QO96007

PROJECT REPORT

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Tactical Pasture Management: Enhancing Profits from Poplar Box Country

Principal investigators

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INTERNATIONAL WOOL SECRETARIAT

QUEENSLAND GOVERNMENT

DPI QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

ISSN 0727-6281
Agdex 130/10

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(DAQ.076)
Final Research Project Report

Roma and Toowoomba

Principal investigators

Richard G. Silcock, Trevor J. Hall

Department of Primary Industries
Queensland

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Executive Summary

The project aimed to assemble basic information to allow effective management and manipulation of native pastures in the southern Maranoa region of Queensland. This involved a range of plant studies, including a grazing trial, to quantify the costs of poor pasture composition. While the results focus on perennial grasses, we recognise the important dietary role played by broad-leaved herbs.

The plant manipulation studies focussed on ways to change the proportions of plants in a grazed pasture, eg. by recruitment or accelerated morbidity of existing plants. As most perennial grasses have a wide range of potential flowering times outside of mid-winter, rainfall exerts the major influence on flowering and seedset; exceptions are black speargrass, rough speargrass and golden beardgrass that flower only for a restricted period each year. This simplifies potential control options through reducing seedset.

Most non-grasses have a much narrower flowering period, controlled mainly by daylength. They also generally germinate at cooler temperatures, irrespective of moisture availability. Yellow daisyburr and wireweed saltweed did not germinate if maximum temperatures exceeded 30^{o}C. Many grasses, especially wiregrasses, germinated less completely at higher temperatures but were less stringent in their germination needs. Temperature still had a large effect on rate of germination and thus on emergence in the field.

Bluebells, stonecrops, cudweeds and spiked centaury come up freely in spring and autumn but not in mid-summer. These ephemerals, plus sedges and grasses with small naked seeds, eg. lovegrasses and dropseed grasses, have large, persistent seedbanks which dominate seedling populations after a drought. In contrast, many valuable perennial grasses such as forest bluegrass, mulga mitchell grass and Queensland bluegrass have short-lived seeds. Fortunately most wiregrasses also have short-lived seeds, and at the end of the 1992-94 drought had few viable seeds left. Woody shrubs and trees tend to have transient seedbanks, but herb legumes have small, very persistent banks. Species with transient seedbanks depend upon rainfall sequences that promote flowering, seedset and germination in close succession. Drought-weakened perennial pastures in the region need **two** consecutive good summers to fully rejuvenate.

No seedlings of golden beardgrass have been seen, yet it is common and sets viable seed. In mid-summer, seedlings of wiregrasses, woollyburr medic and many forbs are largely killed by damping-off fungi. Hence mid-summer rains will rarely result in recruitment of these plants, but will favour many other grasses. The report details the recruitment potential of over 20 native species. This information should assist graziers and extension officers in their management decisions.

Data from field growth studies of four pasture grasses have been used to refine the state pasture production model - GRASP. The model has been invaluable for assessing long-term drought and risk management options elsewhere in the state, and can now be used with confidence in the Maranoa. It mimics the active growth phase well but needs improvement to track declining pasture protein levels in winter. We provide detailed data on the forage value of many native species at different growth stages.: green wiregrass leaf is never very digestible and most forbs have highly digestible leaves that provide valuable protein in dry winters. Mayne's pest can no longer regarded as a weed in grazed pastures on the basis of our research.

The studies into ways to destroy or debilitate established ‘weed’ grasses concentrated on defoliation and root damage. Tall Jericho wiregrass must be defoliated to below 8cm to significantly reduce its seeding potential. This is not feasible with grazing by sheep because they normally avoid the plant, but fire may be an alternative when the plants are very dry. Opportunities to use fire are limited because wiregrass has little leaf and its stems stay quite green for much of winter and freshen up rapidly after spring rains. Wiregrass crowns are, however, readily uprooted by tugging at them or cutting off their roots, eg. with a shallow blade plough. As desirable grass species, such as buffel and Queensland bluegrass are relatively resistant to such damage, a light ploughing may suppress wiregrasses in a mixed pasture.

Wiregrass dominance in pastures on a sandy red earth reduced wool value by only 5-10% at Roma in 1994/95 when winters were very dry and grass seed problems were minimal. Losses were greater at high stocking rates where sheep could not select an adequate diet. Sheep avoided long wiregrass and did not eat even the new green shoots very often. Patch grazing will be a major management problem wherever rank grass accumulates, even with palatable species such as buffel grass. Wool from the wiregrass-dominated pastures was significantly finer but of weaker strength. However lower fleece weights and higher skirting rates usually more than counteracted this price advantage. Fleece growth rate fluctuations mirrored sheep bodyweight changes very closely, so wool production per hectare was driven overwhelmingly by stocking rate, provided there was sufficient pasture.

Rough ploughing of dense wiregrass on sandy red soils followed by sowing of buffel grass would be profitable at 1995 prices provided moderate to high stocking rates were used. If light stocking was needed to maintain the buffel pasture in good condition on poorer soils for 20 years, ploughing out thick wiregrass would not be a profitable exercise at any of the recent wool prices. An extra $3.16 per hectare income from wool was needed to generate an adequate cash flow from a mean stocking rate of 4.2 DSE/ha. This is too high a grazing pressure for sustainable use of such land.

Acknowledgments

The principal project investigators wish to thank the many people who contributed to the project’s achievements:- our technical staff who did much of the routine field and laboratory work; the laboratory group under Peter Martin at the Animal Research Institute, Yeerongpilly for the plant chemical analyses; our statisticians, Alison Kelly and Stephen Silcock; economist Jocelyn Sevil and IWS Queensland liaison officer Tony Montgomery. Particular thanks go to our co-operating land holders Alan Clark of “Euthulla” and Len Pearson of “Roselea”.

The financial support by woolgrowers through the International Wool Secretariat is gratefully acknowledged.

BACKGROUND

The dominant native pasture community of the Maranoa woodlands, *Aristida-Bothriochloa*, is a mosaic of pastures varying in composition with soil type but linked by a group of perennial, palatable *Bothriochloa-Dichanthium-Chloris* grasses and a group of unpalatable *Aristida-Eragrostis* grasses.

Wiregrasses are stalky, sharp-seeded and of low palatability. They provide little feed to sheep at most times. Likewise *Eragrostis* species (Lovegrasses) are stalky, of low nutritive value but set huge amounts of seed. In large numbers, they increase grazing pressure on the remaining palatable species. Wiregrass seeds can also cause serious wool contamination, reducing fleece values by 5-10%. Clearing of woodland has probably enhanced the quantity of wiregrass and lovegrass species in pasture because they are sunloving plants. Major changes in composition can seriously reduce the grazing potential of these lands and indirectly expose them to more sheet erosion and scalding. Further, once unpalatable perennials gain a hold they remain for long periods, even under conservative management.

The problem is exacerbated in the Maranoa where crop areas have increased nearly 40% in the last 15 years (Dalal *et al.* 1991) but sown pasture area and animal numbers have not changed. The result is increased grazing pressure on a diminishing area of native pasture and serious overstocking when dry seasons occur (Murphy *et al*. 1991). Weeds of cultivation, such as Maltese cockspur (*Centaurea melitensis), Pimelea* (flaxflower) and Mayne’s Pest (*Verbena tenuisecta*), have also invaded adjacent native pasture to an unacceptable extent.

The Native Grasses Workshop held at Dubbo in October 1990 (Grice 1990) recommended detailed studies of the biology, ecology and population dynamics of major native pasture species, plus development of economic management practices that can be used to manipulate pasture composition to maintain or improve productivity and stability.

This project proposed to rectify the deficiency in knowledge about the cost of poor pasture composition and to find ways to manipulate key perennial species of the *Bothriochloa-Aristida* pastures of Southern Queensland and Northern NSW. Key species are defined as common plants that are either important forage plants, valuable perennial soil stabilisers or undesirable plants with potential to invade or take over poorly managed pastures.

OBJECTIVES

The project had three main objectives.

1. **Understand life cycles and defoliation tolerance of the desirable and undesirable key species sufficiently to formulate decisive management principles for perennial grass pastures.**

2. **Quantify the economic cost to producers of a high proportion of undesirable grass species in native pasture, especially Wiregrasses and *Eragrostis* species.**

3. **Formulate management strategies for future grazing experiments designed to develop practical ways of achieving better composition.**

Project Sites

Most field work was conducted at the two grazing trial sites of "Euthulla" 20km NNW of Roma and at "Roselea" 20km S of Roma. Euthulla was an undulating site with a previous history of light grazing on one half and moderate to heavy grazing on the rest. It had scattered wilga and myall trees and a range of pasture composition depending on location within the landscape. The pasture was basically bluegrass/wiregrass but graded into buffel grass in places, bottlewasher grass (*Enneapogon* spp.) in heavily grazed patches and dense, coarse wiregrass in waterways. Soil samples from several places were characterised and analysed. The results are shown in Table 1.

At Roselea the site was gently sloping with an excellent buffel pasture on the lower part and a wiregrass-dominated buffel pasture on the upper part. It was largely treeless apart from a few bitterbark suckers and a big emuapple tree. The soil is a fairly deep, sandy red earth. Summarised soil data are given in Table 1. Both areas had been cultivated many years ago.

