Queensland **the Smart State**

PASTURES:

Mackay Whitsunday region

A guide for developing productive and sustainable pasture-fed grazing systems

Mackay Whitsunday Natural Resource Management Group

Queensland Government
Department of Primary Industries and Fisheries

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Foreword

For today's landholders, running a successful grazing enterprise requires a broad range of knowledge, skills and experience. Gone are the days when the main requirement for running some cows or horses was to have access to land (any land), put a fence around it and provide water. Although, even now some in the community believe this approach is acceptable when running a few horses.

In the words of Marlborough landholder/grazier Peter Emmery, 'the most cost-efficient way to reduce age of turnoff is to improve (animal) nutrition through improved pastures' and 'the most economically efficient way to increase (breeder herd) fertility, providing phosphorus nutrition is adequate, is pasture improvement' (Emmery 1997).

The three top priorities for sown pastures in the tropics and subtropics, as presented by Walker *et al.* 1997, are

- Collating all available information on pasture cultivars and sown pasture development and management into a readily accessible form and extending it through pro-active extension activities
- Integrating sown pastures into feeding systems and whole property development
- Monitoring the health and condition of sown pastures to determine rate and cause of decline.

A farming (or grazing) system is said to be sustainable at the farm level if it satisfies the farm (property/grazing) manager's needs (over time) while conserving the natural resource (Gomez *et al.* 1996).

The aim of *Pastures: Mackay/ Whitsunday region - A guide for developing productive and sustainable pasture-fed grazing systems* is to provide information and knowledge on sown and native pasture systems in a form readily accessible to the Mackay Whitsunday region's grazing sector.

Pastures has been compiled and published by the Department of Primary Industries and Fisheries, through the Sustainable Grazing Systems program within the Animal Sciences Group. Its contents draw on a wide range of new and existing information sources (see Chapter 10, References and Resources).

Funding to print Pastures was provided by the Mackay Whitsunday Natural Resource Management (MWNRM) Group. Pastures will be a useful tool to assist implementation and delivery of the MWNRM Group's Sustainable Landscapes (incentive) Program.

Information in this book will progressively be updated and made more locally relevant and applicable through landholder/grazier feedback, following participation in the on-ground grazing land management activities demonstrated and implemented at Grazing Land Management (GLM) and Stocktake workshops and field days.

'It is not enough to know – One must also apply. It is not enough to wish – One must also act' (Goethe).

Harry Bishop

Contents

Overview of Mackay Whitsunday region

Location

The Mackay Whitsunday (MW) catchment/region occupies a narrow coastal strip on the central coast of Queensland extending from south of Bowen, Proserpine, Airlie Beach and the Whitsunday Islands in the north to Sarina and Carmilla in the south, a distance of approximately 300 kilometres. It is about 80 kilometres wide near Mackay and extends from the Great Barrier Reef and Coral Sea coast in the east to the Eungella Tableland headwaters of the Pioneer River in the west. The catchment encompasses an area of 940,000 ha. For statistical purposes the Mackay Whitsunday Natural Resource Management (MWNRM) Region consists of the four shires of Whitsunday, Mackay, Sarina and Mirani. However the actual Mackay Whitsunday catchment boundary excludes bits of Mirani and Sarina shires and includes bits of Broadsound and Bowen shires. The MW region has a population of about 113,000 people, with most living in the larger urban centres of Mackay, Sarina and Proserpine. Approximately 70 percent of the region's population resides in Mackay. Figure 1 presents a boundary and location map.

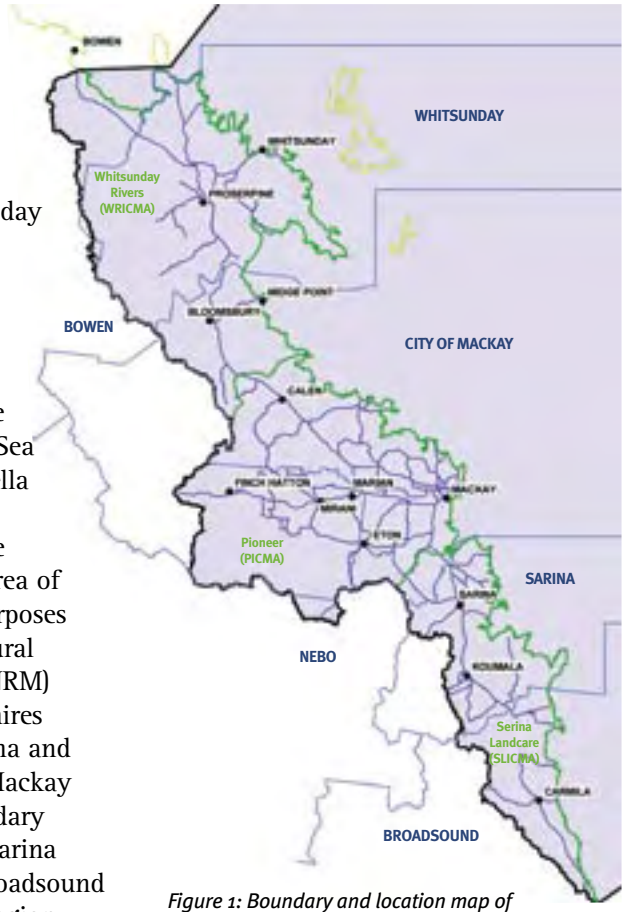

Figure 1: Boundary and location map of Mackay Whitsunday region

Climate

The region's climate is humid and tropical with hot wet summers and cool dry winters. Annual rainfall varies significantly, from more than 2000 mm in elevated sections of the coastal ranges down to 1000 mm per year in other inland areas. January is the hottest month (mean 30°C) and July is the coldest month (mean 11°C) for the coastal city of Mackay. Most (around 70 percent) of the region's rainfall occurs between the months of December and March. Table 1 presents mean monthly rainfall data for six sites in the region plus Tully and Rockhampton. Figure 2 graphs monthly rainfall to show and compare potential seasonal forage growth cycle for Tully (northern wet tropics), Mackay and Rockhampton (drier central tropics).

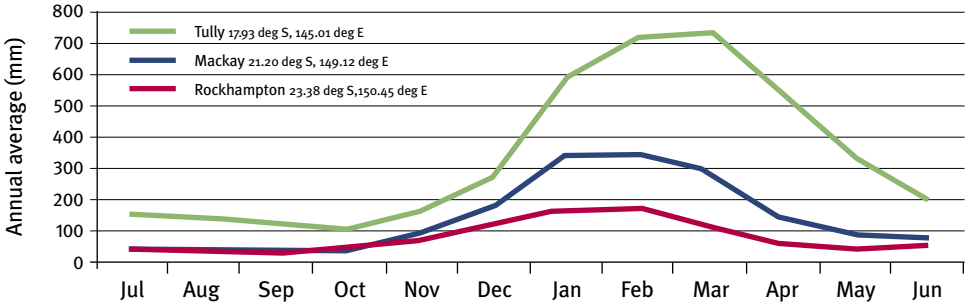

Figure 2: Mean monthly rainfall graphed to show seasonal forage growth cycle for Tully, Mackay and Rockhampton

Table 1: Mean annual rainfall by calendar month for six Mackay Whitsunday centres plus Tully and Rockhampton

Site	Rainfall (mm)													
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Year	No. rain days
Mackay	36	30	28	45	81	179	342	352	281	144	93	62	1677	126
Dalrymple Hts	67	56	39	58	94	201	347	429	324	179	114	103	2017	111
Elaroo	26	22	22	39	75	155	321	320	232	101	53	44	1414	81
Sarina	31	29	24	53	100	186	372	378	274	123	79	55	1708	89
Carmilla	33	28	27	53	106	196	293	312	190	80	56	44	1423	89
Proserpine	37	34	36	41	74	179	362	381	304	151	92	63	1763	111
Rockhampton	38	25	28	48	66	112	162	170	106	56	45	51	908	94
Tully	147	136	117	101	158	274	587	721	729	539	339	195	4057	155

Source: Clewett et al Australian Rainman & Streamflow (2003)

The natural environment

The Mackay Whitsunday region's highly valued natural environment features the Great Barrier Reef World Heritage Area and Whitsunday Island group, extensive wetlands, protected wilderness areas such as Eungella and Cape Conway National Parks and many unique plant and animal species. About 550,000 ha of native vegetation remains in the region as a diverse array of terrestrial, island, aquatic and estuarine ecosystems.

Closed eucalypt and paperbark tea tree forests and rainforests grow in coastal and near-coastal areas while further west, vegetation communities change to eucalypt dominated open forests and woodlands. Aquatic ecosystem health in the Mackay Whitsunday region typically varies from poor in some areas of intensive urban and agricultural land use, such as the lower Pioneer and Proserpine flood plains, to virtually pristine in forested catchments like those of Repulse and Flaggy Rock creeks.

Natural resource assets of MW region

The primary natural assets in the region are land, water, biodiversity and climate. The primary human assets relating to natural resources are the abilities and capacities of the community for long-term adaptive management of their natural resources and the cultural values inherent in natural systems. Until recently, natural resource management tended to be 'problem-based'. The new approach is more strategic and involves addressing the cause of problems rather than symptoms alone. The new logic is that management plans need to protect and when necessary restore assets, both natural and cultural.

Who is the Mackay Whitsunday Natural Resource Management (MWNRM) group?

In 2004 this group was officially designated by government (Australian and State) as the regional body to facilitate and deliver management of natural resources in this region, in partnership with the wider community (private, public, industry and government). Funding support is through the Natural Heritage Trust (NHT) program. The MWNRM Plan 2005 document sets out the regions Vision; 'the region we share will meet our environmental, economic and social needs into the future'.

More detail on MW Natural Resources, Resource Targets and Management Action Targets is available in the MWNRM Plan 2005 and copies are available from the MWNRM Group, 38 Tennyson Street, Mackay; or visit www.mwnrm.org.au. Section 6, in the Plan (Land pages 66-88) is of particular interest and relevance to the grazing sector.

2 Profile of Mackay Whitsunday beef industry

Grazing is the largest land use in the Mackay Whitsunday region. Grazing accounts for 76 percent of the region's land use area while sugar cane accounts for 15 percent of the land use area (Table 5). However on gross dollar value sugar cane is by far the largest industry (Table 4). Agricultural Commodities by LGA Estimates for the year ending 30 June 2001 lists 538 beef enterprises carrying 133,641 cattle (Table 2). DPI&F tail tag records suggest many more enterprises have 'some' cattle than ABS data indicates. It is estimated that improved sown pasture systems provide approximately 90 percent of grazed forage demand with 10 percent supplied from remaining areas of native pastures, mainly in the eucalypt hills and ranges.

The cane and cattle industries are closely linked with more than 50 percent of the region's beef cattle owned and managed by integrated cane and beef enterprises. Many cane farmers took advantage of the tropical sown pasture boom in the late 1960s and early 1970s by using their farming knowledge and equipment to clear and cultivate country, not yet under cane, and planting it to tropical pastures for grazing. When cane assignments were increased they converted the best of these pasture areas to cane and developed new areas to pasture. Subsequently many of these cane farmers purchased fattening country west of the coastal ranges and transported their coastal bred weaners west for fattening.

Table 2: Meat Cattle at 30 June - total number (n)

Local Government area	Estimate	RSE of estimate %	Establishment count (number)	RSE of establishment count %
Mackay (C)	43384.6	5.8	222.2	2.9
Mirani (S)	25080.3	12.6	124.3	4.1
Sarina (S)	36065.5	6.7	125.6	4.1
Whitsunday (S)	29111	8.3	66.1	5.5
Total	133641.4	33.4	538.2	16.6

Source: Agricultural Commodities by LGA Estimates: Year ending 30 June 2001
RSE = residual standard error

Table 3: Number of enterprises (with various number of beef cattle per enterprise) at 30 June 2001 Queensalnd Government area

Local Government area	Less than 50	50 to less than 100	100 to less than 200	200 to less than 500	500 to less than 1000
Mackay (C)	88.6	51.5	30.7	30.2	14.4
Mirani (S)	58.9	20.9	26.5	11.9	2.5
Sarina (S)	46	18.9	18.8	25.6	5
Whitsunday (S)	22.2	12	7.3	7.1	7.2
Total	215.7	103.3	83.3	74.8	29.1

Source: Australian Bureau of Statistics, Agriculture Census 2001.

The predominant beef business is breeding and sale of weaners, stores or cull cows. This differs to the far northern wet coastal areas that are predominately buy-in stores and fatten (for the domestic market). The MW region is bordered on the west by Brigalow Area 3 which provides good cattle 'fattening' pastures and creates a ready market for coastal bred stores. Also land types used for grazing in the MW region are predominantly moderate to low fertility and need high fertiliser inputs to develop productive (fattening) sown pasture systems.

In the MW region more than 50 percent of the region's beef cattle are run by approximately 10 percent of enterprises. There are many small beef operations running a few cattle (Table 3). For the central Queensland region approximately 20 percent of beef cattle numbers are grazed on the coast and 80 percent in the hinterland. The distribution of beef enterprises is

Table 4: Overview of Mackay Whitsunday industry value ($) and status (2002)

Industry	Value $m	Status
Cropping:Sugar Cane	201.7	Decline or limited growth expected until world prices improve. Some cane land is reverting to grazing land.
Cropping: Horticulture and other crops	17.6	Continued growth expected as cane farmers look for complimentary crops.
Livestock grazing	24.4	Some expansion as marginal cane land is returned to pasture. The Borthwicks abattoir at Baker's Creek is a significant regional asset. Investors/retirees are also buying small farms to produce cattle.
Livestock dairy	3.3	Declined markedly since dairy deregulation, future uncertain, milk is shipped to Rockhampton.
Aquaculture	1.7	Expansion dependent upon development of / access to, necessary technology and achievement of sustainable management practices.
Timber and forest products	0.5	Steady with likely reduction of logging on State land, more timber will need to be sourced from public and private plantations to sustain production. Recent expansion of private hardwood plantations for pulp.
Total	249.2	

Source: Australian Bureau of Statistics; Agriculture Queensland (unpublished data); Dodds 2003.

Table 5: Mackay Whitsunday Catchment - current land use (based on area of land)

Catchment	Catchment area sq km	Total protected area sq km	Total protected area %	Grazing sq km	Grazing %	Sugar cane and other crops sq km	Sugar cane and other crops %
Proserpine	2535	265	10	2070	82	200	8
O'Connell	2387	219	9	1904	80	264	11
Pioneer	1570	174	11	1100	70	296	19
Plane Creek	2539	79	3	1830	72	550	21
Total/Mean	9031	737	8	6904	76	1310	15

approximately 80 percent coastal and 20 percent hinterland. The Borthwick's Abattoir in Mackay processes 90 percent of through-put for the export market and 10 percent domestic.

The statistics on the local beef industry are best used to show relative numbers and size comparisons rather than accurate calculations.

Pasture-fed beef production options

A landholder has a number of basic pasture-fed grazing systems to choose from for a whole-of-property/whole-of-enterprise pasture development or pasture upgrade program.

Pasture-fed options for whole property/enterprise:

1. Native grass pastures
2. Native grass over-sown with legumes
3. Sown (improved) grass pastures
4. Sown grass/legume mixed pastures
5. High nitrogen input grass pastures
6. Special-purpose pastures (hay, irrigation, weed management, etc)

Managing a successful grazing enterprise requires knowledge and experience in many areas; natural resources management (land and vegetation), pasture management, cattle management, climate variability, marketing and business management to name a few.

A good starting point is the **property land type map**. You need to know what natural resources you have to work with; **land** (soils, vegetation, topography), **water** (rivers and creeks, underground and surface storages). You also need to know your **property infrastructure** (roads, fences, paddock sizes, watering points and buildings). To do this you will need to access aerial photography or satellite imagery and cadastral and topographical maps.

All this information, coupled with landholder local knowledge and experience, provides a robust platform to initiate the **whole-of-property development plan** based on the property land type map. The appropriate grass/legume species can then be matched to the land types and pasture-fed grazing system(s) that best suit your property.

There are several ways to get help with this process, including the DPI&F delivered Grazing Land Management (GLM) and Stocktake workshops (more information Chapter 7), private consultants, NRW, AgForward workshops and regional NRM groups.

KEY TIP

Matching property land types and pasture species with landholder local knowledge and experience is the key to economic and sustainable beef production systems.

The following diagram provides a framework for integrating information on beef production systems into a whole-of-enterprise/whole-of-property, approach.

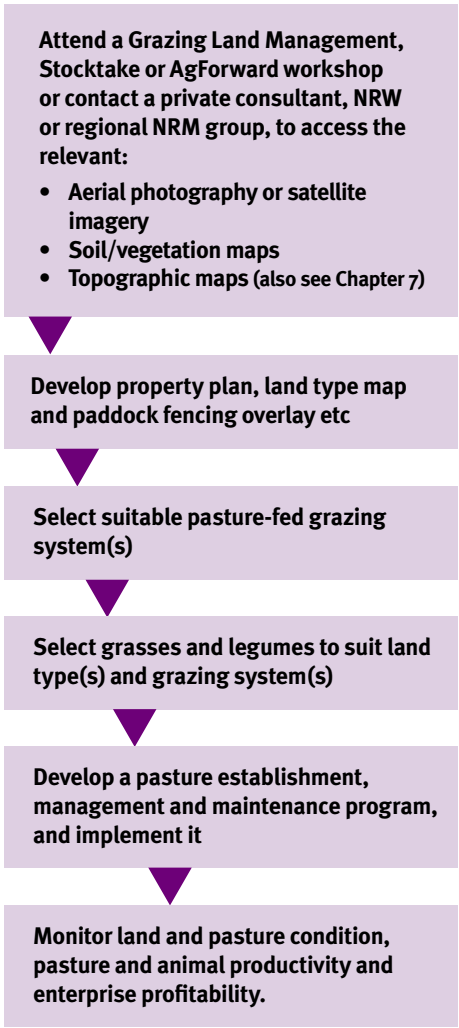

Figure 3: Property development or pasture upgrade grogram

Productivity and sustainability of introduced sown pasture systems depends on selecting the most appropriate variety or species for the particular **grazing system** and **land type(s)** on your property. The production and management of most sown pasture species is strongly influenced by land types (soils, fertility, slope, drainage, water ways, frost, etc).

When selecting sown pasture species, consider:

- Current or desired enterprise(s) for your property
- Desired stocking rate/carrying capacity in relation to pasture area available
- Potential risk for selective over-grazing
- Maintenance costs (particularly fertiliser inputs) for the pasture species and land type combinations
- Existing weed infestations will influence species selection and seeding rates
- Slope and topography limitations
- Fencing requirements, according to land type and grazing systems selected.

KEY TIP

Monitoring land and pasture condition, and balancing stocking rate to pasture available (forage budget), is a key component of any management and maintenance program.

The diversity and number of pasture-fed grazing systems selected for a property development program will be influenced by the number of different land types, the nature of the cattle enterprise (breeding or finishing) and the grazing system used (rotational or continuous grazing).

Pasture-fed grazing systems:

1. Native grass pasture systems

In the MW region remnants of native spear grass dominant pastures tend

to be isolated to the relatively small, less-accessible and/or timbered terrain of the eucalypt land types east of the Clarke/Connors range; small areas of undeveloped coastal tea tree plains and salt and water couch on marine plain and tidal flats (refer Chapter 4 and Appendix 1).

These native pastures, when present, can play an integral role in the overall management of the property;

- Inputs are minimal and they have low maintenance requirements
- They maintain ecosystem diversity and provide a natural habitat for native fauna and flora
- The timbered eucalypt range and undeveloped tea tree areas provide important refuge zones for livestock during inclement weather (summer cyclones and winter frosts).

KEY TIP

Remnant native pastures in the MW region tend to be isolated to small areas of hilly eucalypt country with fragile soil types, low in fertility and requiring careful management

Native grass pasture systems in the MW region are not able to sustain heavy grazing pressure. Stocking rates should be light enough to maintain sufficient pasture ground cover to help prevent weed incursions and soil erosion. Unpalatable weedy grasses such as rats tail, thatch and grader grass, and unpalatable broad-leaf species such as lantana, sicklepod and flannel weed, can quickly dominate overgrazed pastures. Strategic burning and wet season spelling in eucalypt land types can help manage woody regrowth and maintain native pasture seed-banks.

2. Native grass/legume pasture systems

The quality (protein in particular) of native grasses falls quickly following flowering and seed set. Forage quality can be improved by over-sowing with adapted legumes. Over-sowing a native pasture with a perennial legume can lift animal live weight gains (LWG) by 20 to 50 kg/hd/yr. While introducing a legume improves animal production, it does not increase carrying capacity, so stocking rates should not be increased.

As most remnant native pastures in the MW region are confined to hilly or timbered terrain with inherent low fertility, the stylos are the best adapted legume (see Eucalypt hills and ranges land type p.22). Wynn cassis is another option but can become unpalatable on low fertility soils (see Chapter 5). Villose jointvetch is another option in wetter range areas. Although stylos can survive and grow in soils with low phosphorus (P), from as little as 5 ppm, a minimum soil P level of 10 ppm is recommended to maintain cattle growth and stylo populations.

Where mechanical soil disturbance is impractical, heavy grazing or strategic burning prior to distributing stylo seed can reduce grass competition. With this establishment method it may take a number of years to achieve the desired 60:40 grass to legume ratio.

Legumes can dominate native pastures that are heavily grazed over summer (green grass is more palatable than legumes and is preferentially grazed

during the growing season). Native pastures need to be spelled for 6 to 8 weeks over summer to replenish their stored root reserves and encourage seed set.

A fire (post early storms) every 2 to 4 years will encourage regeneration of black spear grass and will reduce woody weed thickening. It will also maintain the grass-legume balance.

KEY TIP

The aim of over-sowing native pastures with stylo legumes is to improve animal performance, NOT to increase carrying capacity and stocking rate.

3. Sown pasture systems

Sown grass and grass plus legume systems are the most widely used grazing options for the MW grazing sector and play a critical role in economic and environmental sustainability of the local grazing industry (refer Appendix 3).

Positive features of sown pasture systems (compared to native pasture systems) include:

- Increased yield and diet quality (protein), longer growing period, higher cattle live weight gain
- A wide choice of improved grasses adapted to a wide range of soil types and climatic conditions
- Sown grass pastures in good condition are competitive against weeds, minimise erosion, and reduce run-off water, thus reducing soil and nutrient losses.

The limitations of sown pasture systems include:

- Establishment and maintenance costs
- Risk of failed establishment
- Potential environmental-weed risk of introduced species
- Pasture rundown (soil nutrient decline or nutrient tie-up, see Chapter 7).

KEY TIP

Most improved grasses were collected from locations with inherent moderate to high fertility. Their persistence and productivity is reliant on maintaining adequate soil fertility.

Matching improved grass species to land type/soil type and grazing systems to be used is the key to realising the pasture-fed grazing system's full potential. A thorough understanding of a species' attributes and management requirements will assist in making appropriate species selections, as in Table 6.

Table 6. Attributes of commonly grown improved grasses in the MW region (also see Chapter 5).

