Tropical Perennial Grasses for Northern Inland NSW — 2nd Edition

CA Harris, SP Boschma, SR Murphy and LH McCormick

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Pasture improvement may be associated with an increase in the incidence of certain livestock health disorders (e.g. photosensitisation from panic grasses). Livestock and production losses from some disorders are possible.

Management may need to be modified to minimise risk. Consult your veterinarian or adviser when planning pasture improvement.

The Native Vegetation Act 2003 restricts some pasture improvement practices where existing pasture contains native species. Inquire through your office of the Office of Environment and Heritage or your Local Land Services for further details.

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Foreword

Although tropical perennial grasses have been grown in New South Wales for many decades, it has only been in the past 10 years that their usage has taken off. Now, tropical perennial grasses are grown over some 400,000 hectares of New South Wales, providing year-round feed to grazing enterprises. As a result, the demand for information about their agronomy has increased, and this book – Tropical Perennial Grasses for northern inland NSW – satisfies that demand. It is a compilation of a wealth of information from research undertaken by the Cooperative Research Centre's (CRC) tropical grass project team.

The Future Farm Industries CRC has supported the expansion of tropical perennial grasses through research projects that improved agronomic knowledge together with the selection of new grass cultivars with superior productivity and persistence. This work has led to commercial agreements being signed with Heritage Seeds for new cultivars of panic grass, which are expected to become available to farmers by 2016. These new cultivars should encourage further adoption of tropical perennial grass pastures, not only in NSW, but also in Queensland and Western Australia.

I would like to acknowledge this book's editors – Carol Harris, Suzanne Boschma, Sean Murphy and Lester McCormick from New South Wales Department of Primary Industries – for their outstanding efforts in producing this publication. They, and others involved in the project, have delivered a resource that will serve the industry well for considerable time to come.

Peter Zurzolo
CEO, Future Farm Industries CRC
June 2014

As a born and bred grazier, it is a great pleasure to be asked to provide a foreword to this book, 'Tropical perennial grasses for northern inland NSW—Second edition'. With the increasing variability in rainfall, both in intensity and frequency, producing high quality green dry matter any time of the year is becoming 'king'. Grazing enterprises are adapting extremely well to these variables, and being able to expand the planted area of tropical pastures throughout much of the inland pasture regions of NSW is an exciting opportunity.

Such a resource as this is invaluable to the central and northern slopes pasture regions of NSW. Covering topics from why grow tropical perennial grasses, to species selection, seed quality, sowing rates and placement, and early establishment, this publication then extends itself to the commercial reality of how best to make money from such pastures; the high quality feed they generate, nutrition requirements, companion legumes, and coping with surplus forage should it eventuate.

The extensive work of the many authors involved in the topics above continues on from much research conducted by various NSW departments from as early as the 1950s. With the revitalised interest in tropical grasses over the last 10–15 years, many farmers and graziers in pasture regions of NSW owe a great deal to these researchers, and NSW DPI in particular, for such a publication. I commend it to all those with an interest in pasture improvement and animal production in areas with a capacity to sustain tropical perennial grasses.

David Harbison
President, Grassland Society of NSW
June 2014

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SECTION TWO — Management
Making the most of tropical perennial grass pastures on-farm

Chapter 1: Introduction

CA Harris, SP Boschma, SR Murphy, LH McCormick, GM Lodge, and BR McGufficke

Evaluation of tropical perennial grasses first occurred in northern inland New South Wales (NSW) in the 1950s. Although their potential was recognised and their use recommended, limited seed availability and the pursuit of cropping resulted in low adoption. Evaluation and establishment methods of tropical grass species and cultivars continued during the 1970s and 1980s. In the 1990s, widespread evaluation of tropical grass species and cultivars was conducted in an area from Forbes in central NSW to the Queensland border and from Scone in the Hunter Valley west to Walgett.

Despite tropical perennial grasses being available for 60 years, it is only in the last 10 years that there has been widespread interest in these grasses and a rapid increase in the area sown. In the past 10 years, it is estimated (based on commercial seed sales in NSW) over 400,000 hectares have been sown in NSW. This period has been characterised by highly variable seasons and long periods of dry conditions with predominantly dry autumns and springs, and wetter early summers. Under these conditions, tropical perennial grass pastures have proved to be more resilient and productive than temperate grass pastures.

This book summarises the current knowledge and experience on the use and management of tropical perennial grasses for northern inland NSW from a wide range of sources, but is largely based on research and extension activities conducted by NSW Department of Primary Industries (NSW DPI) and the Future Farm Industries Cooperative Research Centre. Tropical perennial grass pastures have the ability to increase production, persistence and resilience of the feed base for grazing enterprises, so the aim of this book is to increase the understanding, integration and management of tropical perennial grasses for use on-farm.

Tropical perennial grasses for northern inland New South Wales—Second Edition is divided into two sections:

1. Establishing a productive tropical perennial grass pasture on-farm, and
2. Making the most of tropical perennial grass pastures on-farm.

1.1 Why sow tropical perennial grasses?

In northern inland NSW, tropical perennial grass pastures grow during the warmest months of the year. Growth commences in spring as day temperatures rise and it slows in late summer and autumn as overnight temperatures fall, ceasing when frosts commence with little to nil growth in the winter period. Therefore, tropical perennial grasses can be productive for about 9 months of the year on the North and Central-West Plains, 7–8 months on the North-West Slopes and 5–6 months on the Northern Tablelands (Figure 1.1).

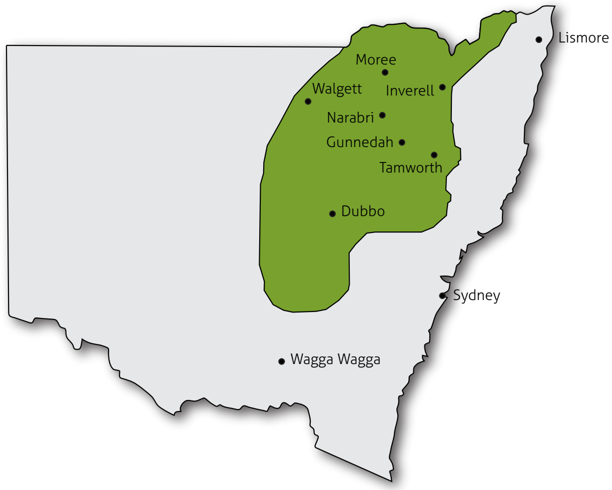

Figure 1.1 The green shading indicates the areas best suited to tropical perennial grasses in inland NSW.

Climate variability, both within years and between years, in northern NSW creates a unique and challenging environment for livestock producers to run productive enterprises. An on-farm feed base including paddocks of both cool and warm season forages is best able to fill the winter-early spring feed gap for green feed and to take advantage of rainfall in the season it occurs (Figure 1.2). This feed base may comprise native perennial grass-based pastures, naturalised pastures (composed of some native, but mostly invasive annual species), lucerne, winter and summer forage crops, sown temperate grass and legume pastures in the more favoured areas and tropical perennial grass pastures. Tropical perennial grasses offer effective use of water, high production and improved natural

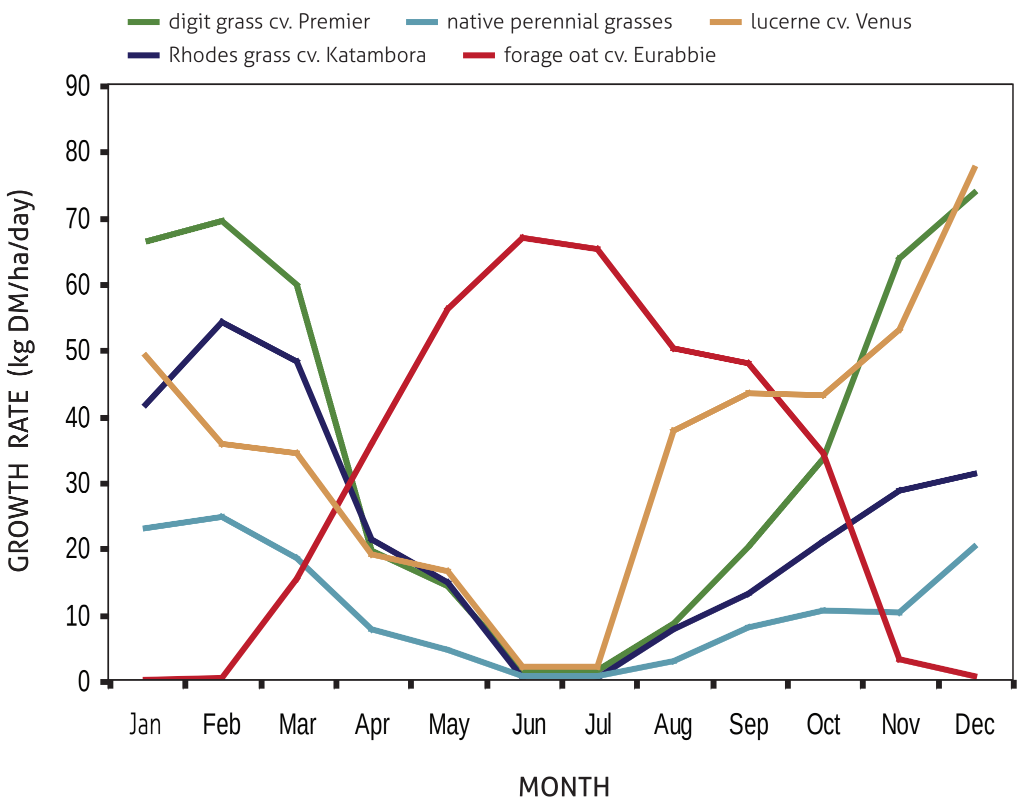

Figure 1.2 Growth rates (kg DM/ha/day) of digit grass, Rhodes grass, a native perennial grass pasture, lucerne, and forage oat on a red Chromosol (duplex) soil on the North-West Slopes of NSW.

resource management outcomes in a summer dominant rainfall environment because of the match between seasonal growth and soil water availability.

In northern inland NSW, tropical perennial grasses are persistent over variable seasons with some productive pastures being 30 years old. Tropical perennial grass pastures are also productive and can produce up to 19 tonnes of dry matter per ha (t DM/ha) in a growing season. However, they also have a role in increasing the presence of perennial species in the landscape as well as providing year-round high levels of ground cover if well managed. Tropical perennial grasses also have high water use efficiencies.

Many tropical perennial grasses have a proven record in the control of weed species such as spiny burr grass *(Cenchrus incertus)*, blue heliotrope *(Heliotropium amplexicaule)*, lippia *(Phyla canescens)* and galvanised burr *(Sclerolaena birchii)*.

Tropical grasses have many advantages for grazing and cropping systems. They:

- Are highly responsive to summer rainfall with growth rates up to 150 kg DM/ha/day. Surplus forage can be baled as hay, or made into silage, or carried into the winter period as dry feed.
- Are persistent and productive in a variable rainfall climate. Our summers tend to be hot with rain falling in storms while our winters are cold with frequent frosts.
- Are more persistent and productive than temperate perennial grass pastures in many areas.
- Are able to increase levels of soil organic matter and litter providing high ground cover which can reduce erosion.
- Have a large fibrous root system, which is effective in improving soil structure.
- Are adapted to a wide range of environments and soil types.
- Have higher water and nitrogen use efficiencies than temperate grasses and a greater tolerance of high temperatures.
- Are far more productive than temperate species in most summer rainfall dominant environments.
- Are useful for regenerating degraded cropping soils in harsh environments.
- Are able to contribute significantly to the management of ground water recharge areas to mitigate rising water tables and dryland salinity.

1.2 Things to know before you sow

The successful sowing, establishment and utilisation of tropical perennial grass pastures in your grazing system requires careful planning. Up to two years 'lead time' is necessary to control summer-growing annual grasses. With some thought and planning this 'lead time' can be incorporated into your cropping or grazing program, reducing the time that a paddock is out of production. The first part of the planning process involves making sure that the species and paddock selections are correct.

The next part of the planning process involves making sure that you understand the specific management requirements for tropical perennial grasses, particularly for nitrogen and the implications that this has for sowing companion legumes to provide that nitrogen and the effect that companion legumes and nitrogen have on seasonal pasture growth, pasture quality, intake and livestock growth rates.

i. Establishing a tropical perennial grass pasture

Paddock preparation should commence at least two years before sowing to control weeds, in particular annual summer-growing grasses. Weed competition is a major cause of pasture establishment failure; however, in farming country good weed control during the cropping phase can be effective in reducing weed competition (Chapter 2).

A number of tropical perennial grass species and cultivars are commercially available with a wide range of growth habits and characteristics. Species and cultivars should be chosen for their suitability to the paddock soil type (Chapter 3). Tropical perennial grass seed is commonly sold in a mix of two or more species. This has the advantage of different growth habits of species potentially complementing each other and exploiting different niches for light, water and nutrients, however, the species can compete with each other and preferential grazing can also occur.

Weed risk: The risk of agriculturally useful plants becoming weeds

Christine Munday

Many characteristics of tropical grasses, such as drought tolerance, good seed production and high growth rate that make them useful in agricultural systems, may also make them a high risk of becoming weeds in other environments. When used in a new area or system, these useful species can invade native vegetation and become environmental weeds. As weeds they may reduce the diversity and abundance of native flora and fauna, and can permanently damage the ecosystem function and amenity value of the native environment.

It is costly to eradicate weeds, so preventing the spread of agricultural species into bush land and other non target areas is more effective than trying to control outbreaks after they occur. Many weed control methods, such as cultivation and herbicide application, damage native plants and can exacerbate weed problems. However, understanding plant characteristics, such as environmental tolerance, growth habit and means of reproduction, can help with appropriate species selection and inform management, not only to improve productivity but also to minimise the risk of it becoming a weed in native environments.

Management to control weed potential can include grazing to prevent seed set, washing down machinery to reduce the spread of seed or plant fragments, and appropriate control where animals have eaten seed that may be spread after passing through the rumen. Some tropical pasture grasses have shown very high biomass production and can spread rapidly when conditions are suitable. This can result in the invasion of native environments if there are not enough stock or other management to control the growth.

A weed risk assessment is a key tool to ensure informed decisions. Weed risk assessments and management guides are available at: www.futurefarmonline.com.au/farm-research/weed-risk

Figure 1.3 Steers grazing a tropical perennial grass pasture on the North-West Slopes of NSW.

Seed quality can be highly variable and growers should always insist on a certificate of seed analysis showing purity and germination before purchasing seed. This certificate will also identify any weed seed contamination (Chapter 4). There can be a high risk of introducing unwanted weeds in seed which can result in considerable ongoing expense. Queensland experience suggests that 17 viable seeds should be sown to produce one established plant. Therefore to achieve a plant density of 10 plants/m^2, 170 viable seeds/m^2 will need to be sown. Chapter 4 has two useful examples to help calculate sowing rate and highlights the importance of buying quality seed.

Sow tropical perennial grasses during the spring–summer period when soil temperatures are increasing (Chapter 5). Rainfall can be variable at this time of year and evaporation rates are high and it is therefore important to have stored subsoil moisture at sowing. In northern inland NSW, tropical perennial grasses are best sown in November–December. Many of these species have low seedling vigour and because of the hot summer conditions rain soon after germination is important for seedling survival. The soil surface dries quickly in spring and early summer, so it is important to sow tropical perennial grasses ahead of a rainfall event. Four and ten day forecasts are increasingly useful for making tropical perennial grass pasture sowing decisions (Chapter 5).

The depth that seed is sown to is important for tropical perennial grass seedling emergence. The ideal depth is 10–25 mm depending on the species, so aiming to sow all species at 10 mm will allow for variation in a paddock and machinery sowing depth (Chapter 5). Conventional sowing and direct drilling are reliable methods of sowing, and the use of press wheels or rollers greatly improves soil-seed contact resulting in better germination (Chapter 6).

Identification of sown and weed grass seedlings can be challenging in an establishing pasture, but a number of species have characteristics that make them easier to identify at the seedling stage (Chapter 7). Early identification can help identify a weed problem and plan a strategy to control weeds if necessary.

Tropical perennial grasses should generally not be grazed in the establishment year until they have flowered and set seed. The two main exceptions to this rule are firstly, when weed competition is severe and secondly, where plants are well advanced early in the season, however, always ensure the plants have a well developed root system before grazing. Grazing can stimulate tillering early in the season when plants are well advanced with good soil moisture. A range of herbicides suitable for controlling broadleaf weeds in establishing tropical perennial grass pastures is registered under a minor use permit (Australian Pesticides and Veterinary Medicines Authority permit number PER12362) until 30 November 2015 (Chapter 2).

ii. Making the most of tropical perennial grasses

Animal production will be highest when pasture quality is optimised. With good management and typical seasonal conditions tropical perennial grasses are capable of playing an important role in both cattle (Figure 1.3) and sheep production systems (Figure 1.4). Feed intake is the driver for animal production so the focus needs to be on optimising the quantity of green feed available. Green pasture dry matter for cattle should be 1.6–2.5 t DM/ha and for sheep 1.0–1.5 t DM/ha (at 65% digestibility) (Chapter 8).

Figure 1.4 Sheep will graze tropical grasses, but there needs to be a greater focus on management to keep it productive and of high quality.

All grasses need adequate nitrogen to maximise protein levels for optimum livestock performance. The protein content in tropical perennial grasses can be increased by applying nitrogen fertiliser. A rate of 50–100 kg N/ha applied to tropical perennial grasses will generally result in increased dry matter of a higher quality (Chapter 9).

The most cost effective method to maximise protein in grasses is to maintain adequate soil nitrogen levels with legumes. The choice of legume type and species is important. The characteristics of some legumes that have shown potential in northern inland NSW are described in Chapter 10. When considering a companion legume it is important to consider soil water, for example, the soil profile under tropical grasses is wettest in September and driest in May. Under these conditions temperate annual legumes will struggle to germinate (Chapter 11).

Growth rates of tropical perennial grasses in northern inland NSW have been recorded as high as 150 kg DM/ha/day with good levels of nitrogen and soil water. With adequate fertiliser annual herbage production may be up to 19 t DM/ha, however, annual production is likely to be less at 11–14 t DM/ha growing at 54 kg DM/ha/day (Chapter 11). Due to the highly variable climate experienced in northern inland NSW, maximising plant dry matter production per unit of rainfall is desirable, and tropical perennial grasses show high water use efficiency (WUE). For example, mean values of water use efficiency for six seasons ranged from 17 (Rhodes grass *(Chloris gayana)* cv. Katambora) to 22 kg DM/ha/mm (digit grass *(Digitaria eriantha)* cv. Premier) compared with a mix of native perennial grasses having a value of 12 kg DM/ha/mm (Chapter 11). To utilise these large quantities over a growing season, flexible grazing or other strategies such as conserving silage or hay and utilising dry feed over winter should be employed (Chapters 8 and 12).

As industry experience in the role and best fit of tropical perennial grasses in livestock production systems evolves in northern inland NSW, further challenges are likely to be encountered and their solutions will need to be found. This guide documents best management practice to ensure successful establishment, maintenance and to achieve optimum pasture quality of tropical perennial grasses on-farm. Best management practice regarding grazing management and companion legume systems will be the subject of future research in collaboration with the producer community.

Case study: Tropicals – the perfect package

Farm info.

Case study: *Stuart and Bronwyn Lockrey*

Location: *Manilla, New South Wales*

Property size: *999 ha*

Mean annual rainfall: *700 mm*

Soils: *Basalt-derived, light brown to heavy black soils*

Enterprises: *Mixed farming — winter cereals, trade beef cattle, Droughtmaster Stud and sheep*

This producer story first appeared in Future Farm *Issue 6, December 2010.*

Stuart and Bronwyn Lockrey are thrilled not only with the production of tropicals, but their ability to improve the overall health of the Lockrey's soils and farming system.

As far as Stuart Lockrey is concerned, the tropical perennial pasture package is near on perfect — from the available seed mixes through to the agronomic advice. During November 2010, facing a bumper start to spring and summer, Stuart shared his delight in the powerhouse of potential offered by his perennial grass pastures.

"From a conventional grain-growing base, during the past few years we have started to move more towards livestock and a conservation tillage system," Stuart explained.

"I'm looking for a more productive, more sustainable system and conventional cropping just wasn't doing it for me.

The soil was suffering, disease pressure was increasing and the whole system was under threat.

In terms of a pasture system, we were using lucerne in a rotation with our grain crops, but we haven't been getting enough rain during summer to get the production. It's a pretty thirsty pasture and if it doesn't get enough moisture it tends to drop leaf so we ended up with bare soil patches and disappointing production.

Our country is a mix of non-arable, native pasture country and arable country that we can really use to boost production.

So when we looked into going from grain into something more productive than lucerne we decided to give tropicals a go.

And while every year is different, since putting our first tropical mix in during the summer of 2007–2008 we haven't looked back.

The productivity off them is incredible — I've never seen anything that's actually responded to so little rain.

Even with as little as 10–15 millimetres of rain you can see a visible difference almost immediately.

Be prepared; establishment and management are crucial to success — but with tropicals, the whole package is available to support a successful result.

There are multiple species with high-quality seed available. We used seed with an 85 per cent germination rate when we established our first paddocks.

Our tropical mix is mainly Katambora Rhodes, Gatton panic, bambatsi panic and Premier digit grass, with a smaller quantity of creeping bluegrass.

Added to this is the back-up of sound agronomic advice.

All my life I've listened to agronomists and found many to be a little over the top, however, they have this absolutely right — the agronomic support package is really sound, all you need to do is listen to the advice and the pasture will be successful.

But if you don't, you'll end up getting a half-baked paddock that will most probably fail. Paddock preparation is really important, with a two-year preparation period from cropping to pasture a must — you can't just whack them in on short notice.

The key is clean paddocks, free of weed competition during the critical period of germination and early pasture growth. We achieved this by cropping with grazing oats for two years and spraying out weed growth during summer.

Also important is time of sowing, with adequate soil moisture, and to fertilise in the first year for production.

We sowed during November 2007 and following this, after only 30 mm of storm rain, the pasture was away — I couldn't stop watching it, I enjoyed it every day. And by the end of March 2008 we were grazing.

We went with a coated seed mix and while it was a bit more expensive I think it was worth it. As the pasture is sown dry, the ants don't carry the seed away and when a storm comes it's just that bit heavier than the uncoated seed and doesn't wash away.

Intense focus

For maximum pasture quality and productivity these grasses need high-intensity grazing when they are established. To do this well you need small paddocks and centrally placed watering points — it's critical to have the water in the right place.

We have 100 hectares of 20 ha paddocks, each divided into four 5 ha paddocks by a single hotwire, with a centrally-placed trough.

I've had no trouble with this set-up so far and I'm currently moving 100 cows through the system.

In terms of how long the mob stays in each paddock; I'm finding it really interesting — if you study them long enough, you'll find the cattle let you know when it's time to move on.

By this stage they are working for you in regards to controlling the pasture management.

Getting the timing right is really important, not just for the pasture and the livestock, but also for the organic matter recycling that comes with high-intensity grazing.

At this stage I'm still investing in fertiliser for the initial establishment and production.

I'm no longer using 20,000 litres each year of diesel we used under our conventional cropping system — we are back to 7000 L per year, which is a huge saving.

Keeping pace with production

If there are any challenges with the tropicals it would have to be trying to keep pace with their production through grazing to keep the pasture at the right growth stage — I can't just run out and buy 50 more mouths for two weeks.

I'm trying to get my head around that right now. We'll just keep trying to keep pace and bring more stock down from the native pastures, utilising the natives as dry feed later when the tropicals have slowed down.

Our program is calving the cows out in our native pasture paddocks, which are larger during spring. We then bring cows and calves down onto the tropicals during summer and autumn.

We wean calves before sending the cows back to the native pasture paddocks.

During 2008 we kept them on the tropicals right through until the pasture looked like a stubble paddock. The following summer it came back green as a leek.

We now have 100 ha of tropicals, with another 50–60 ha in the pipeline for this summer and again next summer.

At the moment it seems to be working and I'm over the moon. The soil biology is increasing and the soil structure and fertility have improved.

SECTION ONE

Establishing a productive tropical perennial grass pasture on-farm

Chapter 2: Weed control

GM Lodge, SP Boschma and CA Harris

Weed control for up to two years before sowing is essential to reduce the soil seed bank of summer-growing annual grasses to levels that will not adversely affect the establishment of sown tropical perennial grasses.

Allowing seeds of annual summer-growing grass weeds to germinate and then preventing new plants from flowering and setting seed is the most effective means of control. Over time this will reduce the soil seed bank of weeds to acceptable levels.

If possible, select paddocks that do not have a long history of summer-growing annual grasses. Use a combination of grazing at high stocking rates and herbicides to reduce summer-growing annual grass soil seed banks. If possible, plan ahead using crop rotations to reduce seed banks.

In the spring before sowing, removal of summer-growing annual grass seedlings on at least two occasions before sowing is still required, even after up to two years of pre-sowing weed control.

One summer-growing annual grass seed per handful of soil indicates that there are about 400 seeds/m². Check the paddock to be sown by sampling handfuls of soil. If in doubt continue weed control rather than sowing.

In an establishing pasture, broadleaf weeds can be controlled by either grazing or application of a broadleaf herbicide. A range of herbicides suitable for broadleaf control in establishing tropical perennial grass pastures is now registered for use under a minor use permit.

2.1 Pre-sowing weed control

Tropical perennial grasses are often sown into old cropping country that has been intermittently grazed for several years and had little or no weed control since the cropping phase finished. The most common weeds in such situations are summer-growing annual grasses, predominantly liverseed grass *(Urochloa panicoides)*, barnyard grasses *(Echinochloa* spp.) and stinkgrass *(Eragrostis cilianensis)*. These can provide valuable green feed and ground cover, particularly in dry summers, but if they have been growing for several years they can build up soil seed banks of more than 50,000 seeds/m².

Seeds from these seed banks germinate and grow at the same time as sown tropical perennial grasses, but because they are annuals they establish faster than the sown grass seedlings and can provide severe competition. Paddocks heavily infested with these weeds can result in the failure of the sown species to establish or plant densities that are below those required for a productive pasture.

Annual grass seedlings are extremely difficult to control in an establishing perennial grass pasture and there are no herbicides that can be applied to selectively remove them without also damaging the perennials. The only way to ensure that annual summer-growing grasses are not going to be a problem at sowing is to run down their seed banks before sowing, so that their numbers are low and competition minimal.

To reduce the annual summer-growing grass soil seed bank in the paddock selected for the new pasture, you will need to start controlling the grass weeds up to two years before sowing (Figure 2.1). As a guide one summer-growing annual grass seed per handful of soil is equivalent to about 400 seeds/m², which would be sufficient to reduce establishment of sown tropical perennial grasses (Figure 2.2). One way to avoid the need for a long period of pre-sowing weed control is to choose paddocks that have a history of low amounts of summer-growing annual grasses. These might be paddocks that have been used in summer-crop rotations where summer-growing annual grasses have been controlled.

Figure 2.1 Makarikari grass establishing where pre-sowing weed control of summer growing annual grasses occurred for two years before sowing (left), one year before sowing (middle) and pre-sowing weed control only in the spring before sowing (right).

