MEAT & LIVESTOCK AUSTRALIA

Grazing land management

Sustainable and productive natural resource management

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Contents

A Quick Quiz to start you thinking

Ask yourself: Do I understand the basic principles of grazing land management, or are there things I could be doing better? Here are a few questions to test your knowledge. Answer 'yes' or 'no' to each of the options in questions 1 to 5, and answer 'true' or 'false' to question 6. Answers are on the last page.

1. **Forage budgeting is:**
   a. buying and selling lucerne hay.
   b. balancing the amount of forage on offer against the forage demand.
   c. setting aside money to buy drought fodder.

2. **Patch grazing can be reduced using the following tools:**
   a. burning every 1–4 years.
   b. spelling paddocks.
   c. fencing-off overgrazed areas.
   d. heavy continuous stocking.

3. **Fire encourages desirable plant species by:**
   a. reducing the competitive advantage of undesirable species e.g. wire grass
   b. encouraging some desirable species e.g. black speargrass.
   c. reducing weed species e.g. rubber vine.

4. **Rundown in improved pastures can be halted by:**
   a. burning to promote nitrogen cycling.
   b. stocking during the summer growing season.
   c. sowing legumes to increase soil nitrogen.

5. **Trees in a pasture have the following effect:**
   a. grass yield declines closer to trees.
   b. total nitrogen is higher in the soil near trees.
   c. soil compaction is higher near trees.

6. **Leaving weeds until they are well established is the most cost-effective way to handle them.**
   a. True, or
   b. False?

Do I need to read this book?

One of the key activities of Meat and Livestock Australia (MLA) is to ensure that beef producers are able to access and implement the latest research results and management recommendations for their enterprise. A basic understanding of 'why' and 'how' things happen is fundamental to adoption of any new technology.

Northern graziers have identified a need for better grazing land management information, and this booklet has been written with this in mind. Leading researchers and extension officers in various specialty fields have developed a series of educational workshops and comprehensive training manuals, combined into a package called the *EDGEnetwork*. Much of the information contained in this booklet is extracted from the Grazing Land Management (GLM) manual, which was specifically designed to introduce producers to the principles and concepts that apply to the grazing lands of northern Australia.

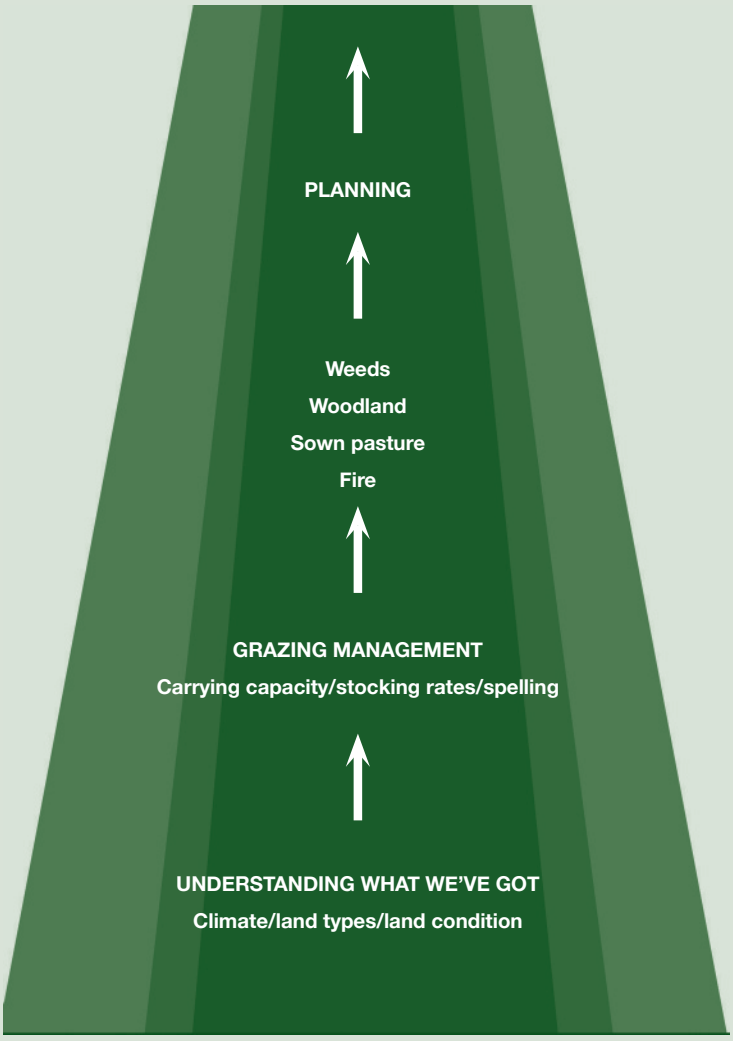
Planning is important for businesses and individuals; it provides a clearer focus on the goals and outcomes and enables recognition of achievements. This booklet encourages producers to consider the information presented in terms of their own overall businesses or property objectives.

It is the hope that those reading this booklet will emerge better informed on how to manage their enterprises. Furthermore, may it encourage enthusiastic operators to participate in an EDGE*network* *Grazing Land Management* workshop. There they will gain a more comprehensive knowledge of the tools available to manage land condition, improve the level and evenness of use and enhance diet quality.

Introduction

The philosophy behind this booklet is to help producers meet their objectives in grazing land management (see Figure 1). It provides a simple roadmap necessary to understand and implement sustainable and productive grazing land management. Much of the approach outlined relates to the *Gateways Model*, a framework of three gateways (Figure 2) that embodies the key points and principles of grazing land management (GLM). These are the land condition gateway, the evenness of grazing gateway, and the diet quality gateway. Each gateway contributes to sustainable livestock production from grazing lands.

Figure 1. The GLM roadmap



This booklet provides an introduction to the grazing land ecosystem then outlines a section on climate and the relationship between rainfall and pasture growth.

Sections on different land types and grass growth are followed by a comprehensive assessment of land condition in an introduction to the 'ABCD' framework and definitions of pasture stability and resilience.

The next subjects are energy flow, nutrient cycling and water cycling. The effect of land condition on finances is discussed, and the topic concludes with sections on monitoring land condition and conserving native plants and animals.

This leads onto grazing management, which begins with the timely maxim that improving land condition is about managing grazing. The discussion covers safe utilisation rate, phases of pasture growth, improving diet quality and forage demand.

Next there is a study of long- and short-term carrying capacities. Then a section on evenness of grazing looks at managing distance to water, examines patch grazing, and outlines some grazing management strategies.

The concepts and practices of using fire as a tool in grazing management are examined. This includes prescribed burning—effective planning to ensure implementation of the right fire regimes. The subject of sown pastures is then addressed, asking 'What is the role for sown pastures?' and examines such factors as the 'rundown' phenomenon and how to bring it to a halt. Next some guidelines are laid out for choosing the most desirable pasture species for individual situations. There are also some considerations about management requirements and financial implications of sown pastures.