Table 1. Soil characteristics at the two main field trial sites

Soil Attribute	Roselea		Euthulla	
	Aristida	Buffel	Poor (Aristida)	Good (Blue grass)
Surface pH	5.5 - 6.0	6.5 - 7.0	6.9	7.1
Subsoil pH	9.3 - 9.5	5.3 - 9.5	9.0	9.0
Surface texture	Sandy loam	Loamy sand	Loamy sand	Loamy sand
Subsoil texture	Med. clay	Clay	Med. clay	Med. clay
Subsoil E.C. (mS/cm)	0.085	0.147	0.650	1.87
Avail. P 0-10cm (Bicarb ppm)	11	14	6	21
C.E.C. 0-10cm (meq %)	4	5	6	21
Org. C (%)	0.6	0.7	0.6	0.9
% K	0.31	0.46	0.76	1.01
% S	0.03	0.03	0.03	0.05
Exch. Ca (0-10cm)	1.30	2.30	2.20	11.00
Rooting depth (cm)	80	60	60	70
Plant avail water storage (mm)	68	50	92	124

Specialised studies on soil seed loads, plant crown damage, primary growth rates, seed germination, pasture quality etc. all centred around these sites or samples collected at these sites. Material from other sites was included as appropriate to give a broader regional perspective to the study's results.

1. KEY SPECIES STUDIES

1.1 Seed Germination Studies

Seed of 21 species was collected in March 1994 from the Roma district (see Table 2) and dried for a few days in paper bags in a glasshouse. It was then tested for potential germination under "typical" autumn temperature conditions (27°/15°C) in a laboratory germinator. Seeds were placed on filter paper in petri dishes and kept moist with tap water for 21 days. Fluorescent lights were on during the 27°C period each day. Germinated seeds were counted on days 3, 5, 7, 10, 14 and 21 and removed. Seeds were stored in the laboratory in paper bags between test runs. Seed of *C. fallax* was added from April 1995 after seed was collected near Flinton on 9/3/95.

Table 2. Species tested for seed quality and germination.

Species	Code	Common name	Perenniality
a. Desirable Grasses			
Bothriochloa bladhii	(bobla)	Forest bluegrass	strongly perennial
Chloris truncata	(chtru)	Windmill grass	weakly perennial
Chrysopogon fallax	(chfal)	Golden beardgrass	strongly perennial
Eriochloa pseudoacrotricha	(erpse)	Early spring grass	weakly perennial
Heteropogon contortus	(hecon)	Black speargrass	perennial
b. Intermediate value grasses			
Aristida calycina	(arcal)	Dark wiregrass	perennial
Aristida jerichoensis var. subspinulifera (early seed)	(arjere)	Tall Jericho wiregrass	perennial
Aristida jerichoensis var. subspinulifera (late seed)	(arjerl)	Tall Jericho wiregrass	perennial
Aristida platychaeta	(arpla)	Curly wiregrass	perennial
Bothriochloa decipiens	(bodec)	Pitted bluegrass	strongly perennial
Cymbopogon refractus	(cyref)	Barbwire grass	perennial
Enneapogon gracilis	(engra)	Common bottlewasher grass	weakly perennial
c. Undesirable Grasses			
Aristida muricata	(armur)	Coarse wiregrass	strongly perennial
Eragrostis molybdea	(ermol)	Granite lovegrass	perennial
d. Desirable Forbs			
Calotis lappulacea	(calap)	Yellow daisyburr	weakly perennial
Vittadinia sp. aff. *V. sulcata*	(vitt)	Fuzzweed	weakly perennial
e. Intermediate value forbs			
Einadia polygonoides (site A)	(eipola)	Wireweed saltweed	weakly perennial
Einadia polygonoides (site K)	(eipolk)	Wireweed saltweed	weakly perennial
f. Undesirable forbs			
Chrysocephalum apiculatum	(chapi)	Golden billybuttons	perennial
Malvastrum americanum	(maame)	Spiked malvastrum	perennial
Verbena tenuisecta (site R)	(vetenr)	Mayne's pest	weakly perennial
Verbena tenuisecta (site L)	(vetenl)	Mayne's pest	weakly perennial

The test was re-run in November 1994 under "typical" summer temperature conditions (35/20°C) to see what changes had occurred in germinability over winter. Subsequently, tests of germinability were done in April 1995 and October 1995 and, at each of these times, both cool (27/15°C) and warm (35/20°C) temperatures were run concurrently. Those species which were not germinating after 8 months were suspected of having water resistant seed coverings. So they were scarified with sandpaper after the 21st day and kept moist for a further 10 days. Those with low germinability were also assessed for caryopsis fill to see if that was the real limitation to high germinability.

Results

The viability of the seed samples varied considerably (Table 3). Some achieved almost 100% germination once the seed was mature, eg. wireweed saltweed. Others had generally poor levels of viable seed, eg. windmill grass, which could be attributed to collection at the wrong time or poor seed setting conditions in the field. Generally, we believe the latter was not the case. Some seeds had strong dormancy or hard seededness which prevented most unscarified seeds from germinating, even with optimal temperatures.

Table 3. Summarised seed quality and dormancy levels of seeds stored in a laboratory

Species	Quality	Dormancy
Desirable grasses		
bobla (For bgrass)	Fair	Slight for 9 mths
chfal (G/brd grass)	Fair; Low seed fill	Nil
chtru (Wmill grass)	Very poor; Low seed fill	Some for 9 mths?
erpse (Spring grass)	Quite good	Strong for 15 mths
hecon (Black spear)	Very good	Strong for 6 mths
Intermediate grasses		
arcal (Dark wgrass)	Poor	Nil
arjer (Jeri wgrass)	Good	Some for 6 mths
arpla (Curly wgrass)	Very good	Some for 12 mths
bodec (Pit bgrass)	Very good	Negligible
cyref (B/wire grass)	Very good	Nil
engra (Bwasher grass)	Very good	Signif. for 12 mths
Undesirable grasses		
armur (Coarse wgrass)	Good	Some for 12 mths
ermol (G lovegrass)	Very good	Strong. Hardseeded
Desirable forbs		
calap (Yell dburr)	Good	Strong for >6 mths
vitt (Fuzzweed)	Very good	Slight for 6 mths
Intermediate forbs		
eipol (W saltweed)	Very good	Strong for >6 mths
Undesirable forbs		
chapi (B buttons)	Very good	Nil
maame (Malvastrum)	Good	Strong. Hardseeded
veten (Mayne's pest)	Fairly good	Signif. for 6 mths

The effect of temperature on total germination was very different between species. Some were highly sensitive, eg. wireweed saltweed, others completely insensitive, eg. barbwire grass (Table 4). Hence time of year when rain falls is not important for germination of some perennial plants but is for others. Of the species tested, any with a strong preference liked cooler germination temperatures. Note how slow the *Aristida* spp. (wiregrasses) were to start germination (day 5 data) compared to many of the other strongly perennial grasses such as barbwire grass, black speargrass and pitted bluegrass (Table 5).

Scarification greatly enhanced germination of granite lovegrass (24-50%) and malvastrum (20-41%) but had no effect on windmill grass, dark wiregrass or spring grass. Switching moist seeds of fuzzweed, wireweed saltweed, yellow daisyburr and golden billy buttons from warm to cool temperatures after 21 days did little to enhance germination (1-3%). This was surprising in view of how well these species germinated normally at cool temperatures. A moist-heat-induced dormancy is suspected.

Table 4. Temperature sensitivity of germinating seeds of various ages

Species	Temperature effect	Temp. Preference
Desirable grasses		
bobla (For bgrass)	Nil	
chfal (G/brd grass)	Nil	
chtru (Wmill grass)	Nil	
erpse (Spring grass)	Nil	
hecon (Black spear)	Nil	
Intermediate grasses		
arcal (Dark wgrass)	Not tested	
arjer (Jeri wgrass)	Significant	Cool
arpla (Curly wgrass)	Significant	Cool
bodec (Pit bgrass)	Nil	
cyref (B/wire grass)	Nil	
engra (Bwasher grass)	Slight	Cool
Undesirable grasses		
armur (Coarse wgrass)	Significant	Cool
ermol (G lovegrass)	Nil	
Desirable forbs		
calap (Yell dburr)	Large	Cool
vitt (Fuzzweed)	Significant	Cool
Intermediate forbs		
eipol (W saltweed)	Very large	Cool
Undesirable forbs		
chapi (B buttons)	Large	Cool
maame (Malvastrum)	Nil	
veten (Mayne's pest)	Nil	

Seed lines with relatively low levels of seedfill were -

Forest bluegrass 22%
Spring grass 20%
Windmill grass < 5%
Golden beard grass 7%

Table 5. Germination levels (%) achieved during testing at ages of up to 18 months

Species	Mean germination		Best 21 day Germination	
	Day 5	Day 21	Warm temp	Cool temp
Desirable grasses				
bobla (For bgrass)	7.4	12.6	14.1	17.9
chfal (G/brd grass)	3.0	7.3	9.5	14.0
chtru (Wmill grass)	3.5	5.0	7.1	9.4
erpse (Spring grass)	4.0	6.1	15.3	17.7
hecon (Black spear)	30.3	31.3	44.4	45.6
Intermediate grasses				
arcal (Dark wgrass)	1.8	7.2	7.5	8.0
arjere (Jeri wgrass)	2.8	28.5	24.1	51.4
arjerl (Jeri wgrass)	0.9	26.8	12.5	56.5
arpla (Curly wgrass)	8.6	31.6	31.0	54.0
bodec (Pit bgrass)	39.3	55.4	59.2	67.8
cyref (B/wire grass)	33.3	50.8	46.7	51.3
engra (Bwasher grass)	14.0	32.8	42.4	58.6
Undesirable grasses				
armur (Coarse wgrass)	0.0	24.3	11.5	48.5
ermol (G lovegrass)	1.0	2.1	1.2	3.3
Desirable forbs				
calap (Yell dburr)	0.0	12.4	0.3	38.2
vitt (Fuzzweed)	6.2	30.7	10.7	60.3
Intermediate forbs				
eipola (W saltweed)	0.0	39.0	0.0	95.5
eipolk (W saltweed)	0.0	10.1	0.0	28.5
Undesirable forbs				
chapi (B buttons)	6.3	24.7	5.8	55.7
maame (Malvastrum)	0.3	1.3	1.8	2.7
vetenl (Mayne's pest)	0.3	16.7	24.6	21.4
vetenr (Mayne's pest)	0.3	16.7	34.0	37.0

1.2 Soil Seed Loads

Soil samples were collected from 11 Roma district locations on 30 March 1993 after a droughty 12 months, especially in summer (Table 6). Five of the same sites were resampled on 26 July 1994 after a reasonable summer and a dry autumn/early winter (Table 9). Ten samples were taken at each place, each sample being from a 10 x 10cm area to a depth of 2cm. Five were from bare spaces and 5 from areas covered by pasture litter. At some locations the samples were from adjacent paddocks that had very different recent management histories, eg. sown pasture vs cultivation.

