Department of Employment, Economic Development and Innovation

Best-bet practices for managing the grazing lands of the Maranoa Balonne

A technical guide of options for optimising animal production, profitability and land condition

MLA MEAT & LIVESTOCK AUSTRALIA

CARING FOR OUR COUNTRY

Queensland Government

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Contents

1. Introduction

This technical guide is designed to help inform and improve grazing management in the Maranoa Balonne. It focuses on four major themes: managing stocking rate, spelling pasture, burning and developing the property with more fences and waters. The guide is a technical resource for use by those working with producers to improve the management of grazing lands for beef production.

The guide is a product of the Northern Grazing Systems (NGS) initiative which has been developed and implemented as a partnership between Meat and Livestock Australia (MLA), CSIRO, AgriScience Queensland (part of DEEDI), the Northern Territory (NT) Dept of Resources, and the West Australian (WA) Dept of Agriculture and Food. This initiative has been designed to ensure that the beef cattle industry in Queensland, the NT and northern WA derives the full benefit from research on how best to manage grazing country for beef production.

Other regional versions of this technical guide are available for the Victoria River District (VRD Northern Territory), Barkly (NT), Fitzroy Basin (Queensland), Queensland Mitchell Grass. Further versions include Alice Springs (NT), Kimberley (WA) and Southern Gulf (Queensland).

The information in this guide has been derived from various sources, including a review of research reports, biological and economic modelling of different management options, and the input of producers and technical specialists from each region.

The next phase of the NGS initiative, after the production of this technical guide, will focus on working with producers and their advisors in the region to increase awareness, understanding and uptake of improved grazing practices. The technical guide will be used to inform this activity and, over time, the guide itself will be improved by the information and experiences shared by producers, their advisors, and researchers. Section 7 at the end of this guide allows you to contribute to future updates of this information.

2. How the guide was developed

This technical guide was developed by combining information from three major sources:

1. A review of reports from completed research on grazing land management relevant to northern Australia (Queensland, Northern Territory, and the northern rangelands of WA—Kimberley and Pilbara). This review focused on four themes: managing stocking rate, pasture rest, burning and intensifying property infrastructure with more fences and waters.
2. Outputs from testing different management options via computer models. Effects of stocking rate, pasture rest and fire on pasture and animal productivity were simulated with the GRASP model. Grazing trial data and pasture growth studies have been used to develop GRASP, which can be run for specific land types and over any sequence of years. The pasture and animal productivity from GRASP was then used in an economics spreadsheet model called ENTERPRISE to assess how stocking rate, pasture rest and fire affect the economics of a beef enterprise with a herd and paddock structure typical of the region. This testing of options with GRASP and ENTERPRISE provides a way of extrapolating responses to grazing management measured in a grazing trial to a wider range of land types and climatic conditions. It also provides a way to test multiple variations in grazing management that would be expensive and time-consuming to test on the ground. This helps identify the practices that have most impact and to narrow down the most cost-effective ways of implementing these practices.
3. Capturing the combined knowledge and experience of producers and technical specialists from the region, including their assessment of the most relevant and useful outputs from the review of research and the modelling. This was done over two workshops and via direct input to reports, including this guide. This local input also helped develop plans for the next phase of the NGS initiative in the region and identified and prioritised information gaps.

Not all practices, or the many variations of these practices, have been objectively evaluated and their impacts measured in each region. Even where there is solid data on a practice, it often represents only one land type and a particular sequence of seasonal conditions. Furthermore, information from grazing trials or other sources of hard data needs to be considered in the context of the whole property. Local knowledge and experience combined, with the biological and enterprise modelling, have therefore been very important in helping form the guidelines and ideas in this technical guide. As there will be some degree of uncertainty about what practices will work best in any particular situation, it is important to see the guidelines and ideas as input to the decision-making process and not as set prescriptions or recipes.

3. Using this guide

The information in the guide has been developed around four major issues common to most regions of northern Australia. These are:

1. How to best manage stocking rates over time to keep pasture in good condition and optimise beef production
2. How to most cost-effectively recover pasture that has declined to poor (or C) condition
3. How to deal with thickening or encroachment of woody plants
4. How to most cost-effectively utilise ungrazed pasture that is distant from stock water.

For each issue, information is presented on:

- Signs (how the issue is expressed)
- Underlying causes
- Responses—the key practices and their rationale
- The specific management actions that can contribute to achieving better practice and the evidence-base for these
- How to implement these actions
- The trade-offs, caveats, uncertainties and other issues associated with this information.

The guide is designed to be technical and comprehensive so that it captures the information, insights, ideas and uncertainties that arose from the research findings, modelling output and the views of producers and technical specialists in the region.

The guide can be used by operatives working with producers in several ways:

1. As a means of improving understanding of key grazing management practices and awareness of the evidence base that underpins these practices.
2. As a source of ideas for management strategies that will most cost-effectively address a particular issue or objective.
3. As a guide to which issues, practices and variations of these, deserve additional extension activity via demonstration sites or other processes.
4. As a guide to which issues, practices and variations of these, require more research and/or on-property testing.
5. As a source of new information and examples for extension activities and information products, including EDGE*network* Grazing Land Management (GLM) workshop materials.
6. As a means of capturing new insights and information from interactions with producers, property case studies and demonstrations, additional research, and additional biological and economic modelling.

4. Guidelines for grazing management across northern Australia

This document outlines best-bet management guidelines for common grazing management issues experienced in the Maranoa Balonne of southern Queensland. It draws on information from recognised literature sources, locally documented demonstrations and regional grazier experiences.

The general guidelines that are applicable in the grazing lands of northern Australia are tabulated below and expanded upon in discussions at the regional level for each of the management issues.

Table 1. Guidelines for managing issues in the grazing lands of northern Australia.

Principle 1. Use fences (paddocks) and water points to manipulate grazing distribution

Guideline 1.1 Smaller paddocks and additional water points can achieve more effective use of pastures i.e. reduce the proportion of the paddock that experiences little grazing.

In the more extensive grazing areas of northern Australia, producers should aim for; paddocks of 30–40 km^2 with two water points, and a maximum distance to water of about 3–4 km to strike a balance between improving grazing distribution and the cost of development.

For the more intensive regions in the eastern part of northern Australia, it is likely that paddocks of 20 km^2 with two water points are sufficient from the perspective of optimising grazing distribution. Smaller paddocks may still benefit from sub-division where cattle show a strong preference for land types within a paddock.

To minimise the development of large sacrifice areas around water points, the number of head per water point should be limited to no more than 300 head per water point.

Guideline 1.2 Smaller paddocks and additional water points do not overcome uneven utilisation by cattle at the plant community or patch scales. Other methods (e.g. fire, careful selection of water point locations) are needed to improve evenness of utilisation at these scales.

Guideline 1.3 Property development can generate significant increases in livestock production only where it results in more effective use of the pasture (increasing carrying capacity) as substantial improvements in individual livestock production are unlikely. If an undeveloped paddock is already operating at its long-term carrying capacity, paddock development may improve the sustainability of grazing through better grazing distribution.

Guideline 1.4 Fencing and water points can be used to help protect preferred land types and sensitive areas from overgrazing. Fencing to separate markedly different land types is an important strategy for controlling grazing pressure on preferred land types, and to get more effective use of all pasture resources on a property. It can be a practical option in some situations and should be considered where property development is planned.

Principle 2. Managing stocking rates is vital to meeting animal production and land condition goals

Guideline 2.1 Set stocking rates to match long-term carrying capacity. Plan for the average paddock stocking rate to match its estimated long-term carrying capacity, as operating at or around the long-term carrying capacity will help maintain land in good condition. The extent to which stocking rates can exceed the long-term carrying capacity without reducing economic returns and/or reducing land condition is unclear.

Guideline 2.2 Regularly assess the need to adjust stocking rates in relation to current and anticipated feed supply and feed quality. Some variation in stocking rates over time is required to manage periods of below-average pasture growth. Capacity to vary numbers over time also provides opportunities to take advantage of periods of above-average pasture growth. The degree of variation that is most beneficial, and achievable, for different production systems is not clear.

Guideline 2.3 Management factors and issues other than forage supply also determine the need to vary livestock numbers. The adjustment of stocking rates over time should also consider land condition trend, ground cover, grazing pressure from other herbivores, and economic risk.

Principle 3. Rest* pastures to maintain them in good condition or to restore them from poor condition to improve pasture productivity.

Guideline 3.1 Rest pastures during the growing season. As a rule of thumb, commence the rest period after 38–50 mm (1.5–2 inches) of rain or sufficient to initiate pasture growth at the beginning of the growing season. If it is difficult to access country after rain then resting should commence before the wet season starts.

Guideline 3.2 Rest pastures for the whole growing season. Resting pastures for the whole growing season is likely to provide the most reliable benefit but most of this benefit appears to accrue from rest during the first half of the growing season.

Guideline 3.3 Pastures need two growing season rests to improve by one ABCD condition class. Pastures in B condition need rest for one or two growing seasons to improve to A condition. Pastures in C condition will need longer so plan on taking four good growing seasons to recover to A condition. Where growing conditions are poor, more rest periods will be required.

*Resting or 'spelling' pastures (as it is referred to locally) is the removal of grazing stock for a period of time to allow for pasture recovery. Rest and spell will be used interchangeably throughout this guide.

Principle 4. Devise and apply fire regimes that enhance grazing land condition and animal productivity whilst minimising undesirable impacts.

Guideline 4.1 Use fire to manage woody species. It may not be necessary to kill target species—topkill can be sufficient to alter the structure of woody populations. Mid-late dry season fires of moderate to high intensity are most likely to be effective in regulating the density and biomass of woody plants. Fuel loads are a critical issue—to reduce populations/biomass of woody species, a minimum fuel load of 2000 kg/ha is suggested.

Guideline 4.2 Use fire to change the composition of the herbaceous layer by killing plants, influencing recruitment or altering grazing preferences. Most research concerns the control of wire grasses in Mitchell grasslands and black spear grass pastures where fire is sometimes (e.g. coarse wire grasses in the Burnett region) but not always effective.

Guideline 4.3 Use fire to change grazing patterns by temporarily improving the attractiveness of previously ungrazed areas and providing rest to previously grazed areas.

Table 2. Management factors that can be used to manage issues in northern grazing lands.

Issue	Management factor			
	Infrastructure	Stocking rate	Pasture rest	Fire
1. Mismatch of pastures to animals		***	*	*
2. Poor pasture condition	(*)	***	***	*
3. Woody plant problems		*	*	***
4. Ungrazed areas distant from water	***			

The guidelines and information in this technical guide are related to the management of three major issues that are common in the grazing lands of the Maranoa Balonne (MB) and a fourth that is not so common in the MB but a major issue in more extensive areas of northern Australia:

1. Matching pasture supply to animal demand on land in generally good condition.
2. Pasture in poor (C) condition.
3. Woody plant problems.
4. Ungrazed areas distant from water.

The relationships between issues and management factors are shown in table 2 and serve as the structure for this chapter.

All these factors, described above, relate to managing for better land condition. An explanation of grazing land condition and the ABCD framework follows.

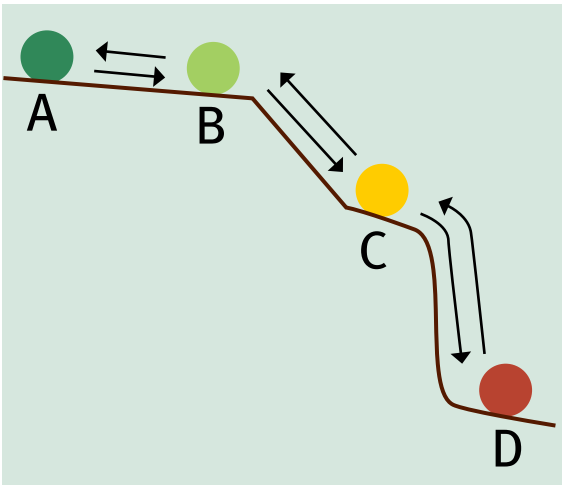
Land condition is the capacity of grazing lands to respond to rainfall and produce useful forage; it is about productivity and sustainability. Land condition is classified into four broad categories; A (good), B (fair), C (poor) and D (very poor) condition.

Land condition has three components:

- **Soil condition**: the capacity of 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 and convert solar energy in green leaf, to use rainfall efficiently to conserve soil condition and to cycle nutrients; and
- **Woodland condition**: the capacity of the woodland to grow pasture, to cycle nutrients and to regulate groundwater.

Soil condition is assessed by the condition of the soil surface, infiltration capacity and amount of ground cover. Pasture condition is assessed by the types of perennial grasses present, their density and vigour. Woodland condition is measured by the tree basal area (TBA m^2/ha) and the balance of woody plants and pasture in different land types (Quirk and McIvor, 2003).

The ABCD land condition framework is a standard framework for measuring the grazing productivity and health of a grazing ecosystem across northern Australia. Much of the information about best-bet practices for grazing land management described in this guide will relate to the impact of those practices on land condition. More information about grazing land condition can be found in the EDGE*network* GLM and the *Stocktake* pasture monitoring workshop packages.