Grass species attributes	**Rhodes grass** *Chloris gayana*	**Signal grass** *Brachiaria decumbens*	**Pangola grass** *Digitaria eriantha*	**Tully grass** *Brachiaria humidicola*	**Creeping blue grass** *Bothriocloa insculpta*
Protection against weeds	Low-Medium	High	High	Very high	Medium
Palatability	High	Medium, improves with fertility	Very high	Low, but improves with fertility	Medium-high
Soil type requirements	Versatile, requires good drainage	Versatile, requires good drainage	Very versatile	Versatile, more palatable if fertile	Versatile, including well drained clays
Sward establishment	Very quick	Medium	Slow *	Very slow *	Slow-medium
Water logging tolerance	Low-medium	Low-medium	High	Very high	Medium
Cool season tolerance	High	Medium	Low	Low	Medium
Grazing tolerance	Low, requires regular spelling	High	High	Very high	Medium
Compatibility with legumes	High	Low	Low	Very Low	Medium
Shade tolerance	Low	High	Low	High	Low
Suitability hay production	Medium	Low	Very-high	Low	High
Response to fertility	High	High	High	High	Medium-high
Suitability for horses	High if regular spelling	Very Low palatability	Good, some risk of 'Big-Head'	moderate	High
limitations	Ability to compete with weeds	Low palatability with decreasing fertility	Stunt virus and Rust susceptible vegetative planting	Slow establishment, low relative palatability	Slow establishment
Niche zones	Cold and salt tolerant, sown with slow establishing spp	High nitrogen systems, weed management	Versatile soil and hay options, weed management	High nitrogen systems, weedy and water logged situations	Horse paddocks and hay options

* Add Rhodes grass seed to mixture when planting, for quick ground cover and early grazing

4. Sown grass/legume pasture systems

The inclusion of legumes in sown pasture systems will deliver a number of significant benefits:

- Legumes 'fix' atmospheric nitrogen which increases the protein content of legume plants. This nitrogen subsequently becomes available for uptake by companion grasses thus increasing pasture yield and quality (refer Chapter 6)
- Increased pasture quality and yield, improves animal weight gain
- The deep tap roots of legumes are extremely efficient at extracting soil moisture and nutrients which enables most legumes to grow longer into the dry season
- Productive legumes can lift available soil nitrogen levels and help reduce pasture rundown.

KEY TIP

The persistence of improved grass species in a pasture is largely determined by the availability of nitrogen and phosphorus in the grazing system.

The benefits of an improved grass/legume pasture are well recognised; however their more difficult management requirements are often seen as a limitation. Special management considerations for grass-legume pastures:

- Selective overgrazing of grass in the wet season can weaken the grass component. Selective grazing of the legume late in the season when they are setting seed can increase the spread of legume. This can eventually lead to legume dominance, especially in stylo (or Wynn cassia) native grass pastures. At other times the grass component can out-compete and dominate the legumes, particularly for improved sown grass systems.
- Tussock grasses that are compatible with legumes (due to an open sward structure) are more susceptible to weed invasion than competitive stoloniferous grasses that form a dense sward.
- Molybdenum needs to be applied every 3 to 4 years to maintain nitrogen fixation in legumes
- The application of extra nitrogen fertiliser to grass/legumes pastures to increase dry matter yield or extend grass growth further into the winter will also put extra competition on the legume component.

KEY TIP

Grass/legume pasture systems require careful grazing and fertiliser management to maintain legume persistence and the optimum 60:40 grass to legume balance.

Legume selection

Graziers have access to a wide range of legumes adapted to a variety of soils (see Chapter 5)

The most commonly planted pasture legumes in the MW region:

- **Stylo legumes,** a diverse range of varieties/cultivars for different land types, soils and situations:
  - **Caribbean stylo** (Verano and

Amiga), Caatinga stylo (Unica and Primar). Short-lived perennial/annual varieties (depending on conditions), fine, branched, medium height. Adapted to low fertility environments but require moderate levels of phosphorus (10 ppm) to achieve a reasonable level of production and persistence.

- **Commom stylo** (Nina and Temprano). Short lived perennials, coarse, branching stems to more than one metre tall are recent varieties with good anthracnose disease resistance. They are a high yielding legume hay crop for the tropics or as a pioneer pasture legume. The new varieties (currently marketed as 'Stylhay') require moderately well drained soils and have the ability to produce high dry matter yields. Previous varieties Graham, Cook and Schofield are susceptible to anthracnose disease and seed is no longer available.
- **Shrubby stylo** (Seca and Siran). Strong and hardy, erect/branching, drought tolerant perennials. They require careful grazing management and monitoring to prevent stylo dominance in native grass pasture situations. Fire, followed by strategic wet season spelling can stimulate grass re-establishment in Seca dominant pastures.

Jointvetch legumes, require higher rainfall and soil fertility than stylos but fix more nitrogen and provide better quality forage:

- **American jointvetch**, (the annual Glenn and short-lived perennial Lee) are palatable legumes well adapted to low-lying situations and tolerant of waterlogging. (Glenn can become 'weedy' in ungrazed waterways)
- **Villose Jointvetch** (Reid and Kretschmer) are short-lived (2 to 4 years) perennial, palatable legumes tolerant of heavy grazing, adapted to low lying areas and moderately tolerant of waterlogging, marketed as Villomix.

Trailing /climbing legumes (Cardillo centro, Aztec-atro (siratro), Glycine) are generally suited to the more fertile areas of the MW region. These legumes are very palatable and careful grazing management, monitoring and maintenance of soil fertility is required to achieve long-term persistence. These legumes are capable of climbing fences and trees and can become nuisance plants in the absence of grazing.

Molybdenum (Mo) is a very important soil trace element to ensure vigorous legume growth via effective root nodulation and nitrogen fixation. Healthy root nodules should be pink in colour; pale green nodules indicate ineffective nitrogen fixation which may indicate molybdenum deficiency. The twining legumes (centro and glycine) have a higher requirement for Mo then do the stylo legumes that have a lower demand for both macro and micro nutrients. Siratro and

the jointvetch legumes are probably intermediate for Mo requirements. (more information in Chapter 7).

KEY TIP

Legumes and grasses in a mixed sward are selectively grazed at different periods in a season; this phenomenon must be considered in the overall management of grass/legume pastures.

5. High nitrogen input grass pastures

In the higher rainfall areas of the MW region, and on fertile land types, high levels of animal production have been achieved by applying 100 to 200 kg/ha Nitrogen (N), or 220 to 440 kg/ha of urea, to sown grass pastures. This system is becoming more commonplace with the 'conversion' of smaller sugarcane farms to intensive livestock enterprises.

Beneficial outcomes with the adoption of high input pasture systems:

- Weed competition is not normally a problem in high N pastures because of the strong competition provided by the vigorous grass sward
- Stocking rates of 2.5 adult equivalents (AEs) per hectare/year are achievable with a normal wet season (see Chapter 8)
- Cattle can fulfil their full genetic potential to meet the specifications for high value markets
- The need for supplementary feeding is reduced or negated due to the high yield and quality of forage produced
- Flexibility in livestock purchases and marketing as other producers are (more often) forced to sell in dry conditions
- Hay production can be a viable option
- Flexibility in managing other grazing systems operating on the property.

KEY TIP

A competitive vigorous grass pasture is the most effective deterrent to weed infestations.

There are a number of critical management requirements associated with a successful high N grazing enterprise:

- The response of the grass sward to high N inputs is reliant on all other essential soil nutrients (phosphorous, potassium calcium and sulphur) being present. As the duration and level of production increases, trace element deficiencies (particularly copper and selenium) may start to limit animal LWG and general health (consult a nutrition specialist or veterinary officer). An annual soil and plant analysis is recommended to monitor soil and plant macro and micro nutrients.
- Timing of N application is important in the MW region. Nitrogen should be applied towards the end of the wet season (April/May) to minimise leaching and to allow the grass to 'bulk up' prior to the onset of cooler temperatures in autumn/winter that slow grass growth.
- In fattening and breeding enterprises cattle with high genetic potential

should be selected to realise the full potential of forage system and offset the high input costs.

- The high N pasture system should be associated with the most fertile land type/soil types with greatest water holding capacity and using the most responsive grasses (refer to Chapter 5).

6. Alternate-use or Special-purpose pastures (refer Chapter 8 for more detail)

Many of our introduced sown pasture species are very versatile in adapting to a wide range of conditions, situations and uses. Examples include:

- **High nitrogen input grass pasture systems.**
- **Hay production**, either dedicated hay enterprises or opportunistic grazing enterprises making grass hay by spelling paddocks in late summer and baling for hay in Autumn. Hay making removes high levels of N, K and P from the soil and these nutrients need to be reapplied as fertiliser to maintain hay yields.
- **Supplementary irrigation**, particularly on high nitrogen input and pasture hay systems.
- **Browse shrub** (Leucaena) **plus grass.** This pasture system is currently very productive and persistent on fertile clay soils west of the coastal ranges but current leucaena varieties are not well adapted to coastal wet tropics (acid, shallow, lower fertility soils and psyllid sap-sucking insect).
- **Horse pastures.** Many tropical pasture grasses contain high levels of oxalates which can cause 'big head' disease in horses. Rhodes grass, Bisset creeping bluegrass, Floren bluegrass and Indian 'couch' bluegrasses have low oxalate content and are readily grazed by horses. Signal grass has high oxalate levels but most horses don't eat signal grass.
- **Short-term pasture leys** (1 to 2 years) are increasingly being used as fallow and disease break-crops in sugarcane.
- **Ground cover and amenity pastures** for orchards, agro-forestry wood lots, horticultural crops, playing fields, parks and house yards.
- **Pasture species tolerant to**; salinity and soda patches, waterlogging and flooding, cold and frost. shade, heavy grazing (weaner and holding paddocks), strong vigorous grasses for weed management.

4 Mackay Whitsunday land types

Land type is a term used to describe units of land with close-to-similar capability to grow pastures or crops. A land type is a composite of and described by, its vegetation, soils, topography and location in the landscape. For the purposes of this publication, the 95 regional ecosystems that exist in the Mackay Whitsunday region (Environmental Protection Agency 2004a) have been grouped into nine broad land types based on their capability to grow pasture for grazing, for ease of recognition and management by the region's grazing sector. As landholders/managers progress their property land management plans they may wish to, or need to, split their land types into smaller units based on soil type, to refine and improve their pasture management inputs (including fertiliser) and to better achieve planned production outcomes.

Alluvial flats and plains

A well grassed small alluvial flat adjacent to a well vegetated stream

Description: Alluvial flats and levees associated with small to large creeks and streams that are frequently flooded.

Vegetation: Some of these areas would have originally been rainforest vegetation with blue gum and Moreton Bay ash. Disturbed areas tend to have regrowth of eucalypts. Originally black spear grass and blady grass native pasture communities where tree vegetation was more open.

Suitable sown pastures: Callide rhodes grass, signal grass, bisset creeping blue grass, pangola grass, Tully grass with stylo and jointvetch legumes. Angleton grass has naturalised many lower clay soil flats and gully areas.

Introduced weeds: Weedy sporobolus grasses, including Giant rats tail (potential), sicklepod, general broad leaf weeds, lantana, grader and thatch grasses.

Soil: Deep with a sandy loam to light clay topsoil over a grey to brown sandy loam to clay subsoil. The soil types include Rudosols and Dermosols. They have moderate to high fertility and water holding capacity with rooting depth of one metre.

Land use and management recommendations: The areas not used for cane growing are very suitable for pasture improvement. Best to fence separate from less fertile land types to avoid over grazing. Retain trees on bed and bank of streams and maintain good pasture cover to avoid erosion during flooding. Where possible use controlled grazing on in-stream riparian areas and install off-stream watering points for cattle grazing on associated flats and plains.

Land use limitations: Flooding and water logging on clay soils with restricted access in wet conditions.

Recommended conservation management: Large gum trees provide important habitat for a range of wildlife, including arboreal marsupials (gliders), boobook and barn owls, white-bellied sea eagles, kites and various other birds. These gums are important food trees for koalas and greater gliders in the region. Blue gum trees flower regularly and reliably, providing a major blossom and nectar source for sugar gliders, nectareous birds and bees. This riparian vegetation is an important corridor for migrating wildlife, often forming the only connecting corridor in the landscape. Manage grazing and fire use to preserve tree vegetation and to encourage some regeneration of blue gum where over-thinning has occurred. Blue gum forests also require periodic flooding to exist (about once every 5 to 20 years).

Coastal eucalypt forest and woodlands

Description: Gravely and low fertility soil on undulating and low hill slopes that support eucalypt woodlands.

Vegetation: Narrow leaf ironbark, grey ironbark, cabbage gum, pink bloodwood, Moreton Bay ash, poplar gum, occasional blue gum and patches of broad leaved tea tree, originally supporting black spear grass and blady grass native pasture communities.

Suitable sown pastures: Rhodes grass, green panic, signal grass, Tully grass, Bisset creeping bluegrass, Indian bluegrass, Floren bluegrass / angleton grass with stylo, jointvetch, Wynn cassia legumes.

Introduced weeds: Introduced weedy Sporobolus grasses (including Giant rats tail), lantana, general broad leaf weeds, including devil's fig, sicklepod, sida and flannel weed, urena/pink burr, noogoora burr, snake weed, grader grass and thatch grass.

Soil: Shallow to moderately deep sand to loam to gravely soil of mostly acid and intermediate volcanic rock origin. Texture contrast soils have grey to brown clay sub-soil. The dominant soil types are Chromosol, Sodosol and Rudosol of low to moderate water holding capacity and fertility and 30 to 60 cm rooting depth.

Enterprise: Breeding/growing, fattening possible in limited areas with high fertiliser inputs.

Land use and management recommendations: Moderate to high fertiliser inputs to maintain high productive sown pastures. Woody regrowth control could be required in previously cleared areas. Where stylo and Wynn cassia legumes sown, careful grazing management required to prevent legume dominance.

Land use limitations: Low soil phosphorous and potential woody weed regrowth following disturbance of eucalypt vegetation.

Recommended conservation management: Habitat is important for significant fauna, including northern quoll, grey goshawk, squirrel gliders, red-tail black cockatoo, orange-footed scrub fowl. Appropriate fire regime to maintain vegetation community and structure.

This site north east of Proserpine was used for field activities at a MWNRMG/ DPI&F Stocktake workshop; lower slope has been developed to Kazungula setaria sown pasture.

Coastal rainforests

Description: Upper slopes and drainage lines of low coastal hills with elevation less than 500 m, may have remnant or regenerating rainforest vegetation.

Vegetation: Vine forest vegetation including White, Mackay and peach cedar, bumpy/silver ash, red kamala, forest sirus, etc; blue gum, swamp mahogany, Moreton Bay ash on fringes; originally pastures sparse or absent native pasture community. Much of this land type is now developed to sugar cane or sown pastures for grazing, depending on slope.

Suitable sown pastures: Rhodes, signal, Bisset, Tully and pangola grasses, jointvetch and centro legumes. Cleared areas not purposefully planted to sown pastures, or following pasture rundown, are now colonised by guinea grass.

Introduced weeds: Susceptible to general broad leaf and grass weeds, depending on pasture and grazing management.

Soil: Shallow to moderately deep, gradational to texture contrast soils less than 0.6 m deep. Soil types include Brown Dermosol and Chromosols. A common soil description could be 20 to 30 cm clay loam to light clay topsoil with brown to reddish clay subsoil; moderate to high water availability (55 to 70 mm) with rooting depth 55 cm; soil fertility moderate to high.

Enterprise: Fattening/finishing.

Management recommendations: Areas not used for cane growing, not growing remnant rainforest or not greater than 20 percent slope are very suitable for pasture improvement. Retain trees on bed and bank of streams, and slopes greater than 20 percent. Selective logging of timber trees is possible if undertaken in accordance with the 2006 Code applying to a Native Forest Practice on Freehold Land; best fenced separate from less fertile land types to avoid over grazing; maintain good pasture cover to avoid gully erosion during high rainfall periods; use off-stream watering points for cattle grazing where possible.

Land use limitations: Vegetation status should be checked before any new development. Soils can be susceptible to erosion so be mindful of slope limitations (less than 20 percent).

Recommended conservation management: Existing rainforest vegetation has high conservation value as habitat for threatened flora and fauna species include rufous owl, Proserpine rock wallaby, burrowing skink and endemic ground-dwelling lizards. Remnant areas should be fenced for controlled grazing and fire management to protect remnant edges.

Sown pastures in Seaforth area on coastal rainforest land type, with high range in background.

Coastal tea tree plains

Description: Very low fertility, flat to undulating land with a sandy to sandy-loam surface that supports predominantly tea tree with scattered eucalypts and cabbage palm.

Vegetation: Broadleaved tea tree, pink bloodwood, narrow leaved ironbark, cabbage palm, occasionally grass tree and small areas of bull oak and grevillea. Originally black spear grass native pasture community, smaller areas of blady grass and low density of native legumes.

Suitable sown pastures: Pangola grass, Tully grass, signal grass, Rhodes grass, setaria, with legumes jointvetch, stylo and centro.

Introduced weeds: Introduced weedy sporobolus grasses, (including Giant rats tail), broad leaf weeds including devil's fig, sida and flannel weed, urena/pink and noogoora burr, snake weed, grader and thatch grasses.

Soil: Shallow to deep sandy loam topsoil over a grey to yellow clay. The dominant soil types are Sodosols, with hard setting sandy to loam topsoil over sodic clay subsoil. Low to very low fertility, water availability with rooting depth 20 to 60 cm.

Breeder cattle resting in Callide Rhodes grass sown pasture.

Enterprise: Breeding and growing; finishing only possible with high fertiliser inputs.

Land use and management recommendations: Tea tree sucker regrowth can be a serious problem. With new country or clearing regrowth leave clumps or strips and blade-plough, disk plough (6 to 8" deep) on deeper soils or Grasslan pellets on shallow soils to prevent tea tree regrowth on the areas to be pastured. Tully and pangola grass recommended for low areas subject to flooding.

Land use limitations: High input costs for sown pastures, tea tree regrowth problems, summer flooding and water logging can affect pasture growth and cause problems for animal and vehicle movement. Soil compaction and 'debil debil' formation (surface roughness) necessitates more frequent renovation (tillage). This country is very susceptible to erosion (gully, stream and creek frontages) despite the lack of elevation and slope.

Recommended conservation management: This land type has a conservation status 'of concern' and a biodiversity status of 'endangered'. It is known habitat for grey goshawk, eastern small-eyed snake, the bar-breasted honey-eater and squirrel gliders, orange-footed scrub fowl and red-tail black cockatoos. Fencing off undeveloped frontage areas to manage grazing during the wet season will reduce erosion and disturbance.

Permanent and semi-permanent wetlands are fish breeding habitats and attract much bird life; they therefore require managed grazing.

Coastal wetlands

Description: Frequently flooded and waterlogged plains which include swamps.

Vegetation: Mixed melaleuca/ tea tree, occasional blue gum, leichhart tree, pandanus and cabbage palm with understorey of blady grass, salt and fresh water couch, reeds, bulrushes and sedges.

Suitable sown pastures: Pangola grass, Tully grass, and jointvetch legumes. Areas of para grass, hymenachne and aleman have naturalised from past plantings.

Introduced weeds: Introduced weedy sporobolus grasses and common broadleaf weeds, environmental weeds hymenachne, para, aleman grasses.

Soil: Deep, clay to gradational soil. The main soil types include Vertosols, Dermosols and Hydrosols with sandy clay loam to medium clay surface over clay loam to heavy clay. Have moderate to high fertility and water holding capacity (70 to 80 mm) with up to one metre rooting depth.

Enterprise: Finishing.

Land use and management recommendations: Fence where possible to protect sensitive areas.

Land use limitations: Flooding. Hymenachne is now a Class 2 declared weed in Queensland and state government policy prevents its planting. Acid sulphate soils can be present and professional advice should be sought before excavating in these wetland areas.

Recommended conservation management: Habitat for migratory birds which are protected by international treaties. Important fisheries habitats should be kept free of declared and environmental weeds. Known habitat for threatened plant species black ironbox and fauna species rufous owl, grey goshawk, eastern small-eyed snake, azure kingfisher and the locally rare bar-breasted honey-eater and for barramundi fish. Fencing off sensitive areas (where possible) for controlled grazing during wet season will reduce disturbance and assist erosion control.

Mixed eucalypt vegetation on range country in Brightly area west of Eton.

Eucalypt hills and ranges

Description: Higher hills and ranges with moderate to steep slopes supporting eucalypt woodlands and forests.

Vegetation: Ironbark, Moreton Bay ash, pink bloodwood and scattered poplar gum, originally with black spear grass native pasture community understory.

Suitable sown pastures: Green panic, Bisset creeping grass, Indian bluegrass, on soils with sufficient depth, with legumes stylo and jointvetch. Wynn cassia, when surface sown into less accessible and steeper areas of native pasture, can dominate native grasses.

Introduced weeds: Introduced weedy Sporobolus grasses (including giant rats tail), lantana, snakeweed and other broad leaf weeds.

Soil: The mostly Chromosol, shallow to moderately deep soil has low fertility, firm to hard setting dark sandy loam to sandy clay loam topsoil with brown clay subsoil. Water availability is low to moderate, rooting depth 20-50 cm and some down-slope risk of salinity if over cleared.

Enterprise: Breeding.

Land use and management recommendations: Limited sown pasture development possible. Woody regrowth control may be required in earlier cleared areas. Where stylo and wynn cassia legumes have been sown, careful grazing management is required to prevent native grasses being grazed out resulting in legume dominance. Clearing is not recommended on slopes more than 20 percent.

Land use limitations: Shallow soils susceptible to erosion, low soil phosphorous, steep topography.

Recommended conservation management: Habitat for the threatened fauna species such as northern quoll, glossy black cockatoo and squirrel glider. Conservative grazing and fire regimes to allow thinning of community and recruitment of canopy species, where appropriate, to maintain eucalypt community. Protect living and dead trees with hollows.

Marine plains and tidal flats

Description: Flat land in and adjacent to mangrove and salt couch areas.

Vegetation: Mangrove associations, melaleuca tea tree and cabbage palms. Original native pasture community 'pastures sparse or absent'. Marine (saltwater) couch, fresh water couch, samphire and sedges.

Suitable sown pastures: Very limited options for sown pasture or introduced weeds; water grasses hymenachne and para grass have colonised some fresh water lagoon areas.

Soil: Very deep cracking and non-cracking clay. The dominant soil types include Hydrosols, Vertosols and Sodosols. Light clay topsoil over grey clay subsoil, moderate to high fertility, moderate to very high salinity, low water availability (50 to 65 mm), moderate rooting depth (45 cm) for adapted plants.

Enterprise: Growing cattle.

Land use and management recommendations: Opportunistic grazing in association with less sensitive land types (coastal tea tree and wetlands).

Land use limitations: These soils are frequently flooded and have waterlogged (poorly drained) subsoil. Low infiltration rates except when very dry. Acid sulphate soils underlay most of these areas. Professional advice should be sought prior to any excavation work in these areas.

Recommended conservation management: Mangroves are a protected plant species and provide valuable marine and fish habitat. Waterbirds are the most common fauna of marine plains and tidal flats because these areas provide abundant food for both local and migratory species. Control cattle grazing with strategic fencing to protect soft edges and allow wetland plants to complete seeding. Where grasses such as para grass and Hymenachne have established, use strategic grazing to ensure they do not spread and exclude native plants.

Periodically grazed marine plain and tidal flats east of Koumala

Poplar gum dominant eucalypt woodlands

Description: Flat to slightly undulating low hills which experiences occasional (one in every 10 to 50 years) flooding (or continually saturated soils for several weeks) and supports eucalypt woodlands dominated by poplar gums.

Vegetation: Poplar gum dominant, with swamp mahogany, pink bloodwood, grey iron bark, Moreton Bay ash, originally supporting black spear grass and blady grass native pasture communities. A lot of this land type has been developed to cane or sown pastures.

Suitable sown pastures: Rhodes grass, green panic, signal grass, Tully grass, Bisset creeping blue grass, Floren/ angleton grass, legumes stylo, jointvetch.

Introduced weeds: Introduced weedy sporobolus grasses (including giant rats tail), lantana, general broad leaf weeds, including devil's fig, sida and flannel weed, urena/pink and noogoora burr, snake weed, grader and thatch grasses.