The samples were sieved through a 5mm mesh to remove stones and large pieces of plant material, then spread about 2cm deep over a 15cm diameter pot which was three-quarters filled with washed sand. The pots were grouped on benches in an unheated glasshouse and gently overhead watered with town water. Watering continued daily for several weeks and was very thorough (several times a day) for the first week. Seedlings were counted and progressively removed as they became identifiable. In some cases, several months elapsed before an identity was possible at ripe seed set.

In most cases, the soil was then allowed to dry out and a repeat run done some months later to ensure the vast majority of viable seed was counted. The repeat runs were also needed to check for species with persistent seedbanks. The first sample was tested 3 times beginning 6/4/93, 19/1/94 (soil undisturbed) and 22/4/94 (resieved soil). The tests run on the second soil samples began on 5/12/94 and 15/4/1995 (redisturbed). Complete fertiliser was added to the sand to ensure healthy growth during repeat runs and to plants that had to be grown for months before they flowered.

Table 6. Location, sample dates and recent management history of soil seedload sites.

Property		Code	Vegetation	March 1993	July 1994
Holyrood	**H**	E.	Plant evaluation exclosure for 4 years	*	
(red earth)		C.	Edge of adjacent cultivation for 4 years	*	
		N.	Poplar box woodland (thinned, grazed)	*	*
		B.	Buffel grass pasture (>10 years old)	*	
Norton	**N**	C.	Plant evaluation exclosure for 7 years	*	
(grey clay-loam)		N.	Adjacent bluegrass pasture (thinned, grazed)	*	
Euthulla	**E**	A.	Dense wiregrass pasture (lightly grazed)	*	*
(brown duplex)		O.	Heavily grazed paddock adjacent	*	
Roselea	**R**	A.	Dense wiregrass pasture (lightly grazed)	*	*
(sandy red earth)		B.	Adjacent buffel grass pasture (well grazed)	*	*
Blythedale	**B**		Grassy poplar box woodland (stock route)	*	*
(brown loam)					

These test showed several things.

1. The main perennial grasses, including buffel grass, do not have large seed banks and they have negligible persistent seed.

2. Naturalised medics and flannel weeds have very persistent seedbanks due to hard seededness.

3. Seed banks of medics can be quite large (200-500 m^{-2}), especially woolly burr medic on loamy soils.

4. Small seeded plants with no husks around the fallen seed often dominate the persistent seedbank, eg. *Sporobolus*, *Eragrostis* and sedge species; *Wahlenbergia* (bluebells), *Centaurium* and *Crassula* spp.

5. Tree and shrub seedlings are generally slow to emerge and seem to require prolonged moisture before they germinate. Numbers of these emerging were extremely low.

Table 7. Seedling emergence in various months from soil samples taken near the end and after a drought at Roma

Site	Cover	MARCH '93 SOIL SAMPLE									JULY '94 SOIL SAMPLE					
		RUN 1 Apr '93			RUN 2 Jan '94			RUN 3 May '94			RUN a Dec '94			RUN b Apr '95		
		Ttl	% Ari	% per	Ttl	% Ari	% per	Ttl	% Ari	% per	Ttl	% Ari	% per	Ttl	% Ari	% per
Blythedale	**B**															
	Bare	86	5	2	2	0	0	30	0	0	127	44	7	38	5	0
	Litter	132	7	1	6	0	0	56	0	0	162	50	0	31	13	0
	Mean	109			4			43			145			35		
Euthulla	**EA**															
Aristida	Bare	96	4	7	1	1	0	28	0	0	114	32	15	58	26	3
	Litter	178	2	3	16	0	0	120	0	0	505	11	4	206	17	0
	Mean	137			9			74			310			132		
Holyrood	**HN**															
Native	Bare	212	0	0	9	0	0	87	0	0	21	24	5	18	0	0
pasture	Litter	647	1	0	19	0	0	348	0	0	283	12	28	39	3	3
	Mean	430			14			218			152			29		
Roselea	**RA**															
Aristida	Bare	120	7	0	7	0	0	15	1	0	61	31	0	49	65	0
	Litter	466	20	0	47	0	0	36	0	0	143	64	1	130	48	0
	Mean	293			27			26			102			90		
Roselea	**RB**															
Buffel	Bare	155	0	1	16	0	0	90	0	0	22	0	36	52	0	8
	Litter	368	0	2	7	0	0	175	0	0	261	1	94	168	0	63
	Mean	262			12			133			142			110		

NOTE: The main perennial grass for site EA is Qld bluegrass, for site HN mulga mitchell grass, for site RA wiregrasses, and for site RB buffel grass. Site B has a diverse range of perennial grasses.

Counts (**Ttl**) are for 500 sq cm areas.

% per = % of perennial grasses other than *Aristida* spp. (**Ari**)

6. Identifying seedlings at an early age (1 - 3 leaves) can be simple for some species eg. *Erodium crinitum* (blue crowsfoot) and *Pimelea trichostachya.* Others have to be almost flowering, eg. *Dichanthium sericeum* and *Sida* spp., while for sedges and some daisies, ripe seed is often needed to identify a species. In most cases, a family identity can be given quite early and soon after a genus name, so once the local vegetation is known, identifying young seedlings to genus level can be done fairly reliably.

7. The relative density of seeds after a good summer (July 1994 sample) compared to before that summer (March 1993) is shown in Table 7. Considering how much seed was on the ground in mid-1994, emerging numbers of *B. bladhii, H. contortus* and *Aristida* spp. were not great and no seedlings of *C. fallax* were recorded. The lack of *C. fallax* is in keeping with other studies by Orr and also McIvor in subcoastal areas where this species is quite common. Our work shows that *C. fallax* sets a reasonable amount of seed and that the seed is viable and will store for at least a year.

8. Wiregrass seedlings are very sensitive to damping-off in mid-summer as are seedlings of many dicotyledons which are normally regarded as winter herbs, eg. medics.

The major species emerging from the soil samples are listed in Table 8 below, broken up into cool season, aseasonal and summer germinators.

Table 8. Main species emerging from soil samples from poplar box country at Roma

Summer germinators		**Aseasonal**		**Cool season germinators**	
Purple lovegrass	E. lacunaria	Bottle washer grasses	Enneapogon spp.	Bluebells	Wahlenbergia spp.
Pigweeds	Portulaca spp.	Buffel grass	C. ciliaris	Stonecrops	Crassula spp.
Small burrgrass	Tragus australianus	Windmill grasses	Chloris spp.	Cudweeds	Gnaphalium spp. and allies
Flannel weeds	Malvaceae (Abutilon etc.)	Buffel grass	C. ciliaris	Yellow daisyburr	C. lappulacea
		Wiregrasses	Aristida spp.	Spiked centaury	C. spicatum
		Early spring grass	Eriochloa pseudoacrotricha	Woollyburr medic	M. minima
		Fringe rushes	Fimbristylis spp.		
		Slender sedge	C. gracilis		
		Mayne's pest	V. tenuisecta		
		Qld bluegrass	D. sericeum		

1.3 Plant Growth

(a) Flowering Time

Most native grasses grown in pots and kept well watered were capable of flowering at any time of year except mid-winter. However their flowering vigour was not great in mid-summer when day lengths were not altering much. In summer, flowering was suppressed and replaced by vegetative growth - new tillers and larger stems. In winter, growth largely ceased but many seedheads were quiescent on distinct stalks within the upper leaf bases and were thus susceptible to grazing. Key grasses with restricted flowering periods were golden beardgrass (*C. fallax*), slender bamboo grass (*S. verticillata*) and poverty grass (*E. bimaculata*)

Non-grass flowering patterns were determined by plant type, some being cool season growers and others warm season. Warm season growers such as the flannel weeds (Malvaceae) grow very little in winter and behave much like the grasses. The cool season ones such as saltweeds grow a lot of leaves in winter and stay fairly prostrate until early spring when they rapidly develop flowering stems and a much more erect habit. Thus grazing the latter in autumn and winter does not remove seeds or potential flowers. There are not many key species in this latter group.