5. Current situation; Maranoa Balonne, climate, businesses and pastures

In the Maranoa Balonne, the proportion of pasture utilised generally increases with reducing property size, increasing soil fertility and increasing association with cropping enterprises. These relationships reflect the landholder's efforts to extract the maximum economic return from high value land—often to the detriment of associated pastures and soil.

Property sizes and enterprise makeup in the Maranoa Balonne vary markedly. Properties in the less fertile parts of the region and to some extent, lower rainfall districts, tend to be larger and run breeding enterprises while those in the more fertile districts trade stock in growing or finishing enterprises. Breeding enterprises have the least flexibility for matching feed supply with demand and thus, varying stock numbers seasonally, relative to trading enterprises.

Equally, breeding enterprises can maintain stock numbers through drier seasonal conditions but maintain productivity by the strategic provision of supplements at critical times, thus maintaining pressure on the pasture resource at times of highest susceptibility to degradation. Many breeding properties remain in fair to good condition but some have declining land condition.

Properties that grow stock for the store market, sell direct to feedlots or fatten for the heavier finished markets have more flexibility in relation to varying stock numbers over the year. Many paddocks are spelled but the period of rest is not necessarily related to improving the resource condition but can be more related to stock purchase and sale times or with the use of forages such as forage sorghum or oats.

Although rainfall is summer dominant (60% received from December to May inclusive), it is highly variable and a higher proportion of average annual rainfall is received in winter and spring (40%) than in other parts of northern Australia. This can have positive effects on liveweight gains of stock when there is sufficient winter rain but small amounts can spoil standover pastures grown through the summer. Winter rainfall and spelling at this time has little effect on improving the condition or dominance of our 3P (perennial, productive and palatable) grasses that are so necessary for good land condition.

Table 3. Seasonal rainfall for Injune, Roma and St George (sourced from the Bureau of Meteorology)

Centre	June-Aug	Sep-Nov	Dec-Feb	Mar-May	AAR*
Injune	85	146	265	135	631
Roma	101	139	223	137	600
St George	86	121	198	124	529

*Average annual rainfall in millimetres (mm)

5.1 Matching pasture supply to animal demand on land in generally good condition

About 30% of the grazing land in the Maranoa Balonne is in good (A) condition (Tothill and Gillies 1992). A major challenge facing managers is how to optimise the use of this feed for animal production, while at the same time maintaining good land condition. High stocking rates increase pasture utilisation. In better years this can increase animal production per hectare, but in poorer years high stocking rates can give low animal production and degrade the pastures.

The amount of feed grown each year can vary widely due to weather changes so the appropriate number of animals to utilise the feed also varies widely. In theory, it would be desirable to change animal numbers each year so that the feed demand by animals matches the feed supply from the pasture. In this way, overgrazing and subsequent pasture deterioration during periods when pasture growth is low are avoided, and animal production increases in years with high pasture growth. However, this is not simple, as the feed supply is not known in advance, and there are limits to how much animal numbers can be altered, particularly in a breeding enterprise.

Properties in the Maranoa Balonne are fortunate to be located relatively closely to a good market, the Roma saleyards, which is the largest cattle selling complex in Australia. Offloading stock in periods of feed shortage, or stocking up to take advantage of periods of feed surplus, is easier to achieve than in other areas of northern Australia, like the Kimberley.

5.1.1 Signs

The pastures in this scenario are generally in A/B condition but may have small areas of overgrazed patches. Typically, such pastures will have more than adequate yield during most winters and will be able to carry a spring fire in nearly all years.

Persistent overgrazing is likely to lead to the patches increasing in size and frequency, and if continued for a longer period it is likely condition of the pastures will decline.

This situation is likely to occur on any of the land types of the Maranoa Balonne but most likely on river and creek frontages on land types such as poplar box on clay or coolabah flats where some of the better pasture species such as the Mitchell grasses, forest blue grass or silky brown top are preferentially grazed over the less favoured pitted blue grass or wiregrasses. In this situation it will result in overgrazed patches expanding as they become dominated by either less preferred species or palatable but less productive annuals, such as small burr grass or button grass.


Good condition


Poor condition

It is assumed for this scenario that pastures are in generally good condition and managers are attempting to match supply (standing pasture yield) and demand (the amount that is likely to be consumed by grazing stock).

5.1.2 Causes

The major cause of mismatches in feed supply and demand is the temporal variability in pasture growth rates. Pasture growth rates can vary widely both between years and during years, usually without any reliable predictors of the seasonal outcome. In addition, most cattle enterprises have a need to carry the same animals over one or more years—especially breeding enterprises—so have an inherent constraint to how much the animal demand can vary from year to year. Years when there is adequate or excess forage are therefore likely to alternate with years when pasture growth cannot meet demand.

Additionally, mixes of contrasting land types in a paddock that result in selective grazing can result in pasture supply/feed demand mismatches and subsequent declines in land condition e.g. sandy loam alluvial box flats in a paddock with ironbark hills and ridges. This commonly occurs on river frontage country in the Maranoa Balonne. Continual grazing pressure on preferred species will result in a decline in pasture condition and the less favoured species will dominate.

5.1.3 Management response:
Improve stocking rate management supplemented by pasture spelling, the use of prescribed fire and infrastructure development

Although changes in growing conditions are a major cause of mismatches between feed supply and demand, they are largely outside the control of managers and the most important management response is to adjust stocking rate.

There are two broad approaches. The first approach is to stock at a relatively low level so that the level of pasture utilisation is not excessive in any year (or at least most years). This approach reduces overgrazing in poor years but forgoes the extra animal production that could be achieved in good years and hence may incur a production penalty.

The second approach is to regularly adjust animal numbers so that animal demand is less than or equal to current and/or anticipated future feed supply. This should minimise periods of overgrazing and feed deficit while making good use of feed in above-average years. It is difficult to predict what the next season's pasture growth is going to be so decisions have to be somewhat reactive. Determining the appropriate time to adjust stock numbers can therefore be problematic. There are forage budgeting tools that can assist with these decisions and these will be discussed in section 5.1.4.2 (implementation).

The simplest process for ensuring stock numbers match feed supply is to make pasture assessments at the end of the growing season, or summer, for the winter period, and reduce numbers if required. Where there is surplus feed of adequate quality, agisting stock or lightening off other paddocks may be the easiest and lowest risk approach to utilising this extra pasture. Animal numbers can be further adjusted once or twice as winter progresses to ensure feed supply matches animal demand.

This second approach can result in higher overall utilisation of feed, approaching an efficient and sustainable utilisation rate, but there is a risk of overgrazing if animal numbers are not reduced quickly enough when pasture supply is low. There are also risks of being caught with excess stock numbers and having insufficient quality or quantity of pasture to carry them through the dry period resulting in either forced sales, perhaps at a loss, or additional expenditure in terms of either supplement costs or lost animal condition.

Pasture spelling can also be used to alter the pasture supply and when it is consumed, and fire can assist in changing grazing patterns to prevent patches increasing.

Selective grazing as a result of contrasting land types in a paddock can be overcome by fencing to land type, or using fire or supplements to attract stock to ungrazed areas of paddocks.

5.1.4 Management action:
Match stocking rate to long-term carrying capacity

A risk-averse approach to managing stocking rates has generally proven to be most successful in the long-term. Stocking at close to the long-term carrying capacity (equal to or less than 30% annual pasture utilisation depending on the land type) of the land in most years is generally the most profitable in the medium to long term and the least risky (economically and ecologically) approach to managing stocking rates. The focus should be on maximising profit per hectare in the long term. However, it should be noted that maximising production per hectare is not always the way to maximise profit.

High stocking rates in excess of the long-term carrying capacity (equivalent to average annual pasture utilisation rates greater than 20–30% for most land types) may be more profitable in the short term but are less profitable over the longer term because of the effect of drought years and declines in land condition and productivity. Maintaining high stocking rates during drought risks causing marked land degradation that can reduce production for years after, and increase subsequent year to year variability in production. High stocking rates (especially on poor condition land or in poor seasons) can mean cattle will be subject to weight-for-age penalties at market or increased supplement costs, both of which can reduce profit. On the other hand, consistently low stocking rates may not be productive enough to be profitable depending on the cost of production, level of debt to be serviced and return on capital invested, if land prices are considered.

The safe pasture utilisation rate concept and historical rainfall and pasture growth data for different land types can be used to develop an understanding of the long-term carrying capacity of the land (see the EDGE*network* Grazing Land Management Manual, Chilcott et al. 2005). Safe pasture utilisation rates tend to be lower in less productive districts and land types (e.g. lower annual rainfall, shorter growing season, less fertile soils) and where annual rainfall is more variable. A more conservative approach to setting stocking rates is required in these districts and with these land types e.g. in the western areas such as Dunkeld on mulga land types.

Safe utilisation rates in the Maranoa Balonne range from 15% for the less productive bendee ridges and hard mulga land types to 30% for brigalow belah and coolabah floodplains. The safe utilisation rate for the commonly occurring box and sandalwood land type is 25%. Other safe utilisation rates can be found on the CD 'Land types of Queensland' (Whish 2010).

5.1.4.1 Evidence

There have been many experiments over more than 50 years examining stocking rate or utilisation responses. Most of these have been in Queensland (both east and west) with several in the VRD. As a general rule they show declines in pasture condition as utilisation rates exceed approximately 30%. Expert knowledge has been used to develop recommended safe utilisation rates for many land types in Queensland and this technique was used in the Maranoa Balonne.

Safe utilisation levels for land types in some regions have been calculated by going to commercial properties with land in good condition and back calculating their historical utilisation rates from the average stocking rates used by managers, modelled pasture growth for the seasons and years in recent history and an estimate of pasture intakes by the class of stock run on the property (McKeon, et al. 1994).

This has not been done for the Maranoa Balonne and should be considered as part of **future research**.

There is a large body of international and Australian literature showing animal production per head declines, and animal production per unit area increases initially to a maximum and then declines, as stocking rate is increased (figure 1). Most studies with intensively managed sown pastures have shown a linear decline in animal production per head with an increase in stocking rate (Jones and Sandland 1974) but Ash and Stafford Smith (1996) have suggested that animal production in rangelands is less sensitive due to the much greater spatial and temporal variability of rangelands.

Figure 1 is adapted from the Jones and Sandland model, it is different in the way it represents the liveweight gain per head data, and uses data from a stocking rate trial conducted in central Queensland on Galloway Plains (Burrows et al. 2010). The figure shows that, as stocking rate is reduced from heavy to light, initially there is a significant boost to individual stock liveweight gains, and a reduction in liveweight gains per hectare. Further reductions in stocking rate give lower increases in liveweight gains per head. For example, reducing stocking rate from 2 ha/head to 4 ha/head can increase liveweight gains from 95 to 130 kg/head, a gain of 35 kg/head. But reducing stocking rates from 4 ha/head to 8 ha/head will only increase liveweight gain by another 15 kg/head.

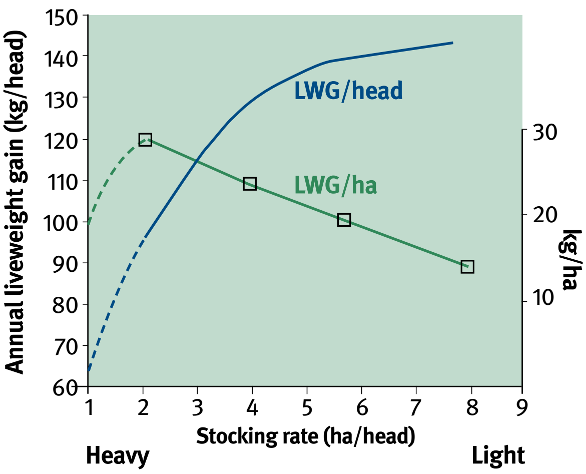


Figure 1. Relationship between stocking rate and liveweigh gain per head and hectare (adapted from Jones and Sandland 1974).

The Aristida-Bothriochloa (AB) project on poplar box woodland near Injune compared ecological and financial outcomes from three different grazing pressures. Grazing pressures were set by adjusting stock numbers in small paddocks at the end of a growing season (summer) so that the stock consumed 25% (light grazing pressure), 50%

(medium grazing pressure) and 75% (heavy grazing pressure) of remaining, or standing, feed over the following 12 months. This does not equate to utilisation rates of 25%, 50% or 75% as the pasture growth in the next summer is not accounted for as part of the calculation.

The results showed that the 'triple bottom line' was highest at medium grazing pressure (an average over the seven years of the trial of 5.3 ha/head) and the low grazing pressure (average of 8.7 ha/head) had the least cumulative soil loss. It also illustrated the large benefits to pasture and cattle growth from clearing trees relative to retaining scattered trees and shrubs (tree basal area of approximately 6 m^2/ha before clearing). From the report it was not possible to determine the separate recommended stocking rates/grazing pressures for with and without trees as data was averaged across both, and so are the recommended grazing pressures given above.