Soil: Mostly Sodosols and Chromosols with moderate to deep soil of low to moderate fertility and water availability, and 30 to 60 cm rooting depth. Have hard setting sandy loam surface over grey to brown clay sub-soil.

Enterprise: Breeding and growing, fattening possible in limited areas with fertiliser inputs.

Land use and management recommendations: Moderate to high fertiliser inputs to maintain high productive sown pastures. Woody regrowth control could be required in areas previously cleared for pasture. Where stylo or wynn cassia is sown into native pasture use grazing management (spelling) or fire to prevent loss of native grasses and subsequent legume dominance.

Land use limitations: Low soil phosphorous, and moderate to poor drainage.

Recommended conservation values: Conservation rating 'of concern' and a biodiversity rating 'endangered'. A diverse vegetation unit which has been poorly surveyed for flora and fauna. Significant fauna species include the black-chinned honeyeater, squirrel glider and koala. Conservative grazing regime to allow recruitment of canopy species. Appropriate fire regime to maintain eucalypt community.

Poplar gum can occur on hills and flats; this is a poplar gum dominant flat north west of Kinchant dam.

Wet highland rainforests

Description: Rainforest on high hills and steep slopes of Clarke range with elevation more than 700 m.

Vegetation: Rainforest vegetation including red, white and Mackay cedar, hoop pine, red Eungella satinash, scrub cherry, black tulip oak, quandong spp; on fringes - flooded/rose/sugar gum. Originally native pastures sparse or absent, considerable areas developed for dairy farms, post 1940s. Narrow leaf mat grass has naturalised following fertility run down post clearing.

Suitable sown pastures: Rhodes grass, setaria grasses, kikuyu grass with clovers, creeping vigna and forage peanut legumes.

Introduced weeds: Introduced weedy sporobolus grasses (giant rats tail), lantana, susceptible to general broad leaf and grass weeds depending on pasture and grazing management.

Soils: Shallow to moderately deep (Dermosols, Ferrosols and Chromosols) with hard setting to firm surface texture, dark loam to clay topsoil over red or brown clay sub-soil. Moderate to high water availability, 0.5 to 1 m rooting depth, originally moderate fertility but quickly runs down in absence of fertiliser inputs once cleared.

Enterprise: Initially developed for dairy farms, currently breeding, and finishing with fertiliser inputs.

Management recommendations: Suitable for pasture improvement

Heavily grazed kikuyu grass pastures on Eungella tableland.

(depending on topography), retain trees on bed and bank of streams. Selective logging of timber trees is possible, if undertaken in accordance with the 2006 Code applying to a Native Forest Practice on Freehold Land. Maintain good pasture cover to avoid erosion during high rainfall periods and use off-stream watering points for cattle grazing where possible.

Land use limitations: For pasture development be mindful of slope limitations (less than 15 to 20 percent) and tree vegetation status should be checked before development. Fertility rundown is quick after cleared (5 years). Need to be vigilant with lantana control.

Recommended conservation management: Very high conservation values, where existing rainforest vegetation remains. Habitat for threatened fauna species including rufous owl, Eungella honeyeater, Proserpine rock wallaby, Eungella day frog and Eungella tinker frog, skink and endemic leaf-tail geckos. Protect remnant edges from encroachment via appropriate grazing and fire management.

5 Sown pasture species information

This chapter describes more than 20 sown grass species and more than 20 sown legume species that are adapted to various land, climate and management conditions throughout the region. Where available, photos are provided to assist with recognition and identification. Species are grouped into several categories to assist with deciding which is best adapted to your property conditions. Five grass species and seven legume species are grouped as widely planted / most used throughout the region. A large grouping of 'alternative species or species planted in the past' contains useful species options. Many of these 'alternative' species are suited to specific conditions and situations. Some are still growing in the region but seed is now difficult to obtain or not available. There is also a small grouping of 'possible problem / nuisance species' that all landholders should be aware of.

Sown grass species

Most planted grasses

Rhodes grass

Chloris gayana, cvv. **Callide** (1963), **Katambora** (1967), **Finecut** (1993), **Topcut** (1990s), **Nemkat** (1992), and **Pioneer** (1901).

Strengths

- Quick to establish and runners root-down at the nodes to form new plants
- All varieties very palatable pre-flowering, variety differences after flowering
- Very responsive to increased soil fertility
- Low oxalate levels in forage
- Good compatibility with legumes
- Good cold tolerance, good salt tolerance
- Hay options.

Limitations

- Poor tolerance of waterlogging
- No shade tolerance
- Allows weed invasion under continuous grazing
- Requires high fertility for production and persistence.

Rhodes grass is a tufted perennial grass (one to two metres tall) with stoloniferous runners that root-down at the nodes to quickly thicken the stand. Its seed germinates fast (1 to 7 days) and seedlings grow rapidly providing quick growth and ground cover. The Rhodes grass sward remains relatively open allowing good compatibility with companion legumes, but weeds can invade if continually grazed short. Young growth of all rhodes grass varieties is very palatable but varieties differ in palatability once they flower and seed. Callide is more palatable then the Katambora types. Because of its palatability Rhodes grass is best managed using a rotational, or periodic summer spelling system.

Rhodes grass grows best in fertile well drained loams to clays, excluding heavy cracking clays. It has high salt and cold tolerance and few pests and diseases. Rhodes grass seed (particularly Callide) is often sown with slower establishing grasses (Tully, Bisset creeping blue grass, signal grass) to provide quick ground cover and early grazing. It can be surface-sown and rolled-in following planting of pangola by runners. Rhodes grass is an ideal pasture for horses as it has low oxalate levels. It should be grazed carefully (regular spelling) to avoid weed invasion.

Rhodes grass responds well to phosphorus and nitrogen, where other nutrients are adequate, and is popular in intensive input irrigated pasture systems; an ideal crop where irrigation water may be saline.

Cultivars or varieties

Callide Rhodes is the best performer in the MW region and is the variety recommended for grazing. It is vigorous, late maturing and remains leafy and palatable well into autumn. It is a good opportunistic hay crop but can develop coarse stems, so cut and process pre or early flowering; or as wrapped silage.

Katambora is a mid-season flowering variety with finer leaves and less demanding of fertility than Callide. Commercial seed became quite variable (with plenty of off-types) during the 1980s and seed is now seldom available. **Nemkat** is a Katambora type selected for root-knot nematode resistance as leys for tobacco farms. **Topcut** (selected from Pioneer) and **Finecut** (selected from Katambora) are varieties initially selected for hay production in the Middle East. They have thinner leaf and finer stems than Callide and therefore dry and cure quicker when cut for hay. However they are not as vigorous and productive as Callide for grazing systems. **Pioneer** was a very early pioneer pasture grass that is now not available.

Signal grass

Brachiaria decumbens (syn. ***Urochloa decumbens***) cv. **Basilisk** (1966)

Strengths

- High production under high input, high fertility, intensive management systems
- Persists under low input, low fertility, heavy grazing systems
- Competes well with weeds
- Good seed quality and yield, plus good seed availability and price
- Has moderate shade tolerance.

Limitations

- Low tolerance of poor drainage and waterlogging
- Difficult to maintain legumes
- Has high oxalate levels but NOT eaten by most horses.

Signal grass forms a dense sward from short stolons that root at the nodes. However it doesn't spread by runners like Tully humidicola or pangola. It is tolerant of heavy grazing and resistant to weed invasion. It establishes faster than humidicola, but freshly harvested seed (of both signal and Tully) can remain dormant for up to six months and should be stored before planting.

Palatability of signal grass, as with humidicola, greatly depends on the fertility status of the soil, particularly phosphorus levels. Signal is more leafy (less stem growth) then humidicola and therefore usually has higher protein and digestibility, under low fertility situations. Signal grass is less palatable than pangola and the Rhodes grasses; for evenness of grazing it is recommended that each be fenced and grazed separately.

Signal grows on a wide range of soils from deep sands to well drained clays. It is tolerant of low fertility and acid soils. It can tolerate short term flooding but not waterlogging. It performs best with annual rainfall of 1000 mm and above. Signal grass has better cool season growth than Tully humidicola and stays green well into the dry season. It has moderate shade tolerance and will recover well from frost and accidental fire. Signal grass has few pests or diseases. It has caused photosensitization in young cattle, sheep and goats in South America and Papua New Guinea, but only isolated cases in Australia, on northern wet tropics.

Signal grass is very responsive to nitrogen and phosphorus fertiliser and is the preferred grass in the northern wet tropics for high input beef production systems using high rates of nitrogen. It has probably been the most planted grass in the region over the past decade.

Pangola grass

Digitaria eriantha subsp. ***pentzii*** cv. **Pangola,** (formally *D. decumbens*)

Pangola was released in Australia in 1962, following testing of vegetative material from Hawaii, and previously released in Florida, USA in 1943, following testing of vegetative material from South Africa.

Strengths

- Palatable, productive, persistent
- Tolerant of heavy grazing, waterlogging, drought and fire
- Spreads from stolons/runners and competes strongly with weeds
- Maintains good nutritive value even at maturity.

Limitations

- Vegetative planting only
- Recorded as having caused big head in horses
- Limited cool season growth
- Susceptible to pangola stunt virus and rust.

Pangola is a stoloniferous creeping grass widely planted throughout Queensland; well adapted to sands, loams and clays, low to high fertility, dry to wet and waterlogged sites and is tolerant of heavy grazing. It responds well to nitrogen, giving linear dry matter increases of up to 300 to 350 kg/ha N (when other nutrients and moisture are not limiting). Pangola has less cool season growth than Signal grass.

Pangola is regarded as one of the higher quality and digestible tropical grasses and retains reasonable palatability at mature growth stage. It is a popular grass hay, especially where irrigation is available for spring and early summer growth. Excess summer growth is often baled at the end of wet season, for yard feeding weaners during the weaning process.

The MW region is the major pangola grass pasture area in Queensland with an estimated 20,000 ha and some individual properties having up to 500 ha of pangola pastures. Originally pangola was widely grown in the northern wet tropics but its performance declined during the 1970s and 80s due to rust, aphids and Crabgrass leaf beetle larvae. Pangola was virtually replaced by signal grass and Tully humidicola, which are better adapted to wet tropics conditions.

Pangola grass flowers throughout the summer growing season but both male and female flowering parts are highly sterile and no viable seed is set. Pangola can only be established using vegetative material. Mature runners are spread onto a prepared seedbed, disced in and/or rolled. Over-sowing seed of a quick establishing grass (Callide

Rhodes grass) following planting and prior to rolling, will provide quick ground cover, stronger competition with weeds and early grazing, while pangola spreads to a complete sward.

The most serious threat to pangola grass, in the long term, is its susceptibility to pangola stunt virus. Over the past decade this virus has been identified in small areas of pangola pastures from Sarina to Proserpine. The virus is spread by a leaf hopper but spread occurs very slowly. Symptoms are stunting and slow growth, distorted seed heads, yellowing, and plants becoming more susceptible to leaf rust in the autumn to winter period. The most practical long-term management plan is to plant alternative grasses when developing new areas.

Although pangola grass contains low levels of total oxalates, relative to Kazungula setaria, there are recorded cases of big head in horses grazing pangola grass for extended periods. There are many examples of horses in the MW region that have spent their life grazing pangola pasture with no obvious symptoms, with no apparent access to other grass species or supplements. So although pangola does not appear to be a major hazard for MW horses, caution should be taken.

Tully humidicola

(Brachiaria humidicola (syn. ***Urochloa humidicola*****)** cv. **Tully** (1981)

Strengths

- Competes strongly with weeds
- Maintains good ground cover even with heavy grazing
- Tolerant of waterlogging
- High carrying capacity under high input, high fertility, intensive management systems
- Persists under low input, low fertility and heavy grazing systems
- Moderate shade tolerance.

Limitations

- Slow to establish
- Can become coarse and unpalatable in low fertility systems under light grazing
- Difficult to maintain companion legumes
- Low commercial seed yields result in higher seed prices.

Tully humidicola is a versatile, vigorous and dense mat-forming grass, tolerant of heavy grazing and resistant to weed invasion. It is commonly

known as humidicola or Tully grass and as koronivia grass throughout the Pacific. Sometimes referred to as creeping signal grass in the literature. Its main limitation as a pasture grass is its slow establishment phase, sometimes taking two to three years to form a complete ground cover. This problem can be overcome by adding quick establishing rhodes grass seed in the planting mixture (to provide quick ground cover and early grazing) and humidicola will subsequently dominate.

Humidicola is a stoloniferous perennial grass that spreads by runners and roots strongly at the nodes. Once complete ground cover is achieved, humidicola competes very strongly with weeds but also with companion legumes. Villose jointvetch and pinto forage peanut are legumes which can grow with humidicola, at least until it forms a dense sward.

Humidicola grows on a wide range of soils from deep sands to heavy clays. It is very tolerant of poor drainage, waterlogging and flooding and can survive prolonged dry periods. It grows best in annual rainfall of 1000 mm and above, has less cool season growth than signal grass and has moderate shade tolerance. It will recover well from frost and accidental fire.

It tolerates low fertility but in such a system, feed quality, palatability and digestibility is also low. Humidicola can be managed in both low or high input production systems, depending on the market product or outcomes required. Palatability, quality and digestibility can decline if the grass is not grazed over summer and becomes mature. Better production occurs when grazed moderately heavily during rapid summer growth periods and more leaf is produced. Tully humidicola pasture can be used for summer spelling of 'softer' grasses (Rhodes, Jarra and Strickland grasses) and is ideal for laneways, weaner and holding paddocks.

Humidicola is also ideal for small sized properties or hobby-farms that want to carry some cattle and horses. It is also ideal for regeneration of paddocks taken over by serious weeds such as GRT and other weedy sporobolus grasses or sicklepod, etc. Renovate/plough and over-sow mixture of Tully and Rhodes grass. Once a dense sward of Tully is formed it will limit weed seedling establishment from seed in the soil.

Most horses seem to graze humidicola, although some people say otherwise, particularly when it is mature. The International fact sheet on *Brachiaria humidicola* (www.tropicalforages.info) states the grass has low calcium content and that high oxalate levels may induce big head in horses. It recommends feeding horses a calcium supplement (if humidicola makes up the majority of a horse's diet).

Potential commercial seed yields in tropical Australia are reasonable (200 to 400 kg per hectare) but has high risk of crop loss which keeps seed price well above most other seed. Fresh seed may be dormant and should be stored for at least six months at low temperatures and low humidity. Seed can rapidly decline in quality if stored inappropriately, such as hot and humid conditions.

Creeping blue grass

(Bothriocloa insculpta cvv. Bisset (1989), Hatch (1978), Cedo (2004)

Strengths

- Grows on heavy clays as well as less fertile forest soils
- Tolerant of moderate to heavy grazing and dry periods
- Bisset cultivar spreads forming dense sward from runners
- Very tolerant of fire
- Palatable, particularly Bisset, with low oxalate levels.

Limitations

- Can be slow to establish and slow regrowth after winter season
- Fluffy seed can be difficult to spread, if not appropriately processed
- Not shade tolerant.

Creeping blue grass is a versatile perennial pasture grass, spread from runners. The Bisset variety roots at stem nodes to form new plants and a dense sward. Creeping blue grass prefers neutral to alkaline, moderate fertility soils including sandy loams to heavy clays. It is best adapted to areas receiving 700 to 1000 mm (28 to 40 inches) rainfall but also in areas receiving up to 1500 mm (60 inches) on well drained soils. Creeping blue grass is mainly sown for grazing but also makes good hay if cut when stems are still leafy and succulent. It is a low oxalate grass and suitable for horses.

The fluffy seed can be difficult to sow unless pelleted or mixed with a 'carrier'. Seeding rates of one to three kg per hectare grass seed mixed with two to three kg per hectare of legume seed should be adequate. Mixing 0.5 to 1 kg per hectare of Callide rhodes grass with the seed mixture will provide quicker ground cover to suppress weeds and provide earlier forage for grazing.

Although adapted to low fertility soils, creeping blue grass will respond well to added nitrogen, when other soil nutrients are in adequate supply. Bisset has also been used in irrigated hay production systems. The quality/nutritive value of forage declines with maturity and particularly after seed set. Seed yields of around 100 to 150 kg per hectare can be expected but this varies greatly depending on soil nitrogen levels. The timing of harvest is critical as the seed dislodges readily when ripe. Freshly harvested seed has high a level of dormancy which breaks down over four to nine months of storage.

Cultivars

Bisset is the variety planted in the MW region and has finer, better developed runners/stolons and rooting at the nodes than Hatch. Bisset is barely affected by leaf rust, is palatable, and flowers in early May, several weeks later than Hatch. **Hatch** is an earlier, less palatable variety, less runners/stolons and fewer tendencies to root down. **Cedo** is a recent variety not yet grown in this region.

Alternative grasses or grasses planted in past

Floren blue grass / Angleton grass

Dichanthium aristatum cv Floren (1995), Bloomsbury strain angleton grass (1960s)

Strengths

- Palatable, withstands heavy grazing, is competitive with broadleaf weeds
- Tolerant of flooding and moderate waterlogging, fire, moderate shade and salinity
- Low oxalate, safe for horses.

Limitations

- Slow spring growth and lower total production than pangola or signal grass
- Not well adapted to acid soils, best on alkaline or neutral soils
- Commercial seed cost remains high, relative to most other grass options.

Floren blue grass is a perennial tufted grass with clumps that expand by rooting at lower stem nodes in contact with moist soil. Floren is weakly stoloniferous, thus forming a close competitive sward over time in higher rainfall situations. It is native to India but a number of different eco-types are now naturalised throughout northern Australia. Floren is best suited to alkaline to neutral clay soils. It has a low phosphorous requirement, but responds to added phosphorus and particularly to nitrogen. It has good flood tolerance and some salt tolerance. Floren has been widely sown throughout the drier clay soil regions of central Queensland (700 to 1000 mm AAR rainfall). It grows well on lighter soils in higher rainfall areas but there is currently little information available on its performance in the MW region. It is readily eaten by cattle and horses.

Jarra and Strickland digit (or finger) grass

Digitaria millianjiana cvv. Jarra (1991), Strickland (1995), Arnham, NT (1996)

Strengths

- Very palatable
- Stoloniferous pangola-type grass with commercially available seed
- Quick establishment.

Limitations

- Intolerant of heavy grazing and of poor drainage
- Susceptible to weed invasion (very palatable and less stoloniferous)
- Check commercial seed label to avoid contamination by annual Digitaria summer-grasses.

These digit grasses are more palatable than pangola but less stoloniferous (fewer runners) and intolerant of waterlogging. Jarra and Strickland do not tolerate heavy continuous grazing. They grow best on well drained fertile soils and make good grass hay. Because of the high palatability of digit grasses, they require wet season spelling, or some form of rotational grazing to improve persistence and weed control.

Cultivars

Jarra has wide leaves and grows more erect and taller than pangola, from one and a half to two metres when in flower (with typical digit seed-head). Jarra was first released in the northern wet tropics as a rotational pasture ley-crop on banana farms, to break the burrowing- nematode cycle. It is also used on the Mareeba Irrigation Area as a grass hay break-crop, to utilise accumulated soil nitrogen following stylo and other legume seed crops. **Strickland** has narrower leaves and is closer in appearance to pangola. It was selected for grazing (and hay) under more subtropical conditions and is slightly more tolerant of waterlogging and cool conditions. It is very palatable and requires careful grazing management. **Arnhem** was released in the Northern Territory in 1996. There is limited experience of its performance in Queensland. It has a tussock growth habit with no stolons and is quite tolerant of waterlogging. It is less palatable than pangola and can tolerate heavy grazing.

African star grass

Cynodon nlemfluensis

Strengths

- Rapid establishment from vegetative plantings and tolerates heavy grazing
- LWG per animal and per hectare similar to pangola but requires more management
- Low oxalate levels
- Makes good hay.

Limitations

- No seed available and may be difficult to find source of runners for planting
- Forage quality drops rapidly after five weeks of regrowth
- Less palatable than pangola.

African star grass is a robust perennial grass that spreads by stolons (runners) that root-down strongly. Grows best in sandy to heavy clay soils with 600 to 2000+mm rainfall. Was mainly used on dairy farms or for stabilising water-ways, banks or erosion prone slopes, due to its quick spread by stolons. Generally palatable but less palatable then pangola grass which it can invade under heavy grazing. Tends to require higher fertility than pangola grass.

Indian bluegrass or Indian pertusa 'couch'

Late flowering variety

Bothriochloa pertusa cvv. **Keppel** (1987), **Dawson** (1991), **Medway** (1991), **Bowen strain** or ecotype; also but less common Emerald and Capella strains or ecotypes.

Strengths

- Relatively palatable and very tolerant of heavy grazing
- Grows in infertile soils and provides effective ground cover for these soils.

Limitations

- Generally not as productive a pasture for high rainfall coastal areas, relative to other sown pasture alternatives such as pangola, signal, Tully, Bisset, Rhodes.

Indian bluegrasses are strongly stoloniferous, perennial and are colonised/naturalised throughout large areas of north Queensland (Bowen, Dalrymple and Nebo Shires). The Bowen strain predominates and can flower within one month of rain. Their spread and distribution is strongly influenced by grazing management and droughts. Continual heavy grazing or frequent mowing favours its spread. It is adapted to a wide range of soils including heavy clays; is tolerant of low fertility; seeds early and continuously, while moisture is available; and is less palatable then most native grasses. Cattle prefer to graze black spear grass over the summer wet season which has allowed the Indian bluegrass runners to spread and invade. However the Indian bluegrass has at least provided ground cover and stabilising of the soil surface against soil erosion.

Cultivars

Keppel is the most suitable grazing variety for the MW region and is an alternative grass for sowing when improving production in eucalypt woodland country (undulating hills and range areas). It is a late flowering type with vigorous fine leafy runners and stems and is an alternative to Bisset creeping bluegrass. **Dawson** is mainly sold as an amenity/turf grass for sports and playing fields as it is a late flowering and shorter growing type than Keppel and Medway.

Setaria

Setaria sphacelata var. anceps cvv. **Kazungula** (1962), **Nandi** (1963), **Narok** (1969), **Solander** (1985). ***S. sphacelata*** var. ***splendida*** cv. **Splenda** (1981).

Strengths (**Kazungula** variety)

- Tolerant of flooding and waterlogging
- Tolerant of low fertility, acid soils
- Reliable establishment
- Good cold tolerance (relevant to most other tropical grasses)
- Palatable.

Limitations

- Heavy early flowering/seeding reduces feed quality
- Kazungula variety tends to develop thick stems, requires regular summer grazing
- Very high oxalate levels.

Setaria is an erect, tufted, thick stemmed grass of African origin with a spike-like seed head and grows up to two metres tall. It is the most cold tolerant of tropical grasses and has moderate shade tolerance. It also has the highest oxalate levels of all tropical grasses. Horses should not graze setaria exclusively for more than one month at a time, in the absence of calcium and phosphorus supplements.

Cultivars

Kazungula setaria is the variety best adapted to the MW region and during the 1960s to 1980s it made up approximately 75 percent of sown pastures planted in the region. Kazangula features include reliability of establishment, adaptation to low and high fertility, adaptation to waterlogging, competitiveness with weeds, and persistence of stand. Some original Kazangula pastures are still productive today, 35 years on. It is palatable to stock with good weight gains. It quickly runs to seed with summer rain and blows over in the wind and new stems quickly grow up and run to seed again. A dense tangle of stems of low quality litter can build up in the absence of summer slashing or grazing. However the build up of litter tends to hold soil moisture and ensures continuing green leaf into the winter. Very little Kazungula, or other setaria grasses have been sown in the past decade, probably because other current grass options are seen as easier to manage.

