# Grazing and Burning Guidelines

## Managing Grasslands for Biodiversity and Livestock Production

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## Managing Grasslands for Biodiversity and Livestock Production

Compiled by

Dr Richard Lechmere-Oertel

for

Developed in partnership with

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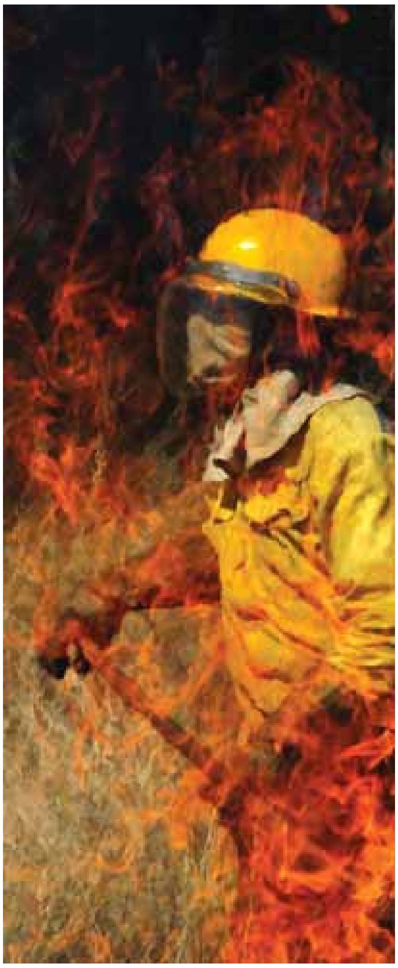
# Executive summary



South Africa's grasslands stretch from the eastern seaboard into a very large part of the interior, and hold many areas considered high priority for biodiversity at an international, national and regional scale. Grasslands also provide indispensable ecological infrastructure and significant economic benefits to South Africa. These often unseen benefits are enjoyed by a range of end-users, including communities near and far, living in both cities and rural areas.

Endowed with rich soils, abundant water resources, minerals and a moderate climate, grasslands are where much of South Africa's agriculture, forestry and mining activities occur. While vital to the economy, these activities have resulted in significant modification of the landscape and the ongoing and necessary growth of these sectors continues to place pressure on the natural systems that sustain these activities. While some economic activities have a greater impact, commercial and subsistence grazing also affect the delivery of grassland ecosystem services over a period of time. As grazing and burning regimes are altered, so grasslands can quickly lose native species, resilience, productivity and ultimately ecosystem service delivery. As this occurs, eventually leading to a very degraded and unproductive state, current and future generations are deprived of the many benefits that are directly or indirectly derived from intact grasslands.

However, the majority of intact grasslands are used for extensive livestock grazing and continue to deliver important ecosystem services and have patches rich in biodiversity. Fire and grazing are the most influential factors in managing these landscapes for both production and biodiversity. Any change in fire and grazing regimes that supports more resilient grassland ecosystems will better support livelihoods, livestock production and biodiversity, even in the face of climate change. Livestock grazing is a land use that can be compatible with biodiversity objectives when subject to biodiversity-friendly management practices including fire and grazing. These can be implemented in ways that also improve the farm-scale productivity and secure ecological infrastructure in the long-term.

Integrating biodiversity objectives into the management practices of extensive livestock grazing will therefore have a variety of positive benefits at various scales. These Guidelines aim to provide the information on how to achieve these benefits.

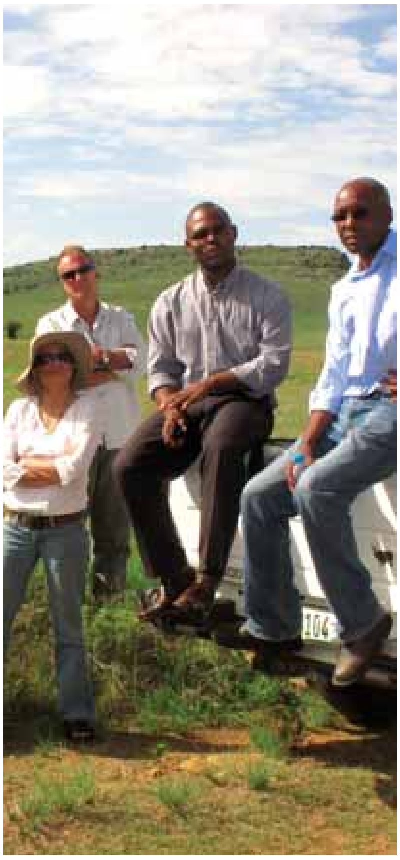
## Guidelines for burning and grazing grassland ecosystems

The Grazing and Burning Guidelines have been collated from the knowledge and expertise of many grassland ecologists, farmers, academics and biodiversity and grazing specialists. They represent the current best understanding of how to achieve the parallel and mutually-beneficial management objectives of:

a) Economically-viable and sustainable livestock **production** founded on improved, or at least stable, veld and soil condition; and
b) **Conservation** of grassland biodiversity and ecosystems, including their component plant and animal species.

These Guidelines are aimed at an audience with some technical understanding of grazing and burning management and who are **willing** and **able** to implement these management principles. In many instances, these Guidelines will be used by conservation and agricultural extension staff who assist farmers and conservation managers on how to achieve the dual objectives described above.

The Guidelines have been written so that any land manager or extension officer can understand the primary principles of grassland ecology in relation to grazing and burning management. They will help clarify management objectives and provide practical best-practice advice that can be applied at the farm-scale.



The Guidelines integrate a wide range of technical information from the fields of agriculture and conservation into an accessible, practical and user-friendly document. While our understanding of ecosystem-specific grassland responses to grazing and burning will improve in years to come, these Guidelines will enable users to improve the likelihood of conserving the remaining plant and animal diversity on the farm, while managing a sustainable commercial or subsistence livestock production system in an indigenous grassland ecosystem (i.e. not a planted pasture or 'improved' grassland).

## What these Guidelines are – and are not

The Guidelines are **designed to encourage grassland managers to think about and observe the dynamics of their particular management scenario, and to apply biodiversity-friendly principles**. The Guidelines are not a list of rules that do not take cognisance of the local ecosystem or management dynamics. Rather, the Guidelines elaborate on the differences in grazing and burning ecology and management in three types of grassland ecosystem: arid, mesic and coastal. Where appropriate, different grassland ecosystems are considered separately in the discussion. Different components of grassland biodiversity that have unique management requirements are discussed, including: forest patches, wetlands, and the various components of the fauna.

Grassland burning and grazing best-practice is no small topic, and there is no shortage of published or anecdotal opinion on which is the best approach. These Guidelines do not attempt to resolve these debates, but rather aim to stimulate land managers to think about the management of grassland in an intentional and principled manner.

These Guidelines are developed and structured around three notions:

### 1. Grassland response to burning and grazing

It is helpful to understand how grasslands respond to management pressures, and a conceptual model showing a potential response scenario is presented to stimulate thinking about grassland management. This model is used to unpack some of the primary differences between the grassland ecosystems and how they respond to different management pressures – emphasising that there is no single management best-practice for all grassland ecosystems.

Considering grasslands are not static, but rather change over time in response to management and environmental drivers, it is helpful to consider basic indicators of change that will give early warning of degradation. The Guidelines provide some elementary tools to do this.

### 2. Best-practice principles for burning and grazing

The principles of burning and grazing with the greatest conservation potential for grassland biodiversity in an agricultural landscape are discussed. The burning best-practice provides insights into frequency, seasonality, type and how to achieve specific management objectives, such as bush control. The grazing best-practice focuses on using rest and rotation to achieve the biodiversity and production objectives, including the need to evaluate carrying capacity and stocking rates. Although there are many synergistic effects between fire and grazing, these management drivers are initially treated separately for sake of clarity, but are later re-integrated at a farm scale.

### 3. A farm-scale approach to burning and grazing

In bringing these principles together, the Guidelines provide an integrated template for farm-scale grazing and burning management planning, based on a four-year rotation system. Although this system is better suited to a more mesic grassland ecosystem, it can be adapted for the dry and coastal grasslands. Indeed, the template is by no means the only way to rotate grazing or burning on a farm, but it is a sound option that can be adapted for the specific management needs of any farm. The Guidelines encourage farmers to employ some form of management assessment that allows them to evaluate how effective their management approach is.

## Using the Guideline

The Guidelines are structured in four sections that lead the reader through a concise theoretical foundation of grassland ecology and best-practice management principles through to practical implementation guidelines at the farm-scale.

The topics of grazing and burning have a very large literature base, and it can be overwhelming to access relevant information depending on the context. A list of resources and suggestions for further reading are provided for those who wish to expand their knowledge of the topics.

Ultimately, land managers and extension staff who are interested in improving the conservation value and long-term production security of their grasslands will benefit from the principles described in the Guidelines.

# Contents









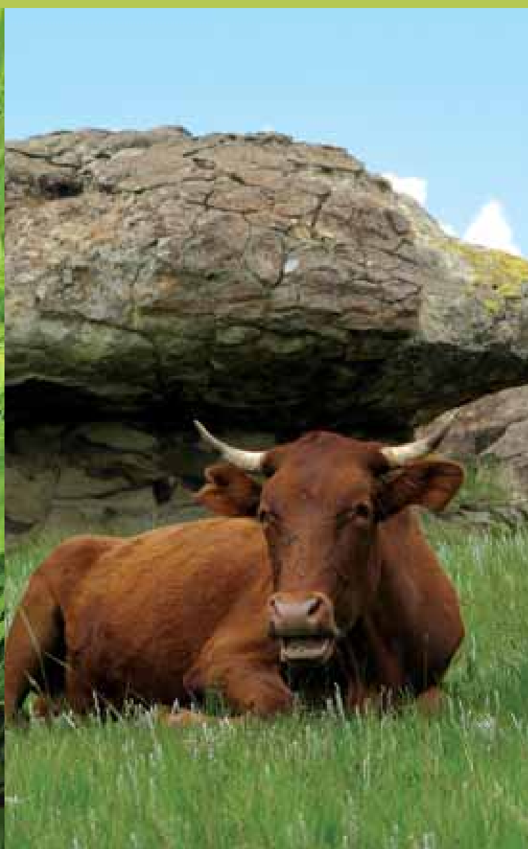
# Boxes, figures and tables



# Acronyms

| | |
|---|---|
| **GEF** | Global Environment Facility |
| **SANBI** | South African National Biodiversity Institute |
| **UNDP** | United Nations Development Programme |

# 1 South African grasslands: Ecosystems, agriculture and conservation



# 1. South African grasslands: Ecosystems, agriculture and conservation

## 1.1. General introduction

South Africa's grasslands are resilient and stable ecosystems, which dominate much of the central and eastern South Africa, and are extremely valuable from three related perspectives: livelihoods, biodiversity, and economics.

**Livelihoods and ecological infrastructure** – Many people rely on grassland ecosystems to some degree for their daily living either from direct benefits of the productivity of livestock or harvesting of plants, or indirectly through the very important ecosystem services provided by grassland ecological infrastructure (see Box 1) – primarily related to water security and climate change resilience.

**Biodiversity** – Many of South Africa's grassland ecosystems are part of globally-important biodiversity hotspots, or at least are prioritised in national and provincial biodiversity plans, and are thus worth considerable conservation effort. Grasslands are visually dominated by numerous species of grass, but in terms of species composition and growth forms they are very diverse, with only one in every six species being a grass. This high diversity of other plant types includes bulbs and soft-leaved herbaceous plants (collectively called forbs), ferns, under-ground trees, shrubs and scattered trees or bush clumps. The non-grass component of plant diversity has high conservation value and significance, and is often more susceptible to poor management. Although not often considered, grasslands also support great diversity from all the major animal groups: mammals, birds, reptiles, amphibians and invertebrates.

**Economics** – The economy associated with the livestock industry in South Africa's grasslands is considerable, and extensive stock farming is the only viable agricultural activity in approximately 69% of South African agricultural land. Livestock is produced at scales that vary from large commercial companies to communal subsistence farmers. Cattle production has increased by nearly 1 million heads from 12.6 million in 1994 to 13.5 million in 2004; while grazing areas declined due to expanding human settlements, alien plant invasions, range degradation, mining, arable agriculture and forestry.

Grasslands are dominated by perennial plants that are relatively resilient to repeated defoliation or disturbance by fire, drought, frost and grazing. However, they are not invincible, and undergo changes in plant vigour, species composition, vegetation structure and productivity in response to various management pressures, particularly inappropriate grazing and burning. These changes are very undesirable from a biodiversity, veld condition or livestock productivity perspective; but are avoidable if the grasslands are well managed.

### Box 1 .What is ecological infrastructure?

Ecological infrastructure refers to naturally functioning ecosystems that deliver valuable services to people, such as fresh water, carbon sequestration climate regulation, soil formation and disaster risk reduction. It is the nature-based equivalent of built or hard infrastructure, and is just as important for providing services and underpinning socio-economic development.

Ecological infrastructure includes, for instance, healthy mountain catchments, rivers, wetlands, coastal dunes, and nodes and corridors of natural habitat, which together form a network of interconnected structural elements in the landscape.