Using modelled pasture growth data from *Stocktake* and the recommended safe utilisation rates for the land type of this trial site (25% for poplar box on duplex soils), a calculated safe carrying capacity (safe CC) is 4.7 ha/head where there are no trees. This is congruent with the recommendations from the AB project above but there is some confusion when the safe CC for this land type is calculated with 6 m^2/ha of tree basal area, as was the case in the 'treed' paddocks of the trial. The safe CC with trees comes to 23.5 ha/head which would give an average for with and without trees of 14.1 ha/head, much lower than the recommendation from the AB project.

More work is required to resolve this issue, mostly through close scrutiny of the AB data. The AB project made some initial calculations of utilisation rates from their results for a land type in the Fitzroy region but not for the Injune site and the land types applicable to the Maranoa Balonne. This data would be invaluable for verifying safe utilisation rates on poplar box land types.

The concept of utilising a certain proportion of end of growing season standing pasture over the next 12 months has long been touted and tested by researchers in grazing trials. In the Maranoa Balonne, the AB Project tested three levels of use over a seven year period, as detailed above. Modelling allows a greater range of these strategies to be tested over longer periods of weather and climate variability and GRASP and ENTERPRISE were used to test a theoretical property representative of range of land types and conditions that would be found in the Maranoa Balonne.

Fixed stocking was compared with three different flexible stocking rate options that varied stocking rates according to the amount of pasture remaining at the end of the growing season (May) each year. The stocking rates were set for the next 12 months by aiming to use a certain percentage of that pasture over the 12 month period. The percentage level of use was set at the Safe Utilisation Rate for each land type of the theoretical property. For example the safe utilisation rate for Poplar box on duplex soils is 25% so stock numbers were set in May each year to use 25% of the pasture remaining in May for the next 12 months. This system does not take into account the pasture grown in the next summer.

As the amount of pasture remaining at the end of the growing season can vary widely from one year to the next, there were limitations set on how much stock numbers could be increased or reduced each year. So the annual variation for two strategies was limited to a 10% increase in numbers in any one year, with annual reduction in numbers of either 20% or 40%. One strategy was allowed to be fully flexible and have no limits set on increases or reductions in stock numbers.

The representative property was stocked at 'safe' fixed rate and the outcomes of differing flexibility options were modelled over a 25 year period of historical climate up to June 2010. The results were very interesting. Fixed and fully responsive strategies were the least profitable management options with almost 50% less annual profit than the other strategies. For the fully flexible strategy, where numbers are allowed to swing widely from one year to the next, there are many opportunities for pasture to become degraded. With this strategy, stock numbers were built up at the end of good seasons, well above average numbers, but could not be reduced in the following summer if seasonal conditions were poor. If a poor growing season followed a good year, and this occurred a number of times, stock numbers remained too high during the growing season when pastures are susceptible to heavy grazing with subsequent reductions in pasture condition, animal performance and enterprise profitability. The purchasing of heifers was allowed with the fully responsive strategy to enable a 'rapid' return of herd numbers following large reductions in breeders. Although the fixed strategy has safe stocking rates that cause less damage to pastures in poorer seasons, it was slightly less profitable than the fully responsive strategy.

The strategies that allow more annual variation in stock numbers were the most profitable. The modelling suggests that limiting stock numbers to 10% increases in good seasons and allowing numbers to be reduced by 40% in poor seasons gave the best outcome for pastures and profits.

Whole herd annual gross margins for the theoretical property averaged:

1. $412,898 for fixed stocking strategy, ($26.03/ha and $197.30/AE);
2. $451,180 for fully flexible strategy, ($28.44/ha and $270.19/AE); and
3. $563,591 for the plus 10% and minus 40% strategy, ($35.53/ha and $206.60/AE)

Annual profits of these options averaged:

1. $234,852 for fixed stocking;
2. $264,164 for fully flexible strategy; and
3. $419,291 for the plus 10% and minus 40% strategy

The main message to come from this modelling exercise is to limit increases in stock numbers in good seasons to 10% and allow reductions of up to 40% in poor seasons. In practice, setting stocking rates for 12 months at the end of the growing season each year may not allow sufficient flexibility. Managers should maintain some flexibility with stock numbers during the next growing season if pasture growth is limited by poor drought conditions.

5.1.4.2 *Implementation*

While the concept of setting long-term carrying capacities using appropriate utilisation rates for each land type is sound, its application is complex, requiring knowledge of average pasture growth rates for different land types on a property and their safe utilisation rates. Most land managers don't have ready access to either the information or concepts and systems unless they attend an EDGE*network* Grazing Land Management (GLM) or Stocktake workshop. **Even these objective techniques employ utilisation levels that, in some instances, require verification** and some adaptive management is required. A process for determining sustainable stocking rates in the absence of these more objective and technical processes is given below and GLM and *Stocktake* are explained in more detail later in this section.

Many land managers in the MB set their paddock stocking rates to align with historical rates. When these are set at moderate levels, land can generally be maintained in good condition. However, when there are changes in either woodland densities or climatic conditions that may not have been experienced before in the manager's lifetime, or where some practices such as the use of fire are changed (resulting in woodland thickening), reduced pasture growth can result and extended periods of overuse of pasture can result in a decline in land condition.

Graziers trying to determine their safe long-term carrying capacities without applying the more complex safe utilisation concept might check the historical stocking rates in paddocks that have remained in better condition and free of woodland thickening. Most experienced operators in the region will have a good understanding of what the required stocking rates need to be. Rates can then vary around this figure by 10–15% as seasonal conditions deteriorate or improve.

Also, table 4 gives recommended stocking rates for different land systems in the Maranoa Balonne. They are suggested rates coming from local experienced graziers and extension officers from a workshop held in 2009, and should be considered as guides only. Other considerations include land condition, timber density and climate or average rainfall of the district in question.

In order to derive the stocking rates in table 4, firstly, the group put together a list of land systems, each an amalgamation of some of the GLM land types of the region. This simplified the process rather than having to consider stocking rates for each of the 18 land types of the MB.

Stocking rates for each of these land type groups are given with a range for land types that might be cleared or have some trees. The figures in the table have also been verified against modelled pasture growth and calculated safe carrying capacities.

Table 4. Land systems of the Maranoa Balonne and their expected carrying capacity ranges for common tree basal areas.

Land system	Carrying capacity range (ha/AE)	Usual tree basal area or range (m^2/ha)
1. Brigalow & better scrubs	2–7	0
2. Alluvial flats	5–7	0–4
3. Mitchell grass	4–6	0
4. Box on duplex	3–14	0–8
5. Pine and box on sands	10–16	0–7
6. Ridges and mulga	18–40	8–20

Note: The land type groups listed above have been ranked from most to least productive.

If there are no historical figures to refer to, look for neighbours in the district with land in good condition to provide some guidance. There are stocking rates for many land types of the Maranoa Balonne available from local consensus data (Lawrence, Slater et al. 1991), and 'An introduction to the Maranoa district of Queensland', Queensland Department of Primary Industries, RQW 87013, 1987. They are also given in Roma District Land Management Manual, Department of Primary Industries, Training Series QE87001, 1987, Table 9.5

While local experienced operators and some of the references (listed above) can provide good guidance on **determining long-term carrying capacities**, the technique provided in the GLM and *Stocktake* workshops offer an objective assessment that is repeatable, uses local climate information and can account for changing conditions such as declining land condition and woodland thickening. The comparative outputs of these assessments can then assist in determining the profitability of a range of management strategies to improve the situation.

The first thing to do is to check land condition and tree densities of the different land types in each paddock. Use the *Stocktake* and GLM approach of checking the presence or absence of 3P grasses and their health, presence of weeds, any signs of erosion or abnormal hard setting soil surfaces and measuring the basal area of existing woody vegetation. If the land condition is good then historical stocking rates and management have been sustainable and can be maintained.

If there appears to be a decline in land condition to B, then reassess carrying capacities using GLM or *Stocktake* techniques. Compare the outcomes with current stocking rates and adjust stock numbers if necessary.

Where there are contrasting land types in a paddock and grazing is concentrated more on one land type than another, fencing out the overgrazed land type should be considered as an option for avoiding further declines in land condition. Using the safe carrying capacity technique described above can show the benefits to production but these results should then be tested in a suitable economic package such as '*Breedcow Dynama*' or '*Testing Management Options*'.

The safe CC calculations given in the GLM workshop can provide an objective assessment of carrying capacities to consider in conjunction with local recommendations. These calculations require pasture growth data for each of the land types on the property, their safe utilisation rates and an estimate of annual pasture intakes by the classes of stock grazing each paddock.

The *Stocktake* database shortcuts these manual calculations to some extent and will calculate current and potential carrying capacities of land types and paddocks once information on land condition and tree densities is entered.

An important consideration in the Maranoa Balonne is to allow for grazing pressure from feral and native herbivores that may be present when setting stocking rates. Kangaroos and wallabies can consume a high proportion of pasture on offer when present in large numbers, so they need to be taken into account or numbers managed. On average, 14 kangaroos will eat as much pasture on a daily basis as a 450 kg steer or dry cow.

Also discount the stocking rate according to the area of a paddock that is not accessible from water. This will include areas too steep or rocky for stock to access or areas more than 3 km from water.

Monitor pastures and woodlands so any resulting changes in pasture growth can be accounted for.

5.1.4.3 *Considerations/caveats*

Local recommendations can vary according to the individual's property circumstances and these circumstances need to be defined and taken into consideration when settling on a new stocking rate or carrying capacity.

The carrying capacities derived using the safe carrying capacity calculators in GLM and *Stocktake* are a guide only but their relative differences due to changes in land condition or tree density are important when making decisions.

There is little or no data to consider the ecological and financial outcomes of varying stocking rates to take advantage of better seasonal conditions, particularly using a practical system for varying stock numbers. The AB project data may lend itself to testing options in a modelling framework and this option should be explored.

5.1.5 Management action: Use forage budgeting to adjust stocking rate to seasonal conditions

Stocking rates may be increased above the long-term carrying capacity in good seasons to take advantage of above average pasture growth with lower risk of harming the pasture, but prompt action is required to reduce stocking rates as pasture availability and seasonal conditions decline. It is usually the combination of high stocking rates during periods of low rainfall and pasture availability that result in major declines in land condition that can persist for years and, perhaps, decades. It is wise to set an upper stocking rate limit even for very good seasons to avoid the risk of excessive pasture utilisation rates if subsequent conditions are poor. This upper limit may need to be specific to land types of the Maranoa Balonne and could be based on an upper limit of about 20–30% increase in stock numbers, depending on the extra pasture growth in better years. Changing stock numbers in this way may not actually change annual pasture utilisation rates in better years but keep the utilisation rate fairly constant.

The local recommendation to come from consultation with experienced graziers is to adopt a conservative stocking rate (i.e., stock around the long-term CC) and vary stock numbers by 10–25% around those numbers.

This approach is largely supported by the biophysical modelling for the MB which suggests that annual variations in stock numbers of +/- 25% per year around a moderate stocking rate, and up to 60% total variation over the longer term, will help avoid penalties to stock liveweight gains, soil loss and loss of perennial grasses.

Seasonal forecasts can be used in areas where they have good reliability to aid in making stocking rate decisions for the coming wet season. However, remember the limitations of seasonal forecasts and be prepared to adjust for different conditions. Estimates of expected pasture production based on historical records can be used where seasonal forecasts are not reliable. The ENSO provides some reliability in parts of the MB and can give some guidance but should not be the sole basis of decision making, as mentioned above.

Some good insights to the reliability of ENSO as a rainfall and pasture growth predictive tool are given in Clewett and Clarkson (2007). They reported that the SOI has the greatest skill for predicting rainfall in the winter and early spring periods for centres in the Maranoa Balonne with a lead time of two months, but it was also a useful tool for predicting pasture growth in the early summer when run in conjunction with the GRASP model. They also showed the median date for break of season pasture growth (>20 kg/ha/day) at Roma is 26 November, but in an El Niño year the median date is 4 December and in a La Niña year it is 15 November. This sort of information can be useful in developing a forage budget and anticipating break of season rain.

Table 5 is adapted from Clewett and Clarkson (2007) and shows the range of median rainfalls and variations according to the ENSO for some centres in the MB and the Upper Murray Darling Basin.

Stocking rates should be reduced in poor years of below average pasture growth, especially during poor wet seasons (because of the sensitivity of perennial grasses to grazing at this time). Plans for a progressive reduction in stocking rates during deteriorating seasonal conditions should be developed to avoid crisis management.

Develop a forage budget at the start of each winter for the coming 6–8 months. This should allow for adequate pasture residue of 800–1200 kg/ha (although there is **no evidence** to say that this equates to 40% ground cover; see below), with >40% ground cover (a recommendation from the AB project) at the start of the next summer and to allow for the possibility of a poor growing season. So the forage on hand at the end of summer should be sufficient to support current stock numbers through the winter and spring and until well after the commencement of the next growing season. If conditions remain dry into the next summer and pasture growth is insufficient to support existing stock numbers, further adjustments may well be required.