(b) Observations of Seedlings

While waiting for seedlings to reveal their identity, we were able to make observations about their growth habit that are useful when considering management strategies. Many bluebells develop rhizomes prior to flowering, yellow daisyburr (*C. lappulacea)* and *Sida subspicata* regenerate well if cut off at ground level while quite young plants. Most sedges have a well buried crown which resists grazing while many wiregrasses do not. The exception amongst the wiregrasses is *A. leptopoda* and sometimes *A. ramosa*. *Stipa scabra* always has a deep crown and pitted bluegrass seedlings are also low-crowned compared to Qld bluegrass and black speargrass.

Aristida seedlings have a characteristic long, thin, erect, hairless first leaf which curves out at the tip while *Enneapogon* seedlings have a covering of short glandular hairs on a long, thin first leaf. *Chloris* species have a characteristic flattened main "shoot" which distinguishes most of them fairly early. *Eragrostis* spp. are usually thin leafed and hairy on at least 1 side of each leaf and often have knobs on the early leaf margins. Despite these early generic clues, these last 2 genera then depend on seedheads for certain identification. Leaf hairiness can be misleading in some genera, eg. *Dichanthium*, yet nodal hirsuteness can be quite helpful.

We consider development of a database for research workers on identifying seedlings would be a good idea, much like what has been done for the crop weeds, *albeit* with photographs (Wilson *et al.* 1995). With the development of CD ROM capability for displaying coloured images of high quality, this is possible and would be enhanced by being linked to a database or decision support module which was used to choose a subset of likely plants for visual display.

(c) Response to rainfall

Introduction

A pasture growth model "GRASP" has been developed by Qld DPI, based on studies from the subcoastal, southern speargrass region. A more robust statewide model is being produced to allow industry and Government to have tools to enhance management of native pastures in the longterm. Grazing trials such as the ones conducted as part of this project can provide the necessary data to support the broader industry aspirations. Therefore pasture production studies using the "Swiftsynd" methodology (McKeon *et al.* 1990) were done at both grazing trial sites. Very little data existed beforehand for the Maranoa region and this was a significant deficiency in Queensland's overall risk and drought management strategy.

This methodology was devised to give the minimum information needed to quantify the key process of pasture growth as influenced by climatic conditions, soil and species properties. Such studies will facilitate extrapolation of trial results to other locations and seasonal conditions.

Methodology

Small (15m x 15m) exclosures were established at both Euthulla and Roselea on areas representative of the major species/soil types in the trial paddocks. Three sites have been studied at Euthulla, buffel grass (*Cenchrus ciliaris*), wiregrass (*Aristida* spp.) and Queensland bluegrass (*Dichanthium sericeum*), and two at Roselea (buffel grass and wiregrass).

Table 9. Monthly rainfall (mm) at Roselea and Euthulla prior to and during the trials compared with Roma's long-term median and mean rainfall.

Roselea	**Jy**	**Au**	**Se**	**Oc**	**No**	**De**	**Ja**	**Fe**	**Ma**	**Ap**	**My**	**Ju**	**Year**
1992-93	10	8	29	18	25	24	11	17	0	0	0	27	167
1993-94	42	10	31	55	33	186	0	162	80	1	21	0	620
1994-95	0	0	0	74	60	80	98	93	6	0	32	42	485
1995-96	8	2	34	41	101	106							
Euthulla	**Jy**	**Au**	**Se**	**Oc**	**No**	**De**	**Ja**	**Fe**	**Ma**	**Ap**	**My**	**Ju**	**Year**
1992-93	8	25	30	22	28	82	5	42	1	4	50	0	297
1993-94	50	7	30	41	34	128	26	122	174	0	0	23	635
1994-95	0	0	0	66	36	32	10	217	35	0	40	29	557
1995-96	8	14	14	48	104	84							
Roma (117 years)	**Jy**	**Au**	**Se**	**Oc**	**No**	**De**	**Ja**	**Fe**	**Ma**	**Ap**	**My**	**Ju**	**Year**
Median	25	19	17	42	39	57	61	60	45	21	27	24	558
Mean	37	27	32	51	55	69	80	76	65	33	37	35	595

Regular measurements of rainfall, soil water, pasture cover, pasture yield and plant nutritional status were made. The grasses were separated into green and dead leaf and stem plus seedheads and samples analysed for nitrogen content. Total soil cover was subdivided into green and dead cover. Pasture height is recorded and soil moisture sampled at regular depths down the profile. Soil bulk density plus profile chemical and physical attributes were also collected at each site. Soil data was provided previously.

Results

Data from January 1993 to June 1994 has been used to tune the GRASP model. Later cuts were taken to provide a check against which the tuned model can be validated.

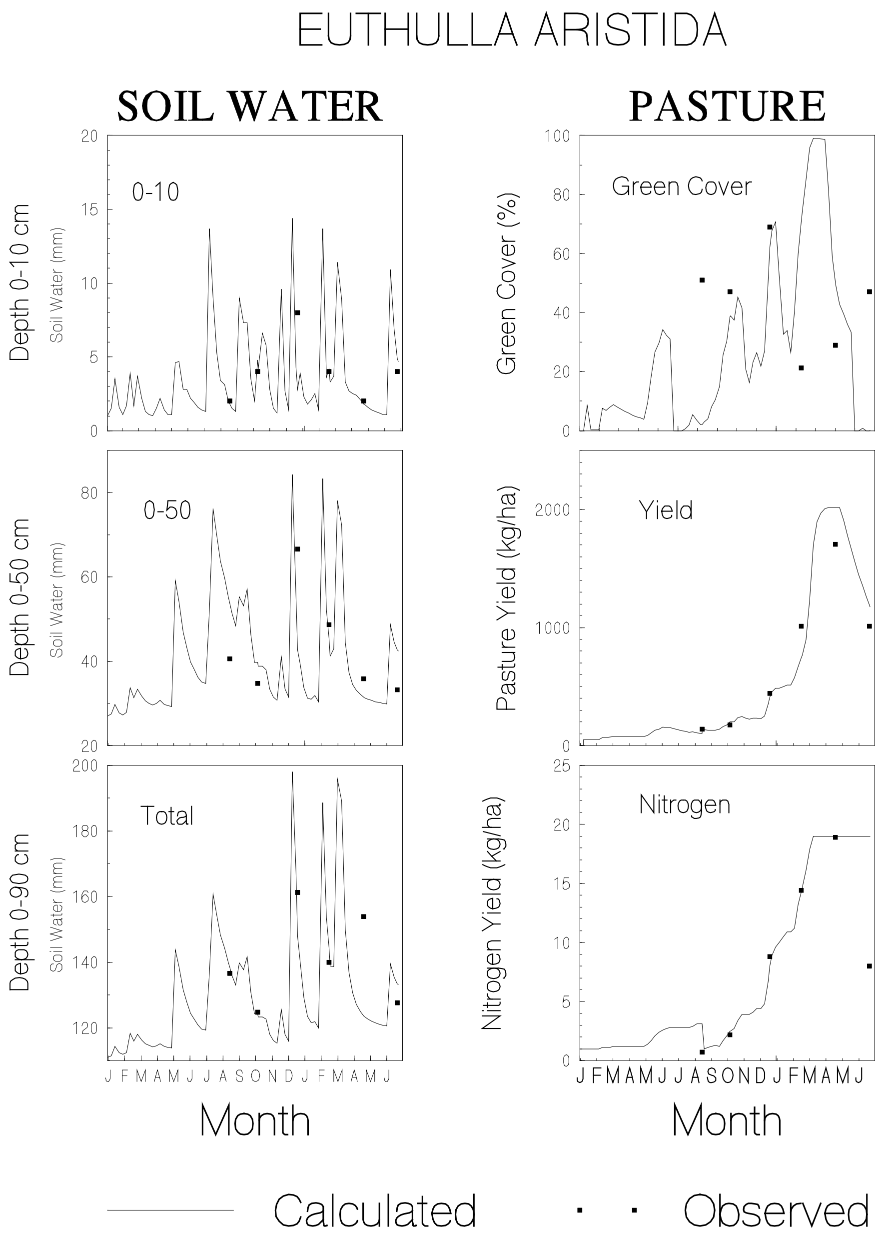

Figure 1. Calculated and observed growth by *A. jerichoensis* dominated pasture in response to soil moisture at Euthulla between Jan 1993 and June 1994.

The generally close agreement between simulation and observation are encouraging (Figures 1 and 2) especially given the extremes of seasonal conditions experienced during the observation period. Soil moisture content fluctuated widely as one would expect in a semiarid environment.

The long dry period from mid-summer 1993 until mid-winter 1993 is very evident. The large peak in pasture yield in summer 1993-94 is also very evident (Table 9).

The GRASP model mimicked pasture dry matter yield changes very well in all cases except buffel grass at Roselea. We are not sure why this is but there is a dense hardpan layer high in the soil profile which may be restricting root penetration. If this is so then the subsoil moisture included in the model will not be available to the grass and predicted growth will not be achieved. Buffel grass maintained its standing forage peak much better than the native grasses.