To reduce the soil seed bank, existing seeds in the soil need to germinate and the new plants prevented from setting seed and replenishing the seed bank. This process needs to be repeated over several germination cycles to deplete the seed bank. Annual summer-growing grass seeds can start to germinate in August and may continue germinating until the following May, if rainfall and temperatures are favourable. It has been observed that once there is a high density of large plants of annual summer-growing grasses their rate of germination declines, so the more open the grass sward the more seeds that will germinate. Seeds will not germinate in the colder winter months, but the seed bank can still be reduced by the activity of soil insects and pathogens, particularly in wet winters.

Just as important as encouraging annual grass seed to germinate, is preventing the seedlings from flowering and therefore adding more seeds to the seed bank. Annual summer-growing grasses can flower quickly, particularly under dry conditions and seedheads can lie flat on the ground. Because of this, and the low feed quality of the seedheads to grazing livestock, it is often difficult to use grazing alone to prevent seeding. Grazing is most likely to be successful if small areas are grazed at high stock densities when plants are young. Sheep may be more effective than cattle, but unless young plants are defoliated to ground level they can tiller and regrow.

Alternatively, cultivation or herbicide application as part of the normal preparation of a seedbed can be timed to kill newly germinated plants and prevent flowering and seed set. The number of sprays required will depend on the seasonal conditions, but weeds may need to be controlled up to six times a season to prevent flowering.

Often two or more applications of a grass herbicide can be used in conjunction with grazing or cultivation to prevent flowering and seed set. Avoid repeated applications of the same herbicide group in any paddock so that herbicide resistance does not develop. If you plan to sow using a tyned seeder that will disturb the soil surface at sowing, it is important to work the paddock during the weed control phase as soil disturbance stimulates the weeds emergence.

In areas suitable for cropping, either a grain or forage sorghum crop can be grown as part of a pre-sowing weed control program. In this situation, the pre- and/or post-sowing use of residual chemicals for control of grass weeds can be an effective way of reducing the summer-growing annual grass soil seed bank and preventing re-seeding. However, tropical perennial grasses should not be sown in areas treated with these chemicals until the recommended plant-back period has passed. Alternatively, the paddock can be left as a fallow, protected by winter cereal stubble. This has the advantage of a broader range of chemical options.

In the spring before sowing, try to allow for at least two germinations of summer-growing annual grasses and control each of them before sowing. If in doubt about soil seed bank levels and whether or not it is safe to sow, check handfuls of soil from across the paddock (e.g. Figure 2.2). If you can see more than one or two annual grass seeds per handful of soil then you are likely to encounter sufficient weed seeds to adversely affect the establishment of the tropical perennial grass that you want to sow. Rather than risk a poor establishment it is wiser to delay sowing until summer-growing annual weed seed bank levels have been reduced to lower levels.

Good pre-sowing weed control will also assist in the accumulation of subsoil moisture which is important for early plant growth. Use a push-probe to ensure that there is a least one metre of subsoil moisture at sowing.

2.2 Post-sowing weed control

If broadleaf weed competition is severe and threatening establishment of the new pasture, grazing or application of a broadleaf herbicide are options. Grazing may be considered as a lower cost, but less effective alternative to herbicide application. If grazing for weed control is being considered make sure that the tropical grass plants are well anchored and that the weeds will be grazed by livestock. Give the establishing pasture plants a small tug. If they can be easily removed by hand, livestock will pull them out while grazing. Consider using less valuable animals to graze the pasture as some of the summer-growing broadleaf weeds can have cumulative poisonous effects on livestock. If you are unsure of the impact of weeds on grazing animals, consult your animal health advisor. Grazing should use high stocking numbers for short periods to ensure that new regrowth of grasses is not overgrazed.

A range of herbicides suitable for broadleaf weed control in establishing tropical perennial grass pastures is now registered for use under a minor use permit from the Australian Pesticides and Veterinary Medicines Authority (Table 2.1) This permit (number PER12362) in force until 30 November 2015, provides a wider choice of post-emergent herbicides and mixtures to control weed species. It is recommended that agronomic advice be sought to ensure an appropriate herbicide is selected for the situation and weed species present.

Table 2.1 Herbicides permitted for post-emergent use on tropical perennial grasses (permit number PER12362).

Herbicide	Rate (per ha)
2,4-D amine 625 g/L	1.7 L
fluroxypyr 200 g/L	1.0 L
metsulfuron-methyl 600 g/kg + MCPA LVE 500 g/L	5 g + 0.5 L
2,4-D amine 625 g/L + triclopyr 600 g/L	1.7 + 0.3 L
2,4-D amine 720 g/L	1.5 L
metsulfuron-methyl 600 g/kg + (aminopyralid 10 g/L+ fluroxpyr 140 g/L)[1]	5 g + 0.75 L
metsulfuron-methyl 600 g/kg + 2,4-D amine 720 g/L	5 g + 1.5 L
MCPA amine 500 g/L	2.0 L
(triclopyr 300 g/L + picloram 100 g/L)	2.0 L

[1] Chem wet added to tank mixture

Figure 2.2 Three handfuls of soil with varying levels of summer-growing annual grass seeds corresponding to: left, almost no seeds/handful or about 15 seeds/m²; centre, an average of about four seeds/handful or 1650 seeds/m², and right, an average of about 14 seeds per handful or 5550 seeds/m².

Chapter 3: Getting species selection right

BR McGufficke, LH McCormick and CA Harris

Tropical perennial grasses have been evaluated in experiments across the north and central west of NSW by the Department of Primary Industries for over two decades. These studies have shown the suitability of species to various climatic zones and soil types and recommendations have been derived for light, medium and heavy textured soils.

Tropical perennial grasses provide a good source of feed in most situations, but occasionally livestock health disorders may occur with some species. Details are provided.

Pasture mixes can consist of different tropical grasses or mixes of tropical grasses and other species, mainly annual or perennial legumes. The advantages and disadvantages of pasture mixes are discussed.

Tropical perennial grasses are adapted to a wide range of environments and soil types with different pH levels. As a general rule avoid selecting sites with shallow soils with low subsoil moisture and hard-setting soils that will be difficult to achieve good establishment. Consider increasing surface organic matter in these difficult sites. To reduce the time required for pre-sowing weed control select paddocks that do not have high levels of annual summer-growing grasses, such as liverseed grass and barnyard grasses.

Avoid selecting low lying creek flats or areas that are prone to waterlogging in winter. Most tropical perennial grasses that have flowered and reach a reasonable plant size can tolerate winter frosts. However, a combination of waterlogging and winter frosts can greatly reduce persistence.

The following information (summarised in Table 3.1) is based on over 20 years evaluation by NSW DPI in northern inland NSW and should be used when selecting tropical perennial grasses suitable for different soil types.

The cultivars discussed in this publication were those evaluated across a range of experimental sites.

New cultivars of tropical perennial grass species will progressively become available commercially and may or may not have similar attributes.

3.1 Light soils

Rhodes grass cvv. Katambora (Figure 3.1) and Pioneer and forest bluegrass cv. Swann *(Bothriochloa bladhii* subsp. *glabra)* all perform well across the slopes on sand and sandy loam soils with a pH_{Ca} <5.0–6.0. Lovegrass cv. Consol *(Eragrostis curvula* var. *conferta)* grows well on sandy soils and is excellent for controlling spiny burr grass. Digit grass *(Megathyrsus maximus)* cv. Premier (Figure 3.2) also performs well across the slopes and plains on these light soils and in western regions. Digit grass has good dry matter digestibility, is widely adapted and will grow well over a wide range of soil types and climatic zones. Panic grass cv. Gatton will grow on these soil types, but is not as productive other species. New panic grass cultivars have exhibited excellent persistence and production on these soils.

3.2 Medium soils

Rhodes grass cv. Katambora performs well on clay loam and silty clay loams with a pH_{Ca} of 5.0–7.0. Two Rhodes grass cultivars, Finecut and Topcut , establish faster than other cultivars on hard-setting soils, but are not as persistent as Katambora. Digit grass cv. Premier and forest bluegrass cv. Swann perform very well on the medium soils as does creeping bluegrass cv. Bisset *(Bothriochloa insculpta).* Panic grass cv. Gatton is persistent and productive on these soil types.

Purple pigeon grass *(Setaria incrassata)* cv. Inverell and Makarikari grass (*Panicum coloratum* var. *makarikariense)* cv. Bambatsi (Figure 3.3) are persistent on these soils if nitrogen levels are adequate. Makarikari grass cv. Bambatsi will survive on medium soils with low nitrogen, but will not be productive.

Table 3.1 Tropical perennial grass species and cultivars suitable for light, medium and heavy textured soils in northern inland NSW.

Species and cultivar	Light Sand, sandy loam; pH_{Ca} <5.0–6.0	Medium Clay loam, silty clay loam; pH_{Ca} 5.0–7.0	Heavy Red/grey clay, black earth; pH_{Ca} 6.0–8.0
Angleton grass cv. Floren [A]			✓
Creeping bluegrass cv. Bisset		✓	
Digit grass cv. Premier	✓	✓	
Forest bluegrass cv. Swann	✓	✓	
Lovegrass cv. Consol	✓		
Makarikari grass cv. Bambatsi [A]		✓	✓
Panic grass cv. Gatton	✓	✓	
Purple pigeon grass cv. Inverell [BC]		✓	✓
Rhodes grass cv. Pioneer	✓		
Rhodes grass cv. Katambora	✓	✓	

[A] Tolerant of flooding [B] Tolerant of waterlogging [C] Performs with high nutrition

3.3 Heavy soils

The best performing species on red/grey clays or black earths with a pH_{Ca} of 6.0–8.0 are purple pigeon grass cv. Inverell, Makarikari grass cv. Bambatsi and angleton grass *(Dichanthium aristatum)* cv. Floren. Plant survival, production and forage quality of purple pigeon grass is closely related to soil nitrogen status.

3.4 Description and features of some tropical perennial grasses

Angleton grass – *Dichanthium aristatum*

A perennial tufted grass, with slender erect or climbing stems that grow up to one metre tall. Best adapted to heavy textured soils, but may be found on a range of soil types. It is drought, flood and salt tolerant, but susceptible to frost although plants recover with warmer conditions. While it is mainly a tussock grass it can spread vegetatively from prostrate stems. It is palatable and persists well under grazing, but has low seedling vigour and is slow to establish. Mature plants flower very late in the season which can result in low seed production. There is one cultivar – Floren.

Creeping bluegrass – *Bothriochloa insculpta*

A perennial grass that spreads by stolons (runners), forming a dense mat, giving high ground cover under grazing. Its leaves and stems have a distinctive scent and plants may also grow up to one metre tall. It has moderate production potential on better soils, but will persist under low fertility conditions and establishes well on heavy textured soils. It is drought tolerant and has moderate palatability, but slower spring growth than Rhodes grasses.

There are two cultivars – Bisset and Hatch. Bisset is finer leaved and has superior stolon development and rooting characteristics which may improve its cover and persistence compared with the cultivar Hatch.

Digit grass – *Digitaria eriantha*

A tufted perennial grass growing over a metre tall. It is palatable and well utilised by stock. Suited to a wide range of soil types from the lower fertility, lighter-medium, medium to heavier textured soils, but grows best on the light to medium soils. It has good drought and frost tolerance. In late winter-early spring, it is one of the first tropical grasses to commence growing. Generally, it is persistent, but it has poor waterlogging tolerance. There is one cultivar – Premier.

Figure 3.1 Rhodes grass cv. Katambora was the best performing Rhodes grass on light to medium soils.

Figure 3.2 Digit grass cv. Premier is an ideal cultivar for light and medium soils.

Forest bluegrass – *Bothriochloa bladhii* subsp. *glabra*

A perennial, erect, tussock grass that can grow over a metre tall. It grows on a range of soil types, but is best suited to light textured, lower fertility soils. It is drought hardy and moderately frost tolerant, but is susceptible to waterlogging and leaf rust. It tolerates heavy grazing, but its stems are not as palatable as those of digit grass. Can be slow to establish from seed, but may spread from rhizomes. There is one cultivar – Swann.

Lovegrass – *Eragrostis curvula* var. *conferta*

A long-lived perennial, with robust stems up to half a metre in height. Its leaves and stems are a blue-green colour, particularly when moisture stressed. It grows in a compact tussock which increases in diameter, eventually forming a ring of independent plants. Particularly suited to light textured acidic soils, with high levels of exchangeable aluminium. Lovegrass has small seeds that may be difficult to sow. It is very drought tolerant, persistent and frost hardy, but has only moderate feed quality. It can grow vigorously, providing high ground cover for soil erosion control and is useful for controlling spiny burr grass and other summer-growing weeds such as blue heliotrope. There is one cultivar – Consol. **Warning:** Not for use in regions where African lovegrass is a declared noxious weed. The cultivar Consol is distinguishable from naturalised African lovegrass and cannot outcross with less desirable types. It is, however, impossible to differentiate Consol and less desirable varieties from each as other as seed so it is important to purchase certified Consol seed.

Figure 3.3 Makarikari grass cv. Bambatsi panic is an ideal cultivar for heavy soils and flood-prone areas.

Makarikari grass – *Panicum coloratum* var. *makarikariense*

Commonly referred to as Bambatsi panic, it is an erect, tussocky perennial that has rhizomes (swollen stem bases), but rarely develops stolons. It can grow to two metres tall and has a seedhead that is an open panicle. It is particularly suited to heavy textured soils. The cultivar Bambatsi has good tolerance to flooding, waterlogging and drought, and some tolerance to frosting. Both its stems and leaves are palatable. It is very persistent once established, but is slower to establish than Rhodes grass and panic grass. Pastures dominated by panics may cause photosensitisation. There is one cultivar – Bambatsi.

Panic grass – *Megathyrsus maximus* (syn. *Panicum maximum)*

Commonly referred to as Gatton panic, panic grass is similar to green panic *(M. maximus* var. *pubiglumis),* but is more robust, particularly on low fertility soils. It is a leafy tussocky perennial with a deep root system capable of growing to two metres tall. The main growth period is over spring, summer and autumn, with better spring growth than other tropical grasses. It has moderate shade tolerance and drought tolerance. It is well suited to medium-textured soils with good fertility, but has performed well on lighter textured loamy soils of northern inland NSW. It is readily established and palatable to stock. While it can withstand heavy grazing during good seasons is not advisable during dry periods as recovery will be slow. Similarly, heavy grazing is not advisable particularly in autumn, as it can die due to frosting. Newly harvested seed of this species can be dormant (that is, seeds absorb water and swell, but do not germinate). To avoid sowing dormant seed only use seed that is 8–10 months old. There are two cultivars – Gatton and G2, and locally developed cultivars are soon to be released (refer to box on p. 20).

Purple pigeon grass – *Setaria incrassata*

This is a tufted perennial that can spread by short rhizomes and grows to a height of one and half metres, with a spike like seedhead. It is drought tolerant and is well suited to heavy textured soils. It has some tolerance to waterlogging, but not as much as Makarikari grass and is susceptible to frosting. It establishes readily and is quite palatable to livestock. Seed of this species is dormant after harvesting so to avoid sowing seed with high levels of dormancy only buy and use seed that is two years old. There is one cultivar – Inverell.

Rhodes grasses – *Chloris gayana*

A tufted perennial plant with above ground stolons (runners) that anchor at the nodes and can rapidly provide ground cover. The leafy, erect stems can grow up to over a metre tall. Seedheads consist of 10−12 radiating brown-green seed spikes. Suited to a wide range of soils from light textured sandy loams to heavy textured clays. It has moderate resistance to drought, but low resistance to frost. Rhodes grass has strong stolon growth and a vigorous root system making it a useful grass for erosion control and control of spiny burr grass. It is easier to establish than many other tropical perennial grasses, although its fluffy seed can be difficult to sow with conventional machinery.

Select cultivars of Rhodes grass on the basis of their maturity. Earlier maturing types (such as Pioneer) are better suited to marginal growth areas and/or soil types that have poor moisture holding ability. Late maturing cultivars are more suited to higher rainfall areas and possible higher management inputs (e.g. nitrogen fertiliser, irrigation and intensive grazing management). Later maturing cultivars included Katambora, Topcut , Finecut and Nemkat. Callide is a very late flowering tetraploid cultivar that has larger leaves, and responds well to increased fertility and irrigation, maintaining good feed quality if well managed.

3.5 Livestock health disorders associated with pasture improvement

Tropical perennial grasses provide a good source of feed in most situations, but occasionally livestock health disorders may occur. Some tropical grass species are known to cause livestock health disorders in certain situations (Table 3.2) and these disorders can also be exacerbated under favourable seasonal conditions. In these circumstances management strategies may need to be modified to minimise risk to livestock health and production losses. These problems can often be avoided by providing a diverse range of pasture species for grazing, and preventing stock from grazing the susceptible species for long periods of time. If sowing a pasture mix take note of what species you are planting and be aware of the possible livestock problems that may occur not only from the grass, but also the legume component which may have associated livestock health disorders.

Consult your Veterinarian or Livestock Advisor for advice on livestock health disorders or production losses associated with tropical perennial grasses.

Table 3.2 Livestock health disorders associated with tropical perennial grasses described in Chapter 3.

Species	Disorder
Angleton grass	No problems reported.
Creeping bluegrass	No problems reported.
Digit grass	No problems reported.
Forest bluegrass	No problems reported.
Lovegrass	No problems reported.
Makarikari grass	Photosensitisation – more likely when grazing fresh regrowth or growing rapidly (e.g. after extended dry season has broken), is grazed by young stock (especially sheep) or the stock are in a stressed condition. Signs of photosensitisation include facial irritation, excessive rubbing, arched neck, swollen ears and muzzle and fluid seeping from ears and eyes. In severe cases animals can die. If you suspect problems remove livestock immediately and graze pasture free of Makarikari grass with access to shade and seek veterinary advice.
Panic grass	Photosensitisation – as for Makarikari grass. Hyperparathyroidism ('big head') in horses – avoid grazing horses in paddocks dominated by panic grass. Occasionally nephrosis or hypocalcaemia can occur in ruminants due to oxalates.
Purple pigeon grass	Frequently hyperparathyroidism ('big head') in horses – avoid grazing horses in paddocks dominated by purple pigeon grass. Occasionally nephrosis or hypocalcaemia can occur in ruminants due to oxalates.
Rhodes grass	This genus can occasionally accumulate high levels of selenium on some soil types.

3.6 Species mixes

There are two different types of pasture mixes – mixes consisting of different tropical grasses and mixes of tropical grasses and other species, mainly annual or perennial legumes.

The advantages of mixes are that species with different growth habits, seasonal growth patterns and responses to management can be used to complement each other and exploit different environmental niches for light, water and nutrients, providing a balanced pasture. This can be particularly beneficial in a variable climate, where different species can respond to markedly different temperatures and rainfall events. A legume can provide a source of nitrogen to promote tropical perennial grass production and persistence and improve overall pasture quality. Species with different growth habits can lead to high ground cover that is desirable for sustainability.

Disadvantages of mixes are that different species may directly compete with each other when establishing or growing together. Aggressive competition of seedlings, for example, may markedly affect the establishment of slower growing, less vigorous seedlings or competition for water may adversely affect the long-term persistence of different species. Preferential grazing and the decline of more palatable species is another disadvantage. Species with different growth habits (e.g. upright versus prostrate) may also have different management requirements and preferential grazing of one species over another in a mixed pasture may affect persistence.

Increasingly, mixes of the seed of two or more tropical perennial grasses are being marketed, usually as coated seed. However, some caution is required when considering these – are they the right species and cultivars for the paddock and soil type you are going to sow and are you going to end up with the type of pasture that you want? For example, prostrate, stoloniferous Rhodes grass cv. Katambora can adversely affect the establishment of more upright and slower growing species such as digit grass cv. Premier and Makarikari grass cv. Bambatsi. Therefore tropical grass mixes with a high proportion (greater than 20%) of Rhodes grass cv. Katambora should be avoided, particularly since it has a small seed size and so a high number of seeds by weight.

New panic grass cultivars for northern inland NSW

Panic grass is an important species sown in many tropical perennial grass-based pastures due to its better spring growth compared to many other tropical grasses and high nutritive value. However, a requirement for fertile soils and sensitivity to heavy grazing limits the use of current cultivars to certain soil types and grazing regimes.

A pasture improvement program by NSW DPI and the Department of Agriculture and Food, Western Australia (as part of the Future Farm Industries Cooperative Research Centre) has developed two locally adapted cultivars of panic grass for northern inland NSW. The plant material the cultivars were developed from originates from South Africa and has been evaluated in northern inland NSW at sites from Yetman to Tamworth since 2005.

The new cultivars are medium-sized panic grasses and have excellent persistence under grazing especially in hot dry conditions with equal or higher herbage mass production compared to Gatton. The new cultivars also exhibited improved cool season tolerance with rapid recovery in spring.

These new cultivars of panic grass should be available from spring 2014.

Chapter 4: Seed quality and sowing rates

SP Boschma, LH McCormick and GM Lodge

Successful establishment of sown tropical perennial grass pastures is highly dependent on the quality of the seed sown. Quality can vary markedly, so you need to know what you are buying – often it is a case of 'buyer beware'.

Buy seed with high purity and germination and low amounts of inert material and other seeds. Always ask for a copy of a current certificate of seed analysis for the seed that you are intending to purchase. Seed with below average purity and germination can adversely affect establishment if you don't compensate by increasing the sowing rate. Increasing sowing rate will increase the cost of establishment. Ask yourself if it is really worth buying poor quality seed?

Calculation of sowing rate for tropical perennial grasses needs to take into account seed size, purity and germination. Aim to establish about 10 plants/m^2. This means sowing about 170 viable seeds per m^2 (1.7 million seeds/ha), because seed and seedling losses can be high.

Seed coatings greatly add to seed weight and sowing rate will need to be increased. This should be taken into account when calculating comparative seed costs.

To achieve a productive tropical perennial grass pasture it is important to establish a good plant density of about 10 plants/m^2. Sowing a sufficient number of viable seeds is essential and depends on seed quality and sowing rate. Sowing low quality seed is a recipe for poor or failed establishment – even if you do everything else right.

4.1 Seed quality

The quality of tropical grass seed available either through retailers or 'over the fence' from other producers varies widely so it is important to know the quality of the seed you purchase (Figure 4.1). The only way to be confident that you are buying quality seed is to ask the seller for a copy of the certificate of seed analysis (see Figure 4.2 for an example certificate). Check to ensure that the certificate is from an accredited laboratory and is no more than 12 months old. There are two main areas of the certificate that you need to look at – purity test and germination test.

Figure 4.1 An example of poor quality seed with a high proportion of darker coloured seeds of other species. Only buy and sow good quality seed with high purity and germination of normal seedlings and low percentages of inert material and other seeds.

Purity test

The purity test indicates the percentage, by weight, of pure seed, inert matter and other seeds of the seed lot tested. Most tropical perennial grass seed is harvested and sold 'in the floret', that is the seed enclosed in the physical structures – the lemma, palea and glumes. Tropical grass seedheads ripen unevenly and at the time of harvest some of the florets may contain ripe seed, others will be empty because the seed has been shed and some contain immature seed. Pure seed is the percentage of caryopses (seed removed from the floret), while empty florets, the physical structures that surround the caryopses and trash will be indicated in the inert matter. Similarly, seeds of species other than one you are buying, including weed seeds, will be indicated by a high value for other seeds.

[redacted]

[redacted]

Certificate Of Seed Analysis

Certificate Number: [redacted]

STATED BY APPLICANT

Kind of Seed: PREMIER DIGITARIA

Markings: 2008

SAMPLE INFORMATION:

Date Received: [redacted] Date Issued: [redacted]

Botanical Name: Digitaria eriantha Sample Weight: 404 grams

This Certificate was issued at [redacted]

ANALYSIS RESULTS:

PURITY TEST (% by Weight)

Pure Seed	Inert Matter	Other Seeds
13.9	82.0	4.1

ISTA PSD: 36#

GERMINATION TEST (% by Count)

Normal Seedlings	Hard Seeds	Fresh Seeds	Abnormal Seedlings	Dead Seeds
47	0	4	2	47

First Count at 5 days .... 37%. Second Count at 10 days....47%
Final Count at 17 days 47%
Method: ISTA TP 20-30°C *KNO_3

Inert Matter: Straw, dead insect material, empty florets, soil, empty seed other species
Sample Weight Examined: 13 grams

OTHER SEEDS:

Botanical Name	Common Name		VIC	NSW	SA	QLD	NT
Chloris gayana	RHODES GRASS						
Eragrostis cilianensis	STINKGRASS						
Eragro..is pilosa	SOFT LOVEGRASS						
Megathyrsus maximus	PANIC						
Panicum coloratum	BAMBATSI PANIC						
Urochloa sp.							

*Dormancy Treatment
The Germination test is carried out on pure seed only (ISTA PSD 36#).
# Pure seed contains a caryopsis
N= Listed on the Noxious Weed Seed List for Australian States & Territories (www.weeds.org.au)

All orders are accepted and all reports and certificates issued subject to the General Conditions for Inspection and Testing Services (available from [redacted]

Sample Submitted By Or On Behalf Of

For and on behalf of [redacted]

DEPT. PRIMARY INDUSTRIES
4 MARSDEN PARK ROAD
CALALA NSW 2340

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Figure 4.2 An example certificate of seed analysis for a commercial seed lot showing low purity and poor germination equating to a pure live seed value of 0.065.

Germination test

The germination test shows the percentage of seeds (removed from the floret) that germinated into normal seedlings (usually after at least 14 days). It also gives percentages of the number of hard, fresh and dead seeds and abnormal seedlings. Tropical grasses do not have hard seeds and fresh seeds are viable seeds, that is, they have a live embryo, but do not germinate. Fresh seeds include those that are immature, damaged and dormant, and should not be included as part of the germination percentage. Dead seeds are those that are not viable.

Seed dormancy in tropical grasses

Seed of some species experience primary or post-harvest dormancy which needs to be considered when buying seed (see boxed text for more information). Certificates of seed analysis of species showing high dormancy will have a large proportion of fresh seeds, but have low germination. Fresh seed may mature and become germinable, but if they were harvested to early, they may never reach maturity nor become germinable.

Seed dormancy

Seed dormancy can be classified as either 'primary' or 'secondary' dormancy. Primary dormancy, sometimes called post-harvest dormancy, is a natural mechanism that enables seed to survive for extended periods in the soil and germinate at different times. It is usually associated with physical structures that surround the seed (lemma, palea and glumes) preventing moisture reaching the seed, chemical inhibition that declines with time, or mechanisms within the embryo. Secondary dormancy is less well understood and may be caused by several uncontrolled factors, such as high temperatures during seed harvesting or storage. Neither the mechanisms that induce this type of dormancy, nor the processes required to break secondary dormancy are known.

Panic grass and purple pigeon grass are species sown in northern inland NSW that have primary dormancy while Rhodes grass cv. Katambora, Makarikari grass, forest bluegrass and digit grass generally do not display any seed dormancy. The time required for dormancy to be broken varies with species. For example, panic grasses can require storage for 8–10 months to achieve maximum germination while seed of purple pigeon grass may require storage for 24 months (germination of purple pigeon grass can increase from 15% to 70% after storage from 12 to 24 months).