Tools such as *Stocktake* are available to help in developing a forage budget and seasonal forecasts (as explained above) can assist with decisions on whether to retain existing stock numbers. These tools can assist graziers in making decisions to offload stock early and avoid offloading stock in flooded markets with depressed prices.

Greater subdivision of paddocks can allow rotational grazing systems. As with continuous grazing, a forage budget for the whole property, or series of paddocks, at the end of the growing season can help determine whether the feed resources will last until the next growing season or whether there is potential to agist or buy in more stock to take advantage of an abundant pasture supply. A rotational forage budget can then be used to determine how long stock can graze each paddock before moving to the next.

Table 5. Annual median rainfall (May–April) for locations in the northern Murray-Darling Basin of southern Queensland, and the percent change in media rainfall when average SOI for the 12 month concurrent period (May–April) was below –5 or above +5.

Bureau of Meteorology station number and name	Annual median rainfall (May-April)	Fall in median rainfall when average SOI is below -5		Rise in median rainfall when average SOI is above +5	
	(mm)	(%)	(P)[1]	(%)	(P)
041017 Chinchilla	658	12	*	26	**
041522 Dalby	654	12	**	18	**
041521 Goondiwindi	590	11	*	35	**
041047 Inglewood	636	17	**	29	**
042022 Meandarra	557	14	**	14	**
042023 Miles	631	13	**	28	**
041359 Oakey	654	15	**	8	**
041082 Pittsworth	683	17	**	18	**
043091 Roma	562	15	**	30	**
043034 St George	456	10	*	43	**
041095 Stanthorpe	745	13	**	20	**
043035 Surat	547	14	**	26	**
041100 Texas	630	9	*	29	**
041103 Toowoomba	913	19	**	11	*
041176 Warwick	682	18	**	18	**
Mean of 112 stations in catchment	616	15		18	

[1]Statistically significant differences in probability distributions (KS test) are indicated by: *P50.05; **P50.01.

Stocking rate decisions should be based on an assessment of current pasture conditions. This should consider patterns of grazing distribution within paddocks. Where they have been developed, use plant and soil indicators to inform decisions about the need to reduce stocking rates to avoid land degradation as pasture availability and seasonal conditions decline. The condition of perennial grass tussocks (such as the amount of residual biomass or stubble height) are important indicators of future plant survival and pasture productivity. Reducing stocking rates late in the wet season may encourage seed production by palatable perennial grasses. Maintaining minimum levels of ground cover is important to protecting the soil.

The following recommendation is a broad indicator of whether the chosen stocking rate is appropriate for a paddock and land type —

'If you come out of a drought or dry season with a good cover of stubble on the ground, seven or eight years out of ten, then your stocking rates are about right' (W.H. Burrows, pers. comm.).

This was Burrows' conclusion after more than 40 years of pasture and woodland research in Queensland. The implication is that at light to moderate stocking rates pastures may be overgrazed two or three years out of ten, but there is sufficient capacity for them to recover condition in the remaining seven years when utilisation rates will (sometimes) be much lower than the average for the whole ten year period. **A modelling exercise using GRASP should be able to validate this.**

5.1.5.1 Evidence

A number of trials have been conducted over the past 30 years examining the effects of utilisation rate on pasture performance [Ecograze (spear grass), Toorak (Mitchell grass), Burenda (Mitchell grass), Arabella (mulga), The AB project at Injune and Rubyvale (Aristida and Bothriochloa based pastures)]. While the method of determining utilisation rate varied between studies (consumption of a percentage of pasture grown during that year for Ecograze versus consumption of a proportion of the end of growing season yield over the following year for other studies), these trials do show declines in both animal production per head and pasture condition as utilisation rate increases.

The AB project showed conclusively that increasing utilisation of pastures reduced liveweight gain per head but liveweight gain per hectare increased. However, there was only a slight increase in production per hectare going from a moderate grazing pressure (50% use of end of growing season standover pasture) to heavy grazing pressure (75% use of standover pasture). Profitability was greatest at the moderate utilisation level but this is somewhat marred by erosion and soil losses being considerably higher than at lower grazing pressure (25% use of standover pasture).

The above 'levels of use' do not equate to utilisation levels and the data in the AB project requires further examination to determine what utilisation levels were achieved with these strategies.

Maintaining ground cover above 40% is a recommendation from the AB project. To achieve this, aiming for residual pasture of 800–1200 kg/ha going into summer is a recommended. However, maintaining these residuals has not been proven locally to achieve 40% ground cover. An analysis of observations from pasture sampling using the GUNSYND technique in black speargrass land types showed that when early leafy growth of black speargrass approached 1000 kg/ha, ground cover levels also approached 30% (Ken Day, pers. comm.). While these levels may equate when pasture is in phase 1 (early leaf growth) of its growth, residues remaining at the end of phase 4 (seeded and hayed off) are more often comprised of stem and litter on the ground.

Another approach would be to develop a set of photo standards of different levels of ground cover and their respective yields for local land types, as done by Karfs et al. (2009) for the Burdekin.

5.1.5.2 *Implementation*

At the end of the growing season, from about the beginning of April to the end of May, assess the total dry matter yield of pasture in paddocks on the property. Experienced operators can use photo standards to assess relative yields but inexperienced operators should cut and weigh some pasture to 'get their eye in'. Even experienced operators are well advised to cut some quadrats (0.5 m x 0.5 m square) of pasture to re-tune their assessments.

On a paddock by paddock basis, calculate whether there is enough feed to last current stock numbers well into the next growing season when there is a reasonable chance of receiving grass growing rain. More detail will be provided on doing a forage budget shortly.

In determining 'a reasonable chance of receiving grass growing rain' we can set some parameters. 3P grasses will respond to rainfall and grow from about September onwards as the weather warms up but growth rates are slow in the Maranoa Balonne until about December so, usually, limited growth is experienced before December. In spring and early summer there would need to be at least 75–100 mm of rain in a period of 20 days or 30 days respectively for it to be effective enough to promote sufficient pasture growth to overcome any existing feed shortages. Seventy five mm would give about 370 kg/ha of growth and 100 mm about 500 kg/ha on box flats at Roma.

Glentulloch AB project sites post project (January 2009)

Using past rainfall records for the last 100 or more years, the chances of getting 75 mm of rain in a 20 day period from:

i) September to November (inclusive) are 57%
ii) September to December are 78%
iii) September to January are 86%.

The chances of getting 100 mm rainfall in 30 days are:

i) September to November 50%
ii) September to December 71%
iii) September to January 83%.

These values demonstrate the importance of your own attitude to risk in forage budgeting. Realistically, however, a forage budget should account for a grazing period from at least the end of the growing season to the end of December which could be as long as 270 days. This is supported by Clewett and Clarkson (2007), as reported above, who found the median date for reasonable pasture growth rates, >20 kg DM/ha/day, is 26 November.

When doing the forage budget, estimate the amount of feed left at the end of the growing season. Unpalatable pasture, residual feed that should be left as ground cover at the beginning of the growing season and pasture that will be lost due to trampling and wastage should now be subtracted. What is left is available for grazing (figure 2). Different classes of stock will eat different amounts of feed. This is usually accounted for by bringing all stock back to numbers of adult equivalents (AEs). For example a 450 kg steer or a 450 kg dry cow is equal to 1 AE and it will eat about 10 kg of pasture dry matter per day on average over

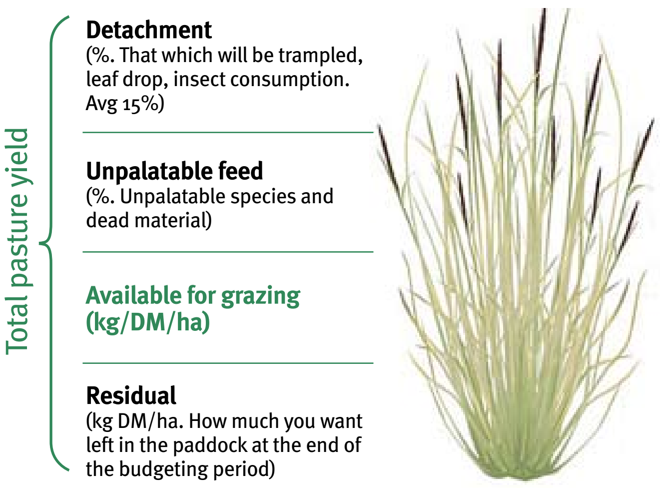


Figure 2. Components of a forage budget

a year. A wet cow is about 1.35 AEs on average over a year and so will eat about 13.5 kg of pasture dry matter per day. We can now calculate how much feed a steer or cow will need for the 270 day grazing period and whether the paddock will have sufficient pasture for stock to last until the end of December.

At the end of the grazing period leading into the early growing season, when storms might be expected, there should be adequate residual pasture to ensure ground cover of at least 40% (AB project). A suggested residual is 1000 kg/ha but this would be a minimum to maintain in years of low pasture growth. The AB project found that a moderate grazing pressure maintained ground cover levels above 40% at all times so this shouldn't be too hard to achieve.

A forage budget might also indicate there is ample feed for existing stock and enough to bring in more cattle if the enterprise allows e.g. growing store cattle for short periods (up to six months) for sale to feedlotters, or taking on agistment stock. Keep in mind that once the amount of feed eaten as a proportion of palatable pasture exceeds 30%, extra supplements may be required to simply maintain the liveweight of cattle.

There are spreadsheets that make these calculations easier and there is one in the *Stocktake* database that allows for more detailed control of intakes at different times of the year if that is the operator's preference. Another useful course that uses forage budgets as part of the assessment process is the EDGE Nutrition workshop.

A forage budget should be done at the end of the growing season and once or twice over the grazing period to check that things are on track. This type of forage budget allows managers to make stocking rate and selling decisions very early in the dry season, or even during the latter part of summer, rather than being reactive and forced to make a decision in crisis situations. It should be done for the whole property at this time of year irrespective of grazing system.

Those using rotational grazing systems tend to use forage budgets or similar tools on a much more frequent basis to determine how long to graze each paddock or sub-paddock in a cell or paddock rotation. This is a useful process but an overall paddock and property forage budget is still necessary at the end of the growing season to forecast feed deficits over the drier part of the year.

5.1.5.3 *Considerations/caveats*

Good growing seasons with an ample supply of feed may be an opportunity to spell pastures to maintain condition (section 5.1.6) and/or to use fire to manage woody plant populations (section 5.3).

Arriving at an estimate of pasture yield for a paddock is often difficult due to variations in yield and species composition across a paddock. It helps to break the paddock into areas of different yield and estimate their proportions of a paddock to give a weighted average yield. For example if a paddock has a pasture yield of 2000 kg/ha but 10% of the paddock is bare, multiplying the yield by 90% will give a weighted average of 1800 kg/ha. Not accounting for the bare areas may have led to overstocking of the pastured areas.

5.1.6 Management action: implement pasture spelling

Spelling pastures can both increase the amount of pasture grown and reduce the amount consumed. This can increase the total feed supply or defer when it is consumed. Pasture spelling also has a role to play in maintaining and restoring pasture condition.

5.1.6.1 *Evidence*

While there has been considerable research on using pasture spelling to improve land condition, there has been little study of the effects of pasture resting on land in good condition. One of the few studies was the Ecograze project at Charters Towers where spelling paddocks in the early growing season each year for eight weeks combined with 50% utilisation gave similar pasture performance to 25% utilisation without pasture rest. Both these treatments maintained land in good condition.

Pasture spelling during the early growing season avoids the grazing of regrowing perennial grasses when they are most sensitive to defoliation. By allowing patches to grow without continual re-grazing, they become more like the remainder of the pasture and animals are less likely to return to these patches (especially if resting is combined with fire—see section 5.1.7).

A general conclusion from South African studies was that pastures in good condition should be rested one year in four. The bio-physical modelling showed that spelling pastures in B condition for two, three or six months every four years allowed pastures to recover to A condition when moderate stocking rates were employed but there was little benefit to spelling pastures in A condition. However, if stocking rates remained high none of the spelling regimes improved land condition unless pastures were rested every year during the growing season for six months.

Spelling pastures is considered a good practice in the MB by experienced graziers and extension staff. This allows pastures to recover condition following droughts or periods of overgrazing. But they add that the benefits of spelling will not be realised unless there is sufficient rainfall for pasture growth and recovery.

This is supported by the data from the AB project that noted 'extreme seasonal rainfall can produce big changes in the species makeup of pastures independent of recent grazing pressure'. They also noted that 'a dramatic change in stocking rate will not, in the short term, always cause rapid change in pasture composition despite a big change in available forage'. The message is to spell pastures when there has been adequate rainfall for growth and recovery.