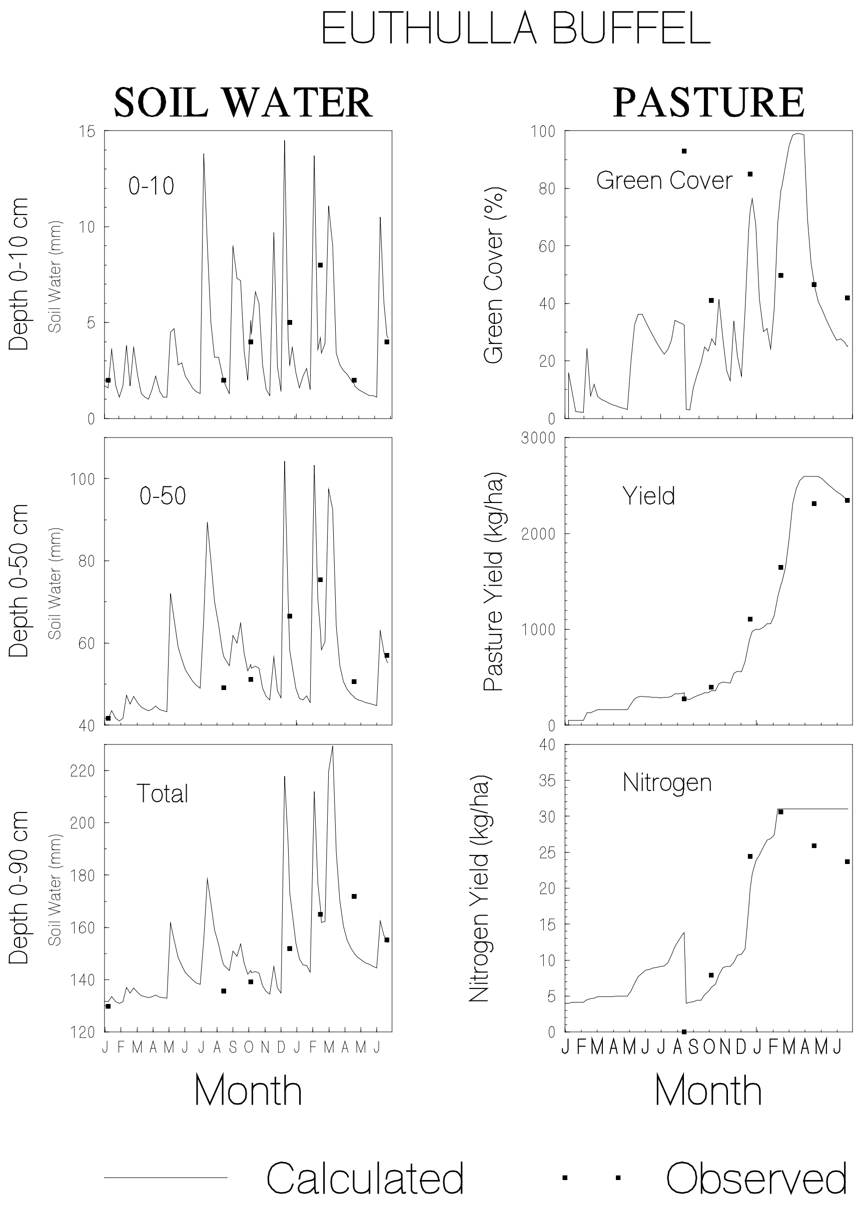

Figure 2. **Calculated and observed growth by buffel grass dominated pasture in response to soil moisture at Euthulla between Jan 1993 and June 1994.**

Green cover has always proven difficult to match with the model because small, annual forbs have a big impact on this parameter yet negligible impact on soil moisture and pasture yield in the short term. The nitrogen yield model currently used works well while the pasture is growing but does not handle senescence well (see Fig. 1).

1.4 Controlling Established Plants

Literature searches led us to believe that **herbicides to control wiregrasses** selectively were not a likely useful option for tropical areas. Wiregrasses are relatively leafless compared to associated species (both grass and non-grasses) and, being C_4 plants, they are comparatively resistant to most common selective herbicides compared to C_3 species. Non-selective chemicals on wick wipers could be an option in abandoned cultivation or on treeless plains but such conditions are uncommon in poplar box country. Even then, old seedheads overtop the canopy and make it difficult to get the wick in contact with actively growing shoots.

So we decided to see how readily the crown of common grasses could be damaged physically. Preliminary observations led us to believe that wiregrasses had great difficulty in re-establishing their root system if it was damaged, while other species did not. Ploughing, blade ploughing or yanking out of crowns (by heavy cattle grazing) may be an option in some cases but we need to know how strongly key species differ in their tolerance of such damage.

(a) Crown Damage Studies

We conducted two sorts of trials on this topic, one by physically yanking at plant crowns in the field and the other by digging up field plants and then seeing how readily they could resume growth in pots when kept well watered.

FIELD UPROOTING

This test was done at Euthulla on two occasions and at Cooreela near Roselea on one occasion. At Euthulla the clay loam soil was moist in March 1994 and very dry in September 1994 while at Cooreela the sandy red earth was moist below a dry crust in May 1995.

At Euthulla the relative ease with which different species were uprooted did not alter between sampling dates and the results are summarised in Table 10. A similar summary is given for the species compared at Cooreela. Most wiregrasses and *Eragrostis* spp. were easily yanked out of the ground leaving little or no crown. By comparison *C. fallax, B. bladhii, C ciliaris, E. molybdea* and *A. leptopoda* were not. Hence heavy cattle grazing is unlikely to damage stands of the latter species but may be capable of thinning out many wiregrasses and lovegrasses.

CROWN RE-ESTABLISHMENT

Blade ploughing and heavy disking is used in some places to control woody weeds, especially brigalow and current bush (*Carissa ovata*). What effect such treatments have on the herbaceous layer is unknown except that buffel grass re-establishes readily. Whether the buffel comes from seed, existing crowns or both is unknown and how other important grasses are affected is not known. We decided to gather information on this topic so we could predict more logically what might happen in other situations.

Two experiments were conducted, the first on a limited range of plants but with a wide range of treatments and the second with many species and only 2 key treatments. In all cases, plants were dug from the field at Roma using a mattock 5 - 10 cm below the crown. Much of the soil remained with the roots until they were potted up 1 - 2 days later in Toowoomba.

Experiment 1

In experiment 1, the uprooted plants were placed in either of 3 types of bag, a plastic bag with extra water, a plastic bag without water or a paper bag. Those with extra water were shaded from the sun and all were taken to Toowoomba where they were potted up the following day (March 1994). The plants were at flowering stage and the 3 species used were Qld bluegrass (*D. sericeum*), Gayndah buffel grass (*C. ciliaris* cv. Gayndah) and curly wiregrass (*A. platychaeta*). The soil was moist below the dry crust. In the glasshouse, the roots were separated from the soil and crown bits were then assigned to the following treatments -

I Roots and shoots intact
T Tops intact but roots trimmed to about 5 mm
R Roots intact (ie. > 5 cm long) but tops trimmed to 3 cm
N Both roots and shoots trimmed as described.

Table 10. Mean Crown Resistance to Uprooting

Species	**Euthulla**	**17 March 1994** Ecol. type	Grwth stage	Nbr plants	Crown diam(cm)	**Soil: Dry surface, wet subsoil** Yanks (nbr)	% uprooted
Aristida	jerichoensis subsp.	i	F	6	4.8	1.2	98
Aristida	latifolia	u	F	5	8.2	2.6	100
Aristida	leptopoda	u	F	5	8.4	3.8	0
Aristida	platychaeta	i	LF	5	4.8	1.6	99
Astrebla	elymoides	d	F	5	7.6	3	97
Bothriochloa	bladhii	d	B	5	10	3.6	100
Bothriochloa	decipiens	i	LF	5	7.4	3.2	69
Calotis	lappulacea	i	F	5	0.5	1	100
Cenchrus	ciliaris	d	F	5	16.4	3.8	25
Chloris	divaricata	i	F	5	3.6	1	94
Chloris	truncata	i	F	5	4.2	1	97
Chloris	ventricosa	i	F	5	3.4	1.4	100
Chrysopogon	fallax	i	F	5	86	2.4	44
Craspedia	globosus	i	F	5	1	1	100
Dichanthium	sericeum	d	F	5	6	1.2	100
Digitaria	divaricatissima	d	F	5	3.6	1.2	91
Enneapogon	gracilis	i	F	5	3.2	1.2	92
Enneapogon	polyphyllus	d	LF	5	2.3	1	98
Enteropogon	ramosus	u	F	5	17.6	3.8	80
Eragrostis	molybdea	u	LF	5	3.3	3	93
Eriochloa	pseudoacrotricha	d	LF	5	3.2	1.6	100
Heteropogon	contortus	i	EF	5	5	3.2	100
Sporobolus	actinocladus	i	LF	5	3.6	1	100
Sporobolus	caroli	d	F	5	2.8	1	100
Sporobolus	creber	u	F	5	10.4	3.8	0
Themeda	australis	d	F	5	6.3	1.8	92

NOTES: Ecological types - d = desirable, i = inbetween, u = undesirable
Growth Stage - B = booting, EF = early flowering, F = flowering, LF = late flowering

Three crown bits (several to many tillers, depending on the species) were planted in a potting mix (sand/soil/leaf mould) in each pot so that the top of trimmed tillers was above ground.

The pots were watered regularly (2-3 times a day) for the next 2 weeks and then daily until the trial ended. Recordings were made of the number of tillers resprouting and the time needed to regrow 5 or 10 cm of new leaf on the biggest shoot. After 31 days all plants were dug out and the number and length of roots recorded. Each treatment had 4 replications.

