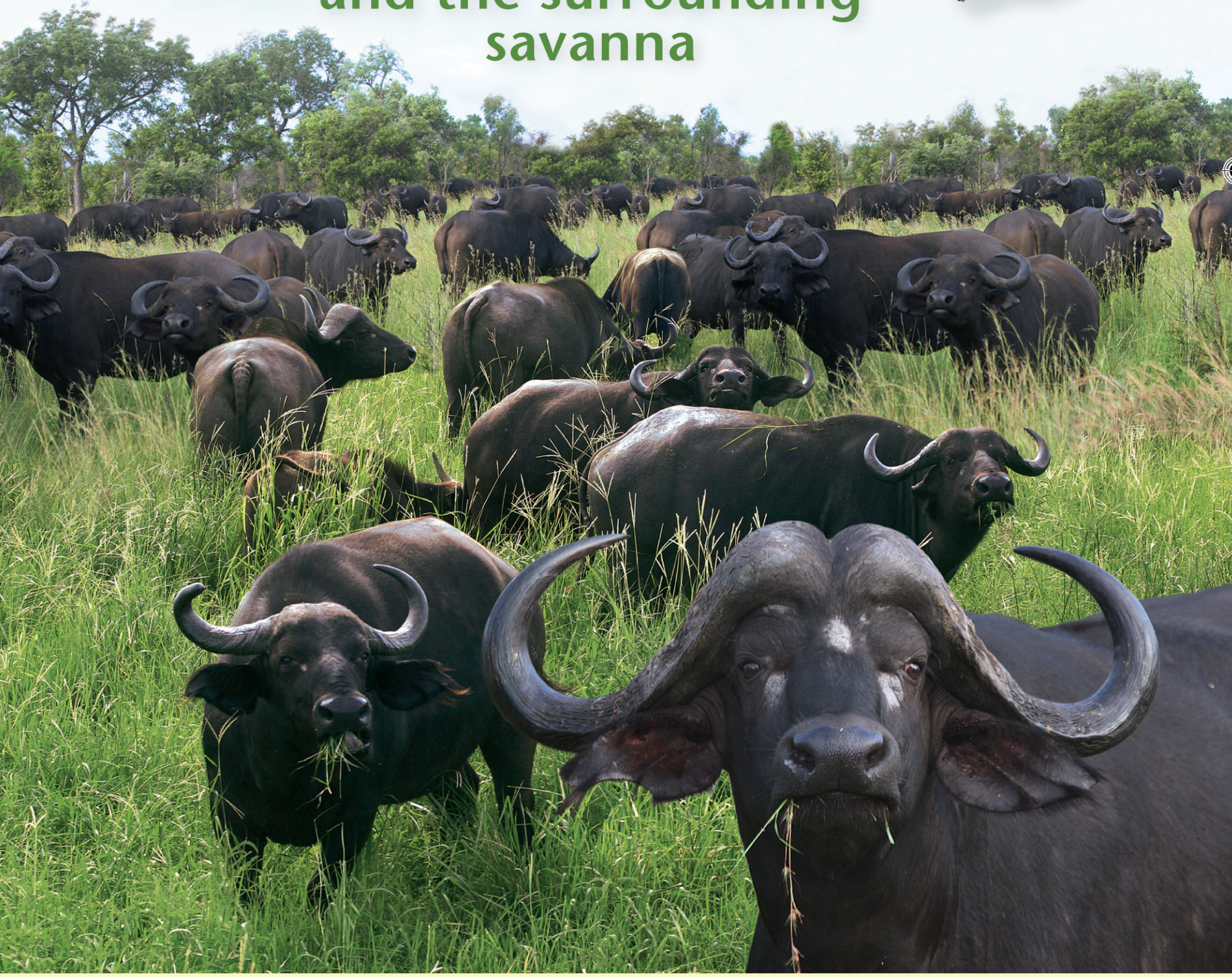
Grasses & Grazers

of Botswana

and the surrounding savanna



Veronica Roodt

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Veronica Roodt

Dedicated to my beloved mother, Ralie Roodt, for her love and inspiration.

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Front cover photographs: Silky bushman grass (*Stipagrostis uniplumis*) (top); buffaloes feeding (bottom)
Back cover photographs, top to bottom: Bottlebrush grass (*Enneapogon scoparius*); Vlei finger grass (*Dicanthium annulatum*); zebras feeding; white rhino feeding on short grass
Title page photograph: White rhino feeding
Page 3 photograph: A harem of zebra

Acknowledgements

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About this book

Grasses and grazers are diverse and interesting species. Many grasses look superficially alike and may go unnoticed, even by nature lovers, yet they, and their soil substrate, form the basis of almost all ecological processes in nature. This book will take you on a journey, first into the intriguing world of grasses, from their germination to their death, and then into the lives of the grazers that feed on them, focusing on their interactions and interdependence: we know that grazers need grasses to survive, but grasses have evolved along with grazers, on whom they, in their turn, are dependent.

Chapter 1 describes the role of grasses in the food chain, outlines some basic grass anatomy and explains how grasses grow. It also clarifies some terminology used in the rest of the book. Chapter 2 describes 98 species of grass that occur in Botswana and the surrounding savanna. The grasses included are those that are preferred fodder species and those that serve as good indicators of veld condition.

Grasses are typically low in protein, and Chapter 3 explains how grazers have evolved to survive on this diet and to thrive in the hot, dry climate. Chapter 4 provides species accounts of all the grazers that occur in the region under discussion, while Chapter 5 outlines some veld management principles that may be of particular interest to those responsible for managing veld or farming livestock. Although there are scientific reference books on the subject of range management and the impact of grazers on their food source, this book aims to be an accessible and easy-to-use reference for students at guide schools and wildlife colleges, for game farmers, tourists and nature enthusiasts, and to inspire an appreciation of grasses and an awareness of their critical importance in the ecosystem.

The savanna biome is one of the seven major biomes in southern Africa, the others being forest, grassland, Nama karoo, succulent karoo, desert and fynbos. The savanna biome is situated in the more tropical parts of southern Africa. A hot, wet summer season, a cool, dry winter season, well-developed grass cover with scattered trees that vary in density, and prominent termite hills are all typical of this biome. Fire is an important factor in the maintenance of plant cover here.

Key to the distribution maps

--- Range

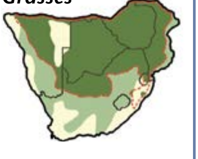
Distribution within range

Distribution outside range

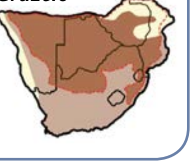
Distribution within range

Distribution outside range

Grasses



Grazers

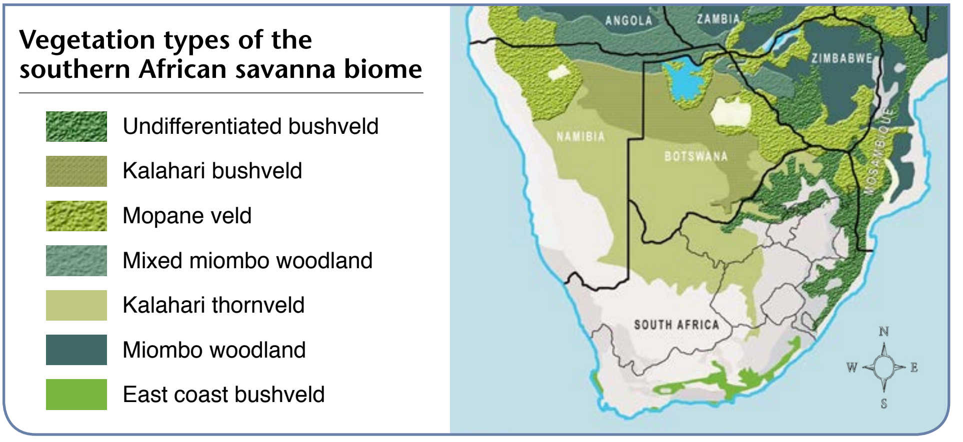


The area covered by this book

This book deals with the grasses and grazers of Botswana and the surrounding savanna, which extends westwards into Namibia, eastwards into Zimbabwe and Mozambique, and south into South Africa.