Nandi is less vigorous than Kazungula, more compatable with legumes and the variety most sown in south east coastal areas, mainly on dairy farms with higher fertiliser use. **Narok** is a more cold tolerant variety with higher winter production. **Solander** is a hybrid setaria from more frost resistant accessions with better seed production than Narok. Both Norok and Solander are used on Atherton Tablelands as dairy pastures where higher fertiliser use is economical. **Splenda** is a hybrid created by crossing variety splendida with variety sericea to improve seed production and adaptation to hot and humid coastal environments.

Guinea grasses

Megathyrsus maximus (Syn. *Panicum maximum*) cvv. **Hamil** (1956), **Gatton** (1964), **Petrie** (1966), **Makueni** (1973), **Riversdale** (1975); plus common and Coloniao guinea)

Strengths

- Palatable, leafy, high quality pre-flowering stage
- Tolerant of long dry conditions
- Shade tolerant.

Limitations

- Requires fertile soils, including high nitrogen for high production
- Intolerant of waterlogging and of heavy grazing
- Becomes thick-stemmed and low quality if not grazed over summer.

Guinea grasses are an extremely variable species, featuring generally erect densely tufted crowns with short rhizomes from roots. They can be divided into three groups - short, medium and tall types.

Short types (1 to1.5 m); **Gatton** and **Petrie**

Petrie (common name green panic), was previously known as *P. maximum* var. *trichoglume*. Petrie green panic has been planted extensively throughout Queensland on developed Brigalow country and is sometimes sown in the MW region on loamy-surfaced and alluvial soils in undulating eucalypt woodland country with rainfall below 1000 mm. Green panic is very shade tolerant and often grows best under the canopy of trees. **Gatton** panic is bit more robust with a longer growing season.

Medium types (1.5 to 2.5 m): **Common, Riversdale** and **Makueni**

Common guinea grass has naturalised many areas of the MW region, particularly in coastal hilly country cleared of rainforest vegetation but too steep to grow cane, and receiving greater than 1000 mm annual rainfall. Common guinea is very palatable to cattle pre-seeding and is a good fattening grass. However it cannot withstand heavy continuous grazing and will quickly allow invasion of broadleaf and other grass weeds. **Riversdale** was a variety selected from common guinea types but now not available. **Makueni** variety is a selection from Kenya with better cool season growth which is adapted to below 1000 mm rainfall areas.

Tall types (2.5 to 3.5 m): **Hamil, Coloniao**

Hamil variety, some times called giant guinea, was originally sown as a 'pioneer' pasture grass following early clearing of coastal rainforest country. It will tolerate moderate waterlogging. It is more robust and later flowering than common guinea. Pre-seeding, Hamil is coarse in appearance but quite palatable to stock. However, once it becomes tall and mature it is too coarse and unpalatable, and difficult to manage, compared to currently available grasses. **Coloniao** type guinea is no longer available.

Elephant grass

Pennisetum purpureum cv. **Capricorn** (1962)

Strengths

- High dry matter yields, predominantly over summer months
- Very palatable, high quality forage
- Drought tolerant from extensive, deep root system.

Limitations

- Needs well drained, fertile soils and good moisture for production
- Sensitive to waterlogging
- Matures rapidly developing thick stems, which lowers quality
- Low production over winter months
- Vegetative planting only.

A tall robust perennial grass with underground stems (rhizomes), grows into dense clumps of upright thick stems (to 3 cm diameter at base) and up to 3.5 m tall. Native to Africa but now a range of types are naturalised in most subtropical and tropical countries. Although elephant grass can produce viable seed, seed set is usually very poor and seed is rarely harvested. Various types of elephant grass are naturalised along many roadsides throughout the Mackay Whitsunday region.

In the 'early days' elephant grass was grown on alluvial and scrub soils as green-chop to feed dairy cows. At least one beef enterprise in Mackay Whitsunday region maintains a small irrigated block of elephant grass to provide green-chop to feed weaners in the yards during the two to three week weaning process.

Capricorn was selected as a late flowering, leafy, grazing type of medium height. However as commercial seed production was not an option, vegetative material was mainly available via nominated 'seed' plots. It would currently be difficult to guarantee vegetative supply of cultivar Capricorn.

Bana grass is a hybrid ecotype of elephant grass (*P. purpureum* X *P. glaucum*) and is commonly used for windbreaks in orchards.

Paspalum species

There are six quite different species of paspalum that have been planted, or are currently available for planting. General characteristics are listed but some species do vary from these generalisations. Currently very few of these paspalum grasses are planted in MW the region.

Strengths

- Tolerant of low fertility soils
- Tolerant of heavy grazing
- Tolerant of waterlogging
- Shade tolerant
- Low oxalate levels and suitable for horses.

Limitations

- Low palatability, particularly as plants mature
- Several regarded as 'weedy' in certain situations.

Paspalum dilatatum; Formed the basis of early sown dairy pastures in New South Wales and Queensland and is now naturalised as a 'low key' pasture grass throughout both states wherever dairy farms have existed. There are no recorded cultivar names in Australia.

Paspalum plicatulum cvv. **Rodd's Bay** (1963), **Hartley** (1963), **Bryan** (1975); common name plicatulum.

Rodd's Bay plicatulum was the second most popular grass planted during the early years of the tropical sown pasture development 'boom' in the MW region, prior to and during the 1970s and 1980s. It was particularly well adapted to low fertility coastal tea tree country subject to waterlogging. Very little or no Rodd's Bay plicatulum is sown these days, largely replaced by Tully humidicola for these situations. Cultivar **Bryan** became available in late 1970s and was more palatable but little was planted in this region and currently commercial seed is not available. It was always very difficult to obtain seed of the cultivar **Hartley**.

Paspalum atratum cv. **HiGane** (1998); common name higane paspalum.

HiGane or atratum paspalum has been tried in a few plantings in the MW region since late 1990s but few commercial plantings have been successful. It is a tall grass (two to three metres) with thick stems and wide leaves but is quite palatable. It is sensitive to waterlogging and requires higher fertility than other paspalums.

Paspalum notatum cvv. **Pensacola** (Florida 1944), **Argentine** (Florida 1950), **Competidor** (NSW 1986), **Riba** (NSW 1995); common name bahia grass.

Bahia grasses are variable, sward-forming perennials with fibrous rhizome-like stolons with deep strong roots at the nodes that grow 40 to 70 cm tall. They are a commonly sown pasture and amenity grass in tropical and subtropical parts of the United States of America. **Competidor** is the most palatable of the cultivars available in Australia but seed is very difficult to obtain. Seed merchants often suggest cultivar **Argentine** as an equivalent alternative but it is difficult to ensure that Argentine seed (mainly imported from the US) is free of the coarser, quite aggressive and less palatable **Pensacola** types. Competidor is often used as an amenity lawn grass for heavy use parks and sporting fields but is also capable of producing high dry matter yields. Cultivar **Riba** is a recent selection by, and for, the turf industry.

Paspalum nicorae cvv. **Blue dawn** (1998), **Blue eve** (1999); common name Brunswick grass.

Blue dawn brunswick grass is another dual purpose pasture and amenity turf grass, which came about due to interest from the amenity/turf industry. It is a perennial erect growing grass with long, deep, vigorous rhizomes in the top 10 cm of soil. Double the normal rates of glyphosate herbicide are required to eradicate Blue dawn once it has established. **Blue eve** is a selection from Blue dawn designed for turf use, with a finer, lower-growing sward with fewer seed heads.

Paspalum wettsteinii cv. **Warral** (NSW 1960s); common name broadleaf paspalum.

Warral broadleaf paspalum should not be planted in Queensland. It was released by the New South Wales Department of Agriculture in the 1940s, and was subsequently used as a pasture for dairy cattle in Queensland. It is now naturalised in some Queensland dairying areas, including Mackay Whitsunday. However, the grass seems to be much less palatable to cattle in Queensland and is often brought into the Department of Primary Industries and Fisheries for identification as it is not being eaten by cattle. Warral is very shade tolerant and in the past has been recommended as a possible ground cover for forestry, but there are better options, namely legumes such as Pinto and Prine forage peanut. Signal grass and green panic are also better options, once the trees are established, though more testing of ground cover species for tree crops is required.

Molasses grass

Melinis minutiflora

Molasses grass originated in Africa and is now naturalised throughout tropical and subtropical countries. Originally used as a pioneer pasture species for developing hilly country because of its characteristics such as fast-establishment, tolerance of low fertility, ability to quickly cover disturbed country and build up sufficient fuel load for a fire to manage woody regrowth. However, the grass declines with regular severe fire and heavy grazing. Molasses grass has pink-purple flowers and leaves that become sticky and have a strong 'molasses' aroma. No cultivars are released in Australia; seed production is difficult, and commercial seed is not available.

Kikuyu grass

Pennisetum clandestinum cvv. **Whittet** (1970), **Breakwell** (1971), **Crofts** (1983), **Noonan** (1983)

Strengths

- Productive under heavy grazing
- More frost tolerant than tropical grasses for tableland areas
- Moderate tolerance to waterlogging and shade.

Limitations

- Requires fertile soils/systems for persistence and production
- Production declines markedly at temperatures more than 21°C
- High oxalate levels, high nitrate levels with high N usage.

A stoloniferous and rhizomatous perennial mostly growing 30 to 40 cm tall. Stolons form a thick mat on the ground surface. Kikuyu has been used extensively as a dairy pasture and is now naturalised on the Eungella Tableland. It reverts back to mat grass when fertility is allowed to decline.

Soil phosphorous levels should be

above 15 ppm and good production requires 150 kg/ha of N per year, in split applications to avoid nutrient runoff. Well fertilised and managed kikuyu produces very high quality forage (more than 25 percent protein and 70 percent digestibility). However it requires regular defoliation to maximise leaf production and minimise stem percentage.
Kikuyu pastures can be oversown with temperate species (rye grass and clovers) to maintain animal production over winter. It is best to weaken the kikuyu stand first, by disc ploughing or spraying with a low rate of glyphosate (1 L/ha). Kikuyu is very sensitive to glyphosate and can be killed by a dose of 3 L/ha. Of the tropical legumes, only creeping vigna and forage peanut have demonstrated promise in their capacity to grow with kikuyu grass.

Kikuyu can be planted vegetatively or by seed. The flowering stems are very short, and are practically enclosed by the leaves, making seed difficult to harvest. It can be used as turf grass under regular mowing.

Whittet is a tall variety with broad leaves and stems and better persistence under lower fertility. **Breakwell** has fine narrow leaves, more prostrate stolons/runners and forms a denser sward. **Crofts** is taller and more upright than Whittet and more cold tolerant. **Noonan** has a growth habit intermediate to Whittet and Breakwell (parents), better seed production and better dry matter production during cooler months. It has better field tolerance to 'kikuyu yellows' which is not significant to Eungella Tableland.

Possible 'weedy' or nuisance grasses:

Grader grass

Themeda quadivalus

Grader grass is native to India where it is an annual component of perennial native pastures. It was first recorded in Queensland at Habana in 1935, at Grech's tram siding. Several theories exist regarding its arrival - one claim is that the seed was in straw packing around electrical insulators; another claims the seed came from straw stuffing used in imported horse collars. Locals chaffed the ripe seed heads and feed it to draft horses with pollard and molasses. Locally it was called 'Habana oats' or 'wild oats'.
It subsequently spread along roadsides and became known as 'grader grass'.

Grader grass is readily grazed by stock before it sets seed but quickly runs to seed and becomes unpalatable to cattle. As an annual it sets a lot of seed and germinates quickly, on early storm rains, and can dominate sown pastures and grow to two metres tall during the establishment year. The best, and only economical means of control, is to keep perennial sown pastures

healthy and vigorous with good ground cover, to prevent establishment of grader grass from seed. Being an annual, it has to re-establish from seed at the start of each wet-season. The use of fire will remove ground cover and actually stimulate mass germination of grader grass (more information from Bishop 1981).

Thatch grass

Hyparrhenia rufa

Thatch grass is native to Africa and is used as a pasture grass for cattle grazing in Brazil. Like grader grass, it has a low leaf to stem ratio, and becomes unpalatable and turns brown on maturity, but thatch grass is a perennial. As a perennial, it has replaced grader grass along many road sides and highways throughout Queensland. Often mistaken for grader grass, thatch grass stands more erect (stems and seed heads) and re-grows from the old crowns with the onset of storms. It is advisable to restrict its spread into pasture paddocks using pasture and grazing best management practice to ensure strong, vigorous, perennial sown pastures.

Scented top

Capillipedium spicegerum

Scented top is a stout and robust perennial native grass with stems up to 1.5 m tall. When crushed, the inflorescence gives off an aromatic odour. The grass is widespread in forest country in eastern Queensland, is readily eaten by cattle, and responds to good fertility (Tothill and Hacket 1983). However, during the 1990s and early 2000s the DPI&F received plant specimens of scented top for identification from numerous coastal properties where it is invading and spreading into sown pastures and is not being eaten by cattle.

Scented top can become coarse and less palatable to stock in poor coastal soils with higher rainfall, and coastal cattle have not adapted to this grass. In such cases it is recommended that the scented top be slashed or sprayed with glyphosate, to reduce seed set. Existing sown pastures should also be renovated, or new pastures established, to compete with this native scented top grass, using fertiliser and grazing best management practice.

Forest blue grass

Bothriochloa bladhii

Forest blue grass is a widespread native forage grass mainly found growing in heavy clay soils in grassy forests and woodlands, predominantly west of the coastal ranges. The inflorescence and leaves can be strongly aromatic but the grass is readily eaten by stock (Tothill and Hacket 1983). However, during the 1990s and early 2000s the DPI&F received plant specimens of forest blue grass for identification from numerous coastal properties, as it was spreading into their sown pastures and not being eaten by cattle.

Coastal cattle have not adapted to Forest blue grass which can become coarse and less palatable when grown in poorer coastal soils with higher rainfall. In such cases it is recommended that forest blue grass be slashed or sprayed with glyphosate, to reduce seed set. Existing or new sown pastures should also be renovated or established using fertiliser and grazing best management practice to compete with the native forest blue grass.

Warral broadleaf paspalum

This grass should not be planted. See previous paspalum grasses, pg 40.

Water grasses

All introduced water-grasses are now considered 'environmental weeds' in Queensland, and State government policy restricts planting of para and other species such as Aleman and Hymenachne grass in sensitive wetlands.

The following information is to assist recognition of these species.

Para grass

Brachiaria mutica

Para is a creeping perennial grass with long, coarse stolons that root readily at the nodes. Native to tropical Africa, it has been naturalised in tropical Australia and used as a pasture grass in seasonally inundated or high rainfall locations. It is capable of high production, being second to pangola grass in early yield comparison trials under irrigation and high nitrogen inputs in far north Queensland. It will grow in water up to 30 cm deep. It can be established from runners or from seed, but the seed is most often not available due to difficulty of harvest. However in ungrazed situations para grass can become an environmental weed.

Aleman grass

Echinochloa polystachya cv. Amity, (1987)

Aleman is a sub-aquatic perennial grass with semi-upright stems emerging from a long rhizome root system. It will grow in water up to one metre deep and will survive in two metre deep water for short periods. Native to North America, it is very palatable and was introduced as a pasture grass to complement para grass grazing systems. It sets very little viable seed.

Hymenachne

Hymenachne amplexicaulis cv. Olive, (1987)

Hymenachne is a perennial stoloniferous grass with upright, ascending stems and stems that run on wet ground or float on water and develop adventitious roots. It is native to North America where it was used as a dry-season grazing forage as it will grow in two metre deep water, and occasionally in three to four metre deep water where its stems float on the surface. It has low drought and salt tolerance but produces viable seed that can establish in silt line following flooding.

Sown legume species

Legumes most commonly planted

Common stylo

Stylosanthes guianensis var. guianensis cvv. **Nina** (2003), **Temprano** (2003), retailed as '**Stylhay**'. (Previous cvv. Schofield, Cook, Endeavour (1971) and Graham (1980) now not available due to susceptibility to anthracnose).

Common stylo is a robust, semi-erect, short-lived, perennial legume herb/sub-shrub that grows to 1 to 1.5 m tall. It prefers moderately fertile, well-drained sandy loam to light clay soils that receive 1000 to 2000 mm of rainfall. The legume can extract phosphorus very efficiently from low P soils. It nodulates adequately on native rhizobium but the use of a commercial product to inoculate the legume is recommended when planting into new country. Depending on the situation, common stylo can be used as a hay crop or ground cover/green manure crop for horticultural or forestry tree crops. Cutting or heavy grazing of mature stands (post flowering) can kill plants due to lack of new growing points on lower stems. It is best to stimulate lower branching early by grazing or cutting (to 15 to 20 cm) in the first few months.

Strengths

- Highly tolerant of current anthracnose fungal strains
- High dry matter yields, makes high protein hay (best cut during early flowering stage)
- Leaf stays green into dry season
- Adapted to low fertility soils, responds well to added phosphorus.

Limitations

- Short lived perennial (improved with rotational grazing pre-flowering)
- Intolerant of waterlogging
- Seed tends to drop on ripening, reducing commercial seed yield.

Caribbean stylo

Stylosanthes hamata cvv. **Verano** (1973), **Amiga** (1988))

Caribbean stylo is an annual to short-lived perennial, semi-erect, heavily branched herbaceous legume 0.3-1 m tall. Performance of the two varieties is very similar and both are adapted to sandy-surfaced duplex to clay loam soils receiving 900 to 1500 mm rainfall.

Strengths

- Tolerant of current anthracnose fungal strains
- Tolerant of drought, good regeneration from seed
- Adapted to low fertility soils, responds well to added phosphorus
- Can spread via seed in cattle dung.

Limitations

- Less palatable than green grass during wet/growing season
- Can become dominant under continuous heavy grazing
- Potential threat of anthracnose in 'wet' years and long term
- Intolerant of prolonged waterlogging.

Shrubby stylo

Stylosanthes scabra cvv. **Seca** (1977), **Siran** (1990))

Shrubby stylo is an erect/semi-erect, strong, perennial legume (one to two metres tall) with a strong deep tap root (up to four metres). It is very drought hardy and well adapted to infertile, acid, and friable to hard setting soils. It is not adapted to heavy clays. With infertile soils, phosphorus supplements may need to be fed to cattle to achieve best animal performance. Shrubby stylo is mainly sown in areas with 600 to 2000 mm rainfall, and is not very tolerant of waterlogging. Established plants are susceptible to fire which can be used to control legume dominance situations. Shrubby stylo is a legume that can be added to most sown pasture seed mixtures.

Strengths

- Tolerant of current anthracnose fungal strains
- Widely adapted, persistent perennial
- Tolerant of drought and adapted to low fertility soils
- Can spread via seed in cattle dung.

Limitations

- Lower palatability during wet/growing season, cattle prefer green grass

- Can become dominant under continuous heavy grazing
- Not as productive as jointvetch or centro legume in high P input pasture systems
- Potential threat of anthracnose and little-leaf diseases in long term.

Caatinga stylo

Stylosanthes seabrana cvv. **Primar** (1996), **Unica** (1996); common name caatinga stylo

The characteristics, growth and form of Caatinga stylo is in-between shrubby and Caribbean stylo types. It was specially selected for inland, heavy clay soils of brigalow and downs country. It was selected for anthracnose tolerance but needs to be monitored when sown in wetter coastal areas. Generally retailed as a mixture of the two varieties.

Strengths

- Hardy and drought-tolerant, short lived perennial
- More suitable for clay and clay-loam soils than shrubby and Caribbean stylos
- Earlier flowering, and more prolific seeding than shrubby and Caribbean stylos
- More cold tolerant then shrubby and Caribbean stylos.

Limitations

- Highly specific rhizobium requirement
- Drops leaf in cool/dry season
- Not yet widely evaluated on wet coastal areas.

American jointvetch

Aeschynomene americana cvv. **Glenn** (1984) and **Lee** (1994)

American Jointvetch is an erect or ascending, branched, annual (Glenn) or short-lived perennial (Lee) shrub legume that grows 0.5 to two metres tall and one to1.5 metres wide. It becomes more branched and leafy if grazed early once established.

Grazing should be managed to ensure a good seed set which is essential for regeneration of the annual Glenn as it dies off during winter. Glenn flowers in late March to early April with Lee flowering four to six weeks later. The seed spreads readily via cattle dung. Glenn can be a nuisance weed of other legume seed crops and in irrigation channels.

Strengths

- High nitrogen fixation and high digestibility and nutritive value of leaf material
- Very palatable
- Grows in low-lying wet areas and waterlogged soils
- Tolerates low fertility, responds well to added phosphorus
- Persistent and prostrate under heavy grazing
- High seed yields and seed readily available
- Moderate shade tolerance.

Limitations

- Annual (Glenn) or short lived perennial (Lee)
- Glenn best grazed during wet season, has poor quality stand-over forage (annual)
- Mature growth is susceptible to powdery mildew (leaf fungus) with the onset of winter
- Quite susceptible to heliothis attack in seed crops.

Villose jointvetch

Aeschynomene villosa cvv. **Reid** and **Kretschmer** (retailed as '**Villomix**').

Villose Jointvetch is a prostrate to weakly erect, short-lived (two to four years) perennial legume with stems up to one metre long. It is tolerant of heavy grazing and more compatible with stoloniferous grasses than American jointvetch. It is adapted to a wide range of soils (sands to clays) and best adapted to more than 1000 mm of rainfall. Villose Jointvetch will nodulate with native rhizobia but it is best to use special jointvetch rhizobia at first planting.

Strengths

- High nitrogen fixation
- High palatability, high quality, high digestibility, forage
- Responds well to added phosphorus
- Perennial, fine stems, semi-prostrate/ semi-erect habit
- Tolerant of heavy grazing
- Grows in low wet areas but cannot tolerate prolonged waterlogging
- Good seed yields via direct and suction harvesting
- Some shade tolerance.

Limitations

- Seed pods shatter requiring direct and suction seed harvesting
- Susceptible to powdery mildew in autumn/winter.

Bargoo jointvetch

Aeschynomene falcata cv. Bargoo (1973)

Bargoo jointvetch is a ferny-leafed, trailing, perennial legume with a woody tap-root. It was tested extensively, and is now naturalised, in some of the subtropical spear grass country in south east Queensland. Its target area locally would be eucalypt hilly country with black spear grass, and other low input pasture systems, but commercial seed is not currently available.

Strengths

- Persistent, hardy legume on well drained sandy to light clay soils
- High quality, palatable forage but low-yielding
- Tolerant of heavy grazing and low fertility soils
- Tolerates mild frosts, recovers well from heavy frosts and following fire.
- Moderate shade tolerance.

Limitations

- Growing tips susceptible to anthracnose and seed pods drop as they ripen throughout growing season
- Commercial seed rarely available as difficult to harvest
- Low dry matter production.

Alternative legumes or legumes planted in past

Centro

Centrosema molle cv. Cardillo (1995), and common centro; was previously *C. pubescens*

Centrosema pubescens cv. Belalto (1971)

Centro is a perennial, trailing-climbing legume with a strong tendency to root at the nodes of trailing stems. Common centro was a legume for early beef and dairy pastures in wetter tropical areas with early seed imported from Papua New Guinea and south-east Asia. Common centro is now naturalised throughout the MW region particularly on developed coastal and tableland rainforest hilly country, especially in situations inaccessible to cattle grazing.

Belalto has poor seed production and little commercial seed was ever produced.

Cardillo centro with dense sward

Common centro with sparse sward

Cardillo is the ideal centro to plant. It roots much more from the nodes and forms a dense mat of legume on the ground and is one of the few legumes that can persist with stoloniferous grasses, particularly under rotational grazing. It has better cool season growth then common and much higher harvestable seed yield than did Belalto.

Strengths

- Good seed production (Cardillo)
- Cardillo persists longer than siratro under grazing on coastal tea tree country subject to intermittent short-term waterlogging events
- Appears to have some shade tolerance.