Best practices for pasture spelling identified at the MB regional workshop recommended:

- Spelling as soon as it rains (for a minimum of one to two weeks and maximum of six months) during the summer growing season.
- Length of spell is dependent on purpose—whether for regrowth control, pasture maintenance or pasture recovery (after grazing or dry spell).
- Spell pine country every three years and box country every four or five years to control woody regrowth with fire and maintain pastures in good condition.
- Spell in winter for (winter active) legumes, saw fly and using oats.
- Generally, a number of smaller paddocks allows rotational grazing systems to be employed so that paddocks in poorer condition can be spelled every growing season to speed up recovery. These systems do not need to be complex (see section 5.2.3.2).

5.1.6.2 *Implementation*

Where the aim is to grow more feed then spelling pastures will need to be during the growing season and after sufficient rainfall to promote enough growth of pasture to transfer energy and nutrients back to the depleted root system but if the aim is to reduce consumption then this can be any time during the year.

From a practical perspective, the spell period to improve land condition should commence at the beginning of the growing season for long enough to allow the 3P grasses to reach phase 2 growth stage (extended green leaf stage) or phase 3 (seed set). By this stage there should have been sufficient transfer of nutrients to the plant roots for recovery providing there has been enough rain, as discussed earlier.

It is also important to allow 3P grasses to set seed periodically depending on their life expectancy for plant replacement. Mitchell grasses can live up to 30 years (D. Orr and D. Phelps, pers. comm.) and so need to set seed at least two to three times in that period to ensure new plants establish and replace those that have died. Queensland bluegrass plants however, only live for three to five years and it would be advisable to allow them to set seed at least twice in this period.

The AB project found that the grass plants present at the Injune site in 1995 steadily died over time in all treatments so that fewer than 50% of them remained in 2000. Loss rates of individual species differed with Queensland bluegrass having a high rate (71% dead by 2000) and twirly windmill grass a relatively low rate (46% dead).

Generally, it is advisable to manage stocking rates to allow seed set of most pasture species in most years where possible.

5.1.6.3 *Considerations/caveats*

Although the aim of spelling in this case is concerned with the amount of feed available for animals, spelling may give additional benefits in terms of maintaining or improving land condition.

If the area of the paddock requiring a spell is on the better soil type of the paddock and it is likely to be preferentially grazed. This area will need fencing to exclude stock or the other grassed areas will require management such as fire or supplement placement to attract stock to them and away from the preferred area (see 5.1.7).

Kangaroos and wallabies are a major problem in many parts of the Maranoa Balonne. Spelled pastures are often over-grazed by very high densities of roos and wallabies and land condition suffers as a consequence and landholders are invariably discouraged from spelling pastures. There are control techniques, some involving elaborate technology, or simply culling. Culling is often unsuccessful due to the high numbers of roos and wallabies involved and other options such as roo-proof fencing and high-tech options are expensive. The economics of fencing and high-tech options have not been rigorously tested to date, or little information exists, but there are some demonstrations in the region employing these techniques.

5.1.7 Management action: Implement a prescribed fire regime

Fire can be used to influence where animals graze and encourage them to leave heavily grazed patches and graze elsewhere. It also evens out pastures so they are at the same stage of growth, reducing selective grazing of the regrowth.

There can be some short-term benefits to cattle liveweight gains from burning but where burning results in feed shortages the benefits are not realised and in fact, liveweight losses can occur.

5.1.7.1 *Evidence*

There is both experimental evidence (e.g. Andrew 1986) and a lot of practical experience that animals prefer burnt areas that are regrowing over unburnt areas.

There is a range of contrasting results in relation to liveweight gains of stock after using fires. Ash et al. (1992) found a short term (6 months) benefit to liveweight gains from burning pastures in black speargrass country in south-east Queensland. At *Galloway Plains* near Calliope in central Queensland, burning reduced liveweight gains due to feed shortages after the fires. There was no advantage to liveweight gains of cattle grazing patch burnt pastures in the AB project at their site near Injune.

5.1.7.2 *Implementation*

Plan stocking rates to leave enough pasture for a fire that will achieve the goals of burning. Preferably, burn in spring after 25—50 mm of rainfall. Burnt pastures will also require careful management, including spelling, to prevent overgrazing in the early phases of growth.

5.1.7.3 *Considerations/caveats*

Consider the timing of the fire so that it does not damage pastures or result in feed shortages. Preferably, burn in spring after 25—50 mm of rainfall. Burning small areas or proportions of a paddock can concentrate stock on those areas leading to a decline in land condition. Burn at least a third of each paddock to avoid this situation.

5.2 Pasture in poor C condition

Section 5.1 referred to a situation where a paddock is in good overall condition and the challenge was to optimise the stocking rate management. In this section we are dealing with pastures in poor condition due to a history of overgrazing and loss of many of the 3P plants. Section 5.3 deals with land in poor condition due to too many woody plants.

The question for land in C condition is how to manage animal numbers to minimise periods of feed shortage while using pasture spelling (and sometimes fire) to improve land condition.

5.2.1 Signs

Most of the paddock or particular parts of the paddock (e.g. preferred land type) are in C condition. There are two common scenarios:

- The amount of pasture is chronically low due to a low density and vigour of 3P grasses; ground cover is poor with deteriorating soil surface condition, with some erosion and significant loss of moisture through runoff. Areas between remaining 3P grasses are dominated by low yielding annuals of less preferred perennials.
- Less palatable perennials, such as wiregrass or tall reed grass dominate yield but the 3Ps present are selectively grazed, weak and a low proportion of yield. In this scenario there appears to be a lot of pasture and ground cover but little is useful for grazing stock.

5.2.2 Causes

The primary cause leading to poor land condition is usually chronic and continuing overgrazing which may be exacerbated by drought and/or intense wildfire events. Frequent and severe defoliation can have deleterious effects on both individual plants by reducing their vigour and on soils and pastures by reducing land condition (lower cover and more bare ground, lower infiltration and more run-off, altered botanical composition, patchiness). Drought and intense wildfire can sometimes enhance damage to already weakened pasture.

The 3P grasses are often selectively grazed within the pasture leading to them being weakened, resulting in their death or reduction in size and vigour. Seed production of 3P grasses may be prevented and recruitment of new 3P grass seedlings is minimal.

With the demise of 3P grasses other plants increase which have strategies to survive the grazing pressure. This may be quick growing and prolific

C land condition pastures

seeding species (e.g. button grass) or species with unpalatable traits (e.g. wiregrasses, rattlepods) resulting in avoidance by livestock. Unpalatable traits may include tough leaf blades and stems, chemical deterrents or physical deterrents (prickles and spines).

5.2.3 Management response: Amount of pasture is low with 3Ps present or pasture total yield is high with a low proportion of 3Ps

The question is how to manage animal numbers to minimise periods of feed shortage while using pasture spelling (and sometimes fire) to increase the 3P grasses, reduce undesirable species and improve ground cover and rainfall infiltration.

The most effective actions will be pasture spelling combined with matching stocking rates to the amount of available 3P forage in pastures. This is an important consideration as merely matching stocking rates with total forage on offer ignores the extra grazing pressure exerted on the 3Ps due to their limited presence in pasture.

Graziers will often look across a paddock and see a high yielding pasture, apparently capable of supporting many stock. A closer look at the species composition might reveal that, for example, half the species are unpalatable and not being grazed, and the remainder are 3P grasses. When the paddock is stocked at its normal rate, the grazing pressure exerted on the 3P species is twice what it would be if that paddock contained 100% 3Ps. The outcome is a further decline in land condition. Forage budgets cater for reducing stocking rate allowing for the proportion of unpalatable species present.

Installing additional infrastructure may be useful to move stock away from preferentially overgrazed land types or to enable the application of pasture spelling.

A general recommendation for improving pasture condition is to have a planned but flexible regime to spell paddocks for the whole growing season commencing from the first rain event sufficient to initiate new growth (38–50 mm within three days). Spelling regimes can be described by their timing (seasonal), duration and frequency or number of rest periods.

Substantial evidence exists across many regions that indicate spelling during the growing season (summer) and particularly during the early growing season when grasses are most susceptible to heavy defoliation is important for encouraging 3P grasses. Rest during the dry season may also be useful for maintaining ground cover and improving rainfall infiltration for the following growing season.

At the individual 3P grass scale, the grass needs time to initiate a leaf canopy to commence photosynthesis, and then to grow, re-build root reserves and produce seed (figure 3). Seedlings require time to grow a strong root system to survive the follow dry season.

The required frequency of resting or number of rest periods to achieve a certain goal will be determined largely by growing conditions experienced during the rest period (pasture maintenance and recovery are boosted by good seasonal conditions). Establishment of seedlings from the seed set during an earlier rest period may be enhanced by a subsequent rest period.

Increasing the number of rest periods can be expected to give a greater pasture response but represents a trade-off as grazing is foregone during the rest period. There are no experiments

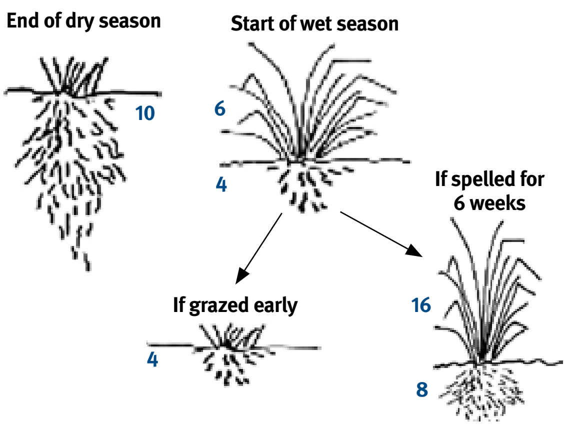


Figure 3. Plant, energy and grazing interaction. Numbers are indicative units of energy

in northern Australia dealing explicitly with comparisons of the frequency of rest periods but a number of trials provide useful information indicating that as land condition declines pasture rests need to be more frequent if land condition is to be improved.

The duration of rest period for poor condition pastures should be a minimum of eight weeks, however spelling for the whole growing (summer) season has been shown to be desirable particularly in below-average rainfall years. The AB project ran for only seven years but in that time they found that spelling for one growing season did little to improve land condition unless there was above average rainfall during that time.

Three producer demonstration sites (PDS) at Bollon, in the south-west of the Maranoa Balonne region, implemented tactical pasture spelling practices between 2008 and 2010. Demonstration paddocks selected were in an average of C land condition in 2008 and were spelled either after sufficient rainfall for pasture growth (30+ mm of spring/summer rainfall) or during the early phases of pasture growth in summer.

The demonstration sites proved that summer spelling of pastures improved land condition (by at least 1 condition score) at all properties irrespective of pasture type. It is important to note that 2009 and 2010 were above average rainfall years. However, these spelled paddocks appeared to recover more quickly then neighbouring paddocks and properties in the region due to tactical spelling management (Hamilton and Paton, 2010).

Wet season spelling was modelled using GRASP and ENTERPRISE for the theoretical MB property using 25 years of climate data up to mid 2010. A one in four year rotational spelling strategy was modelled on four breeder paddocks on a variety of poplar box land types with both native grasses and buffel. All the paddocks to be spelled were in poor condition with less than 30% good perennial grasses present. The remaining paddocks on the property were modelled in A condition to enable the benefits of spelling to be realised through carrying capacity and increases in herd numbers. The economics presented show the effects of spelling each paddock on the whole property gross margins and profits. Each paddock was rested from grazing for the entire summer once every four years and stock were agisted in that time.

In summary, resting pastures every four years improved land condition, carrying capacity and profitability, with little differences between paddocks. The effectiveness of spelling pastures is dependent on stocking rates, duration and timing of the spell period, particularly in relation to rainfall and the growing season, and land type.

The poplar box on alluvial plains land type required three summer spells to recover and recovered to more than 80% perennials over a eight to nine year period (figure 4). The box and sandalwood with buffel land type only required only two spells to recover but still needed seven years to reach 80% dominance by buffel (figure 5). The graphs also show that with no spelling pastures recovered to some degree in better years but went downhill again with the return of drier years.

Spelling improved gross margins on a whole property basis by about $55,000 (12%) annually, and profits by about $100,000 (32%) annually. Gross margins are averages for the 25 year period. Gross margins per hectare were $24.16 without spelling and $27.62 with spelling, and $207.53/AE without spelling and $192.02/AE with spelling. Spelling improved pasture condition over time and therefore carrying capacity was improved as well.

Other modelling exercises showed that pasture and land condition could only recover under a set stocked regime when stocking rates were initially reduced to less than 'safe' stocking rates. The lighter stocking rate enabled recovery to good A condition over a 17 year period, much longer than required with a full summer spell every four years (as above pastures recovered in seven to nine years). Maintaining medium or high stocking rates didn't allow pasture to recover to better condition over the 25 year time frame. The lighter stocking rate was also more profitable.

5.2.3.1 *Implementation*

Fencing to subdivide paddocks allows more flexibility for resting pastures and this is where rotational grazing systems may play a role, although there is no literature that is conclusive in determining that rotational grazing systems are any better at improving land condition than continuous stocking of paddocks interspersed with periods of rest.

The rationale behind this suggestion is as follows.