VEGETATION AND VELD TYPES WITHIN THE SAVANNA BIOME

Most of Botswana and the surrounding savanna is covered in a mixture of grass and trees. The major vegetation types seen are:



- **Undifferentiated bushveld** roughly incorporates the bushveld from Pretoria northwards to the Limpopo valley, westwards to the Botswana border and eastwards to the Lowveld, and includes the Kruger National Park, western Mozambique and the northern parts of KwaZulu-Natal.
- **Kalahari bushveld** occurs in northeastern Namibia and in northern and central Botswana. The soils consist mainly of sand mixed with some clay, and the rainfall is higher than in Kalahari thornveld (between 400mm and 550mm per annum).
- **Mopane veld** forms broad belts along the Zambezi and Limpopo valleys, extending through the northern parts of Botswana and into northern Namibia. The rainfall is fairly high (about 400–650mm per annum) and the soil type is clayey. Mopane (*Colophospermum mopane*) is by far the most dominant tree, often forming homogenous stands.
- **Mixed miombo woodland** represents a transition zone between true miombo woodland and Kalahari bushveld. It is also referred to as Kalahari miombo. It stretches from eastern Zimbabwe through northeastern Botswana and the Zambezi region to northern Namibia. The soil is sandy,

Undifferentiated bushveld

Kalahari bushveld

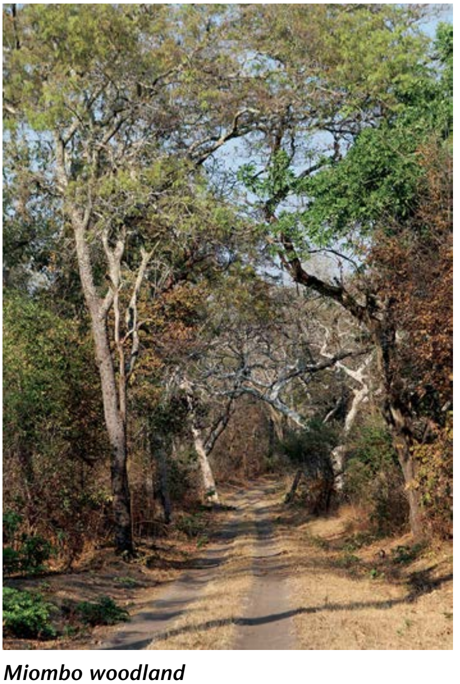
Mopane veld

Mixed miombo woodland

Kalahari thornveld

IOA

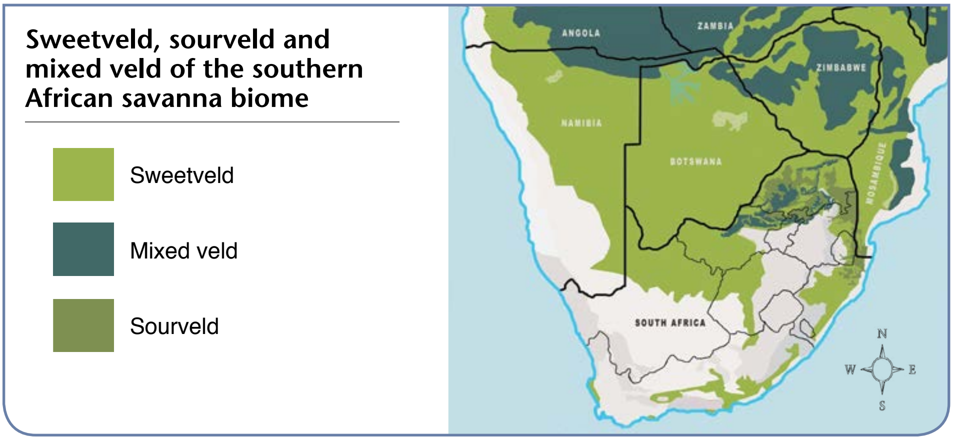
East coast bushveld



Miombo woodland

but the rainfall is not as high as it is in true miombo woodland (450–750mm). Most trees in this woodland type belong to the pod-bearing family.

- **Kalahari thornveld** occurs in the more arid parts of the Kalahari. The trees here are mainly *Acacia* spp. The soil is sandy and the rainfall is very low (about 200–400mm per annum).
- **Miombo woodland** occupies high-rainfall areas (750–1,200mm per annum) with sandy soils. The grasses are tall and wiry and do not remain palatable during the dry season. It occurs in northeastern Mozambique and central Zimbabwe.
- **East coast bushveld** tends to be dominated by thorny, semi-succulent shrubs, interspersed with occasional small trees. Rainfall may occur at any time of the year. However, this vegetation type falls beyond the scope of this book.



Sweetveld, sourveld and mixed veld of the southern African savanna biome

Vegetation types should not be confused with veld types. Veld can be classified into sweet*veld*, sour*veld* or mixed *veld*, depending on the quality of the forage that is provided.

Various factors, including rainfall, elevation, soil type and the ability of the soil to hold on to its nutrients, determine the palatability of the grass species growing in an area. Sweetveld is generally more acceptable to grazers than sourveld, and sweetveld grasses remain palatable during the dry season, while sourveld grasses do not. Most vegetation types in the savanna biome can be classified as forms of sweetveld or mixed veld. (Mixed veld contains both sweetveld and sourveld components.) The exceptions are the Waterberg sourveld region northwest of Pretoria and the miombo woodland of Zimbabwe and Zambia, which also tends to be sour. The summary on p.8 outlines the key differences between sweetveld and sourveld.

Sourveld grasses are unpalatable for 6–8 months of the year.

Sweetveld is highly palatable and occurs at lower altitudes than sourveld, in frost-free areas.

COMPARISON OF SWEETVELD AND SOURVELD	
Sweetveld	**Sourveld**
Occurs at **lower altitude** than sourveld, in frost-free areas.	Occurs at **higher altitude** than sweetveld, in areas prone to winter frost.
Average annual rainfall is **250–500mm**.	Average annual rainfall **exceeds 500mm**; may be up to 750mm.
Minimal translocation of mineral nutrients to the roots from late summer to autumn.	**Most mineral nutrients translocated** to the roots from late summer to autumn.
Grasses and woody species **remain palatable** and digestible for most of the year; therefore more desirable than sourveld.	Grasses **unpalatable for 6–8 months** of the year, when they are particularly low in phosphate and protein.
Highly susceptible to overgrazing, especially during drought years when grass yield is lower.	**Not susceptible to overgrazing**, as higher rainfall causes leeching of nutrients, rendering many grasses unpalatable.
Low yields, but greater variety of palatable species.	**High bulk, but little palatable browsing,** as it is dominated by tall, fibrous grass species.
Supports a large diversity of herbivores at different feeding strata (levels), ranging from dwarf antelope to giraffe, and can also support animals that naturally occur in sourveld.	**Supports a low diversity of herbivores**; before the introduction of livestock, it supported a few bulk roughage feeders – elephant, zebra, buffalo, reedbuck, blesbok, black wildebeest, sable and roan antelope.
Slow natural regeneration; over-utilisation is common and disturbs the ecosystem; continuous pressure causes a downward spiral beyond the threshold of regeneration, and management becomes costly.	**Faster natural regeneration;** recovers faster after disturbance than sweetveld does.
Soils alkaline since lower rainfall results in less leaching of nutrients and a higher pH.	**Soils acidic** since a higher rainfall results in greater leaching of nutrients and a lower pH; this reduces levels of potassium, phosphate and protein in grasses; livestock require phosphate licks to make grasses palatable, but game is less sensitive and can eat mineral-rich soil and select protein-rich plants to achieve balance.
Little surface water, especially in the dry season.	**Readily available surface water** throughout the year, although animals graze on sourveld grasses mainly in the rainy season.