Limitations

- Requires moderate to high fertility, including molybdenum
- Requires specific rhizobium
- Seedlings slow to establish relative to siratro and glycine.

Siratro

(Macroptilium atropurpureum cvv. **Siratro** (1971), **Aztec** (1994), retailed as **Aztec-atro**

Siratro is an herbaceous, perennial legume, with trailing, climbing, twinning stems and with a swollen taproot once established. The original Siratro was a foundation legume for early tropical sown pasture development in the MW region during the late 1960s and 1970s. Although it establishes and grows quickly it is susceptible to waterlogging, continuous grazing and to leaf rust. It has poor persistence in continuously grazed sown pastures, particularly in coastal tea tree country. It is a climbing legume and can potentially become a nuisance weed in tree crops, in the absence of grazing.

Aztec was bred and selected from siratro for rust resistance and is claimed to have higher leaf production. All commercial seed is now sold as Aztec-atro. It remains a highly productive pasture legume and fixes large amounts of nitrogen but requires careful grazing management to persist in grass/legume pasture systems. Aztec

should be grazed lightly to moderately, with rotational spelling. A good seed set and seed drop should occur in the establishment year and every two to three years subsequently, to ensure soil seed reserves for regeneration of replacement seedlings. Only limited plantings have occurred in recent years but its rust resistance may be breaking down, particularly if there is a return of wet humid summers.

Strengths

- Wide soil and climate adaptation
- High nutritive value and palatability
- Good nitrogen fixation, including with native rhizobia in most soils
- Drought resistant.

Limitations

- Intolerant of poor drainage
- Declines under continuous grazing
- Requires moderate fertility or added fertiliser, particularly phosphorus and molybdomum
- Susceptible to leaf rust in long term.

Glycine

Neonotonia wightii cvv. **Tinaroo** (1962), **Clarence** (1962), **Cooper** (1962), **Malawi** (1976)

Glycine is a strong, deep rooting legume with long branched and trailing/climbing stems. It was used extensively during the 1970s and 1980s as a legume in dairy pastures. It demands high amounts of nutrients, a long growing season and can tolerate cooler weather than most tropical legumes. Glycine grows best in well drained, moderately fertile soils in tableland areas, including Atherton and Eungella where the Tinaroo variety is mostly used. Although a considerable amount of glycine still persists in pastures around the MW region, it is now seldom sown due to its aggressive climbing habit, which can make it an environmental problem 'weed' in tree crops and ungrazed situations such as new subdivisions and housing estates.

Strengths

- Better cool season growth then most tropical legumes
- Late flowering, long growing season.

Limitations

- High nutrient requirements, including molybdenum
- Can become environmental problem 'weed' in subdivisions and treed areas.

Butterfly pea

Clitoria ternata cv. Milgarra (1991)

Butterfly pea is a vigorous, persistent, perennial legume adapted to sandy loam to clay soils and 700 to 1500 mm of rainfall. It is grown extensively in the heavy clay soils of inland central and north Queensland. It has a role as a pasture legume, a ley legume in farming systems and as a hay crop. It is adapted to moderately fertile, loam to clay soils on the coast and has minor use as a green manure rotation and/or hay crop in fallow cane land. It initially has upright growth and subsequently develops rambling/climbing stems. It nodulates readily from native soil rhizobia and has good nitrogen fixation but seed should be inoculated for initial plantings. Butterfly pea is sometimes used as an ornamental garden or trellis plant and has predominantly blue with some white flowers. Young seed pods can be eaten as a vegetable.

Strengths

- Perennial legume, adapted to loams and clay soils
- Dual purpose grazing, hay, ley legume for cropping soils.

Limitations

- Sensitive to waterlogging
- Sensitive to competition from vigorous companion grasses.

Round-leaf cassia (useful pasture legume or nuisance weed?)

Chamaecrista rotundifolia cv. Wynn 1984)

Round-leaf cassia is a short-lived perennial (with more than 900 mm rainfall) or self-regenerating annual (with less than 900 mm rainfall), herbaceous legume with shallow taproot and semi-erect growth from 0.5 to one metre tall. It grows best in free-draining lighter soils of low to moderate fertility. Wynn cassia flowers early and continues flowering until it is too dry or cold. Cattle tend not to eat it during the growing season, particularly in higher rainfall and low fertility situations. Due to its massive seed production and low seasonal palatability, Wynn cassia often becomes dominant under moderate to heavy grazing, as green grass is grazed in preference over summer.

Wynn cassia has recently received a lot of negative press from the Northern Territory, south east Queensland (Gympie, Bundaberg, Miriam Vale) as well as several landholders in the MW region. Other graziers regard it as a useful pasture legume, particularly

if it has been sown with a vigorous companion grass such as Bisset creeping blue grass or signal grass.

Strengths

- Tolerant of low fertility, acid soils
- Rapid establishment and spread
- High seed yields.

Limitations

- Frost sensitive
- Acts mainly as an annual
- Low palatability, particularly during summer growing season
- Tends to dominate under heavy stocking, grass can get grazed-out.

Pinto forage peanut

Arachis pintoi cv. Amarillo (1987)

Rhizome forage peanut

Arachis glabrata cv. Prine (1995)

Both Pinto and Rhizome forage peanut are strongly-perennial herbaceous legumes. Both are multi-purpose legumes for grazing, hay, and ground cover for horticulture and tree crops.

Pinto develops a strong taproot and spreads by forming a dense ground-cover mat of stolons. With the onset of flowering, seed pods are produced underground, attached to the plant by a 'peg', until maturity. Each pod contains a single seed. Rhizome peanut has a more upright growth habit with erect stems developing from underground crowns and rhizomes. Rhizome produces very little seed and needs to be sown vegetatively using rhizomes.

Harvesting the seed or rhizomes of both Pinto and Rhizome for planting requires considerable mechanical sward disturbance and planting material is costly, relative to most other pasture species. In the early development stage for both forage peanut cultivars, a special harvester was imported from Florida USA, where forage peanut is widely sown.

Strengths

- Persistent and productive under heavy grazing
- Tolerant of low fertility (particularly Rhizome), responds well to increased fertility
- High quality forage, palatable and highly digestible
- Survives prolonged dry periods (particularly Rhizome), re-grows from underground seed or rhizomes
- Shade tolerant (particularly Pinto)

- Pinto tolerant of waterlogging, Rhizome of short-term waterlogging
- Mat forming, good ground cover for landscaping and under tree crops
- Combines well with competitive sward grasses.

Limitations

- Needs good moisture/high rainfall for high production, more than 1500 mm for Amarillo, more than 1000 mm for Rhizome
- Seed/nuts form underground, high seed costs, difficult to eradicate once established, attracts rodents and scrub turkeys
- Sowing by seed requires highly specific rhizobium for nitrogen fixation
- High establishment cost, slow establishment (depending on sowing rate)
- Above ground forage dries off over long dry spring to early summer period.

Hetero

Desmodium heterophyllum cv. Johnstone (1971)

Hetero is a perennial tropical legume that is compatible with vigorous creeping tropical grasses such as Tully humidicola, pangola and signal grass (other compatible legumes are rhizome and pinto forage peanut and possibly villose jointvetch and Cardillo centro). It has prostrate stems that root strongly at the nodes and flower continually from April to December when moisture is available. It tolerates waterlogging, acid and infertile soils, and responds well to added phosphorus. Its seed pods are segmented and break and fall as the seeds mature. Commercial seed is not available but hetero can be established readily from cuttings. Cattle will spread the seed via their dung. Considerable areas of hetero still exist in the northern wet tropics and several MW properties planted small areas in the 1970s. Problems with commercial seed harvesting has greatly restricted its use.

Strengths

- Compatible with stoloniferous grasses and tolerant of heavy grazing
- Can be planted vegetatively and spreads via prostrate stems
- Seed is spread via cattle dung
- Palatable and good protein forage
- Very shade tolerant.

Limitations

- No commercial seed available
- Requires high rainfall (more than 1500 mm).

Temperate cool-season legumes

Clover legumes (White, Subterranean, Kenya white)

Trifolium repens cvv. Haifa, Ladino (1964) common name white clover

White clover is a temperate legume with sufficient heat tolerance to grow in tableland areas of the tropics (including Eungella and Sarina range areas) where there is sufficient rain or irrigation during autumn through to the spring period. It tends to act as an annual, dying off over summer and regenerating from soil seed reserves during autumn. It combines well with kikuyu grass but requires annual phosphorous applications and regular grazing to maintain a high legume component. **Haifa** was the preferred variety for Eungella and Sarina dairy farms with **Ladino** an earlier variety.

(Trifolium subterranean cvv. Clare common name subterranean clover

Clare subterranean clover is a true annual that can be sown as a legume component with rye grass for autumn through spring feed on tableland areas, where moisture is available. There is a need to use high sub-clover seeding rates (10 to14 kg per hectare) to provide quick pasture grazing.

Trifolium semipilosum cv. Safari (1973) common name Kenya white clover

Kenya white clover is a perennial tropical clover with many similarities to white clover. It has a stronger taproot and better heat and dry period tolerance than white or Clare clover. Kenya white clover was grown in Eungulla and Atherton Tableland dairying areas during the 1970s and 1980s but persistence and production was somewhat erratic and the legume has lost favour.

Creeping vigna

Vigna parkeri cv. Shaw (1984)

Creeping vigna is a perennial legume with climbing and prostrate stems, which root at the nodes and form dense ground cover. It is suitable for sandy to well drained red clay soils in subtropical and tropical tableland areas. The best growth for creeping vigna occurs during moist periods in autumn and spring. It has been successfully grown with kikuyu grass on Eungella Tableland dairy farms but requires careful management during establishment and second years (periodic moderate grazing to reduce competition from companion grasses to ensure long term legume persistence).

Strengths

- Persistent and will spread by runners under managed heavy grazing
- Can tolerate moderately low fertility and acid soils but responds well to added phosphorous and molybdenum
- Moderately shade tolerant
- Nodulates with native rhizobium but it is recommended seed be inoculated with commercial product for new plantings.

Limitations

- Can be slow to establish and may not seed in first year
- Susceptible to dry periods greater than three months
- Top growth cut by light frosts but recovers from crown
- Susceptible to diseases and lacks persistence on humid coast
- Seed is difficult to obtain.

Lotus

Lotus uliginosus (synonym *L. pedunculatus*) cv. **Maku grasslands** (NZ 1975), **Sharnae** (NSW 1991)

Lotus is a stoloniferous perennial legume with scrambling stems and an underground crown. It is a temperate legume ideal for subtropical and tropical tableland areas. It tolerates wet and waterlogged soils and low fertility better than clovers. It does not cause bloat in cattle or sheep. Lotus has been grown on some Eungella dairy farms but has not been extensively used in the MW region.

Strengths

- Adapted to infertile and acid soils and wet, poorly drained soils
- Frost tolerant
- Does not cause bloat in cattle or sheep
- Moderate shade tolerance.

Limitations

- Poor drought tolerance
- Requires specific inoculation
- Low seedling vigour, slow to establish, slow to regrow following grazing.

Short-term, ley or green manure legumes

Greenleaf desmodium

Desmodium intortum cv. Greenleaf (1964)

Silverleaf desmodium

Desmodium uncinatum cv. Silverleaf (1971)

Greenleaf and Silverleaf desmodiums are large trailing and scrambling, short to moderately lived perennial legumes suited to cool tableland areas in the tropics. The plants lower stems root at the nodes when in contact with moist soil and can be planted vegetatively using rooted cuttings. Both were important pasture legumes for dairy cattle at Eungella and Sarina range during the 1970s and 1980s. Greenleaf and Silverleaf desmodiums are now seldom sown but Greenleaf seed is available from north Queensland. The legumes may have a minor role to play as a green manure crop to improve soil organic matter in tree crop rotations.

Strengths

- Suitable for cooler areas with long growing season
- Shade tolerant.

Limitations

- Poor persistence under heavy grazing
- Requires high fertility
- Susceptible to root eating larva of soil weevils.

Lablab

Lablab purpureus cvv. **Rongai** (1962), **Highworth** (1973), **Endurance** (on pre-release)

Lablab is a vigorous herbaceous, prostrate to semi-erect, climbing, annual legume grown mainly for grazing forage or as a green manure crop. It has a longer autumn growing season then cowpea and has better resistance to *Phytophthora* root and stem rot, and to insect attack. Endurance is a perennial lablab but had poor seedling vigour and not much was planted.

Strengths

- Multi-purpose (green manure, grazing, hay)
- Ease of establishment in 'rough' seedbed, large seeded
- Adapted to wide range of soils, tolerates acid soils and is more tolerant of short term waterlogging then cowpea
- Drought tolerant.

Limitations

- More sensitive to waterlogging then soybean.
- Cattle can take time to acquire a taste for lablab and its coarse stems have limited grazing value.

Cowpea

Vigna unguiculata cvv. **Ebony PR** (1996), **Arafura, Meringa, Red Caloona** (1975), **Kalkie**

Cowpea is an herbaceous, semi-erect, climbing, annual forage legume and is one of most widely used legumes throughout the tropical world. Ebony PR, Arafura and Meringa are later maturing (longer growing season) forage types while Red Caloona is a faster maturing grain and forage dual-purpose variety.

Strengths

- Multi-purpose (grain, green manure, grazing, hay)
- Ease of establishment, large seed and large yields in short time, high seed yields
- High nutritive value and high palatability
- Adapted to wide range of soils, tolerates acid soils better then most legumes
- Drought tolerant.

Limitations

- More sensitive to waterlogging and flooding then lablab, soybean and butterfly pea
- Can be sensitive to plant pests.

Soybean

Glycine max cvv. **Leighhardt , Y-Y, Stuart**

Soybean is an herbaceous, semi-erect, climbing, annual legume grown widely around the tropical world as a high value grain crop. It has become an important multi-purpose crop for sugar cane farming systems in the last decade. It is mainly planted as a green manure 'break' crop on fallow cane land but can be a high value grain crop if seasonal conditions allow. It can also be a useful hay crop.

The Leichhardt, Stuart and Y-Y varieties are long growing season types and are specially adapted to the tropical coastal areas from Mackay to far north Queensland. In trials to find green manure legumes tolerant to waterlogging held in Mackay in the late 1980s, soybean demonstrated superior survival to several weeks of cyclonic rain than did cowpea or lablab (Bishop, unpublished data).

Strengths

- Versatile multi-purpose (green manure, grain, hay) crop for fallow cane land
- High nitrogen fixation for soil improvement
- More tolerant of waterlogging then cowpea or lablab.

Limitations

- Requires better seed bed preparation and weed control than cowpea or lablab
- Seed for planting is more expensive than for cowpea or lablab.

Burgundy bean

Macroptilium bracteatum cvv. **Cadarga** (2000), **Juanita** (2000)

Burgundy bean, including the erect Cadarga and trailing Juanita varieties, are herbaceous, perennial legumes adapted to heavy textured soils and tolerant of cooler temperatures than butterfly pea. Due to its high palatability it is normally a short-lived pasture legume but can regenerate well from seed fall. It is potentially a useful short-term ley legume alternative to lablab or butterfly pea. To date there is little experience of Burgundy bean in MW region.

Strengths

- Adapted to wide range of soil texture, including heavy clays
- Germinates and grows under cooler conditions than butterfly pea
- Extremely palatable, requires rotational grazing, non-bloating
- Regenerates well from seed set.

Limitations

- High palatability restricts use to ley and short-term phase pastures
- Specific rhizobium required
- Susceptible to bean mosaic virus (Cadarga variety) in wet conditions.

Browse shrub legumes

Leucaena

Tip sucking psyllids

Leucaena leucocephala subsp. ***glabrata*** cvv. **Taramba** (1995), **Cunningham** (1976), **Peru** (1962) are the forage varieties recommended for leucaena/grass grazing systems. Cultivar **K8** (University of Hawaii 1960s) is a tall predominantly timber variety, little used in Australia.

The leucaena legume browse-shrub/grass pasture system, is based on subsp. glabrata, and this system can be the most productive, profitable and sustainable grazing system available in northern Australia. The most suitable soils are deep (more than one metre), fertile, clay loam to heavy clays, and occur predominantly west of the coastal ranges. Suitable soils within the MW region are very limited, plus the leucaena psyllid (a sap-sucking insect) can greatly reduce leucaena forage yields in humid coastal areas. Consequently there are currently very few, if any, successful leucaena/grass grazing systems in the MW region.

Strengths

- Highly productive on suitable (deep, fertile, clay) soils
- High nutritive quality and digestibility for ruminant livestock
- Highly persistent perennial legume shrub/tree
- Strong deep root system, tolerance of dry periods and retains leaf into dry season
- Moderate tolerance to salt in soil profile
- Good nitrogen fixation and can provide multiple products and services to a wide range of production systems.

Limitations

- Poorly adapted to shallow, infertile, acid soils
- Needs to be inoculated with very specific rhizobia for nitrogen fixation
- Relatively weak in seedling stage, slow to establish, susceptible to weed competition
- Attacked by sap-sucking psyllid insect in humid coastal areas
- Can become a nuisance plant in absence of grazing (environmental weed)

- Mimosine' in forage can cause ill thrift in animals eating > 30 percent leucaena in diet, need to inoculate cattle with rumen bacteria (available DPI&F Brian Pastures R.S. Ph: 4161 3700).

Leucaena leucocephala subsp. ***leucocephala*** is native to southern Mexico and has been naturalised throughout the Asia-Pacific region for centuries. It probably entered Australia in the late 1800s and is now naturalised and widespread, being particularly visible along roadsides in tropical and subtropical Queensland. It is an earlier flowering type with low leaf production and is not recommended for use in grazing systems. The Leucaena Network (made up of commercial leucaena growers) is working with local shire councils throughout Queensland to develop and implement a strategic plan to eradicate this 'feral' leucaena from roadsides.

The University of Queensland is currently developing a forage hybrid leucaena ('KX2') with improved psyllid resistance, cold tolerance and lower seed yield, and is due for release in 2008-2009. It is also 'proposed' that a sterile hybrid be developed for timber production.

Leucaena is listed as an environmental weed by some local authorities in Queensland, due to its ability to regenerate and spread from seed. As mentioned above subsp. *leucocephala* is the predominant culprit with respect to weediness. However the Leucaena Network has developed a '*Code of Practice for the sustainable use of leucaena/grass pasture systems in Queensland*'. The code aims to restrict leucaena planting near potential weed risk zones, minimise seed production in grazed stands, diminish the risk of live seed dispersal and control any plants that escape from grazed stands (Refer to Code in Appendix 11.5).

Possible problem legumes

Archer axillaris (useful pasture legume or nuisance weed)?

Macrotyloma axillare cv. Archer (1966); previously *Dolichos axillare*

Archer axillaris is a trailing and twining perennial legume that develops a strong woody taproot. It has moderate shade tolerance and the ability to climb up trees. The young growth of the legume is less palatable then old growth and initially not relished by cattle. However, once cattle become accustomed they will readily eat the legume, but will select other legumes where available. Commercial seed is not available and Archer axillaris is not recommended for planting due to its low palatability and risk of becoming a weed in native woodlands and forests.

Round leaf Wynn cassia

Chamaecrista rotundifolia cv. Wynn

Useful pasture legume to some and a nuisance weed to others (see fact sheet description this Chapter, pg 53).

6 Selecting sown pasture grasses, legumes & mixtures

Chapter 3 of this book presents information on the different pasture-fed grazing systems that can be used in the MW region. Chapter 5 provides a comprehensive list of pasture species available to choose from. This chapter provides information on selecting pasture types.

Pasture type choices

Grass-only pastures using one species or variety are simple to sow and the easiest to manage. However this equates to 'all the eggs in one basket' and the simplest option does not always give the best outcome.

Local examples of single species grass pastures are pangola, signal and Tully humidicola. These three pasture types develop into strong, dense swards and persist over the long term. However pangola and Tully are most often sown as mixtures using a quick establishing grass such as Callide rhodes grass to achieve quick ground cover, and early forage for grazing. Jointvetch and stylo legume seed is often added to the mixture to provide nitrogen for the grass and high protein forage for the grazing animals, at least for the first two to four years, by which time the pangola, Tully and signal grasses will dominate and 'push-out' the rhodes grass and the legumes. Once the pasture becomes grass dominant, applications of bag-nitrogen are required to maintain vigorous growth and high forage production. Other examples of single grass-only pastures are for hay production and short-term forage crops using sorghum species.

Legume-only pasture grazing systems are not generally recommended as they provide insufficient energy and protein excess to grazing animals' normal requirements. Long-term legume-only pastures can increase soil acidity due to nitrogen leaching from the accumulated nitrogen fixed by

The Tully humidicola grass plot (front left) demonstrates its competitiveness against the invasive weedy sporobolus Giant Rats Tail grass, in a sown pasture species demonstration trial at Mirani

Pangola grass is starting to over-run the Callide rhodes following over-sowing the pangola runners with rhodes grass seed at planting

legumes. In the absence of a grass to utilise this nitrogen it is leached down the soil profile. This can also happen over time with grass-legume mixed pastures that have become legume dominant through continuous heavy grazing, particularly with Wynn cassia and shrubby stylos. Legume-only pastures can be grown for hay, short-term legume forage crops for grazing or legume green-manure crops.

Grass-legume mixed pastures have many advantages. They provide nitrogen, improve diet quality and digestibility and slow or prevent soil fertility decline and pasture run-down. However grass-legume mixed pastures require very careful grazing, fertiliser and weed management. Optimum grass-legume balance is around 60 to 40 but even 20 percent legume (by dry matter yield) will significantly contribute to pasture and animal production.

Importance of legumes

Nitrogen is required in large quantities by all plants and is the main component of protein. Reserves of nitrogen in the soil are held in the form of organic matter which is constantly being broken down, releasing ammonia. Ammonia is then converted by soil bacteria into nitrates which is the form taken up through plant roots. Nitrates are soluble so can be leached from the soil and lost in runoff water.

Legumes have an association with nitrogen-fixing bacteria in the soil for mutual benefit. These bacteria obtain their main food requirements from the legume roots and in return these special bacteria provide the legume with nitrogen. This process takes place in the nodules that form on the legume roots. As well as supplying the legume plant with nitrogen and thus high protein content, the nodules eventually fall off and decay and the nitrogen becomes available to associated grasses. Many introduced pasture legumes require specific bacteria that needs to be applied to the seed prior to sowing. This process is called 'inoculating the legume seed with its specific rhizobium'. The recommended rhizobium is available from seed merchants.

Molybdenum (Mo) is a very important soil trace element to ensure vigorous legume growth via effective root nodulation and nitrogen fixation. Healthy root nodules should be pink in colour; pale green nodules indicate ineffective nitrogen fixation which may indicate molybdenum deficiency (see Chapter 7 for more information).

Ideal pasture species to plant

Many grasses and legumes are available for sowing in the Mackay Whitsunday region (see appendix 4 and Chapter 5). When choosing the most suitable grass and legume species the following factors should be considered:

- **Land type/soil type**; fertility, texture and drainage
- **Climate**; rainfall and temperature
- **Management system**; high, medium or low input system
- **Saleable commodity being targeted**; breeding weaners / stores, growing / fattening / finishing, hay production, etc.

Some species characteristics to consider:

- Growth habit (erect clump/stools or stoloniferous/runners)
- Persistence (long term / short term)
- Waterlogging / flooding tolerance
- Drought tolerance
- Cold and frost tolerance
- Grazing tolerance
- Palatability
- Ease of establishment and speed
- Response to low/high soil fertility/ fertiliser inputs
- Competition against weeds
- Compatibility with legumes
- Ground cover/soil stabilisation.