Some certificates of analysis may give results for a tetrazolium test. This test determines if a seed has a viable embryo and is an important test for seeds with high levels of dormancy. It also includes seeds that are dormant, immature and damaged and so should not be included in the germination percentage.

If a current certificate of seed analysis is not available, consider sending some seed to an accredited laboratory for an analysis to be conducted. It takes a few weeks, but compared with the cost of buying seed it is 'cheap insurance'.

Pure Live Seed

This is a measure of the seed quality of a sample and is expressed as a number between zero and one. Pure Live Seed (PLS) is the purity percentage multiplied by the germination percentage (shown as a value for normal seedlings) and divided by 10,000. The higher the seed quality the closer the PLS is to one; the lower the seed quality the closer the PLS is to zero. Pure live seed of the species and cultivars commonly sown in northern inland NSW varies and average values for some of the more commonly sown cultivars are shown in Table 4.1. These values can be used as a guide to determine whether the seed you are buying is above or below average. For example, if the seed you are considering buying has a PLS below the values shown in Table 4.1 then its quality is below average and you should consider looking for better seed.

4.2 Sowing rate

Once you have found high quality seed, you need to ensure that a sufficient number of viable seeds are sown and this depends on the sowing rate. Don't be tempted to save on sowing costs by reducing sowing rates. If sowing rates are too low, moderate savings made on seed cost at establishment may incur large losses in the early years after establishment, since low density stands have low production, low ground cover and are prone to weed invasion.

Table 4.1 Average purity (%), germination (%) of normal seeds, and pure live seeds (PLS) of some tropical perennial grass cultivars commonly sown in northern inland NSW.

Common name	Cultivar	Purity (%)	Germination (%)	PLS
Angleton grass	Floren	73	30	0.22
Creeping bluegrass	Bisset	68	29	0.20
Digit grass	Premier	72	55	0.40
Makarikari grass	Bambatsi	95	60	0.57
Purple pigeon grass	Inverell	94	26	0.24
Rhodes grass	Katambora	94	55	0.52

Table 4.2 Variation in caryopsis (seed removed from the floret) weight and number/kg for a range of tropical perennial grasses. Data provided by W Scattini and G Lodge.

Common name	Cultivar	Seed weight (g/100 seeds)	Number of seeds/kg
Angleton grass	Floren	0.090	1,111,100
Creeping bluegrass	Hatch	0.116	862,100
Digit grass	Premier	0.043	2,325,600
Forest bluegrass	Swann	0.017	5,776,250
Lovegrass	Consol	0.021	4,761,900
Makarikari grass	Bambatsi	0.093	1,075,300
Panic grass	Gatton	0.068	1,470,600
Purple pigeon grass	Inverell	0.104	961,500
Rhodes grass	Callide	0.033	3,030,300
Rhodes grass	Katambora	0.024	4,166,700
Rhodes grass	Pioneer	0.037	2,702,700

Seed companies commonly provide sowing rates (kg/ha) for tropical grasses. These are ranges largely based on seed weight, intended purpose of the pasture (e.g. irrigated hay versus dryland grazing), whether or not the seed is coated and seed company preferences, however, these rates do not take into account purity and germination of individual seed samples or strike rate.

Seed weight

The size and weight of caryopses (seeds removed from the floret) can vary greatly due to a range of factors including nutritional and soil water status at seed fill. Average size and weight of caryopses of a range of tropical perennial grasses are shown in the Table 4.2.

As a general rule the larger the seed the more vigorous the seedling, although Rhodes grass cv. Katambora seedlings grow rapidly from a very small seed and angleton grass cv. Floren seedlings tend to grow slowly from a moderately sized seed.

Strike rate

Strike rate is the term used to describe the percentage of seed sown that emerge and it tends to be highly variable due to the many factors that impact on pasture establishment. In southern Queensland, a strike rate of about 15% is anticipated if seed is sown into a well prepared, even seed bed at the correct depth. However, a strike rate of 3% is more likely if the seedbed has not been well prepared, the surface is rough and seed is not sown at a consistent and correct depth, even with adequate rainfall. Based on many years experience in Queensland, the recommendation is to sow 17 live seeds to produce one established plant (strike rate of 6%) with an aim to achieve a plant density of 10 plants/m^2, that is sow 170 viable seeds/m^2.

Seed coating

All seed is sold and sown by total weight. Seed coating improves the flow of light, fluffy seeds through sowing equipment and is good for checking sowing depth, but does not affect either its purity or germination. It is important to remember that while coated seed lots look consistent, they still contain all material contained in bare seed lots – empty florets, other seeds, plus any other trash like stem and leaf material.

The choice to sow coated or bare (uncoated) seed is individual but it is important to remember that coating greatly increases seed weights and therefore sowing rates. A 2:1 seed coating (2 kg of seed coating for every 1 kg of 'seed' material by weight) triples the rate of seed sown per hectare. Similarly, a 4:1 seed coating will increase sowing rate five-fold. Therefore for the same seed quality (purity, germination and proportion of other seeds) it is usually more cost effective to buy seed in the floret and increase the sowing rate than it is to buy coated seed.

Calculating sowing rate

An alternative method to the prescribed range for sowing rate is using germination and purity percentages and seed weight (number of seeds/kg). The calculations are as follows:

$$\text{Weight of pure live seed sown (kg/ha)} = \text{Sowing rate} \times \frac{\text{Germination (\%)}}{100} \times \frac{\text{Purity (\%)}}{100}$$

$$\text{Number of seeds sown/m}^2 = \text{Number seeds/kg} \times \frac{\text{Weight of pure live seed sown (kg/ha)}}{10{,}000}$$

These calculations can be used to determine the sowing rate and seed cost of individual seed samples.

4.3 Examples of two seed lots with different quality

The following examples for digit grass are commercial seed samples and demonstrate the effect of seed quality on the potential sowing rate and the resulting seed cost. They highlight the major differences in seed cost when comparing good and poor quality seed. Seed of digit grass cv. Premier has an average PLS of 0.40 (Table 4.1) and 2.3 million seeds/kg (Table 4.2).

Example 1 – Good quality seed

A seed lot that has 75% germination and 90% purity has a PLS of 0.68 which is above the average for digit grass. If sown at 1 kg/ha of seed:

$$\text{Weight of pure live seed sown (kg/ha)} = 1 \times \frac{75}{100} \times \frac{90}{100} = 0.68 \text{ kg/ha}$$

$$\text{Number of seeds sown/m}^2 = 2{,}300{,}000 \times \frac{0.68}{10{,}000} = 156 \text{ viable seeds/m}^2$$

To achieve 170 viable seeds/m^2, this seed lot would need to be sown at 1.1 kg/ha (170 ÷ 156). If this seed cost $20/kg the seed cost would be $22/ha (1.1 x 20).

Example 2 – Poor quality seed

If a second seed lot had a germination of 47%, and low purity of 14%, the PLS would be 0.07 which is well below the average of 0.4 for digit grass. The number of viable seeds/m^2 when this seed lot is sown at 1 kg/ha would be:

$$\text{Weight of pure live seed sown (kg/ha)} = 1 \times \frac{47}{100} \times \frac{14}{100} = 0.07 \text{ kg/ha}$$

$$\text{Number of seeds sown/m}^2 = 2{,}300{,}000 \times \frac{0.07}{10{,}000} = 15 \text{ viable seeds/m}^2$$

To achieve 170 viable seeds/m^2, this seed lot would need to be sown at 11 kg/ha (170 ÷ 15), 10 times the rate of the good seed. Even if this poor quality seed cost $10/kg the seed would cost $110/ha (11 x 10).

The old saying 'you reap what you sow' is very true when it comes to buying seed of tropical perennial grasses as quality (germination rate, purity, dormancy, and the presence of weed seeds) can vary widely. If you take the time to buy high quality seed, with high purity and germination, then you have taken the first step necessary for good establishment.

Always consider buying seed with the highest purity and germination and the lowest cost per unit of seed weight. Ask yourself – is it really worth buying poor quality seed?

Chapter 5: Sowing time and depth

GM Lodge

In northern inland NSW sow in November–December when day temperatures have consistently been above 20°C and night temperatures above 10°C for a period of seven to ten days.

Sow at a shallow at a depth of about 10 mm.

Although the soil surface may be dry, use a push-probe to ensure that there is at least one metre of subsoil moisture before sowing.

Sowing after the end of January in the northern inland of NSW is generally not recommended since plants will be too small to withstand frosting in the subsequent autumn, winter and spring.

Research has clearly shown that the best plant establishment results occur from sowings made in November–January when seeds are sown shallow at a depth of 10–25 mm. Aim to sow at a depth of 10 mm to allow for paddock variation and differences in surface roughness and furrows (Figure 5.1). These differences can markedly affect the accurate placement of seed at the right sowing depth or to cover seed with the right amount of soil. Since many tropical perennial grass seeds are small, sowing deeper markedly reduces the plant establishment of most species. Rubber tyred rollers and press wheels improve the soil–seed contact which helps increase plant establishment.

The best 'sowing window' is late November to early December when day temperatures have consistently been above 20°C and night temperatures above 10°C for a period of seven to ten days. Sowing in early spring or autumn when temperatures are below these levels greatly reduces seed germination and establishment may be poor. Sowing when temperatures are high can also reduce establishment, since water losses from the soil by evaporation are high and rainfall is less effective.

Figure 5.1 Good tropical perennial grass establishment occurs when high quality seed is sown into a weed-free seedbed at the right depth and time of the year.

Sowing in late November–early December maximises the chances of receiving sufficient summer rainfall for germination and establishment (Table 5.1). As a guide one to two rainfall events of 20–25 mm are required.

It has been said that 'ideally', the best time to sow tropical grasses is just before 50 mm (two inches) of rain'. This may not be as impractical as it first sounds since a high proportion of summer rainfall can occur as a result of tropical low pressure systems. In summer, these systems can build up off the north-west coast of Western Australia or coastal Queensland, taking three to four days to arrive in northern NSW and often delivering substantial rainfall events. Keeping a close watch on weather maps and four to ten day forecasts may allow you to time sowing to coincide with the likelihood of these events occurring.

It is important to remember that because of high summer rainfall intensity, high temperatures and high evaporation rates, most summer rainfall events are only likely to wet the uppermost part of the soil profile. Even if establishment is good, sowing on a low subsoil moisture profile is risky and young plants may subsequently fail as they run out of water. Use winter-fallowing techniques in conjunction with pre-sowing weed control to store subsoil moisture, and a push-probe to monitor stored water levels. Do not sow unless there is one metre of stored subsoil moisture on most soil types.

Ground cover from cereal stubble, can greatly improve establishment when compared with bare fallows. Ground cover can lower summer soil temperatures and reduce evaporation providing a better environment for seed germination and plant establishment in marginal conditions (Figure 5.2).

Although temperature and/or rainfall conditions can be favourable for germination and establishment, do not sow after the end of January. Seedlings that emerge from later sowings remain small and may not flower as temperatures decline in autumn. Up to 70% of late sown seedlings can be lost because of frosty conditions in autumn, winter and spring. Frosts can occur from April to October (145–150 days of frost occurrence) and typically up to 60 frosts may occur each year.

Anecdotally, some producers believe that seed sown in one year will remain viable in the soil and come up in the next year, when temperature and rainfall conditions are favourable. In moist soil, seeds contained in either florets or seed-coats will soften and be prone to insects, soil fungi and bacteria attack, resulting in high seed losses. In wet years, losses can be as high as 100%, in drier years some seeds may survive and subsequently germinate, but this is an unreliable and risky method of establishment. Seeds in seedheads of flowering plants, that are held in the plant and litter material above the soil, can successfully survive over winter. These seeds may produce new plants the following year. Therefore allowing plants to flower, set seed and recruit new seedlings over time is one way of naturally increasing the plant density of thin stands.

Figure 5.2 Establishment of digit grass cv. Premier sown with stubble cover (left) and without stubble cover (right).

Table 5.1 Rainfall (mm) statistics for four locations on the North-West Slopes of NSW. The median (50th) and 30th percentile values indicate that there is a 50 and 70% chance, respectively of monthly rainfall exceeding these amounts. Values are from Rainman Streamflow 4.3.

Rainfall	November	December	January
	Moree		
Mean	56	58	71
Median	47	47	56
30th percentile	29	30	37
No. rain days	6	6	7
	Warialda		
Mean	69	71	85
Median	58	57	72
30th percentile	33	44	43
No. rain days	7	7	8
	Gunnedah		
Mean	60	66	72
Median	53	60	54
30th percentile	29	41	32
No. rain days	6	7	7
	Tamworth		
Mean	68	75	86
Median	64	73	74
30th percentile	41	53	47
No. rain days	7	8	7

Case study: Tropical pasture establishment — worth the wait

Farm info.

Case study: *Brett and Bernadette Holz*

Location: *Quirindi, New South Wales*

Property size: *1130 ha (300 ha leased)*

Mean annual rainfall: *750 mm*

Soils: *Black basalt ranging to chocolate loam*

Enterprises: *Cattle*

This producer story first appeared in Future Farm *Issue 3, June 2009.*

Establishment of their new tropical perennial pastures seems to have been a success for Brett and Bernadette Holz so far.

Brett and Bernadette Holz are making their first foray into tropical perennial pastures with an *EverGraze®* Supporting Site and they recently shared their establishment experiences.

"Working with dryland pasture systems has been a steep learning curve for us, coming into the area from the Hunter Valley," Brett said.

"I grew up on a dairy farm, which relied heavily on irrigated pasture and without the water it wouldn't work.

Learning to manage dryland pastures and how to get the best out of what is there is a real challenge.

Initially we've been cropping for the purpose of cleaning up the country, with the long-term goal of establishing permanent pastures for our cattle.

All the country is clean and ready now, but we need to take a step-by-step process to produce some winter feed.

We are running 280 breeders, 165 weaners and dry cattle, and 140 steers on a leased paddock. These steers are aimed at the feedlot market.

When we first got here, there was a ryegrass mix, which was totally impractical — great for about two weeks during spring, then a big storm would come and it would all fall over.

We've sprayed out the paddocks, cropped with oats and forage sorghum and slowly moved into perennials.

At this stage we have lucerne as pure stands for hay and are now venturing into summer-active tropical grasses and tall fescue for grazing."

Promoting perennials

"During late November 2008, I attended a Landscan course run through the New South Wales Department of Primary Industries (NSW DPI) in the Willow Tree area," Bernadette said.

"They were promoting perennial pastures and looking for trial plots; so we got involved.

It was quite coincidental and good timing, the paddock at the top of our property was so well cleaned it had eroded. During Summer 2007–08 heavy rain caused wash and we were looking at planting lucerne. But because of the erosion, we thought we could try the tropicals to hold the soil together.

Currently we have a six-hectare trial block and a 25 ha *EverGraze* Supporting Site with additional tropicals pastures funded by Namoi CMA — the rest is fallow.

One of the fallow paddocks will go into tall fescue and the balance is sown to oats and wheat for winter grazing.

All going well this country will later go down to tall fescue and tropicals."

Lightly lightly

"This is our first experience with tropicals and we were quite nervous. They have tiny seeds, and establishment is well known to be the hardest part of the process," Brett said.

"But, the timing and amount of rainfall we received since they went in is unbelievable.

Everyone tells you the same story — watching it establish is so painful, but because we've been warned you accept that you need to be patient with these pastures.

Our agronomist said we had to put it in and not look at it. We sowed it with an agrodrill during November and we had good follow-up rain, so that has helped.

The ability of the pasture to thicken has been particularly impressive. When you walk in there you can still see patches of bare ground, but we're expecting that to be a different story by next year.

I think a key to our success so far has been the cleanliness of our paddock and we were fortunate with rain. The timing of the NSW DPI course and the introduction was very timely with the paddock.

We've added a tall fescue component to the tropicals to provide winter feed, so this should be our last year of putting in oats and wheat.

Next year we'll have a good start with the tropicals during summer and the fescues during winter.

Our chosen species include Bambatsi and Gatton panics (45 per cent each), Katambora Rhodes grass (10 per cent) and floren bluegrass and Bambatsi in the second paddock.

Katambora Rhodes grass should help with erosion due to its prostrate growth habit.

All in all, both paddocks seem to have established successfully.

The small seed of tropicals makes establishment a challenging and expensive process, but Brett aims to have a productive perennial pasture for many years to come.

Sowing the seeds of success

There are two different seed principles to choose from when sowing — coated or uncoated seed.

NSW DPI wanted to use uncoated seed in the trial block and it was blended with fertiliser at sowing to help flow.

When we went to buy seed for the top block there were many opinions. But the general consensus was the coated seed is the safer, albeit more expensive.

And if establishment is so important then to us it seemed worth the effort.

At the time we looked at annual systems and the cost of chemical, fertiliser, seed and diesel on an annual basis — when we did the comparison, the cost was justified.

The thing we found ironic was that nobody seems to question purchasing oats seed at $1000 plus and fertiliser annually and when you sit down and look at doing that anyway, compared with a one-off expense, it really made sense.

The advice is to graze them lightly for the first 12 months and let them go to seed.

That is where we are at now — the grasses have gone to seed and we about to graze with weaners."

Chapter 6: Sowing machinery

BR McGufficke

When sowing tropical perennial grasses the aim is to choose machinery that gives good soil-seed contact and will sow at the optimum soil depth of 10 mm.

If you are using zero till and chemical fallows, but plan to cultivate the paddock to establish a tropical perennial grass pasture, it is important to use cultivation at some time in the weed control phase prior to sowing. Cultivation is required to bring weed seed to the surface and stimulate germination.

Sowing with modern direct drilling machinery can result in excellent stands of tropical perennial grasses providing paddocks are properly prepared, sowing rates are adequate and seed is sown at the correct time and depth. Direct drilling retains cover on the soil surface providing protection from water loss and soil erosion.

Rigid framed machines, such as combines, can have major variations in sowing depth because of localised ground variation. Also, in conventionally prepared seedbeds rough surfaces and furrows can lead to seeds being buried too deeply by trailing harrows or rollers. Cultivated surfaces should be harrowed before sowing and a levelling bar used at sowing to reduce the risk of sowing too deeply.

The economics, risks and benefits of introducing tropical perennial grasses into native pastures should be carefully compared against improving these pastures by strategic grazing management.

Apart from conventional sowing and direct drilling there are a number of other options available such as aerial sowing into crop stubbles and using fertiliser spreaders.

A wide variety of methods can be used for sowing tropical perennial grasses. These include direct drilling with specialised machinery, using combines or precision seed drills, band seeders and fertiliser spreaders.

Seedbed preparation can vary from fully prepared seedbeds to crop stubble and a range of modified or undisturbed seedbeds. The reliability of these sowing methods will vary substantially with soil type, nutrition and climatic variability, but good establishment with all methods depends on adequate planning and pre-sowing weed management.

Well designed direct drilling machinery can produce excellent stands of tropical perennial grasses. However, many commercially available conventional machines cannot adequately control sowing depths to consistently place the seed at the required sowing depth (10 mm) particularly if the soil surface is uneven. To overcome this problem seed is often dropped on the soil surface of a cultivated paddock and then harrowed or rolled to provide adequate seed-soil contact. However, if the seedbed is rough and cloddy, results can be variable with seeds falling into depressions where the seed is buried too deep to emerge. The aim is to sow and have the seed covered by only 10 mm of soil.

High soil surface temperatures and evaporation rates in summer create a hostile environment for germinating seeds as the soil surface dries rapidly, so some soil cover and a close seed-soil contact is desirable. Also, with unprotected seed, losses from ant predation on the soil surface can be very high.

Many tropical perennial grasses (e.g. Rhodes grasses and creeping bluegrass) have light, fluffy seeds that do not flow well in conventional machinery. Seed can be mixed with superphosphate or a low-nitrogen compound fertiliser as a carrier, but much of the available seed is now coated, which overcomes these problems (see Chapter 4: Seed quality and sowing rate). If using coated seed the sowing rate must be increased to allow for the weight of the seed coating, which can be 50–80% of the total weight. Ensure that the seed purchased has high levels of purity and germination as the proportion of live seed is an important factor for adequate pasture establishment. Sowing tropical perennial grasses under a winter cereal crop is not recommended because of the high potential for seed loss over winter due to attack by insects, soil fungi and bacteria, and resultant poor establishment in spring.

Conventional row spacings are often adequate. Widening the row spacing may benefit companion legumes or provide space for subsequent legume sowings, but it can also allow for increased weed invasion and may increase the risk of erosion.

6.1 Direct drilling – ground contour following machines

Development of specialised direct drilling machinery has greatly improved the establishment of tropical perennial grasses. The trend toward minimum ground disturbance also greatly reduces the risk of erosion and helps to maintain soil structure, whilst providing improved seedbed preparation.

Conventionally prepared seedbeds have traditionally been considered the most reliable method of tropical perennial grass establishment, but modern precision planters are now giving excellent results. They are available with individually mounted sowing units comprising a single vertical disc opener, or narrow tyne, with an integral depth control device, a seed and fertiliser delivery tube and a press wheel (Figure 6.1).

Figure 6.1 Modern single disc opener with depth control wheel and press wheel.

Precision planters are capable of sowing at an even, shallow depth in a wide variety of soil conditions and are often the same design as the shallow sowing disc units used in broadacre cropping. Broadacre cropping units with air seeders can also be used for tropical perennial grass sowing provided they have air diffusers fitted to the tynes to eliminate seed bounce.

Other contour following machines include triple disc seeders and old-style disc seeders (Figure 6.2). Triple disc seeders are a cheaper option to modern single disc, no-till drills. Disadvantages of these machines are that soil slot walls can become glazed in moist, heavy soils and machinery maintenance costs can be high.

Figure 6.2 Twin disc seeder with press wheel controlled sowing depth.

Older style disc seeders are generally inferior, but can be fitted with inverted 'T' Baker Boot points for better results.

Direct drilling can be used in both old cropping country and previously undisturbed areas. Since direct drilling retains cover on the soil surface it provides protection from evaporation and soil erosion.

In previously cropped areas, stubble can also have advantages of reducing soil temperatures and helping to retain moisture, but in thick stubbles specialised sowing machinery may be required. When intending to direct drill into crop stubbles use a header that spreads straw relatively evenly.

In most situations, sowing under a cover crop is not be recommended. Winter crops are sown when temperatures are too low for adequate tropical perennial grass germination. Summer cereals and crops are sown when high temperatures and evaporation rates rapidly dry the soil surface and the crop provides too much competition for moisture to ensure adequate establishment.

i. Tyned drills

Trailed tyne drills can be good contour following machines. When using a tyned implement for direct drilling the sowing point is very important. Several successful points have been used to adapt sowing tynes for direct drilling. Narrow points with a leading edge only 6–10 mm wide are most suitable (Figure 6.3). High wear rate is a problem with most narrow soil openers. Steel lucerne points are relatively cheap, but must be hard faced as wear and maintenance is excessive in most soils. These points perform best on tight spring tynes where plenty of vibration can produce a good tilth.

Figure 6.3 Spear point on an air seeder with trailing press wheels to maintain clearance from the frame.

ii. Baker Boot

The first direct drill point developed specifically for pastures was the Baker Boot. It was designed with an edge-on-blade that incorporated wings at the bottom to create tilth and throw most of the soil out of the furrow. This point can be described as an 'inverted T' and it produces a flat bottomed furrow with a narrow surface opening that protects the seedling from moisture stress. An adapter is required to use Baker Boots on conventional tynes. High wear rates are a problem with these narrow points.

iii. Caldow 'T' Boots

Caldow 'T' Boots are a development of the Baker Boot, designed to reduce the amount of surface wearing. They produce a V-shape at the bottom of the furrow and throw more soil out of the furrow. The V-shaped bottom is achieved by pitching the point forward so that the leading tungsten tip is 6–8 mm lower than the rear of the wings. These wings then produce a mini seedbed at the bottom of the furrow with tilth scraped from the sides of the furrow.

6.2 Combines – rigid framed machines

Most combines and chisel seeders are rigid framed machines. The problem with these machines is that all tynes have a fixed position on the frame in relation to the ground so variation in soil surface can result in major variations in sowing depth. For example, if the average sowing depth is set at 25 mm, ground variations could produce furrows varying in depth from zero to 50 mm. This can greatly reduce the emergence of tropical grasses, which germinate best when sown at a shallow 10 mm depth.

If using a combine to sow tropical perennial grasses into conventionally prepared seedbeds, the preferred sowing method is to attach a band seeder (Figure 6.4). A levelling bar will also improve the accuracy of the sowing depth.

Seed is commonly sown using a combine with a small seeds box, or through the grain or fertiliser box with covering harrows. Seed may be mixed with fertiliser in the fertiliser box and tubes used to connect the fertiliser box to a band seeder. Superphosphate or a low nitrogen compound fertiliser can be used to mix with the seed provided only 10–15 kg N/ha is applied. Coated seed can be sown with the small seeds box attached to a band seeder.

Some tips when using fertiliser as a carrier are:

- Mix one part of seed to three parts of carrier when using a combine grain box and adjust rates to suit your machine.
- Mix 1 part of seed to 15–25 parts of fertiliser (for example, 2 kg bare seed mixed in 40 kg fertiliser) when using a combine fertiliser box, with the rate set for the fertiliser.
- Sow Rhodes grasses with a carrier through the coarse side of the grain box or through the fertiliser box.
- Sow panic grass and purple pigeon grass through the fine side of the grain box when mixed with a carrier, or if available, through a small seeds box.

Figure 6.4 Band seeders incorporate levelling bars to improve seed placement.

When the soil is uneven, or the combine tynes are working the soil, it is essential to use a levelling bar in front of the band seeder. Band seeders create a shallow groove about 20 mm deep and place the seed in the groove. A trailing chain gently covers the seed at a shallow depth. A rubber-tyred roller should be used to firm the soil around the seed. This will improve seed-soil contact to help the seed imbibe moisture from the soil.

Band seeders are a very reliable method of establishing tropical perennial grasses into a well-prepared seedbed using a levelling bar. When sowing without a band seeder attached, it is still possible to achieve satisfactory results if the soil surface is very even and seed is dropped onto the soil surface and rolled or harrowed with light harrows to minimise sowing depth. Rollers are preferred as they tend to give better soil-seed contact and sowing depth is not affected as much as with harrows.

6.3 Other options

Seed mixed with fertiliser and distributed through a fertiliser spreader and harrowed or rolled has also resulted in successful establishment of tropical perennial grasses. A cultivated soil with an even surface is best for this method.

Aerial sowing into crop stubbles has the advantages of speed, reduced costs, and low erosion risk, but an increased chance of failure compared with direct drilling or conventional sowing. Successful establishment is highly dependent on good soil moisture and good rainfall after sowing. Immediately following a crop, subsoil moisture levels may be low and germination of grain from the previous crop may compete with emerging tropical perennial grass seedlings. It is desirable to use a header that spreads straw evenly. Treat seed to prevent predation by ants when surface sowing. Aerial sowing or using a fertiliser spreader into seedbeds prepared by conventional cultivation and then harrowing or rolling after sowing can be successful, but the soil surface must be as level as possible.

Chapter 7: Seedling identification

MA Brennan, SP Boschma and CA Harris

Mixes of tropical perennial grass species are commonly sown into farming country which has had a history of summer-growing annual grass weeds, for example, liverseed grass, barnyard grasses, and stinkgrass. The seed bank of these annual grass weeds should be controlled prior to sowing a new tropical perennial grass pasture. However, even after the best weed control some of the seed of these annual grass weeds will remain and germinate.