*Extracted from SANBI 2013. Ecological infrastructure. Nature delivering services. SANBI Factsheet, August 2013. Available at http:http://www.grasslands.org.za/images/Ecological_%20Infrastructure_Fact_Sheet.pdf*

This guideline booklet is intended to provide farm managers, conservation and agricultural extension officers and various decision-makers with the best-practice principles needed to graze and burn the different grassland ecosystems of South Africa in a way that doesn't compromise their production potential or inherent biodiversity value.

This booklet has four sections:

1. The **introduction** describes the origins and intentions, assumptions and limitations of the Guidelines, and provides a description of the **grassland ecosystems** with a practical interpretation of their ecology that is relevant to the discussion on grazing and burning.
2. A theoretical model of **grassland response to fire and grazing** is used as the foundation for the best-practice guidelines.
3. The **best-practice guidelines for burning and grazing** for a biodiversity objective are presented for the main grassland ecosystems.
4. A **template farm-scale management plan** is provided as a basis for implementing the guidelines.

## 1.2. Purpose and focus

In South Africa, there has recently been a significant investment in improving the conservation and sustainable use of grasslands, primarily driven by South African National Biodiversity Institute (SANBI) and its partners in the form of the Grasslands Programme (see Box 2). The Grasslands Programme has also already developed guidelines for sustainable development in grassland ecosystems[1]. It focuses on the principles of ecosystem management from a development perspective, aiming to provide development planners and environmental impact assessment practitioners with the tools needed to make sensible decisions within the Grassland Biome. *The Grasslands Ecosystem Guidelines only deal with grazing and fire in a cursory manner, hence the publication of these Guidelines*.

The Grazing and Burning Guidelines also emerge from the Grassland Programme and provide best-practice advice to rangeland managers, including commercial and subsistence livestock farmers, who also want to see biodiversity persist on their farms in the long-term. **They are designed to be implemented at a farm-scale where the management objectives are:**

**a) Economically-viable, sustainable livestock production founded on improved, or at least stable, veld and soil condition.**

**b) Conservation of grassland biodiversity and ecosystems that occur in and around grazing areas, including their component plant and animal species.**

The successful implementation of these Guidelines pre-supposes three very important criteria:

1. The farm (or land management area) is under some form of intentional management[2].
2. The long-term conservation of grassland condition and diversity is one of the objectives of the management.
3. The land manager (owner, manager, tenant or community) is willing and able to implement the management actions described here.

Although it is recognised that many grazing areas do not meet these criteria, there is no foreseeable way to implement these Guidelines without such management intentionality and control. If these are absent, the capacity to plan and manage will need to be established before trying to implement this best-practice.

[1] SANBI. 2013. Grasslands Ecosystem Guidelines: landscape interpretation for planners and managers. Compiled by Cadman, M., de Villiers, C., Lechmere-Oertel, R. and D. McCulloch. South African National Biodiversity Institute, Pretoria. 141 pages. Available at http://www.grasslands.org.za/document-archive/category/21-grassland-ecosystem-guidelines

[2] The management plan should ideally be in a document that clearly states the objectives and criteria for management, but may equally exist in the head of the land manager.

Although these Guidelines are focused on grazing, the issue of burning cannot meaningfully be excluded from the discussion. Rangeland management revolves around the integration of grazing and burning as the two primary management tools available to a manager, particularly in the more mesic grasslands, and hence this document provides an integrated approach.

These Guidelines will not address other topics that contribute to successful farming, such as herd genetics and health, nutrient requirements, business plans and financing, staff, infrastructure and equipment, and so on. These are assumed to be viable and well-managed in themselves.

As the Guidelines are applied across increasing areas of our grasslands, there is greater likelihood for the persistence of biodiversity across the large portions of the Grassland Biome that are used for extensive animal production.

## 1.3. South Africa's grassland ecosystems

The grassland landscape spans the altitudinal range from sea level to over 3,000 m and includes highly varied topography - from the sandy coastal plains and rolling hills of the eastern seaboard, to the steep slopes, valleys and ridges of the sub-escarpment, up onto the peaks and plateaus of the high escarpment and the plains of the central Highveld. Across this landscape 72 grassland vegetation types are recognised[3]; differentiated from each other by shifts in species composition that result from a complex interplay of environmental variables such as climate (temperature, frost and precipitation), topography, geology and soils. These environmental patterns influence other ecological forces, such as grazing and fire, which give rise to finer differentiation of the grassland types. To add greater and mostly unquantifiable complexity, the long history of livestock grazing in South Africa, from the early 1800's until now, will have had varying impacts across the biome, depending on the unknown interaction of grazing pressures, burning and climate through the decades.

### Box 2. The Grasslands Programme: living in a working landscape

These Guidelines are part of a larger focus of work in grassland ecosystems, coordinated under the SANBI Grasslands Programme. The SANBI Grasslands Programme is a 20-year initiative to mainstream biodiversity into production practices in grasslands, thereby balancing biodiversity conservation and economic development imperatives in a landscape. Mainstreaming biodiversity means "incorporating biodiversity priorities into the policies, decisions and actions of a diverse range of people and organisations in various sectors" to increase awareness, minimise impact and mitigate risks to biodiversity and the ecosystem services that it supports. A large part of the Programme was made possible through an investment from the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF), with SANBI as the implementing agent. However, the Programme relies on multi-sector partnerships between government, business and civil society to mainstream biodiversity objectives into the major production sectors that operate in the Grassland Biome, including agriculture, forestry, coal mining, and urban economies, as well as into the enabling environment.

The Grasslands Programme seeks to find solutions in which economic development is sustained by the ecological services provided by a healthy and well managed Grassland Biome. These *Grazing and Burning Guidelines: Managing Grasslands for Biodiversity and Livestock Production* are part of a broader programme of action which has been put in place by the SANBI Grasslands Programme to respond to this challenge.

[3] Mucina, L. & M. Rutherford, (eds) 2006. The vegetation of South Africa, Lesotho & Swaziland. Strelitzia 19. South African Biodiversity Institute, Pretoria.

These 72 grassland vegetation types have been arranged into three broad groups based on their species composition, community structure, ecological characteristics and environmental factors.

- Dry Highveld Grassland
- Mesic Grassland [4]
    - o Mesic Highveld Grassland
    - o High-Altitude Grassland
    - o Sub-Escarpment Grassland
- Coastal Grasslands [5]
    - o Maputaland Coastal and Wooded Grassland
    - o Pondoland-Ugu Sandstone Coastal Grassland
    - o KwaZulu-Natal Coastal Belt
    - o Transkei Coastal Belt

[4] Mesic grasslands, sometimes referred to as humid grasslands, are found in the wetter parts of the country, where annual rainfall is generally above 500mm. Light and leached soil conditions are often more limiting than water availability in the growing season. Mesic grassland includes the 'Drakensberg Grasslands' as defined in Mucina and Rutherford, the KwaZulu-Natal / Free State escarpment and the north-eastern Mpumalanga escarpment.
[5] Embedded within the Indian Ocean Coastal Belt Biome.

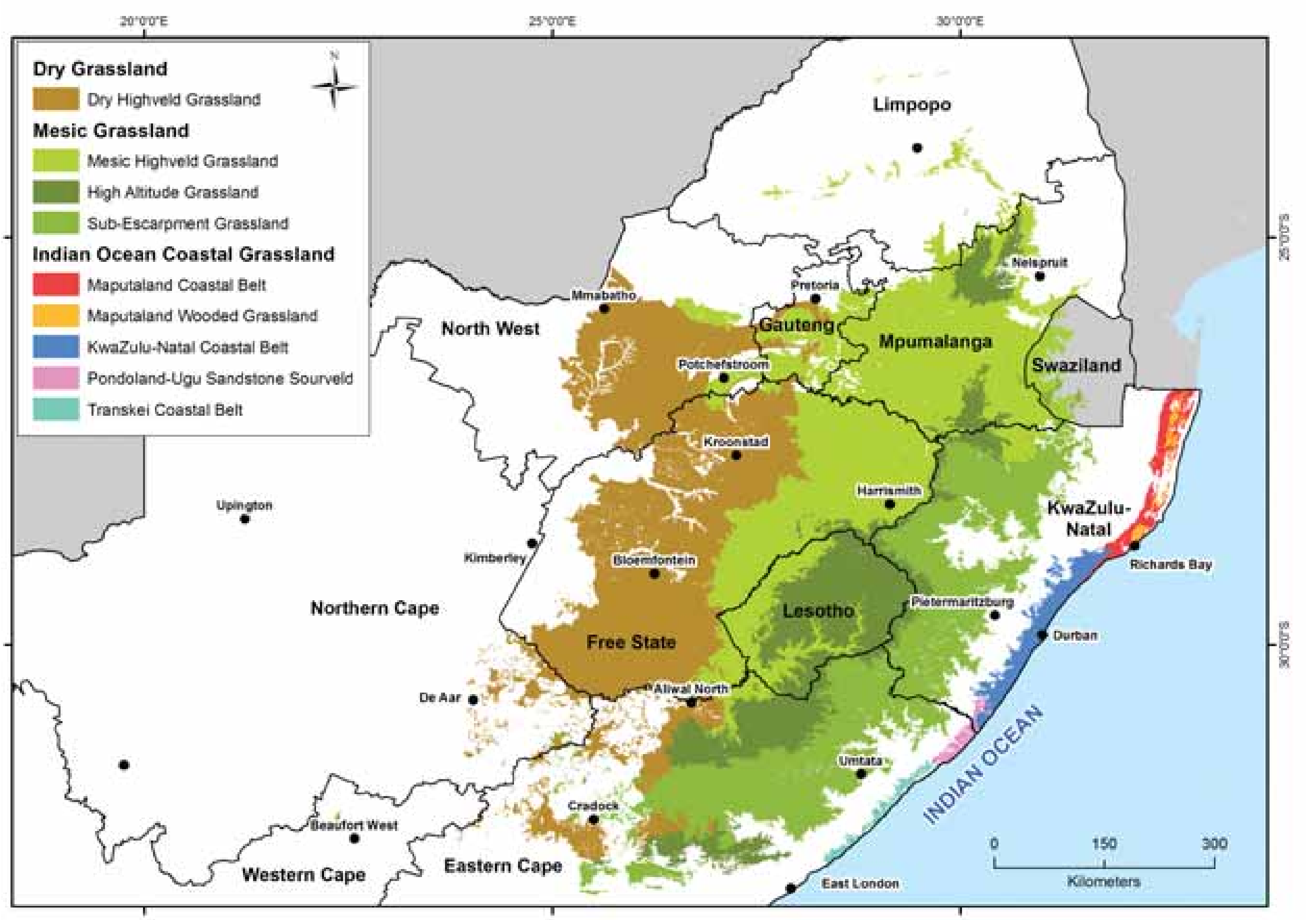
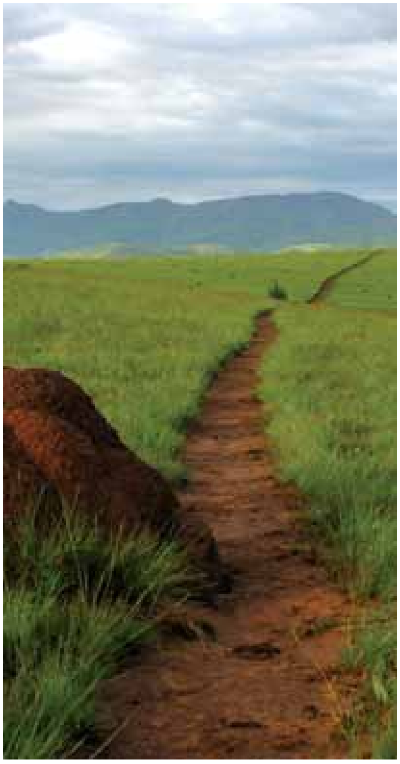



*Figure 1. Map of South Africa showing location of three broad groupings of grassland ecosystems*

Although there are many similarities, each grassland ecosystem is relatively unique in its sensitivity and response to grazing and burning, and requires a different management approach. Within each of the five broad grassland ecosystems, the vegetation types share similar structure and species composition, and are maintained by similar ecological processes and have similar management requirements.

There are many instances where grassland vegetation is found embedded within other biomes, including: Nama-Karoo, Thicket, Savanna, Forest and Fynbos. Although these are not specifically dealt with here, the same principles will apply in most instances.



## Box 3. Primary and secondary grasslands

Many land-use activities place pressure on South African grasslands, and these can be divided into those that result in **irreversible modification** [6] (such as ploughing, timber planting, roads, dams, etc.) and those that cause **degradation** (changes in composition, structure or functioning to reduce the potential of the grassland to meet the management objectives). These Grazing Guidelines aim to minimise the degradation of biodiversity. Grasslands are often described according to the degree of change they have undergone, with:

**Primary grasslands** are those that have not been significantly modified from their original state and that still retain their essential ecological characteristics and functions; even though they may no longer have their full complement of naturally-occurring species. They have not undergone significant and/or irreversible modification.

**Secondary grasslands** are those that have undergone modification (e.g. by ploughing) but have then returned to 'grassland'. A common example is when old cultivated lands are re-colonised by indigenous grasses. Although secondary grasslands may superficially look like primary grasslands, they differ markedly from their original state in species composition, vegetation structure and cover, soil characteristics, ecological functioning and the ecosystem services they deliver. Typically, they are not considered of high priority for species conservation, but may deliver some of the ecosystem services expected of grassland.

Primary grasslands are the focus of these Guidelines, although some of the principles do apply to secondary grasslands.

