat Naturally Pty (MNP), 2014-2023). While 68% of the Matatiele population live in female-headed households, the figure is 57% if only cattle-owning households are considered, and a much lower 25% if the best endowed 1,220 households are considered. Women are therefore commonly involved in the cattle industry in some way, though their power is relatively small among the wealthiest cattle owners.

With regards to grains and food crops, the uMzimvubu municipalities agricultural activity or participation is more than double the national rate as a proportion of total households. If agricultural participation is indicative of lower levels of education and lower incomes in general, then municipalities in uMzimvubu (including Matatiele) are more vulnerable on average given the trends presented above. For the GFBVC, the implications are bittersweet; improving agricultural productivity and formalising cattle markets has an important socio-

political and economic role to play. The efforts of supporting and expanding the work of NGOs around Matatiele on the environment and agricultural sector (including on GFBVC) are of great socio-economic and political importance. For the GFBVC, there seems to be greater opportunities than threats when looking at the current socio-economic conditions of the Matatiele area.

Summary

Matatiele is composed of a fairly young population with a higher majority being female. Female-headed households are also more common in Matatiele compared to nationally. Younger people are found to be better educated than older people and over time, patterns have moved from a male advantage to a female advantage. These findings are similar to national estimates. Having an education is not linked to cattle ownership and more so, households that own cattle and/or engage in agriculture are found to experience food insecurity.

2.3.2 Key economic factors

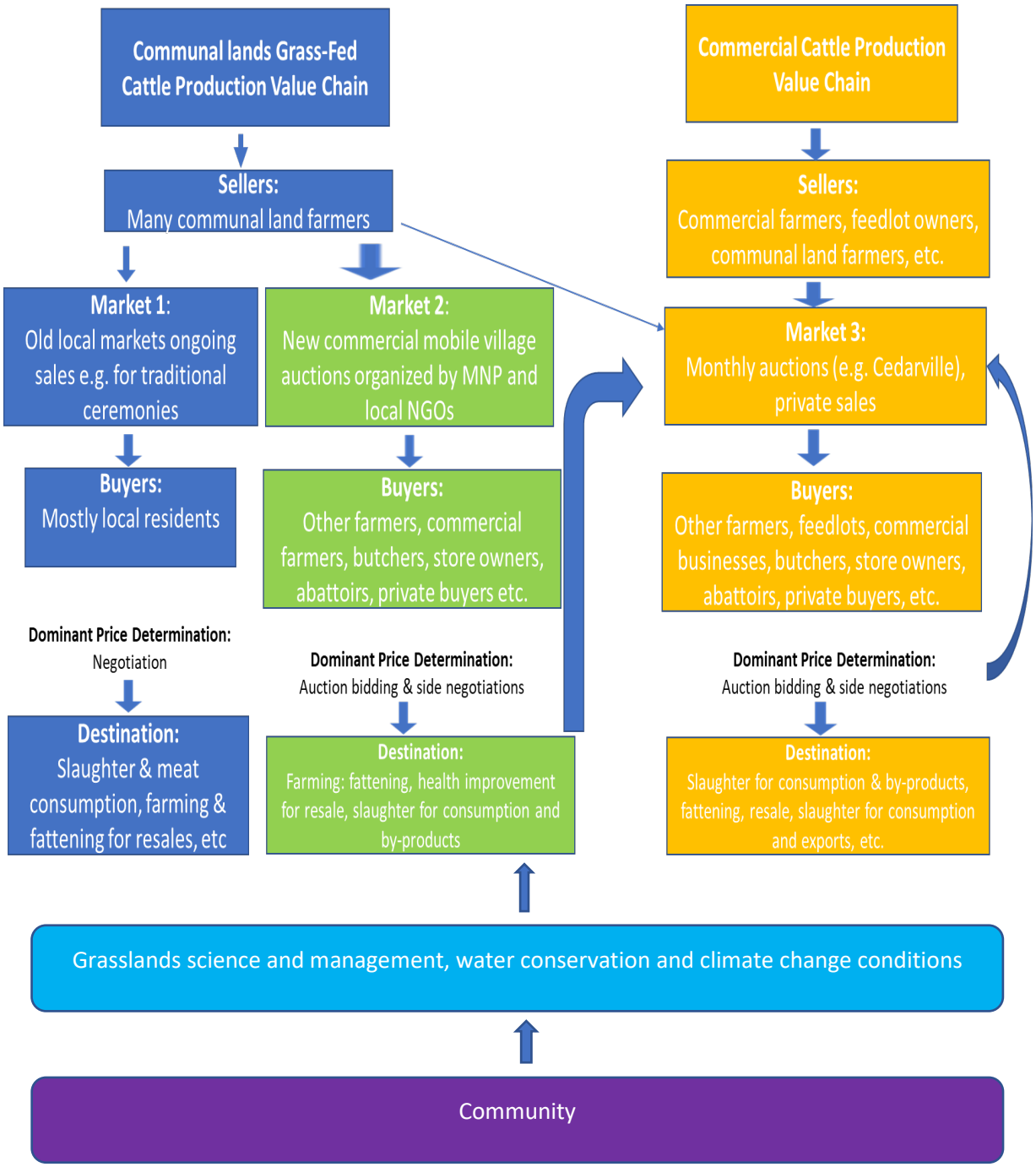
South Africa currently produces over 21% of Africa's total meat production, which makes up 1% of meat production worldwide. The country's livestock industry contributes around 34% of total domestic agricultural production, supplying around 36% of the nation's protein needs (RMRDSA, 2018 in AgriSeta 2021). Overall, the review of various data and case studies suggest that there is no global threat to the supply and demand for beef and beef products. At the international level, the prices and consumption of beef were reported to be on the rise, alongside production increases (TradeMap, 2022). Most suppliers recognise the opportunities that exist for beef production which are characterised by a reduced regulatory environment and an increasing demand and prices for beef. The overall signal to new entrants, including communal land farmers of Grass-fed beef is that the sector has business opportunities in the medium to long term (BeefMaster, 2019). The supply of cattle livestock and its associated products in South Africa is essentially divided into two main markets. Beef is supplied from commercial livestock farms and communal land areas. In 2020, the number of commercial beef producers was estimated at 22 000, employing over 138 000 people. The number of small and communal farmers was estimated at 3 million, employing over 9 million people, most of these