Early identification of seedlings of sown species and annual grass weeds is important for management of newly sown pastures.

This chapter contains photos of seedlings and descriptions of some characteristics of both the commercial tropical perennial grass species and a number of common summer-growing annual grass weeds.

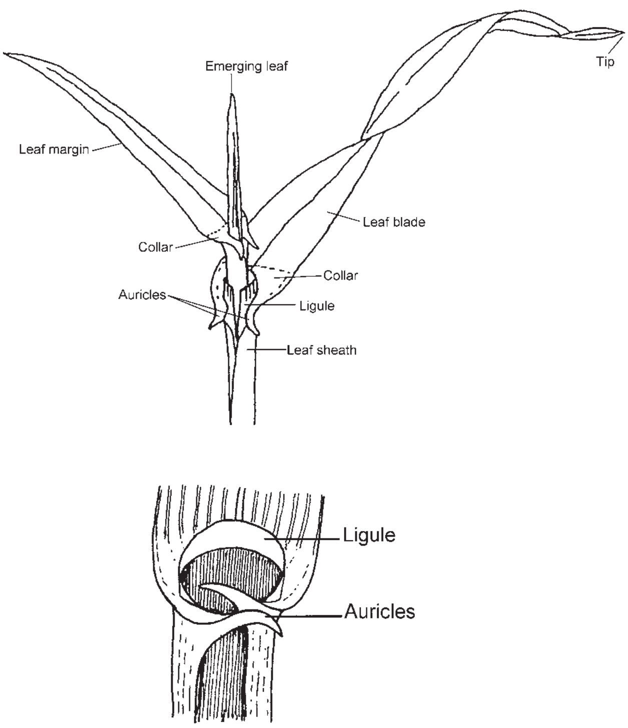


Figure 7.1 The plant features used to assist in the identification of grass seedlings [Modified from Moerkerk (1998) and Wheeler et al. (2008)].

Tropical perennial grasses are commonly sown as a mix of several species. They are also often sown into country that has a history of farming and therefore an increased burden of summer-growing annual grass weed seed in the seed bank. Weed species of interest include liverseed grass, barnyard grasses and stinkgrass *(Eragrostis cilianensi)*. While these grass weeds should be controlled to prevent seeding to ensure the weed seed bank has been reduced prior to sowing a new pasture, some seed invariably remains.

Distinguishing between the sown species and annual grass weeds at the seedling stage in an establishing pasture can be difficult. This chapter contains photos and descriptions of some characteristics that can be used to identify seedlings of both the sown tropical perennial grass species and a number of common summer-growing annual grass weeds.

7.1 Seedling characteristics

An understanding of the basic leaf structures of a grass seedling is necessary to be able to look for and identify any key characteristics that distinguish the different grass species. These features — leaf sheath, leaf blade, leaf tip (sometimes called apex), collar, ligule and auricles are shown in Figure 7.1. All of the characteristics described in this publication can be seen either with the naked eye or a hand lens with a 10 power magnification.

Each leaf consists of a sheath (portion of the leaf that encircles the stem) and a blade (the flat expanded portion of the leaf). The leaf blade has an upper and lower surface, margin and tip. The junction of the sheath and the blade is referred to as the collar region and usually includes a ligule and sometimes auricles. The ligule is an outgrowth on the inner surface of the leaf blade in the collar region. The outgrowth can be membranous (thin and soft like a membrane) or hairy. The shape, colour, and margin of a ligule are usually consistent and very useful identifying characteristics for a species. The auricles are appendages that may be found wrapped around the stem in collar region, they can also be membranous or have hairs.

Characteristics such as colour and hairiness can be useful for identifying grass seedlings, however, they can change as plants develop. The descriptions in this chapter focus on the seedling stage, from emergence and the following six weeks after emergence. The photographs are to assist with identification, but it should be noted that growing conditions such as temperature, sunlight, nutrition and available moisture may also change the physical appearance of seedlings at similar stages. For example seedlings can appear compressed when moisture stressed or elongated under very moist conditions.

7.2 Tropical perennial grasses

Angleton Grass

Cultivar: Floren⑰

Leaf: Sheath is hairless, but has distinct long hairs on the margin of the upper side of the leaf blade towards the collar (usually visible after the 3-leaf stage) (Fig. 7.2).

Ligule: Distinct and membranous (Fig. 7.2).

Auricles: Not distinct, but there may be long sparse hairs on the edge of the collar (Fig. 7.2).

Other features: Seedlings can appear compact in marginal growing conditions (Fig. 7.3).

Figure 7.2 Floren has a membranous ligule and long hairs on the top of the leaf blade near and at the edge of the collar.

Figure 7.3 Seedlings can appear compact in marginal growing conditions.

Creeping Bluegrass

Cultivars: Bisset⑰, Hatch

Leaf: There are no visible hairs on the sheath or blade up to 3-leaf stage. Leaves are blue-green in colour (Fig. 7.4).

Ligule: A short papery membrane with a few hairs on the edges.

Auricles: Not distinct.

Other features: After the 3-leaf stage there may be some sparse hairs at the base of the plant. A distinct red colour may be visible at the base of the seedling (Fig. 7.5).

Figure 7.4 Creeping bluegrass seedling compressed in stressed conditions showing blue-green colour.

Figure 7.5 Creeping bluegrass seedling elongated in moist conditions and showing distinct red colour at the base of the seedling.

Digit Grass

Cultivar: Premier

Leaf: Noticeable hairs on leaf sheath. The first leaf is broad with a round tip (Fig. 7.6). Leaf blades mostly hairless on the upper side, but some fine hairs may be detectable with a hand lens. The underside of the leaf blade is covered with fine hairs becoming less hairy to hairless as the seedling matures.

Ligule: Small, membranous and rounded.

Auricles: Not distinct.

Other features: Noticeable hairs at the base of the plant (Fig. 7.7).

Figure 7.6 Digit grass seedlings in moist conditions showing the broad first leaf.

Figure 7.7 Digit grass seedling showing hairs on the underside of the leaf and base of the plant.

Forest Bluegrass

Cultivar: Swann⦷

Leaf: Sheath smooth without hairs. Leaf blades long and narrow tapering to a point at the tip and mostly hairless.

Ligule: Short and membranous.

Auricles: No distinct auricle, but there may be sparse hairs at the collar region (detectable with magnifying lens).

Other features: Colour of seedling will change depending on growing conditions. In moist conditions seedling will usually be light green with a slight red-purple colouring at the base of the seedling (Fig. 7.8). When establishing under cool conditions seedling will generally be blue-green in colour, but will still have a purple-red base (Fig. 7.9).

Figure 7.8 Swann grass seedlings are brighter green with a red base in moist conditions.

Figure 7.9 Swann grass seedlings are blue-green when establishing during cool nights, but still have a red base.

SECTION ONE — ESTABLISHMENT

Lovegrass

Cultivar: Consol

Leaf: Sheath may have some short fine hairs. Leaf blade is long, narrow and tapering (Fig. 7.10). Blade is predominantly hairless, sometimes with a few hairs on margin of leaf near the collar region (Fig. 7.11). The leaf blades can be variable in colour from blue-green to green and slightly rough on both sides to touch.

Ligule: A short rim of hairs which can be seen with a hand lens.

Auricles: Sparse hairs detectable with a hand lens (Fig. 7.11).

Other features: Base of the seedling may have some short fine hairs, and becomes hairier as plant matures.

Figure 7.10 Consol lovegrass seedling showing the narrow and tapering of the leaves.

Figure 7.11 The collar region of a Consol lovegrass seedling showing sparse hairs.

Makarikari Grass

Cultivar: Bambatsi

Leaf: The leaf blade is predominantly hairless, but sparse long hairs on leaf blade margin near the collar may be evident (Fig. 7.12). As the seedling matures the leaf blade changes from a pale green to a blue-green colour. A distinct white mid-rib colouration on the leaf blade can be seen as the seedling matures (Fig. 7.13).

Ligule: Short and membranous with a fringe of minute hairs (Fig. 7.12).

Auricles: No distinct auricle, but has long hairs along the edge of the collar (Fig. 7.12).

Figure 7.12 A leaf blade of a Bambatsi seedling showing the white-mid-rib, ligule with a fringe of minute hairs and long hairs along the leaf margin at the collar.

Figure 7.13 A Bambatsi seedling showing the blue-green colour as the seedling matures.

Panic Grass

Cultivar: Gatton, G2

Leaf: Sheath has short fine hairs. Short fine hairs may also be present on the under side of the leaf (detectable with magnifying lens). The upper side of the leaf blade is smooth. Leaves are often arranged in pairs opposite each other on the stem (Fig. 7.14). Leaves of Gatton seedlings have a distinct mid-rib.

Ligule: Membranous.

Auricles: No distinct auricles, but fine short hairs at the collar region.

Other features: The base of Gatton seedling is a distinctly red-purple colour (Fig. 7.15).

Figure 7.14 A Gatton seedling showing the distinct arrangement of the leaves.

Figure 7.15 A Gatton seedling showing distinct red-purple colour at the base of the seedling.

Purple Pigeon Grass

Cultivar: Inverell

Leaf: Sheath may have fine hairs that are usually only visible with a hand lens. Leaf blade is hairless and sharply narrows to a pointy tip (Fig. 7.16).

Ligule: Short and membranous fringed with hairs that are visible with a hand lens.

Auricles: Not distinct.

Other features: A reddish base may be visible (Fig .7.17).

Figure 7.16 A purple pigeon grass seedling in the field showing the narrow leaf tip.

Figure 7.17 An Inverell purple pigeon grass seedling with red base.

Rhodes Grass *(Chloris gayana)*

Cultivars: There are many cultivars including diploids; Katambora, Finecut⁽ᵇ⁾, Nemkat⁽ᵇ⁾, Topcut⁽ᵇ⁾, Tolgar⁽ᵇ⁾, Gulfcut⁽ᵇ⁾, Pioneer, and Reclaimer⁽ᵇ⁾ and tetraploids; Callide, and Toro⁽ᵇ⁾.

Leaf: Sheath is covered with fine hairs. The leaf blades are flat and curved downwards with a slight twist (Fig. 7.18). The leaf blades are also covered with fine hairs that disappear as the seedling matures.

Ligule: Small and membranous (Fig. 7.19).

Auricles: No distinct auricle, but has long sparse hairs in the collar region.

Other features: Seedling has a distinct red-purple base. Tiller bases are distinctly flattened.

Figure 7.18 The leaf blades of a Rhodes grass seedling has a slight twist and curve downwards and the seedling has a distinct red-purple base.

Figure 7.19 A Katambora seedling showing a membranous ligule and fine hairs on the leaf sheath.

7.3 Common grass weeds

Barnyard Grasses

There are two species of this annual grass weed — awnless barnyard grass *(Echinochloa colona)* and barnyard grass *(Echinochloa crus-galli).*

Leaf: Leaf blades are long, tapering to a point (Fig. 7.20) and predominantly hairless.

Ligule: Not distinct.

Auricles: Not distinct.

Other features: Seedling base is hairless and may be a red-purple colour (Fig. 7.20). Awnless barnyard grass often has a red base while barnyard grass does not. As the plant matures purple-red bands are often seen on the leaf blade of awnless barnyard grass particularly when the plant is stressed. The tiller base is distinctly flattened.

Figure 7.20 A barnyard grass seedling showing the red-purple colour at the base of the seedling.

Liverseed Grass

Leaf: Sheath hairy. First leaf to emerge is short and broad (Fig. 7.21). Leaf blade has a distinct wavelike pattern along the margin with long hairs (Fig. 7.22).

Ligule: Membranous with fringe of hairs.

Auricles: No distinct auricles, but hairy at the collar region.

Other features: Very vigorous seedling and will germinate in early spring if present in the seed bank.

Figure 7.21 The first leaf of a liverseed grass seedling to emerge is short and broad.

Figure 7.22 Hairs on the leaf margin and sheath of a liverseed grass seedling. This photo also illustrates the wave like nature of the leaf margin.

Stinkgrass

Leaf: Sheath may be a red-purple colour. Leaf blades are smooth with glands present along the leaf margin (Fig. 7.23). Some sparse fine hairs may be visible on the underside of the leaf blade.

Ligule: A fringe of short hairs.

Auricles: Not distinct, but hairs can be found at the collar region.

Other features: Seedling base may be a red-purple colour (Fig. 7.24).

Figure 7.23 The leaf blades of stinkgrass seedlings have glands along the margins.

Figure 7.24 The base of stinkgrass seedling may be a red-purple colour.

Case study: Tropicals set pace for rapid transformation

Farm info.

Case study: *Marty and Karen Brennan*

Location: *Boggabri, New South Wales*

Property size: *1600 ha*

Mean annual rainfall: *600 mm*

Soils: *Alluvial flats to heavier chocolate country and red gravel ridges*

Enterprises: *Sheep, cattle and cropping*

This producer story first appeared in Future Farm *Issue 4, December 2009.*

Tropical pastures have transformed the landscape on Marty and Karen Brennan's mixed farming property in northern NSW and Marty shares his story.

"We run a mixed farming enterprise where we crop on our most productive ground and have traditionally run sheep on the poorer country," Marty said.

"Our pastures were a mix of lucerne and native grasses, but with increased dry seasons the lucerne just wasn't coping. When the leaves fell to the ground, the soil was exposed to the heat during the
dry summers.

Our native grasses just weren't giving us any bulk feed and any carryover feed they had tended to be worthless without rain.

So we were looking for something that would boost our livestock production and give us better groundcover to prevent our soils from washing away during heavy storms.

Other local producers were having great success with tropicals, so we thought it was worth giving them a go.

Getting started

After much procrastination we started off after the local Namoi Catchment Management Authority got some funding and we were away.

Marty and Karen Brennan have been overwhelmed at how the tropical grasses have revitalised land they previously considered to be their least productive paddocks.

We sowed Katambora Rhodes, Bambatsi panic, Consol lovegrass and Premier digit as a bare seed mix at 4 kilograms per hectare with 70 kg DAP fertiliser.

We were a bit late sowing as we were still using conventional machinery and undertook a few preparatory cultivations to get the weeds under control first.

But after getting the pasture in between Christmas and the New Year, we were grazing it by February with sheep and cattle.

We were absolutely gobsmacked with what the paddock did — we started with our worst country and it just transformed it into some of our best feed in no time.

Spreading the benefits

Our next step was to sort out a bit of plan with how to bring the rest of the farm into tropicals, while still copping our better country.

We've now got about 445 ha of tropicals established and we're working hard to match feed with stocking rates and water.

It's bit hard to quantify, but we've certainly increased stocking rates with of the tropicals.

We've also had to reduce the size of the paddocks to make the best use of the feed.

We had to install a reticulation system for stock water as their is no longer any run-off on the paddocks — it's not a bad problem to have.

And we've seen a transformation in the soil — it now takes in the water easily, the organic matter created from the bulk of the feed is making an environment that allows the nutrient cycle to really get going.

The country you couldn't drive a crowbar into before you can almost just push a shovel in now.

I'm amazed at how quickly the country has responded and what it can actually do — we've never seen it grow so much feed.

Facing the challenges

Probably the biggest challenge we still face is a dry autumn. If you don't get a break and some clovers happening you can have a bit of a quality feed gap during late autumn.

We usually have a good carryover of feed after the tropicals dry off. But without an autumn there is a bit of a gap where the feed isn't quite as valuable. But you've got to weigh that up with the rest of the year.

Paddock size or mob size is important just so you can move stock in to eat the bulk down and move them on — it's a totally different scenario to the old set stocking regime.

It's a matter of getting your head around set stocking as it takes a bit of getting used to. There's still heaps of feed in the paddock but you're moving the stock out of it.

Before we made the move to tropicals, we'd done a lot of investigation through field days and talking to lots of people — somewhere along the line you realise you've just got make the change.

People often shy away because of the costs and risks involved with establishing tropical pastures.

But we look at in two different ways — we've grown wheat crops before that have failed and we've gone back in the next year. It's the same with tropicals.

Secondly, if you get a successful establishment it's cheap — the pasture will be there for a long time. People still go back in and grow oats year in year out and don't question the cost of doing that.

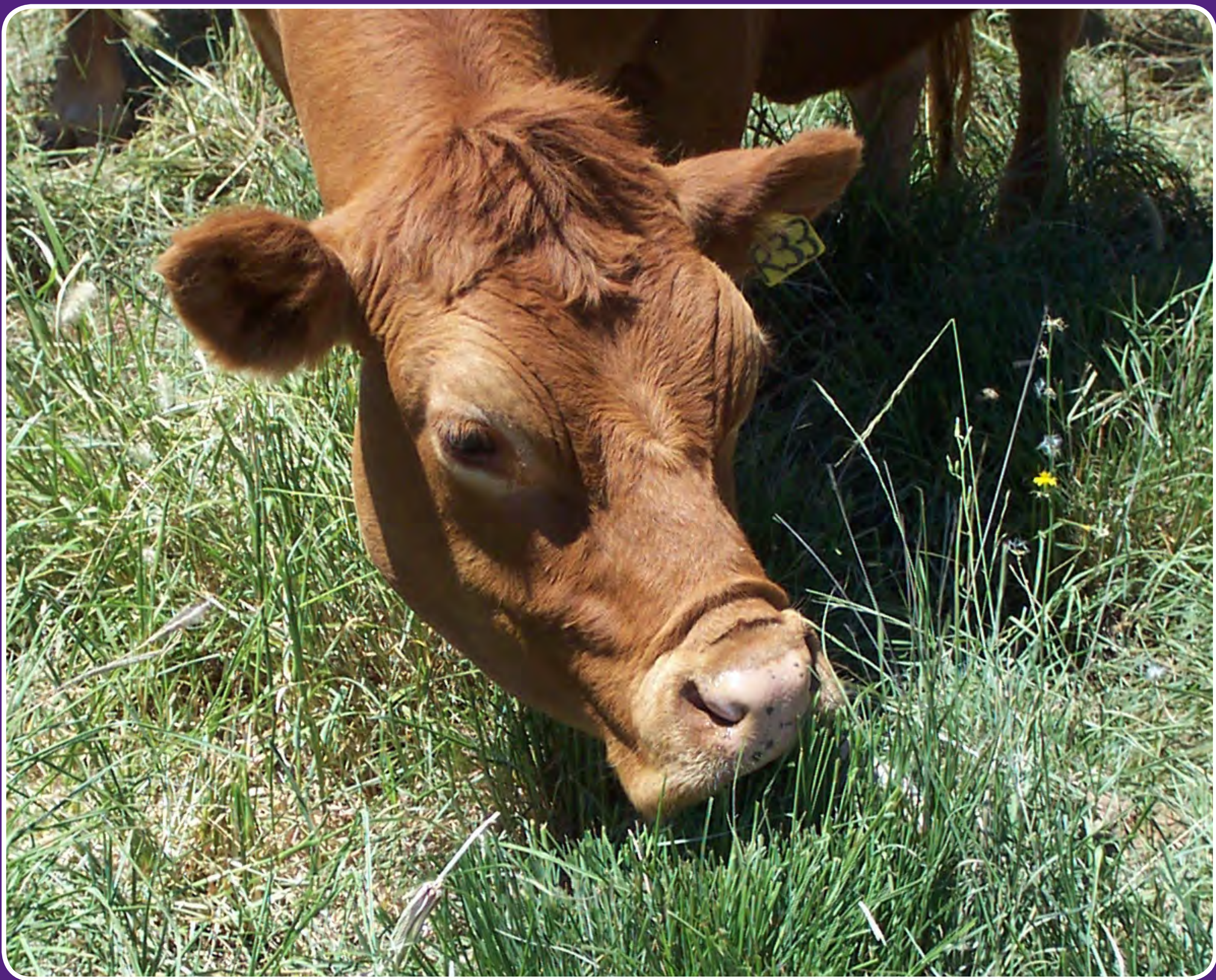
In terms of additional inputs, we do fertilise the tropicals when the cash is available.

If you've got the whole-farm plan right, where your paddock size is right and your water is right, you'll get the most value out of the fertiliser you put on.

The tropicals are a real success story for our mixed farming system. In a dry season like this, where we have only had 254 mm of rain for the year, 63 mm during the growing season — our crops have suffered. But we've had a bit of rain during harvest and the grasses have jumped away to a great start.

We've still got a way to go with our livestock system, but the tropicals are helping us with our move from trade cattle to a breeding operation and have transformed our pasture country along the way.

SECTION TWO



Making the most of tropical perennial grass pastures on-farm

Chapter 8: Pasture quality for cattle and sheep production

SP Boschma, ML Lollback, AJ Rayner and RP Graham

Fertilised tropical perennial grasses have higher quality forage than other summer-growing forages such as forage sorghum and native pastures dominated by summer-growing grasses.

Pasture quality is optimised with good plant nutrition and grazing management. Application of nitrogen increases crude protein levels by up to 5%. Grazing management strategies that maintain the pasture in the vegetative growth stage and reduce the proportion of stem and dead material will also enhance feed quality.

Animal production will be highest when pasture quality is optimised. With good management and average seasonal conditions tropical perennial grasses are capable of playing an important role in both cattle and sheep production systems.

Feed intake is the driver for animal production so the focus needs to be on optimising the quantity of green feed available. Green pasture dry matter for cattle should be 1.6–2.5 t DM/ha and for sheep 1.0–1.5 t DM/ha (when digestibility is 65%).

Tropical perennial grasses can provide adequate nutrition for moderate to high growth rates in growing animals and ensure suitable condition of dry cows for successful joining.

For sheep production, tropical perennial grasses can be used for autumn joining/spring lambing systems prior to joining, during early pregnancy and in late lactation prior to weaning, and for spring born lambs following weaning. For spring joining/autumn lambing systems, tropical perennial grasses can be used pre-joining in spring and to maintain ewe fat score in early to mid-pregnancy (i.e. throughout summer).

Good plant nutrition is essential for tropical perennial grass pastures to achieve optimum growth and quality for animal production. Tropical grasses are responsive to increasing nitrogen and can produce an additional 100 kg DM/ha in the growing season for every kg N/ha applied. That is, the application of 50 kg N/ha can increase dry matter production from 5 to 10 t DM/ha over a growing season.

The most useful measure of pasture quality is its digestibility, which is defined as the proportion of feed that an animal consumes that is used to satisfy its nutritional requirements. It is expressed as a percentage. It is directly related to the energy content (metabolisable energy) of a pasture and has a positive relationship with protein. Metabolisable energy is needed by animals for body functions and is expressed as megajoules per kg of dry matter (MJ ME/kg DM). Energy intake is the driving influence on animal performance, followed by the intake of protein, vitamins and minerals. This means that a pasture with a digestibility of about 70% will have a high proportion of green leaf and have energy and protein levels capable of supporting high levels of cattle or sheep performance. In contrast, a pasture of lower digestibility (e.g. 55%) has a higher proportion of stems and dead herbage with energy levels only capable of maintaining animals.

Pasture digestibility is directly related to stage of growth and declines as pastures mature and have increased amounts of stem and dead material. Protein content of a pasture is also influenced by species composition and plant nutrition. For example, legumes have a higher protein content than grasses, and grass pastures, either fertilised or with a legume component, have higher protein than unfertilised legume deficient pastures.

Digestibility and protein are important because they influence the speed at which forage is digested. Forage with high digestibility moves through the rumen quickly, generally allowing the animal to eat more, which increases the level of animal production.

The quality of tropical perennial grasses tends to be lower than that of most sown temperate perennial grasses. This is associated with greater lignification of the plant leaves, a mechanism they have developed to minimise water loss (transpiration) that increases their survival in hot summer conditions.

This perceived 'poor' quality of tropical perennial grasses has deterred some producers from considering them as valuable pasture species. However, it is important to remember two things, firstly, that temperate and tropical grasses grow at different times of the year and so in practice comparisons are often of little relevance. Secondly, some information suggests that the relative performance of animals grazing temperate and tropical perennial grasses may be different (Figure 8.1). In the field, this difference is thought to be associated with the higher intake of green leaf material of tropical grasses, which is related both to their more upright structure and the indeterminate growth of green leaves during stem elongation and flowering. While animal performance will be higher for a temperate grass with digestibility greater than 66%, it may be greater for a tropical grass when digestibility is below 66%.

An important potential role for tropical pastures in NSW is to help fill the feed gap that regularly occurs in late summer-autumn as native pastures decline in quality and lucerne growth slows, and before early sown grazing oats are available. When considering the advantages and disadvantages of tropical perennial grasses they should be compared with other summer-growing forages such as native perennial grasses, forage sorghum and lucerne.

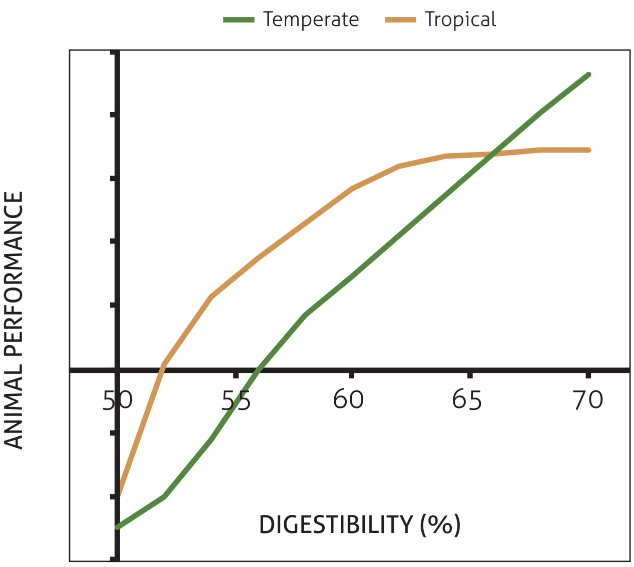
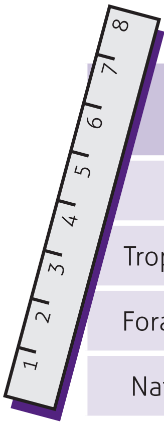


Figure 8.1 Relative performance of animals grazing temperate and tropical perennial grasses varies as pasture digestibility changes. Animal performance may be higher for tropical perennial grasses when digestibility declines below 66%.

In northern inland NSW, native pastures dominated by summer-growing perennial grasses are not suitable as the sole forage base for profitable breeding or fattening enterprises. To successfully run breeding or finishing enterprises their use needs to be integrated with other forage sources such as sown pastures, forage crops and/or supplements.

Forage sorghum generally has lower forage quality than tropical perennial grasses (Figure 8.2), requires re-sowing each year and is not available for grazing until about December. Native pastures dominated by summer-growing grasses such as redgrass *(Bothriochloa macra)* and Queensland bluegrass *(Dichanthium sericeum)* can produce good quality herbage, but they tend to mature quickly and so only produce higher quality forage for short periods in spring-summer, particularly following rainfall.



	Energy (MJ/kg DM)	Protein (%)
Lucerne	9.9–10.4	20–23
Tropical grasses	8.6–9.6	13–18
Forage sorghum	5.6–8.5	5–12
Native pasture	5.0–8.4	5–18

Figure 8.2 Well managed actively growing tropical perennial grasses can have higher forage quality than forage sorghum and native perennial grasses, but less than that of lucerne.