The next topic, managing tree–grass balance, begins by examining why tree–grass balance is important then leads into what controls the balance of trees and grass and how trees affect pasture. It then looks at how tree–grass balance can maintain or improve land condition, and includes some financial considerations of woodland management.

Weed management is vital for good pasture. The final topic encompasses weeds and land condition, what weeds to look out for, the life cycle of weeds and the key to controlling them. It covers an introduction to developing a weed management plan, including the six principles of weed management.

The Gateways Model

The Gateways Model organises information around three gateways, each of which leads to sustainable livestock production from grazing lands. They are:

1. ***The land condition gateway***—the conversion of rainfall into useful pastures (this is known as rainfall use efficiency)
2. ***The evenness of grazing gateway***—the consumption of pastures by cattle (known as the utilisation rate)
3. ***The diet quality gateway***—the conversion of pasture to beef (known as conversion efficiency)

Central theme: Managing utilisation rate is a major part of grazing land management

Utilisation rate has a direct impact on both land condition and diet quality gateways. Thus grazing land management should focus on:

- improving land condition
- improving evenness of use
- improving diet quality.

Additionally, grazing practices can contribute positively to the environmental status of the catchment and region. There are tools available to manage land condition—they improve the evenness of use and enhance diet quality. These tools are:

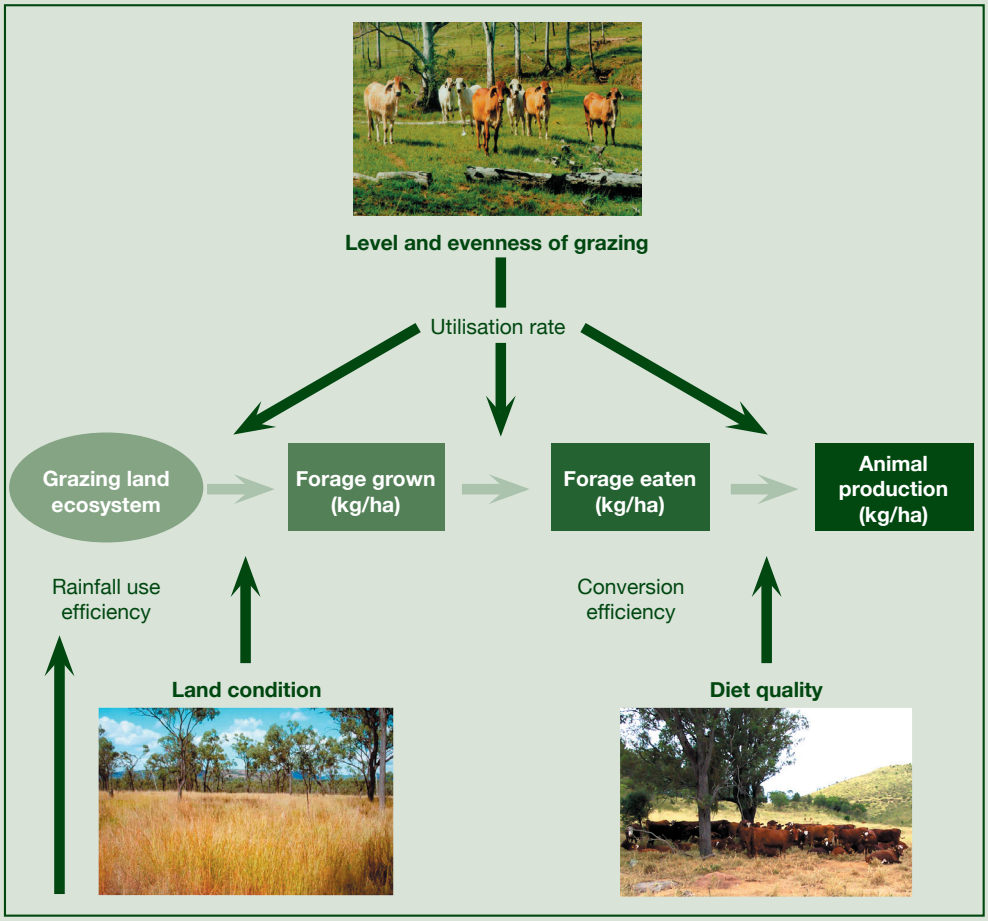
- managing grazing
- using fire
- managing tree–grass balance
- using sown pastures
- managing weeds.

Understanding the grazing ecosystem

Ecosystems are communities of organisms (microbes, plants and animals) and their environment. Understanding the grazing ecosystem (Figure 2) requires an understanding of the important components, in particular:

- climate—with a focus on the amount and distribution of rainfall
- land types—the combination of soils and vegetation
- land condition—how well the land type is functioning.

Figure 2. The grazing land ecosystem, showing also the interaction of the three Gateways



Grazing land ecosystems provide important functions (nutrient cycling and energy flow) that keep ecosystems ticking over. These functions are like the fuel and cooling systems of an engine. If they fail then the ecosystem fails, and the productivity of the ecosystem and the number and variety of organisms will all decline. A land type (or grazing land type) is a discrete type of grazing land—an area of grazing land with a characteristic pattern of soil and vegetation. Land types should be viewed as ecosystems under management.

Climate

The interaction between soils, plants, and animals on grazing lands is influenced strongly by climate. For every property, the amount of rainfall varies year to year, and consequently the amount of pasture grown and the risk of overgrazing vary. Appreciating that the amount of rain that falls in a season varies a lot (and has done over the past 100 years) gives a broader perspective of climate and encourages a more deliberate approach to managing for variation.

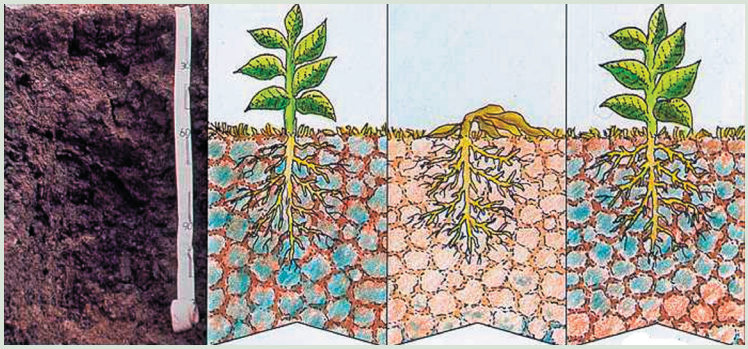
A study of the relationship between rainfall and pasture growth is aided by the application of a grass growth calculator, GRASP (the GRASs Production model). This model is built around the relationships between rainfall, nitrogen, temperature and grass growth. It enables prediction of grass growth for different land types, as well as from a retrospective examination of the history of pasture growth. This is helpful in terms of determining the optimal number of animals that can be carried over the longer term, essential for any form of business planning. It is essential for the producer to know how to estimate long-term carrying capacity and identify opportunities to improve it.