Brief history of tropical pasture species used in the Mackay Whitsunday region

Following initial experimental and demonstration work from 1960 to 1966, the area planted with tropical pastures increased to 60 000 ha by 1979, reaching an annual peak of 5000 ha in 1974-75. Approximately half of this development was by sugarcane farmers with land surplus to cane requirements (Bishop and Walker, 1980). The paper 'Pastures for the Mackay wet coast' (published in the July-August Queensland Agricultural Journal) lists and describes 19 grasses (from eight genera/ 12 species) and 15 legumes (from six genera/10 species).

The most common grass planted at that time was Kazungula setaria, followed by Rodd's Bay plicatulum. Together they made up greater than 90 percent of the grass component of sown pastures, largely because of their reliability of establishment, adaptation to most conditions (wet and dry, low and high fertility) and long term persistence. Some of these original pastures are still productive today, 35 years on. However, very little Kazungula has been sown in the past decade, probably because other grass options are seen as easier to manage. During the normal summer wet season

(of the 1970s) Kazungula quickly grew tall and ran to seed, fell over, ran to seed and fell over again, throughout summer. This built up a dense tangle of stems of low quality litter and smothered legumes, but Kazangula setaria quickly sent up new green leaf and was competitive with broadleaf weeds. In a grazing trial conducted on the 'Tedlands' property at Koumala in the 1970s, live weight gains of around 180 kg/year were achieved from Kazungula/siratro pastures stocked at 1 AE/ha. Similar performance was recorded for Kazungula plus nitrogen pastures, stocked at 2 AE/ha (Walker 1980). Rodd's Bay plicatulum is not sown in current times because of its low palatability.

Over the past decade Rhodes grass (mainly Callide variety) and signal grass have been the most planted grasses. Bisset creeping blue grass is also becoming popular for grazing and for hay. However these three grasses (signal, Rhodes and Bisset) are susceptible to (moderate) waterlogging. Pangola grass and Tully humidicola are very tolerant of waterlogging and of heavy grazing pressure but are slow to establish.

The main legumes sown up to 1980 were Siratro and Schofield stylo. Persistence of both under continuous grazing was poor and neither could survive in waterlogged soils. The saying of that time, 'sensitive weed is my best legume', was mostly a cynical comment but it was also true as sensitive plant did, and still does, add a lot of nitrogen to heavily grazed coastal pasture systems.

Today the new stylos and the four jointvetch legumes offer better persistence and production options for sustainable pasture systems. The most recent centro (Cardillo centro) roots down much more at the nodes forming a more dense sward and climbs less than common centro. More information and options for sown grass and legume pasture species is available in Chapter 5.

7 Establishing and managing sown pasture systems

This chapter describes and provides information on the processes and activities involved in developing a productive and sustainable sown pasture grazing system.

Planning

Planning is a key component of any pasture development activity and needs to start well ahead of planting time. Figure 3 in Chapter 3 presents a basic framework for property/enterprise planning and for developing pasture-fed beef production systems. The desired outcome should be a strategic part of the property management plan and whole of enterprise business plan. Careful planning will greatly enhance the process of developing productive and sustainable sown pastures and the economic success of the beef enterprise.

Planning steps when developing new sown pasture systems:

- Mark the development site or paddock on your property map
- Determine land type(s) and soil type(s), soil drainage, slope/streams, tree/vegetation cover and status, cattle watering points, fence lines, current or potential weed status/ threats, etc.
- Arrange for soil testing at the site and where applicable check if a permit for weed or woody regrowth control is required
- Select pasture species mixture based on land type, site conditions and class of animals/target market (growing, breeding, fattening/ finishing or a combination of all three); or an alternate use such as hay, agistment, water-way, leys rotation, land stabilisation, nutrient filter belt, etc. (See Chapter 6 for a

Developed coastal tea tree country with emerging tea tree regrowth problem

guide to selecting pasture species and mixtures)

- Erect any required fencing prior to planting the pasture
- Measure and record paddock size so seed requirements and stocking rate can be calculated accurately
- Calculate number of cattle the pasture area will safely carry and still meet target market
- Attend a 'Stocktake' workshop on forage budgeting and setting stocking rate based on pasture supply and demand. Monitor stocking rates to ensure good pasture and land condition and to maintain sustainable economic production.

Establishing sown pastures

The pasture establishment phase is probably the most important event in developing sustainable sown pasture systems. Successful rapid establishment ensures a healthy pasture that will deliver sustainable production while maintaining land condition. Poorly established pastures will deliver low production and declining land condition. It therefore warrants as much planning, care and attention as possible, within time and cost constraints.

Establishment processes (seed-plant-pasture)

Pasture establishment occurs in three phases:

1. Seed germination and seedling emergence (1 to 4 weeks).

The seed takes up moisture from the soil and the primary root (radical) and primary stem (plumule) emerge to create a secure, independent seedling.

2. Plant establishment (1 to 4 months). Grasses form their characteristic fibrous root system until onset of tillering (multiple stems) and legumes form their characteristic tap root and secondary roots. This allows the new seedling to obtain its moisture and nutrient requirements from the soil and photosynthesis begins in the leaves. The green chlorophyll in the leaf traps the sun's rays to convert the water and nutrients, taken from the soil, into starches that provide energy for plant growth.

3. Pasture development, consolidation and sward thickening into a permanent pasture (1 to 3 years). This is the period of rapid plant growth, development of tillers or secondary branches, spread of stolons/runners, and the occurrence of first flowering and seed set. During this phase seed production allows new seedlings to fill in gaps and replace any weak or dying plants, thus maintaining a dense healthy pasture sward. A dense pasture sward greatly helps to minimise weeds, increase rainfall penetration and effectiveness, reduce runoff and improve water quality entering the streams.

Rainfall following sowing is usually the critical issue with regard to successful pasture establishment. As rainfall, outside of irrigation, cannot be controlled efforts must concentrate on providing optimum conditions for establishment, which are;

- Treat sowing of pastures as if planting a crop

- Prepare best possible seed bed for the particular site; fine but not powdery, and firm not loose and cloddy
- A wet soil profile prior to planting (if possible) will greatly improve establishment success
- Select species best adapted to site and conditions
- Plant at recommended seeding rates (seed cost is small when compared to total cost of pasture establishment)
- Use high quality seed and check germination percentage
- Sow shallow (no deeper than 1 cm or 3/8") and distribute seed evenly
- Minimise weeds during establishment process.

Seedbed preparation

A good seedbed is friable and fine enough to allow good contact between seed and soil but not so fine and powdery to crust following rain. A clean seedbed will reduce competition for the germinating sown seed. The soil seed reserves from any pre-existing grass and broadleaf weeds can be reduced by allowing weed seeds to germinate following first rain then spraying with a herbicide before sowing pasture seed onto surface and rolling seed into soil. This can be done several times but caution is required if using glyphosate (*Roundup*) herbicide on light soils to avoid any possibility of residue risk. Weed seed banks can also be reduced using shallow cultivation but each cultivation will bring fresh weed seeds to the surface. Both methods will also increase pasture establishment costs. Sown seed may be left on the surface to be covered by soil at first rain, rolled into the soil with a light roller or by using a light harrow or drag-chain. Most pasture seed is small and burying it greater than 1 cm deep may reduce establishment, particularly for some grasses.

In situations where land has been cleared of tea tree or some eucalypt country and not followed up by deep (15 to 20 cm or 6 to 8") cultivation with disk or blade ploughing, any subsequent sucker or seedling (woody) regrowth may require attention prior to seed bed preparation. Treatment and control of woody weed regrowth areas prior to renovating the area to a sustainable pasture production system must be done in accordance with current vegetation management legislation.

Seed quality

When purchasing seed remember to check seed quality; ask for a copy of a recent seed analysis report. Review the purity of seed being purchased (percentage) as opposed to inert, non-seed matter and other seeds including 'weed seeds' (prohibited seeds are listed in the report). The germination test shows the number of seeds that produced normal seedlings, based on laboratory tests.

Purity multiplied by germination percentage gives the percentage of pure live seed, which is the best indicator of seed quality. **If seed has 80% purity and 60% germination, pure live seed content is only 48%.**

Inexpensive seed may prove much more expensive when compared on a 'pure live seed' basis.

Pelleted seed

Commercially pelleted seed allows easier handling and distribution of fluffy grass seed, such as Rhodes grass, Bisset and the various blue grasses. Pelleting of legume seed and free flowing grass seed (signal, Tully, setaria, panics) is generally not necessary. Sometimes insecticides, fungicides, fertiliser or legume inoculums can be included in seed coat on request. However with most pelleted seed the sowing rates need to be increased as pelleted seed usually contains much less 'live seed' per kilogram than non-pelleted seed. The 'live seed' percentage should be requested when purchasing pelleted seed.

Legume seed inoculation

Seed of some legumes require inoculation with a specific rhizobium bacteria prior to sowing, to ensure the legume plants can fix nitrogen via their root systems (clovers, creeping vigna, Lotus, centro, forage peanut, desmodiums, Caatinga stylo, leucaena). Other legumes can nodulate and fix nitrogen from 'common' rhizobia already in the soil (stylos, American and villose jointvetches, siratro, butterfly pea). However when planting into 'new' country not previously growing legumes it is recommended all legume seed be inoculated with the appropriate rhizobia, available from seed outlets.

Molybdenum (Mo) is a very important soil trace element to ensure vigorous legume growth via effective root nodulation and nitrogen fixation. Healthy root nodules should be pink in colour; pale green nodules indicate ineffective nitrogen fixation which may indicate molybdenum deficiency.

Mo is best sprayed directly onto bare soil prior to sowing of the legume based pasture. Sodium Molybdate is the form recommended for spray-on application and should be applied at a rate of 100 to 200 g/ha of elemental Mo, mixed in water and boom spray or aerial apply every 3 to 4 years. Foliar spraying in established pastures should be timed when the pasture has been heavily grazed. Broad-acre spraying onto well grown, bulky pasture can cause cattle to ingest the sprayed on Mo and concentrate it into small 'patch' areas of the paddock, via their urine. Molybdenum Trioxide can be used as a seed coating with lime but is not suitable for spray application (detailed information on molybdenum is available in Incitec Pivot AGRITOPIC January 2005, or www.incitecpivot.com.au). The earlier traditional method of applying Mo to single super phosphate is no longer a real option, for reasons of cost (transport from SEQ) and the difficulty to achieve even distribution of the Mo.

Pasture planting methods

The aim is to apply the pasture seed mixture evenly over the whole site/paddock, at the recommended sowing rate, with the seed lightly covered. Most pasture seed is small and burying it greater then 1 cm or 3/8" deep can reduce establishment, particularly with grasses.

Options for distributing seed include:

- *Contractors* - Particularly for larger development or if you have limited equipment. Stock and Station or Rural Supply Agents/Companies usually offer soil sampling and testing, supply of seed and fertiliser and ground or aerial application of both.
- *Combine seeders or air-seeders* -This option may require modifications to suit smaller pasture seed.
- *Fertiliser spreaders* - Grass seed and legume seed not requiring inoculation can be mixed with fertiliser, but inoculated legumes require an inert carrier such as cracked grain, bran, sand or sawdust. However, evenness of spread is difficult to achieve with a fertiliser spreader.
- *Roller drum seeders* - Can put different seed sizes in different compartments.
- *Crocodile seeders* - Similar to roller drum principal but 'rolling' cylinder has 'lugs' that scoop small holes in ground to catch seed as machine travels along; usually used where a ploughed seedbed cannot be prepared, or where sowing legumes into native pastures or rundown sown pastures.
- *Bucket brigade* - Suitable for smaller areas of several hectares, use a 'carrier' mixed with seed.

It is important to calibrate for correct seed application rate prior to sowing, for whatever machine or method is used. If difficulty is experienced the machine supplier or Rural Supply Agent should be contacted for assistance.

Best time of year to plant pastures

Obviously the best time to plant pasture seed would be just before three to five consecutive days of steady rain with similar follow-up rain within two to three weeks. During the 1970s and 1980s recommendations were to sow seed from late October through to December, to catch early storms so the pasture was established earlier and was thus better able to handle likely wet and waterlogged periods during January and February. Early planting also resulted in quicker establishment and the pasture could be stocked/grazed by the end of the wet season after the first seed crop had dropped.

There now seems to be a higher risk of prolonged hot and dry heat-wave periods between less frequent early summer storms over the past two decades and germinating seedlings can die if the soil profile is not wet-up prior to sowing pasture seed. Another risk of sowing in early summer is strong competition to establishing pastures from broadleaf and other common weeds, which have a bigger soil seed-bank and seem to germinate and establish faster then pasture seedlings. Late summer, autumn sown pastures have less competition from weeds but often do not set seed, are not fully established, and can only be lightly grazed until the second summer.

This drier and more variable weather pattern during the 1990s and onwards has made when to plant a bit of a guessing game! However, over the past decade and currently there

has been a lot of research studies and development of new weather forecasting models, systems and approaches to assist landholders with land management decisions relating to seasonal weather forecasts. Examples include Southern Oscillation Index (SOI) and Madden Julian Oscillation (MJO) or '40-day wave'. Believers and optimists can access more information from Climate Note at www.dpi.qld.gov.au/climate or through the DPI&F on 13 25 23.

Fertilising sown pastures

The majority of soils in the MW region are phosphorus deficient and applications of phosphorus are required for both pasture growth and for animal growth and production. Virgin coastal tea tree country is usually very low in phosphorus (around 3-5 ppm bicarb P), as well as low in potassium and molybdenum. Although friable earth soils on the coastal undulating and low hilly country, originally supporting rainforest and eucalypt vegetation, have better physical properties (for example Hay Point, Kuttabul and Habana areas) some of these soils in their virgin state can still be phosphorus deficient. The upland rainforest areas are inherently fertile but fertility rundown has occurred because of clearing and development to dairy pastures. Fertiliser application, and ongoing fertiliser maintenance, is required on all soil types to maintain pasture condition and meet animal production targets.

With any new pasture development, whether from sugar cane to pasture, new land to pasture, or renovation of previously pastured areas, a soil nutrient analysis (soil test) is recommended as an integral part of the pasture development and ongoing pasture maintenance process. Attention to fertiliser requirements is good insurance against pasture establishment failure. Expenditure on land and seedbed preparation, plus the cost of seed and its distribution, is wasted if pastures are not adequately fertilised. An enterprise with limited funds should only sow an area that its budget can accommodate, as per the enterprise business plan, rather than reduce fertiliser application rates.

Phosphorus increases the liveweight gain of animals for the following reasons:

- Increased pasture **yield** (higher dry matter production)
- Increased pasture **quality** (higher protein and P content in grasses and legumes)
- Increased pasture **digestibility** (higher conversion of pasture to beef).

For strong, healthy, beef pastures, the ideal phosphorus level is around 15 ppm (bicarbonate) in the top 10 cm or 4" of soil. Higher input dairy pastures and pasture-fed beef production systems generally aim for greater than 20 ppm P. Once the surface soil drops below 10 ppm P, pasture yield and quality, and animal performance, has already start to decline.

How much fertiliser?

Previous experimental work and experience has shown that for sustainable pasture and cattle production a minimum application of around 20 kg/ha of phosphorus (approximately 100 kg/ha of Triphos or DAP or 200 kg/ha of straight Superphosphate) is required at planting for grass legume mixed pastures. A similar application is required at the beginning of the second year to build soil P reserves. If sowing grass-only pastures Di-Ammonium Phosphate (DAP) can be used as it has 18 percent nitrogen (as well as 20 percent phosphorus) and will boost grass growth. A further application of 100 kg/ha Urea (45 percent Nitrogen) in autumn (March/May) will keep grass growing longer into the cooler weather. In grass-legume pastures the legumes provide the nitrogen and legumes retain higher protein as they mature, relative to grasses.

When extra nitrogen fertiliser is applied regularly to grass pasture, or when grass-legume pastures are receiving higher inputs of phosphorus, these pastures will also need extra potassium (K), probably a minimum 50 kg/ha/year of muriate of potash) depending on soil potassium status as per soil analysis. Pastures with high fertiliser inputs require regular soil testing to monitor all nutrients, with particular attention to calcium, sulphur, molybdenum and copper.

Soil acidity should also be monitored under high input management systems, as high rates of nitrogen can increase the risk of acidification via N-leaching. Optimum pasture growth is achieved from soils with pH6 to pH7 (slightly acid to neutral). The economics of liming pastures is doubtful unless soil acidity is in the low pH 5's. High fertiliser input systems could expect a pasture growth response to the element calcium, or the raising of pH by liming which can make trace elements more readily available to pasture plants.

Grazing management

The key to good grazing management is matching forage availability with forage demand and adjusting stock numbers accordingly. The amount of forage available does not equal total pasture grown. Arriving at the end of the dry season with no forage (pasture) on the ground (eaten bare) means this pasture has already been given a severe shock, whether native or sown pasture.

Under continuous heavy grazing any surviving desirable pasture plants will have small root systems and be slow to re-start growing when rain does arrive. Pastures will also be slow to develop sufficient leaf area to replenish their root system energy reserves. There will be a lot of bare ground providing an opportunity for weedy species to establish/re-establish from high reserves of weed seed already in the soil. When first rains are substantial and the ground surface is bare, the resulting runoff will transport the fertile surface soil (as sediments) into the creeks and rivers and out to the reef. The resulting runoff, erosion and increase in weed growth are the start of declining pasture and land

The continuously grazed and ageing paddock of Callide rhodes grass (right) has been invaded by Parramatta grass, a weedy sporobolus grass. The pangola grass (on the left) remains weed free.)

condition, and subsequently, declining animal production. If repeated annually, the land and enterprise income earning capacity will decline and remedial management costs will greatly increase.

To achieve pasture production systems that are economically sustainable, ensure your property comes out of the dry season (including droughts) with pasture stubble on the ground. This 'stubble' is not wasted pasture but rather an essential part of a healthy sustainable production system.

Grazing principles for the establishment year

- No grazing until plants have developed a strong root system; budget for little animal production in first year. A short duration light grazing pre-flowering of sown species, to 'knock down' weeds and open pasture to more light, may be an advantage.
- Withhold grazing once grasses and legumes start to flower to maximise seed set and seed fall and ensure future seedling re-establishment. In a new pasture, good management can turn a two to four kg/ha seed investment at sowing into a 100 kg/ha return to the soil seed-bank with one good seed set.

KEY TIP

Grazing systems are often a personal choice, with many types and combinations used. However, stocking rate has a greater influence on animal production than the grazing system used.

Utilisation affects pasture growth; continuous heavy grazing of above ground plant leaves and stems will greatly reduce below ground plant root systems.

Grazing system options

- **Set stocking** (constant number of cattle per paddock or per property, every year)
- **Variable stocking rate** (adjusting cattle numbers based on pasture forage available)
- **Continuous grazing** (cattle in paddock all year round)
- **Rotational grazing** (varying from time-control or cell-grazing to some form of summer-spelling system).

Grazing management tips and sayings

- What you see above ground (leaf growth) is what is happening below ground (roots); pasture plants continually grazed short have small root systems
- Stock light enough that you don't go into shock when it hasn't rained for a few months
- When animal performance starts to slip, pasture condition has already deteriorated
- More enterprises go broke from over-grazing than from under-grazing
- There are three main causes of pasture degradation; over-grazing, regular over-grazing and continuous over-grazing.

Grazing and land management tools

Two grazing land management education packages and workshops, originally developed for native pasture grazing lands, are now being customised for catchment regions that utilise more intensive sown pastures production systems (Coastal Intensive GLM Package 2).

These workshops present and discuss a range of principles and activities that optimise pasture and land condition and the flow-on to economic and sustainable pasture-fed beef production systems. Land owners and managers are encouraged to use their local experience, knowledge and skills to test and adapt these principles to their specific conditions on their property and to apply what works best for them.

1. **The Grazing Land Management (GLM) Education Package** is a MLA EDGEnetwork® workshop delivered over three days. This workshop builds on the participating graziers' understanding of their properties and the way they manage them. An out-of-doors follow-up day provides the opportunity to discuss processes and progress.

The GLM workshop covers:

- Grazing resources of land and vegetation (ecosystems) and the factors that affect grazing lands (climate, grass, trees, cattle, fire) and things that make grazing lands tick (soils, plants, graziers)
- Tools available to manage land condition and enhance diet quality

Grazing Land Management and Stocktake workshops introduce land owners and managers to a range of grazing management options and tools that can be adapted and applied to suit their own property conditions.

(managing grazing, using sown and native pastures, managing weeds, managing tree-grass balance, using fire)

- How to combine this knowledge to develop a grazing land management plan.

2. **The Stocktake (Balancing forage supply and demand) Workshop** is a paddock-scale land condition monitoring and management package developed by DPI&F. It involves one day of interactive sessions developed to provide grazing land managers with a practical, systematic way to assess land condition and long-term carrying capacity, and to calculate short-term forage budgets. In other words, the workshop helps participants 'take stock' of their grazing resources and points to improved management decisions.

Weed management in pastures

By definition a weed is a plant out of place. Weeds in sown pastures include broadleaf plants and grasses that are less palatable than the sown species. Weeds decrease diet quality and animal carrying capacity. Weeds also compete with sown species for soil moisture and nutrients. Because most weeds are not grazed they grow faster and can quickly dominate pasture systems. Weeds can be a cause of and a symptom of poor pasture/land condition.

KEY TIP

A competitive vigorous grass pasture is the most effective deterrent to weed infestations

Practices to lessen weed problems when establishing sown pastures

- Good seedbed preparation. Where the seedbed is known to have high weed seed soil reserves, allow a couple of germination events followed by herbicide spray-out prior to sowing improved pasture seed mixture.
- Use adequate seeding rate to get quick and full ground cover.

- Mix a fast establishing grass (such as rhodes grass) when sowing a known slow establishing grass (Tully humidicola or pangola grass by runners).
- Ensure adequate fertiliser is applied for maximum pasture growth and seed set.
- Broadleaf weeds are more easily controlled with herbicides in early growth stage. Act early, 'one year's seed is seven years (plus) weeds'.
- Graze lightly, with regular spelling, in the year of establishment and allow sown species to set a good seed crop for ongoing regeneration from seedling plants.
- In subsequent years, avoid overgrazing to ensure adequate stubble and litter on ground for healthy pastures. The majority of weeds are relatively poor competitors and thus adequate and healthy pasture will greatly reduce germination and establishment of any weed seed already in the soil; 'weed prevention is better than a subsequent cure'.
- Where existing pastures are experiencing some weed competition, the strategic application of low rates of N (55 kg/ha or 125 kg/ha of urea) early in the wet season (Dec/Jan) can increase the competitiveness of the grass sward. Herbicide application and pasture spelling (post N application) may be required where weed pressure is high.

Two particular weeds are a serious threat to the sustainability of pasture grazing systems in the Mackay Whitsunday region:

- **Introduced weedy sporobolus grasses**, including Giant Rats Tail Grass (GRT), and
- **Sicklepod**, a non-nitrogen fixing annual legume that seeds profusely with seed remaining viable in the soil for around 20 years or more.

It is important that these weeds be recognised. On properties that don't have these weeds, every effort should be made to ensure the property stays that way. Land owners/managers should work 'day and night' to eradicate small areas of these weeds. It is necessary to develop a whole-of-property weed/pasture/grazing land management plan and be fanatical and persistent with control and reduction measures on properties with large areas, to prevent weed spread to clean areas.

Information Fact Sheets on risk, management and control of most weeds are available on the Department of Natural Resources and Water and website - www.dnr.qld.gov.au/factsheets/pests/.

Other information sources include:

- Local Shire Council weeds officers
- DPI&F on telephone13 25 23 and local DPI&F Extension Officers
- Stock & Station and Rural Supply Agents/Companies
- Neighbouring properties

8 Special purpose pastures

Most sown pasture systems are rain grown, paddock grazed systems. However there are many uses for sown grass and legume species and this chapter describes some alternative or 'special purpose' systems.