Lucerne is the benchmark summer-growing perennial legume in northern inland NSW and produces higher quality forage than tropical perennial grasses. However, in pure stands it has the disadvantage of low ground cover, increased risk of bloat and it tends to lose its leaves when it becomes water stressed in summer.

8.1 Achieving high quality tropical perennial grass pastures

One of the biggest challenges with tropical grass pastures is maintaining high feed quality. This can be achieved with both good plant nutrition and appropriate grazing management strategies. Plant nutrition can be improved by annual application of fertiliser, in particular nitrogen applied either as fertiliser or provided by a legume in the pasture. Research in northern NSW found that the addition of 100 kg N/ha increased crude protein (CP) levels by up to 5% and maintained these levels throughout the growing season. In contrast, unfertilised tropical perennial grasses may have reasonable quality at the start of the season, as they utilise mineralised nitrogen that has accumulated over winter, but once this has been used CP levels rapidly decline (Table 8.1).

Table 8.1 Crude protein (%) and metabolisable energy [MJ ME/kg of dry matter (DM)] of green leaves of Premier digit grass unfertilised (Nil) or fertilised (Fert.) with 100 kg/ha of nitrogen during the growing season. Forage quality is higher in fertilised regrowth. Crude protein levels declined markedly from November to March in the unfertilised grass.

Month	2 weeks regrowth		6 weeks regrowth	
	Nil	Fert.	Nil	Fert.
Crude protein (%)				
Nov.	15.9	18.7	14.2	17.0
Jan.	14.7	18.4	13.4	16.9
Mar.	13.1	18.0	11.8	17.4
Metabolisable energy (MJ ME/kg DM)				
Nov.	9.5	9.6	9.1	8.6
Jan.	9.1	9.5	9.2	9.5
Mar.	7.1	7.7	7.2	7.3

Effective grazing management is required to maintain pasture in a vegetative growth stage, because as it matures stem elongation commences and pasture quality declines. Data from cutting trials has shown that CP and metabolisable energy (ME) levels of the green leaf proportion of digit grass plants cut every two weeks were higher than those cut every six weeks (Table 8.1). As an example, in March, the CP of green leaf of digit grass fertilised with 100 kg N/ha and cut every two weeks was 18.0% and ME was 7.7 MJ ME/kg DM. When fertilised and cut every six weeks green leaves CP was 17.4% and ME was 7.3 MJ ME/kg DM. In both fertilised and unfertilised digit grass, the proportion of green leaf after two weeks regrowth was about 75%, but declined after six weeks of regrowth.

During mid-summer, when there is good soil moisture tropical perennial grasses have high growth rates and will require regular grazing at high stock densities to maintain them in a high quality, leafy stage of growth. For example, to utilise the growth of a tropical grass pasture (with pasture dry matter availability non-limiting for animal intake and a digestibility of 68%) growing at 100 kg DM/ha/day, stocking rates would need to be about 60 lambs/ha (25 kg liveweight with an intake of 1.6 kg DM/head/day) or 11 steers/ha (about 300 kg liveweight, intake 9 kg DM/head/day). Therefore to utilise these grasses and maintain quality they need to be either set stocked, maintaining the benchmarks shown in Table 8.2, or rotationally grazed with only short rest periods between grazing, depending on seasonal conditions and regrowth.

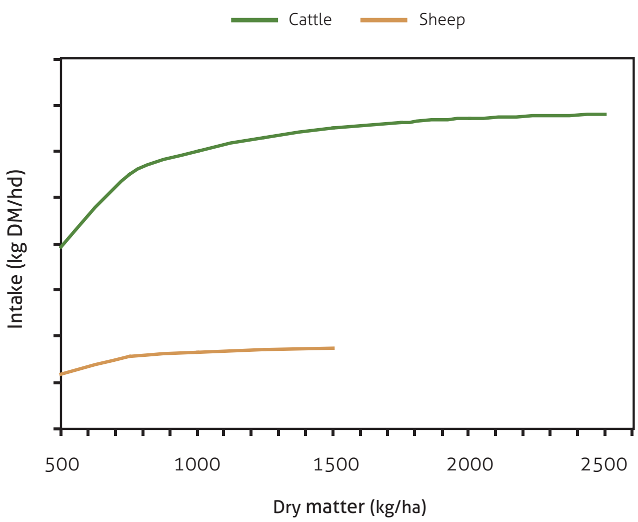


Figure 8.3 Change in intake with increasing pasture dry matter. Green dry matter within the range of 1.6–2.5 t DM/ha is optimum for intake of cattle, while maintaining high quality. For sheep, a green dry matter of 1.0–1.5 t DM/ha is optimum for intake and quality.

Table 8.2 Minimum green dry matter (kg DM/ha) to maintain satisfactory production levels in cattle and sheep on tropical perennial grass pastures with digestibility of 65% (9.2 MJ ME/kg DM), 60% (8.4 MJ ME/kg DM) and 55% (7.5 MJ ME/kg DM) (modified from Prograze manual). Note these predictions are based on a pasture which includes 400 kg DM/ha of dead pasture with a digestibility of 45%. The value 'ns' indicates that the feed quality is not suitable for this livestock class.

Livestock class	Pasture digestibility		
	65%	60%	55%
Cattle			
Dry cows	870	1250	2400
Pregnant cows (7–8 months)	1650	2700	7500
Lactating cows + 2-mth-old calf	2500	4000	ns
Growing cattle – % of potential growth			
30	770	1150	2400
50	1050	1700	4500
70	1600	2700	ns
90	2200	ns	ns
Sheep			
Dry sheep	560	800	1300
Pregnant ewes (100 days)	800	1700	2300
Lactating ewes + single lamb	1200	ns	ns
Growing lambs – % of potential growth			
30	500	600	1100
50	600	750	1900
70	800	1250	ns
90	1300	ns	ns

8.2 Animal production

Tropical perennial grass pastures are often considered to be better suited to cattle, but they can also be suitable for sheep – grazing management is the key. The availability of pasture dry matter has a major influence on the daily feed intake of livestock. To maximise animal intake and performance, producers should aim to maintain green pasture dry matter (with a digestibility of 65%) between 1.6–2.5 t DM/ha for cattle and 1.0–1.5 t DM/ha for sheep (Table 8.2, Figure 8.3). If green dry matter is less than these minimum amounts, then feed intake will be less, resulting in lower levels of animal performance. However, if green pasture dry matter is above these maximum levels there is no increase in feed intake or animal performance. This occurs because firstly, the animals meet their 'gut fill' requirements in an optimum time frame and secondly, at high levels of pasture dry matter digestibility is generally lower. Plant material with low digestibility slows the passage of feed through the animal's digestive system, reducing intake levels.

It is also important to realise that as tropical perennial grasses mature, digestibility declines more rapidly than in temperate perennial grasses. This means that the 'window' for moderate to high animal production is small without appropriate grazing management and may not be sustained for long periods.

8.3 Role of tropical perennial grasses in cattle production systems

Cattle production is driven primarily by feed intake. Therefore the focus should be on optimising the quantity of green feed available (1.6–2.5 t DM/ha) and maximising the quality of feed-on-offer. The ability of tropical perennial grasses to respond to rainfall, producing large quantities of dry matter means that they can be effective at meeting these quantity targets. However, the greater challenge for producers is to meet the quality targets which can be achieved with stocking rate. Producers should aim to maintain pastures in a range of 60–70% digestibility (Figures 8.4 and 8.5) and above 65% for moderate to high levels of production. It is important to recognise that below 60% digestibility, production levels will be much lower and the pasture may not suit some classes of cattle, such as lactating cows or high growth rates in growing stock (Table 8.2).

Time of calving may determine the usefulness of tropical perennial grass pastures in a breeding herd. Generally, lactating cows have twice the energy requirements of a dry cow and so to ensure milk production and successful joining, they must graze high quality pastures

Figure 8.4 Tropical perennial grasses should be maintained in a range of 60–70% digestibility.

(i.e. digestibility about 65%) with a green dry matter of about 2.5 t DM/ha. For spring calving herds, tropical perennial grass pastures may not meet these quality requirements. Therefore, producers may need to consider grazing alternative pastures or crops, or provide an appropriate supplement to meet the needs of lactating cows. However, tropical perennial grass pastures may provide adequate levels of nutrition to ensure the successful rejoining of cows in summer, or moderate to high growth rates (0.7–1.0 kg/head/day) in growing animals (Figure 8.6).

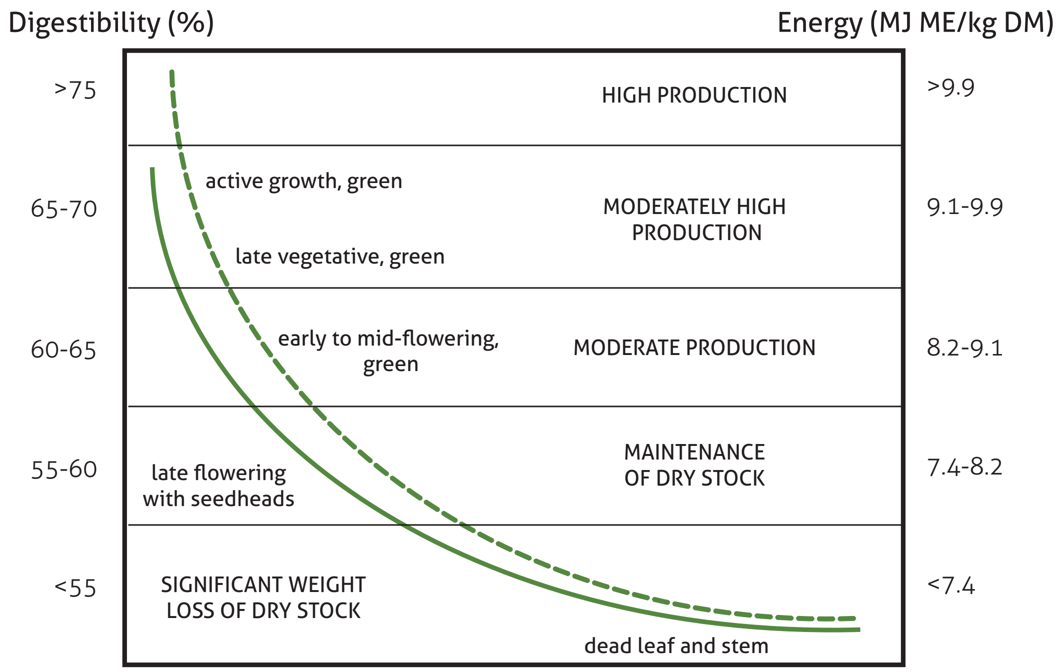


Figure 8.5 Guide to digestibility decline as tropical (—) and temperate perennial grasses (- -) mature. For moderately high levels of production, digestibility must be maintained above 65% (modified from Prograze manual).

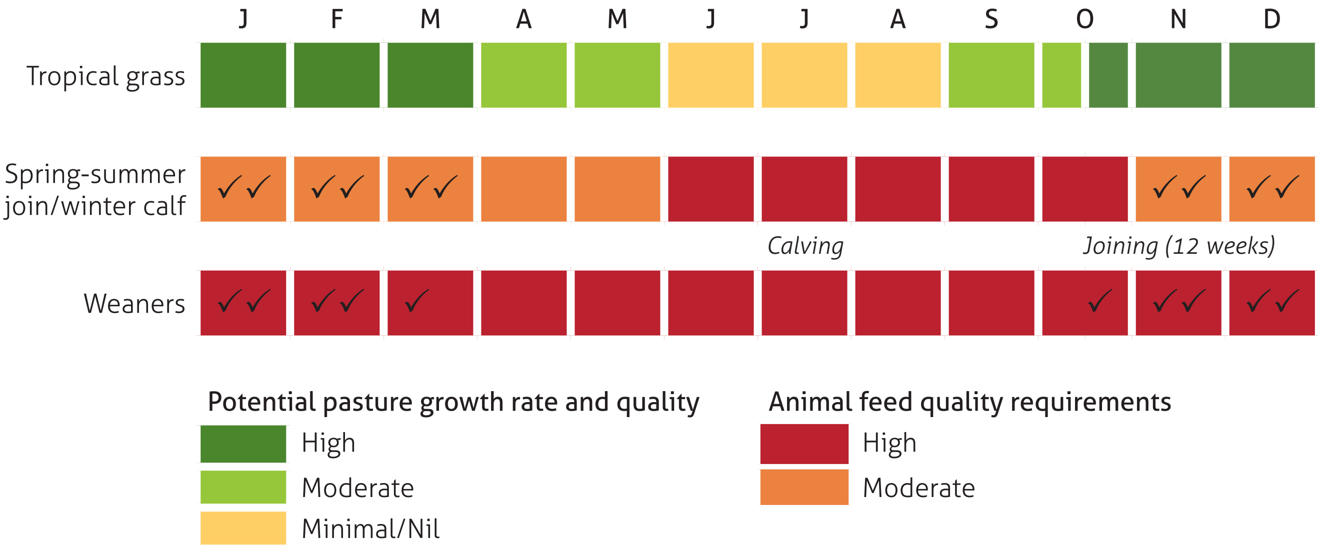


Figure 8.6 Tropical perennial grass pastures are suitable for successful rejoining of cows in summer, or moderate to high growth rates in growing animals from spring (indicated by ticked boxes), when the tropical grass pastures commence growth, until autumn.

Similarly, in winter when carry-over feed has frosted it will be mostly dead material with a low digestibility and so would be unable to support moderate growth or lactation unless supplementation is provided.

8.4 Role of tropical perennial grasses in sheep production systems

In northern NSW, sheep breeding production systems are based on an autumn joining/spring lambing or a spring joining/autumn lambing program. Within each production system it is critical that ewes attain a fat score of 3–3.5 at joining and that it does not fall below 3-score throughout pregnancy, particularly in the last 50 days.

In an autumn joining/spring lambing system, lambs born in spring (September) are weaned at three to four months of age (December–January). This allows about three months over summer for ewes to regain condition for joining in March–April. Commonly, ewes will need to regain 1–1.5 fat scores to attain a fat score of 3.5 by joining. This equates to 7–10 kg liveweight over a period of about 100 days (i.e. a growth rate of 70–100 g/head/day).

Figure 8.7 Sheep grazing a mixed tropical perennial grass pasture.

Tropical perennial grass pastures with the appropriate grazing management system should enable ewes to achieve these growth rates (Figures 8.5 and 8.7). Once ewes have attained these target fat scores for joining they will need to be maintained (or allowed to fall by no more than 0.5 of a score) during the first 100 days of pregnancy. In early pregnancy, tropical perennial grasses may meet these needs, but with frosts and declining feed quality they are unlikely to meet ewe nutritional requirements in mid to late pregnancy.

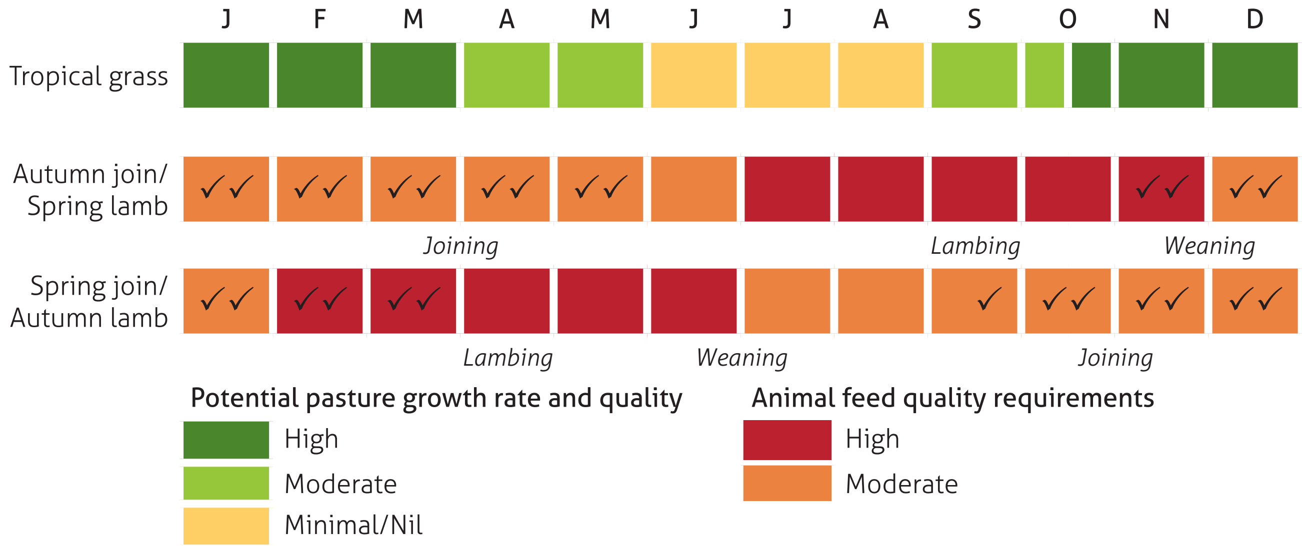


Figure 8.8 Tropical perennial grass pastures are suitable for autumn joining/spring lambing sheep enterprises from weaning in December until after joining in autumn (as indicated by ticked boxes). Tropical grass pastures can supply suitable feed for spring joining/autumn lambing systems from spring (ticked boxes), when they commence growth, until about lambing in autumn.

Similarly, for lambing (in September) and early lactation tropical perennial grasses are unlikely to provide sufficient quality feed (Figure 8.8, Table 8.2). After weaning, prime lambs are usually grazed on lucerne or summer-growing forage legumes such as lablab or cowpeas to maximise growth rates. However, Merino weaners or lambs that are held-over to be later finished on forage oats could achieve moderate to high growth rates on tropical grasses.

In a spring joining/autumn lambing system, lambs are weaned in June–July which allows three to four months for ewes to regain condition before joining in October–November. In late winter–early spring, adequate weight gain for both dry ewes and weaned lambs would be dependent on forage sources such as lucerne, winter forage crops or native pastures oversown with an annual legume such as subterranean clover. Once tropical perennial grasses have begun growth in spring they may be suitable for preparing ewes for joining, or for moderate growth rates in lambs. In the critical last 50 days of pregnancy (February–March) and lactation (April–June), well managed tropical perennial grasses could contribute towards meeting ewe requirements, particularly if grain supplementation was also available.

Chapter 9: The role of fertilisers and nitrogen

SP Boschma

Nitrogen, phosphorous and sulphur applied to an establishing tropical perennial grass pasture can enhance vigour and production. In an established pasture, nitrogen, phosphorus and sulphur should be applied annually to ensure the pasture remains vigorous, producing high quality forage.

When there are no legumes in the pasture, application of nitrogen is essential to achieve maximum growth rates, forage production and quality. Growth rates of up to 150 kg DM/ha/day can be achieved with the application of nitrogen.

As a rule-of-thumb, an additional 100 kg DM/ha of herbage can be produced in the growing season for each kg N/ha applied. Nitrogen applied at rates of 50–100 kg N/ha will give good responses and higher quality in tropical perennial grass pastures.

Plant nutrition is important both during establishment of new pastures and for the ongoing production of established pastures. A fertilised pasture is more resilient to stressors such as pests, disease, drought and cold weather during winter, and will respond quickly to rainfall, generate higher growth rates, and produce more herbage of higher quality, which are all important contributors to animal production.

9.1 In the establishment year

A soil test conducted by an accredited laboratory prior to sowing will highlight soil nutrient deficiencies. To achieve optimum pasture growth, all essential nutrients must be present in sufficient amounts. Addressing both macro- and micro-nutrient deficiencies identified will ensure the pasture has the best start. The main nutrients that are commonly deficient include phosphorus, sulphur and nitrogen.

Soil nitrogen levels can be adequate for establishment when a pasture is sown in to a prepared seedbed that has been in fallow (mineralised nitrogen). However, a low rate of nitrogen (e.g. applied as a 'starter fertiliser' is recommended at sowing to encourage grass growth. If using a starter fertiliser it should be placed separate from the seed, or otherwise applied after emergence. Delaying application until the pasture has emerged provides the opportunity to assess both the pasture strike rate (for example, in a poor stand the decision might be made to not fertilise) and any emerging weed population. An application of nitrogen will also fertilise the weeds, which generally have greater seedling vigour than the sown species. Up to two years of weed control prior to sowing the pasture and selection of high quality weed-free seed will ensure the fertiliser is used by the pasture and not by the weeds.

9.2 Established pastures

Nitrogen, phosphorus and/or sulphur may need to be applied annually to maximise herbage quality and production from a tropical perennial grass pasture. Soil testing will identify deficiencies in macro- and micro-nutrients. Fertilisers, in particular nitrogen, increase pasture growth rates, annual production and forage quality. Pastures use applied fertilisers most effectively when the nutrients are in correct proportion to one another. For example, if nitrogen is applied at 50 kg/ha, phosphorus and sulphur may need to be applied at about 15 kg/ha; but if nitrogen is applied at 100 kg/ha the equivalent phosphorus and sulphur rates would need to be increased to about 25 kg/ha. Addition of a legume to a perennial tropical grass pasture can also provide nitrogen.

In northern inland NSW, tropical perennial grasses grow during the warmest months of the year. Growth commences in spring, as day temperatures rise and slows in late summer-autumn, as overnight temperatures fall. Growth ceases when frosts commence, with little or no growth in winter. Therefore tropical perennial grasses can be productive for about 9 months of the year on the North- and Central-West Plains, 7–8 months on the North-West Slopes and 5–6 months on the Northern Tablelands.

Within a growing season growth rates vary among grass species. Research on 2–3 year old pastures has shown that peak growth rates occur in early summer for digit grass cv. Premier and Rhodes grass cv. Katambora fertilised with 100 kg N/ha. Peak daily growth rates of 150 and 105 kg DM/ha/day were observed for digit grass cv. Premier and, Rhodes grass cv. Katambora respectively.

Table 9.1 Average growth rates (kg DM/ha/day) of unfertilised and fertilised tropical perennial grasses (100 kg N/ha) measured at four times in a growing season. A fertilised pasture consistently has higher growth rates than one that is unfertilised.

Season	Unfertilised pasture	Fertilised pasture
Early-spring	15	27
Late-spring	56	78
Summer	34	78
Autumn	25	38

Figure 9.1 Digit grass cv. Premier fertilised with 100 kg N/ha (top) and unfertilised (bottom) with eight days regrowth in March. The fertilised grass has higher growth rates and quality and therefore higher potential animal production than the unfertilised tropical grass.

In addition to variation in growth rates among species, there is also variation with stored soil moisture and fertility status. For example, when soil water is adequate unfertilised tropical grass pastures can produce about 34 kg DM/ha/day in summer (Table 9.1). With the addition of nitrogen fertiliser at 100 kg N/ha, growth rates in summer average about 78 kg DM/ha/day, but can be as high as 150 kg DM/ha/day. However, once the pasture has used the stored soil water, growth will decline to less than 10 kg DM/ha/day.

A fertilised tropical pasture is more responsive to rainfall and with higher growth rates its total production will also be higher. The question is how much nitrogen needs to be applied? The growth response of tropical perennial grasses to increasing nitrogen fertility is variable, for example digit grass cv. Premier has been found to respond to rates up to 150 kg N/ha. However, Rhodes grass cv. Katambora production continued to increase even when rates as high as 300 kg N/ha were applied (Figure 9.2). The grasses responded when 300 kg N/ha was applied, however, rates as high as these are not recommended because they are unlikely to be economical in dryland environments and may have potential environmental consequences.

This study showed that as a rule-of-thumb, for each kg N/ha applied, up to 100 kg DM/ha of additional herbage was produced in the growing season. Over an average growing season, the application of 50 kg N/ha to digit grass cv. Premier could increase herbage production from 5 to 10 t DM/ha, while the addition of 100 kg N/ha could increase production by 10 t DM/ha.

An annual application of 50–100 kg N/ha is recommended, with the rate varying depending on area of tropical grass pasture to be fertilised, type of livestock that will be using the pasture and ability to utilise the potential forage production. For example, higher rates of nitrogen would be suitable for a small area which will be utilised by stock with higher forage quality requirements such as lactating cows or fattening stock. These livestock classes will provide a return on the fertiliser investment, while dry cows grazing the same area will not. Further information on animal production can be found in Chapter 8. Options for utilising and conserving the additional forage produced are outlined in Chapter 12. Fodder budgeting is important and there are a range of tools to assist in this process.

Nitrogen can be made available to a tropical grass pasture either as fertiliser or by growing a legume in the pasture. Legumes are considered the most economical source of nitrogen and have the advantage of potentially increasing the period that forage is available to livestock and providing a 'buffer' to a farm enterprises, particularly if climate is highly variable.

On average, legumes fix about 35 kg N per tonne of dry matter produced. However, this value varies widely with legume species, existing soil nitrate levels and pasture vigour. Of this 35 kg, about 13 kg N/ha is available to plants in a perennial pasture. Therefore, in a tropical grass pasture a companion legume that produces 4 t DM/ha/year would provide 50 kg N/ha/year and one that produces 8 t DM/ha/year may provide 100 kg N/ha/year to the pasture. These nitrogen levels (50–100 kg N/ha) are within the range required to achieve high quality pasture production and therefore good animal production.

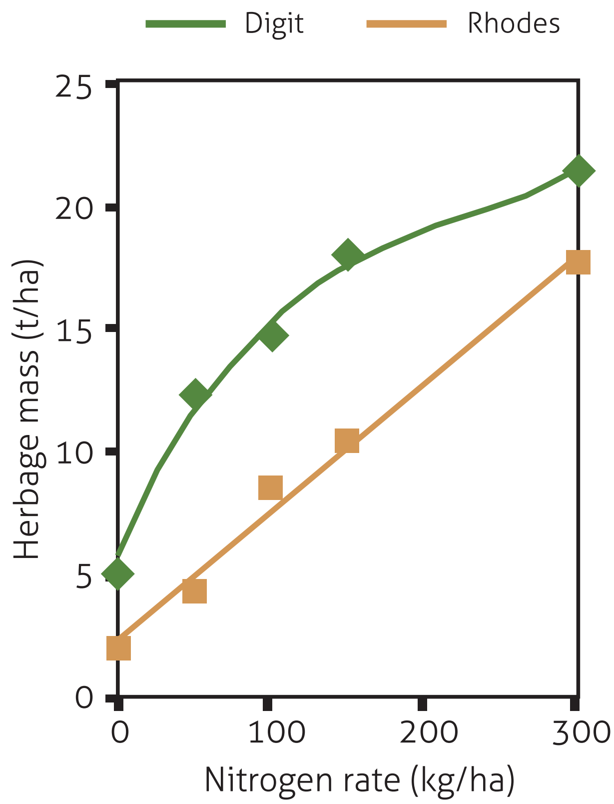


Figure 9.2 Application of nitrogen increases annual production, but the rate varies with species. Production of digit grass cv. Premier (◆) plateued from 150 kg N/ha, while Rhodes grass cv. Katambora (■) production continued to increase even when 300 kg N/ha was applied.