## 1.4. Conservation of grasslands in South Africa

Although there are existing protected areas across the Grassland Biome, many of the grassland vegetation types are not adequately protected. It is neither desirable nor practically feasible for the state to purchase and formally proclaim sufficient land to meet all the conservation targets for grassland ecosystems, and alternative low-cost ways of conserving the valuable grassland biodiversity need to be implemented. These Guidelines will equip land managers to make a significant contribution to the long-term persistence of grassland biodiversity within a livestock-production context.

## 1.5. Agricultural best-practice for rangelands

These Guidelines build on the very extensive body of agricultural principles that currently guide grazing practice in South Africa. Some of these principles, such as **moderate stocking rates** and **rest**, are complementary to what is needed for biodiversity conservation. Indeed, correct application of the agricultural best-practice[7] is a minimum starting point for biodiversity-friendly rangeland management, and there is a strong correlation between veld condition (emphasising healthy veld and soil) and biodiversity values.

There are already several published theories regarding grazing best-practice that differ significantly in their foundations and practice. Indeed, grazing and burning management in South Africa is a hotly debated topic with many strongly-voiced opinions. It is not the purpose of this document to review the relative strengths and weakness of such management regimes, but rather to focus on the principles of biodiversity-friendly grazing. A potential model for grazing and burning is presented towards the end of the document as an example from which land managers can develop their own thinking, but this should not be seen as the only correct model.

[6] These activities are the primary focus of the Grassland Ecosystem Guidelines. (see footnote 1)
[7] For example: Tainton, N. 1999. Veld Management in Southern Africa. University of KwaZulu-Natal Press.

Although there are considerable empirical data to underpin agricultural aspects of grazing and burning, there are relatively few comprehensive data sets that can be used to develop biodiversity-friendly best-practice. Indeed, the absence of such conclusive data and theory for any of our grassland ecosystems has allowed the debate to be dominated by anecdotal evidence and speculation rather than sound science backed by long-term data. It is thus important to recognise that all the principles recommended here are based on few data and much 'expert' opinion; derived from several workshop discussions by grassland ecologists and grazing specialists.

There is thus a legitimate caution that many of the statements presented here are not empirical, but rather based on expert opinion. Considering that grasslands are very complex systems, about which there is insufficient knowledge to make absolute ecological statements, the focus of the Guidelines will be on management drivers, indicators, and principles adopting a precautionary approach. The Grazing Guidelines are conservative to ensure that we do not cause damage through ignorance.

## 1.6. The context for rangeland management in South Africa

There are several higher-level drivers of biodiversity loss in rangelands, including issues of governance, climate change, economic dynamics, patterns of ownership and land tenure systems, and the history of land management. These contextual drivers may well have much greater influence on the biodiversity of grasslands than the prevailing management, but it is beyond the scope of these Guidelines to describe these drivers or to provide solutions for them. However, recognizing the consequences of these drivers provides a context for managers focusing on improving, and not just maintaining, veld condition and biodiversity conservation.

These Guidelines are based on the assumption that the manager is willing and able to manage the land within the context of their situation. Furthermore, the principles of biodiversity-friendly range management apply across all ownership and tenure systems, although the extension approach and likelihood of successful implementation may differ considerably.

## 1.7. Management principles are better than rules

It is also important to note that there will never be a recipe for successful management for all grassland types, climatic periods and socio-economic contexts. It is thus better to avoid a strict rules-based approach and rather have an adaptive management approach that takes cognisance of the saying, slightly adapted for this context:

***"The eye of the owner makes for healthy veld and fat cattle"***

The farm manager should observe the grassland and build up knowledge how it responds under different management and climatic regimes and base management decisions on these observations, using the principles presented in these Guidelines.

# 2 Grassland response to grazing and burning

# 2. Grassland response to grazing and burning

Grassland is not a static vegetation type, and environmental and management dynamics cause shifts in the plant and animal communities and soil (e.g. species composition, functional types and structure), ecological functionality (e.g. nutrient cycles) and service delivery (e.g. water delivery, fodder amounts and palatability). In terms of human livelihoods, changes in species composition, vegetation structure or the soils of primary grassland are often considered as "degradation".

Although degradation is a value-loaded term, with different meanings for different people, it is generally understood to mean an undesirable shift in the vegetation or ecosystem function relative to its ORIGINAL state and relative to the management objectives. Considering the management objectives raised earlier in these Guidelines, degradation is reflected in a variety of indicators (Table 1).

*Table 1. Measures of degradation per management objective*

| Management objective | Indicators of degradation |
|---|---|
| Improved, or at least stable, veld and soil condition that leads to **good animal production** | • Declining veld condition (e.g. plant vigour, basal cover, switch from Decreaser to Increaser grass species).<br>• Declining soil health or accelerated soil erosion.<br>• Decreasing animal health.<br>• Reduced annual animal production per unit of veld, which is linked to veld condition. |
| Maintained or improved **conservation of the grassland** species and ecosystems | • Loss of species diversity.<br>• Reduced populations of species of conservation concern.<br>• Reduced ecosystem area, stability or functionality (e.g. less water infiltration or carbon sequestration). |

**Decreasers** are native plant species that dominate in good condition (climax) grassland, but that decrease in response to poor management. They are generally palatable and desirable.

**Increasers** are also native species but they increase to take the place of decreasers that have died due to poor management (either over- or under- stocking or selective grazing). The increaser plants are less palatable and undesirable Generally, two types of increasers are recognized.

- o Increaser I species thrive with under- or selective- grazing
- o Increaser II species that thrive with over-grazing conditions.

In terms of management, burning and grazing are considered the most important drivers of degradation in our rangelands if incorrectly applied. The following section describes a theoretical model of how grassland degradation occurs in response to these drivers.

## 2.1. A model describing grassland degradation

Although there is no conclusive model of grassland degradation[8], there is some agreement amongst grassland ecologists that degradation of grasslands is thought to be non-linear; progressing in a series of step-like stages that represent observable shifts in species composition, structure and function. As the exact details, such as rates of change or the order of species loss, will vary between ecosystems and even farms, it is better to emphasise that grassland ecosystems can move into different states in response to various management drivers, **primarily burning (including the absence of fire) and grazing, and their interaction**. The bigger-scale environmental drivers, such as climate change, are beyond the scope of this document, which focuses on management. However, it is possible that such environmental drivers will exacerbate the rate of change induced by the management drivers.

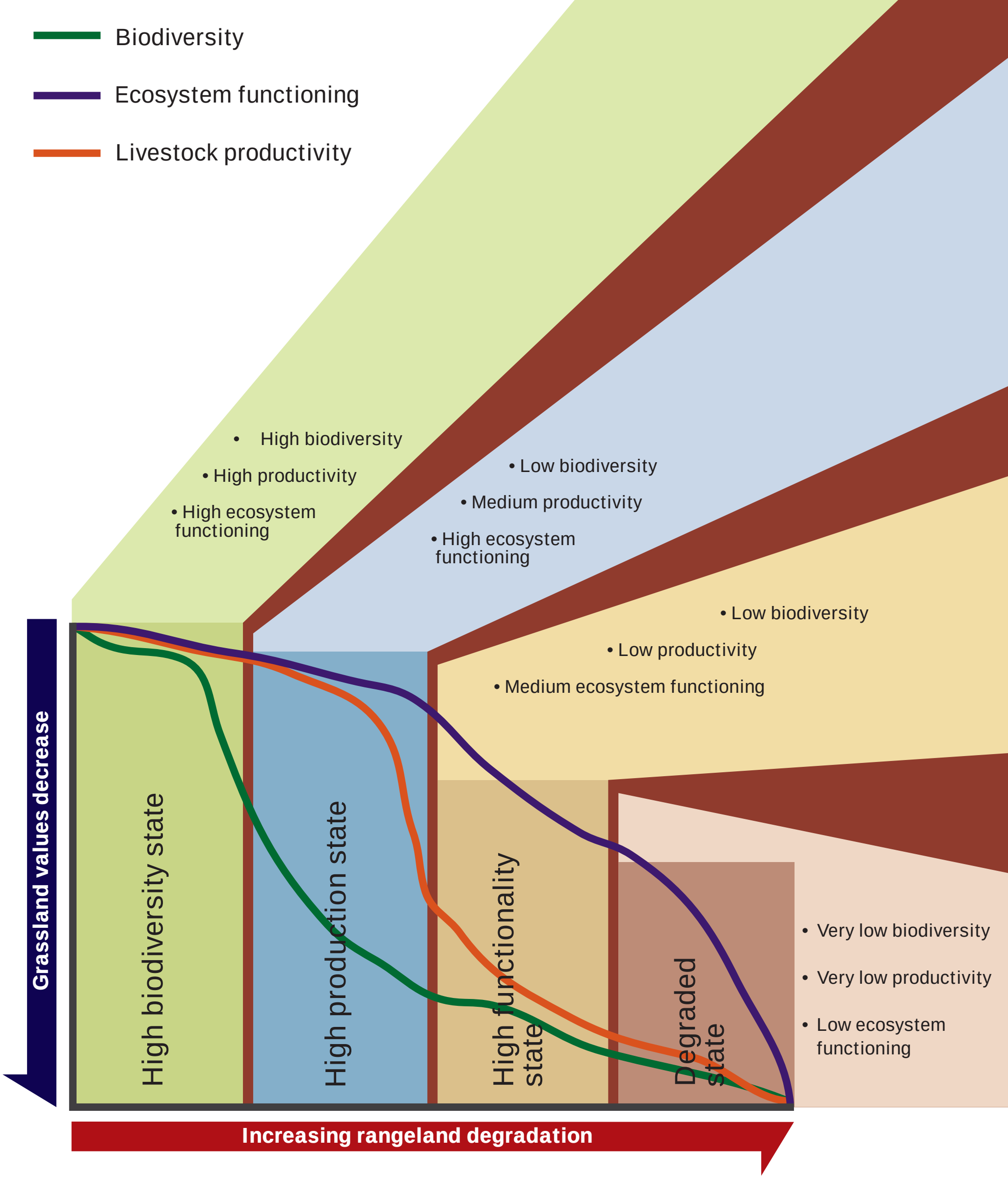
The rate and end result, of the transition between states, particularly for the mesic grasslands, depends very much on underlying geology and climatic zone. Generally, the igneous geologies give rise to nutritious soils that support grassland more resilient to pressure, and that recover more quickly, than the sedimentary geologies. Similarly, grasslands in higher rainfall areas are generally more robust than drier areas, although mesic grassland can easily become dominated by tall and robust increaser grass species, which will have a negative impact on biodiversity.

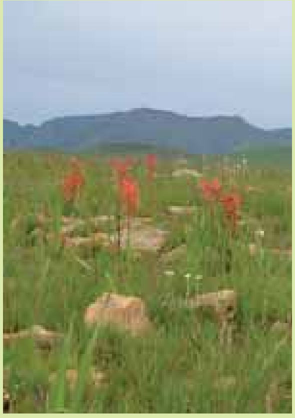
[8] It is important to remember that this section is largely based on expert opinion as there are few data to support any conclusive general model of degradation in grassland.

Degradation is often gradual and difficult to observe, especially in its initial stages, as the changes are quite subtle. Thus grassland may appear to be maintaining condition under a management scenario, but could be degrading without the obvious signs being evident. This highlights the need for sensitive observation of the grassland by the manager to be able to know whether the management model is meeting its objectives or not. In particular, reduced plant vigour is probably the earliest sign of degradation. This is discussed in more detail later.

For illustration purposes, four potential states are presented with examples of the transitions within the degradation gradient (Figure 2). It is important to note that much of the following discussion focuses on the plant component of grasslands, but assumes that there are similar patterns of change amongst the faunal components of biodiversity.

*Figure 2. A schematic showing a possible ecological degradation model of grasslands*





Prior to the arrival of livestock in South Africa with the African and then colonial settlers, grasslands were in their original state. We have almost no reference point to know what these grasslands were like and it is probable that little of the original vegetation remains due to the long grazing history in these pre-colonial and colonial periods.

However, there are still areas of grassland where there are still very high levels of plant (and presumably animal) diversity and these have the greatest conservation value as they are the closest to the original state. Such areas often have very high grazing potential due to the dominance of palatable grasses and forbs. Some farmers believe such areas give rise to the healthiest livestock due to a natural pharmaceutical effect from the diversity of plants in the veld, including some forb species, and there may be some evidence to support this theory. Such grassland also has the highest levels of ecosystem functionality.

Where they do occur, they have typically been protected from mis-management through natural geographic features that prevent easy access, such as rocky ridges. Many unplanted areas within the forestry estates that have not been grazed also fall into this category, and often represent the last remaining examples of the high biodiversity state for a grassland ecosystem.

*When such high biodiversity areas are grazed or burnt inappropriately, reduced plant vigour of the most susceptible plant species results in a loss of diversity of grass and forb species. The grassland becomes more uniform and dominated by a few grass species, even palatable ones. Many of the conservation-worthy species may have been lost - reducing the conservation value of the grassland. Because agricultural veld condition and ecosystem functionality remain high, these objectives are only minimally compromised.*
*(NOTE: Inappropriate grazing can either be under- or over-stocking, both of which can lead to detrimental shifts in species composition, especially if fire is also being mis-managed or withheld.)*

From an agricultural veld condition perspective, this new state may still be in very good condition, as measured by the dominance of palatable grass species. Agricultural condition mostly ignores the forb component of the flora and is designed to measure the relative abundance of palatable (decreaser) and unpalatable (increaser) grass and forb species. However, the very high plant (and presumably animal) species diversity characteristic of the previous state has diminished significantly.