Land types

The knowledge gained about climate is useful in progressing to a study of land type, which, as already mentioned, is regarded as an ecosystem and is defined as *an area of grazing land with a characteristic pattern of soil and vegetation*. So in this context graziers are regarded as ecosystem managers. Grazing lands are linkages of land types, all of which have different capacities to grow grass.

There are two key characteristics that control a soil's ability to grow pasture—its moisture-holding capacity and its ability to hold nitrogen (Figures 3 and 4). The soil type and its condition are major drivers of pasture and animal production. Many of the benefits of improved grazing land management are due to the effects of soil characteristics.

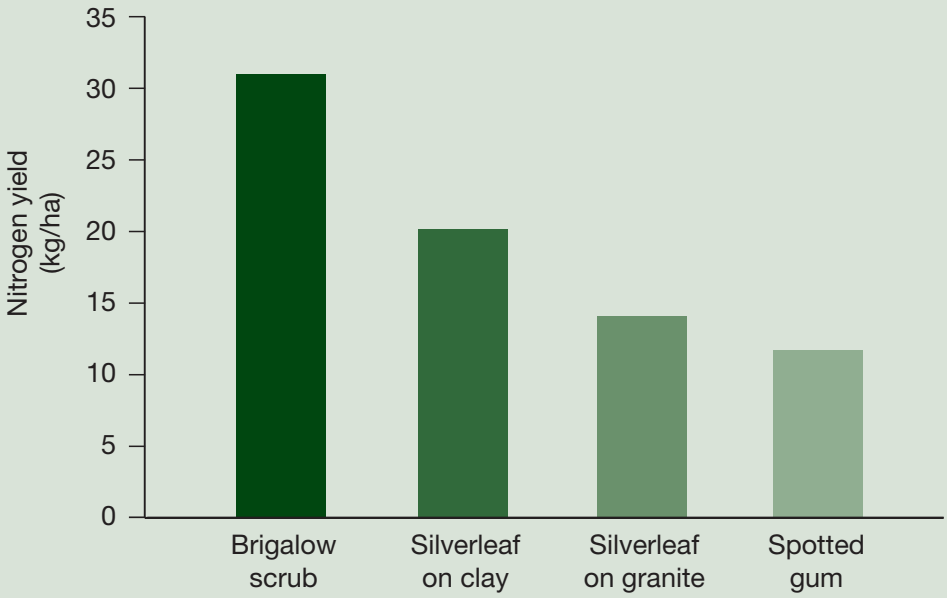
Figure 3. Ability of different soils to store plant-available water (mm water to 1 metre of soil)



Soil texture	Field capacity	Permanent wilting point	Plant available water content
Well-structured clay	500	300	200
Clay	380	240	140
Loam	340	120	220
Sandy loam	230	90	140
Sand	90	20	70

Source: DPI (1992) Understanding Soil Ecosystem Relationships

Figure 4. Nitrogen yield on different land types



Land condition

This is the next factor to consider. Grazing land condition is defined as the capacity of land to respond to rain and produce useful forage, and is a measure of how well the grazing ecosystem is functioning. It has three components:

- soil condition—the capacity of the soil to absorb and store rainfall, to store and cycle nutrients, to provide habitat for seed germination and plant growth, and to resist erosion;
- pasture condition—the capacity of the pasture to capture solar energy and produce palatable green leaf, to use rainfall efficiently, to conserve soil condition and to cycle nutrients;
- woodland condition—the capacity of the woodland to grow pasture, to cycle nutrients and to regulate ground water.

Degradation, the loss of land condition, is discussed in terms of capacity for rehabilitation by management changes, and the time scales and expense involved. The *ABCD framework* can be used to classify land condition, aid in adjusting pasture growth estimates and for providing management options. The terms A, B, C and D (see photos A–D below) describe progressive deterioration of land condition.

'A' condition

'B' condition

'C' condition

'D' condition

Photos A–D exemplify the four stages of progressive land deterioration.

In this context land condition is related to stability—a grazing land's ability to persist and retain or recover function following disturbances such as drought, wildfire, overgrazing, or infestation by pests or disease. Stability is enhanced by improving land condition (not pushing land so hard that

it passes a threshold that constitutes a point of no return) and promoting diversity in vegetation

Maintaining a high density of perennial grasses is the key to good land condition. The GLM Edge course looks at how to encourage grasses that meet the 3P criteria—perennial, palatable and productive—and maintain soil organic matter, thereby stimulating soil organisms and promoting soil structure.

A study of different grasses reveals that they respond in different ways to grazing. It is possible to classify grasses as either *decreasers* (grasses that tend to decline under persistent grazing) or *increasers* (grasses that tend to increase under persistent grazing). Although most 3P grasses are decreasers, there are ways that they can be maintained in pastures through careful grazing management.

Monitoring land condition

Regular monitoring can be used to determine the condition of a grazing ecosystem over time. Many signs of land condition can be noted during normal property operations such as mustering and water runs. Important observations are the abundance of various pasture plants, the amount of ground cover, the presence of weeds, the amount of woody plant regrowth, the health of trees, the condition of the soil, and signs of erosion.

Managers are encouraged to start a diary of observations. Those who take part in the GLM will learn to:

- identify the soils and land types of their region and properties
- allow for climate variability in planning management
- determine the land condition of their properties
- understand basic landscape processes (energy flow, water and nutrient cycling) and factors affecting land condition
- identify key plant species for their properties
- assess land condition to manage long-term productivity goals.

Grazing management

Grazing management is all about managing the numbers, type and location of animals on the property. Planning for grazing will ensure that each paddock (or land type) receives the intensity and timing of grazing that suits both the long-term and short-term cattle production and land condition goals.

Better grazing management is a combination of the following factors:

- balancing forage growth and use so that land condition is improved
- accurate assessment of pasture quality and quantity
- accurate assessment of animal demand for forage
- optimisation of water point distribution and paddock design
- management of stocking rates to reach production and land condition targets.

Lack of attention to grazing management is the cause of common problems in grazing land ecosystems, such as:

- the loss of desirable pasture plants, which are usually replaced by undesirable ones
- forage supply being out of balance with forage demand
- cattle not meeting production targets
- declining land condition
- uneven use of pasture, with some areas of paddocks grazed out and others hardly touched.

Managing utilisation is the key to improving land condition. It is about balancing how much forage is grown with how much forage is eaten. A feature of the GLM course is instruction on how to calculate the pasture utilisation level, which determines that balance. Safe utilisation rate—the average rate of pasture consumption relative to long term growth which is consistent with maintaining or encouraging good land condition—varies with land type, grazing strategy and evenness of forage use.

Grazing management can improve the diet quality gateway by:

- encouraging desirable plants—the 3P grasses
- controlling competition between animals for the high quality parts of the plant, by controlling stocking rates.