Feed budgeting tools and calculators

There are a range of tools and calculators available including:

BeefSpecs

www.mla.com.au/News-and-resources/Tools-and-calculators/BeefSpecs-calculator

Stocking Rate Calculator

www.mla.com.au/News-and-resources/Tools-and-calculators/Stocking-rate-calculator

Feed Demand Calculator

www.mla.com.au/News-and-resources/Tools-and-calculators/Feed-demand-calculator

Feed Budget Tool

www.evergraze.com.au/library-content/feed-budget-rotation-planner-excel-pre-2010-version/

Case study: Perennials support generational regeneration

Farm info.

Case study: *Don, Gay and Jason Mack*

Location: *Bingara, New South Wales*

Property size: *3100 ha*

Mean annual rainfall: *700 mm*

Soils: *Highly variable, including black and grey clay soils, fine-grained red basaltic clays and pale Kaolinitic clays*

Enterprises: *Beef cattle and fodder crops*

This producer story first appeared in Future Farm *Issue 11, August 2012.*

Tropical perennial grasses have provided multiple benefi ts for Don Mack (pictured speaking at field day on his property) and his family, including improved ground cover, soil fertility, bountiful summer feed and increased carrying capacity.

On Mitiamo and Berrybank, fourth and fifth generation farmers, Don and Gay Mack and son Jason have seen the full spectrum of intergenerational farming systems. The current focus is on sustainable production for the long term based on perennial tropical and native pastures.

"Our farm is an extension of ourselves," says Don. "Our properties need to generate enough income for our families to live comfortably, to be viable and to be able to invest back into our farm.

We want our land to be covered in diverse pastures making a healthy environment for our beef cattle production and native wildlife to flourish. We also want to pass the land down to future generations in the best condition possible.

After decades of dryland cereal cropping and set stocking the soils of our two properties were worn out and prone to erosion.

Approximately 50% of the property was cropped at Mitiamo until recently. We had no organic matter in the soil and the soil surface had developed hard crusts in some paddocks.

In turn, the lack of infiltration resulted in poor crop establishment and yields, with areas of bare and eroded soil. The entire farming system was breaking down, depleting our soil, consuming excessive time, becoming expensive and unsustainable. We needed to change the system and decided to head down the conservation farming path.

Incentive to change

During 2006 we received a grant from the Border Rivers-Gwydir Catchment Management Authority (CMA) to convert to a direct drill sowing system. We have since reduced our cropping area from 800 ha to 240 ha and now only grow oats and lucerne on the heavy clay soils on the fl ats in the valley. This is the best fit for our landscape.

These days, only about 10% of the properties are fodder cropped, while the balance is sown to tropical grasses and native pasture.

The direct drill system has reduced the need for multiple passes and has cut back the wear and tear on the tractor and the number of hours we clock up on it each year.

Since we stopped chisel ploughing there is more organic matter in the soil, we have seen less run-off from our paddocks and the moisture is held in the soil longer, giving us a longer sowing window.

Grazing conversion

More recent funding from the CMA has allowed us to subdivide some of our larger paddocks, install new water points and move away from set stocking to a rotational grazing system.

Many cropping paddocks at Mitiamo have returned to native pasture, simply through the passage of time, and are now dominated by redgrass, Queensland blue grass, plains grass and slender rat's tail grass.

There is close to 100% ground cover in most paddocks, protecting against erosion and encouraging water infiltration.

We apply single superphosphate fertiliser at the rate of 125 kg/ha every three years or so, in rotation across the property. We also sow sub-clover at the same time to provide extra protein for the stock during winter, unless the clover is already well established. The clover also provides the nitrogen for the native grasses and tropical grasses.

Tropical grasses are sown following an oat crop, where we carefully manage weeds. It's a quick way to get back into a permanent and productive grass-based pasture.

Our preferred mix of grasses includes Bambatsi panic, Gatton panic, Premier digit and Katambora Rhodes grass. More than 300 ha are established now with more planned for the future.

We're interested to see whether the natives come back in these paddocks, because they have typically done poorly in these paddocks since taking them out of cropping.

Tropicals top production

The tropical pastures serve a dual purpose: they provide year-round ground cover and a productive, resilient feed base.

The tropical pastures cope well with the warm climate and respond well to rainfall, which can be erratic in this part of the world.

We have been planting tropical pastures on Mitiamo for about eight years — they give us a more productive pasture base than the natives, which boosts cattle production.

Establishment costs about $100/ha including labour, seed and fuel. But it's a good investment in my eyes.

The cattle gain about one kilogram a day on the tropical grass pastures and maybe only half a kilogram a day on the native pastures.

We aim for a tropical pasture paddock size of around 20 ha and a stocking rate of up to 300 head.

We supplement with a dry mix during winter, depending on the season. We make our own dry mix with cotton seed meal, urea and various mineral supplements.

Because the tropical pastures grow so quickly, rotational grazing is essential to manage the excessive biomass production.

Our grazing management revolves around the 30% rule, across all our pasture: that means the cattle eat 30%, trample 30% and leave 30% of the biomass.

The biomass allows the pastures to regenerate and maintain ground cover to slow erosion and soil loss.

Looking forward

Our plan is to move from a principally cattle trading enterprise to a cattle breeding venture. We're in the process of building up our cow numbers, which will take time.

Our five-year production goal is to have a self-replacing EU herd. To achieve this, we are taking a long-term view towards our pasture base, with paddocks small enough to rotationally graze, without cell grazing.

Stock records help us manage and plan our rotation around the paddocks. Our records also allow us to keep track of where the stock are gaining weight and which paddocks are our most productive.

We have embarked on significant changes recently and it has been critical to get quality advice along the way. The FFI CRC experiments on our property illustrate what works and what won't with our soil types, climate and management, reducing the risk of failure.

It's always good to compare what you are doing with what others round about are doing, to benchmark your successes. We can see where we are ahead and what we can do better just by looking around the valley every now and then.

Chapter 10 Companion legumes

SP Boschma and CA Harris

Over recent years a range of legumes have been evaluated for their potential as companion legumes in tropical grass pastures. The legumes fall into three categories:temperate annual, temperate perennial or tropical perennial legumes. While research continues in order to refine recommendations, this chapter outlines some of the findings and characteristics of a number of legumes that show potential.

Tropical perennial grasses are highly responsive to nitrogen and it is an essential nutrient to maintain high production and pasture quality. Nitrogen can be supplied either by fertiliser or legumes. The annual or biannual application of fertiliser nitrogen can be costly – both money and time, making legumes an attractive option. Legumes are also important for animal production. Forage with high protein content is important to maintain optimum rumen function, which thereby increases the rate that forage moves through the rumen, allowing animal intake to increase and so ultimately animal production.

A legume will be effective in a tropical perennial grass pasture when it:

1. Fixes nitrogen. To fix nitrogen a legume must be adequately nodulated with the correct strain of rhizobia. Functional nodules are pink and commonly found around the crown and lateral roots of the legume.
2. Produces herbage. The amount of nitrogen fixed is proportional to the amount of herbage produced. There are many factors that affect nitrogen fixation, but as a rule of thumb, temperate legumes fix about 35 kg N/ha per tonne of dry matter produced and about 13 kg N/ha of this becomes available to plants in a perennial pasture. Research on the North-West Slopes has shown that the greatest dry matter response of tropical perennial grasses occurred when 50–100 kg N/ha was applied per growing season. Therefore, in a tropical grass pasture a legume needs to produce about 4–8 tonnes DM/ha annually to provide the recommended 50–100 kg N/ha/year.
3. Persists and is resilient. An effective legume must be able to persist in competition with the tropical grass, even through highly variable seasons, and respond quickly to rainfall when it falls during its growing season. Annual legumes need to be able to establish quickly and set large quantities of hard seed to maintain a seed bank. Perennial legumes need to have various means of perennation to survive highly variable seasons.

While northern inland NSW has a summer dominant rainfall pattern, traditionally, temperate legumes (i.e. annual – subterranean clover, perennial – lucerne) have been sown. Recently, NSW DPI and the Future Farm Industries Cooperative Research Centre evaluated a range of legumes to identify plant characteristics and potential species that may be effective companion legumes for tropical grass pastures in northern inland NSW. The legumes that were investigated fall into three categories based on their annual or perennial habit and their growing season. Below is a short description of each type: temperate annual, temperate perennial and tropical perennial demonstrating the range available that may assist in finding one that works within both your climatic area and your pasture/livestock system. More studies are currently underway to evaluate a wider range of species and understand the characteristics important for each species group and practical agronomic requirements for their persistence in mixed pastures on-farm.

Table 10.1 Annual herbage production (t DM/ha) of pasture mixes with temperate annual legumes and digit grass cv. Premier at Tamworth over 3 years, September 2009–August 2012. Years when about 4.0 t DM/ha or more was produced are shaded yellow (L = legume component and G = grass component).

Annual legume-grass mix		Year 1	Year 2	Year 3	Average
Woolly pod vetch cv. Namoi	L	0.8	11.4	7.7	6.6
	G	20.6	15.6	14.4	16.9
Arrowleaf clover cv. Cefalu(b)	L	0.4	11.0	2.9	4.8
	G	20.9	13.4	11.4	15.2
Purple clover cv. Electra	L	0.4	4.7	1.5	2.2
	G	20.6	13.8	10.3	14.9
Barrel medic cv. Caliph(b)	L	0.3	3.4	0.3	1.3
	G	21.5	16.2	11.5	16.4
Rose clover cv. SARDI Rose	L	0.2	2.9	0.3	1.1
	G	21.2	14.8	12.9	16.3
Subterranean clover cv. Dalkeith	L	0.4	1.0	0.3	0.5
	G	21.2	14.8	12.3	16.4
Subterranean clover cv. York(b)	L	0.5	1.7	0.9	0.9
	G	21.1	14.9	11.9	16.0

10.1 Temperate annual legumes

These legumes grow during the cooler part of the year (autumn to spring) and are well adapted to areas that receive winter rainfall. They regenerate from seed in autumn then flower and produce seed in spring before dying. These legumes have a long history in northern inland NSW and have traditionally been widely sown in both native and sown pastures; subterranean clover on the slopes and medics on the plains. One of the advantages of temperate legumes is that they grow during winter–early spring thereby providing green feed at a time that complements the lack of tropical grass growth during this period. During the dry decade 2000–2010, subterranean clover repeatedly failed to regenerate and/or set seed, resulting in seed banks becoming depleted in many areas. Research in northern inland NSW has shown that soil water levels under tropical perennial grass pastures are lowest in April–May, meaning that temperate annual legumes are dependent on receiving growing season rainfall to establish, grow and set seed. See Chapter 11 for more information on the annual pattern of soil water content under tropical grasses and what it means for choosing a companion legume.

In autumn 2009, six annual legume species were sown into established digit grass cv. Premier in experiments at Tamworth and Bingara. The mixes were assessed for four years.

At Tamworth, woolly pod vetch cv. Namoi was the most productive followed by arrowleaf clover cv. Cefalu . These two legumes averaged 6.6 and 4.8 t DM/ha per year respectively – within the range required to fix 50–100 kg N/ha. In contrast, subterranean clover averaged less than 1 t DM/ha (Table 10.1). The addition of a productive legume increased total production of the pasture and provided forage for grazing in late winter–early spring. It was also noticed that the foliage of digit grass was greener in the plots with productive legumes, indicating likely higher quality (Figure 10.1). Interestingly, over the four years that this experiment was conducted, the summer peak of herbage mass showed a marked decline each year in the grass-subterranean clover pasture compared to the grass-vetch pasture possibly due to lack of nitrogen.

Figure 10.1 Digit grass cv. Premier had higher herbage production and its foliage was darker green, suggesting a higher forage quality when grown with woolly pod vetch cv. Namoi (left) compared with other legumes (right).

At Bingara all six annual legume species germinated, but production and seed set of the legumes was poor due to dry conditions in the first year. In the second year only purple clover cv. Electra, arrowleaf clover cv. Cefalu and rose clover cv. SARDI Rose regenerated, produced biomass and then again set seed. These legumes averaged 7.0, 1.9 and 0.7 t DM/ha per year, respectively. There was no legume biomass in the other treatments after the first year. Like the Tamworth site the addition of a productive legume increased total production of the pasture and provided forage for grazing in late winter–early spring.

These and other studies have indicated that the plant characteristics required for long-term persistence of temperate annual legumes are: high seedling vigour so that the legume can establish quickly; deep rootedness allowing the legume to quickly access more soil water; early flowering, producing large quantities of hard seed. This allows the seed bank to increase in the year the legume flowers and minimise rundown over a series of poor non-legume years. The ability of the legume to continue growing after flowering if the season is good is also a desirable characteristic for maximising the amount of nitrogen that can be fixed in 'good' years.

While specific management of tropical grass-temperate annual legume mixes is not largely understood, some known principles can be applied. Pastures containing annual winter-growing legumes need to be grazed hard in late summer–early autumn to remove the bulk of the grass herbage and open the pasture to allow light penetration and legume regeneration. In spring, aerial seeding annual legumes require rest from grazing to allow flowering and seed set; annual legumes that bury their seed, such as subterranean clover, need to be grazed so that the plants are not shaded and flower and seed production is high.

Definition of hardseededness

Hardseededness, sometimes called 'seed coat impermeability' is the main seed dormancy mechanism that regulates the germination of pasture legumes. Hard seeds have an impermeable seed coat that prevents water entering and the seed imbibing. Seed softening is the process where the seed coat softens in response to high temperatures and day–night temperature fluctuations. These eventually cause the seed coat to split and the seed will germinate the next time it rains. This process can occur over a few weeks or over many years.

Hardseededness varies between species and also cultivars within a species. For example, biserrula (Biserrula pelecinus) *has very high levels of hard seed compared to subterranean clover* (Trifolium subterraneum). *Within biserrula cultivars, Casbah has higher levels of hard seed than Mauro*⍬. *In Western Australian conditions, the hard seed content of both biserrula cvv. Casbah and Mauro*⍬ *immediately following seed set and senescence is about 99%. In the paddock, this reduces to about 85% by May for Casbah and about 70% for Mauro*⍬ *which breaks down more quickly.*

Hard seed protects a species or cultivar against the seed bank depleting when summer storms and false autumn breaks cause a succession of early germinations without follow-up rain. In these situations, young seedlings commonly die after a few days of hot weather. Hard seed also provides a bank of seed capable of germinating after a year, or multiple years for some species, when seasons are more favourable for legume regeneration and/or seed set.

Subterranean clover *(Trifolium subterranean)*

Subterranean clover grows mainly in autumn, winter and spring and can produce high quality forage and hay (Figure 10.2). It is a prostrate, self-regenerating annual legume and most types tend to bury their seed. As it regenerates in autumn from buried seed, it is dependent on a seed bank for long-term survival. This seed bank can be reduced by repeated false breaks and/or dry winter conditions that prevent plants from setting seed. Cultivars are suited to soil pH ranging from moderately acid to neutral, with soil textures ranging from sandy to clay loams. Subterranean clover is tolerant of grazing and current cultivars are low in oestrogen. When selecting cultivars to sow, choose those suited to the rainfall and soil type of the district for reliable seed set and improved persistence. Early maturing cultivars are better suited to areas that have lower rainfall and a shorter growing season. Mixing cultivars can provide more reliable production in variable seasonal conditions e.g. later maturing cultivars will perform well in higher rainfall years, while earlier maturing cultivars will set seed more reliably in below average rainfall years and be more persistent.

Minimum average annual rainfall: 600 mm (northern NSW)

Sowing rate: 4–10 kg/ha alone; 3–6 kg/ha in mixes with grasses and other legumes

Inoculant: C

Livestock disorders: Some older cultivars of subterranean clover (e.g. Dwalganup, Yarloop) contain high levels of phyto-oestrogens, which can cause livestock infertility, however, the current commercially available cultivars have low levels of oestrogen and fertility is unlikely to be affected. Subterranean clover dominant pastures can cause bloat in cattle.

Cultivars: A number of subterranean clover cultivars are commercially available (Refer to *Pasture Varieties used in New South Wales* for a complete listing of cultivars). Note that there are three main types (sub species) of subterranean clover:

Subterraneum **–** black seeds; adapted to neutral to moderately acid soils

Brachycalycinum **–** mostly black seeds; suited to neutral to alkaline clay soils

***Yanninicum* –** yellow seeds; suited to poorly-drained, waterlogged soils

Figure 10.2 Digit grass cv. Premier and subterranean clover cv. Dalkeith on 14 February 2012 demonstrating how early in the year this clover can germinate in northern inland NSW. This early germination occurred following 43 mm rainfall over 5–9 January and growth followed an additional 150 mm rainfall over 31 January–2 February. The daily maximum temperatures were also mild during this period.

Woolly pod vetch *(Vicia villosa)*

Woolly pod vetch grows during autumn, winter and spring and is commonly used as a pasture, forage, hay, grain and/or green manure crop (Figure 10.3). It sets a lot of seed and regenerates readily in late summer–early autumn. Woolly pod vetch is suited to a wide range of soil types, especially those that are well-drained. It tolerates acid soils with moderate levels of exchangeable soil aluminium, but is susceptible to waterlogging. Woolly pod vetch is resistant to chocolate spot and rust, and is susceptible to blue oat mite. The grain produced by woolly pod vetch is toxic to livestock and can be a weed problem in subsequent winter crops for many years.

Minimum AAR: 650 mm (northern NSW)

Sowing rate: 4–10 kg/ha

Inoculant: E

Livestock disorders: The seed of woolly pod vetch can be toxic to livestock, causing illthrift, and even death. The plant is also associated with causing dermatitus.

Cultivars:

***Capello*⊕ –** mid-maturity with low hard seed

***Haymaker Plus*⊕ –** mid-maturity with high hard seed

***Namoi* –** mid-late maturity with high hard seed

Figure 10.3. Woolly pod vetch cv. Namoi

Arrowleaf clover *(Trifolium vesiculosum)*

This deep-rooted legume has an erect growth habit and a long growing season that extends into summer when there is adequate soil moisture (Figure 10.4). It is highly palatable and considered a productive and persistent legume suitable for grazing, hay and silage production. Arrowleaf clover is adapted to a wide range of soil types with pH_{Ca} 5.0–7.5 with moderate to high fertility, but is not suitable for saline soils or those prone to waterlogging. Arrowleaf clover is commonly sown in mixes for short- to medium-term pastures or as a component of high density legume crops. Arrowleaf clover has a longer growing season than many other legumes and requires good soil moisture during spring to reach its yield potential. Arrowleaf pastures should be rotationally grazed and destocked during flowering to ensure seed production. The seedheads of arrowleaf clover are easily harvested and the seed produced is very hard and requires scarification prior to sowing to improve germination.

Minimum AAR: 500 mm (northern NSW)

Sowing rate: 6–10 kg alone; 1–4 kg/ha in mixes with species such as subterranean clover or serradella

Inoculant: C

Livestock disorders: There have been no problems reported for arrowleaf clover.

Cultivars:

Cefalu⁽ᵖ⁾ ***and Zulumax –*** early maturing

Seelu and Zulu II – late maturing

Zulu – late maturing, very high hard seed

Arrotas⁽ᵖ⁾ ***–*** very late maturing

Figure 10.4. Arrowleaf clover cv. Cefalu with characteristic leaf markings

Purple clover *(Trifolium purpureum)*

Purple clover is an erect, deep-rooted, productive legume that is suitable for high quality silage and hay production (Figure 10.5). It is suited to a wide range of soil types, from sandy loams through to clay loams with pH_{Ca} 4.5–8.5 and is tolerant of short-term waterlogging. It is late flowering and tends to have poor seed production.

Minimum AAR: 550 mm (northern NSW)

Sowing rate: 7–10 kg/ha alone; 1–4 kg/ha in mixes.

Inoculant: C

Livestock disorders: No livestock disorders have been reported, however, bloat can be an issue in pastures with a very high proportion of purple clover. Purple clover has very low to undetectable levels of the isoflavones, which have been associated with infertility in sheep.

Cultivars:

Electra – late maturity, good disease tolerance, susceptible to aphids

Figure 10.5. Flower head of purple clover cv. Electra

10.2 Temperate perennial legumes

Temperate perennial legume species can survive for a number of years and can grow year round if sufficient moisture is available. The ability of perennial species to survive multiple years means that they have the potential to fix more nitrogen than annual species and are not reliant on suitable conditions to regenerate each year. Lucerne is the most productive and persistent temperate perennial legume in northern inland NSW. This legume and birdsfoot trefoil *(Lotus corniculatus)* warranted investigation as companion legumes with tropical grasses.

In January 2009, lucerne cv. Venus and an experimental line of birdsfoot trefoil were sown in alternate row mixes with digit grass in experiments at Tamworth and Bingara and were monitored for 3.5 years. Over the assessment period the Tamworth experiment was assessed and grazed 7–8 times a year and total annual production of the lucerne-digit pasture ranged from 23 to 27.5 t DM/ha. Lucerne produced on average 14.9 t DM/ha per year in the mix, while for digit grass fertilised with 50 kg N/ha production declined from 22.7 to 11.8 t DM/ha over the 3 years. The lucerne-digit pasture had a longer total growing season than the grass-only pasture, due to winter-spring growth of lucerne. At Bingara, lucerne produced on average 2.2 t DM/ha per year and the experimental line of birdsfoot trefoil 1.7 t DM/ha. This experimental line of birdsfoot trefoil is not commercially available, but has shown potential in these and other studies and will be further progressed for cultivar release.

One of the challenges for sowing mixes of temperate and tropical species is successfully establishing both species of the pasture. This can be particularly challenging for perennial species because not all species self-thicken and poor establishment can result in a low plant population with limited opportunity to improve it. Research has shown that establishment is more likely to be successful when each species is sown at its optimum sowing time, although the species that establishes first will tend to monopolise resources, thereby inhibiting establishment of the species sown later.

Lucerne *(Medicago sativa)*

Lucerne is an erect and leafy perennial legume that provides high quality dry matter as standing feed, hay or silage. Its main growth periods are spring, summer and autumn when soil moisture is available and it responds quickly to spring and summer rainfall (or irrigation). Lucerne is suited to a wide range of soils from slightly acid to alkaline (pH_{Ca} 5.2–7.5) that are well-drained. Although susceptible to waterlogging and has moderate tolerance of saline and sodic soils. It is drought resistant and growth slows and can cease under moisture or severe heat stress. Lucerne has a strong deep taproot that allows it to access soil moisture and nutrients deep in the soil profile. Lucerne can also cause bloat in cattle. For good persistence, lucerne must be either rotationally grazed or cut at about 6 weekly intervals (Figure 10.6). Lucerne is usually sown in autumn or spring (when irrigated) when the soil temperature is high enough and there is sufficient moisture for establishment. Lucerne is the most persistent and productive temperate legume on the North-West Slopes of NSW. It is highly productive under irrigation. There are a range of cultivars available, which differ in their insect and disease resistance and activity of winter growth.

Minimum AAR: 400 mm (northern NSW)

Sowing rate: 1–5 kg/ha (dryland, depending on rainfall), 10–15 kg/ha (irrigated)

Inoculant: AL

Livestock disorders: Lucerne can cause cattle bloat, nitrate poisoning and red gut in sheep when fresh, lush growth is grazed in lucerne dominant pastures

Cultivars: There are many available. Contact your local agronomist or check *Pasture Varieties used in New South Wales* for a complete listing of cultivars.

Figure 10.6 Lucerne and digit grass cv. Premier in a mixed pasture.

10.3 Tropical legumes

Tropical legumes have not been widely tested in northern NSW, especially on the North-West Slopes. These legumes are frost susceptible and have the same growth pattern as tropical grasses; growing from spring, through summer and into autumn. A number of these legumes were grown at Tamworth (2009–2012) to investigate their potential suitability to the region.

Desmanthus cv. Marc⑁ was evaluated in mixes with digit grass cv. Premier for 3 years at Tamworth. It established readily and produced an average of 4.9 t DM/ha/year over the 3 years of the experiment, while digit grass produced 9.9 t DM/ha/year. The original plants of desmanthus thinned over time, but they set large quantities of seed each year with large seedling recruitment occurring each spring-summer following significant rainfall (Figure 10.7).

Leucaena is a shrub/tree legume grown extensively in central Queensland. Leucaena cv. Tarramba⑁ was established in twin-rows in January 2009 and produced an average of 4.9 t DM/ha/year over the 3 years it was assessed. Digit grass sown in the alleys between the twin rows produced 7.4 t DM/ha/year. Leucaena was persistent at Tamworth, establishing with 4 plants/m of shrub row declining to 3.6 plants/m of shrub row after 3 years. At Tamworth, leucaena was totally frosted during winter, but regrew from the plant base in spring with the first graze generally occurring in late-November.

Desmanthus *(Desmanthus virgatus)*

Desmanthus is a summer-growing perennial legume that is highly palatable to livestock, but does not cause bloat in cattle (Figure 10.7). Suited to medium and heavy textured soils, but can be productive on lighter soils. Desmanthus grows from spring until autumn and growth ceases when frosts commence. The plant will regrow from the plant crown in spring but can also regenerate from seed. It is considered to be productive, persistent, and tolerant of drought, cold (will recover from frost damage) and heavy grazing.

Minimum AAR: 550 mm

Sowing rate: 1–2 kg/ha

Inoculant: CB 3126

Livestock disorders: No toxicities have been reported and desmanthus does not cause bloat because it contains 2–3% (of total DM as tannic acid equivalent) condensed tannins

Cultivars:

Marc , Progardes™ (Note, Progardes consists of five lines of desmanthus from three desmanthus species; *D. virgatus, D. leptophyllus* and *D. bicornatus*)

Figure 10.7 Desmanthus cv. Marc at Tamworth, NSW. It grows to about 0.7 m tall, produces large quantities of seed and regenerates readily from seed the following year.

Leucaena *(Leucaena leucocephala* ssp. *glabrata)*

This shrub legume (or tree if left ungrazed) is suited to fertile, well drained, neutral to alkaline soils (Figure 10.8), but will also grow on acid soils if aluminium levels are low. It is poorly adapted to acid-infertile soils. Light frosts will kill the leaf of leucaena while heavy frosts will kill stems back to ground level, but will not kill mature plants. Leucaena is commonly sown in twin rows in an alley farming system (Figure 10.8). The legume is slow to establish but reported to be extremely tolerant of regular defoliation by either cutting or grazing once established. It is highly palatable and produces high quality forage for ruminant livestock. Leucaena does not cause bloat in cattle, but animals do need to be inoculated with a specific rumen bug required to prevent mimosine toxicity. Animal production is highest when a tropical grass is grown in the inter-rows.

Figure 10.8 Leucaena cv. Tarramba and digit grass cv. Premier at Tamworth.

Warning – There is a seedy, unproductive type of leucaena of a different subspecies (subspecies *leucocephala)* that is naturalised and a minor weed of roadsides and riparian zones in urban and coastal zones of Queensland. The commercially available leucaena cultivars can also produce large amounts of hard seed that can be moved by water or livestock and has weed potential. To prevent the commercial leucaena from becoming a weed producers in Queensland manage commercial stands of leucaena by a Code of Practice that has been developed to minimise the risk of weediness.