Livestock continue to thrive in such areas, but a large portion of the original species, primarily the forbs, have been lost.

The ecosystem continues to function well as grassland, with little loss of water-related services but some loss of ecosystem functions such as pollination biology that are reliant on the species that have been lost.

It is likely that the majority of grasslands that are considered to be in good veld condition and are under agricultural management fall into this state.

*Ongoing unsustainable grazing pressure on the rangeland, coupled with an inappropriate burning programme will result in increasingly rapid shifts from palatable to unpalatable grass species, and further loss of remaining forb species. This effect is accelerated under selective-grazing scenarios, where livestock eliminate palatable species from the grassland and allow non-palatable species to dominate.*

From a conservation perspective, this state represents a species-poor grassland, with very few forbs and a relatively low diversity of grass species. Because most of these grasses are increasers with poor grazing value, its value from an agricultural perspective is also significantly diminished.

The grassland may appear to be intact to the casual observer, with an apparently healthy sward of grass and good basal cover, but its species and grazing value have been significantly compromised.

However, such areas are still providing many of the ecological services of grassland, such as water infiltration, soil retention, soil carbon sequestration, animal movement corridors, climate amelioration and so on. They also do provide some grazing value in their 'green flush' growth stage after burning.

Many communally-grazed areas are in this state and, although animal production may not be as high as in better condition areas, these areas are able to sustain livestock in reasonable condition.

*Continued inappropriate grazing and / or burning practices are reflected in decreased vigour of the grass sward and then loss of basal cover of the plants. There is an increase in topsoil erosion and a resulting decrease in soil fertility. As the grass vigour and cover decreases there is less forage available for the livestock, whose numbers rarely decrease in response, especially in communally-managed areas. Thus the grazing pressure on the remaining grass actually increases and the rate of degradation accelerates; a typical self-reinforcing feedback. Ultimately, there is a near-complete loss of plant cover and topsoil, leaving a deeply scarred and almost entirely unproductive land surface.*

In this state, the ecosystem has lost the majority of its original biodiversity and is characterised by a low cover of weedy and pioneer species. Basal cover is very low and soil erosion evident at a large scale. Much of the top soil has been lost and the ecosystem services associated with the soil diminished, such as water infiltration and carbon sequestration. The little vegetation present is of very poor fodder quality and will not sustain livestock.

It is obvious that this state is highly undesirable from every perspective!

## 2.2. Indicators of loss of biodiversity and veld condition

One of the risks of grassland management is that there are few early-warning indicators of imminent change, and the signs typical of change, e.g. bush encroachment leading to the unnatural dominance of woody species such as ouhout (*Leucosidea sericea*) or *Acacia* spp., occur when transition is already quite advanced. However, with careful observation of the rangeland, it is possible to pick up early signs of change that indicate the system is undergoing undesirable change.

The best indicator of imminent change in grassland is the loss of plant vigour, particularly in grass plants. If a plant like *Themeda triandra* pulls out of the ground easily, implying its root system is weakened, this is a clear indicator that some intervention is required if degradation is to be avoided. Such self-tests can be done with some degree of confidence so long as they same person is doing the pulling and estimating the 'pull factor' on a crude scale of easy – medium – hard.

More detailed, yet non-specialist, measures of ecosystem health include in:

1. Basal cover.
2. Forb and grass species richness and proportional occurrence.
3. Seedling occurrence.
4. Species dominance (increaser – decreaser concept).
5. Woody plant (bush) encroachment.
6. Populations of key species of concern.
7. Residency and breeding of listed bird and mammal species.

Land managers should familiarise themselves with the key indicator species of their vegetation type so that they can look for changes in the species composition before it is too late to change management action. Ideally this should involve a formal baseline survey using a species index method, followed by regular monitoring. There are some very helpful toolkits designed to equip managers on identifying key species to interpret the state of their grassland (for example de Wet, 2010).

It is not difficult to establish a very simple fixed point monitoring system using a camera, 100m rope and tape measure: making observations along the length of rope, recording every species it touches, noting seedlings and forb occurrences, and measuring distances between grass bases. Maintenance of such a data set will ensure that the managers will be able to observe the shifts in the grassland in response to their management.

*It does not require specialist knowledge for a farmer to be 'in touch' with the grassland, but rather a simple, intentional approach to observation and record keeping.*

## 2.3. Differences in degradation between the grassland ecosystems

The different grassland ecosystems respond differently to the pressures that lead to degradation. Both the mesic and dry grasslands occur in areas that experience various degrees of frost, which causes plants to have a period of dormancy during which they are highly flammable. However, the most significant difference between mesic and dry grasslands is their palatability during dormancy; and they can be divided along a gradient of palatability ranging from sourveld to sweetveld:

- **Sourveld** occurs in higher rainfall regions with highly leached, nutrient-poor soils. In these grasslands, animal production off the veld is only possible for six-eight months of the year. Lower temperatures, shorter days

and drier conditions in early autumn cause the grasses to withdraw nutrients from their leaves, massively reducing their quality and palatability until new leaves grow in spring. Maintenance of livestock through winter in such areas is only possible with appropriate supplementation in the form of protein or nonprotein nitrogen supplements.

- **Sweetveld** is found in the semi-arid regions of the country where, due to lower rainfall and less leaching, soils are nutrient-rich and forage quality is maintained throughout the year. Sweetveld grasses tend to have lower fibre content and are palatable to grazing animals throughout the year, leading to year-round animal production off the veld. The quantity of sweetveld forage is limited by rainfall, but the carrying capacity is generally higher than sourveld.

### 2.3.1. Dry Highveld Grassland

The dry grasslands are generally considered sweetveld. The primary ecological difference between dry and mesic grasslands seems to lie in their capacity to recover from disturbance, particularly grazing and fire. Regarding grazing, anecdotal historical evidence suggests that large migratory herds of bulk and concentrate grazers migrated across the dry landscapes following the growth of vegetation after rain. This caused a grazing regime that was very intense for short periods of time, with long periods of effective rest. Dry grasslands have a reproductive biology more adapted to such disturbance, and thus recover relatively rapidly from a soil seed bank, even if the adult plants have been killed. Thus, dry barren areas very quickly re-vegetate from seed when it rains if the seed bank is still intact.

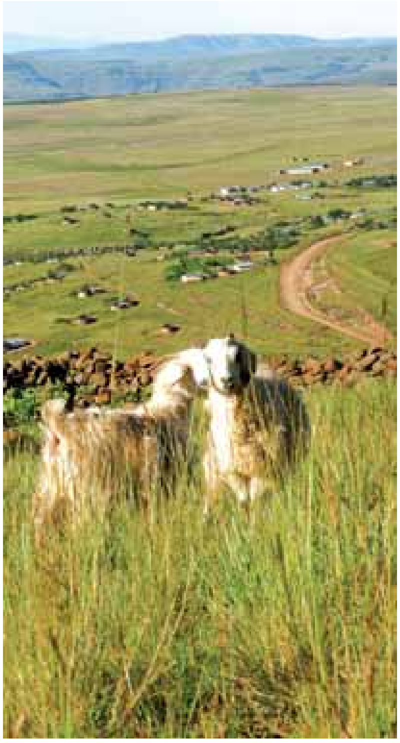
Biomass rarely accumulates quickly in dry grasslands due to the low and erratic rainfall, and fires were probably quite rare and localised, occurring in years after high rainfall, and in the absence of heavy grazing pressure. Thus the plants generally take a long time to recover from fire, particularly in the absence of sustained early season rainfall. Fire can be quite disruptive in that it burns off grazable forage (being sweetveld, the residual grass remains reasonably palatable through winter) and the mulch layer that protects the soil, leaving it bare and exposed to wind erosion.

### 2.3.2. Mesic Highveld, High-Altitude, and Sub-Escarpment grasslands

All these mesic grasslands behave and respond in a similar manner to the management drivers of burning and grazing, but very differently to the dry grasslands. The mesic grasslands generally recover very slowly from any disturbance that kills the adult plants, and recruitment from seed is very slow, especially amongst the forb component. The plants are generally very well adapted to fire, and recover quickly after burning, depending on the season and rainfall.

Light is a very important factor in mesic grasslands, and many of the plants are susceptible to shading from the bigger and more robust species. Thus, if left unburnt and not grazed, mesic grasslands can quickly become moribund, with dense mats of dead material building up that reduce the vigour of the plants by shading the new leaf shoots and seedlings. This reduces the basal cover in the grassland and results in species losses, which are very undesirable.

Although grazing can reduce the moribund material by eating and trampling, it also causes physical damage to some grassland plants, especially the fleshy forbs. Furthermore, unless the grazing is very controlled, the animals will generally select the more palatable species and cause a shift in species composition towards an unpalatable state. Thus a combination of fire and grazing is advocated for preventing the moribund state, because fire is the ultimate 'non-selective grazer'.



When managing grassland for sheep productivity, there is a risk of burning too frequently as they thrive on the post-burn green flush. Furthermore, the practice of burning for a 'green bite' in summer or autumn is extremely detrimental for biodiversity and veld condition, and should rarely be considered in these seasons. However, the practice of burning residual material in mesic grassland during late winter or early spring to take advantage of the high quality graze in the following season is a universally accepted practice that results in high animal performance and non-selective grazing, and is not detrimental to the grassland.

### *2.3.3. Coastal grasslands*

Although the coastal grasslands are also mesic, in that they are found in the high rainfall part of the country, they differ from the other mesic grasslands primarily in that they do not experience a very distinct winter that causes dormancy. Essentially, they are able to grow all year round, limited primarily by soil moisture, nutrients and light. Indeed, the latter is very important and coastal grassland quickly becomes moribund due to the rapid growth rates allowed by the high temperature and moisture regimes, particularly in the Maputaland areas of northeastern KwaZulu-Natal. In the absence of fire and adequate grazing pressure, there is a relatively rapid increase in woodiness, often including invasive weeds. An irreversible switch from grassland to bush can occur within three to five years of no fire or grazing!

Although Pondoland grassland experiences lower average temperatures and a more seasonal rainfall with much lower rainfall during winter, it should be defoliated by fire periodically to avoid shading out of sensitive species.

## 2.4. Rehabilitation of degraded rangelands

This booklet will not address the very complex issue of rehabilitation of degraded rangelands other than to make a few generalisations. Firstly, any form of rehabilitation is likely to be very expensive and time consuming, and will require clarity regarding the historic context and the current management scenario. The bottom line is that it is relatively easy and rapid to cause extensive damage to grassland, and extremely difficult and expensive to undo this damage, especially at a scale anything larger than a camp. Once plant diversity, basal cover and then soil have been lost from a grassland, they are unlikely to return in a meaningful management time frame. This emphasises the need for a precautionary approach in all management to ensure damage is not done in the first place.

# 3 Best-practice principles for burning and grazing



# 3. Best-practice principles for burning and grazing

Describing a single biodiversity-friendly best-practice for burning and grazing in grassland is not possible as the different grassland ecosystems, and the different components of biodiversity, respond in different ways to the many variations of grazing and burning regimes. There are simply insufficient data to develop an all-encompassing recipe for biodiversity-friendly management in all ecosystems. It is better to present important principles of management that will allow land managers to develop management plans that meet the objectives described earlier that can be adapted to their context and the prevailing condition of the grassland.

This section is divided into three parts:

1. General management principles that apply to the vegetation and soil;
2. Guidelines that apply to embedded ecosystems such as wetlands, riverine areas, rocky outcrops and forest patches;
3. Guidelines that apply to the faunal components and to individual species of conservation concern.

## 3.1. General burning best-practice

### *3.1.1. Burning as part of the management plan*

The topic of fire is highly contentious and there is great diversity of opinion, especially concerning what was the 'original' natural fire regime prior to the arrival of African and European settlers.

Many believe that the natural fire cycles in South African grasslands, especially the mesic and coastal grasslands, have become severely disrupted because of misconceptions about the important role of fire and because of the risks associated with managing fire in a production landscape. Unplanned or poorly-timed fires can be detrimental, affecting natural habitats, damaging ecosystem functioning, endangering life, and destroying property. Pro-active fire management through planned and controlled burning, however, is an essential part of wise management in grasslands, as well as being a legal requirement.

Fire is both a requirement in terms of fire protection legislation, and tool for landowners to manipulate the state of the rangeland. **Management of fire is governed by law in South Africa and there are legal implications for negligence.** All landholders are legally required to draw up and implement an appropriate fire management plan that should be approved by the local Fire Protection Association. The Fire Protection Association will also provide guidance on the local interpretation of the Conservation of Agricultural Resources Act (No. 43 of 1983).

Where land managers are interested in general biodiversity conservation, and do not have a more specific management goal (such as the conservation of an individual species or ecosystem), then the following principles should be applied.

Fire can be used proactively for rangeland management and fire protection by manipulating the frequency, intensity and season of burn, in accordance with the requirements and tolerance of the particular grassland ecosystem, and the use to which it is being put. Grassland species and ecosystems respond differently to varying fire regimes, especially when the effects of fire are considered in conjunction with the grazing regime. The **incorrect application of fire**, including the complete exclusion of fire, can result in a shift in species composition, encroachment by invasive alien or indigenous woody species, a decline in basal cover and an associated increase in soil erosion.