Table 10 (cont). Crown Resistance to Uprooting

	Euthulla			**9 Sept 1994**		**Soil: Very dry**	
Species		Ecol type	Grwth stage	Nbr plts	Crown diam (cm)	Yanks (nbr)	% uprooted
Aristida	latifolia	u	D	5	5	1.2	99
Aristida	leptopoda	u	D	5	5.2	2	81
Aristida	platychaeta	i	D	5	4.3	1	100
Astrebla	elymoides	d	D	5	5.9	2.6	92
Bothriochloa	bladhii	d	D	5	12	3.6	77
Cenchrus	ciliaris	d	D	5	5.6	3.8	0
Dichanthium	sericeum	d	D	5	3.2	1.6	99
Digitaria	divaricatissima	d	D	5	5.1	1.2	97
Enneapogon	gracilis	i	D	5	2	1	100
Enneapogon	pallidus	i	D	5	3.1	1.4	100
Eragrostis	molybdea	u	D	1	2.5	3.8	0
Eriochloa	pseudoacrotricha	d	D	5	5	1.5	100
Heteropogon	contortus	i	D	5	4.1	2.2	100
Sporobolus	creber	u	D	5	21	3	77
	Cooreela			**16 May 1995**		**Soil: moist**	
Aristida	calycina	i	LF	6	3.8	1.8	95
Aristida	ramosa	u	LF	5	3.2	2.8	95
Bothriochloa	decipiens	i	LF	6	6.3	2.7	30
Calotis	lappulacea	i	V	2	1	1	100
Cenchrus	ciliaris	d	LF	5	4.6	1.8	70
Cymbopogon	refractus	i	LF	3	7	2.8	96
Digitaria	brownii (sm form)	d	LF	5	6.4	1.4	45
Digitaria	coenicola	d	LF	3	3.5	2.4	55
Enteropogon	acicularis	i	LF	6	8.3	1.2	85
Enteropogon	ramosus	u	LF	6	5.7	2.7	85
Eragrostis	lacunaria	i	LF	5	1.6	1	100
Eragrostis	molybdea	u	LF	5	3.2	2	55
Eragrostis	sororia	i	LF	3	2.5	1	98
Eriochloa	pseudoacrotricha	d	LF	5	5.4	1	95
Fimbristylis	dichotoma	i	LF	6	4.5	1.2	20
Sporobolus	caroli	d	LF	5	3.2	1.2	50
Stipa	scabra	i	V	5	4.8	1	95
Triraphis	mollis	i	LF	3	2.5	1	95

NOTES: Ecological types - d = desirable, i = inbetween, u = undesirable
Growth Stage - V = vegetative, LF = late flowering, D = dormant

Results

Trimming shoots and roots had no effect on the results. Almost all crowns transported in paper bags died and failed to resprout. Those kept in water survived no better than those put into open-mouthed plastic bags. The *Aristida* found it almost impossible to resprout (3 crown bits out of 48) while the other 2 had a high recovery rate (Table 11). Buffel grass was slower to resprout than Qld bluegrass but once buffel shoots reappeared, they grew more vigorously. Qld bluegrass has many small-diameter, above-ground tillers in a crown while buffel has much sturdier tillers and significant numbers of underground / rhizome buds.

Table 11. Grass Crown Regeneration Trial 1 (March 1994)

Treatment			At 5cm		At 10cm regrowth		At Harvest			Alive but no growth
	Rt	Tp	Days	NT	Days	NT	NT	NMR	n	
Dichanthium sericeum										
Wet roots										
R	p	m	8.1	10.6	12.9	10.5	11.2	15.7	11	1
N	m	m	12.0	7.3	16.2	6.7	6.6	11.3	12	1
Plastic bag										
I	p	p	12.0	1.8	17.7	1.7	2.3	3.5	7	3
R	p	m	15.0	3.3	29.6	2.8	3.1	3.7	7	0
T	m	p	13.6	3.1	18.4	4.4	6.1	9.9	10	3
N	m	m	17.7	3.3	18.7	3.9	4.6	7.9	7	0
Dry paper bag										
R	p	m	-	-	-	-	-	-	0	0
N	m	m	-	-	-	-	-	-	0	0
Cenchrus ciliaris										
Wet roots										
R	p	m	11.9	1.0	14.2	1.0	2.8	8.7	9	0
N	m	m	14.2	1.0	16.8	1.0	2.0	5.3	6	0
Plastic bag										
I	p	p	14.4	1.9	16.7	2.3	2.4	8.6	10	0
R	p	m	17.3	1.2	21.2	1.2	2.2	4.9	9	2
T	m	p	13.8	4.8	17.9	2.4	2.3	7.9	12	0
N	m	m	18.2	1.2	25.0	1.1	1.7	3.9	7	0
Dry paper bag										
R	p	m	19.0	1.0	25.5	1.0	2.0	6.5	2	0
N	m	m	22.0	1.0	-	1.0	-	-	2	2
Aristida platychaeta										
Wet roots										
R	p	m	22.0	3.0	-	2.0	-	2.0	3	0
N	m	m	-	-	-	-	-	-	0	0
Plastic bag										
I	p	p	-	-	-	-	-	-	0	0
R	p	m	-	-	-	-	-	-	0	0
T	m	p	-	-	-	-	-	-	0	0
N	m	m	-	-	-	-	-	-	0	0
Dry paper bag										
R	p	m	-	-	-	-	-	-	0	0
N	m	m	-	-	-	-	-	-	0	0

Notes: NT = Nbr of tillers NMR = Nbr of main root axes
Rt = Root presence (p = present, m = missing) Tp = Tops retained (p or m)
n = Nbr of plants contributing to the means (out of 12)

These results are compatible with field observations that buffel readily "recolonises" blade ploughed country. If rain fell shortly after treatment or the soil was quite moist at ploughing, then our research would suggest that uprooted buffel could re-establish, provided its roots were not completely exposed. Inspection of recently blade ploughed country confirms these impressions and we believe the same could apply with Qld bluegrass while *A. platychaeta* should largely be killed. New root numbers are proportional to regrowing shoot numbers.

Experiment 2

On the basis of Experiment 1 results, we decided to expand the range of species and reduce the range of treatments. We dug plants out in wet conditions in February 1995 when most species were at an early flowering stage, the exception being *Stipa verticillata* which was not growing very actively. Plants came from 3 soils, a neutral clay loam with sandy lenses near Euthulla, a sandy red earth near Roselea , and a sandy duplex, cypress pine soil south of Miles.

Table 12. Crown regeneration from 27 species in trial 2 (February 1995)

	At 5cm regrowth		At Harvest		Live bits
Bag	Days	NT	FH	FNT	n
Aristida calycina					
W	-	-	-	-	0
D	-	-	-	-	0
Aristida jerichoensis var. subspinulifera					
W	-	-	-	-	0
D	-	-	-	-	0
Aristida latifolia					
W	-	-	-	-	0
D	-	-	-	-	0
Aristida leptopoda					
W	7.0	1.5	-	-	0
D	-	-	-	-	0
Aristida muricata					
W	-	-	-	-	0
D	-	-	-	-	0
Aristida platychaeta					
W	-	-	-	-	0
D	-	-	-	-	0
Aristida ramosa					
W	18.0	1.0	3.0	1.0	1
D	-	-	-	-	0
Bothriochloa bladhii					
W	10.3	1.1	27.0	2.0	8
D	-	-	-	-	0
Bothriochloa decipiens					
W	10.1	2.8	17.9	3.4	9
D	-	-	-	-	0
Bothriochloa ewartiana					
W	23.3	1.7	7.9	1.6	7
D	26.0	1.0	7.0	1.0	1
Chrysopogon fallax					
W	9.9	1.7	11.7	2.6	10
D	29.0	1.0	7.5	1.0	2
Dichanthium sericeum					
W	16.0	1.6	13.2	3.0	6
D	-	-	-	-	0
Digitaria brownii					
W	15.1	2.3	17.2	1.8	10
D	-	-	1.0	1.0	1

Bag	At 5cm regrowth		At Harvest		Live bits
	Days	NT	FH	FNT	n
Digitaria divaricatissima					
W	12.7	1.0	12.3	3.0	6
D	15.0	1.0	26.7	6.7	3
Enneapogon gracilis					
W	15.0	2.0	18.0	3.0	1
D	-	-	-	-	0
Enteropogon acicularis					
W	11.0	1.0	16.0	1.5	2
D	-	-	-	-	0
Enteropogon ramosus					
W	-	-	4.0	2.0	1
D	-	-	-	-	0
Eragrostis molybdea					
W	8.8	2.1	24.6	4.3	12
D	-	-	-	-	0
Eragrostis sororia					
W	12.6	2.2	22.3	4.9	11
D	14.5	1.0	16.5	2.5	2
Eriochloa pseudoacrotricha					
W	12.0	1.5	26.7	4.5	6
D	-	-	-	-	0
Heteropogon contortus					
W	11.0	1.0	-	-	0
D	-	-	-	-	0
Panicum effusum					
W	11.2	2.5	23.7	7.6	11
D	-	-	-	-	0
Panicum queenslandicum					
W	-	-	-	-	0
D	-	-	-	-	0
Paspalidium caespitosum					
W	7.4	2.4	2.0	2.0	1
D	-	-	-	-	0
Sporobolus caroli					
W	12.7	1.7	24.0	4.0	3
D	-	-	-	-	0
Stipa verticillata					
W	18.0	1.0	5.0	1.0	1
D	-	-	-	-	0
Tripogon loliiformis					
W	13.6	6.4	6.8	8.0	11
D	-	-	-	-	0

Notes: Days = number of days to 5cm; NT = Number of tillers
FH = Final height(cm); FNT = Final number of tillers
W = Wet roots (bag); D = Dry roots (bag)
n = Nbr of plants contributing to the harvest means

Plants were transported in plastic bags to Toowoomba, half with added water. Because of the wet conditions, plants in bags to which water was not added were taken out and allowed to "dry out" in a glasshouse next day under heavily overcast skies. This simulated some dehydration prior to replanting, as a contrast to the plants with roots kept in water.