Minimum AAR: >600 mm

Sowing rate: Commonly sown in twin rows at sowing rates of 1.5–3.0 kg/ha

Inoculant: CB 3126

Livestock disorders: Leaves, pods and seeds of leucaena contain a toxic amino acid called mimosine, which stops cell division. Toxicity occurs when leucaena comprises more than about 30% of untreated animal's diet. Symptoms can include suppressed intake, reduced growth/weight gain, hairless sores on the skin, and in extreme and rare situations the result can be fatal for animals eating large amounts over a long period. Drenching animals that are grazing leucaena with a rumen fluid containing the detoxifying bacterium will prevent this toxicity. About 10–20% of the herd need to be drenched and the bacteria spreads quickly to other animals in the herd. A few inoculated cattle should be retained in the leucaena paddock to pass the bacterium on to new stock entering the paddock

Cultivars: Cunningham, Tarramba⦶, Wondergraze⦶, Peru

Chapter 11: Effective use of soil water, pasture growth, and companion legumes

SR Murphy

Tropical perennial grasses offer effective use of water, high dry matter production and improved natural resource benefits.

Tropical grasses are best grown on soils with at least 150–200 mm water holding capacity and/or where pastures can develop root depths of up to 1.7 metres.

Peak annual dry matter production from these grasses in good seasons with adequate fertiliser may be up to 19 t DM/ha with peak growth rates of up to 138 kg DM/ha/day. Long term annual production is likely to be less at 11–14 t DM/ha growing at 54 kg DM/ha/day.

Water use efficiency (WUE) is a measure of plant growth per mm of water used – including rainfall and stored soil water. Tropical perennial grasses show high WUE with mean values for six seasons ranging from 17 (Rhodes grass cv. Katambora) to 22 kg DM/ha/mm of water (digit grass cv. Premier).

The soil profile under a tropical grass pasture is wettest in September and driest in May, which helps explain the challenge of attempting to establish a temperate annual legume in autumn in a pasture mix with these grasses.

Production and growth from tropical perennial grasses is likely to show a decline after several seasons after reserves of soil water and nutrient are used by the pasture.

The availability of water in rain-fed production systems has decreased and become episodic in the past decade due to rainfall variability. This has renewed interest in both effective use of water of different pastures when rainfall occurs, and how pasture systems can be modified to more efficiently use water. Two of the attractions of tropical perennial grasses are their impressive annual production of dry matter and their effective use of water.

Research conducted over a six year period on a red Chromosol soil (duplex soil) in northern inland NSW has shown that tropical perennial grasses can produce large amounts of growth from available soil water while providing natural resource benefits such as high ground cover. A red Chromosol soil is a common type across northern inland NSW and is susceptible to surface crusting following typically long cropping histories, making them an ideal soil to target for establishing tropical perennial grasses. The outcome being that these species produce more dry matter, compared with native species, which provides options for boosting livestock production.

11.1 Soil water and plant root depth

Soil under tropical grasses is wettest in spring and driest in autumn

Knowing the annual pattern of change in stored soil water under tropical perennial grasses provides an understanding of how well suited these grasses are to the local environment, enables planning for seasonal growth and guides the potential for adding companion legumes to a pasture mix.

Repeated measures of soil water content under tropical perennial grasses show a strong annual pattern of being wettest in spring (September) and driest in autumn (May, e.g. Figure 11.1). This demonstrates that these pastures capture rainfall during the cool season from May to September when pastures are dormant and then use these reserves in addition to rainfall during their growing season from October through to May (Figure 11.1). Rainfall storage efficiency represents the proportion of rainfall that is retained in the soil and under tropical perennial grasses about 55% of winter rainfall is stored in the profile compared with just 25% in summer.

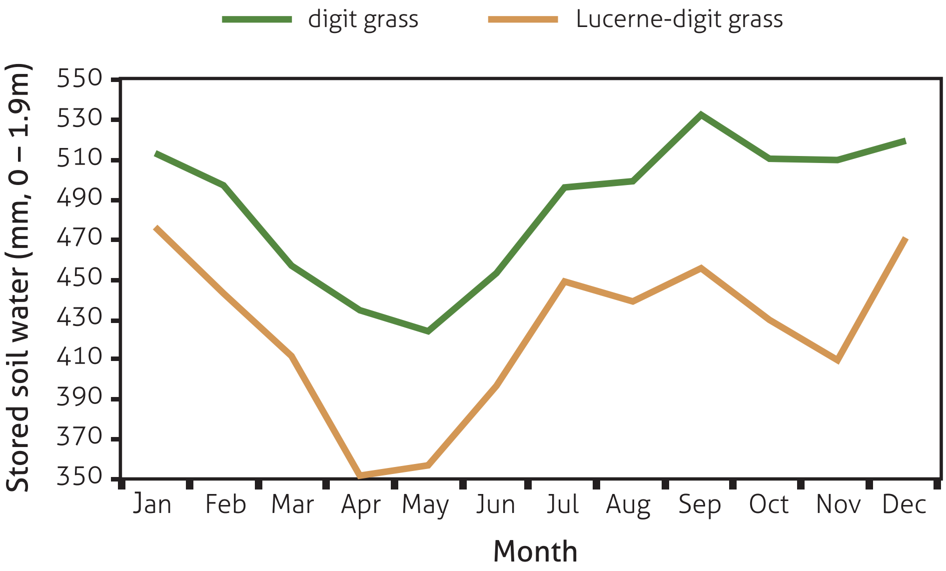


Figure 11.1 Mean profile stored soil water (mm) for each month of the year for digit grass and lucerne-digit grass mixed pasture. The soil profile for digit grass is driest in autumn and wettest in spring.

Tropical grasses have plant root depths of up to 1.7 m on red Chromosol soil

Plant root depth is an important characteristic that determines a plant's ability to use stored soil water and therefore make effective use of rainfall. Deep rooted species can exploit larger reserves of stored soil water and nutrient to both prolong growth during dry conditions and protect against water losses by deep drainage in wetter conditions.

On a red Chromosol soil, the depth of active plant roots in each growing season over a 4–6 year period varied in response to reserves of plant available water and soil nutrient, with rooting depth observed to be generally deeper in the first two years after sowing. The root depth of Rhodes grass cv. Katambora (1.37 m) was equal with that of lucerne cv. Venus (1.37 m), while root depth for digit grass cv. Premier (1.17 m) was shallower (Table 11.1). Plant root depth of a mixed stand of native perennial grasses was slow to develop but attained a mean value of 1.23 m (Table 11.1). In latter years, plant root depth was limited by the extent of profile refilling during winter, with a full wet profile enabling the plant roots to explore deeper in the profile. These data demonstrate that tropical grasses are suited to soils that provide at least 1.4 m soil depth.

Growing lucerne in a pasture mix with a tropical grass increased the overall plant root depth for both the digit grass mix (1.17 to 1.35 m) and Rhodes grass mix (1.37 to 1.40 m, Table 11.1), which reflected the impact of lucerne in the mix and so a need for greater soil depth.

Table 11.1 Mean (+/− standard deviation) plant root depth (m) indicated by the maximum depth of a 2% decrease in soil water content over the growing season and plant available water capacity (mm) for years 2006 to 2012.

Pasture	Root depth (m)	PAWC (mm)
Digit grass cv. Premier	1.17 (+/- 0.2)	138 (+/- 36)
Rhodes grass cv. Katambora	1.37 (+/- 0.3)	173 (+/- 36)
Lucerne cv. Venus	1.37 (+/- 0.2)	189 (+/- 27)
Native grasses	1.23 (+/- 0.1)	133 (+/- 40)
Lucerne-digit grass	1.35 (+/- 0.2)	176 (+/- 28)
Lucerne-Rhodes grass	1.40 (+/- 0.2)	187 (+/- 26)

Tropical grasses are more productive on soil with moderate to high water holding capacity

Plant available water capacity (PAWC) is the difference between the upper water storage limit of the soil and the lower extraction limit by the pasture over the depth of rooting and is usually measured in millimetres (mm) of water. The PAWC can be likened to a bucket; when the bucket is full the upper water storage limit has been met and when the bucket is empty all available water within the plant's rooting zone has been used. The winter period is the usual time for the bucket to refill, although it may not refill in all years for reasons of insufficient rainfall, and growth of other species such as companion temperate legumes or weeds.

Soil and pasture type characteristics combine to determine PAWC, with differences influenced by the species ability to extract water (i.e. the length, density and osmotic potential of their roots), the length of growing season and soil water holding capacity. The capacity of a soil to store water will depend on the soil's physical characteristics such as clay content, structure and depth. The magnitude of PAWC gives an indication as to the depth and quality of the soil that is best suited to the species.

Digit grass and Rhodes grass had greater values of PAWC (138 and 173 mm, respectively) compared with the native perennial grasses (133 mm, Table 11.1). The value of PAWC for Rhodes grass was only 8% less than that of lucerne (189 mm, Table 11.1). However, this indicates that Rhodes grass has a high water requirement similar to lucerne and so is better suited to paddocks with higher water holding capacity. Growing lucerne in a mix with tropical grasses increased values of PAWC, most notably for digit grass (138 to 176 mm) and to a lesser extent for Rhodes grass (173 to 187 mm, Table 11.1), indicating an additional water requirement of the mix, meaning that mixes with lucerne are best sown on soils with higher water holding capacity.

11.2 Dry matter production

Tropical grass dry matter production can equal that of lucerne

Tropical perennial grasses have the potential to produce large amounts of plant dry matter in a growing season, provided that they have adequate soil water and nutrients. On a red Chromosol soil over a 6 year period, digit grass cv. Premier produced 13.5 t DM/ha/year, while Rhodes grass cv. Katambora produced a lower amount of 9.5 t DM/ha/year (Table 11.2). Both grasses produced more dry matter than a native perennial grass pasture (6.9 t DM/ha/year), and in the case of digit grass, similar to lucerne (13.6 t DM/ha, Table 11.2). However, production from the native perennial grass pasture included growth of winter-growing annual grasses in late winter and spring, providing an additional 4 t DM/ha in some years.

Table 11.2. Mean (+/− standard deviation) annual total dry matter production (t DM/ha/year) and growth rate (kg DM/ha/day) for years 2006 to 2012.

Pasture	Dry matter (t DM/ha/year)	Growth rate (kg DM/ha/day)
Digit grass cv. Premier	13.5 (+/- 3.6)	54 (+/- 17)
Rhodes grass cv. Katambora	9.5 (+/- 2.8)	39 (+/- 11)
Lucerne cv. Venus	13.6 (+/- 3.6)	52 (+/- 14)
Native grasses	6.9 (+/-2.8)	27 (+/- 10)
Lucerne-digit grass	11.7 (+/- 3.8)	44 (+/- 7)
Lucerne-Rhodes grass	12.4 (+/- 4.7)	46 (+/- 10)

Growing lucerne in a mix with a tropical grass decreased total annual production for the digit grass mix (13.5 to 11.7 t DM/ha/year) and increased production for the Rhodes grass mix (9.5 to 12.4 t DM/ha/year, Table 11.2) compared with the pure grass sward. Growth rate of the lucerne-digit grass pasture was less than the pure digit pasture (54 to 44 kg DM/ha/day) and increased for the Rhodes grass mix (27 to 46 kg DM/ha/day, Table 11.2). However, the lucerne-Rhodes grass mix achieved additional growth in all months of the year compared with the pure grass (Figure 11.2), but importantly the digit grass mix showed no additional growth during November–December or February–March (Figure 11.3). Growth in winter of lucerne cv. Venus was low as it is a semi-dormant type, but it did provide some growth through the cool seasons.

Digit grass showed peak daily growth rates as high as 138 kg DM/ha/day in early summer (late November−mid January) when both adequate stored soil water and nutrition were available. Mean daily growth rate of digit grass (54 kg DM/ha/day) was twice that of native perennial grasses (27 kg DM/ha/day), 1.4 times that of Rhodes grass (39 kg DM/ha/day) and similar to lucerne (52 kg DM/ha/day, Table 11.2).

Values of both daily growth rate and seasonal dry matter production tended to be higher in the first two years after the pasture was established, reflecting higher plant nutritional and soil water availability at that time. These high values of total production and growth rate indicate that appropriate grazing management and livestock systems are required to effectively utilise the dry matter. Careful planning is required to match stocking rate with pasture growth rate to achieve high utilisation of plant dry matter and maintain green leafy growth in order to optimise forage quality.

11.3 Effective use of water

Tropical grasses make effective use of water

Water use efficiency (WUE) is an index of dry matter produced per millimetre (mm) of water used (that is, rainfall plus PAWC) over a known period of time. It is expressed as kg DM/ha/mm, and it is a measure of total growth achieved for each unit of evapotranspiration by the pasture.

WUE is best used to compare the relative efficiency of different species to produce plant dry matter at the same site each year. Some species with greater plant root depth can access more water, while others are more able to extract a greater proportion of water from the soil. The overall goal of a pasture system is to maximise production from each millimetre of water available, so species with deep plant roots and an ability to make effective use of that water are desired.

For growth data on a red Chromosol soil collated over 6 years of production, values of WUE ranged from a low of 12.5 for native perennial grasses to a high of 21.8 kg DM/ha/mm for digit grass (Table 11.3). Lucerne also had a high WUE of 20.4 kg DM/ha/mm, but Rhodes grass was considerably less (16.6 kg DM/ha/mm). Values of WUE in specific years were highest in the first and second growing seasons after sowing, reflecting higher growth rates observed at those times, when soil water and nutrient were not limiting growth.

Growing lucerne in a pasture mix had different affects on WUE, depending on the species of grass. For the seasons when direct comparisons were made, the WUE of a pasture mix of lucerne-digit grass was slightly lower compared with digit grass alone (15.8 cf. 16.1 kg DM/ha/mm, respectively). However, WUE for lucerne-Rhodes grass was substantially higher compared with Rhodes grass alone (17.7 cf. 11.7 kg DM/ha/mm, respectively).

Table 11.3. Mean (+/− standard deviation) annual values of water use efficiency (kg DM/ha/mm) for years 2006 to 2012.

Pasture	WUE (kg DM/ha/mm)
Digit grass cv. Premier	21.8 (+/- 8.2)
Rhodes grass cv. Katambora	16.6 (+/- 7.1)
Lucerne cv. Venus	20.4 (+/- 4.5)
Native grasses	12.5 (+/-5.4)
Lucerne-digit grass	15.8 (+/- 3.9)
Lucerne-Rhodes grass	17.7 (+/- 4.6)

Management tips to maximise effective use of water

To achieve high effective use of water it is important to maintain high levels of ground cover and to maximise soil water content at all times. High levels of ground cover increase rainfall infiltration, while reducing surface runoff and evaporation losses of soil water.

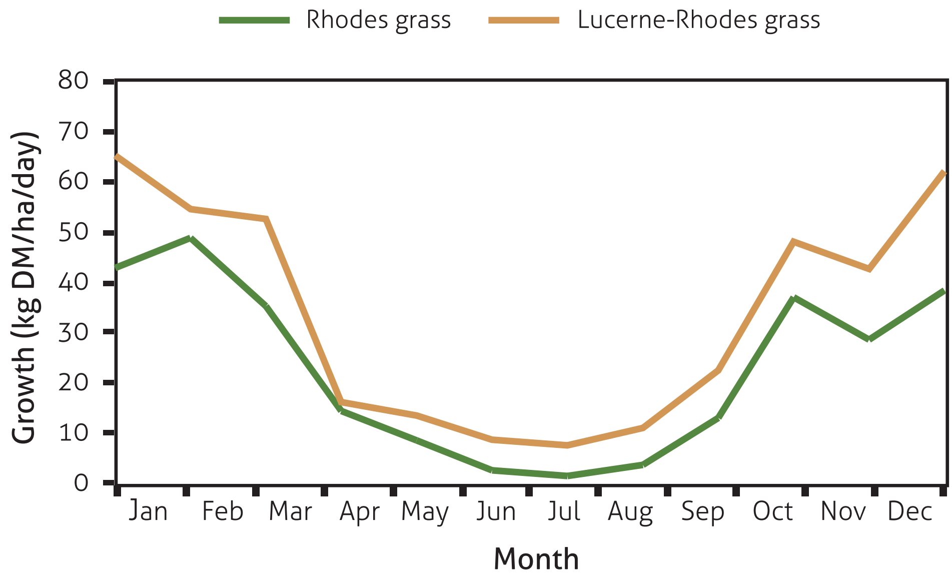


Figure 11.2. Mean daily growth rate (kg DM/ha/day) for each month of the year for Rhodes grass and lucerne-Rhodes grass mixed pasture, showing the benefit of lucerne in the mix.

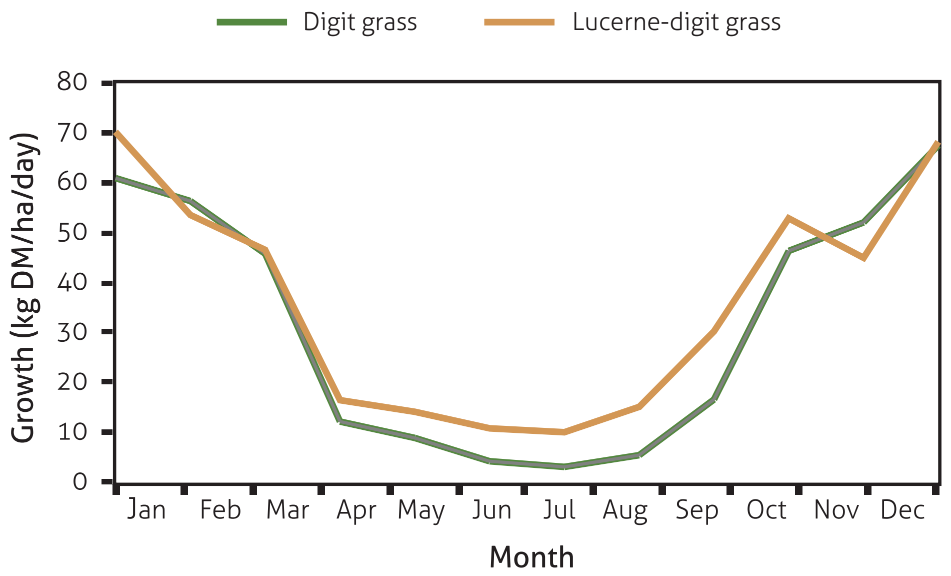


Figure 11.3. Mean daily growth rate (kg DM/ha/day) for each month of the year for digit grass and lucerne-digit grass mixed pasture, showing little benefit of lucerne in summer to the mix.

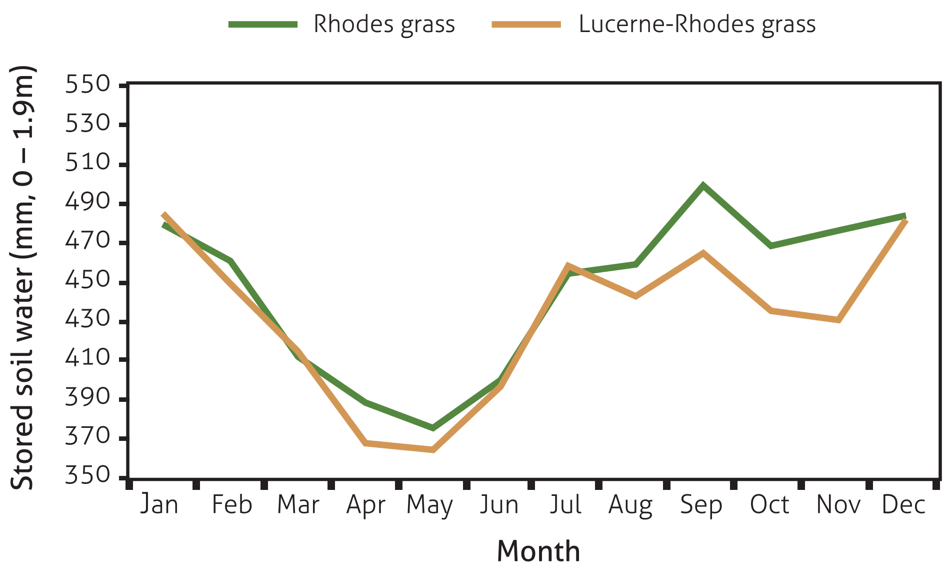


Figure 11.4. Mean profile stored soil water (mm) for each month of the year for Rhodes grass and lucerne-Rhodes grass mixed pasture.

In northern NSW, about 40% of total annual rainfall falls from April to October. This rainfall can benefit tropical perennial grasses because it allows soil water content to be replenished when the grasses are dormant. However, recent research has shown that sown companion species such as subterranean clover or lucerne will also utilise this water as can annual weed species that grow in winter and early spring. In those situations less winter rainfall will be accumulated in the soil profile for tropical grasses to use later in the year.

To maximise effective use of water, tropical perennial grasses need a high level of nutrition, high amounts of green leaf, high ground cover with litter, and an active root system. Dry matter production data collected over six consecutive years (see Table 11.2) from pastures fertilised at a rate of 55 kg N/ha/year showed a sharp decline in both growth rate and efficiency after the first two years. Fertiliser application rates to maintain growth are discussed in Chapter 9.

Figure 11.5. Subterranean clover cv. Dalkeith growing in pasture mixes with digit grass cv. Premier (top), and Rhodes grass cv. Katambora (bottom) in late-September.

11.4 Soil water limits choices for companion legumes

Soil water is a challenge for a legume and tropical grass mix

The occurrence of driest soil conditions for a tropical perennial grass pasture in May demonstrates why temperate annual legumes struggle to establish and be productive during most years. Dry initial soil conditions mean annual legumes will struggle to germinate and that rainfall during the growing season will determine dry matter production from the legume and seed set will depend on spring rainfall.

When lucerne was grown with tropical grasses the effect on soil water content varied with grass species. In a lucerne-digit grass mix, total soil water content was substantially lower throughout the year compared with pure digit grass (Figure 11.1) while in a lucerne-Rhodes grass mix, soil water content was only substantially lower in spring compared with pure Rhodes grass (Figure 11.4). For both mixes, a similar annual pattern resulted, with the soil being driest in autumn (April). Both mixes also showed a marked decline in soil water content during spring (September to November) coinciding with the period of high growth for the lucerne. This decline showed that lucerne makes first use of the stored soil water well before the tropical grass commences its growing season and so lucerne tends to dominate dry matter production in this mix. There was very little difference between the pure Rhodes grass and the lucerne-Rhodes grass mix demonstrating how demanding Rhodes grass on its own is for soil water.

What to consider when choosing a companion legumes

When choosing an appropriate companion legume to grow in a mix with a tropical grass, the time of year that soil water is available to the legume is an important factor.

Driest soil conditions occur under a tropical grass in April–May, which means that traditional temperate annual legumes (e.g. subterranean clover, Figure 11.5) may struggle to establish. Dry and variable autumns, commonly experienced in northern inland NSW, exacerbate this effect. Future research (Chapter 10) investigating the benefit of hard seeded temperate annual legume species may provide better options for mixes with tropical grasses.

Lucerne, is the best adapted temperate perennial legume for northern inland NSW, and when grown in a mix with a tropical grass it will result in greater effective use of soil water throughout the year (e.g. with digit grass, Figure 11.1). Growing lucerne in a mix with a tropical grass means that such pastures should be grown on soils with higher water holding capacity. Lucerne cv. Venus (winter activity rating 5) used in recent studies began growth 6 weeks earlier in spring than the tropical grass (Figure 11.6), which meant that it was able to produce substantial leaf area before the tropical grass, monopolise use of available soil water and so dominate growth in the pasture mix for the season (see Figure 11.7). However, good summer rainfall may replenish available soil water allowing the tropical grass to produce growth during the hottest part of the year, when lucerne is less productive. Future research (Chapter 10) investigating the benefit of growing lucerne with different winter activity ratings may provide more balanced options for mixes with tropical grasses.

Figure 11.6. Lucerne cv. Venus growing in pasture mixes with digit grass cv. Premier (top), and Rhodes grass cv. Katambora (bottom) in late-October, showing the early growth of lucerne compared with the tropical grass.

Figure 11.7. A pasture mix of digit grass cv. Premier and lucerne cv. Venus in November, demonstrating that lucerne can dominate at this time of the year because it commences growth earlier in spring than does the tropical grass.

Chapter 12: Options for using the surplus forage produced by tropical perennial grasses

SP Boschma, RP Graham and NW Griffiths

Tropical perennial grasses have the potential to produce large quantities of forage over the summer months. In most years the quantity of forage grown exceeds animal requirements, making it difficult to maintain quality of the pasture. Options to use this forage are; increasing stock numbers, conserving as silage or hay, or utilising it as dry feed over the winter.

Stock numbers could be increased by buying store stock and fattening over the summer, or backgrounding or taking on agisted stock. These methods offer flexibility.

Conserving forage by cutting pastures at an optimal growth stage to make quality silage or hay can be an effective method to utilise surplus feed, while maintaining high quality pasture and with good growth rates on the remainder of the area.

Leaving the pasture to senesce at the end of the growing season and utilising this dry standing feed over the winter months can be an effective method for utilising surplus forage out of the growing season. This feed will have low quality and livestock will require supplementation to increase pasture utilisation and prevent excessive weight loss.

The 'window' for moderate to high animal production from tropical grass based pastures is closely linked to using appropriate grazing management that maximises herbage quantity and quality. The optimum herbage mass to maintain a tropical grass pasture at maximum animal intake (with a digestibility of about 65%) is between 1.6–2.5 t DM/ha for cattle and 1.0–1.5 t DM/ha for sheep (Chapter 8). Managing tropical perennial grass pastures to maintain these levels can be difficult, particularly during mid–summer when high soil moisture, temperatures and solar radiation can drive high growth rates. At these times regular grazing at high stock densities is required to maintain the pasture in a high quality, leafy stage of growth. To maximise pasture utilisation, depending on seasonal conditions and regrowth, these pastures will need to be either set stocked or rotationally grazed with only short rest periods between grazing.

Dividing a large paddock into multiple smaller ones will assist management and can be easily achieved for cattle with a single wire electric fence. One of the advantages of smaller paddocks is that they allow flexibility to vary stocking rate and maintain optimum animal growth rate.

When pasture production exceeds animal requirements and there is surplus forage other strategies need to be implemented. These include:

1. Increasing stock number to use feed during the growing season,
2. Conserving the excess feed as silage or hay, and
3. Allowing some of the pasture to mature and senesce, and utilise it as dry standing feed over winter.

12.1 Increasing stock number

The challenge of increasing stock numbers is that pasture production is dependent on available soil water, so if it does not rain, pasture production will fall and the result could be a shortage of feed and de-stocking required. Further information on soil water and pasture production can be found in Chapter 11. To increase stock numbers and maintain pasture quality infrastructure changes including subdivision and additional watering points may be required to deliver water to higher stock numbers and should be considered when planning to use this strategy.

Sourcing additional stock is an option to utilise the excess forage produced during peak periods of growth. This can be achieved by buying or agisting stock.

Buying stock

Incorporating tropical grass pastures into the feed base can allow producers to adjust their livestock enterprise mix by having both breeding and trade cattle enterprises. Trade cattle can graze the tropical grasses in spring–

summer and then be finished on either oats or lucerne. This system provides flexibility as the number of stores bought each year can change in relation to the available feed and seasonal weather outlook, and allow easy selling to reduce stock numbers if the season turns unfavourable.