CHAPTER 1 Introduction to grasses

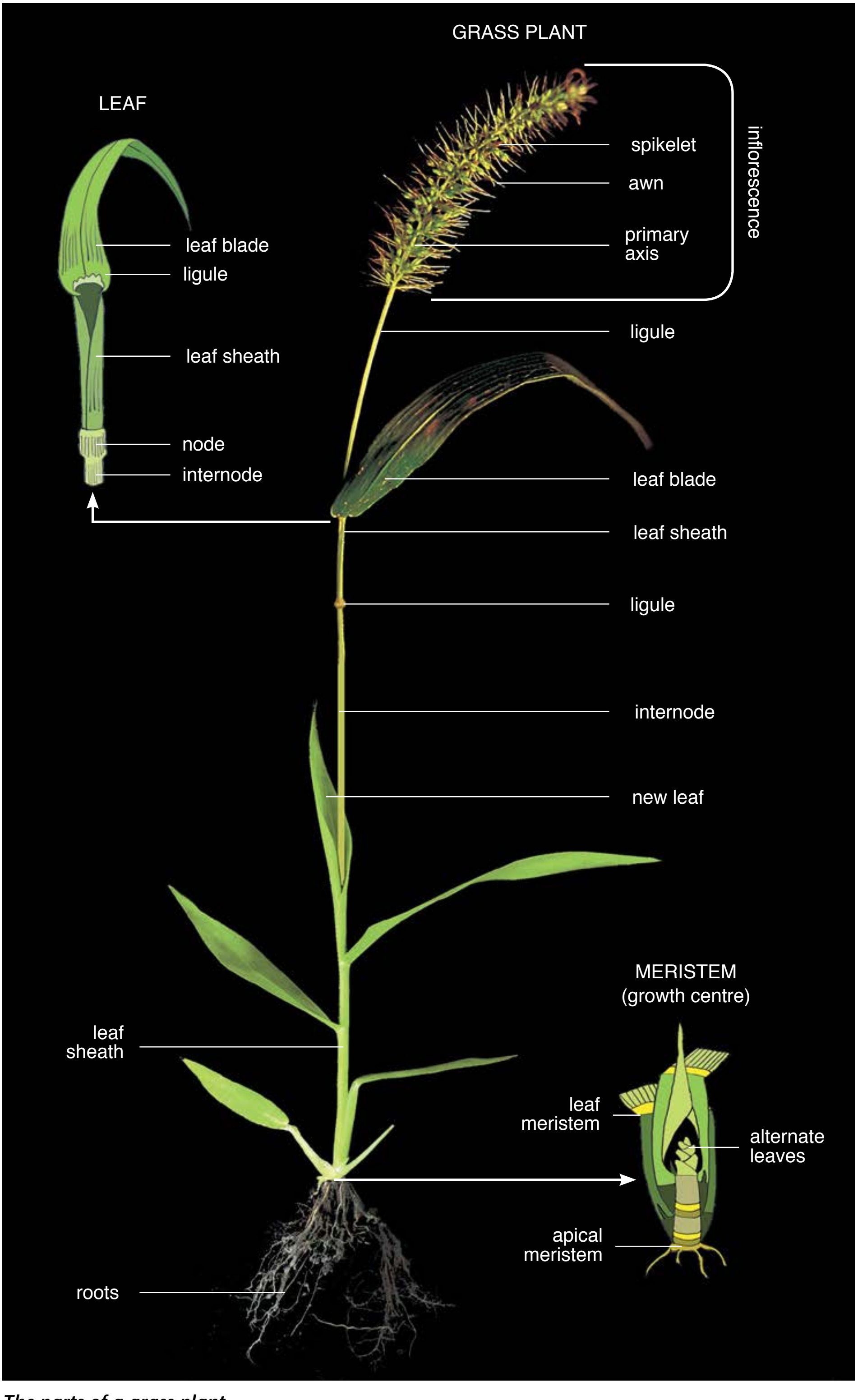
Grass forms one of the major platforms of the energy cycle (food chain). This cycle begins with plants, the producers, which draw on water and nutrients in the soil, such as nitrogen, and combine them with carbon dioxide, oxygen and sunlight to produce energy. Herbivores, or primary consumers, eat the plants and in turn are fed upon by carnivorous animals, the secondary consumers. When plants and animals die, the decomposers – fungi, protozoa, bacteria and other micro-organisms – feed on them. This decomposition returns nutrients to the soil in a form that plants can absorb.

Soil is thus both the substrate in which plants grow and the place where decomposed nutrients are returned to the energy cycle. The most important life-giving elements required by plants, including grasses, are oxygen (O), hydrogen (H), carbon (C) and nitrogen (N).

Nitrogen is especially important for building proteins. However, plants and animals cannot use atmospheric nitrogen directly. A plant obtains its nitrogen from the soil, where it occurs as complex organic compounds in dead animals and plants. Plants depend on fungi and nematodes and earthworms to break them down into simpler compounds, and on micro-organisms (bacteria and protozoa) to complete this process. The action of micro-organisms splits off ammonia, which forms ammonium salts and nitrates in the soil solution. In the plant the ammonium salts and nitrates combine with carbohydrates to form amino acids – the building blocks of protein.

Atmospheric nitrogen can also be converted directly to nitrates by means of lightning and when these nitrates enter aerated soil, plant roots can absorb them directly. A number of micro-organisms have the ability to combine atmospheric nitrogen with other elements to form organic compounds. The best known are bacteria belonging to the genus *Rhizobium*, which have a close relationship with leguminous (pod-bearing) plants. These bacteria infect the roots of a pod-bearing plant and the plant responds by forming swellings called nodules on the surfaces of its roots. The bacteria thrive and multiply inside these nodules, absorbing insoluble nitrogen and processing it to produce fixed nitrogen. The plant can absorb the fixed nitrogen compounds (ammonia) and use them to manufacture protein.

Herbivores, which are primary consumers, eat plants; in turn, they are fed upon by carnivores, which are secondary consumers.



The parts of a grass plant

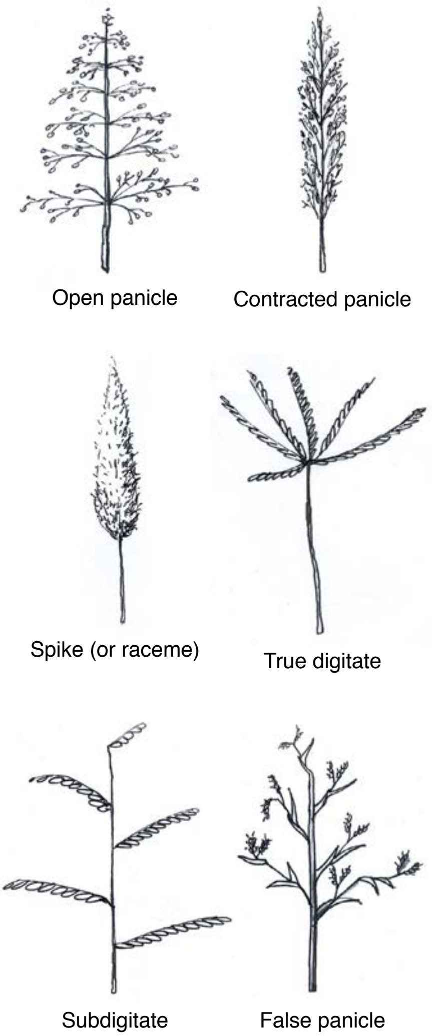
The parts of a grass plant

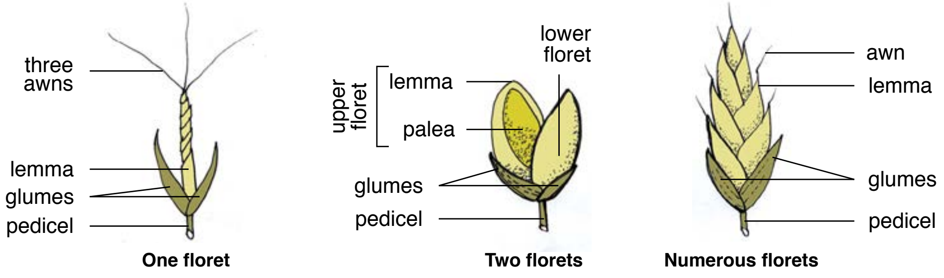
A grass seedling consists of a base or growing point called the *apical meristem*, which generates a shoot called a *mother tiller*. The stem of a grass tiller is called the *culm*, and is made up of alternating jointed sections. These sections each comprise: a *leaf*, a stem *node*, a stem *internode* and a *bud*.

Each grass leaf comprises three parts: the *blade*, the *sheath*, which is wrapped around the culm and supports the blade, and the *ligule*, which occurs where the leaf blade and leaf sheath meet. A grass *inflorescence* (flower head) is the part of the grass that grows at the end of the culm and that bears florets.