Irrigated pastures

(abstracted from DPI&F note; Agdex 134/20)

Grazing irrigated pastures can be a relatively cheap form of feed-lotting for beef cattle. Irrigated pastures are intensive systems and need careful and specific management. Irrigated pasture systems do not incur the costs of cartage and handling of feed material. However, establishment and production maintenance costs are high, so good pasture management and marketing of the target beef product is needed.

Irrigating selected grasses and fertilizing with high rates of nitrogen (N) provides the most productive, water efficient and cost effective scheme. Combined grass and legume pasture mixtures will provide good live weight gains per animal but cannot sustain increased stock numbers, relative to irrigated grass plus N pastures. Therefore grass plus N pastures are more water efficient.

When planning for a full year of irrigation, 8 to10 ML of water per hectare should be budgeted for. Rainfall at the right time would reduce irrigation needs, particularly in the summer months of December to the end of March for the Mackay Whitsunday region. Water supply is always limited and costly to apply so water use efficiency is of prime importance.

Tips

- Ensure all soil nutrients are in adequate supply at all times (annual soil testing)
- Match forage system to suit animal needs to meet target market product (include cold tolerant grasses for winter production; Callide rhodes, setaria, ryegrass)
- Excess forage can be baled for hay (on the Mackay Whitsunday coast the winter to spring period is more favourable for hay making then the summer months).

Nitrogen requirements

(see next section 8.2 High fertiliser input on grass pastures)

Suitable species (more information Chapter 5)

- Rhodes grass varieties (Callide most productive)
- Bisset creeping blue grass
- Jarra and Strickland digit grasses
- Pangola grass
- Setaria (Solander or Kazangula for better autumn/winter production)
- Ryegrass (for winter production).

High fertiliser input / intensive nitrogen on grass pasture systems

Pastures sown with a grass and legume mixture with moderate soil phosphorous (P) levels of around 10

to 12 ppm P should carry one adult equivalent (AE of 450kg liveweight) per hectare/per year, with weight gain of 160-180 kg. With 'bag' nitrogen, 50 to 180 kg N per hectare\year on grass only pastures, plus higher inputs of phosphorus (soil levels of 15 to 20 ppm P) should carry two to four AE's/ha/year with similar liveweight gains. Supplementary irrigation could again increase carrying capacity but expect some loss of per animal weight gain. Obviously these high input systems produce high LWG/ha.

With regular and increasing applications of phosphorus and nitrogen, particularly where irrigation is used, it will become necessary to apply other soil nutrients such as potassium, calcium (lime), sulphur and possibly trace elements. With high input systems soil and plant testing/analysis should occur each year to ensure nutrient deficiencies are not limiting production, for both plants and animals.

Reasons for using high input production systems

- increased overall carrying capacity of property
- increased opportunity to meet more target product markets
- increased flexibility in managing other native or sown pasture paddocks
- improved weed control/management through stronger pastures
- increased pasture quality and carrying capacity in weaner paddock
- increased pasture growth and quality longer into winter months
- increased quantity and quality from pasture hay paddocks
- increased water use efficiency of irrigated pasture systems.

A summary of MW producer demonstration sites using high N on grass is in Appendix 11.4

Hay crops

The MW climate (wet and humid summer and showery autumn) is a significant impediment to commercial hay production. However, many grazing enterprises make late autumn pangola grass hay from summer spelled pasture paddocks. There are also quite a few commercial hay enterprises producing mainly grass hay but some legume hay as well. The best quality hay is usually produced with supplementary irrigation during the winter and spring months. Some enterprises concentrate on wrapped pasture silage which allows more flexibility during autumn when persistent showers can be expected.

Most pangola grass hay (two to five months growth) is used for feeding weaners in cattle yards during the two weeks immediately following weaning. This pangola hay maintains its palatability and reasonable quality. Together with supplements, such as M8U (molasses plus urea), weaners maintain body weight and the process is a key management strategy to quieten weaners and get them familiar with working through the stock yards and crush as well as being 'tailed' out to graze pasture paddocks close by.

Sown grasses used for hay production

include pangola grass, rhodes grasses, Bisset creeping blue grass, and Strickland and Jarra finger grasses. However any of the sown grasses grown in the Mackay Whitsunday region would make reasonable pasture hay if cut at pre or early flowering growth stage. The quality of grass hay depends on soil P, N levels and stage of maturity when cut.

Lucerne (*Medicago sativa*) is not a legume for hay production in the Mackay Whitsunday region. Hot, humid and/or wet summers lead to heavy grass invasion and lucerne is very susceptible to waterlogging and root diseases. Even in well drained soils the new 'tropical' lucernes virtually act as an annual crop due to grass invasion and reduced summer growth. Although legume hay has higher protein content and therefore demands a higher price, it normally yields less than grass hay on an annual basis, and costs more to grow and make.

Alternative legume hay crops include common stylo (Stylhay), butterfly pea, soybean, cowpea and lablab (see species details in Chapter 5).

Fertiliser requirements

All coastal soils are low in phosphorus (P) and potassium (K). Some are low in calcium (Ca) and may need the addition of lime. Typical requirements are 20 kg of P and 50 kg of K per hectare. For high production add nitrogen (N) at 50 kg/ha/cut. Liming at one tonne per hectare every three to five years is required if calcium levels are low, or if the pH is below 5.5.

Hay production extracts lots of nutrients from the soil, relative to grazing, as the entire crop is cut and removed from the paddock. For sustainable production these nutrients need to be replaced. Annual maintenance fertiliser requirements are 20 kg/ha of P and 50 kg/ha of K and for production, 50 kg/ha of N per cut (50 kg N is obtained from 110 kg urea). With irrigation, more cuts per year are achieved and this may require the addition of more P and K. It is good insurance to get a soil test done each year, or every two years for lower input systems, to determine exact fertiliser requirements.

Yield

In rain-grown situations on the Mackay coast, annual production of 18 to 20 tonnes per hectare is common from pangola and Callide, Rhodes grass. With irrigation and using more nitrogen, production could reach 40 tonne per hectare. Adverse weather conditions and low fertiliser use will limit hay production. The price received for grass hay depends on seasonal demand and supply. Most grass hay is used for weaner or drought feeding purposes. It is not used for production feeding.

Vender Declaration Forms should accompany all sales or trading of hay, to ensure declared or nuisance weeds (weedy sporobolus grasses, sickle pod, grader or thatch grasses, parthenium, others) are not spread and to protect sellers' reputation and purchasers' confidence.

More information on hay making, including the process, is available via the DPI&F web site, Prime Notes CD, or on 13 25 23.

Pasture leys/short term pastures

There is an increasing demand for tropical pasture species that present minimum weed potential especially on properties where sugar cane farming and cattle grazing are integrated land uses. An increasing number of cane enterprises throughout Queensland are adopting the new farming system practise of moving away from cane monoculture and integrating short term legume leys and complementary crops or medium term pasture leys on fallowed cane land.

Bundaberg cane farmer Andrew Howlett believes the days of cane monoculture are over. Due to low cane prices he successfully trialled peanuts as a complementary crop but is planning to rotate back into cane. However, peanuts will remain part of his cane and cropping mix (Australian Canegrower Vol. 28, No. 4 2006, p. 20).

Gordonvale (north Queensland) cane growers John and Helen Amadio have integrated their horse breeding operation into their cane fallow management program. They now establish pastures on their fallow blocks and sometimes keep the fallow pastures for two years (Australian Canegrower Vol. 28, No. 4 2006, p. 13). There is an increase in the number of central region cane farms planting legume 'green manure/break' crops as well as soybean seed and peanuts as 'cash' crops.

Species options
(more information Chapter 5)

Short term legume leys:

- Cowpea
- Soybean
- Lablab
- Stylhay
- Burgundy bean
- Butterfly pea.

Medium term grass / legume leys (two to three years):

- Callide rhodes grass - very quick to establish, high drymatter yield, late flowering
- Jarra and/or Strickland finger grass - quick establishment, very palatable to stock, less aggressive than pangola grass, sensitive to waterlogging
- Villomix - a companion legume but seeds early and may regenerate when returned to cane
- Stylhay or Burgundy bean.

Ground cover pastures (horticultural and forestry tree crops)

The benefits of ground cover pastures to horticultural and forestry tree crops can include weed control, erosion control, soil improvement through addition of organic matter and nitrogen, and provision of grazing once trees crop has established. Depending on the tree crop type, ground cover pastures can compete for available moisture.

Species options
(more information Chapter 5)

- Forage Peanut, Pinto or Prine (shade tolerant)
- Villose jointvetch, Villomix
- Caribbean stylo, Verano
- Greenleaf desmodium
- Signal grass, Tully humidicola, Green panic, Competidor paspalum, Blue Dawn paspalum (all shade tolerant).

Tolerance

(more information Chapter 5)

- **Salinity** - Rhodes grasses, pangola, Floren (not as tolerant as rhodes)
- **Cold** - Kazungula and Solander setaria, rhodes grasses, Kikuyu, Ryegrass, Clovers, creeping vigna, Lotus
- **Shade** - Signal grass, Tully humidicola, Green panic, Competidor paspalum, Blue Dawn paspalum, Pinto and Prine forage peanut
- **Waterlogging** - Tully humidicola, pangola, Kazungula setaria, Paspalum grasses, Glenn and Lee American jointvetch (high), Villose jointvetch (moderate), Pinto and Prine forage peanut
- **Grazing** - Tully humidicola (very high), pangola and African star grass (high), Signal grass, Bisset (moderate). Kazungula setaria, Glenn jointvetch and Villose jointvetch, Stylos.

Leucaena/grass grazing systems on the 'wet' coast

(more information Chapter 5)

There are well publicised, very successful, productive, profitable and sustainable leucaena pasture grazing systems, based on three cultivars of *Leucaena leucocephala* subsp. glabrata (Tarramba, Cunningham and Peru), growing on deep fertile clay soils predominately west of the coastal ranges. Many coastal soils are shallow and infertile with acid reaction (less than pH 6). In addition, the sap sucking psyllid insect is most common in coastal areas, and can delay new spring growth of leucaena by six weeks.

Currently there are no leucaena grazing systems, or properties with recognised successful leucaena grazing systems, on the Mackay Whitsunday coast. This indicates that leucaena, as a pasture production system for cattle grazing, is currently not adapted to this region. There is plenty of leucaena visible along many of our coastal road networks, but most, if not all, is a type that found its way to Australia in the late 1800s (often referred to as 'feral' leucaena).

There is some interest from landholders in growing leucaena under irrigation on the coast. Also, research being conducted by the University of Queensland is aiming to develop a leucaena variety that is more tolerant of acid soils and psyllid attack, and has lower seed yields. It is due for release in 2008-09.

The 'feral' leucaena seen on coastal roadsides is *L. leucocephala* subsp. *leucocephala*. It is a smaller tree with less leaf and sets plenty of seed early. **It is not recommended for grazing systems**. Due mainly to its visibility on roadsides, plus spread into water courses and creeks, many local councils and community groups perceive all leucaena as a serious environmental weed.

Leucaena Code of Practice (see Appendix 11.5)

It is extremely important that anyone planting leucaena as a grazing system becomes familiar with and implements the Leucaena Code of Practice. This code has been developed by The Leucaena Network (made up of commercial leucaena growers) and is made available with all purchases of leucaena seed. The intent of the code is to demonstrate that landholders are using and managing their commercial areas of leucaena responsibly, with respect to environmental weed issues. The key issue is to reduce seed dispersal via grazing management.

Pasture management for horses

Source: Feeding horses in Australia: A guide for horse owners and managers by John R. Kohnke, Dr. Frank Kelleher and Dr. Penny Trevor-Jones. RIRDC Publication No. 99/49. 242 pages. This book is available for sale from DPI&F offices for $36.10, or free on the web.

Horses are hard on pastures. Unlike cattle, horses have upper incisors and mobile lips which enable them to selectively and heavily graze pastures. 'Horse' pastures are easily recognised because they have alternating areas of heavily and lightly grazed pasture. This pattern is referred to as 'lawns' and 'roughs'.

A large proportion of the Australian horse population is owned and managed on small land holdings ranging from one to four hectares, many of which become seriously degraded by continuous grazing by horses. This is likely to result in 'horse sick' pastures, soil erosion and compaction, and severe soil mineral imbalances by nutrient transfer between grazed 'lawns' and dunging 'roughs'.

Many commercial beef properties also run their horses in designated horse paddocks. Problems similar to those on small holdings can occur in these pastures.

The owners of small land holdings face the greatest challenge in achieving a desirable level of pasture feeding, simply because they lack adequate land area and/or have too many horses to allow paddocks to be rotated effectively enough to prevent degradation. In these cases it is better to confine individual horses to small yards and to maximize the pasture area available on the remainder of the land.

The pasture area should be subdivided with temporary fences and individual horses allowed a period at pasture each day, either singly or in company, depending on paddock size and the nature of the individual horses. As

with larger holdings, paddocks should be rotated on a regular basis to avoid overgrazing and to allow the pasture to recover.

Cattle can be used to even out the grazing in horse paddocks, especially if used in rotation on a seasonal basis. This may also aid in breaking parasite cycles. Fire also has a role in native pastures. During periods of drought or slow pasture growth, it may be necessary to exclude horses from the pasture areas completely.

Pasture requirements

Horses require/eat as much or more pasture then do cattle. An adult equivalent (AE) beef animal (450 kg live weight) is equivalent to a (14-15 hands) stock horse. An AE beef animal requires approximately 1 ha of rain grown sown pasture (that receives moderate fertiliser inputs) on a per-year basis. With higher fertiliser inputs, irrigation and supplements the carrying capacity can be increased; but do be aware that horses need a lot of grass.

Information on the **risk of 'big head' in horses grazing tropical pasture grasses** is in appendix 11.6

Water requirements for cattle and horses

The amount of water livestock consume is subject to considerable variation. Consumption depends on the type, age and condition of the animal; available fodder; climatic conditions; and the quality of the water. The following table provides a guide to the amount of water that cattle and horses might be expected to consume each day (litres).

Further information is available from Tim Biggs, DPI&F, Gatton QLD 4343 or DPI&F on telephone 13 25 23.

	Average daily consumption	Peak daily consumption
Type of cattle		
Dairy cows in milk	70	85
Dairy cows in dry	45	60
Beef cattle	45	60
Calves	22	30
Type of horses		
Working	55	70
Grazing	35	45

9 Weeds and legislation

(abstracted from MWNRM Plan 2005, section 6.5 Pests)

Pest plants (weeds) are those plants growing in the wrong place at the wrong time. Weeds usually spread rapidly and produce unwanted economic, environmental or social impacts. They may have been accidentally or intentionally introduced into an area, or could be native plants that have become weedy due to inappropriate management. Some of the major negative impacts of weeds include reduced land condition, competition with pastures, reduced grazing potential, toxicity to stock, reduced water quality, lower ecosystem/biodiversity values and affects on human health.

Weeds can be classified on different levels of priority or significance based on invasiveness, impacts, potential spread, and their economic, environmental and social aspects:

- **Weeds of National Significance** (WONS) - 20 WONS are recognised with nine WONS occurring in MW region (Table 7).
- Within Queensland **(State) Declared Weeds**, under the *Land Protection (Pest and Stock Route Management) Act 2002 (LP&SRM) Act 2002*, are plants that are or could have significant economic, environmental and social impacts. This legislation has Class 1 and Class 2 weed categories and aims to prevent the introduction and establishment of new weeds, prevent the spread of established weeds and reduce the extent of existing weeds where feasible. Class 3 weeds are referred to as environmental weeds.
- All Local Government Shires currently need to develop Pest Management Plans (plant and animal). These plans are broken into two sections including a strategic plan (an overview of the Shires goals and priorities) which is reviewed every four years, and an annual action plan which is reviewed yearly. Local governments also have the ability to locally declare, under a subordinate local law, significant pests not currently declared under State legislation.

All local councils now have designated Pest Management Officers, to implement Shire pest management plans. These officers are responsible for maintaining roadsides, and other council public lands, free of declared pests. Local Pest Management Officers are a good source of information to landholders on identification and managing pests. They have an important role and are responsible for implementing the State Government's (LP&SRM) Act 2002. Under this Act it is the Landholders responsibility for pest management and thus the Pest Management Officers role is to ensure all landholders within the region are meeting their pest management obligations.

The Mackay Whitsunday Regional Pest Management Group was initiated in July 2002 to focus all individual stakeholder pest planning and activities on common agreed strategic outcomes. Stakeholders involved include Local Shire/City Councils (Mackay, Broadsound, Nebo, Mirani, Sarina, Whitsunday); Department of Natural Resources and Water; Queensland Parks and Wildlife Service; Ergon Energy; Queensland Rail; Department of Main Roads; Mackay Areas (Cane) Productivity Service; Agforce; Sarina Landcare Catchment Management Association; Whitsunday Catchment Landcare; Pioneer Catchment

and Landcare Group; and the Mackay Whitsunday Natural Resource Management Group.

In 2004 the Regional Pest Management Group came to a consensus on a prioritised list of both Declared and Non-State Declared pest plants currently occurring within the Mackay Whitsunday Region. Table 7 shows the State declared pest plants, indicating those that are also WONS and shows the priority allocated by the Regional Pest Management Group.

More information on pest plants and animals appears in the Mackay Whitsunday Natural Resource Management Plan 2005; Section 6.5 p. 72 to 78 and Appendix 6 p.138-141 lists a very wide range of local pest and environmental plants/weeds.

Table 7. State Declared Class 1-3 Pest Plant Priorities in the Mackay Whitsunday Region

Priority	Common name	Scientific name	State declared class	WONS
1 #	Mimosa pigra	*Mimosa pigra*	1	✓
2 *	Rats tail grass – Giant rats tail grass, Giant Parramatta grass, Parramatta grass, American rats tail grass.	*Sporobolus pyramidalis, S. natalensis, S. fertilis, S. africanus, S. jacquemontii.*	2	
3	Sicklepods – Sicklepod, Hairy senna	*Senna obtusifolia, S.tora, S.hirsuta*	2	
4	Parthenium	*Parthenium hysterophorus*	2	✓
5 #	Hymenachne	*Hymenachne amplexicaulis*	2	✓
6	Rubbervine	*Cryptostegia grandiflora*	2	✓
7 #	Salvinia	*Salvinia molestra*	2	✓
8 #	Water hyacinth	*Eichhornia crassipes*	2	
9 #	Water lettuce	*Pistia stratiotes*	2	
10	Singapore daisy	*Sphagneticola trilobata*	3	
11	Bellyache bush	*Jatropha gossypifolia*	2	
12	Prickly acacia	*Acacia nilotica*	2	✓
13	Parkinsonia	*Parkinsonia aculeata*	2	✓
14	Giant sensitive plant	*Mimosa invisa*	2	
15	Mother of millions	*Bryophyllum* sp.	2	
16 #	Cabomba	*Cabomba* sp.	2	✓
17	Broadleaf pepper tree	*Schinus terebinthifolius*	3	
18	Captain cook bush	*Thevetia peruviana*	3	
19	Harrisia cactus	*Eriocereus* spp.	2	
20	Lantana	*Lantana* spp.	3	✓
21	Tobacco weed	*Elephantopus mollis*	2	
22	Chinee apple	*Ziziphus mauritiana*	2	
23	Thunbergia	*Thunbergia grandiflora*	2	
24	African tulip	*Spathodea campanulata*	3	
25	Dutchmans pipe	*Aristolochia sp.* Other than native sp.	3	
26	Asparagus fern	*Asparagus aethiopicus, A. africanus, A. plumosus*	3	
27	Cats claw creeper	*Macfadyena unfuis-cati*	3	
28	Prickly pear	*Opuntia* spp. Other than *O. ficus-indica*	2	
29	Camphor laurel	*Cinnamomum camphora*	3	

* Note: Currently there are five *Sporobolus* species declared under the *Land Protection (Pest and Stock Route Management) Act 2002* including *Sporobolus pyramidalis, S. natalensis, S. africanus, S. fertilis, S. jacquemontii.* Difficulties arise at all levels identifying between these five species. *S. pyramidalis and S. natalensis* are priority 2 within this region, however the remaining species may fall below priority 2, dependent on the shire/city council.

Aquatic weeds

10 References and resources

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Wills, A.K. and Baker, D.E. (1988) Plane Creek Sugar Cane Land Suitability Study, QDPI Land Resource Bulletin QV88003.

Other information sources and further reading

- Mackay Whitsunday Natural Resource Management Plan 2005. Can be obtained via the MWNRM Office, 38 Tennyson Street, Mackay Qld 4740, website: www.mwnrm.org.au, via email at admin@mwnrm.org.au, or phone 07 4953 5298.

- DPI&F website www.dpi.qld.gov.au. Useful links include:
  - Plant industries>Field crops & pastures>pastures
  - Animal industries>Beef >Beef pastures>Stocktake for information on forage budgeting and assessing land condition and long term carrying capacity
  - Plus lots of other beef industry information.
- Available for sale from the Queensland Government bookshop online at www.publications.qld.gov.au, by phoning DPI&F on 13 25 23, Fax 61 7 3246 3534, Email: books@dpi.gov.au
  - DPI&F Prime Notes CD and a wide range of books.
  - Managing a beef business in the subtropics (2004). DPI&F, Queensland. ISBN 0-7242-0270-2.
  - Plants of central Queensland (2003). E.R. Anderson. Department of Primary Industries and Fisheries, Queensland. ISBN 0 7345 0249 4.
  - Managing southern speargrass: a grazier's guide (1993), I.J. Partridge. DPI&F Qld. ISBN 0-7242-5389-0.
- DPI&F newsletters
  - Beeftalk - Taking stock of your future (prime news and views for beef producers of south east Queensland), a bi-annual newsletter.
  - Northern muster - Taking stock of your future (prime news and views for beef producers of north Queensland), a quarterly newsletter.
- Tropical Grasslands Society www.tropicalgrasslands.asn.au/pastures. For extensive lists of grasses and legumes, each with sketch of stem, leaf and seed head plus brief description and characteristics.
- Tropical Forages, an interactive selection tool; www.tropicalforages.info/. A detailed International database containing descriptions of sown pasture species listed in alphabetical order by scientific names; or purchase as CD from Tropical Grasslands Society via e-mail, tgs@csiro.au
- Incitec Pivot AGRITOPIC January 2005, or (www.incitecpivot.com.au) for information on Molybdenum.
- NRW website for weed legislation and Fact Sheets (description, threat to land, vegetation and pasture): www.nrm.qld.gov.au/pests/.
- Using herbicides on lantana, a guide to best management practices (2006) NRM&W ISBN 1 74172 112 1. Copies from landcentre_warehouse@nrm.qld.gov.au or phone 07 3896 3224.
- Weeds in Australian Cane Fields; Part A, a guide to identification of weeds. BSES Bulletin No. 28 1989. This publication is now out of print but for cane farmers and others who have a copy it is a very useful publication for identifying and controlling common grass and broadleaf weeds of the region. The Mackay Area Productivity Board is planning to update this 'Weeds' guide but updates may only be accessible to levy payers via their web site.

Appendix 11

1: Native pasture communities (types) in the MW Region, pre-development

Role of native pastures

Although native pastures originally provided the main source of forage for grazing animals in this region, they now play a relatively minor role as grazing enterprises rely predominantly on sown pasture systems. Remaining areas of native pasture in the MW region occur mainly in the hilly range country where slope and shallow soils, forest/woodland vegetation and the dry winter/spring climate rule out cropping options and conditions are not favourable for replacement pastures. Small areas of coastal tea tree country also remain undeveloped. However some of these native pasture areas have been modified by over-sowing the native grasses with legumes such as the stylos and the jointvetches to improve pasture quality and their grazing productivity. Refer Chapter 3 for more information.