Tom Bowman, a grazier near Barraba on the North–West Slopes, runs beef cattle on 2700 ha using this strategy. He has a spring calving enterprise and buys trade steers in spring and fattens them over summer. He divides his tropical perennial grass pastures into 10–15 ha blocks using a single wire electric fence and aims for a stocking rate of 25 animals/ha, rotating them though paddocks that are at the optimum growth stage. This can be around 15 days regrowth during periods of peak growth. Mr Bowman has found that tropical perennial grasses allow him to carry steers through autumn, which traditionally is a feed gap. Tom Bowman's story can be found on p76.

Agistment or backgrounding

Another option for increasing stock numbers is either agistment or backgrounding stock. Agistment is only likely to be suitable in certain situations. For your property to be attractive for agistment the following conditions should apply:

- Agistment is available within a few hundred kilometres of drought areas,
- The cost of agistment is lower than the cost of hand feeding,
- The forage available at the agistment site is good quality and the length of agistment available is at least 12 weeks, and
- The fee for agistment is influenced by the quality of feed available, the number of stock involved, duration of the agreement, the level of stock monitoring/handling to be provided, the type and availability of facilities and the payment method.

Some producers increase stock numbers over the summer period by backgrounding or growing stock for producers in other locations. This tends to occur in the dairy and feedlot industries. Steve and Paddy Campbell have been growing out dairy heifers for several years (see p78).

Figure 12.1 Silage being stored in a pit

12.2 Conserve as silage or hay

With adequate soil nutrition and soil water tropical grasses can grow at rates up to 150 kg DM/ha day. During these times it can be difficult to maintain the pasture in the vegetative growth stage where it is at its highest quality for animal production. During these periods it might be necessary to set stock or rotate stock between a few small paddocks rather than move around all paddocks, but this will leave some paddocks of the pasture under–utilised. Conserving this surplus forage as silage or hay can be an effective method to utilise surplus feed, while maintaining high quality pasture and with good growth rates on the remainder of the area.

Production of silage or hay is an opportunity to store quality forage that can be used as a supplement for 'out of season' production, increase enterprise flexibility or create new marketing opportunities. It is also means that in coming weeks, high quality regrowth is available for grazing rather than old rank pasture with lower quality that will reduce animal growth rates. Controlling surplus summer growth also reduces shading and competition in autumn giving temperate annual legumes a better chance to establish.

Silage often has feed quality and management advantages over hay when used on the farm where it is produced. Silage does not require long periods of drying so is easier to make in a wet season when surplus feed is likely available to be conserved. Baled silage is convenient to make and feed out, but can be expensive. Bulk, chopped silage stored in a pit or bunker is better suited to long-term storage and can be cheaper for larger enterprises (Figure 12.1)

Conserving surplus feed comes at a cost so the amount stored needs to reflect the requirements of the enterprise. Harvesting fodder will increase the fertiliser requirements for the paddocks cut as nutrients are removed in the silage or hay.

As a pasture management tool, silage and hay offer the potential to increase productivity, however, it is important to have clear objectives and plan how it will fit into the overall grazing management program. The main objectives when integrating silage cuts or hay production with grazing management are to:

1. Improve pasture utilisation by strategically timing cuts to use surplus pasture,
2. Maximise total forage production, either from grazing or silage and hay making, during the period of peak pasture growth, and
3. Maximise the quality of both the silage/hay and grazed pasture.

While either hay or silage could be produced from surplus growth, the advantages of silage compared to hay include:

1. The ability to cut silage earlier in the growing season and produce a higher quality product,
2. Reduced loss of dry matter and feed quality during wilting and harvesting operations compared to hay making, and
3. Reduce susceptibility to adverse weather conditions.

The following focuses on silage production, however, the principles are the same for hay making.

Kikuyu is the tropical grass most frequently conserved as silage in Australia and can produce large quantities of medium quality silage (metabolisable energy (ME) of 9–10 MJ ME/kg DM). The principles used for conserving kikuyu forage are the same for other tropical grasses commonly used in northern NSW. Kikuyu has high CP levels, however, it has low levels of water soluble carbohydrate which means that wilting is essential to concentrate the carbohydrates and improve fermentation. The best quality kikuyu silage is made from young, leafy growth that has 4 to 5 new green leaves. At this growth stage the pasture is about 25–30 cm high, commonly with about 25–35 days regrowth (under good growing conditions). Delaying harvest after this period will result in a decline in energy and protein levels. Cutting at this growth stage also gives the best regrowth from the pasture. The comparative yield, management and quality of silage made from kikuyu compared to lucerne are shown in Table 12.1.

Table 12.1 Production potential, management requirements and suitability of kikuyu and lucerne for silage production (modified from Kaiser et al. 2004).

Crop	Kikuyu	Lucerne
Pasture growth stage at harvest	4–5 leaf	1–10% flower
Potential yield[1] (t DM/ha/cut)	2–3.5	1.5–3.2
Potential number of cuts per year[1]	1–3	4–7
Wilting requirement	Yes	Yes
Target range DM content (%)		
— Chopped	35–40	35–40
— Baled	35–50	35–40
Metabolisable energy[2] (MJ ME/kg DM)	8.5–10	9–10.5
Crude protein[2] (% DM)	12–18	18–24
Suitable for chopped silage	Yes	Yes
Suitable for baled silage	Yes	Yes

Notes:
[1]Yields and potential number of cuts are for pastures at the optimum growth stage. Yields at the higher end of the range can be obtained with irrigation or when pastures are grown under ideal growing conditions.
[2]Metabolisable energy and crude protein values shown are in the range that is achievable with good management.

Optimising quality

When deciding the best time to cut for silage, the aim should be to optimise the yield and quality of both the silage and the grazed pasture. To produce high quality silage, tropical grass pastures must be cut when they are at a vegetative stage of growth. While delaying cutting often produces a higher silage yield, the quality will be lower and the product will not be suitable for achieving high animal production targets (Table 12.2). The optimum stage for harvest is often a compromise between quality and quantity, with the recommended growth stage targeting a time when forage quality is acceptable and DM yields are sufficiently high to produce economic silage yields. Additional benefits from harvesting early include faster wilting rate and higher pasture regrowth potential.

Table 12.2 Effect of growth stage on quality and potential yield of kikuyu silage (Kaiser et al. 2004).

Growth stage	Metabolisable energy (MJ ME/kg DM)	Crude protein (%)	Potential yield (t DM/ha)
Vegetative (25–35 days regrowth)	9–10	15–20	2.0–3.5
Late vegetative (40–50 days regrowth)	8–9	11–15	2.5–5.0
Rank (>50 days regrowth)	6–8	6–10	3.0–8.0

In glasshouse pot experiments Makarikari grass cv. Bambatsi and Rhodes grass cv. Katambora were found to produce about 6 leaves per tiller before stem elongation occurred while panic cv. Gatton and digit grass cv. Premier produced about 4 leaves per tiller. At 4–6 leaves per tiller Makarikari grass herbage had 10.6 MJ ME/kg DM. At stem elongation herbage production had almost doubled, but ME had declined to 7.9 MJ ME/kg DM. Similarly Rhodes grass production increased 3–fold from the 4–leaf per tiller growth stage to stem elongation, but ME declined from 9.7 to 7.4 MJ ME/kg DM. Moderate animal production can occur when ME of forage is greater than 9, but weight loss occurs when metabolisable energy is less than 7.5.

The bottom line is – poor quality pasture will not produce high quality silage. NSW DPI run TopfodderTM silage courses which cover all aspects of silage making, storing and feeding.

12.3. Dry standing feed

In most years, it is not possible to utilise growth from all tropical grass pastures and inevitably there will be a bulk of dry standing feed going into winter (Figure 12.2). This effectively is a 'standing haystack' which can be utilised during winter and early spring. This feed will be poor quality and have very little or no green leaf. Livestock on this low quality feed will require supplementation to increase pasture utilisation and prevent excessive weight loss (Figure 12.3).

In years that have an early autumn break, temperate annual legumes growing in a tropical grass based pasture can be an effective source of protein during the winter and early spring period. However, to achieve this outcome the tropical grass pasture must be managed in late summer-early autumn to allow for legume regeneration (see Chapter 10).

Leaving the pasture rank creates an option for it to be used later in the growing season, but it is recommended that only a small proportion of tropical grass pastures on the property be used this way. Legume regeneration can be adversely affected through shading by the rank grass material, and so this strategy should be used only for pastures that do not contain legumes, or just one year at a time so that the legume seedbank is not compromised (Figure 12.3).

Supplements are an essential tool to allow livestock to utilise dry standing tropical grass pastures, and they can also be used in the shoulder periods of autumn and spring to help maintain animal production.

Figure 12.2 If allowed to senesce in autumn tropical perennial grass pastures (left) can provide a large bulk of feed for use with supplements during the winter months.

Figure 12.3 This tropical grass pasture is being left to be grazed by animals with supplements over the winter period as once frosts commence the quality will be low. The dead seed heads of temperate legumes from the previous spring can be seen. Grazing to remove some of the bulk and open the pasture will encourage annual legume regeneration.

Supplementary feeding

Supplementary feeding is a term loosely used across the grazing industry. By definition, supplementary feeding is supplying additional forage (hay or silage), grain, concentrates or minerals to animals grazing a pasture to improve animal performance. While supplements are commonly used during drought, they have a role in improving animal performance from pastures during an average year or during winter because an appropriate supplement can supply nutrients that are otherwise deficient allowing better use of a pasture or forage.

The type of supplement being fed to livestock can affect they way they graze a pasture. The most common effect is substitution of the pasture for the supplement. This occurs when high-energy feeds are offered and pasture intake declines. In some cases the supplement can complement pasture intake resulting in increased pasture intake. This occurs when stock are grazing dry pasture or crop stubble with very low levels of digestibility and the supplementation improves the animal's ability to digest the feed. The third and rare situation is where the supplement is eaten, pasture intake remains unchanged and animal production improves.

Examples of pasture characteristics at different times of the year and supplements that might be suitable for different classes of cattle are provided in Table 12.3.

For a supplement to be effective, it must contain the main nutrients to make up for those deficient in the paddock feed. For example, dry feed is often deficient in protein while in cases where the feed is green, but very short, production is limited by low energy intake. For efficient use of supplements the following steps should be followed:

1. Identify the components that are most limiting to animal maintenance/production (usually protein and metabolisable energy) and select supplements containing high levels of the identified components.
2. Balance the supplement to ensure efficient rumen function (remember that young and lactating animals have greater need for protein).
3. Choose feeding techniques that minimise disruption to the animals' digestive system.
4. Monitor feed consumption, animal live weight and condition so that you can confirm that your strategy is working.
5. Understand your livestock production targets. Dry standing feed plus a protein supplement can be a maintenance feed, but if higher weights gains are required then additional energy will be required in the supplement, e.g. urea provides nitrogen for rumen function and molasses the energy.

Table 12.3 Examples of tropical perennial grass pasture characteristics outside the growing season and possible supplementary options for cattle utilising the pasture at that time (modified from Joshua 2006).

Class of stock	Supplement	Frequency
Plentiful dry feed (e.g. late autumn–winter) *Characterised by:* – *Low pasture digestibility limiting intake* – *Protein supplements increase pasture intake*		
Cows and calves, dry adult stock	Urea/molasses	Continuous access
	or High–protein grains	Feed every second day
	or Protein meals	Feed twice weekly
Weaners	Supplement and frequency as for other classes of stock, but high protein grains or meals preferred	
Deteriorating dry feed (e.g. late winter) *Characterised by:* – *Quantity and digestibility restrict intake* – *Energy/protein supplement mixes required*		
Cows and calves	Molasses/urea/protein meal	Continuous access
	or Grain/protein meal	Feed daily or 3 times/ week
Dry stock	Grain/protein seeds or meals	Feed daily or 3 times/ week
Short green feed (e.g. early spring)[1] *Characterised by:* – *Quantity of pasture limits intake* – *Feed energy supplements*		
Cows and calves	Good quality hay/silage	Feed twice weekly
	or Cereal grains	Feed twice weekly
All dry cattle	Hay/silage	Feed once a week
	or Cereal grain	Feed once a week

Notes:
[1]At this time of year it is recommended to rest the pasture until there is about 1 t green DM/ha before grazing.

The Topfodder™ program includes hands-on inspection and assessment of silage on farms using both bulk and baled silage.

More information can be found at **www.dpi.nsw.gov.au/agriculture/profarm/courses/topfodder-silage**

SW Department of Primary Industries have also developed a number of tools that can be used to assist with silage production.

These can be found at **www.dpi.nsw.gov.au/agriculture/pastures/pastures-and-rangelands/silage**

Case study: Tropical grass pastures have it covered

Farm info.

Case study: *Tom Bowman*

Location: *Barraba, NSW*

Property size: *2700 ha*

Mean annual rainfall: *700–750 mm*

Soils: *Basalt clay*

Enterprises: *Beef cattle (spring calving enterprise and opportunistic trade cattle)*

This producer story first appeared in Future Farm *Issue 8, August 2011.*

Tropical perennial grasses have allowed the Bowman family, in northern New South Wales to boost cattle numbers, while improving the condition of their soils. Tom Bowman shares the tricks to this successful outcome.

"We started investing in tropical perennial grasses four years ago after seeing the positive impacts they have had on other local properties," Tom said.

"After conventional cropping during the 1980s, our production system is now focused on cattle production and before the tropical perennial grasses we relied on a combination of lucerne, native pastures and winter grazing oats.

While the lucerne provides some green feed during summer, groundcover is an issue, with patches of bare soil leading to significant compaction between plants and resulting in soil erosion from summer storms.

Our main aim in introducing the tropical grasses was to improve groundcover and reduce this erosion.

We direct drilled 40 hectares of undulating hill country down to a locally-recommended mix of Premier digit grass (*Digitaria eriantha*), Katambora Rhodes grass (*Chloris gayana*), Bambatsi panic (*Panicum coloratum* var. *makarikariense*) and Gatton panic (*Megathyrsus maximus*) during early November 2007.

Following this we had a couple of heavy summer storms providing about 50–75 mm of rainfall each.

I thought the seed would be washed away, but two months later it was all up and we had weaners grazing the new pasture by the second week of February.

Our 600 weaners continued to graze the paddock from March through to April — this is a real bonus for us as autumn is a feed gap.

Getting established

Since that first paddock we have continued to establish more country to tropical perennial grasses each year.

The key to success is to make sure your paddocks are weed-free before you start.

We establish our tropical perennials onto paddocks that have had at least two years of grazing oats and we control weeds throughout the crop and fallow periods.

High stocking rates and regular rotation help maintain the feed quality of Tom's (right) tropical grasses, as he explains to Bob McGufficke (left).

We aim for a plant density of about 10 plants per square metre.

Post establishment we continue to invest in the pasture base through soil fertility to support maximum growth.

We soil test each paddock and apply nitrogen and trace elements as needed.

The cost of soil testing to determine appropriate fertiliser rates is nothing compared with cost of fertiliser — testing allows us to supply only what is needed.

The growth potential is spectacular, both with and without the summer rainfall, and the challenge is to ensure there are enough mouths to keep the pasture under control.

To this end, effective grazing management requires small paddocks and high stocking rates to maintain the tropical grasses at the leafy growth stage during periods of peak growth.

We have divided paddocks into blocks of 10 to 15 ha using single wire electric fencing, with watering points supplied to each paddock.

It is a significant investment in water and wire, but we achieve longer and better grazing than we did under lucerne and the results are worth the investment.

During the warmer months (November–February), when the tropical perennial grasses are actively growing, we stock at a density of about 250 steers to 10 ha, moving the stock every three to five days.

To achieve sufficient stocking densities during this period of rapid pasture growth we bought in trade steers during spring and fattened them over summer.

The key is to know the appropriate length of time the pasture will need to recover before the next grazing — this varies according to temperature and soil moisture.

We generally move stock when there are 1200 to 1500 kg DM/ha left in the paddock and ideally place them into each new paddock before stem elongation commences.

It can be difficult to keep these grasses at the leafy growth stage as large stock numbers and strict rotational grazing are required.

However by maximising the energy and protein of the pasture through fertiliser and careful grazing management, we have been able to achieve growth rates of about 1.5 kg/hd/day.

We have had a mob of steers that increased from an average weight of 400 kg to 480 kg after 50 days grazing perennial tropical grasses.

The grasses also help us fill the autumn feed gap for our weaners. The native pastures only provide low-quality fodder during autumn, which is unsuitable for weaners.

With well-planned grazing, the tropical grasses provide suitable feed right through late summer–autumn until oats are available for winter fodder.

Up until now we have only had enough tropical grass pasture for trade stock and weaners, but as we establish more we will put more cows and first calvers on these paddocks."

Tom Bowman (far left) is thrilled with the rapid response of tropical perennial grasses in his grazing system.

Case study: Tropical grasses offer safety and substance

Farm info.

Case study: *Steve and Paddy Campbell*

Location: *Manilla, NSW*

Property size: *1012 ha*

Mean annual rainfall: *710 mm summer-dominant*

Soils: *Red chromosol soils*

Enterprises: *First-cross lambs, backgrounding dairy cattle, trading beef cattle*

This producer story first appeared in Future Farm *Issue 15, December 2013.*

Tropical grasses are offering enterprise flexibility for Steve and Paddy Campbell, who have used them for backgrounding dairy heifers and running beef cattle and first-cross lambs. tropical perennial grasses in his grazing system.

Tropical grasses are providing a productive, persistent and bloat-safe summer feed option for Steve and Paddy Campbell, Manilla, northern New South Wales.

"When we purchased the property about 16 years ago it was completely unimproved, native grassland," Steve explained.

"Since then we have developed the more arable country with a combination of summer-active perennial pastures and annual grazing crops (oats and winter wheat). The hill country is still under native species, which we use for lambing. We then bring the ewes and lambs down to the better country.

We have about 160 ha of oats and winter wheat, 60 ha of tropical grasses and the rest is native grasses. The oats and winter wheat form the basis of our fat lamb production and we have been looking for a persistent and productive pasture option to fill the seasonal feed gaps.

We had sown a couple of paddocks down to lucerne, but we just couldn't get it to persist for more than a few years.

About three years ago an opportunity arose to background dairy heifers and we were looking for a good feed through the summer for the heifers. We needed something to take place of the lucerne that didn't pose a bloat risk to the cattle.

I had been to a few field days locally to look at how the tropical grasses were performing, which convinced me they could to the job.

Ease of integration

Our experience has been that tropical pastures are not difficult to establish, particularly if the summer seasons are good — everything comes down to rainfall, no matter what you are establishing.

We have been establishing about 20 ha each year for the past three years.

Weed control leading up to establishment is paramount, but our system of winter feed crops means weeds are under control before we sow the tropical grasses around November.

We spray out the oats during summer and fallow the new pasture paddock for about nine months, keeping on top of the weeds in the meantime.

The other trick is to not sow the tropical grass seed too deep — it needs to sit virtually on top of the ground with minimal soil cover.

In fact we sowed a paddock last year and we ran out of seed and Paddy and I went back later with a bucket of seed each and broadcast it by hand — it actually came up better than the sown stuff.

After sowing we avoid stocking the new pasture too heavily in the first year and let it set seed before popping in about 100 heifers on 20 ha for a light graze to take the top off during late autumn — we might leave them in for about a month depending on the seasonal conditions. This approach means the pasture is ready for standard grazing the following spring.

Rapid rainfall response

Grazing management for the tropical grasses is all about being flexible and responding to the season. The grasses respond so quickly to rain — a couple of days after summer rain you can literally see it shooting. So if it rains you need to hammer it — once you get a bulk of feed it is a big bulk.

We do try to keep the feed at a manageable level with grazing, but this can be difficult when the pasture responds so quickly to rainfall. When we can't match the growth with stock we run the slasher over the paddocks to keep the quality in the feedbase.

At the moment, after a dry winter and spring, our tropicals are very short and we are keeping stock off them.

We have just finished lamb marking and we have had to put ewes and lambs back onto the hills — normally they would go back on the tropical grass paddocks until weaning. Then the lambs would go onto the oats or winter wheat to fatten.

Although the dairy heifer job is falling away because of the industry, at one point we had 400 heifers we were backgrounding on the tropical grasses. When we were weighing dairy heifers, we were averaging about 0.7 kg/hd/day.

You need to remember these girls are not built for putting on weight, so this is a great result — we never had to worry about bloat.

Tropical grasses have proven a valuable and bloat-safe feed source for dairy heifers.

Feeding the feed

Because the tropical grasses produce such a huge amount of feed after rain, they are hungry for nitrogen — you can run out of nitrogen when there is a big bulk of feed.

Last autumn we decided to incorporate some temperate legumes — lucerne and sub-clover broadcast with fertiliser — to supply nitrogen to the grasses, but it was an ordinary winter and we haven't seen many plants emerge as yet.

It just hasn't rained this winter and rain controls everything.

We will persist with the winter legumes and try to get them going in a better season. I have seen some pastures that have a really strong legume component and this is what we are after.

What we are trying to achieve is an additional feed source during winter and a source of nitrogen for the grasses — making it more of an all-year pasture."

Case study: Tropicals exceed all expectations

Farm info.

Case study: *Stuart and Bronwyn Lockrey*

Location: *Manilla, NSW*

Property size: *999 ha*

Mean annual rainfall: *700 mm*

Soils: *Basalt-derived, light brown to heavy black soils*

Enterprises: *Mixed farm — winter cereals, trade beef cattle, Droughtmaster stud and sheep*

This producer story first appeared in Future Farm *Issue 16, April 2014.*

Bronwyn and Stuart Lockrey couldn't be happier with the change tropical grasses, such as this panic, have enabled them to make on their property.

Stuart and Bronwyn Lockrey are long-time enthusiasts of tropical grasses. In mid-February 2014, with the region in the grip of one of the driest summer periods he could remember, Stuart's enthusiasm for tropicals remained near-evangelical. If anything, the dry spell had him even more excited about them.

"What has been happening during the past few years is that we get a big lot of wet followed by a big lot of dry, so you need something that can carry you from rainfall event to rainfall event," Stuart said.

"It goes from feast to famine up here all the time these days — for example, we had a deluge in June and then nothing till November, when we had 150 mm up until Christmas. We've had practically nothing since.

That's what led to me to the tropicals in the first place — these more frequent climatic fluctuations.

Since I left school in 1980 I have seen the seasons changing. We were told these tropicals were the answer to the changing climate — and they are. They have more than impressed.

The original idea was they would provide feed over summer, when our traditional native and winter-active pastures were not producing. But these grasses can perform all year round if conditions are right. For example, last year (2013) was a funny year season-wise. We only had two mild frosts, if any, and the tropicals grew all winter — they didn't go dormant.

The cattle had them eaten back by November and then rain came and kicked them on again. The cattle have been grazing them ever since.

From here I can see for about 40 km and ours are the only green paddocks in sight.

The uptake on these perennial grasses has been fairly slow; but the past three weeks have sparked a lot of interest. Even people who have been dead against the tropicals are starting to show interest. They are looking hard at our fat cattle and know we haven't had to supplementary feed in a season that has had most others beat.

Steady progress

We still have the first tropical paddocks we established during the summer of 2007–08 and they haven't looked back. We are now up to about 180 ha of tropicals (from about 100 back in 2010).

Our tropical mix is mainly Katambora Rhodes, Gatton panic, Bambatsi panic and Premier digit grass, with a smaller quantity of creeping bluegrass. We have included the creeping bluegrass where I was worried about bare patches — it runs along the ground, but seems to be better for stock and covers up the bare patches of soil. I also think the clover comes away better under the bluegrass. But at the end of the day it all comes back to grazing management. We just keep sub-dividing and crash grazing to manage the feed bulk. This is still the biggest challenge.

Of course the idea is to buy more stock to eat the feed as it comes away, but that just isn't always possible.

We do monitor the paddocks closely and keep the stock moving to promote new growth over rank feed. But I don't worry about it so much anymore. If we can't keep up, we can't keep up — it is really just like having a hayshed in the paddock. Even if you don't keep on top of the feed bulk, at some stage it will get eaten.

After the early summer rains this year the feed bolted way and the cattle are now just getting the paddocks down and evenly grazed. I could make hay, but I like leaving it on the paddock — whatever doesn't get eaten returns to the soil through nutrient cycling.

Feeding the feed

Our other challenge has been supplying enough nutrients to support the dramatic amount of dry matter the tropicals produce year on year.

We now sow clover into the tropicals during autumn and hope seasonal conditions allow them to take hold — we have been lucky. We initially direct drilled about 2 kg/ha of arrowleaf clover and we had a great year. "The clover established and produced about 5–7 t/ha of feed.

Since the clovers have been coming away they have produced enough nitrogen to sustain the grass production. We are working on the basis that our clover will produce about 80 units of nitrogen per hectare.

We have found arrowleaf clover easier to grow than sub-clover — it is more hard seeded, so you need more than one year to get it established. It can be a bit hit and miss, but I believe it is worth experimenting with.

We have oversown about half our tropicals with clover now and I will keep going until they are all done. We have also used urea and chicken manure to provide nitrogen for the grasses. The urea is a quick fix, but you just have to keep applying it year in year out. The chicken manure is a longer-term option and has the added benefit of additional organic matter to nourish the soil.

We will return to applying chicken manure as some new chicken sheds are under construction locally — supply has been the issue during recent years.

Opportunity knocks

I can't praise these pastures enough — particularly when times get tough; like now. They have allowed us to take our cattle off half our place (500 ha) and hold them on the tropicals for about 12 months. And we have been able to agist a couple of hundred cattle on our native pastures.

I'm looking across at it now, with a beer in my hand, and it is just astounding — the natives have all but dried to powder as you drive across them and the tropicals are still there, just waiting for the next rain.

We have had the driest January on record and we haven't had to destock or feed our cattle. That makes a big impact on your mental health and well-being — this is the worst of times and it looks like this. I'm happy.

Slow on the uptake

I suspect the reason the uptake hasn't been greater is the initial cost of getting tropicals to grow — it's not cheap. But then neither is buying feed for hungry stock.

The great thing is that if you follow the program it will happen. In fact even if you don't follow it to a 'tee' it will happen anyway.

We planted a paddock a few years with the help of some funding, which was tied to a deadline for establishment. The deadline came and I didn't feel the conditions were right but our hands were forced so we went ahead anyway.

It was totally wrong. Nothing happened. Oats germinated and grew during winter and I thought it was a lost cause. But next summer arrived and the tropicals just shot out of the ground. I used to worry about perfect preparation, but you just have go with the season.

I think the key is to keep feeding the tropicals — but then if you feed them too much then they get carried away in terms of production, so it is a balancing act.

Our sub-tropicals have stopped growing now (February), but it looks like some rain could be on the way and if it arrives soon they will just bounce away again.

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THE GRASSLAND SOCIETY OF NSW INC.

A Group of people with a common interest in developing our most important resource, our grasslands

The objectives of the Grassland Society of NSW are:

- to provide an organisation in which landholders are the major participants in the dissemination of pasture production information
- to provide opportunities for those concerned with grassland production to meet and exchange information
- to encourage the investigation of problems affecting grassland management
- to stimulate the incorporation of advances from research and producer experience into practice
- to provide a means of social and business contact for those engaged in grassland production
- to afford pasture production an ordered structure and an industry status

The Grassland Society of NSW was formed in March 1985. The Society membership maintains a unique blend of producers and technologists.

The Society holds a conference each year, publishes a quarterly newletter and has branches across NSW.

Our internet address is www.grasslandnsw.com.au

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