as herders. In total, the beef industry as a whole contributes to the livelihood of around 2,13 million people (Department of Agriculture, Land Reform and Rural Development, 2021, 6).

A snapshot of local cattle ownership in Matatiele shows that while 30% of households in Matatiele engage in livestock production only 17% report owning cattle. The total number of cattle owned in Matatiele was around 95,000 – this figure is just under half of the human population of Matatiele. Numbers could also vary seasonally within the year, and across years depending on climatic conditions. Around half of households with cattle in Matatiele have between 6 and 20 cattle. Households owning cattle tend to also own other farm animals. Sheep ownership seems to be linked with cattle ownership, which is typical and expected of the Eastern Cape, based on the traditional and (emerging) business importance of sheep. Goat ownership also rises with cattle ownership and additionally, households that own cattle also own chickens, pig and other poultry, albeit a smaller number of households (Community Survey, 2016).

A key economic factor linked to cattle ownership and the sale of cattle in the Matatiele area is the presence of three market systems which are interlinked and reliant on the community and availability of healthy grasslands. Figure 10 presents an illustration of these markets and values chains. The local market in Figure 10 (Market 1) is an old, fairly ad-hoc and informal type. Villagers self-organise themselves interchangeably into buyers or sellers, depending on proximity, nature and urgency of the purposes for which a purchase for an animal is made. Negotiations for the price of an animal would also depend on the type of a traditional ceremony for which an animal is sought. For this market there are no clearly written or fast set rules on how prices are negotiated. The rules applicable in these market settings are determined culturally by prevailing traditional institutions (ERS, 2022).