Of the 14 broad native pasture communities defined for Queensland, based on aggregation of 35 vegetation zones (Weston 1988), only three are present in the Mackay Whitsunday region;

Pastures sparse or absent

Closed forests and two coastal communities, namely rainforest, littoral and heath, are grouped together because they have limited usefulness for animal production in the natural state. Rainforest has few grasses until cleared and sown to introduced pastures. However, much of the region's remaining rainforests are contained in national parks, state forests or timber reserves. Although the littoral (marine) areas contain a rich ground flora, these pastures have a low productive value. The exception is on some tidal flats where valuable seasonal grazing is obtained from *Sporobolus virginicus* (marine/sand couch) and *Paspalum distichum* (water couch). Prominent soils in the rainforest areas are friable earths and fertile loams; in littoral zones they are plastic clays and texture contrast soils with grey clayey subsoils; and in heath areas, infertile sandy earths. This pasture community would have originally occupied approximately 30 percent of the Mackay Whitsunday catchment region.

Blady grass (*Imperata cylindrica*)

Blady grass includes a composite of sandy coastal lowlands and undulating low hills with open forest and woodland communities. The major trees are *Melaleuca* (tea tree/ paper bark) species, *Eucalyptus* and *Corymbia* species and *Lophostemon* (swamp mahogany) species. The characteristic grasses are *Themeda triandra* (kangaroo grass), blady grass and *Heteropogon triticeus* (giant spear grass). Soils are generally infertile, mostly with a shallow A horizon and an impervious B horizon in the duplex profiles. Intensive use, as in cane growing, is only possible in soils with deeper top soil and where much of the remaining area has been sown to improved pastures. This blady

grass pasture community would have originally occupied approximately 30 percent of the Mackay Whitsunday catchment region.

Black spear grass (*Heteropogon contortus*)

Black spear grass is the most extensive native pasture community in the Mackay Whitsunday region. Woodlands and open forests on undulating plains and low hills to higher range areas to the west of the catchment. Tree vegetation consists mainly of *Eucalyptus* spp. (*E. crebra* / *E. drepanophylla* (Iron bark), *E. mollucana* (Grey gum / Gum topped box), *E. tereticornis* (Blue gum / Forest red gum), *Corymbia tessellaris,* (Moreton bay ash / Carbeen). Induced by management practices, black spear grass (*H. contortus*) is the most characteristic native grass species, although *Bothriochloa bladhii* (Forest blue grass) and *Themeda triandra* are dominant in some parts of the community. While black spear grass occurs on almost all soil types, a lot of its area is confined to shallow and infertile texture contrast soils and earths. Most areas have been modified, some extensively, by tree ring barking or poisoning and sowing of improved pastures. This pasture community would have originally occupied approximately 40 percent of the Mackay Whitsunday catchment region.

2: List of sown pasture species for the MW region

Sown grasses

Most common

Rhodes grass (*Chloris gayana* cvv. Pioneer, **Callide**, Samford, Katambora, Topcut, Finecut, Nemkat,)

Signal grass (*Brachiaria decumbens* cv. Basilisk)

Tully humidicola (*Brachiaria humidicola* cv. Tully)

Bisset creeping blue grass (*Bothriochloa insculpta* cvv. **Bisset**, Hatch)

Pangola grass (*Digitaria eriantha* subsp. *pentzii*, previously *Digitaria decumbens*)

All five grasses are capable of high production, provide good dense ground cover and, with appropriate management, compete well with weeds.

Alternative and previously planted grasses

Digit or finger grass (*Digitaria milianjiana* cvv. Jarra, Strickland)

African star grass (*Cynodon nlemfluensis*)

Angleton grass (*Dichanthium aristatum,* common or Bloomsbury strain, cv. Floren)

Indian blue grasses / Indian 'couch' / pertusa (*Bothriochloa pertusa* cvv. Medway, Dawson and strains Keppel / Yeppoon, Emerald, Bowen)

Setaria (*Setaria sphacelata* var. anceps cvv. **Kazungula**, Nandi, Norok, Solander, Splenda)

Guinea grasses:

- *Megathyrsus maximus* (Syn. *Panicum maximum*), cvv. Riversdale, Makueni, Hamil, Coloniao, common)
- Green panic (*Megathyrsus maximus* (Syn. *Panicum maximum* var. *trichoglume*) cvv. Petrie, Gatton)

Elephant grass (Pennisetum purpureum cv. Capricorn)

Paspalum grasses:

- Paspalum, (*Paspalum dilatatum*, no recorded cultivars)
- Plicatulum, (*Paspalum plicatulum* cvv. Rodd's Bay, Bryan, Hartley)
- Hi-gane, (*Paspalum atratum* cv. HiGane)
- Brunswick grass, (*Paspalum nicorae* cvv. Blue Dawn, Blue Eve)
- Bahai grass (*Paspalum notatum* cvv. Pensicola, Competidor, Argentine, Riba)

Molasses grass (*Melinis minutiflora*, no cultivars registered)

Kikuyu grass (Pennisetum clandestinum cvv. Whittet, Crofts, Breakwell, Noonan)

Potential problem grasses (Introduced and native)

Broad-leaf paspalum (Paspalum wettsteinii cv. Warrigal), is very unpalatable.

Grader grass (*Themedaquadivalus*)

Thatch grass (*Hyparrhenaia rufa*)

Scented top (*Cappillipendium spicegerum*)

Forest blue grass (*Bothriochloa bladhii*)

Water grasses

Para grass (*Brachiaria mutica*)

Aleman grass (*Echinochloa polystachya* cv. Amity

Hymenachne grass (*Hymenachne amplexicaulis* cv. Olive

All introduced water grasses are now considered 'environmental weeds' in Queensland, and State government policy restricts planting para and other species such as Aleman grass and Hymenachne in sensitive wetlands.

Sown legume species

Most common

Stylo:

- Common stylo (*Stylosanthes guianensis* var. *guianensis*, new cvv. Nina, Temprano; old cvv. Graham, Cook, Endeavor, Schofield)
- Caribbean stylo (*Stylosanthes hamata*, cvv. Verano, Amiga)
- Shrubby stylo (*Stylosanthes scabra* cvv. Seca, Siran)
- Caatinga stylo (*Stylosanthes seabrana* cvv. Unica, Primar)

Jointvetch:

- American jointvetch (*Aeschynomene americana* cvv. Glenn, Lee)
- Villose jointvetch (*Aeschynomene villosa* cvv. Reid, Kretschmer; marketed as Villomix)

Alternative and previously planted legumes

Centro:

- *Centrosema mollo* (Syn. *Centrosema pubescens*) cvv. Cardillo, Common
- *Centrosema pubescens* cv. Belalto

Siratro (*Macroptilium atropurpureum* cv. Aztec)

Glycine (*Neonotonia wightii* cvv. Tinaroo, Clarence, Cooper, Malawi)

Butterfly pea (*Clitoria ternatea* cv. Milgarra)

Round-leaf Wynn cassia (*Chamaecrista rotundifolia* cv. Wynn)

Forage peanut:

- Pinto peanut (*Arachis pintoi* cv. Amarillo; nine other cultivars in The Americas)
- Rhizoma forage peanut (*Arachis glabrata* cv. Prine; eight other cultivars in Florida and one in South Africa).

Hetero (*Desmodium heterophyllum* cv. Johnstone)

Temperate and cool-season legumes

White clover (*Trifolium repens* cvv. Haifa, Ladino, El Lucero, Kopu)

Subterranean clover (*Trifolium subterranean* cvv. Clare)

Kenya white clover (*Trifolium semipilosum* cv. Safari)

Creeping vigna (*Vigna parkeri* cv. Shaw)

Lotus (*Lotus uliginosus* (synonym *L. pedunculatus*) cv. Maku Grasslands, Sharnae)

Greenleaf desmodium (*Desmodium intortum* cv. Greenleaf)

Silverleaf desmodium (*Desmodium uncinatum* cv. Silverleaf)

Short-term, ley or green manure legumes

Lablab (*Lablab purpureus* cvv. Rongai, Highworth, Endurance

Cowpea (*Vigna unguiculata* cvv. Ebony PR, Arafura, Meringa, Red Caloona, Kalkie)

Soybean (*Glycine max* cvv. Leighhardt, Y-Y)

Burgundy bean (*Macroptilium bracteatum* cvv. Cadarga, Juanita

Greenleaf Desmodium (*Desmodium intortum* cv. Greenleaf

Browse shrub legume

Leucaena (*Leucaena leucacephala* cvv. Taramba, Cunningham, Peru)

Potential problem legumes

Archer axillaris (*Macrotyloma axillare* cv. Archer; previously *Dolichos axillare*, has low palatability)

Round-leaf cassia (*Chamaecrista rotundifolia* cv. Wynn)

3: History and role of sown pastures in MW region

Liveweight gain from native pasture is low due to low quality of pasture in all but the early wet season (Bishop and Walker 1980). Experimental and demonstration work on introduced sown tropical pastures for the MW region progressed during the 1960s. This was followed by a period of rapid development of sown tropical pastures for beef and dairy cattle grazing, reaching a total of around 60 000 ha by 1979-80. Half of this development was undertaken by cane farmers with land surplus to cane requirements. Sown pasture development reached an annual peak of around 5000 ha in 1974-75. Beef cattle numbers in the Mackay Whitsunday region increased from around 80 000 in 1967 to towards 200 000 in 1980. This increase was largely attributed to the expansion of tropical pasture development and improved cattle breeds and improved herd management (Bishop and Walker 1980).

The most common grass planted at that time was Kazungula setaria, followed by Rodd's Bay plicatulum. Together they made up greater than 90 percent of the grass component of sown pastures, largely because of their reliability of establishment, adaptation to most conditions (wet and dry, low and high fertility) and long term persistence. Some of these original pastures are still productive today, 35 years on. However, very little Kazungula has been sown in the past decade, probably because other grass options are seen as easier to manage. During the normal summer wet season (of the 1970s) Kazungula quickly grew tall and ran to seed, fell over, ran to seed and fell over again, throughout summer. This built up a dense tangle of stems of low quality litter and smothered legumes, but it quickly sent up new green leaf growth and it was competitive with broadleaf weeds. In a grazing trial conducted on the 'Tedlands' property at Koumala in the 1970s, live weight gains of around 180 kg/year were achieved from Kazungula/siratro pastures stocked at 1 AE/ha. Similar performance was recorded for Kazungula plus nitrogen pastures, stocked at 2 AE/ha (Walker 1980). Rodd's Bay plicatulum is no longer sown because of its low palatability. However it is a safe tropical grass for horses.

Over the past decade Rhodes grass (mainly Callide variety) and signal grass have been the most planted grasses. Bisset creeping blue grass is also becoming popular for grazing and for hay. However these three grasses (signal, Rhodes and Bisset) are susceptible to (moderate) waterlogging. Pangola grass and Tully humidicola are very tolerant of waterlogging and of heavy grazing pressure but are slow to establish.

The main legumes sown up to the 1980s were Siratro and Schofield stylo. Persistence of both under grazing was poor and neither could survive in waterlogged soils. The saying of that time, 'sensitive weed is my best legume', was mostly a cynical comment but it was also true as sensitive plant did, and still does, add a lot of nitrogen to heavily grazed

Sensitive weed (Mimosa pudica) in run down sown pastures. Sensitive weed is a naturalised legume that adds a lot of nitrogen to the soil and pasture system but its dominance is a symptom of heavy continuous grazing and/or rundown in soil fertility, particularly phosphorus.

coastal pasture systems. Today the new stylos and the four jointvetch legumes offer better persistence and production options for sustainable pasture systems. The most recent centro (Cardillo) is promising; it roots down much more at the nodes forming a denser sward and climbs less than common centro.

Positive role sown pastures play in sustainable production systems

A farming or grazing system is said to be sustainable at the farm level if it 'satisfies the farm/grazing manager's needs over time while conserving the natural resource' (Gomez *et al.* 1996). Sustainable production systems include virtually all agriculture related land use enterprises in the landscape that rely on natural resources of land, vegetation, and water, and certainly includes cattle grazing, cropping, horticulture and agroforestry systems. Mining has a less obvious link with agriculture but certainly is a significant end-user of sown pasture technologies.

Given that ongoing broad-scale tree clearing is no longer an option to maintain or increase production for some properties, landholders will need strategies that optimize production from land already cleared. Sown pastures have an important role in achieving this outcome in a sustainable way.

The positive features of sown pastures include:

- Longer growing season means sown pastures retain nutrient value longer and animals gain weight for longer.
- Higher nutritive value in both grasses and legumes results in quicker liveweight gain, and meets market demand for younger age of turnoff.
- High dry matter yield, high seed yield, and capacity to increase soil organic matter, which means higher carrying capacity, cheaper, quicker and easier propagation, and less sediments and nutrients in runoff water.

- More tolerant of grazing, more competitive against weeds, and more cover on the ground.
- Can be used to lighten grazing pressure on native pastures during stress periods, on a whole property basis, resting native pasture in late summer to allow seeding.
- More responsive to fertiliser and moisture inputs which is sustainable for high and low input systems.
- Selected for adaptation to niche situations, such as climate (frost resistance), rainfall (drought or water-logging tolerant), shade tolerance (growing in fertile area under tree canopy), soil fertility, soil texture, etc.
- Selected for landscape stabilisation (creeping sward forming, less erosion).
- Helps deliver the healthy food that the community/consumers demand that is readily available, fresh, safe and reasonably priced.
- Can be an environmentally friendly alternative to grain feedlotting (high input pasture-fed grazing systems).
- Can maintain/improve the sustainability of farming land (ley pastures) through inputs of nitrogen and organic matter (Weston *et al.* 2000).

The uses and limitations of sown pastures in sustainable production systems include:

Uses

- Grazing, hay and silage crops.
- Ley pasture crop/pasture rotation (grain, horticulture, sugar cane, agroforestry).
- Water quality; erosion prevention, stabilisation of banks, roads, waterways, riparian filter zones to reduce sediments/nutrients entering streams.
- Mine site rehabilitation.
- Amenity parks, gardens, playing fields, etc. The annual value of turf sod and seed in Queensland is $50 to 60M (Loch 2003).
- Lifestyle blockies, hobby farmers, species available for small, intensive, high-input systems.
- Weed control (parthenium, GRT, Broadleaf, etc). Good pasture development/management is often the only economic management for broad scale weed outbreaks.
- Salinity, deep-rooted perennial grasses have important role in paddock and catchment hydrology (grasses and legumes have varying tolerances to salinity).
- Provide flexibility in property management planning.

Stresses and limitations on sustainability of sown (and native) pastures:

- Climate; total rainfall and its variability is a major challenge to sustainable pasture systems.
- Soil fertility; low phosphorus and plant rooting depth.
- Tree vegetation density; competition for light and moisture.
- Management; stocking pressure and long term stocking rate, fire, competing land uses.
- Excessive expectations by land managers; grazing too early, stocking pressure above land type

capability, not reducing stocking pressure to allow seed set, etc.

- Environmental weed threat; requires awareness of management practices to restrict spread away from sown target area.
- Human population growth; houses, towns and cities.

Critical issues, impacts and threats (to pasture and land condition)

Weeds are rated by the Mackay Whitsunday grazing sector as one of the major issues with regard to productivity, viability, and land condition. A highly variable rainfall, combined with cyclic commodity prices for beef and sugar, places extra land use management pressures on the grazing industry (largest extensive land use) and sugar cane industry (major intensive land use).

For the grazing industry, integrated whole-of-property management systems and tools for calculating, implementing and managing safe stocking rates is the critical issue in sustainable management and use of natural resources. Soil erosion, and thus sediment and nutrient loads in runoff water, is closely related to ground cover (Rayment and Neil 1996). Stocking rates need to be set on the basis of forage budgeting via the Stocktake workshop information package. Not all the pasture forage grown is to be made available for grazing. Some of the pasture dry matter produced needs to be retained for plant health and to achieve more than 70 percent ground cover.

4: Demonstration sites using high N Pasture-fed grazing systems

Producer demonstration sites:

To demonstrate the use of high rates of nitrogen on grass pastures, producer demonstration sites were established in the Mackay Whitsunday region between 1992 and 1996 with funding from Meat and Livestock Australia. Fertiliser from Incitec was spread by Crokers Rural and project managed by the Department of Primary Industries with then extension officer George Lambert as project leader. The aim was to improve the quantity and quality (protein) of the grass in order to fatten cattle while increasing stocking rates on that pasture from one beast per hectare to three or more beasts per hectare.

Background

Dairy farmers started using high rates of nitrogen fertiliser on rye grass pastures during the mid 1970s to boost autumn, winter, and spring milk production. Many coastal graziers were fertilising areas of pangola grass for several purposes such as hay making, weaner, hospital and holding paddocks. Most considered the practice uneconomic for fattening and doubted other grasses would respond the same way as pangola.

Method

Following farmer meetings held throughout the region four producer demonstration sites were established at Proserpine (Callide rhodes grass);

Bloomsbury (pangola grass); Koumala (pangola grass); and Mt Christain (signal grass). Following soil tests all other nutrient deficiencies were corrected and demonstration paddocks were fertilised with 180 kg N per hectare per year (equates to 400 kg Urea per hectare per year).

Summary

It must be noted these were demonstrations, not trials with replicated treatments, so summary points are generalisations only:

- Koumala – Steers on pangola fertilised with 180 kg N per hectare put on over 160 kg/ha/year stocked at 3 to 3.5 AEs/ha. In dry years stocking rate dropped to 2.5/ha.
- Bloomsbury – Comparing performance of pangola with 180 kg N/ha/yr and without N. Animal performance was about the same (150-160 kg/head/year), but carrying capacity was 3.1 and 2.0 animals/ha respectively. The fertiliser just paid for itself in the first two years but 1994 was a complete failure because of drought.
- Proserpine – Callide Rhodes with 180 kg N/ha. Stocking rate varied from 2.75 to 3.1 /ha according to dryness of the year. Steers were fattened and met Japanese specifications.
- Mt Christian – Signal grass and pangola grass was compared with 180 kg N/ha and stocked at 3.7 and 4.5 animals/ha respectfully. First year weight gains were disappointing with signal grass gaining 102 kg/head and pangola 131kg/head over 341 days when paddock was destocked due to lack of grass from dry conditions and the demonstration was not continued. Preliminary first year results suggest pangola can carry more stock and give higher LWG than signal grass.

5: The Leucaena Code of Practice

A Code of Practice for the Sustainable use of Leucaena/Grass Pasture Systems in Queensland

Purpose of the Code
(updated May 2006)

The Code aims to promote the responsible, sustainable and productive development of leucaena/grass pastures. It is essential that the Code be adopted by all graziers and natural resource management agencies.

Features of the Code

The Code targets those features of leucaena that predispose it to weediness and advocates management to limit their impact.

Aims of the Code

- Restrict leucaena planting near to potential weed risk zones
- Minimise seed production in grazed stands
- Diminish the risks of live seed dispersal
- Control of escaped plants from grazed stands.

Tenets of the Code

1. Plant leucaena ONLY if you intend to graze it and are prepared to manage it
2. Do not plant leucaena near creeks or major watercourses
3. Maintain a dense grass buffer between leucaena plantings and creeks or boundary fences
4. Control escaped leucaena seedlings and plants
   - on creek banks and other adjoining areas where cattle do not normally have access
   - on public roadsides (after first obtaining a permit from Main Roads or Shire Council)
5. Fully fence leucaena paddocks to avoid the unlikely risk of stock spreading ripe seed
6. Keep leucaena at least 10m away from external fence lines
7. Replant poorly established leucaena (can not be remedied by encouraging ripe seed drop)
8. Graze or cut leucaena to keep it within reach of animals and so minimise seed set
9. Graze leucaena strategically to minimise flowering and seed set
10. Establish vigorous grass in the inter-rows to
    - provide competition to minimise establishment of leucaena seedlings
    - use the excess fixed nitrogen the system produces
    - provide ground cover and prevent soil erosion
11. Do not plant leucaena in pure stands with no grass as
    - the system will be more prone to soil erosion
    - on light-textured soil this may cause soil acidification over time
12. Be familiar with any Local Law that may have been established, and assist your Local Government agency to identify any escaped or

feral leucaena so that action can be taken to control it

13. Give a copy of this Code to all who should have an interest in the responsible establishment and management of leucaena.

For more information contact The Leucaena Network:

Executive Officer
Ph. 07 4939 5711.
Email keithmcl@bigpond.net.au

6: Risk of 'big head' in horses

Big head in horses grazing tropical pasture grasses

Big head is a condition of horses and donkeys caused by a calcium deficiency. The condition is usually associated with introduced tropical pasture grasses. It occurs when oxalates in the grass bind calcium and prevent the horse from absorbing it. Cattle and sheep are not normally affected because rumen bacteria break down oxalates, freeing the bound calcium.

Signs of big head include:

- Lameness – animals appear stiff in the joints and have a shortened gait.
- Ill thrift – loss of condition on pastures which look nutritious.
- Swollen jaw bones – upper jaws, lower jaws or both.

Some or all horses on a pasture may develop big head. The disease can develop within two months of horses being grazed on hazardous pastures but commonly takes six to eight months. Mares and foals are more susceptible than stallions and geldings, but all can suffer from the disorder.

Which grasses are hazardous?

Cases of big head have occurred on introduced tropical grasses including buffel, green panic, setaria, kikuyu, guinea grass, para grass, pangola, signal grass and purple pigeon grass. The hazard is greatest when these grasses provide all, or almost all, of

the available feed. There is no record of the disease being caused by native grasses, introduced temperate grasses (such as ryegrass) or the sorghums. Safe tropical grasses include rhodes grass, the paspalums, the couches and creeping blue grass.

Author's note: Although pangola grass contains low levels of total oxalates, relative to Kazungula setaria, there are recorded cases of big head in horses grazing pangola grass for extended periods (McKenzie 2005). However there are many examples of horses in the Mackay Whitsunday region that have spent their life grazing pangola pasture, with no apparent access to other grass species or supplements, with no obvious symptoms (David Lemon, Mackay Vet and Ross Dodt, DPI&F; personal communications). So although pangola does not appear to be a major hazard for MW horses, due caution should be taken.

How can big head be prevented?

Use native pastures where possible. Horses should not graze hazardous pastures for more than one month. Horses can be grazed on these pastures if they have access to other 'no risk' pasture. If only hazardous grasses are available, encourage the growth of a legume component in the pasture to provide a source of oxalate-free feed, and provide a calcium and phosphorus supplement.

Mineral and supplement mixtures which will provide the required amount of calcium and phosphorus for horses include:

- 1 kg of low cadmium rock phosphate mixed with 1.5 kg molasses.
- 1 kg of a mixture of one third ground limestone and two thirds dicalcium phosphate (DCP) mixed with 1.5 kg molasses.

Either of these mixtures should be fed to each horse once a week. The molasses is used as a carrier and attractant. There is no cause for concern if horses eat a weeks worth of supplement in one or two days as it contains enough mineral to last them the full week. The weekly amount can be divided up and fed to horses each day if desired. Twenty kilograms of good quality lucerne hay will provide approximately the same amount of calcium and phosphorus as the above mineral mixtures. Other mineral mixes which provide a 2:1 calcium to phosphorous ratio can be used but are likely to be more expensive than rock phosphate or ground limestone and DCP.

The lameness and ill thrift caused by big head can be cured. Affected animals should be fed double the amount of mineral supplement outlined above for at least six months to replace the mineral lost from their bones. The swelling of the jaws may not fully disappear if the animal is severely affected.

For further information contact Dr Ross McKenzie DPI&F Yeerongpilly, QLD 4105 on 13 25 23.