Managing short- and long-term carrying capacity

Long-term carrying capacity is the key to managing utilisation. The average number of animals that a paddock can be expected to support over a planning horizon (5–10 years) depends on:

- current mix of land types
- condition of these land types
- climate
- evenness of use by cattle
- grazing strategy or method
- goals for animal production and land condition.

Determining long-term carrying capacity entails assessment of the expected supply of pasture (dependent on land type, climate and land condition), the safe utilisation level that will maintain or improve land condition, and the amounts of pasture consumed different by animals (using AE tables–see Table 1).

Table 1. Adult equivalent (AE) ratings for different classes and weights of animals

Category	Adult equivalent rating	Average liveweight (kg)
Females		
Dry cows (>30 months)	1.00	450
Wet cows	1.35	450
Weaners (6–8 months)	0.54	200
One-year-old heifers (8–18 months)	0.68	265
Two-year-old heifers (18–30 months)	0.87	370
Males		
Weaners (6–8 months)	0.54	210
One-year-old steers (8–18 months)	0.68	275
Two-year-old steers (18–30 months)	0.93	405
2½-year-old steers (18–30 months)	1.00	450
Three-year-old bullocks (30–42 months)	1.16	545
Four-year-old bullocks (42–52 months)	1.46	630
Bulls	1.50	650+
Sheep	0.11	45
Horses	1.20	
Kangaroos	0.10	

Short-term carrying capacity differs from long-term carrying capacity, due to variation in rainfall received. It is defined in terms of the number of animals that a paddock can support for a week, a month, a season or a year, and depends on:

- available pasture
- anticipated pasture growth
- the quality of the pasture and the animal performance desired

The three broad approaches to managing variation in short-term carrying capacity are:

1. *Conservative* approach, which plans for little variation in stock numbers over time (set stocking).
2. *Opportunistic* approach, where the base number of animals changes little over time but uses temporary stocking-up to take advantage of runs of wetter years and stocking-down when conditions are poor.
3. *Trading* approach, where stock numbers are frequently adjusted (at least once per year) in line with short-term carrying capacity and in response to seasonal conditions, and takes full advantage of good seasons while protecting land condition during poor times.

All three approaches require careful monitoring of land condition, animal condition, forage supply and markets to avoid a decline in land condition that can affect profitability!

Forage budgeting is the practice of balancing the amount of forage on offer against the forage demand, in order to maintain land condition. Some useful tools are *photo standards*, which help to determine the amount of pasture in the paddock and *pasture growth tables* and *seasonal forecasting* which predict how much grass should grow next season.

The four most common reasons cattle don't evenly use a paddock—distance to water, land type preference, patch grazing and plant species preferences of cattle—require the producer's attention. Patch grazing can lead to chronic over-use or under-use of significant areas within a paddock, and in this instance the calculation of 'safe' carrying capacity for the whole paddock needs adjustment.

Patch grazing can be addressed with the following tools:

- fire—animals prefer burnt areas, and pastures burnt every 1–4 years have far less patchiness than unburnt pastures

- spell paddocks—wet-season spelling (every 3–4 years) will help over-used patches recover
- fencing-off of overgrazed land types.

Using GLM Edge methods, a producer can develop a successful system that will:

- manage utilisation effectively (carrying capacity and timing of spelling)
- reduce uneven grazing that is either wasteful or harmful
- match stocking rate to the diet quality required by the animal production targets.

Seven steps towards systematic evaluation of grazing management options

1. Analyse and make an inventory of the situation; establish the current stocking rate, land condition, grazing and water distribution, and estimated long-term carrying capacity?
2. Identify opportunities to improve land condition, evenness of use and diet quality.
3. Select those options worthy of further evaluation.
4. Assess profitability of selected options.
5. Assess affordability of more profitable options.
6. Plan implementation, including a monitoring and recording system.
7. Implement your findings.

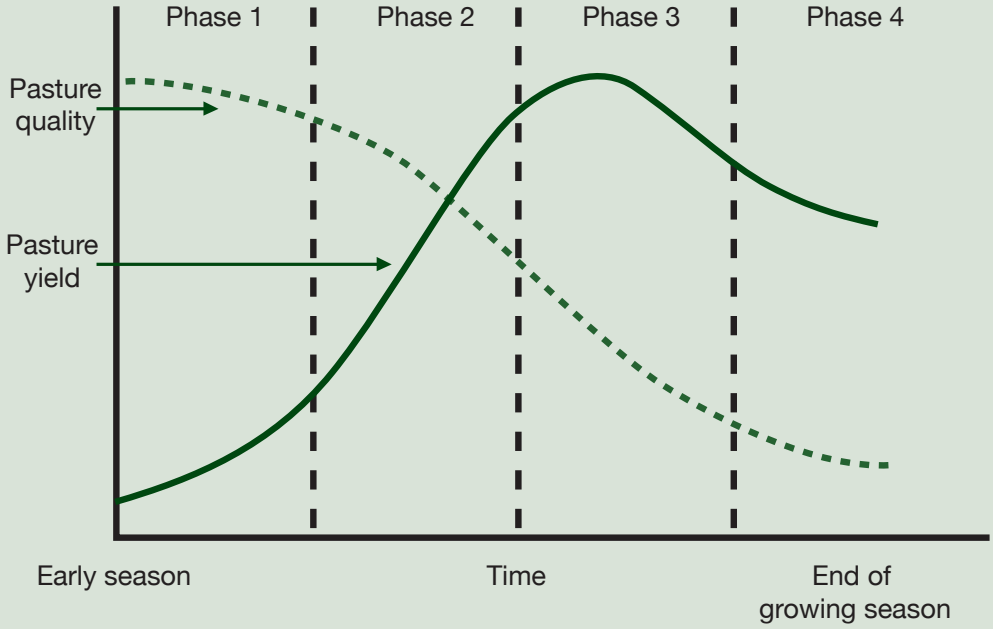
The GLM EDGE guidelines for grazing management equip producers with skills to:

- know how grazing affects pasture plants, their productivity and regrowth
- manage the balance between good land condition and production
- understand the concepts of utilisation, forage demand and their effects on diet quality
- assess long- and short-term carrying capacity
- assess pasture supply and conduct a forage budget
- know when and how to use pasture spelling
- know how to improve evenness of use
- start a personalised grazing management plan.

Fire management

The way fire is managed affects all three gateways. Fire can enhance land condition by controlling woody regrowth, promoting desirable pasture species, suppressing weeds and unpalatable species and maintaining healthy pastures. Fire can spread grazing pressure across a paddock and minimise the effects of patch grazing. Finally, the conversion efficiency gateway is affected by fire, because rank pasture (Phase 4) is removed and replaced with new pasture growth of better quality (Phases 2 and 3). Figure 5 outlines the four phases of pasture growth.