The inflorescences of different grasses vary in size and pattern. The inflorescence may be an open panicle, a contracted panicle, a spike (or raceme), digitately compound (finger-like), subdigitate or a false panicle. The inflorescence bears the spikelets, which are vessels for carrying the florets – a spikelet may have one, two or more florets. A floret is a minute, modified flower. Spikelets have two glumes at their base, a lower (outer) and an upper (inner) glume, which hold one (as in *Sporobolus* spp.), two (as in *Eragrostis biflora*) or several (as in *Eragrostis superba*) florets. Florets consist of a pair of bracts, a lemma and a palea. The palea is usually smaller than the lemma and its margins are enclosed within the lemma. In cases where grass seeds are designed to travel through the digestive systems of grazers, they have a lower lemma, an upper lemma and a palea that act as protective layers together with the glumes.

INFLORESCENCES





Different kinds of spikelets

How grass grows

Grasses go through various phases of development, which are outlined below. We then take a brief look at the processes that sustain plant growth.

GRASS DEVELOPMENT PHASES

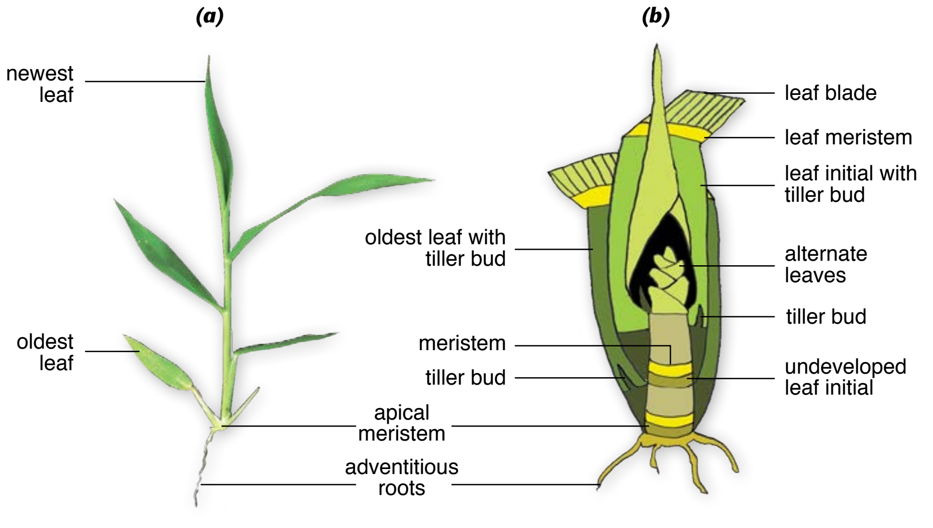
Grasses may be annuals, which means they complete their entire life cycle in one year, or perennial, which means they live for two years or more. Both types of grass plant go through three main phases of development in their life cycle: the *vegetative* (leaf growth) phase, the *transition* (elongation) phase and the *reproductive* (flowering) phase. Understanding these phases informs various veld management decisions, such as when livestock should graze or when it is best to conduct controlled veld burns.

Both annual and perennial grasses can reproduce sexually by producing seeds. This is the exclusive method by which annual grasses reproduce, but perennial grasses depend more heavily on *asexual reproduction* by tillering. This is the process of producing side shoots from which new grass plants (tillers) grow. Being able to reproduce by two means is useful, because animals that graze on grasses may eat the flowers before the seeds have dispersed. Although annuals also tiller, this does not serve to perpetuate the plant.

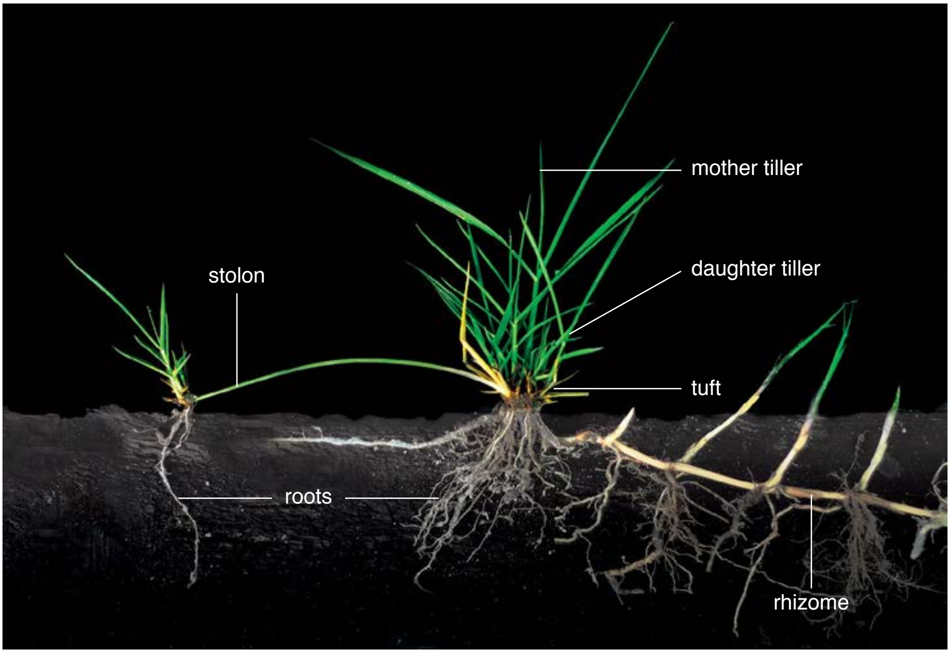
Vegetative (leaf growth) phase

During the vegetative phase a grass seed germinates and the seedling produces a root system and leaf blades. Germination occurs only once the seed has absorbed sufficient water for metabolic activity to take place. Rapid cell formation results in the formation of adventitious roots (later replaced by actual roots) and the apical meristem (the beginning of a stem and leaves).

Rapid cell division takes place at the growth point, or apical meristem to form leaf initials (the beginnings of new leaves) on alternating sides of the unelongated culm. As new leaf initials form, earlier ones are pushed upwards. Where the leaf initials attach to the culm at the nodes, buds called *tiller buds* form. These may remain dormant, or, if conditions are right, develop into daughter tillers.



***Leaf formation (a)** Notice how the leaves are pushed up alternately with the oldest leaves at the bottom and the youngest at the top. **(b)** The apical meristem is situated at the bottom of the plant and consists of a number of compacted leaf initials and tiller buds.*



Couch grass (**Cynodon dactylon*****) is an example of a species that forms tufts, stolons and rhizomes.***

The leaf initials in their turn produce leaf sheaths, which are all closely compacted. There may be up to 20 such leaf ‘beginnings’ in a perennial grass and they are all squashed into 1cm of pseudo-stem – that part of the new shoot that looks like a stem is in fact just folded sheaths. The first blade to unfold always emerges from the outermost leaf sheath. Newer leaves are at the centre. The real stem is safe from grazers, at the base of the shoot, and only emerges after all the leaves have been pushed up. The growing area of each leaf blade is at its base, making the tip of the leaf older than the base. If the leaf is not completely developed and it is grazed, it will continue growing as long as the leaf meristem remains undamaged. The lower leaves, which are the oldest, are always the first to die. If the grasses are left ungrazed at this time, valuable forage can be lost.

As mentioned, tillering, or vegetative propagation, is the process where lateral buds are formed at the stem nodes and continue to develop to form new tillers. The tiller buds that are compacted in the lower nodes can develop in three ways: they can grow upright, as is typical of *tufted* grasses; they can form lateral above-ground stems, known as *stolons*; or they can form lateral underground stems known as *rhizomes*. Tillering is an essential survival mechanism in areas where grasses are continuously grazed. In annuals the tillers die when the plant dies, after flowering. In perennials the buds may also die, but generally they remain dormant until the next season, or develop leaves and flowers or, if it is too late in the season for flowering, they may develop only leaves. In the latter case, they provide valuable grazing during the late dry season and an opportunity for the grass plant to build up more carbohydrates for storage. Lateral tillers are formed mainly in spring and autumn, but during the elongation phase, when lots of energy is required, tillering stops temporarily. In some cases the tillers are so shaded that growth is inhibited, but they may be stimulated to grow when grazing or burning removes excess plant material. Grasses and grazers have evolved alongside each other to such an extent that some grasses cannot grow optimally without the stimulation provided by grazers.