Excluding fire for prolonged periods can cause permanent damage in mesic grassland. The period of exclusion that results in such damage differs according to the rainfall and other factors, but too-infrequent burning is very detrimental to mesic grasslands as it leads to a moribund state, even if the grassland is being grazed.

### *3.1.2. Adaptive management with fire*

Fire is a complex dynamic and different outcomes can be achieved (intentionally or not) by different burns, influenced by fuel load, fuel moisture content, season, type (head- or back-burns), and prevailing weather (time since rain, wind, temperature, and relative humidity). These variables control the heat intensity, the height of the flames, and the duration for which the soil and plants are exposed to high temperatures.

The decision on when and how to burn a portion of grassland must always be founded on a clearly articulated set of **management objectives** for the land, as well as knowledge of the **nature of the ecosystem** (e.g. its productivity and life-history characteristics) and its ecological requirements. The decision should rest on an assessment of current veld condition and available biomass, rather than recipe-based management. Indeed, burning should only be implemented if there is sufficient biomass to warrant it. The best approach is for the manager to be a **'student of the veld'**, making frequent observations of veld and biodiversity condition, and adapting their management to suit the objectives.

Burning to remove residual or moribund grass should be done with a cool head fire under moist conditions (early morning, late afternoon, or after a light rain), aiming for a patchy burn that leaves some of the mulch layer.

Although mesic grasslands can persist under annual burns, too frequent burning can be a problem for important invertebrates that live in the soil detritus, such as the larvae of monkey beetles, which are primary pollinators in the grasslands. Thus annual burns other than the fire breaks are not recommended for more than 2 or three years in a row.

### *3.1.3. Variability is important for biodiversity*

In all grassland types, the key to biodiversity-friendly burning lies in the variability in geography and time, and in avoiding a rules-based approach. Any regime that does the same type of burn, in the same area, under the same conditions and in the same season (i.e. very low variability), is likely to cause levels of diversity to decrease. Conversely, management that allows variability in time, geography and type of fire will be better, especially if it includes variability in the grazing regime. There is a lot of evidence that variations of 'patch mosaic' burning result in the greatest levels of biodiversity in grasslands.

Burns that create a mosaic of different habitats will be the most beneficial for biodiversity.

### *3.1.4. Burning to control bush*

Although there has been a long debate in the ecological literature, it is now widely accepted that fire plays an important (but not exclusive) role in keeping woody plants suppressed in mesic grasslands. In the absence of fire, many mesic grassland ecosystems experience an increase in woody plant dominance. In terms of veld management or conservation, such bush encroachment is not desirable as it is associated with both decreased species diversity and loss of animal production.

Climate change is an environmental dynamic likely to influence grasslands, particularly through a predicted increase in woody shrubs and trees as the average temperatures and levels of atmospheric carbon dioxide increase. This could significantly exacerbate the problems associated with bush encroachment.

Fire can be a very useful tool to control bush encroachment, but it has to be used under very specific conditions, otherwise it can make the problem worse!

The key to controlling bush with fire is to ensure there are periodic hot fires with high flame heights in the grassland. This means areas that are being burnt for bush control should be **rested from fire and grazing** until sufficient biomass accumulates to ensure a very hot fire. Burning too frequently results in cool fires with low flame heights that consume the grass fuel, but do little other than provoke the woody plants, and often causes their seeds to germinate.

Most farmers mitigate fire risk by managing for frequent, cool fires, which can unwittingly favour bush encroachment. Unfortunately, the best conditions for burning for controlling woodiness are those that carry the highest risk in terms of run-away fires. Such fires should be planned for and discussed in advance so that adequate protection can be organised in the form of enlarged fire breaks and more staff and equipment during the burn. Making bigger fire breaks will also encourage a mosaic of time-since-last-burn.

Specific conditions required for burning to control bush encroachment include:

- Larger than usual firebreaks and extra personnel and equipment.
- Permission from the Fire Protection Association and notification of neighbours.
- Dry vegetation for fuel, exceeding 3,000 kg / ha.
- Air temperature > 25$^{o}$C.
- Relative Humidity < 30%.
- Moderate wind to create updraft to get into the bush canopies.
- The target woody plants should have started growing.

### Box 4. Summary of the good and bad reasons for burning grassland

**Good reasons to burn:**

- Removal of residual plant material in a completely non-selective manner.
- Promotion of non-selective grazing of newly emerged grass shoots in degraded grasslands.
- Control of woody invaders or undesirable plants.
- It is a natural ecological process (in mesic grasslands, but less frequently in drier areas) that influences factors such as nutrient turnover, germination, and population dynamics; thereby promoting persistence of biodiversity.
- Fire protection requirements.

**Poor reasons to burn:**

- Summer or late autumn burning to stimulate a green flush for late season grazing.
- To improve livestock productivity and performance over and above carrying capacity. A short-term gain will be traded off against a longer-term loss.
- Trying to destroy populations of parasites such as ticks (this doesn't work).
- Early block burning to avoid implementing fire breaks.

The impacts of fire and grazing, and their interaction, on grassland biodiversity differ radically between the mesic and dry grasslands, and the resulting best-practice similarly so.

### *3.1.5. Burning in dry, mesic and coastal grasslands*

#### Dry Highveld Grassland

There is very little evidence to predict the impact of fire on the plant (or faunal) diversity of dry grassland ecosystems, although it appears they are considerably less resilient to fire than the mesic grasslands, and recover slowly after a fire. In the drier grasslands, fire causes extensive and long-term exposure of the soil and subsequent erosion. Re-colonisation of these areas from seed occurs, but can take some time, depending on rainfall and grazing pressure. Even those individuals that survive the fire may take a long time to re-grow, especially if the following summer has below-average rainfall. There also does not seem to be evidence that withholding fire in the dry grasslands is detrimental for plant diversity, as is the case for mesic and coastal grasslands, as biomass accumulation is determined by rainfall, and the frequent drought years prevent aerial dominance of any one species.

In the Dry Highveld grasslands, **fire should only be used where there is a clear management objective to be achieved** (e.g. bush control), and dry grasslands should not be burnt more frequently than every 8-10 years. Burning too frequently can be very damaging to the veld, leading to a poor species composition, which impacts negatively on animal production.

However, the rapid growth resulting from periods of above-normal rainfall leads to high levels of biomass with a relatively low nutritional value. Animals then graze very selectively, and the non-palatable species build up and suppress the growth of the palatable grasses during the following year. Burning under these conditions can 'level the field', and growth in the following year can be very nutritious and the animal production higher than normal. Burning should only be considered when the grass growth has become too rank for the animals to graze satisfactorily.

#### Mesic and Coastal Grassland

There are some in the agricultural sector that advocate withholding fire altogether from mesic grassland, based on the premise that grazing and/or mowing can replace fire in terms of preventing a moribund accumulation of biomass. However, the majority of grassland specialists DO NOT advocate withholding fire for several reasons.

Mesic and coastal grasslands appear not only to be able to survive regular burning, but may actually require it. Such grasslands are thus both fire-prone and fire-dependent, requiring fire to maintain their biodiversity patterns and ecological processes. Indeed, the greatest effect of fire on mesic grassland is withholding it; which causes a conspicuous shift towards woody (and often weedy) shrubland – especially if grazing is insufficient to defoliate the residual material. Fire is, therefore, critical for maintaining the health of mesic and coastal grassland ecosystems. Although grazing or mowing are partial substitutes for fire, in that they defoliate the grassland and partially prevent it becoming moribund, fire should never be excluded for the following reasons:

- Fire 'resets' the grassland ensuring the species-rich forb component of the grasslands is given an opportunity to flourish amongst the more dominant grasses.
- Fire removes residual plant material that will shade out the next season's growth.

- Fire enhances primary productivity by stimulating new growth.
- Periodic fuel load accumulation and the subsequent hot fires are vital to controlling woody plant encroachment.
- Fire increases habitat diversity, by forming a mosaic of structurally-differing habitats within the grassland landscape, especially when smaller areas are burnt.
- Fire contributes to many other ecological processes such as nutrient cycling, stimulation of germination, and invertebrate population dynamics.
- Fire causes the release of nutrients back into the soil, and increases soil carbon levels at a depth below 2cm. Interestingly, and perhaps counter-intuitively, regular fire causes an increase in soil carbon storage over time. **There is no basis for the argument that burning releases carbon into the atmosphere and thus contributes to global warming. Although this statement is true for the day of burning, the net effect over many years is the reverse.**
- Fire doesn't physically damage the plants, unlike mowing, which is often done at the end of the growing season when the plants are flowering and fruiting. Mowing also physically compacts the soil causing considerable damage to root structures.

Withholding fire in mesic grassland has much greater effect than manipulating the season, frequency, and type of the fire, and generally results in significant decreases in diversity and veld condition.

The drier the climate, the longer the period between burns needed.

In terms of season for burn, the best generalisation is that mesic grasslands need to be burnt during late winter to early spring. This is determined by the start of active growth as it is best to burn just before growth starts; initiated through the combination of increasing water availability, temperature and day length. Grasses are cued to start growing by day length and temperature, provided there is sufficient soil moisture, and late winter burns do not damage the growing points of the plants. Autumn burns reduce diversity and change species composition as they leave the soil exposed for long periods of time, with increased soil temperatures, increased drying and greater potential for erosion. However, there are some components of the flora, those that emerge and flower prior to the first rains, which can be eliminated from the grassland if they are only ever burnt in spring. As mentioned above, variability is very important.

Coastal grasslands differ from the mesic grasslands in that they generally do not experience a cold winter dormancy period, and are thus limited more by rainfall than temperature. This means there is no defined period of dormancy during which burning can take place. However, the coastal grasslands occur in a predominantly summer rainfall region, and thus winter does coincide with the dry period when growth rates are reduced. It is thus best to burn coastal grassland in late winter / early spring.

### Box 5. Summary of burning guidelines for different grassland ecosystems

**All grasslands**

- Fire frequency should be determined by the rainfall and grazing, and not be rule based.
- Try to vary the season and type of fire across the area to be burnt, aiming for a patchy mosaic.

**Dry Highveld Grasslands**

- Only burn when there is a specific need to do so, such as for bush control or when there has been an accumulation of unpalatable biomass.

**Mesic and Coastal Grasslands**

- Not burning, or under-burning, can be very damaging – especially if grazing is also withheld. Mowing and grazing cannot fully substitute for fire.
- Burn every 2-5 years, depending on the prevailing conditions, biomass, and grazing regime. Coastal grasslands can be burnt frequently due to the very high growth rates in coastal areas.

## 3.2. General grazing best-practice

### *3.2.1. Grazing impacts and grassland responses*

**Grazing is the biggest management factor that influences grasslands**, and any change in the grazing regime will have a significant impact. Many grassland species show life-history traits that are compatible with some grazing pressure, and it is generally understood that grazing plays a role in maintaining the ecological character of grassland ecosystems, particularly the more arid ecosystems. However, the majority of grassland ecosystems are not adapted to continuously high grazing pressures, with very little variety in management (fire frequency and type, grazing intensity, resting, and so on).

Species composition changes in both mesic and dry areas are usually brought about by certain species gaining a competitive advantage as a result of selective grazing. Selected species and tufts gradually lose vigour at the expense of unselected species and tufts, and eventually die. Mesic grasslands take much longer to recover from any disturbances that kill the grass tufts, whereas the drier grasslands generally recover more easily from seed.

#### Fire-grazing interaction

It is difficult to separate out the effects of grazing and fire as these two factors work closely together, with many subtle interactions. Mesic grasslands are generally adapted to, and indeed require, a combination of fire and grazing. The proportions of each will vary across the range of ecosystems from mesic to dry, but exclusion of either is likely to be detrimental.

As a principle, the lower the grazing levels the more fire is needed.

Fire only defoliates during the dry season, and many grasses respond well to defoliation during the growing season, which stimulates lateral tillering, increases tuft basal area, increases water infiltration, and improves soil health. There are examples of grasslands that are regularly burnt but not grazed where the lack of summer defoliation results in low basal cover and eventual erosion. It is also likely that many forbs require summer defoliation of grasses in order to have access to light and other resources. In the absence of summer defoliation, the grasses form a closed canopy and leave the forbs with little access to such resources.

**Carrying capacity** is the number of animals that can be sustained per unit area per unit time without deterioration of the natural resources - measured in livestock units per unit area per unit time.

### Forb responses to grazing

Although the forbs that characterise grassland that is good condition[10] are generally well-adapted to fire, they are less able to cope with sustained grazing pressure. This means that maintenance of forb diversity and some commercial grazing systems are not compatible, and specific management strategies are required if such grasslands are being managed to retain biodiversity, such as in a protected area or biodiversity stewardship areas. **This means that most grassland ecosystems will lose some forb species when exposed to the sustained pressure typical of most commercial grazing regimes**.