Figure 5. The four phases of pasture growth



Fire encourages desirable plant species by:

- reducing the competitive advantage of undesirable species, e.g. wiregrass
- encouraging some desirable species, e.g. black speargrass
- suppressing and reducing weed species, e.g. rubbervine and lantana
- removing moribund (Phase 4) pasture, especially in under-utilised areas.

Patch grazing is common in most pastures as animals prefer to consume fresh nutritious regrowth from previously grazed patches, rather than old rank material. However, if patch grazing persists land condition is affected, desirable species decline and bare scalds can form. Regular burning can spread grazing pressure, reducing the likelihood of overgrazed patches forming.

Significant factors:

- fire during the dry season when pasture is dormant has little impact on pastures
- perennial grass tussocks regenerate from protected buds near or below the soil surface, so are sensitive to heavy grazing immediately after being burnt.
- burning during the growing season can be harmful to some grasses
- annual grasses regenerate from seed buried and protected in the soil.

Fire and tree management

A planned burning regime can be used to manage the composition (species mix) and structure (density and height) of trees and shrubs. The aim of prescribed burning is to suppress the growth of new plants (or regrowth), and control woodland thickening. The effectiveness of using fire to manage trees and shrubs is dependent on the species present. For some woody species fire softens hard seed and stimulates germination; it can cause a population explosion of wattles while other species can be completely killed.

The frequency, timing and intensity of fires determine the effect on plants and woodland structure. Fire can be effectively used to manage the structure of resprouter tree and shrub populations that are less than 200cm high. However, if regrowth is greater than 200 cm, top-kill and subsequent regrowth control is difficult to achieve. A grass fuel load of at least 1500 kg DM/ha is needed to carry an effective fire. Fuel loads of 2000 kg DM/ha or more are recommended to suppress woody regrowth.

Is there enough grass to burn?

The optimum fire frequency for controlling tree and shrub species in regions with 500-600 mm of annual rainfall is 3–5 years. In these areas less frequent burning allows the plants to reach over 200 cm in height, making them more resistant to fire control. Many tree species, including most eucalypts, survive by resprouting from the base of the plant. Mortality of many resprouting species following burning is very low, but it is higher when plants are smaller.

Prescribed burning—getting the regime right

Prescribed burning is the deliberate ignition of vegetation and the subsequent control of fire spread to achieve a desired management objective. The fire regime describes the intensity, timing and frequency of burning.

The best timing for fires is during the dry season or in early spring following a fall of at least 25–50 mm of rainfall. To maintain good pasture composition and a good balance of trees and grass, a fire frequency of once every three to four years is adequate. It is important to burn when the prevailing seasons are favourable, i.e. it is probably best not to burn during a drought. To have the opportunity to burn, grazing pressure must be managed so there is sufficient fuel and groundcover to meet prescribed burning goals.

Planning effective fire regimes

Mapping out the following steps will give the best results:

1. Start with a goal
2. Analyse the current situation for each paddock
3. Design a strategy for the desired fire regime for each paddock
4. Ensure the grazing strategy is consistent with the fire strategy
5. Ensure the fuel load is sufficient for the desired result
6. Plan grazing to allow post-fire pasture recovery that improves or maintains land condition.

The GLM course defines the role of fire as managing pastures for:

- ensuring vigour and quality
- controlling species composition
- controlling grazing distribution
- establishing sown pastures
- maintaining the tree–grass balance in grazed woodlands
- conserving the habitat of native species and biodiversity

Using sown pastures

Sown pastures can improve diet quality, especially when using a legume, and therefore their use can improve conversion efficiency and liveweight gain. Using sown pastures can also allow higher utilisation rates, and may help in improving land condition by increasing desirable 3P grasses.

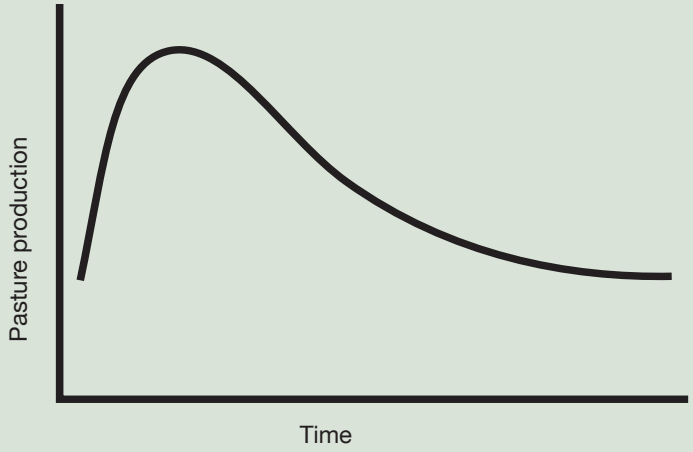
Most grazing lands are dominated by native and naturalised pasture species. Sown pastures (sometimes call 'improved' pastures) can extend the length of the forage growing season and often provide higher levels of protein and energy to cattle. This can allow graziers to finish cattle at a younger age and target different markets.

Sown pastures can also:

- increase carrying capacity
- provide alternative fodder while spelling native pastures
- provide special purpose pastures to specific classes of livestock (for example, first calf heifers) when diet quality is critical
- help in the restoration of degraded lands.

Sown pastures can suffer from a gradual decline in the level of available soil nitrogen. After ploughing, clearing or planting new sown pastures there are relatively high levels of available nitrogen. As the pasture develops over time, the nitrogen gradually becomes tied-up into soil organic matter and plant roots. On good soils, rundown may take 20–50 years before production declines are noticed, but on poorer forest soils, rundown may take five years or less. Although rundown is inevitable, the speed of decline depends on the initial soil fertility, and the grazing management regime adopted. It is important to recognise that *overgrazing makes rundown worse—as land condition declines, nitrogen losses are greater*.

Figure 6. Pasture rundown due to the gradual decline in the level of soil nitrogen



A trial of different species (both sown and native) at Brian Pastures Research Station found that, when compared at the same level of soil fertility, there were few differences in productivity. The native black speargrass and forest bluegrass, included in the trials for comparison demonstrated productivity equal to the sown grasses.

This trial illustrated that, provided the grass is palatable and productive, the grass species does not influence production as much as available soil nitrogen. Native grasses are more competitive in situations of low soil fertility (sandy soil), while sown grasses are able to respond to higher fertility (e.g. clay soils or newly renovated brigalow soils) and fertiliser application than their native counterparts.

Halting the rundown

Good grazing management is the key to halting pasture rundown. So what are the options?

- *Burn*—fire can promote nitrogen cycling by releasing bound nutrients from litter and plant material. But the effect will be short-lived, and pastures are sensitive to heavy and sustained grazing pressure immediately after burning.
- *Rip*—renovation can work, but its success (and cost-effectiveness) depends on initial soil fertility, the rainfall following renovation and the severity of the renovation. The effects of renovation may last 2–3 years, but may be as little as six months.
- *Sow*—legumes can fix atmospheric nitrogen in the soil, and thereby maintain or increase soil fertility. The more productive the legume, the more nitrogen it can contribute to soils. Lotononis, Sirato and Verano

stylos contribute approximately 20–50 kg of nitrogen per year; while Leucaena can contribute up to 180 kg of nitrogen per year.