5.2.4 Suggested systems that allow spelling regimes

The principles and best practices referred to above require systems of management to implement at

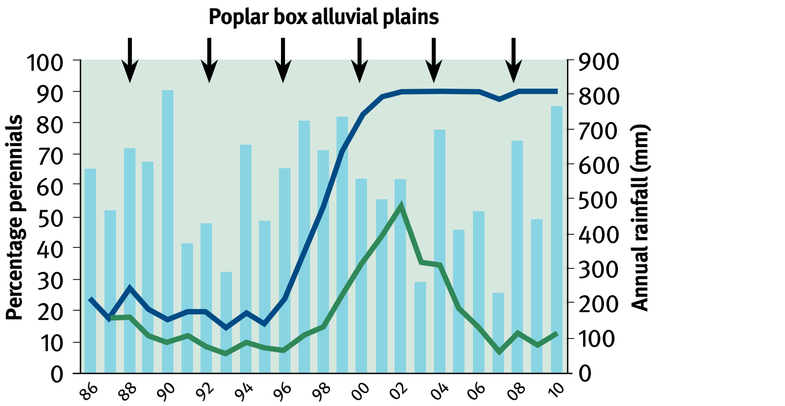


Figure 4. Annual rainfall and the proportion of perennial grasses in pastures on a poplar box on alluvial soils land type, either spelled every 4 years or not spelled. Arrows indicate when spelling occurred.

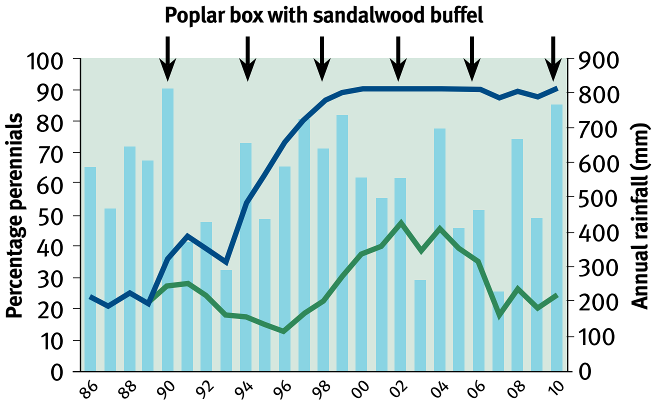


Figure 5. Annual rainfall and the proportion of perennial grasses in pastures on a poplar box with sandalwoods land type, either spelled every 4 years or not spelled. Arrows indicate when spelling occurred.

the property level. The literature and biological modelling shows that pastures in poor condition require spelling for at least two good (above average) growing seasons for recovery to one higher condition state e.g. to go from C condition to B condition. In fact, recovery may only occur over many years depending on prevailing seasonal conditions as indicated above. On properties with large paddocks this can only be achieved by selling sufficient stock to destock or agist stock from one paddock for a growing season each summer until all the poor condition paddocks have had two seasons rest.

This means pastures will only recover slowly over the whole property taking many years depending upon the number of paddocks requiring spelling. For example, if there are six paddocks on the property, one sixth of the property's stock need to be sold to spell a paddock in each growing season. Using a spell for two growing seasons per paddock, it will take 12 years to lift land condition on the whole property one condition state, and this assumes that each spell coincides with an above-average growing season which, of course, is not going to be the case.

On the other hand, rotational grazing systems, that allow every paddock on the property to be spelled for some time in every growing season, should assist recovery to a higher condition state in a shorter time period and more cost effectively. For example, if the cattle on the property with six paddocks are put into one mob and grazed on a rotation through the six paddocks, shifting every two to six weeks, each paddock will get a spell in some part of the growing season in most years. It would be particularly important to start this system once there has been sufficient rain for pasture growth in the spring or summer. Using a rotational forage budget to graze 10% of available pasture from each paddock will achieve this sort of outcome. However the proportion of pasture to be grazed on each rotation has not been tested scientifically and the figure of 10% is only supported with anecdotal evidence and grazier experience.

Even when using a rotational forage budget to calculate the movement of stock through paddocks, the overall property long-term carrying capacity needs to be determined to help set initial stock numbers.

A short-term seasonal forage budget can be used at the end of each growing season to determine whether the whole property or set of paddocks in the rotation have sufficient feed available to last stock through the drier part of the year until there is a reasonable expectation of pasture growing rain.

Once land condition has been lifted to A or B condition, the less intensive systems of spelling each paddock for all or part of a growing season every four or five years can be re-employed.

Two suggested systems of rotational grazing are given below.

Breeding herds are difficult to manage when calving in rapid rotational grazing systems. If a mob is moved every few days or each week during the calving season, young calves are at risk of being separated from their mothers.

For breeding properties, aim to have at least three to four paddocks to shift breeders through over a year including the growing season. Determine the long-term carrying capacity according to land condition and tree basal area and sell excess stock. Run the breeders in three of the four paddocks in the early part of the growing season, until about mid January or the first round of branding. At first branding, redistribute cows to another three of the paddocks, spelling a second paddock in the later part of the growing season and grazing the paddock that was spelled during the early part of the growing season. At the second branding and weaning in June, redistribute cattle to all paddocks or rotate the cattle in one mob through all four paddocks. A forage budget at this time of the year will determine whether there is sufficient pasture to carry cattle through to the next growing season. If not, cull dry breeders, cull for age and other criteria to reduce numbers.

Repeat this system in the second year, spelling the two paddocks that weren't spelled in the first year. In the third year spell the two paddocks that were spelled in the first year but in a different order so that each is now being spelled at a different part of the growing season than when spelled in the first year.

Figure 6 illustrates how this system might work.

For **dry stock and growing cattle**, aim to have four to six paddocks so stock can be rotated through paddocks regularly, using short term rapid rotational forage budgets. This will allow paddocks to be grazed for periods of two to eight weeks (two months) at a time giving each paddock a spell for some time in every growing season. Use forage budgets at the end of the growing season to determine whether there is enough pasture to last stock until the onset of the next growing season.

Minimal gains will be made with spelling if following the rest period stocking rates are not matched to feed supply and ongoing overgrazing occurs. Section 5.1 describes how to match pasture supply and animal demand.

5.2.4.1 *Using fire to manage pasture composition*

Some grass species are sensitive to fire (e.g. some wiregrasses and twirly windmill grass in the Maranoa Balonne). Fire can be used to manipulate herbaceous species composition by killing plants, influencing recruitment or altering grazing preferences. Local knowledge should be sought to determine the expected impact of individual fires or particular fire regimes on the specific target unpalatable grass species (e.g. different types of wiregrasses). Some unpalatable grass species may be encouraged by fire. The fire regime may also encourage other desirable species.

Implementation of a fire regime will require planning to ensure adequate fuel is available which may mean adjusting stocking rates or spelling to

Year 1 growing season	
Paddock 1 Spell during the early growing season until first branding in January.	**Paddock 2** Spell after the first round of branding until weaning in May or June.
Paddock 3 Not spelled and take some stock from the spelled paddock.	**Paddock 4.** Not spelled and take some stock from the spelled paddock.
Year 2 growing season	
Paddock 1 Not spelled and take some stock from the spelled paddock.	**Paddock 2** Not spelled and take some stock from the spelled paddock.
Paddock 3 Spell during the early growing season until first branding in January.	**Paddock 4** Spell after the first round of branding until weaning in May or June.
Year 3 growing season	
Paddock 1 Spell after the first round of branding until weaning in May or June.	**Paddock 2** Spell during the early growing season until first branding in January.
Paddock 3 Not spelled and take some stock from the spelled paddock.	**Paddock 4** Not spelled and take some stock from the spelled paddock.
Year 4 growing season	
Paddock 1 Not spelled and take some stock from the spelled paddock.	**Paddock 2** Not spelled and take some stock from the spelled paddock.
Paddock 3 Spell after the first round of branding until weaning in May or June.	**Paddock 4** Spell during the early growing season until first branding in January.

Figure 6. A diagrammatic representation of a simple four paddock spelling system.

preserve fuel followed by conservative stocking in the post fire period to encourage the recovery of desirable pasture species. Additional infrastructure may be useful for enabling smaller areas to be burnt at one time.

Determine the fire regime required to manage the target species (a fire regime over many years may be required, not just a single fire). The intensity of fire for changing the composition of the herbaceous layer appears to be less important than for managing woody species. However an important consideration prior to burning is to ensure there are adequate fuel loads and appropriate weather conditions to carry the fire. Land type, soil type and land condition will influence capacity for effective fires.

Post-fire spelling and setting stocking rates may be critical for maximising any benefits of using fire to manage herbaceous species. Where there are few desirable plants there may be little positive response to prescribed burning in the short to medium–term.

Also, look for opportunities to address two or more 'purposes' with the same fire regime (e.g. manage a woody plant and an unpalatable grass). Importantly, consider the risk of a low rainfall season and have strategies in place if the season following burning has low rainfall.

Prescribed fire is not commonly used in the MB, particularly in mixed farming enterprises, due to:

- Dry seasons and lack of fuel.
- Economic pressures—use the feed rather than burn it.
- Uncertainty of follow-up rain.
- Reducing knowledge and experience with fire in the grazing community, and some poor responses to single occurrence fires or wildfires.
- High macropod grazing pressure prior to and after burning.
- Legislation and fear of litigation.

The areas of the region where prescribed fire is more common includes box and pine country on larger properties that historically stock more lightly, where it is used to suppress woody regrowth (refer to section 5.3.3) and to some extent, manage pasture composition.

Work at Injune, as part of the AB project, found that the frequency of forest blue grass and slender chloris doubled with regular fires and the frequency and yield of Queensland bluegrass was consistently higher with fire. They recommended using fire every two to four years to manage pasture composition but concluded more frequent fires could be detrimental.

Best practices for prescribed burning raised at the two MB regional workshops at Roma were:

- Avoid hot fires on bendee and mulga ridge land types, as these will scorch the ground and pasture regeneration takes a long time.
- Infrequently burn Mitchell grass as it takes too long to regenerate; an exception may be when it is being invaded by Mimosa.
- Do not burn after Christmas as it can be too hot and pastures are seeding.
- Need to manage total grazing pressure to have effective fires.
- Patch burn on flats to control wiregrass (and pine) and stimulate green pick.
- Burn hills to move grazing pressure from flats to hills.

Some of these points deal with the use of fire for timber regrowth control but inherent in its use, fire would also play a role in managing pasture composition and selective grazing. Graziers in the Maranoa Balonne often use fire to reduce the competitiveness of wiregrasses on alluvial flats where forest blue grass (a 3P grass) would benefit and become dominant.

Most of our native grasses in the MB have some tolerance of fire and some of the 3P species are favoured by it e.g. black speargrass and kangaroo grass. Although they are both fire climax species the timing of fires for each is slightly different. Kangaroo grass can be damaged by spring/summer fires when it is actively growing. The point is that while most native species are tolerant of fire to some extent, it is the timing and intensity that is important for the species in question.

The AB project found that dark wiregrass (*Aristida calycina*) is sensitive to spring fires but purple wiregrass (*Aristida ramosa*) is not. Work in the Burnett (Orr and Paton, 1993) found both species were sensitive to fire and the results were conclusive —wiregrasses declined in yield and as a proportion of pasture over the three years of the trial and the 3P grass black speargrass became dominant.

The differing results with wiregrasses may reflect different fire conditions, or it may be because dark wiregrass has a crown above ground which is more susceptible to fire whereas purple wiregrass crowns are largely below ground and somewhat insulated from the effects of fires (Silcock, pers. com.).

Nonetheless, in their report on the AB project the authors conceded that burning wiregrass dominant pastures can help to remove the overburden of old growth on wiregrass plants—even those less susceptible to fire—and open up the pasture to allow other species to compete more favourably. This practice is often employed by local landholders.

If fire is to be used to manage pasture composition, it is preferable to use a cool fire and burn in spring after 25–50 mm rain. The pastures can regrow after the fire to give ground cover in the event of further storms and provide forage for stock. Burning within a couple of days after rain also helps to retain litter as ground cover. The litter remains moist for a short period and is less inclined to burn.

5.2.4.2 *Implementation*

List paddocks in a priority order for burning and start with the top priority paddock after the first fall of sufficient rain. As more rain is received progress to the next paddocks until it becomes too late in the season to continue with burning. Be wary of burning too much country and risking feed shortages if there is no follow up rain.

Always burn at least a third of each paddock so stock preferentially grazing the burnt area don't cause damage and a further decline in land condition.

See section 5.1 on matching stocking rates and spelling.

5.3 Woody plant problem

In the Maranoa Balonne, there are still significant areas of semi-natural plant communities used as pasture for the grazing of livestock, mostly cattle but some sheep in western and southern parts of the region. Most of these grazing systems depend on vegetation that includes some woody species, both trees and shrubs. While many areas have been cleared or thinned in the past, there is often a component of remnant or regrowth woody vegetation.