Figure 4. Illustrative presentation of Cattle and Beef Market Value Chains and markets



The newer mobile market auctions in Figure 4 (Market 2) are more organised with clearly defined operational rules for players. The MNP, in partnership with local NGOs (like ERS, LIMA and CSA) bring the auctions directly to the community where participation in these

auctions require adherent to rangeland conservation efforts in the area. Making these markets accessible to communal farmers means that costly logistics like transportation of cattle are reduced however, prices fetched for animals sold at these mobile auctions (although they have improved over time) remain typically lower than those fetched at established commercial auctions like Cedarville (Market 3) (Frazee, 2022). The more formal markets like those held at Cederville are more structured and price driven however, communal farmers pay a higher commission for participation and are responsible for transport logistics, certification with police authorities and the like (ERS, 2022).

Tying these market systems together is the support from the community and moreover, healthy grassland management, water conservation efforts and climate change mitigation behaviours. For future sustainability of the business model, the question would then be whether or not the model of mobile auctions would still be sustainable without the indirect benefits accruing to the communities stemming from donor supported NGO work. If the indirect benefits stemming from donor supported work far outweighs the forgone profits from lower prices fetched at mobile auctions compared to established commercial auctions, then the answer is “no”, the mobile auctions business may not be sustainable in the long term. This and other factors will be drawn out further in the business case study and policy brief.

Summary

There are three main market systems which operate in the Matatiele area: old markets, mobile markets and formal markets. The older markets are very informal and cattle sales at this market are usually for traditional ceremonies. Participation in the mobile auctions are linked with rangeland conservation efforts which minimise the costs linked to cattle sales. The formal auctions are more structured compared to old and mobile auctions and yield a higher price per kilo for cattle sold. Underpinning these markets is the support from community and the integration of rangeland science and management, water conservation efforts and climate change mitigation behaviours. The supply and demand for beef is driven by local and international markets and is characterised by an increase in price and demand for beef and an overall, reduced regulatory environment.

2.5. Conclusion and policy implications

Leaders in the Matatiele community stand to benefit from deepening the understanding of how policy, from the global to the local level, influences the local GFBVC. Such an understanding can help to shape realistic expectations and inform when it is worth investing in advocacy to influence policy. Five policy areas stand out as particularly relevant: (a) general emissions reduction policies; (b) human resources development; (c) social grants to address climate change-related disruptions to income; (d) carbon offsets programmes; and (e) policy around the certification of beef.

Firstly, the national government's global commitments to mitigation, or to reducing global greenhouse gases, is a contentious and important matter. The current commitments, and they could change in future, say almost nothing about the beef industry specifically. Mitigation commitments largely centre around the reduction of fossil fuel combustion. However, increasingly each country's commitments will be considered when rules around international trade, including trade in beef, are up for renewal. Commitments viewed favourably by the rest of the world could result in South African exports being treated favourably. Conversely, if South Africa's commitments are considered inadequate, the importation of South African goods could suffer new restrictions. Importantly, because of the global nature of climate change, mitigation efforts by the South African government do not influence harmful climate effects for South Africa specifically, but for the world as a whole. Agricultural sectors are particularly vulnerable to climate change and can therefore be expected to play a large role in advocating for emission reductions. However, it would be difficult for Matatiele community leaders to influence directly national and global policy. What is optimal is for these leaders to interact with broader government and non-government organisations that can play a policy advocacy role. Such organisations include the Eastern Cape Department of Economic Development, Environmental Affairs and Tourism (DEDEAT), the WWF and Conservation South Africa. DEDEAT works with the national Department of Forestry, Fisheries and the Environment, which periodically produces the 'national communication', a voluminous report to the United Nations system where details of South Africa's mitigation efforts are outlined.

Secondly, developing human capabilities to respond to coming threats and opportunities is important. For this, both sound foundations in areas such as literacy and numeracy in the broad population, and relevant specialisation among a sufficient number of experts, are necessary. Eastern Cape is by several measures the province in the country with the greatest basic education challenges. This limits the pool from which expertise can be drawn, and the ability of the population to engage effectively with evidence, manuals and advice. Interventions focussing at the primary level to address the very serious reading and numeracy problems will benefit the community in the long run, not just in terms of the readiness to deal with climate change. Such interventions should include ensuring that primary schools are duly accountable to the communities they serve. At the secondary level, while around 30% of Grade 12 learners in Alfred Nzo West, the education district within which Matatiele is situated, write examinations in the largely theoretical subject Agricultural Sciences, none write examinations in the more prestigious and practically oriented subject Agricultural Technology, and only 2% take Agricultural Management Practices – the latter is offered by three of the district's 81 secondary schools[8]. It appears that there is scope to advocate for a more relevant coverage of agriculture in secondary schools. Of the 50 public TVET[9] colleges in the country, one has campuses within 50 kilometres of Matatiele, namely Ingwe College. However, this college does not include agricultural subjects within its list of offerings, for instance Primary Agriculture, a subject offered by other colleges. This appears to be a gap which should be addressed.