The same potting mix was used and 3 crown bits were planted in each pot but all plants had both tops and roots trimmed this time. Pots were watered regularly, as before, and there were 4 replications of each treatment. Records were kept of how many crowns resprouted and how quickly etc., as in Exp. 1. After 32 days all crowns were dug out and root numbers counted. Crowns of non-sprouted plants were snapped to see if they could still be viable, based on colour and texture. Those still crisp and white, eg. some *C. fallax*, were assessed as still viable; those coloured yellow, brown or grey and spongy were regarded as dead.

Results

The inability of *Aristida* species to resprout was confirmed (Table 12). So too was the detrimental effect of short term root drying on most species, including *T. loliiformis* which is reputed to be a “resurrection plant”. The 2 *Eragrostis* species resprouted readily as did *C. fallax, P. effusum, T. loliiformis, B. bladhii* and *B. decipiens*. Many species with rhizomes or large, bulbous, underground buds resprouted well but not *S. verticillata*, *E. ramosus* and *A. leptopoda*. The *Bothriochloa* and *Digitaria* species seemed to stand root damage better than many other genera, especially blackspear grass. The practical implications need to be assessed on a species by species basis. However, *E. ramosus, S. verticillata* and *A. leptopoda* seem amenable to ploughing out when they build up in discreet areas, as is quite common.

(b) Defoliation Study

We did this study on a dense tall Jericho wiregrass (*A. jerichoensis* var. *subspinulifera*) area at Roselea in 1995. Our aim was to see if time of year or height of defoliation had a major impact on plant survival, flowering or yield potential. Wiregrasses normally flower in early or late summer and the latter often results in massive seed production.

The trial area (30 x 20 m) was mown back to 8 cm on 17/1/95 after a December seeding and cut material removed. Thereafter three plots (1 m x 1 m) were cut to either 8 cm or 2 cm every fortnight for the next 14 weeks. Then on 16/5/95, two weeks after the last set of cuts, all plots were re-cut at their previous height (8 or 2 cm). Thereafter plots were re-cut at times shown in Table 14 to test for residual effects of the earlier time of cutting.

Rain fell early in the trial but then no rain fell from 16/3 to 2/5/95. Between 2 and 16 May, 22mm was recorded and another 56mm fell in Sept/Oct and active growth occurred in spring. Hence all 16 treatments had a good chance to grow away in mid-summer and early spring. Good early summer rains followed (226 mm to 20/12/95) and continued (166 mm) prior to the last cut on 25 January 1996.

Results

Average plant density was 31 m^{-2}, basal area 4.8% (17 cm^2/plant) and tillers averaged 13.3 per plant initially. Overall, regrowth was greater if the second cut was later (500 compared to 300 gm/plant) due to extra stem growth. Rainfall use efficiency (mg DM / mm rain) increased as cutting height was lowered, 336 compared to 187 mg/mm/m^2 (Table 13).

Very few tillers were produced in winter, on average 2 per plant over 2 cm high. Once cut back in summer, more tillers regrew from the higher cutting height (125 compared to 66 m^{-2}), so severe defoliation will reduce the number of tillers available to set seed or use moisture.

Table 13. Effect of recut height and interval on wiregrass growth near Roma

TRT	Harvest Date	Cutting Hght (cm)	Days Grth (no)	Mean DW/fl til (mg)	Flw tiller density till/sq cm	Yield/ mm rain mg/mm	Rain bet cuts (mm)	Bulk N %	Bulk P %
MEANS 2cm cuts									
A	1-Feb	2	15	-	-	212.0	58.5	1.05	0.13
B	15-Feb	2	29	M	M	365.5	108	1.05	0.15
C	1-Mar	2	43	448.8	0.26	219.2	151	0.80	0.12
D	16-Mar	2	58	252.2	0.44	302.2	157	0.67	0.14
E	31-Mar	2	73	250.2	0.51	395.4	157	0.43	0.09
F	17-Apr	2	90	178.6	0.69	510.7	157	0.41	0.08
G	2-May	2	105	189.2	0.70	379.0	157	0.40	0.08
H	16-May	2	119	205.9	0.55	303.3	179	0.45	0.07
	MEAN	**2**		**217.8**	**0.45**	**335.9**		**0.66**	**0.11**
				- = no seedheads					
MEANS 8cm cuts									
P	1-Feb	8	15	-	-	93.2	58.5	1.44	0.18
Q	15-Feb	8	29	M	M	118.7	108	1.23	0.15
R	1-Mar	8	43	273.8	0.27	129.6	151	0.92	0.14
S	16-Mar	8	58	146.9	0.47	212.1	157	0.79	0.13
T	31-Mar	8	73	177.5	0.59	247.1	157	0.61	0.12
U	17-Apr	8	90	116.5	0.73	254.0	157	0.47	0.10
V	2-May	8	105	125.4	0.53	188.8	157	0.41	0.09
W	16-May	8	119	154.6	0.63	255.2	179	0.47	0.08
	MEAN	**8**		**142.1**	**0.46**	**187.3**		**0.79**	**0.12**

Flowering data from later cuts on 16 May, 16 October, 20 December and 25 January are given in Table 14. Time of cut in late summer/autumn did not affect the percentage of tillers which flowered in spring but cutting height did. More tillers from the 8 cm cutting height flowered, 40 vs. 33% in October and 56 vs. 25% in December (Table 14). The percentage and number of flowering tillers in December were also less for treatments defoliated heavily in February rather than April. Flowering was only strongly calendar controlled in mid-winter.

By January 1996, one year after the first controlled cut, no obvious original treatment effects remained. Plants/m^2, tillers/plant and basal cover were unaffected by treatment although they had declined generally. Cutting back to 2cm in December severely reduced the proportion of tillers with seedheads a month later, compared to those last cut in October, 11 vs. 57%. The effect of an 8cm cutting height was minimal and inconsistent by comparison.

In terms of practical management, defoliation of this common red soil wiregrass has to be very severe before flowering, and thus seed set, is significantly reduced. This is impractical by sheep grazing but burning could possibly work.

Table 14. Summarised data from all cuts of a tall Jericho wiregrass pasture at Roma

Clearing cut 17 Jan 1995		First reharvest			16 May 1995 Cut				16 Oct '95 Cut [153 d, 118mm]		20 Dec '95 [226mm]	25 Jan '96 [166mm rain]
TRT	DATE 2nd cut	Days after (no.)	Mean DM/fl til (mg)	Rain bet cuts (mm)	Since Cut 2 (days)	Flw Tills (%)	Growth/ mm rain (mg /sq m)	Rain bet cuts (mm)	% Flw Tillers (%)	Mean Dry wt/til (mg)	% Flw tillers (%)	Flwg tillers (%)
MEANS 2cm cuts												
A	1-Feb	15	0.0	58.5	104	93.8	120	120.5	33.3	208.0	15.9	6.1
B	15-Feb	29	M	108	90	92.8	101	71	24.8	141.3	n.c.	48.9
C	1-Mar	43	448.8	151	76	48.4	119	28	40.9	179.0	20.4	6.8
D	16-Mar	58	252.2	157	61	3.0	6	22	22.6	139.5	n.c.	45.4
E	31-Mar	73	250.2	157	46	38.9	10	22	32.2	320.2	30.0	17.3
F	17-Apr	90	178.6	157	29	11.1	20	22	46.3	180.0	n.c.	72.4
G	2-May	105	189.2	157	14	27.8	8	22	25.5	194.6	32.1	14.3
H	16-May	119	205.9	179	0	90.0	303	179	37.0	244.9	n.c.	61.8
	MEAN		217.8			50.7	86		33.7	200.9	24.6	34.1
MEANS 8cm cuts												
P	1-Feb	15	0.0	58.5	104	96.8	362	120.5	34.1	148.2	61.6	28.2
Q	15-Feb	29	M	108	90	65.7	359	71	48.4	156.3	47.4	82.3
R	1-Mar	43	273.8	151	76	67.5	421	28	54.2	113.8	48.8	57.9
S	16-Mar	58	146.9	157	61	61.8	123	22	36.0	124.5	66.9	61.0
T	31-Mar	73	177.5	157	46	56.3	55	22	44.2	129.5	56.5	52.4
U	17-Apr	90	116.5	157	29	16.7	6	22	35.7	157.1	62.3	62.2
V	2-May	105	125.4	157	14	5.6	11	22	41.3	135.9	48.9	24.9
W	16-May	119	154.6	179	0	96.4	255	179	36.7	165.1	n.c.	79.2
	MEAN		142.1			58.3	199		40.7	141.3	56.1	56.0

n.c. = not cut

1.5 Pasture Quality

Strategic heavy stocking is an option for controlling the build up of normally unpalatable plants. This is most likely to be useful at times when the unwanted plant has a higher palatability or digestibility than normal, usually when new shoots are prevalent in grasses. In forbs, this may not be as predictable. Some species ‘look’ palatable but animals largely reject them (on taste, texture or toxicity) eg. mintweed and rhynchosia pea, while others seem to be sought out despite looking no better than others, eg. mulga nettle, mulga mitchell grass.