Woody species differ in their growth form, mode of reproduction and reproductive output, mode of dispersal, recruitment patterns and longevity. They also differ in their palatability to different types of herbivores (including livestock) and their responses to different types of disturbance. Browsing and fire, as well as other kinds of shoot damage, will influence different species, or even different individuals of a species, in different ways. All these factors make for enormous spatial variation in the woody component of northern Australian vegetation, including areas in the Maranoa Balonne.

While many areas in the Maranoa Balonne are cleared, there are areas of intact or regrowth woodland or shrubland of importance for grazing, and there is ongoing concern about how best to maintain a healthy balance of pasture. Native plants that proliferate in some circumstances in the Maranoa Balonne include poplar box, pine and mulga. Others that can become dominant after clearing of original woodlands include false sandalwood, mulga, turkey bushes (*Eremophila* spp.), wattles and brigalow. Some of the woody non-native species that are invasive in the Maranoa Balonne include prickly acacia, mimosa bush, parkinsonia and mesquite.

There is great concern from graziers on State leasehold properties about areas of pine thickets. The State departments charged with overseeing management of these leases regard the pine trees as an asset for future harvest for timber and disregard the reduction in grazing capacity that has occurred. Recent evidence has shown that there is less biodiversity and reduced land condition in many of these thickets than in well managed adjacent grassy woodlands with scattered pine and box trees (Eyre et al., 2010).

5.3.1 Signs

The relationship between woody and herbaceous plants is a critical one. In general, the biomasses of woody and herbaceous components of the vegetation are inversely related to one another (figure 7): all else being equal, higher woody plant biomass is associated with lower herbaceous biomass. The size, number and distribution of woody plants can all be useful indicators of the impact that woody plants are having on the herbaceous layer. A low density of large scattered trees and shrubs is likely to have little deleterious effect on a pastoral production system and may, in fact, be beneficial.

Memories of previous vegetation states (lower tree and shrub densities, for example) can be unreliable. Importantly, the change in woody plant biomass may be gradual and imperceptible

Woody plant problem

so photographic records, including aerial photographs, and satellite imagery provide useful and, perhaps, more reliable information.

Another important sign of current or impending problems can come from an examination of tree and shrub population structures. A large proportion of small plants (seedlings, saplings) may indicate a growing population though caution is necessary when making such interpretations.

The most obvious woodland thickening in the Maranoa Balonne occurs in the mulga, pine and box land types. Mulga thickening is particularly well known and there are many studies and anecdotes of mulga thickening in the regions' history.

Thickening of all the above mentioned woodlands results in a curvilinear reduction in pasture growth, where a small increase in tree basal area per hectare can give a dramatic reduction in annual average pasture growth. Figure 7 illustrates the effect of increasing trees on pasture growth for five land types of the Maranoa Balonne.

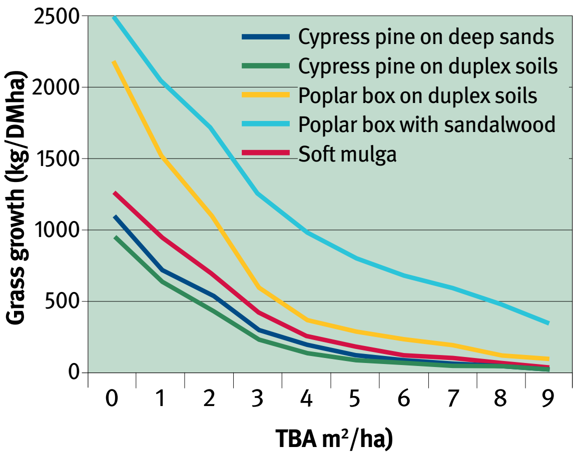
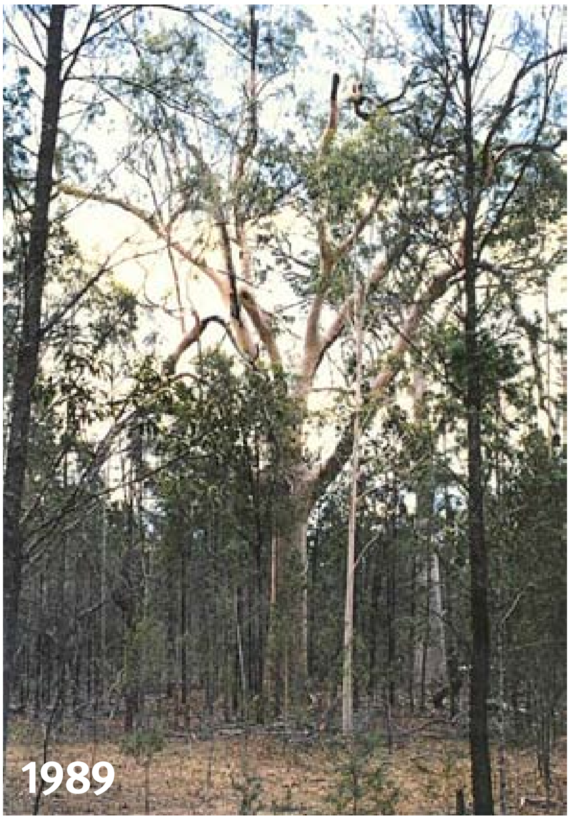


Figure 7. The effect of increasing tree basal area on grass growth for five land types in the Maranoa Balonne

The photos below depict the changes that can occur in mulga woodlands. The photos were taken from the same point near Wyandra (south-western Queensland) 44 years apart.

The photos below show a spotted gum and pine woodland near Chinchilla 53 years apart.



5.3.2 Causes

Many factors drive tree and shrub populations. Some of the important ones are indicated in figure 8 which portrays the dynamic balance between woody and herbaceous (mainly grasses) components of the vegetation. The main drivers of the dynamic are rainfall as a promoter of germination and growth, drought as a cause of mortality, competition between grasses and woody species (for water, light and/or nutrients), grazing and browsing differentially affecting biomass and possibly survival, and fire as a remover of herbaceous biomass and a cause of top-kill and mortality of woody species. Some of these factors can be managed, some cannot. Among the factors driving observed or quantified increases in populations of woody plants are:

- sequences of very wet years
- reduced competition from grasses due to heavy grazing
- reduced frequency and/or intensity of fire because of lack of fuel or active fire suppression
- rising CO_2 levels, as suggested in some literature.

The significance of these factors is likely to vary from place to place.

One important relationship is that between plant size and susceptibility to fire. For many species, small plants are more susceptible to fire than large plants. This means that increasing 'woodiness' associated with a lack of fire can create a positive feedback in which effective fire becomes less likely. This feedback loop is exacerbated by the negative effect of increasing woodiness on fuel loads and is evident in many of the areas of the Maranoa Balonne. The previous photos depict this well and the graph of pasture yields (figure 7) relative to tree basal area quantifies these effects.

5.3.3 Management response: Fire and grazing

Fire and grazing/browsing are the principal manageable factors that influence the woody components of northern Australian vegetation. Critically, these two manageable factors interact with one another (figure 8) as herbivores and fire, in effect, compete for herbaceous material. Prescribed burning, then, constitutes a management response to increasing woodiness of northern Australian vegetation.

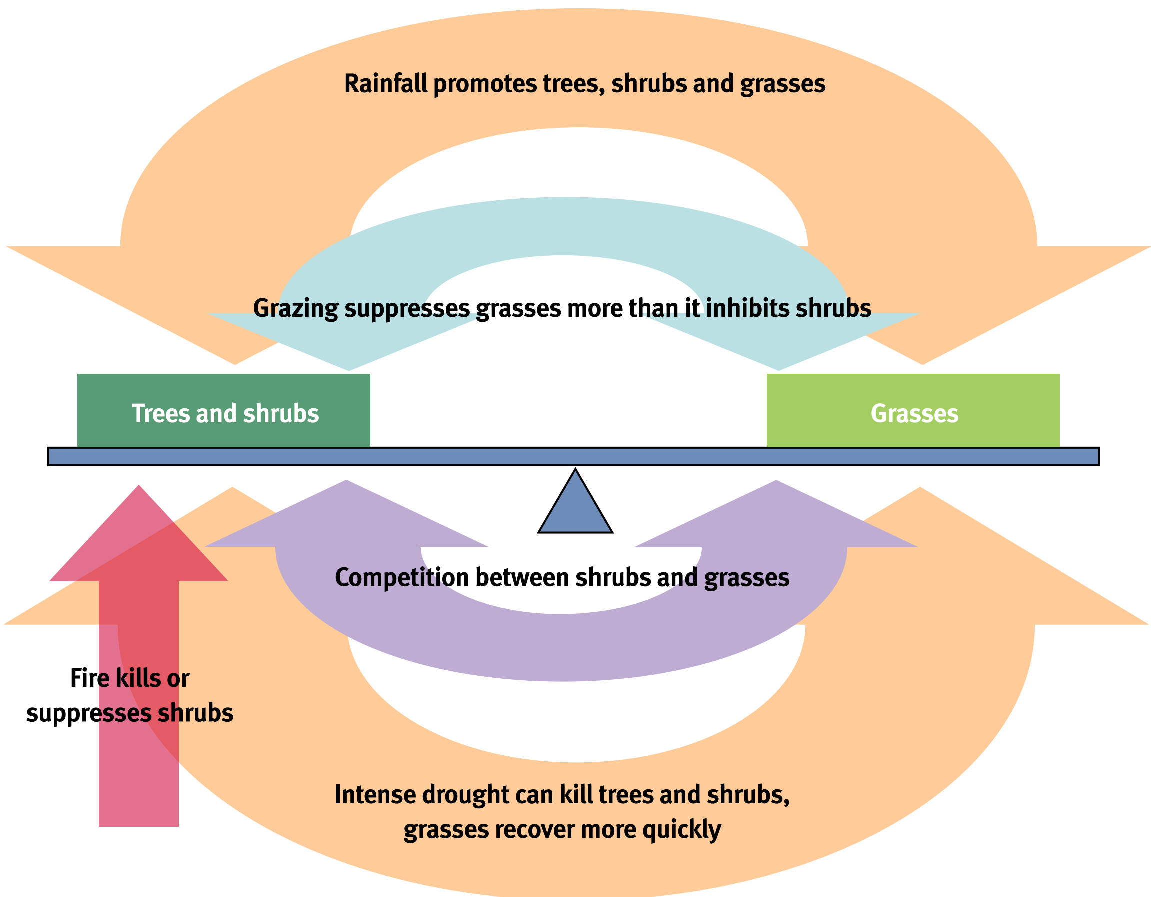


Figure 8. Factors affecting tree and shrub populations

5.3.4 Management action: Use prescribed fire to kill or suppress woody plants

If it is judged that woody plants are reaching densities or a biomass that is deleterious, prescribed burning is one of the options open to land managers. The action would involve instituting a regime of mid to late dry season burning, the most useful regime depending on the woody species present, their density and the size class structure of their populations. More intense fires may be useful for species that are more tolerant of fire, where tree and shrub densities are high and where plants are large. Less intense fires may be suitable for fire-susceptible species or where the purpose is to reduce or suppress a cohort of recently established (i.e. small) shrubs.

5.3.4.1 Evidence

A lot of the fire research that has been conducted in northern Australia has focused on the ecology and management of the woody plant strata of the vegetation. This work has included research on native communities in the Top End and Victoria River District of the Northern Territory, the Northern Gulf savannas and Cape York Peninsula woodlands in Queensland, and to a lesser extent the box woodlands of central and southern Queensland, as well as on invasive woody species in the Burdekin woodlands of north-east Queensland. Research is lacking for many regions and vegetation communities.

There is ample anecdotal and trial data to show that both cypress pine and mulga are susceptible to fire. Even tall mature trees of both can be killed with intense/hot fires. As mentioned above, once woodland thickening gets to high densities of these species, pasture growth is suppressed, sometimes so much that no grass will grow.

Some wattles are susceptible to fire while others will resprout from roots and lignotubers following fire that kills above ground plant parts. A good example of the different reactions comes from work in the Burnett where two apparently similar wattles, black wattle (*Acacia leiocalyx*) and *Acacia grandifolia*, were both present and had tops killed by spring fires. The black wattle regrew from roots but the *A. grandifolia* did not. Repeated fires over the next five or so years gained control of the black wattle.

Poplar box is a major woodland type in the Maranoa Balonne. Small seedlings are susceptible to fire but once plants are more than 1.5 m tall, they are much more fire tolerant.

Other species such as false sandalwood, a common shrubby understorey of box woodlands, are not killed by fire to the same extent but burning can suppress these shrubs so they are less competitive with pastures.

Data from a burning trial in the mulga lands with an understorey of green turkey bush showed that fire significantly reduced their density by 99% and canopy cover by 96%. The bushes gradually came back from seed but densities remained low for three years after the fire. Two to two and a half years after burning the density and canopy cover of green turkey bush was 78% and 91% less, respectively, than the original population. These reseeders will come back from seed about three years after fire and will return to pre-fire size after five years.

Table 6 lists common woody weeds of the Maranoa Balonne, their susceptibility to fire and the different fire regimes and fuel loads needed to maintain a good balance of trees and pasture.

Graziers in the Maranoa Balonne and mulga region report that goats give good control of many shrubby species but this technique for controlling woody weeds is not well researched and requires more work.