Transition (elongation) phase

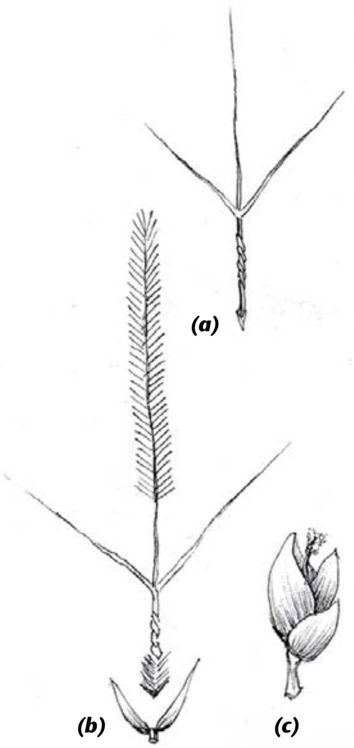
During the transition phase, the young grass plant prepares for flower development. The leaf sheaths supporting the blades start to grow longer, as does the culm (the jointed stem that supports the leaves and eventually carries the flower head). Up until this point, the culm has been tightly compacted at the base of the plant, with very short spaces between each leaf-bearing node. Now, the growing point in the crown stops generating leaves and starts generating a flower head. At the same time, the distance between the nodes grows because the internodes lengthen and raises the flower to the top.

Reproductive (flowering) phase

The top internode of the culm is called the *peduncle* and it eventually carries the flower, which bears the seeds. The flowers open when the culm attains its full length. If grazers are allowed to graze at this stage, they will remove the flower heads and prevent seeding. Since perennials can also reproduce vegetatively by tillering, seeding is not vital for their reproduction. Annuals, however, reproduce exclusively by seed and their survival depends on undisturbed seeding. In sensitive, damaged areas that consist mainly of annuals, grazing should be suspended from the time of culm formation and throughout seed production and should only be reinstated after seed dispersal.

Once seed formation is complete, the seeds disperse. Most grasses have special adaptations that aid dispersal, except for *Eragrostis* and *Agrostis* spp., whose seeds have no appendages and simply fall to the ground until ready to germinate. Note that spear grass and three-awn grasses have a combination of bent awns, which aid propulsion, burs that can snag in hair or fur and the capacity to despiral as soon as they absorb water, allowing them to bore into hard ground. Interestingly, some seeds are specially adapted to pass through the digestive systems of grazing animals so that they can be dispersed via droppings. Grasses in this group are soft and palatable, so grazers consume the entire plant, seeds and all. The seeds of these grasses have protective layers (glumes, lower and upper lemmas and paleas). This ensures their safe passage through the digestive system. Examples are panicums (*Panicum* spp.), signal grasses (*Brachiaria*) and dallis grasses (*Paspalum* spp.). Most seeds remain dormant until the next growing season or until conditions are favourable. Their most important requirement is water. Only once the seed has absorbed enough water is germination initiated.

How the spikelets of different grasses are adapted for seed dispersal



*Silky hairs in a bushman grass (*Stipagrostis* spp.) with spiralled column **(a)**; Spiralled column and bent awns in a stick grass (*Aristida* spp.) **(b)**; Protective paleas and lemmas in blue buffalo grass (*Panicum* spp.) **(c)***

PROCESSES SUSTAINING GROWTH

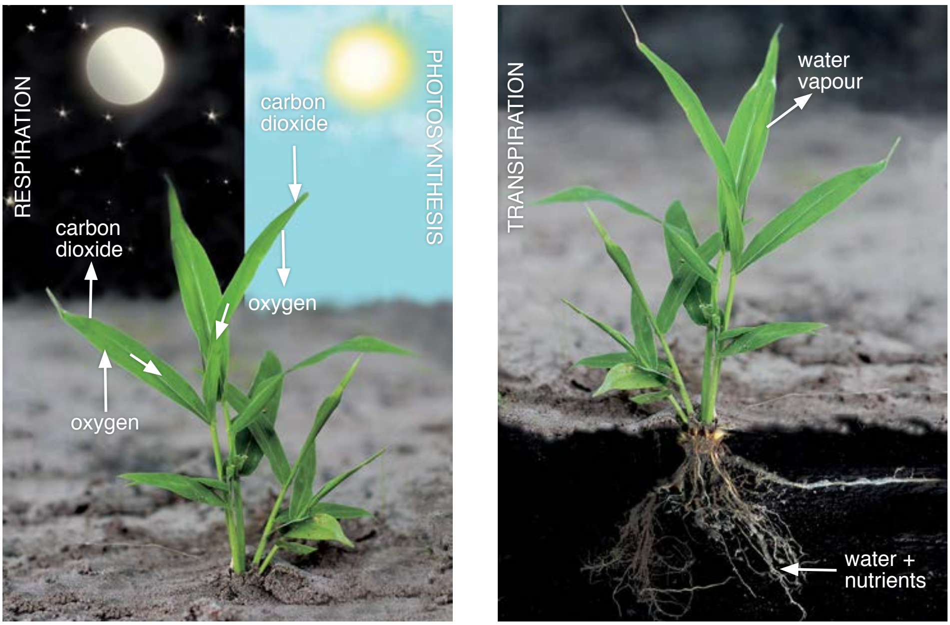
Sunlight, oxygen, carbon dioxide, water and nutrients are necessary to maintain a healthy grass cover, as these components are essential for life-giving processes such as photosynthesis, respiration, transpiration and the translocation or storage of nutrients to take place.

During photosynthesis plants manufacture energy; they absorb carbon dioxide from the atmosphere via stomata (small pores) that occur on the leaves. It dissolves in the cell sap and diffuses into the chloroplasts, which are cells containing green chlorophyll pigments. Chlorophyll is the only organic substance that can absorb sunlight and convert carbon dioxide into chemical energy. For this reason, only green plants can photosynthesise. It is here, in the chloroplasts, that carbon dioxide combines with water to form glucose and oxygen. The oxygen, a by-product of glucose formation, escapes via the stomata, while the glucose supplies the basic material for building more complex carbohydrates such as cellulose and starch. Photosynthesis can take place only during the day, because sunlight is vital to power the process (*photo* means 'light').

Respiration is the process of releasing energy from food. It is the reverse of photosynthesis. Where photosynthesis uses up carbon dioxide and generates oxygen, respiration uses oxygen and produces carbon dioxide. Respiration takes place in all plant tissues day and night.

Transpiration is the process whereby water and nutrients move through a plant. The root hairs absorb water and soil nutrients, which are taken to the rest of the plant via vascular tissue called xylem. The water then diffuses into the plant cells and is used in photosynthesis and respiration. Water vapour then escapes via the stomata.

Translocation is the transfer of nutrients to the roots and rhizomes. It takes place in perennial grasses after flowering, when the grass starts drying out. This ensures that there will be sufficient reserves for the following growing season. Translocation does not occur in annuals since they reproduce by means of seeds. This mechanism also enables grass to survive burning, as the nutrients are stored safely underground and the tillers are protected at the base of the plant by a collection of basal sheaths, enabling the plants to resprout after a fire.



Respiration (release of energy) takes places day and night, but photosynthesis (production of energy) occurs only in sunlight. During transpiration, excess water is lost via the stomata.

Growth forms of grasses

One method of categorising grasses is to distinguish them by their growth form, that is, by whether they grow in tufts, produce stolons or are rhizomatous (see image, page 13). 'Tufted' indicates being 'held together at the base', and is the term used to describe the most common growth form among grasses – one in which a bunch of grass is anchored by multiple roots. In this case the daughter tillers develop vertically (upright), but as each daughter tiller develops and photosynthesises, it produces enough carbohydrates to grow its own roots. This is why a tuft is easily separated into individual units. Strongly tufted grasses have fairly deep and robust root systems, are not easily pulled out and are usually perennial, while weakly tufted grasses are easily dislodged and are usually annuals.

In stoloniferous grasses some tillers develop laterally and form horizontal stems *above the ground*. Roots form at nodes along each culm, and shoots are sent out to develop into new, independent, reproductive plants.

Rhizomatous is the term for a growth form in which tillers grow out laterally from the parent plant to form *underground* horizontal stems. Because they are stems, not roots, they retain their nodes with tiller buds, each bud being able to form shoots and roots of its own. Only some develop; others remain dormant or die. These underground stems are whitish in colour and their leaves are reduced to membranous scales. Rhizomes are a rich source of protein and other nutrients.