Risk factors

The benefits of sown pastures must be weighed up against the risks, which include:

- poor establishment affected by soil fertility, rainfall reliability and sowing methods; in addition, some legumes have specific planting needs and are especially susceptible to low phosphorus soils
- poor persistence, affected by soil fertility and overgrazing
- legume dominance, which may lead to problems with soil erosion and soil acidification
- localised effects on pasture diversity and landscape health; sown pastures are implicated in tree decline in parts of Australia
- weediness, especially as environmental weeds where they invade native ecosystems
- toxicity problems in cattle, although rare with sub-tropical and tropical pasture species.

When selecting from the many different pasture species the following should be taken into consideration: climatic conditions; soil type; need for short- or long-term pasture; sowing method; herbage quality required; seed costs; fertiliser requirements; existing pasture resources (from inventory provided); management requirements.

The following requirements for sown pastures need to be considered:

- suitable land types for sown pastures
- establishment needs
- needs of ongoing management.

The important factors to consider when establishing sown pastures are to eliminate or reduce competition from other plants, and to provide a quality seed bed with good contact between the seed and moist soil.

The main factors in the ongoing management of sown pastures include:

- grazing management—spell pasture until well established and spell at critical times during the plant's life cycle to allow regeneration and seeding

- fire management—use fire to control legume dominance and ensure adequate soil seed reserves
- managing pasture rundown—by stimulating the soil nitrogen through fire, renovation cropping, fertiliser or adding legumes
- mineral supplementation—to enhance animal performance.

The GLM EDGE course leads to an understanding of:

- the role sown pastures can have in improving land condition and productivity
- the best suited pastures for individual situations
- the benefits and limitations of sown pastures and how to manage them.

Managing the tree–grass balance

Management of tree and grass balance can affect land condition in a positive or a negative way. These two types of vegetation compete for the moisture and nutrients needed for pasture growth. When used as browse species, trees may enhance the diet, but their presence may also affect pasture quality—both these factors impinge on the diet quality gateway. Trees may also affect the evenness-of-use gateway by supplying shade and shelter for cattle.

Photo: The balance between trees and grasses can affect land condition in both positive and negative ways.

A majority of the grazing lands in northern Australia are woodlands—in fact, Queensland has 60 million hectares of grazed woodlands. Thinning and clearing to increase grass production has been common in some areas. With the introduction of domestic livestock, also the reduction of fires, woodland thickening has occurred within some 'intact' eucalypt woodlands.

Woodlands play a critical role in our grazing land ecosystems. They provide habitats for native fauna and flora, they carry out key ecosystem functions such as water and nutrient cycling, and act as a sink for carbon. There is increasing recognition of the role woody vegetation plays in grazing land ecosystems, which has led to demands for woodland management that is both sustainable and compatible with broader environmental issues.

Woodland density and structure continuously changes in response to climate and disturbances such as fire and grazing. Defining a 'natural' density at any time is difficult, as the population will vary. Climatic conditions and disturbances modify woodlands, and large changes to woodland density and structure have occurred in recent times. In a particular land type (such as ironbark woodlands) climate variation over decades and centuries causes increases and decreases in the 'natural' density of trees. For example, the drought in the early to mid 1990s saw tree deaths around Charters Towers and in the Burnett. This is part of the natural thinning and thickening that occurs under natural conditions.

However, over a time scale of interest to management—usually years to decades—options such as fire management can affect the density of trees. Arguing about the true natural balance is futile. Instead, the focus should swing to the balance that meets production and environmental objectives for a particular property and catchment.

Trees influence the surrounding grazing land ecosystem in some of the following ways:

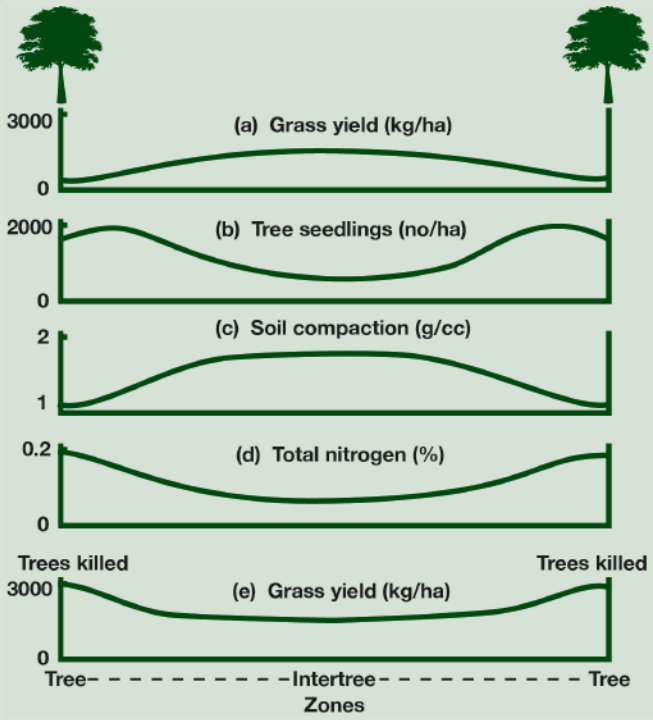
- Through nutrient cycling processes such as litter fall, nitrogen fixation, influencing litter decomposition rates, and by capturing nutrients that pass through the grass root zone
- They influence soil biology populations and numbers by affecting habitat and food supply. Soil microbial activity (the decomposers) generally increases when trees are present
- They improve the structure and chemical conditions of soil by increasing organic matter and soil nutrient status
- They influence the water cycle by competing with grasses for soil moisture, altering the surrounding microclimate that lowers evaporative demand on pasture beyond their canopy
- They provide shade that lowers temperature extremes (including the incidence of frost), relative humidity and wind speed,
- They influence the species composition of the grass layer

Through the interactions between trees and grass within an ecosystem (Figure 7), pasture production and soil conditions in woodlands have the following characteristics:

- Grass yield declines closer to trees, due to competition for water between trees and grasses.
- There are more tree seedlings near trees as mature trees act as a seed source.

- Soil compaction is lower near trees because of tree roots and higher soil biological activity (related to the higher soil biota populations beneath trees). Soil structure is better near trees in comparison with open paddocks.
- Total nitrogen (along with most other nutrients and carbon) is higher in the surface soils near trees, which act as 'nutrient pumps' to redistribute nutrients via woody leaf litter. Tree root distribution (up to 20 m from the base of the tree) means trees can access nutrient pools unavailable to grasses (with their shallower, less extensive root systems).
- If you kill trees, then grass growth will increase as the grasses are able to capture released nutrients (from decomposing tree roots) and water competition is removed. The increase in production gained from removing trees will be short-term.