The biological and economic modelling tested the use of fire in four of the seven paddocks of the theoretical property. A one in four year burning regime was implemented on these paddocks that were either cypress pine on duplex or poplar box with sandalwood land types. The woodland densities were set at 2 m^2 tree basal area (TBA) per hectare initially and allowed to regrow over a 25 year period. In that time six burns were attempted, with one paddock successfully achieving six burns whilst the other three paddocks achieved five burns.

Where burning wasn't used on the cypress pine country, stocking rates declined as much as allowed from 15ha/AE to 25 ha/AE after 11 years due to the reduction in pasture growth with the presence of trees (figure 9). By using fire, tree growth was controlled and stocking rates remained the same in most years.

The paddocks with poplar box and sandalwood land type maintained higher stocking rates when burnt and, in fact, regular fires allowed stocking rates to increase slightly (figure 10).

Table 6. Common woody weeds in the Maranoa Balonne, their susceptibility to fire and the types of fire needed for their control.

Woody species	Susceptibility to fire	Intensity and frequency of fire required	Additional comments
Brigalow	Low	Hot fires every five to seven years	Fire will help to suppress regrowth and increase the time until mechanical control is needed.
Poplar box	Seedlings: High Plants taller than 1.5 m: Low	Cool fires every three to five years will maintain open box woodlands	Once box seedlings survive for several years they develop lignotubers and are much less susceptible to fire.
False sandalwood	Low	Medium intensity every four to seven years	Fire kills very few sandalwoods but will suppress regrowth.
Turkey bushes	High	Fuel loads of 1000 kg or more; burn every five years if possible;	Use pushed mulga to aid with fuel for fires and accumulated litter will also help.
Cypress pine	High	Cool fires every three to five years will maintain open box/pine woodlands	Pine is very susceptible to fire when small but it is possible to keep larger pine trees in paddocks using cool fires. This often means burning frequently to reduce fuel build up and hot fires.

Burning to control tree regrowth increased the whole property average gross margins from $236,794 each year when unburnt to $353,617 each year. Also, average gross margins when fire was not used were $14.93/ha and $139.08/AE. When fire was used to control regrowth average gross margins were $22.29/ha and $202.29/AE.

These examples show how useful fire can be in controlling regrowth from an ecological, production and profitability perspective.

5.3.4.2 Implementation

Implementation of a regime of prescribed burning to manage woody plant populations requires planning. The emphasis should be on a fire regime rather than on individual fires. Fires should be timed to suit the purpose for which they are intended rather than following a simple schedule. This will generally mean waiting for years in which fuel loads are adequate.

Set a priority order of paddocks to burn and plan their grazing strategies to take advantage of those years where it is possible to burn.

Discussion of the use of fire by local graziers and extension staff at both Maranoa Balonne NGS workshops gave the following recommendations.

The potential best bet management practices for prescribed burning that are considered to have the most potential for improving resilience of beef grazing enterprises are:

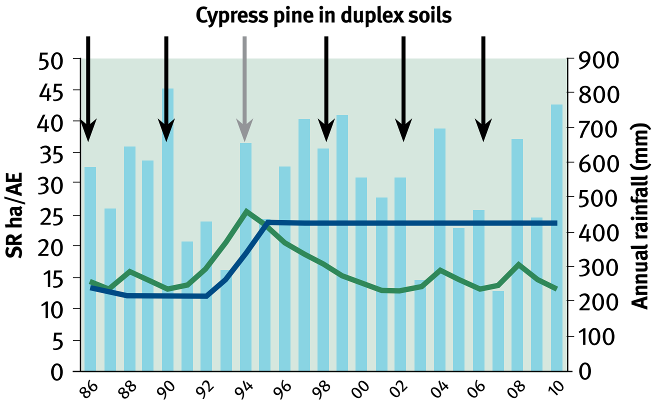


Figure 9. Stocking rates maintained on cypress pine on duplex soils land type with and without fire over a 25 year time period. Black arrows indicate successful fires and grey indicate unsuccessful burns due to a lack of fuel.

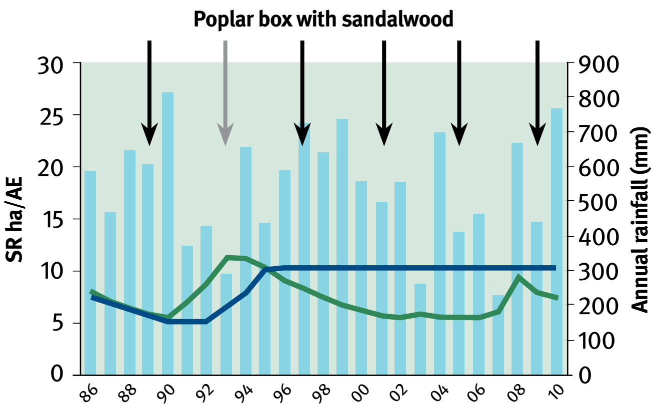


Figure 10. Stocking rates maintained on cypress pine on duplex soils land type with and without fire over a 25 year time period. Black arrows indicate successful fires and grey indicate unsuccessful burns due to a lack of fuel.

- Burn to achieve a goal which may include: regrowth control, to stimulate grass growth, remove rank material, redistribute grazing to non-preferred areas like hills, reduce wildfire hazards, and change pasture composition.
- Use local knowledge to understand the response of target species (woody and herbaceous) to individual fires and fire regimes.
- Determine the fire regime required to manage the target species (a fire regime over many years may be required, not just a single fire).
- Use fires of the appropriate intensity and residence time by managing fuel load, burning in appropriate weather conditions and utilising head or back burning.
- Use hot fires in November-December to control woody species such as white pine.
- Burn woody regrowth when less than 2–3 m tall during the late dry season.
- Burn brigalow, coolabah floodplains and poplar box flats every five to seven years to manage Buffel and brigalow regrowth, according to season, and to reduce the need for mechanical control of regrowth.
- Burn cypress, poplar box and bendee ridge land types every two to four years if seasons permit (fuel load).
- Pre-fire spelling of pastures intended for prescribed fires, including the wet and dry season, may be necessary depending on the seasonal conditions and land type productivity.
- Use forage budgets to set stock numbers so that target fuel loads can be achieved for planned burning operations.
- Utilise fuel accumulation in above-average seasons to minimise the cost of spelling prior to burning.
- Use late dry season fires in successive years, combined with wet season spelling, to reduce the abundance of wiregrass.
- Preferably, burn after 38–50 mm of season breaking rain so pastures can regrow after burning.
- Burn under-utilised patches of rank grass after last frost and before first rain to encourage livestock to graze them and change overall paddock grazing patterns.
- Consider the risk of a low rainfall season and have strategies in place if the season following burning has low rainfall.

5.3.4.3 Considerations/caveats

There are some important considerations when contemplating the use of fire to manage woody plant populations. The first is that prescribed burning comes at a cost. Costs will be associated with any spelling of pastures that is required in order to build up fuel loads so that an effective fire can be achieved. Burning when fuel loads are inadequate to achieve the purpose of the fire is obviously counter productive. Likewise, it is important that pastures are not grazed too soon after the fire.

Grazing in the immediate post-fire period would hinder the recovery of desirable pasture species. In particular it is ideal that 3P grasses are allowed to set seed in the post-fire period and this may require destocking or—at least—very low stocking densities. If pre or post-fire destocking is necessary, forage must be available for livestock on other parts of the property or off-property or they would have to be sold.

Fire can promote germination of some woody species, notably wattles, of which mulga is one. It is important to monitor the area in the post-fire period in order to be able to respond appropriately to large-scale germination events. If large recruitment events are triggered by a fire, a second fire will be necessary. Conducting a second prescribed fire before recruits set seed could reduce the build-up of seed-banks of species such as wattles. Many wattles don't set seed until they are three years old, so a follow-up fire before seed set can help to reduce the seed bank and potential re-invasion.

5.4 Ungrazed areas distant from water

In large paddocks considerable areas of ungrazed palatable forage often occur. This unused pasture represents livestock production that is forgone by the pastoral business, whilst areas near water often become degraded through overgrazing. Management options that create the opportunity for cattle to use this pasture have the potential to increase returns to the livestock enterprise by allowing more cattle to be carried where paddocks are currently stocked below the carrying capacity. Improvements in individual livestock production however are unlikely.

Developing the water point and fencing infrastructure on a property to improve grazing distribution is the primary management option to address this issue. Fire may sometimes have a role to remove accumulations of old forage and improve grazing distribution and spelling may aid the recovery of previously overgrazed areas.

A study undertaken in the Desert Uplands (Jones and Aisthorpe) showed that 90% of grazing occurs within 3 km of a watering point and 10% of the grazing occurs outside that distance. This principle can be adopted as a suitable planning tool for the Maranoa Balonne.

Paddock sizes and watering points in the Maranoa Balonne are generally small enough and close enough respectively for ungrazed areas of paddocks not to be an issue (table 1).

Having some areas distant enough from watering points can assist with maintaining biodiversity that is sensitive to grazing. With the generally smaller paddocks of the Maranoa Balonne the best way to cater for grazing sensitive plants and animals is to fence out those areas from grazing stock and only graze periodically. A recent study, the BioCondition project, has shown that some grazing is not detrimental to most of our regional biodiversity and that periodic light grazing will maintain biodiversity (Eyre et al, 2010 unpublished work).

Outcomes from the workshops in the Maranoa Balonne gave these recommendations in regard to water placement:

- Paddocks should be less than 2000 ha in area and contain two waters that are well-separated and away from fences which provides a maximum distance to water of about 2.2 km.
- Distances that stock walk to water should be less than 3 km.

The following recommendations should be considered in conjunction with water placement to manage for even grazing pressure across paddocks. The potential best bet management practices for infrastructure development that are considered to have the most potential for improving resilience of beef grazing enterprises in the Maranoa Balonne are:

- More and smaller paddocks to allow for improved management of stocking rate, pasture spelling, segregation into small mobs that are easier to manage, to minimize high concentrations of livestock within paddocks, and to facilitate a systems approach to grazing land management.
- Aim to have paddocks that can run 100–150 AEs all year round. This is particularly important for small family operations where only one or two people can muster at a time.
- Fence to land type where contrasting land types cause excessive stocking of preferred land types over non-preferred.
- Do not rely solely on infrastructure to manage grazing distribution. Locate supplements away from water points and vary location of these.
- Use laneways for easier handling of stock.
- Control access to waters with fencing.
- Trap stock onto water on larger properties.
- Good yard facilities and portable yards.

6. Conclusion

Any of the best-bet practices for managing grazing lands in the Maranoa Balonne described in this guide ultimately have two desired outcomes:

– Optimising animal productivity; and
– Keeping the land healthy and productive.

No matter which grazing strategy is used on a property as long as management has planned to:

- Stock to carrying capacity for that land type and region
- Factored in spelling to allow for pasture recovery, seed set and land condition maintenance or improvement
- Are using strategies to even up grazing (fire, sown pasture, forage crops, strategic placement of waters, fences and supplements)
- Manage the encroachment of weeds, in particularly woody weeds,

they will be helping to improve land condition and productivity.

7. Contributing to the best-bet practices for managing the grazing lands of the Maranoa Balonne a technical guide

This guide and other regional versions are the product of the Northern Grazing Systems (NGS) initiative which has been developed and implemented as a partnership between Meat and Livestock Australia (MLA), CSIRO, Agri-Science Queensland (part of DEEDI), the Northern Territory Department of Resources, and the Western Australian Department of Agricultural and Food.

Not all the regional guides were developed concurrently however to access other regional guides please contact David Phelps DEEDI Longreach email: david.phelps@deedi.qld.gov.au, phone: (07) 4650 1206 or Meat and Livestock Australia

Research and development is ongoing.

We are continually improving our knowledge and skills when it comes to Research, Development and Extension (RD&E) for the grazing lands of northern Australia.

You (the reader) in your work are also either contributing to or coming into contact with RD&E regularly and as such we would like you to contribute to improving this technical guide by filling in the form below and returning to DEEDI Roma (PO Box 308 Roma, QLD, 4455).

Any contributions to this document will be welcomed and regular revisions of this document will help inform the work we and others do with grazing industries into the future.

Key findings from research projects right through to anecdotal evidence from reputable landholders will be gladly considered in future revisions.

Information should address the four main issues or additional issues if you think necessary. Then address one of the following headings;

- **Signs** (how the issue is expressed)
- **Underlying causes**
- **Responses** – the key practices and their rationale
- The specific **management actions** that can contribute to achieving better practice and the evidence base for these
- How to **implement** these actions
- The **trade-offs**, caveats, uncertainties and other issues associated.

Contribution to NGS technical guide form

Name ____________________

Company ____________________

Contact details;

Email ____________________

Phone ____________________

Fax ____________________

Date ____________________

Issue this information is related to: ____________________

Details (please include reference, contacts or page numbers where appropriate):

Other general comments: ____________________

(Please attach additional pages if needed).

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