A tuft is easily separated into individual units.

Digestibility, palatability and nutritive value of grasses

The anatomical, structural and chemical features of grasses affect their digestibility, palatability and even nutritive value, and often reflect various adaptations for deterring herbivores.

DIGESTIBILITY OF GRASSES

Digestibility is determined both by the structure of a grass and by its chemical content. Structural carbohydrates, such as cellulose and lignin, make grasses difficult to digest, but herbivores have evolved to overcome this problem. The chemical substances that have the greatest impact on digestibility are tannins. Woody plants contain more tannins than grasses do. Kalahari sour grass (*Schmidtia kalahariense*) is a good example of a species that contains high levels of tannins; although it is high in protein, it is totally ignored by most grazers on this account. Plant tannins have long been used to cure animal skins so that they become leathery and will not rot. Tannins function in much the same way in an animal's digestive system as they do in the tanning process. During tanning, tannins combine with the proteins in the animal's skin, stabilising them and preventing them from decomposing. In the digestive system, tannins combine with protein molecules, rendering them unavailable as metabolic energy. Additionally, the tannins react with those micro-organisms in the rumen (the first part of the stomach in a ruminant) that are necessary for efficient digestion.

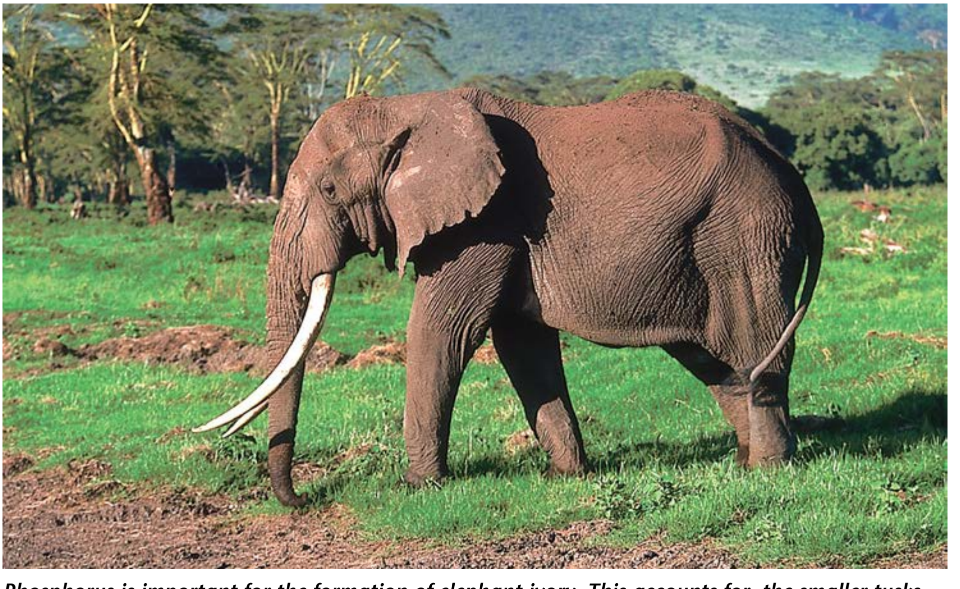
PALATABILITY OF GRASSES

Grasses have evolved various mechanisms to deter herbivores: they may be tough, have hairs or burs, or exude unpleasant substances or volatile oils, any of which would impact on their palatability. High levels of structural carbohydrates, such as cellulose and lignin, make a grass not only more fibrous and difficult to digest, but also less pleasant to eat – however nutritious it may be. An example of an unpalatable species with a high nutritive value is turpentine grass (*Cymbopogon excavatus*), which is distasteful, because, despite its very high protein level (about 8.5%), it contains a high percentage of aromatic oils and smells strongly of turpentine, and because it becomes tougher with age. Research with cattle has shown that the tastiest, most desirable grasses are less fibrous, and are relatively high in protein, non-structural carbohydrates (sugars and starch), unsaturated fats, phosphate and potassium.

NUTRITIVE VALUE OF GRASSES

Whether or not a grass is nourishing depends on its content of minerals, crude protein, non-structural and structural carbohydrates:

- The *minerals* that contribute most to the nutritive value of grasses are calcium and phosphorus, which are necessary for the formation of bones, teeth and horns and for the ossification of the skeleton. Phosphorus is a vital element in plant growth and a lack thereof in plants prevents other important nutrients, such as soil nitrogen, from being acquired. When plants ripen and dry, the phosphorus is translocated to the roots and, in sourveld areas particularly, the aerial portions may lose up to nine-tenths of this element. Under normal circumstances this factor does not impact negatively on animals as they take in enough phosphorus during summer. However, in severely phosphorus-deficient areas animals



Phosphorus is important for the formation of elephant ivory. This accounts for the smaller tusks of elephants in phosphorus-deficient areas, like Botswana. The soils of the Ngorongoro Crater, Tanzania, by contrast, are very high in minerals (derived from volcanic ash). Ngorongoro elephants like this one therefore have exceptionally large tusks.

Grasses that grow under pod-bearing trees like acacias often have a higher protein content.

can develop bone softening and, as a consequence, the bones become enlarged. In livestock this condition is known as 'stiff-sickness'. A typical symptom of the deficiency is that mammals will chew foreign bodies, especially bones. This bone hunger is known as 'osteophagia' or 'pica'. An unfortunate consequence of osteophagia is that animals sometimes chew bones that are infected by the *Clostridium botulinum* bacterium. Ingesting the toxins produced by this bacterium can cause complete paralysis of all muscles – a disease known as 'botulism'. Therefore stiff-sickness and botulism often occur together in phosphorus-deficient areas.

- Crude *protein* values of 8–12% are considered very high for grasses. A value of 5–8% protein is fair to good, but anything below 5% is low. Protein levels often decline dramatically in the dry season but levels of 4–5% are still acceptable. In arid areas some animals have evolved a physiological defence against low protein values – they recycle the urea in their urine to extract the maximum amount of nitrogen (which is found in amino acids, the building blocks of proteins). Drought-stressed plants have a lower protein content than usual. This is especially true of grasses, which means that grazing animals are affected long before those animals that take browse from woody species. Protein deficiencies lead to a loss of condition, and may cause pregnant females to deliver underdeveloped or stillborn young. Those grasses that grow under pod-bearing trees like acacias often have a higher protein content, because nitrogen is returned to the soil as the tree's fallen leaves and fruit decompose, benefiting the grasses that grow beneath them. Buffalo grass (*Panicum maximum*), which is very high in protein, often grows under large acacia trees and capitalises on the extra nitrogen.

A sign of phosphorus deficiency is bone hunger, known as 'osteophagia' or 'pica'.

- Structural carbohydrates in grasses, such as cellulose and lignin, help give the grass its structure. Although some lignin is digested, most of it is returned to the soil via faeces. Cellulose, however, can be broken down in a herbivore's digestive tract by micro-organisms that produce fatty acids, which fulfil the animal's fat requirements.
- Non-structural carbohydrates, such as glucose, fructose, sucrose and starch, are essential for the production of energy. A deficiency in these carbohydrates will lead to loss of condition in grazers.

Differences between annuals and perennials

The main difference between annuals and perennials is that perennials store their nutrients in their roots during the dry season and have a life cycle of two years or more. Annuals can only reproduce by seed and have a life cycle of a year or less. They therefore do not need to store their nutrients and can use all of them for growth and to produce seeds. Perennials are almost always far more desirable than annuals for fodder. The exceptions are the thatching grasses (*Hyperthelia* spp., *Hyparrhenia* spp. and *Cymbopogon* spp.), which are all perennials, but become hard and unpalatable with age. Many annuals are eagerly grazed while still green, for example, giant crowfoot (*Dactyloctenium giganteum*) and jungle rice (*Echinochloa colona*). Severe and continuous grazing pressure on perennial grasses will inhibit photosynthesis, thus preventing carbohydrates from accumulating. This will limit new root development and eventually cause perennials to succumb and make way for less desirable annuals. This dynamic is known as 'retrogressive plant succession'.