### Positive aspects of grazing for grassland health

There are some grazing specialists who advocate that grazing is not only a necessary ecological driver in grasslands, but that high-intensity short-duration grazing mimics the evolutionary herbivory of grasslands. A prediction from this hypothesis is that withholding grazing would be disruptive to grassland ecology. However, this theory is by no means widely accepted, and many ecologists and grazing experts believe that the role of grazing in maintaining grassland health varies across rainfall and altitudinal gradients. This is a contentious topic, primarily because of the absence of conclusive research across the grassland ecosystems. The key to responsible management in the absence of these foundational data is to combine keen observation of grassland condition with a willingness to alter the management approach to reduce the likelihood of long-term damage to the grassland. There are, however, several positive effects for biodiversity of appropriate grazing:

- Stimulating biomass production and removing moribund plant biomass (dead or dying vegetation) that might limit new growth, especially during the growing season.
- Creating habitat variation through localised disturbance, which results in higher species richness and abundance of small grassland animals.
- Breaking up the soil surface, allowing better infiltration of rainfall and germination of seed (this is particularly important in areas where hardening of the soil surface has occurred).
- Redistributing nutrients through dung and urine – and increasing the rate of nutrient cycling.

Furthermore, there are many instances where grazing, and especially high intensity grazing, can be used to manipulate and even improve the condition of degraded grassland. For example, mesic grasslands unnaturally dominated by unpalatable wire grasses can be improved (in terms of grazing palatability) through careful manipulation of non-selective grazing and fire.

## *3.2.2. Factors to be considered in a grazing plan*

There are several factors to be considered when developing any grazing plan, and these are expanded on below:

### Carrying capacity at a camp scale

Not all grasslands have the same ability to sustain grazing pressure, and different areas within a farm will respond differently to grazing pressure and fire. Thus it is important to assess carrying capacity (the number of animals that can be sustained per unit area per unit time without deterioration of the natural resources - measured in livestock units per hectare / time) for each camp, based on a detailed site assessment that includes:

- Species composition or veld condition
- Geology and soil type
- Slope angle and aspect
- Rockiness
- Weed infestation and bush encroachment

[10] There can be an increase in forb diversity in degraded grassland, but it is of the undesirable weedy species that are not characteristic of the 'original' grassland.

Stocking rate is the number of animals grazing on a given area over a predetermined period of time - measured in livestock units per unit area per unit time.

Together, these factors can be used to generate a map of ecotypes (areas of similar character), each with its own carrying capacity. This approach is far superior to just using the agricultural recommended stocking rate for the region multiplied by the farm area, which is a poor indication of actual stocking rate. Carrying capacity will vary from year to year depending primarily on rainfall, and the stocking rate should be sensitive to these fluctuations to avoid long-term damage to the veld. The delineation of ecotypes is described later in more detail in the farm-scale approach to grassland management (see section 4).

### Animal type

Different animals graze in different ways, and this will result in different outcomes in the grassland. The most basic differentiation is between concentrate and bulk grazers.

**Concentrate or selective grazers**, such as antelope, horses, goats and sheep, are very picky about what they eat and generally nibble their way through grassland, focusing on specific species that they find palatable. They also often eat the plants down to the roots, stunting future growth of the plant. Concentrate grazers will have a significant impact on species composition if grazing is continuous through a season.

Most grassland game species common on farmland (such as blesbok, black wildebeest, fallow deer) are concentrate grazers. All these animals should be included in the carrying capacity calculation as the equivalent of sheep. Burning a patch-mosaic areas in game areas, or staggering the burns of smaller blocks a few weeks apart, allows stricter control of their grazing and helps minimise their localised impact.

As a generalisation, concentrate grazers have a much higher impact on plant diversity compared the bulk grazers, and will cause a significant decline in plant diversity soon after they are introduced into grassland that has high plant diversity.

**Bulk grazers** are less selective and generally ‘mow’ their way through grassland. Good examples include white rhinos, buffalo and cattle. Bulk grazers generally have a much lower impact on grassland than the equivalent mass of selective grazers. Although much less problematic for plant diversity than sheep (if grazed at reasonable stocking rates), cattle can cause a lot of damage because of their weight and the resulting hoof action and trampling, especially on steeper slopes in the mesic grasslands. It is thus important to avoid grazing steeper areas during the wetter periods. Furthermore, it is important to prevent the formation of ruts and erosion paths that form when cattle move regularly back and forth across the land, from an upslope grazing area to the river. Such areas often quickly form erosion gulley’s and reduce the grazing area.

### Stocking rate

**Stocking rate** (the number of animals grazing on a given area over a predetermined period of time - measured in livestock units / area / time) is an important factor determining rangeland condition and impact on grassland biodiversity. The stocking rate should never exceed the carrying capacity, otherwise there will be insufficient fodder for livestock and too much pressure on the grassland, which causes loss of biodiversity, reduced animal productivity and deterioration of veld condition. Indeed, biodiversity-friendly stocking rates should be even more conservative as the aim is to conserve the plant and faunal diversity as well as animal production. **Interestingly, it is possible to get higher performance per animal at lower stocking rates and it is better for the veld**. It is possible to maintain an equivalent farm-scale level of animal production (kg of beef per hectare) even if the stocking rate is reduced to 70% of the agricultural carrying capacity.

However, it is not only over-stocking that can be problematic, and low stocking rates that lead to selective grazing are also problematic. For example, a conservatively stocked camp that is continuously grazed, or where the camp is too large relative to the numbers of grazers, can cause the grassland to be selectively grazed, leading to an increase in tall Increaser I grass species[11], that can out-compete many desirable species. This is particularly a problem where fire is not used frequently enough.

It is important to realise that most sourveld grasslands cannot carry animals over winter unless supplementary licks are provided, due to their low winter nutritional value. Thus, in sourveld grasslands, carrying capacity is calculated over the growing season, normally about 210 days. In situations where livestock are sustained through winter by bales or crop residues, an artificially high summer stocking rate can occur, leading to degradation. Furthermore, considerable damage can be done to winter camps where hay is imported, due to concentrated trampling around the feeding sites. Where there is a reliance of winter supplementary fodder, there is pressure to fully utilise the summer grazing every year - making rest very difficult. Where no supplementary fodder is provided, the summer grazing capacity exceeds the winter capacity and rest is easier to achieve.

It is thus better to calculate carrying capacity over the full year and not to rely on hay imports, but rather to use the dry matter in the rest camps or crop residues and supplement protein through licks. There is also strong financial argument for not relying on external fodder due to the high costs of producing or importing these.

*The overall principle is to determine the stocking rate based on having adequate fodder flow to carry stock over the whole year, without excessive supplementation, and without loss of animal or veld condition.*

### Rest and Rotation

Effective management of stocking rate is also determined by how livestock are moved across the landscape in what is called a grazing system. There are many permutations of grazing systems, but they can basically be divided along gradients of rest, rotation, and intensity (see figure 3).


*Figure 3. Gradients of rest, rotation and intensity characterise grazing systems*

The initial split is into those systems that allow for the camps to be rested and those that don't. Then there is further division into those that have continuous grazing and those where the livestock are rotated in some way. Finally, there is further division along a gradient of intensity from the High Intensity Short Duration systems to the Low Intensity Long Duration systems. There is much debate about the likely impact of each grazing system on grassland productivity and diversity, but a few generalisations can be drawn.

[11]Such as the turpentine grasses (*Cymbopogon* spp.) or thatching grasses (*Hyparrhenia* spp.).

Irrespective of grazing system used, **rest** is one of the most important factors in conserving plant diversity and maintaining animal production in grazing lands.

Despite the many options when it comes to rotating the impact of grazing from one part of the grassland to another, and a similar number of opinions as to which is best, **all grasslands respond well to a full growing season of rest**, and this should be considered in all grazing planning. Indeed, there is a lot of evidence that rest significantly increases plant vigour. Conversely, repeated grazing, especially selective grazing, through the summer season leads to depressed vigour and a depletion of the root reserves. If this happens several years in a row, then the grassland will become degraded.

In order to achieve rest, it is vital to have a system of moving the livestock through a series of camps with approximately 60-75% of the farm every year being utilised in the growing season, with the remainder being rested. In grasslands that have a dormant season, the rested veld can be grazed during the dormant period.

A recent review of grazing best-practice showed that **high intensity grazing systems** have a greater impact on biodiversity than continuous or conventional grazing systems, especially in the mesic grasslands. This is primarily because of the intense trampling effect of the confined herd. Considering the majority of plants in mesic grasslands are long-lived and do not easily re-establish from seed, any damage to adult plants can be quite detrimental to the grassland. High intensity systems are, therefore, not encouraged in grasslands that have very high levels of plant diversity.

However, high intensity grazing can play a role in restoring degraded or unpalatable grasslands, if managed well. It must be remembered that any increase in livestock density requires an increased level of management to avoid degradation to the veld and reduction in livestock performance. Poorly managed High Intensity Short Duration systems are likely to impact both livestock and the veld negatively more severely than poorly managed conventional systems that operate at lower densities.

The other extreme of grazing system is **continuous selective grazing**, where livestock are given free access to the grassland at relatively low densities for long periods of time. This approach is generally considered poor for plant diversity, especially in mesic grasslands, as the animals are allowed to be very selective about which species they eat, resulting in significant losses in plant diversity and changes from palatable to unpalatable species composition.

In communal areas that may not have any fences, it is more difficult to move animal herds in a controlled manner, but it can be done using a regular burning programme to entice livestock into a recently burnt area for the primary grazing, while leaving the other two unburnt areas for rest and secondary grazing. When doing this, it is very important to ensure the burnt area is big enough to support the herd so that stocking rate does not exceed the carrying capacity of the burnt area.

### Box 6. Rest versus recovery

It is very important to have **a clear definition of rest**: "*A full growing season from first greening to first frost with no grazing at all*". In frost-free areas, it is less clearly defined, but can be considered from early spring until late autumn.

This is very different from the concept of **recovery** in rotational grazing, which describes the few days to weeks the grass is given to re-grow after a grazing event. Neither recovery nor delaying grazing until later in the season can be considered adequate rest.

**Box 7. Summary of grazing do's and don'ts**

Both over- or selective-grazing can cause significant changes in the species composition of grasslands, especially when over-grazing is combined with poor use of fire. This comes at the cost of both biodiversity and livestock production and is highly undesirable. The following insights summarise the main points from the section on grazing:

**Do:**

- Employ an adaptive management system that responds to the veld condition, climatic variation and changes in plant diversity.
- Plan the camp and water point configuration to aim for variation of impact in time so that the camps are grazed at different seasons in different rotations.
- Ensure the grazing rotation allows each grazing camp a full-season's rest every 4-5 years.
- Limit sheep grazing in areas important for biodiversity, especially in the Dry Highveld.
- Have a conservative stocking rate during the spring period, as this is the peak growing period for grasses and forbs, which are impacted by trampling and grazing, and very vulnerable to grazing pressure.

**Don't:**

- Graze steeper slopes during wet periods to avoid permanent damage to the soil.
- Allow cattle to form deep paths through regular movement over the same area. These become an erosion risk.
- Allow high-intensity or selective grazing system in areas important for plant diversity.
- Ever leave sheep to graze rocky areas for extended periods of time. These areas are often the last remaining refugia for plant diversity, and the sheep will have a big impact on this biodiversity.
- Stock exotic game species, especially selective grazers such as fallow deer.

## 3.3. Wetlands

Various types of wetlands are embedded in the grassland matrix, including high altitude mountain seeps (where water comes out of the ground), river catchments, peat wetlands, flood plains, oxbow lakes and permanent or temporary pans. These should be treated as part of the management camp, but should enjoy some additional thought and intensive management because they are often more susceptible to erosion caused by livestock.

### *3.3.1. Grazing in wetlands and along river banks*

Although wetlands are generally quite resistant to the impacts of grazing on species composition, the main concern is the potential for channel erosion due to hoof action. Small seepage areas are particularly prone to erosion damage, especially during winter when they may become the only water source in a camp. In drought years, wetlands and riparian zones are very impacted by grazing as it is the only wet grass, and the exposed soil surface can often erode catastrophically the next rainy season.

Livestock are generally habitual in their approach to water areas, and will form deep paths and bare areas into wetlands and river banks. In such cases, it is best to allow them to use this access point, but to stabilise it from erosion, and to restrict access to other areas in the wetland or riverbank. If a wetland forms an unnatural channel due to hoof action, then it is imperative to rehabilitate this channel, e.g. using a few hay bales to jam the channel.

### 3.3.2. *Burning wetlands*

**Wetlands should not be burnt annually and burning the entire wetland in a single fire should be avoided if at all possible**. Where possible, natural breaks (such as wetter areas or the river channel itself) should be used to divide the wetland, rather than artificially dividing it using fire breaks. This is important for the many animals that use wetlands seasonally for nesting, including rare species such as African Grass Owl, Wattled Crane, Grey Crowned Crane and Long-toed Tree Frog.

Wetlands are often burnt annually in mid winter to obtain a green flush that is grazed until the wetland is too wet for the animals. This is not ideal, and excluding fire periodically so that the wetland is not grazed in winter is beneficial. When burning, aim for cool patchy burns in late winter every 2-3 years, in early spring, and avoid autumn/summer burns.

Peatlands should only be burnt under very cool moist conditions to ensure the peat doesn't ignite.

## 3.4. Forest margins

### 3.4.1. *Grazing in forest margins*

Forest margins should be grazed as part of the camp to ensure the fuel load adjacent to the forest doesn't build up and increase the risk of fire penetrating the forest canopy. It is not recommended to fence the forest margins off from grazing, as this allows tall Increaser I species to dominate, decreasing basal cover and increasing the risk of erosion after fire. Furthermore, these tall species increase the risk of catastrophic fire penetrating the forest canopy. Most devastating fires that occasionally sweep through indigenous forests get into the canopy because of very high fuel loads in the margin.