Figure 7. Interactions between trees and grasses in an ecosystem can lead to different patterns in pasture production and soil condition



If the density of trees increases over time, increasing competition for nutrients and soil moisture begins to reduce pasture growth and land condition.

Woodland management can improve available pasture, by clearing and thinning to reduce the density of woody vegetation, and by using fire. The carrying capacity can be increased, but the effectiveness of reducing woody cover depends upon pre-clearing the tree basal area and how much the density of trees is reduced. Other important factors are land type

and fertility, rainfall patterns following clearing and the amount and control of subsequent regrowth. Land type in particular has a big bearing on the response to clearing and potential grass production.

Fire is another way to reduce the density of trees and shrubs. As already outlined in the fire management section, grazed woodland ecosystems evolved with fire, which suppresses woody 'thickening'. Without a disturbance such as fire, many land types will have a higher tree density. For fire to be successful in controlling tree density, the grazing manager must leave enough grass to get a an effective burn. Without fire, woodland thickening is likely to continue, and as a consequence lead to reduced pasture growth, lower carrying capacity, and ultimately poorer land condition. **Therefore, there is a cost in not using fire.**

The 'best-bet' recommendations for using fire to maintain tree–grass balance are:

- Burn every 5–6 years
- Have at least 2000 kg DM/ha of fuel
- Have fuel cover of at least 60%
- Burn late in the dry season when pasture are dormant or at the start of growing season.

As with all management tools, there is a risk that things will not go as planned. The list below outlines the risks associated with clearing woodlands.

Poor pasture response

Some land types do not respond as well as others to clearing, i.e. they grow less grass. Response to clearing may be disappointing on infertile land types, so you should set realistic expectations of what effect clearing will have. The response may also be short-lived as the initial flush of nutrients associated with the clearing will not last, and the long-term grass growth will reflect the underlying soil fertility. Pasture run-down may also occur and it is likely it will happen quickly. Managers should keep in mind how different land types respond to clearing when considering their grazing management plans.

Regrowth problems

Depending on the land type cleared, and the post-clearing grazing and fire management, regrowth control may be an issue.

Loss of land condition Following clearing, it is important to encourage grass growth that allows maximum groundcover, otherwise there will be to lower production in the future

Increased erosion Clearing does not necessarily increase erosion risk, especially if paddocks are spelled to allow pastures to establish. In some cases, removing trees may decrease erosion, but post-clearing grazing management must allow adequate groundcover to establish to minimise erosion and the concentration of water flows.

Decline in soil fertility After clearing there is an associated initial flush of grass growth from disturbing soils and releasing nutrients from dead roots and tree leaf litter. This flush will not last and grass growth will reach a new equilibrium level that reflects the land type's inherent fertility. Grazing management post-clearing should be at the level of the inherent soil fertility, not that of the post-clearing flush; otherwise a decline in the soil nutrient status is inevitable.

The following steps are vital in planning tree-clearing activities:

1. Evaluate benefits, costs and risks;
2. Identify areas that are not to be cleared. This includes: areas that cannot be cleared due to current regulation; areas that are too steep (>20% slope); areas within 100 m of creek-lines; areas prone to erosion and salinity risk. Managers need to check the regulations within the *Native Vegetation Management Act* (1999), and speak to the local Vegetation Management Officer from the Department of Natural Resources and Mines.
3. Identify most suitable areas for clearing;
4. Define method and pattern of clearing;
5. Anticipate ongoing management needs;
6. Prioritise areas that may be cleared based on the following: potential response in long-term carrying capacity; likely costs; ongoing management needs; financial sums.

If clearing is still an option, then:

- determine the appropriate pattern of clearing
- retain 20% of the original tree population in wide strips or clumps
- make the clumps at least 2–5 ha in area

- interconnect the timbered strips to watercourses and retained woodland areas
- do not leave trees scattered over the paddock as a means of achieving the 20% retention. This leads to chronic problems with seedling regrowth, it fragments habitat and is not sustainable
- evaluate the most cost-effective and sustainable method for clearing
- plan ongoing management needs.

Managing weeds

Weeds affect land condition by utilising water and nutrients and lowering the rainfall use efficiency. Figure 8 depicts the general life cycle of a weed. Weeds can restrict access to grazing lands and cause overuse of desirable and palatable 3P grasses, thus affecting the evenness of use. As many weeds are toxic or have poor quality, they can lower conversion efficiency and affect the diet quality gateway.

Weeds can be a cause of poor land condition by reducing the amount of useful vegetation, as well as a symptom of poor land condition, as they can fill gaps in the pasture created by overgrazing. Weeds compete with desirable 3P pasture species and reduce rainfall-use efficiency. There is often a reluctance to control weeds early as the effects are not always obvious, but leaving it till later can be a costly mistake.

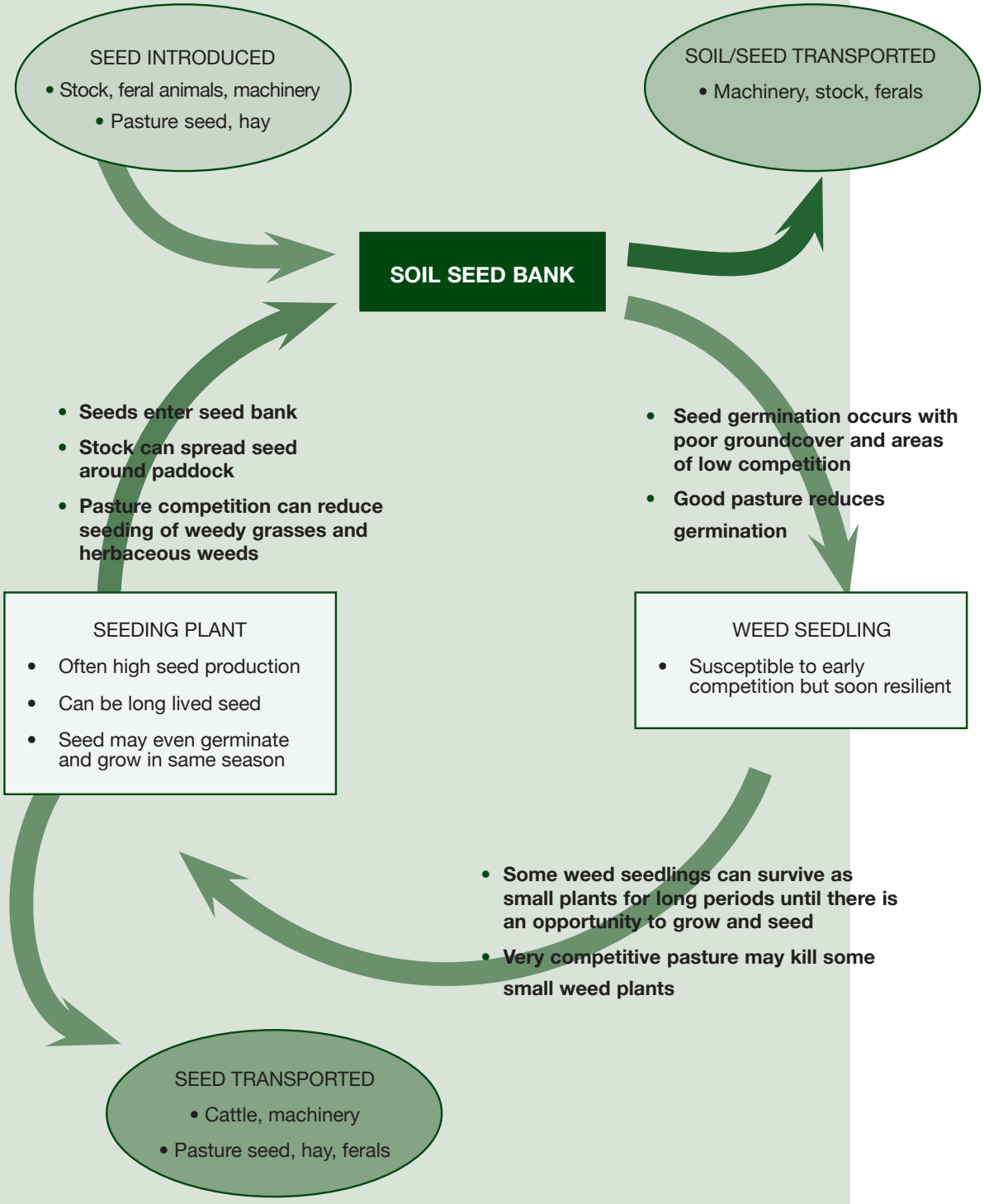
Early prevention of weed problems is a key to cost-effective improvement in land condition.