Thirdly, government grants to households to alleviate poverty play an important economic and social role in Matatiele, and in other rural parts of South Africa. Increasingly, South Africa's social grant system will have to become sensitive to largely unanticipated climate-related calamities, such as droughts and floods. A key grant in this regard is the Social Relief of Distress (SRD) benefit, which is specifically designed to deal with emergencies, and was expanded significantly during the COVID-19 pandemic. It is in the interests of leaders in the Matatiele community to lend their voice to how this grant is used and aligned to climate-related contingencies. According to South Africa's Third National Communication, the Agricultural

[8] Communication with Department of Basic Education.
[9] Technical Vocational Education and Training.

Research Council should play an increasing role in monitoring the impacts of climate change on agriculture. It is in part the research of this key institution that would inform when SRD grants would be used to address climate change-related contingencies. The Matatiele community has an interest in following closely how the Agricultural Research Council fulfils this role.

Fourthly, the promotion of 'payments for environmental services' (PES) by the state is something that activist groups in Matatiele and elsewhere have promoted for many years. This would involve formula-driven government transfers to groups successful in taking steps to advance the conversation of the environment, for instance water resources, where this conservation is broadly beneficial to regions even outside the locality of the conservation efforts. This has not taken root in government policy, but what has begun to emerge is something similar, namely carbon offsets programmes. These programmes would involve, for instance, a group in Matatiele being certified as having brought about higher levels of carbon sequestration through improved conservation efforts, and for this group to be paid through international mechanisms whereby rich countries pay developing countries. To facilitate this, the Department of Energy has established the Carbon Offset Administration System (COAS). While this type of work is still in its infancy, it is important for actors in areas such Matatiele to identify opportunities, and to influence the way the regulatory framework and supporting systems evolve in South Africa.

Fifthly, the certification of beef is likely to become increasingly complex and influential, in part as consumers, be they individual consumers or importing countries, demand greater clarity around the greenhouse gas emissions associated with products. Apart from greenhouse gas emissions, health and animal welfare concerns are likely to feature more prominently in a context of cultural change among consumers, but also technological changes in the meat industry. Currently, the certification of beef in South Africa is largely managed by industry bodies, with government's direct role largely confined to the monitoring of abattoirs in terms of the 2000 Meat Safety Act. Certification of grass-fed beef by non-government organisations has already begun in the country, though this is still limited. Government is likely to become increasingly involved in overseeing the various certification bodies. Here a key challenge is

the absence of research into the emissions associated with the entire life cycle of different types of beef in South Africa. Government is well-placed to promote and fund such research. A life cycle approach involves examining not just, for instance, the methane emissions typically associated with ruminants such as cattle, but also the emissions embedded in for instance electricity usage, transportation, and grain feed used in feedlots. Existing research from beyond South Africa that uses this approach does not point to lower total emissions for grass-feed beef, yet exact emissions per unit of beef are sensitive to several factors, some of which may be specific to South Africa. The available evidence suggests that the marketing of grass-fed beef in South Africa is likely to benefit from an emphasis on its health and animal welfare elements. The GFB industry should view the certification system holistically and understand that certain cost differentials between GFB and more commercial beef rely on the stringency of the health and animal welfare practices of the latter. One way for the GFB industry to lower its relative costs is thus to advocate for proper regulation of the more commercial part of the industry. One marketing message that the GFB industry may wish to consider in an increasingly complex context, where the emissions associated with any form or beef are likely to become more widely understood, is in fact to advocate for lower beef consumption overall, *but* then to emphasise that when beef is consumed GFB is preferable due to its health and animal welfare benefits.

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