Where forest patches are not absolutely required for shelter, livestock should not be allowed to penetrate the forests as they cause erosion paths, introduce exotic weeds on their hooves, and graze the understorey plants and tree seedlings.

### 3.4.2. *Burning forest margins*

Forest margins should be burnt as part of the camp, but with the specific intention to ensure there is a cool fire around the margin of the forest. This cool fire consumes the grassy fuel load, but doesn't damage the woody component of the forest margin. This is achieved by igniting the fire in the forest margin under cool weather conditions (early morning) and allowing it to burn outward into the surrounding grassland. This should be done especially in situations where the forest is on a slope above the grassland.

It is important to prevent fire from rushing up a slope into the forest margin; rather start the fire at the forest margin and allow it to burn down slope some distance, and then start a second fire line at the bottom of the slope.

## 3.5. Fauna-friendly management

For various reasons, grassland management ecology has focused on the plants, either from an agricultural or biodiversity conservation perspective. However, grasslands are home to a very rich diversity of fauna, including mammals, birds, reptiles, amphibians and invertebrates. In general, the burning and grazing regimes described in this document, which are aimed primarily at the conservation of plant diversity, will also be appropriate for grassland fauna conservation.

However, the following sections provide burning and grazing recommendations in management scenarios where faunal conservation (in general or for a specific group or taxon) is a specific management objective.

This section is, in part, a summary of a document produced by BirdLife South Africa[11]. If bird conservation is a specific management objective of the area, it is worth reading the entire document. The exact detail of the management depends on the species, and should be developed in collaboration with the relevant avian specialists.

### *3.5.1. Minimising impacts of fire on grassland fauna*

**Avoid annual burning** other than in fire breaks, as this may lead to altered species composition and may result in insufficient food (i.e. forb and invertebrate) availability, fewer refugia to escape from the elements, and inadequate cover for nesting by increasing detection by predators. Annually burnt fire breaks within a matrix of unburnt blocks can provide sufficient habitat heterogeneity (i.e. variability) to accommodate the majority of faunal diversity requirements.

**Avoid regular burning after the start of the growing season or in autumn**. Repeated burning long after the growing season has begun (i.e. beyond the recommended fire season) will negatively impact the breeding and recruitment stages of many faunal groups. Likewise, repeated burning more than just fire breaks in autumn may result in equally unwanted damage to soil and vegetation, with a knock-on effect on faunal species as they may have insufficient cover and food to survive the winter.

**Burn to create a mosaic of clean-burnt and patchy grassland** in order to leave natural refugia for the fauna. Patchy burns also establish and maintain habitat heterogeneity, providing habitat for the majority of different requirements.

**Burn less than two thirds of the farm or grazing area** in one year to maintain the necessary patchwork of burnt and unburnt areas. Conversely, management areas should also not be burnt less frequently than every four years in mesic grasslands and every 10 years in dry grasslands. In particular, mesic grasslands are fire climax adapted systems and need to be burnt in order to retain their diversity and ecosystem processes.

**Avoid burning extremely large camps**. Some fire-intolerant animal species recolonize burnt areas from neighbouring unburnt source populations. If the burnt area is always too large and not burnt patchily, localised extinction of fire-intolerant species may occur.

### *3.5.2. Minimising impacts of grazing on grassland fauna*

Current livestock grazing practices have significant ecological impacts, especially on the forb component of floral diversity in grasslands, the invertebrate food webs, and the other species that depend on these forbs. When managing for faunal conservation as a parallel objective with commercial grazing, the following recommendations will help minimise the impacts.

**Prevent over-grazing**, as this may lead to a loss of vigour in the sward, altered species composition and veld degradation, and a resultant change or decrease in faunal diversity.

**Avoid selective-grazing by concentrate grazers** such as sheep and wild ungulates (e.g. blesbok), as this may decrease forb and associated invertebrate diversity.

[11] Uys, C., Smit-Robinson, H. & Marnewick, D. (2013). Bird-friendly burning and grazing best-practice for grasslands: achieving bird conservation and economic grazing objectives together in South Africa's grasslands. Unpublished report, BirdLife South Africa.

**Avoid late season grazing in all camps**, as many forb species only grow and flower late in the season and are damaged by intensive late season grazing. Similarly, many ground-nesting birds could be negatively impacted by intensive late season grazing, through direct damage to nests or indirectly by increasing predator detection of nests.

### *3.5.3. Invertebrates, reptiles and small-mammals*

There is very little information on the impacts of different grazing and burning regimes on the other faunal components, and it is generally assumed that if the grassland vegetation is intact and functioning as it should, then the fauna that rely on this food base will be adequately managed.

The most important factor to consider is the size of the area being burnt or intensively grazed. Many small fauna have a limited dispersal distance and if they are locally eliminated because of a large fire, then re-colonisation will depend on the distance to the nearest population. Thus, the smaller and more patchy the burning and grazing, the better it is for these less visible faunal elements.

### *3.5.4. Conflicting species- or ecosystem-specific management requirements*

There are many species and ecosystems that have potentially conflicting burning and grazing requirements, and it can be overwhelming to plan for all these simultaneously. For example, just from among some bird species:

- The endemic, Endangered Botha's Lark prefers heavily grazed or recently burnt areas, and uses both good (naturally short) and poor quality (over-grazed) grassland habitats.
- The endemic, Critically Endangered Rudd's Lark favours short, dense highland grassland on hilltops and ridges, tolerating heavy winter grazing.
- The endemic, Vulnerable Yellow-breasted Pipit requires intact natural grassland.
- The Red-winged Francolin cannot tolerate intensive grazing or frequent burning and is becoming increasingly dependent on isolated patches of tall, rank, pristine highveld grassland.
- The Vulnerable African Grass Owl requires areas of tall, dense grass for roosting and nesting. However, grass that has become moribund with collapsed dead material in areas is generally not suitable because they need to "burrow" in order to build an overhead shelter.
- Many of the larger bird species, e.g. the Vulnerable Denham's Bustard and Secretary bird, are grassland generalists, requiring large areas (several $km^2$) of suitable habitat. Maintaining habitat connectivity is thus important, and needs to be managed at both a farm and landscape scale.
- Some animal species need areas of thick rank grass (African Grass Owl nests, oribi, quail, etc.), while others need the 'cleaner' areas.

**In such cases it is better to aim for the greatest degree of spatial and temporal variability that is possible in the management context**; ensuring that land is not subjected to the same kind of fire, applied at the same time of year, every year. In this way, conflicting ecosystem requirements for the various species are met in different spatial areas. This emphasises the need for a shifting mosaic of different ages since last burn / graze.

# 4 A farm-scale approach to burning and grazing



# 4. A farm-scale approach to burning and grazing

Ecotypes are mappable management areas that share obviously similar ecological characteristics, biodiversity features and grazing capacities.

In most instances, grassland management takes place at the scale of a farm unit, with various ecosystems, land-types and camps dividing up the area into management units. Typically, the farm is managed as a single entity, with no one farm camp or ecosystem being treated in isolation. It is thus important to plan for and implement management of the entire management area in a single management plan.

## 4.1. Ecological zonation and the delineation of ecotypes

Different natural areas within a farm will vary in carrying capacity, resilience, sensitivity and biodiversity value. An important aspect of biodiversity-friendly management is to delineate these 'ecotypes' and manage them in accordance with their inherent characteristics. It is especially important to be able to separate the more palatable ecotypes from the less palatable ones, because if they both occur in one camp, the livestock will over-graze the palatable area and selectively graze the non-palatable area; leading to degradation. **The primary aim of using ecotypes as the basis for camp delineation is to prevent selective- or over-grazing.**

Ideally, a farm should be mapped according to the biophysical characteristics, and camps aligned to the ecotype boundaries. The camps can then be grazed at a stocking rate and intensity appropriate to their biophysical characteristics. When a camp includes two or more such ecotypes (e.g. a valley floor and hillslope), the livestock will likely concentrate on the more desirable areas, effectively elevating the stocking rate there, while under- or selectively-grazing the less desirable areas. Although the existing camp system on a farm may not be ecologically based, a revised camp system is achievable using electric fencing or even fire as a tool to influence livestock behaviour.

Identification of landscape ecotypes can be done in an uncomplicated manner using a bit of common sense, a map or aerial photograph and a walk-about. The landscape can be divided into the ecotypes based on facets such as those described in Table 3.

*Table 2. Landscapes divided into ecotypes by general landscape features identified through general observation, a map or aerial photograph and a walk-about.*

| Landscape facet | Classification | Management implications |
|---|---|---|
| **Topographic position** | Plateaus, ridges, scree slopes, lower valley slopes, valley floors, undulating plains, ... | Soil depth, vegetation types and carrying capacity vary across these land forms. |
| **Geology** | Igneous, sedimentary, serpentine, ... | Igneous rocks, such as dolerite, generally give rise to more nutritious soils than the sedimentary rocks, such as sandstone. Certain geologies, such as serpentine, have relatively unique flora. |
| **Aspect** | Flat, north, south, east, west | North aspects are hotter than south aspects, and can either elevate or depress productivity, depending on whether water or energy is the limiting factor. |
| **Slope angle** | Steep, moderate, gentle, flat | Steeper slopes generally have shallower soils than flatter valley bottoms and are less productive. |
| **Land types** | Palatability, woodiness, weediness, rockiness | Areas with a high proportion of surface rock, woody plants or invasive weeds physically have less grass than open grasslands. |
| **Landuse history** | Old lands, over-grazed or degraded areas, proximity to the homestead | Areas that have experienced very high impacts historically will typically have low productivity and biodiversity value. |

## 4.2. Limited-graze zones in sensitive and species-rich areas

There are natural hotspots of diversity across South Africa's grasslands where the levels of plant diversity are significantly higher than the surrounding areas due to geographic or other reasons that gave protection from the long-history of grazing pressure experienced across much of South Africa. These isolated pockets of higher-than-average diversity are often associated with remote, inaccessible and ecologically sensitive areas such as **steep slopes, rocky outcrops, seep zones along the bases of cliffs, riverine edges** and other natural refugia. In many instances, other significant species are associated with these habitats. For example, in the Drakensberg, these refugia offer suitable habitat for endemic bird species such as Buff-streaked Chat, Drakensberg Prinia, Drakensberg Rockjumper and Drakensberg Siskin. Due to the levels of biodiversity in these refugia, they should be zoned with the intention to conserve the grassland endemic species and managed with a separate biodiversity objective within the overall management context of a farm.

**Zonation** of grasslands is imperative to enable different regimes of fire and grazing to be applied to different areas. As it is generally believed that even conservative levels of commercial grazing are not compatible with the maintenance of high-levels of plant diversity, and that where there are instances of higher-than-average diversity, these areas should not be included in the grazing rotation, but rather treated separately. Thus, within any rotation grazing system, it is important to identify areas of significantly high diversity within the farm that should be treated within the management plan as **grazing exclusion zones**. This is unlikely to significantly affect the overall carrying capacity of the farm as the areas are often relatively small

Conservation of natural fire refugia could be achieved by occasional cool burning (when there is moisture in the soil and under cool weather conditions). If fire is "withdrawn" artificially from outcrops and wetlands, the build-up of phytomass (plant material) could become a significant risk to their destruction. Runaway fires generally occur under hot, dry conditions, and the accumulation of too much phytomass creates conditions that will burn into the soil. Conservation of natural fire refugia is essential to ensure that habitats of threatened bird species, nesting, and to a lesser degree foraging, are managed appropriately.

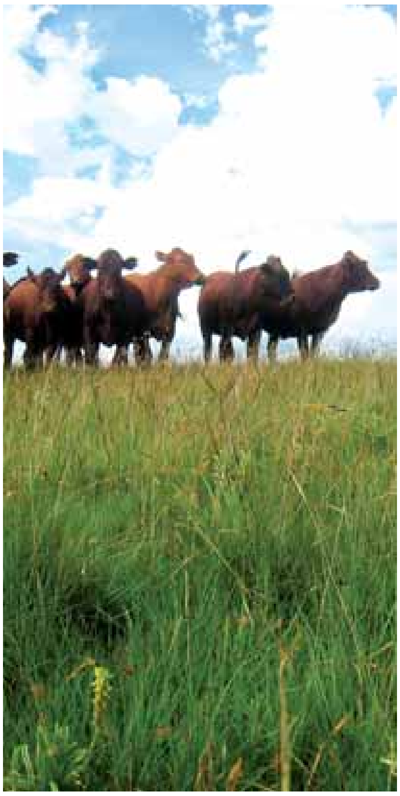
## 4.3. Template management cycle

Although there is no perfect grazing regime for all situations, it is helpful to include variability in the fire frequency, timing and intensity, as well as the appropriate grazing system that avoids the extremes of high- or low-intensity grazing, **but that ensures complete rest for at least one growing season out of four**.

The following camp rotation is offered as an example of a system that would allow for maintenance of the current plant (and presumably faunal) diversity in the non-hotspot grazing areas in mesic grassland. There are many variations of this theme, although the principles described above remain valid, such as rest. There are two main grazing strategies employed here, both of which should be used in concert:

a) Non-selective grazing
b) Controlled selective grazing.