Six principles of weed management

The following principles provide a basis for managing weeds.

1. Awareness—be aware of existing and potential weed problems.
2. Detection—be on the lookout for new weed infestations before they become too large and difficult to contain.
3. Planning—prioritise efforts and plan a strategy for successful control.
4. Prevention—is better than a cure, so preventing new weed infestations and containing spread of existing weeds will make life easier.
5. Intervention—and do it early. Controlling weeds now rather than later will prevent them spreading out of control.
6. Control and monitor—as always, monitoring is a critical component in weed management. Managers need to gauge how well they are controlling weeds and re-plan their efforts for the future.

Figure 8. General view of the life cycle of a weed



Weeds are loosely divided into two categories:

- *weeds of production systems*—these are plants like parthenium and rubber vine and they directly affect land condition and carrying capacity. Native woody regrowth would be considered a production weed because, if not kept under control, it will significantly reduce land condition and carrying capacity.

- *environmental weeds*—these plants include those that have escaped from gardens or those sown as part of normal agricultural practices. Environmental weeds disrupt ecosystem processes and habitats, can change fire regimes, displace native endemic species and change the structure of vegetation.

The key to controlling weeds

Managers need an understanding of weed ecology (Figure 8) to prevent introduction of new weeds and contain existing weeds. The knowledge of a weed's life cycle can help to identify the weed's strengths and weaknesses. This assists the formulation of plans to attack the weed's weaknesses and avoid its strengths.

Important facts to know:

- how weeds are transported and how they spread
- the preferred habitats of a species and what grazing management regime encourages its growth
- the relative life of seeds of different species.

Prevention the best form of attack

Good property weed hygiene is essential. Early intervention is also critical, knowing the location of weeds on the property and prioritising actions to control them as soon as possible can prevent any future outbreaks. It is important to know where weed outbreaks have occurred in order to monitor the success of initial control measures.

Follow-up management is also important. Monitoring suspect areas and areas where weeds were previously controlled will help to prioritise weed management. Ensure that grazing management enhances land condition to help reduce weed problems, and recognise that failure to manage early weed problems leads to major outbreaks.

Poor weed management could lead to the following:

- *Poor kill*—weeds are very adaptable plants so there is always a risk that treatment will be unsuccessful and therefore money and resources wasted. Where treatment is ineffective and a poor kill results, the same weed (from surviving plants or seeds) may refill the gaps created by the treatment, or other weed species may invade the area.

- *Creation of gaps for other weeds*—ironically successful weed control will leave gaps that can be exploited by other plants. It is essential that post-treatment management favours desirable pasture plants and limits further weed invasion.
- *Safety and health factors*—many weed control methods have inherent risks, e.g. the use of large machinery to clear infestations of woody weeds or the application of toxic chemicals. Proper training of operators is essential.
- *Effect on non-target plants*—while the careful application of herbicides can eliminate weeds with little or no damage to other plants, there remains the possibility that non-target plants will be affected if the herbicide drifts in windy conditions or moves in water to other locations.
- *Residues in animals*—residues in animal tissues arising from the use of pesticides are a major concern. Managers must be aware of potential residue problems: check the label and seek advice if in doubt.
- *Development of herbicide resistance*—this problem has become an important issue in the past decade. It developed with annual weeds in temperate areas, where the use of herbicides has been greater and more frequent than in the grazing lands of the tropics and subtropics. In the tropics and subtropics there are currently no reported cases of weeds developing resistance to herbicides.
- *Off-site effects*—movement of pesticides into waterways or drift into surrounding native vegetation is a risk in weed management. Precautions to protect surrounding native ecosystems are paramount in weed management on-property.

Early intervention is critical, weeds can be both a symptom and a cause of poor land condition.

Pulling it all together

Graziers acknowledge that grazing land management information is important to their ongoing viability and sustainability. This booklet has presented key elements of sound grazing land management, based on the gateways that lead to sustainable livestock production from grazing lands.

Those three gateways are:

1. The *land condition* gateway.
2. The *evenness of grazing* gateway.
3. The *diet quality* gateway.

The booklet has also described the major impact of *utilisation rate* on both land condition and diet quality, and emphasised its vital role in grazing land management.

The information in this booklet has provided an introduction to the important management tools to improve land condition and evenness of use and to enhance diet quality, i.e. managing grazing, using fire, managing tree–grass balance, using sown pastures and managing weeds.

This is a good start in helping you to develop more understanding about your property and its management. Should you choose to attend a grazing land management workshop in the future you will already have a sound knowledge base on which to acquire more detailed information on each topic. Such a workshop will also give you the opportunity to put these tools to work on your own property, and to learn from shared experiences with other graziers from your district.

Answers to Quick Quiz

1a no; 1b yes; 1c no.

2a yes; 2b yes; 2c yes; 2d no.

3a yes; 3b yes; 3c yes.

4a yes; 4b no; 4c yes.

5a yes; 5b yes; 5c no.

6 is false.

If you are dissatisfied with your scores, here is your opportunity to learn more. Read on!

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