SUMMARY OF KEY DIFFERENCES BETWEEN PERENNIALS AND ANNUALS

Perennial grasses	Annual grasses
Life cycle lasts two years or more. Do not die after flowering; nutrients are translocated to the roots.	**Life cycle** lasts a year or less. Die directly after flowering; nutrients are not translocated to the roots.
Rapid regrowth follows first rains, drawing on nutrients stored in roots. New roots replace portions of old root system each year, using up some mineral and carbohydrate stores.	**Slow regrowth** follows first rains, as dormant seeds must first germinate. Thrive with good rains. Like cereal crops, may not germinate in drought conditions.
Nutritional value and palatability preserved throughout growth cycle, except in sourveld where grasses become tough and wiry.	**Nutritional value and palatability decline** after flowering, when grasses become dry and die.
Strong root systems, often strongly tufted and/or with stolons, rhizomes, or both.	**Weak root systems,** usually loosely tufted, without strong secondary roots.
Robust, providing good ground cover and a high yield.	**Less robust**, providing poor ground cover and, usually, a low leaf yield.
Ground coverage provides soil protection, promotes water infiltration and limits erosion.	**Poor ground coverage** provides limited soil protection. Loosely tufted annual grasses dislodge easily, leaving bare patches, which promotes rainwater runoff, loss of nutrients and soil erosion.
Climax or sub-climax species. (See 'Stages of succession', p.20.)	**Pioneer** species, by and large. (See 'Stages of succession', p.20.)
Decreasers; usually replaced by annuals when veld deteriorates because of overgrazing and trampling.	**Increasers**; usually replace perennials when veld deteriorates because of overgrazing and trampling.

Plant succession and successional status

Vegetation communities are dynamic: they change continuously in response to external factors such as climate change, grazing pressure, changes in the availability of groundwater, erosion, drought and fire. Undisturbed plant communities are inclined to return to a state of balance; in other words, there is a gradual process of evolution in the species structure at a site, known as 'plant succession'. *Progressive succession* describes the gradual replacement of annuals with perennials, thereby improving pasture. *Retrogressive succession* describes the gradual replacement of perennials with annuals, thereby causing pasture to deteriorate.

STAGES OF SUCCESSION

There are three recognised stages of succession in plant growth, namely the pioneer, intermediate or sub-climax and climax stages.

Pioneer stage: Pioneers are the first species to occupy disturbed areas such as patches of bare soil, heavily eroded roadsides and damaged agricultural lands. Grass pioneers are specially adapted for tough environments. For example, the seeds of *Aristida* spp. are capable of spiralling down into hard soil. Pioneer grasses are vital for stabilising soil.

Most pioneer species are annuals and are not preferred food species. Many are only loosely tufted with relatively small root systems and die after flowering, but their importance should not be underestimated. Their presence protects the topsoil and impedes the runoff of rainwater that would otherwise cause erosion. Other than binding the soil, they also provide shade so that less hardy species can germinate, and enrich the soil when they decompose – all of which prepares the area for the next successional stage. Although couch grass (*Cynodon dactylon*) is usually a climax grass, it can also be a pioneer and is of tremendous value in binding the soil, because its rhizomes and stolons are aggressive. Most pioneer species are grazed while still developing, but others are eagerly grazed even when mature, such as giant crowfoot (*Dactyloctenium giganteum*), common crowfoot (*D. aegyptium*),

Although couch grass is usually a climax grass, it can also be a pioneer and is of tremendous value in binding the soil, because its rhizomes and stolons are aggressive.

Domestic grazing stock (like the donkeys shown here) often cause overgrazing, because they select the sweetest, most palatable grasses. If the grassland is not afforded the opportunity to recover, the veld will remain in the pioneer stage of succession.

goose grass (*Eleusine coracana*), jungle rice (*Echinochloa colona*), couch grass (*Cynodon dactylon*) and common nine-awned grass (*Enneapogon cenchroides*). The grazers that they attract enrich the soil further with their urine and faeces.

Sub-climax stage: As the soil is stabilised and the plant cover increases, annual grass species make way for perennials, which have a more stable production capacity than the plants that characterise the pioneer stage. Most sub-climax species are perennials (living longer than one year), form strong tufts and many have stolons and rhizomes. As perennials continue to form new tillers after flowering, they keep forming leaves, continue producing carbohydrates by photosynthesis and thus offer more grazing. The more desirable plants attract more grazers whose urine, faeces and hoof action improve the production capacity of the area. At this critical stage grazing should be light, because overgrazing will lead to retrogressive succession, allowing annuals to take over. If the plants are left undisturbed, the sub-climax stage is followed by the climax stage. Under moderate grazing pressure and favourable climatic conditions, the sub-climax stage often provides much better grazing than the climax stage.

Climax stage: If the conditions are good and grazing pressure is kept to a minimum, the intermediate or sub-climax stage will develop into the climax stage – a phase of development that is in complete equilibrium with the environment. The vegetation is now stabilised until such time as overgrazing, fire, drought or a major flood disturbs it again.

Sweetveld in the climax phase; the dominant grass here is finger grass (**Digitaria eriantha*****). The climax stage is reached when grazing pressure is mild and the grasslands have enough time to recover from grazing.***

In sweetveld, most climax grasses are very nutritious. However, climax grasses are not always the most desirable for grazing. In sourveld, for instance, which occurs in areas of higher rainfall, thatching grasses such as *Hyparrhenia* and *Hyperthelia* spp. often represent the climax stage. Because these grasses are unpalatable when mature, it is advisable to keep sourveld in its sub-climax stage, which is the stage in which red grass (*Themeda triandra*), an excellent grazing species, flourishes. Pasture can be maintained in the sub-climax stage by careful manipulation of grazing pressure.

Ecological status: decreasers and increasers

The intensity of grazing has a dramatic effect on grasses. Too much grazing pressure (overgrazing) can be detrimental to the grassland, but too little grazing pressure (undergrazing) or selective grazing – the selection of only the sweetest, most palatable grasses – can be equally detrimental. Grasses may be categorised according to their ecological status, that is, by how they respond to grazing. The grasses with the highest ecological status are more desirable species, and are known as 'decreasers'. These species predominate in healthy, stable grasslands, but steadily decrease with over-, under- or selective grazing. As the desirable grasses decrease, the less desirable 'increasers' replace them. These two groups are further subdivided as follows.

ECOLOGICAL STATUS: DECREASERS AND INCREASERS	
Decreasers	• Abundant in veld that is stable and in good condition. • Decrease when the veld deteriorates because of overgrazing, trampling, uncontrolled burning, selective grazing, encroachment or soil erosion. • Typically have a high fodder value (nutritious and palatable). • Comprise mainly climax and some sub-climax grasses.
Increasers I	• Present in stable, undergrazed grasslands. • Tend to take over where neither fire nor grazing inhibit them. • Comprise climax grasses and can thrive without any defoliation (not necessarily desirable for grazers, especially in high-rainfall areas, where the grasses become unpalatable and thatch-like when mature).
Increasers II	• Increase in overgrazed veld. • Generally undesirable, although there are some exceptions that, with careful management, can contribute to the grazing value of the grassland. **Can be further divided into grasses:** • grasses that increase in *lightly overgrazed* areas – these mostly palatable, perennial, sub-climax grasses can contribute to the fodder value of grassland, provided there is no further deterioration. • grasses that increase in *severely overgrazed* areas – these mostly annual, pioneer grasses are suggestive of severe disturbance, although they are mostly palatable when young; best management practice is to remove all grazers and allow these pioneers to make way for more desirable species.
Increasers III	• Thrive in overgrazed and selectively grazed veld but, unlike the sub-climax and pioneer grasses described above, are unpalatable, hardy, dense climax grasses and are very difficult to eradicate. • Are virtually ignored by grazers and can therefore complete their life cycle; if grazers are forced to feed on them late in the season, defoliation stimulates daughter tillers to develop new shoots and roots, thereby exacerbating the problem. • Best practice is to remove them manually (labour-intensive) or to leave them ungrazed until they 'smother' themselves when the dense tufts do not allow light to penetrate, which inhibits germination.

CHAPTER 2 Identifying grasses

The grasses in this chapter are listed in alphabetical order, based on their scientific names.

The best time to identify an unknown grass is when it is flowering. Compare its inflorescence with those shown in the quick reference table that follows, and try to determine into which group it falls. Is it an open panicle, a contracted panicle, a spike (or raceme), a digitate or subdigitate inflorescence or a false panicle?