The overall aim of the system is for a combination of non-selective grazing immediately after the burn, followed by controlled selective grazing for the remainder of the year.



This should be done in a way so that the same camp is not treated in the same fashion on every cycle. In mesic grassland, biennial or triennial burning (depending on fuel load) with big fire breaks and early spring burns should be encouraged. For example, a farm could be divided into four blocks of approximately equal carrying capacity. Each block is then divided into camps based on natural features ecotypes and existing fence lines (example in Figure 4). The number of camps depends on the size of the herd on the farm, aiming for camp sizes that ensure non-selective grazing. Although camps do not have to be equal in area, they should not be so big that the herd is unable to consume the available fodder in a few weeks as this will promote selective grazing, and smaller camps will just have shorter graze duration.

Then, in any one year, there will be a block that is for:

- Rest
- Primary grazing
- Secondary grazing
- Tertiary grazing.

### The rest block

This was the tertiary grazing block from the previous year, and it is not to be burnt at the start of the season. **The entire block should not be grazed at all throughout the growing season**. This allows the plants to complete their reproductive cycles, for seed to be released, and seedlings to establish adequately. The adult plants can also replenish their root reserves and increase their vigour for the following year.

### The primary grazing block

This is the block that was rested from grazing the previous year. It will be burnt after the first spring rains and the herd can start grazing the first camp within the block once the grass sward is above 15-20 cm. As soon as the sward in that camp has been grazed to about 5 cm, then the animals are moved to the second camp, and then the third, and so on. As soon as the grass in the first camp has grown back to about 15 cm, the livestock are moved in there again. The time spent in each camp may be reasonably short (i.e. 3-4 days), depending on its carrying capacity and size.

Depending on the herd size, the entire block may soon have been consumed, and the sward in all the camps is still in recovery. At this point the herd is moved into the Secondary Block.

### The secondary grazing block

This is the block that was the primary grazing block the previous year. It is unlikely to have needed burning due to the high levels of grazing the previous year. Once the fodder in the primary block is all grazed and is in recovery, the herd starts in the first camp of this block, and the herd will be moved through the secondary block in a similar way to the primary block.

The difference between the secondary and primary blocks is that as soon as the first camp in the primary block is ready for grazing, then the herd is moved back there and the grazing cycle in the primary block resumes, only coming back into the secondary block when the primary block has been fully consumed. In this way, the animals are moved between the primary and secondary blocks, always returning to the primary block when it has recovered.

When coming back into the secondary block, the grazing should start with the next camp in the rotation (i.e. the one after that which was being grazed) and not always the first camp.

## The tertiary grazing block

The tertiary grazing block, which was the secondary grazing camp from the previous year, is considered a grazing reserve that will only be grazed lightly unless there is a very poor growth rate that year, **in which case it is an indispensable fodder reserve**. For example, in a below-average rainfall year, growth rates of the grassland may be low and the primary and secondary blocks both become exhausted. Without the tertiary block, the farmer will either have to use the rest block, or import fodder, or reduce the herd size. All of these options have significant negative consequences either for the grassland or the farm finances. Thus the tertiary camp is the 'insurance' policy in the grazing rotation, and its value becomes apparent in years when there are regional fodder shortages.

The tertiary camp is only burnt at the start of spring if there is sufficient fuel load (>1,500 kg / ha at the very least), otherwise it is not burnt.

## Some general principles

- Once the growing season has finished and the plants have released their seeds, any of the camps with sufficient biomass can be grazed during winter, including the rest camp. In systems where there are no crop residues or opportunities to import fodder, it is important to ensure there is sufficient fodder left in the grassland to sustain the herd through winter. In mesic grassland approximately half the grazing should be set aside for winter fodder. In the drier areas, more than half the grazing will be needed for winter grazing.
- If all the grazing camps (excluding the rest camp) are exhausted by January, when 60% of growth has already occurred, then it is unlikely that the herd will survive through winter without supplementary feed. At this point, it would be better to destock in January, while market prices are high. If the grazing is exceeded by mid-March, then there will be trouble in winter. These time-frames can vary depending on seasonal rainfall, and on different grassland bioregions.
- It is important not to use the same camp and any of the blocks as the starting point in the rotation every year. Rather rotate the starting camp.
- The four-block system can be reduced to a three-block system by dropping the tertiary grazing camp, but the implication is that there is no reserve grazing and this is not recommended for areas that have a high variability of rainfall.
- If the herd size is not big enough to fully consume the grazing in the primary camps, and there is evidence of selective grazing, it is better to reduce the camp size to ensure non-selective grazing and then use fire to manage the accumulation of biomass in the ungrazed camps.
- This, or any management cycle, is likely to be disrupted periodically by runaway fires, droughts and other unpredictable events. These do not diminish the importance of the plan and, should they occur, it is important to try bring the management back in line with the plan as soon as possible.

| Year | Block 1 | | Block 2 | | Block 3 | | Block 4 | |
|---|---|---|---|---|---|---|---|---|
| | *Burn* | *Graze* | *Burn* | *Graze* | *Burn* | *Graze* | *Burn* | *Graze* |
| 1 | SB | P | NB | S | SB+ | T | NB | R |
| 2 | NB | S | SB+ | T | NB | R | SB | P |
| 3 | SB+ | T | NB | R | SB | P | NB | S |
| 4 | NB | R | SB | P | NB | S | SB+ | T |

| Legend | Burning | | Grazing | |
|---|---|---|---|---|
| | **SB** | Spring burn after first rains | **R** | Full season's rest: potential winter graze if needed |
| | | | **P** | Primary grazing |
| | **SB+** | Spring burn after first rains if sufficient fuel (>1,500kg/ha) | **S** | Secondary grazing for when all primary camps are exhausted |
| | **NB** | No burn | **T** | Tertiary grazing only if primary and secondary camps ar exhausted |

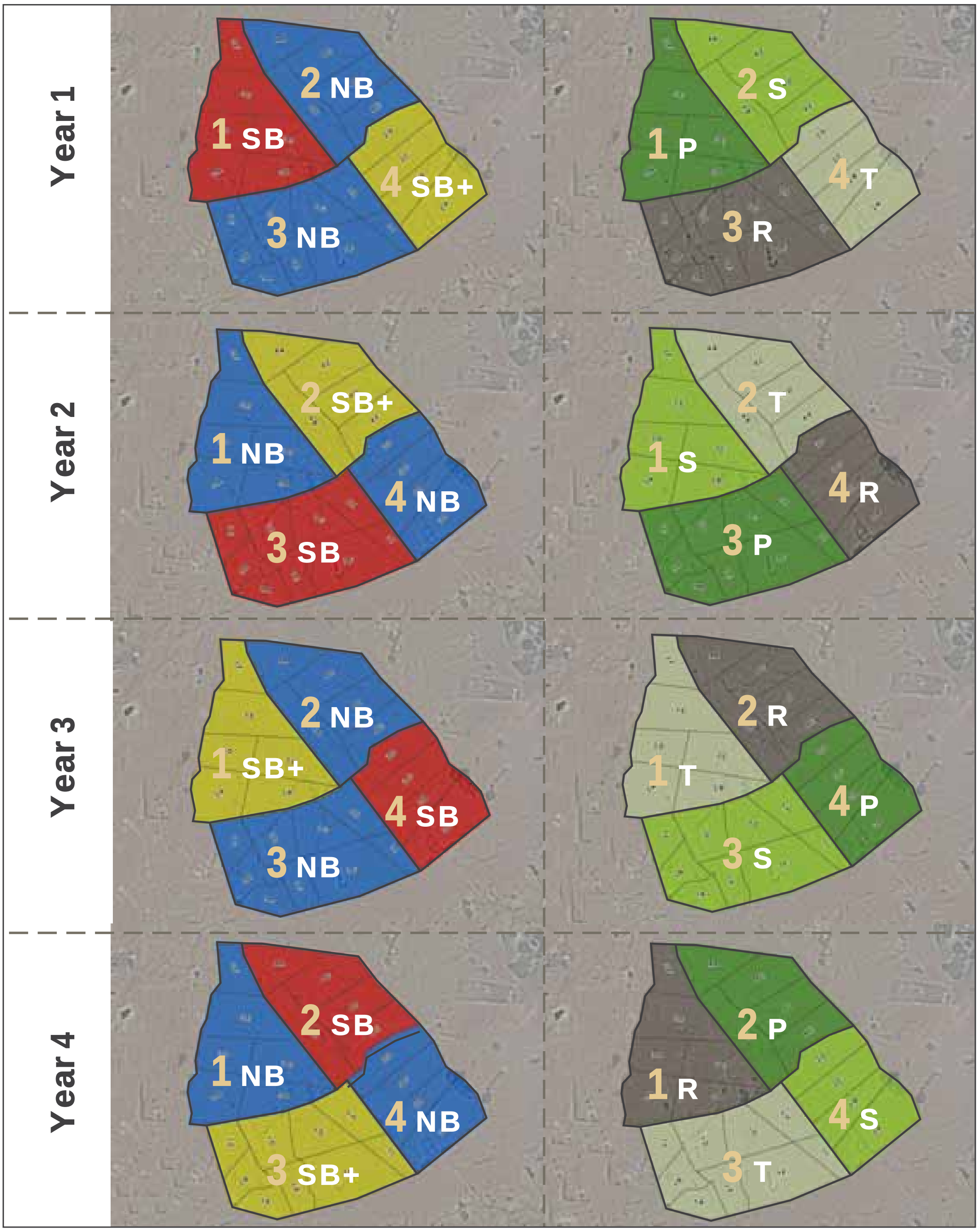



*Figure 4. Example of a four block grazing and burning rotation system*

## 4.4. Assessment of management effectiveness

Assessment of management effectiveness is a vital part of ensuring that biodiversity and productivity are conserved on a farm. The principles described here are ideally implemented in the context of a management plan that is periodically updated. However, it is possible to apply these principles just by being intentional about management and making frequent observations of the veld.

Good management should include an annual audit of how effective the management was. This does not have to be a complex or costly exercise at all, but can be done by the farmer or an external party. It does, however, take resolve and intentionality. All the audit requires is to examine if the management goals for the year were achieved or not, and if not, then why not? For example, if a camp was to be burnt in September after the first rains using a cool head fire, then the farmer can say whether this was done or not. The goal of such an honest self-evaluation is to improve the management in the following year, by identifying problem areas where management is failing for some reason.

# 5 Useful resources for further reading



# 5. Useful resources for further reading


Botha, J. 2001. An Examination of Holistic Grazing Management. Specialist Advisory Services Report. KZN Department of Agriculture and Environmental Affairs, South West Region.

de Wet, F.W. 2010. Key Grasses and other grasses identified for Grazing Management at Wakkerstroom Montane Grassland: An Identification Field Guide using Vegetative Characteristics. Unpublished report, WWF-SA.

Fynn, R., C. Morris, T. Edwards. 2004. Effect of burning and mowing on grass and forb diversity in a long-term grassland experiment. Applied Vegetation Science 7: 1-10.

Little, I., P. Hockey & R., Jansen. 2013. A burning issue: Fire overrides grazing as a disturbance driver for South African grassland bird and arthropod assemblage structure and diversity. Biological Conservation 158 258–270.

Kirkman, K. & P. de Faccio Carvalho. 2003. Management interventions to overcome seasonal quantity and quality deficits of natural rangeland forages. Proceedings of the VIIth International Rangelands Congress. Eds: N. Allsopp, A.R. Palmer, S.J. Milton, K.P. Kirkman, G.I.H. Kerley, C.R. Hurt, C.J. Brown. ISBN Number: 0-958-45348-9.

O'Connor, T. G. 2005. Influence of land use on plant community composition and diversity in Highland Sourveld grassland in the southern Drakensberg, South Africa. Journal of Applied Ecology 42, 975–988.

O'Connor, T., G. Martindale, C. Morris, A. Short, E. Witkowski & R. Scott-Shaw. 2011. Influence of Grazing Management on Plant Diversity of Highland Sourveld Grassland, KwaZulu-Natal, South Africa. Rangeland Ecology & Management, 64(2):196-207.

O'Connor, T.G., P. Kuyler, K.P. Kirkman & B.J. Corcoran. 2010. Which grazing management practices are most appropriate for maintaining biodiversity in South African grassland? African Journal of Range & Forage Science 27(2): 67–76.

SANBI. 2013. Grasslands Ecosystem Guidelines: landscape interpretation for planners and managers. Compiled by Cadman, M., de Villiers, C., Lechmere-Oertel, R. and D. McCulloch. South African National Biodiversity Institute, Pretoria. 139 pages.

Short, A. 2011. Grazing and fire management guidelines for biodiversity in moist grasslands. Unpublished report, WWF-SA.

Weir, J. 2007. Patch Burning: Integrating Fire and Grazing to Promote Heterogeneity. Unpublished report E-998, Department of Natural Resource Ecology and Management, Oklahoma Cooperative Extension Service, Oklahoma State University.

Uys, C., H. Smit-Robinson & D Marnewick. 2013. Bird-friendly burning and grazing best-practice for grasslands: Achieving bird conservation and economic grazing objectives together in South Africa's grasslands. Unpublished report, BirdLife South Africa.

Uys, R., W. Bond, & T. Everson. 2004. The effect of different fire regimes on plant diversity in southern African grasslands. Biological Conservation 118:489-499.

# Notes

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