For the beginner, the following are useful tips for identifying some of the common genera:

1. *Aristida* spp. have one thing in common: their spikelets all have three awns.
2. *Stipagrostis* spp. also have three awns, but at least one of them is feathered.
3. *Eragrostis* spp. can be recognised by their overlapping, many-flowered spikelets.
4. Another group that is easy to recognise is *Sporobolus*. These grasses resemble *Eragrostis* spp. but do not have overlapping spikelets. They always have single seeds.
5. *Chloris* spp. are usually digitate (like the fingers on a hand).
6. *Urochloa* spp. have subdigitate secondary branches, which are spaced along the central axis and form a more or less 90-degree angle with the primary axis.
7. *Pogonarthria* spp. also have subdigitate secondary branches, but they curve upwards and are tapered at the ends, like a fish skeleton.

Each account is accompanied by photographs of the plant and its inflorescence. Identification sketches are also provided, including illustrations of the spikelet and of the ligule (which is where the leaf blade and leaf sheath meet) – if it is an identifying feature.

IOL / NIGEL J. DENNIS

Springbok favour short grasses

Quick reference

OPEN AND SLIGHTLY CONTRACTED PANICLES

Annual three-awn
Aristida adscensionis
p.36

Tassel three-awn
Aristida congesta
subsp. **congesta** *p.38*

Gongoni three-awn
Aristida junciformis
p.40

Coppery three-awn
Aristida meridionalis
p.42

Rough three-awn
Aristida rhiniochloa
p.44

Purple three-awn
Aristida scabrivalvis
subsp. **contracta** *p.46*

Long-awned three-awn **Aristida stipitata**
subsp. **stipitata** *p.48*

Purple plume grass
Bothriochloa bladhii
p.50

Gha grass
Centropodia glauca
p.60

Swamp grass
Diplachne fusca
p.86

Common nine-awned grass **Enneapogon cenchroides** *p.94*

Eight-day grass
Enneapogon desvauxii *p.96*

Bottlebrush grass
Enneapogon scoparius *p.98*

Rough love grass
Eragrostis aspera
p.102

Shade love grass
Eragrostis biflora
p.104

Stink love grass
Eragrostis cilianensis
p.106

Weeping love grass
Eragrostis curvula
p.108

Tick grass Eragrostis echinochloidea
p.110

Gum grass
Eragrostis gummiflua
p.112

Tite grass
Eragrostis inamoena
p.114

Mauve love grass
Eragrostis lappula
p.116

Lehmann's love grass
Eragrostis lehmanniana *var.* lehmanniana *p.118*

Wether love grass
Eragrostis nindensis
p.120

Broom love grass
Eragrostis pallens
p.122

Broad curly leaf
Eragrostis rigidior
p.124

Vlei plume grass
Eragrostis rotifer
p.126

Saw-toothed love grass
Eragrostis superba
p.128

Hairy love grass
Eragrostis trichophora *p.130*

Sticky love grass
Eragrostis viscosa
p.132

Cottonwool grass
Imperata cylindrica
p.144

Rice grass
Leersia hexandra
p.148

Natal red top
Melinis repens
p.150

Pampas grass
Miscanthus junceus
p.152

Brack-quecke
Odyssea paucinervis
p.154

Wild rice
Oryza longistaminata
p.156

Small buffalo grass
Panicum coloratum
p.158

Buffalo grass
Panicum maximum
p.160

Couch panicum
Panicum repens
p.162

Common reed
Phragmites australis
p.166

Kalahari sour grass
Schmidtia kalahariensis *p.176*

Kalahari sand quick
Schmidtia pappophoroides *p.178*

Arrow grass
Setaria sagittifolia
p.180

Bur bristle grass
Setaria verticillata
p.184

Fries grass
Sorghastrum friesii
p.186

Wild sorghum
Sorghum bicolor
p.188

Red dropseed
Sporobolus festivus
p.190

Bushveld dropseed
Sporobolus fimbriatus *p.192*

Pan dropseed
Sporobolus ioclados
p.194

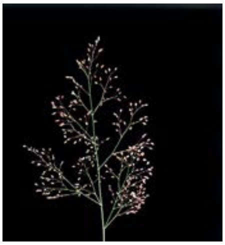
Catstail dropseed
Sporobolus pyramidalis *p.196*

Tall bushman grass
Stipagrostis ciliata *var.* **capensis** *p.200*

Blue bushman grass
Stipagrostis hirtigluma *subsp.* **patula** *p.202*

Small bushman grass
Stipagrostis obtusa
p.204

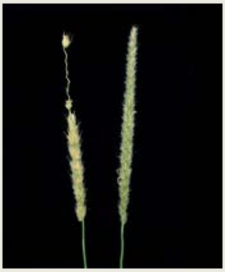
Silky bushman grass
Stipagrostis uniplumis var. ***uniplumis*** ***p.208***



Blue-seed grass
Tricholaena monachme ***p.216***

Small rolling grass
Trichoneura grandiglumis ***p.218***

SPIKES (OR RACEMES)



Wool grass
Anthephora pubescens ***p.34***

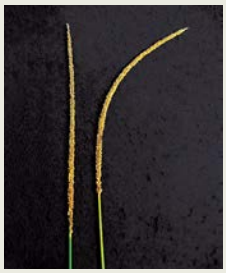
Blue buffalo grass
Cenchrus ciliaris
p.58

Wire grass
Elionurus muticus
p.92

Needlegrass / Mopane grass
Enteropogon macrostachyus ***p.100***

Thimble grass
Fingerhuthia africana
p.134

Catstail grass / Bottlebrush
Perotis patens ***p.164***



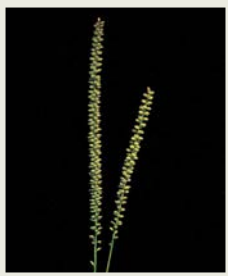
Purple hood grass
Sacciolepus typhura
p.172

Silky autumn grass
Schizachyrium jeffreysii
p.174

Golden bristle grass
Setaria sphacelata
p.182

Spiky dropseed
Sporobolus spicatus
p.198

Giant spear grass
Trachypogon spicatus
p.212



Carrot-seed grass
Tragus berteronianus
p.214

DIGITATE (FINGER-LIKE) AND SUBDIGITATE ('RAILWAY SIGN' OR 'FISHBONE) PANICLES

Pinhole grass
Bothriochloa insculpta *p.52*

False signal grass
Brachiaria deflexa *p.54*

Spotted signal grass
Brachiaria nigropedata *p.56*

Rhodes grass
Chloris gayana *p.62*

Spiderweb chloris
Chloris pycnothrix *p.64*

Plume chloris
Chloris roxburghiana *p.66*

Feather-top chloris / Old land grass
Chloris virgata *p.68*

Couch grass
Cynodon dactylon *p.74*

LM grass / Natal crowfoot
Dactyloctenium australe *p.77*

Giant crowfoot
Dactyloctenium giganteum *p.78*

Vlei finger grass / blue grama **Dicanthium annulatum var. *papillosum*** *p.80*

Common finger grass
Digitaria eriantha *p.82*

Broad-leaved bluestem
Diheteropogon amplectens *p.84*

Jungle rice
Echinochloa colona *p.88*

Goose grass
Eleusine coracana subsp. *africana* *p.90*

Turf grass
Ischaemum afrum *p.146*

Small herringbone grass Pogonarthria fleckii *p.168*

Herringbone grass Pogonarthria squarrosa *p.170*

Bushveld signal grass Urochloa mosambicensis *p.220*

Hairy signal grass *Urochloa trichopus* *p.222*

Hippo grass Vossia cuspidata *p.224*

FALSE PANICLES (MAINLY THATCHING GRASSES)

Snowflake grass Andropogon eucomus *p.30*

Blue grass Andropogon gayanus *p.32*

Broad-leaved turpentine grass Cymbopogon excavatus *p.70*

Bitter turpentine grasss Cymbopogon plurinodis *p.72*

Spear grass Heteropogon contortus *p.136*

Common thatching grass Hyparrhenia hirta *p.138*

Yellow-spike thatching grass Hyparrhenia rufa *p.140*

Yellow thatching grass Hyperthelia dissoluta *p.142*

Red grass / Red oat grass Themeda triandra *p.210*