Other species are relatively more beneficial to stock because of inherently greater protein or digestibility or because of their genetics or plant anatomy, eg. kangaroo grass is palatable but relatively low in protein compared to other grasses. Non-grasses always have higher protein levels than grasses at the same growth stage. Little published information exists about many of the common pasture plants of the Maranoa woodlands. Data in Quirk (1988) is limited to those plants which also grow in better researched regions.

Methods

Whole plant samples were taken at key times of the year. Plants were separated into leaf and stem (dead and live) and seedhead. The components were then analysed for nitrogen, phosphorus, acid detergent fibre (ADF) and IVDMD (*in vitro* dry matter digestibility), if enough sample was available. Some were also analysed for calcium to gauge overall mineral levels. Most samples were grasses but a few forbs were selected in winter when they are an important component of sheep diets. From this data we can determine protein content and metabolisable energy of the various plant parts at different stages of growth and time of year. Samples were collected from Roselea and Euthulla on the dates shown in Tables 15 and 16.

Results

Most results are within the expected range, determined largely by plant part and greenness of the material. Table 16 has a summary of the results of the chemical analysis while Table 15 shows the proportion of leaf and stem in the middle of a very dry winter. In mid-winter 1994 (a very frosty winter), the wiregrasses had a comparatively high proportion of green stem which could enhance their palatability relative to other grasses. However at Roselea there was little evidence that wiregrass palatability ever approached that of buffel grass and both had low IVDMD values. In summer, most leaf and stem was green.

The forbs *V. tenuisecta* and *Vittadinia* spp. both were high in protein and digestibility in mid-winter which equates with their highly preferred status in sheep diets in mid-winter. Mayne’s pest is regarded as a weed and fuzzweed (*Vittadinia spp.*) is not eaten with relish if other fodder is green. However in mid-winter their forage value is probably high when they are eaten in conjunction with dry grass. Whether their protein is highly digestible *in vivo* is unknown. Tannins tie up protein in the rumen and plant tannin content was not measured.

Buffel grass contained surprisingly high levels of calcium and phosphorus at times. Whether much of the calcium was immobilised as oxalate is unknown but that is a possibility for this oxalate accumulator. It could be postulated that stock preference for buffel in winter is due to its higher mineral content at a time when this would be low in the animal’s diet.

Table 15. Percentage green material in pasture plants in the middle of August 1994, a dry, cold winter

Site	Species	HEADS	STEM			Stems	LEAF			#Green
			2yo dead	1yo dead	1yo green	gr/d %	dead	green	gr/d %	Lf/Stem %
Roselea	Ari. jer. var. subspin.	14	4	13	50	74	16	0.00*	0	0.1
Roselea	Ari. latifolia	17	0	20	20	50	33	8	21	43
Roselea	Ari. muricata	19	8	28	36	50	6	0.00	1	0.1
Roselea	Cen. ciliaris (grazed)	0	6	79	6	7	6	0.00	7	6.8
Roselea	Cen. ciliaris (ungrazed)	0	2	12	38	72	45	0.00	2	2
Roselea	Cym. obtectus	10	1	17	2	11	32	35	52	1494
Roselea	Het. contortus	25	0	0	31	100	20	22	51	72
Roselea	Ver. tenuisecta									89
Roselea	Vittadinia spp.									81
Euthulla	Ari. latifolia	19	3	24	12	29	34	5	13	42
Euthulla	Ari. platychaeta	29	0	16	11	40	35	6	16	59
Euthulla	Cen. ciliaris (bulk)	2	0	28	30	51	37	0.00	0.1	0.2
Euthulla	Chr. fallax	1	0	14	0.00	5	75	6	8	900
Euthulla	Dic. sericeum	4	0	38	8	17	47	1	3	15.5
Euthulla	Enneapogon spp.	20	0	18	36	66	14	10	41	28
Euthulla	Enteropogon spp	3	5	11	12	43	48	18	27	140
Euthulla	Eri. pseudoacrotricha	3	0	56	2	4	35	1	5	67
Euthulla	Rue. australis				41	100	15	43	74	106
Euthulla	Scl. birchii									255
Euthulla	Stipa scabra									419
Euthulla	Stipa spp. (bulk)	14	0	43	0.00	1	27	14	35	6350
Euthulla	The. triandra	31	0	9	39	81	18	0.00	3	1.6

NOTE: #Green = Ratio of green leaf to green stem as a %. 0.00* = < 1%

There were no consistent differences in chemical composition of buffel grass between Euthulla and Roselea despite the big differences in animal production between the two sites.

Five minute grass (*T. loliiformis*) had surprisingly low digestibility (<40% for green leaf) and high ADF (42-50%) for such a fine-leaved plant. Green leaf of *C. fallax* had surprisingly poor digestibility. *Stipa scabra* was low in digestibility (32 -35%) for a C_3 plant, indicating that the rough texture of its leaves is significantly related to its forage value. The leaf of wiregrasses never exceeded 56% IVDMD which reinforces the perception of low quality feed at all times. The winter greenness of most wiregrass stems (Table 15) does not significantly offset the low digestibility and protein content of grass stems. The stem of non-grasses was also of low forage value, even when green, but their leaves are very nutritious.

Very old (two-year old) dead stem was no less digestible than one year-old stem of grasses. This says that very old, grey standing dead is no less valuable to hungry stock than last season's dead stem, - if it is eaten. Dry buffel grass leaf was of low quality (2-4% protein, 40-47% IVDMD) and despite being slightly more nutritious than green winter stem (20-30%

IVDMD), it was not actively selected by sheep. In a dry winter, the green stem of blackspear grass (35% IVDMD) was surprisingly unpalatable to sheep.

The dietary preferences of the sheep were recorded from visual observations in mid-winter 1994 (when everything was very dry and frosted) and in early December 1995 when plants were green and growing. Some species change in their attractiveness to stock with seasonal conditions, eg. *Pterocaulon* spp. and *Abutilon fraseri*. Buffel grass and Qld bluegrass are relatively more palatable in winter while *C. fallax* is less palatable in winter.

Table 16. Chemical composition of different parts of main plant species at trial sites.

Genus	species	Plant part	Site	Sample Date	% N	% P	% Ca	% PROT	% ADF	MJ/kg ME (A)	% IVDMD
Aristida	jerichoensis	dead leaf	Euth	9/05/94	0.64	0.04		4.0	42.6	5.7	27.9
Aristida	jerichoensis	dead stem	Euth	9/05/94	0.41	0.02		2.5	55.7	4.5	17.5
Aristida	jerichoensis	green leaf	Euth	19/03/94	1.28	0.06		8.0	37.8	7.7	50.2
Aristida	jerichoensis	green leaf	Rose	19/03/94	1.02	0.07	0.19	6.4	42.7	6.6	41.3
Aristida	jerichoensis	green stem	Euth	19/03/94	0.68	0.04		4.3	51.5	5.8	37.4
Aristida	jerichoensis	green stem	Rose	19/03/94	0.82	0.06	0.05	5.2	53.0	5.6	31.1
Aristida	jerichoensis	green stem	Euth	9/05/94	0.90	0.12		5.6	51.6	5.7	34.4
Aristida	jerichoensis	inflors	Euth	9/05/94	0.95	0.11		6.0	43.4	6.3	42.7
Aristida	jeri var. subspin	dead stem	Rose	18/08/94	0.30	0.06		1.9	53.8	4.9	22.1
Aristida	jeri var. subspin	green leaf	Rose	18/08/94	0.44	0.04	0.19	2.7	46.0	5.3	27.2
Aristida	jeri var. subspin	green stem	Rose	18/08/94	0.48	0.16	0.08	3.0	50.1	4.6	31.4
Aristida	latifolia	dead leaf	Euth	9/05/94	0.63	0.04		3.9	44.5	5.5	29.1
Aristida	latifolia	dead leaf	Euth	18/08/94	0.47	0.03		2.9	43.8	5.1	31.7
Aristida	latifolia	dead stem	Euth	9/05/94	0.32	0.01		2.0	56.3	4.2	20.8
Aristida	latifolia	green leaf	Euth	18/08/94	1.02	0.09	0.06	6.3	38.6	7.1	39.0
Aristida	latifolia	green leaf	Euth	19/03/94	1.23	0.07	0.23	7.7	40.2	6.8	44.2
Aristida	latifolia	green leaf	Euth	9/05/94	1.58	0.12		9.9	38.7	7.8	43.7
Aristida	latifolia	green stem	Euth	18/08/94	0.76	0.05	0.03	4.8	49.7	5.8	23.0
Aristida	latifolia	green stem	Euth	19/03/94	0.63	0.06	0.05	3.9	53.3	5.1	39.1
Aristida	latifolia	green stem	Euth	9/05/94	0.60	0.06		3.8	52.6	5.2	27.9
Aristida	leptopoda	dead leaf	Euth	9/05/94	0.50	0.03		3.2	47.6	5.1	24.4
Aristida	leptopoda	dead stem	Euth	9/05/94	0.58	0.02		3.6	54.3	5.1	12.5
Aristida	leptopoda	green leaf	Euth	20/03/94	1.61	0.11		10.1	41.8	7.4	56.4
Aristida	leptopoda	green leaf	Euth	9/05/94	1.48	0.08		9.2	40.8	7.3	47.6
Aristida	leptopoda	green stem	Euth	20/03/94	0.89	0.09		5.6	46.2	6.4	40.2
Aristida	leptopoda	green stem	Euth	9/05/94	0.79	0.05		5.0	49.9	5.8	23.5
Aristida	muricata	dead stem 2 yo	Rose	18/08/94	0.37	0.02		2.3	55.5	4.7	6.0
Aristida	muricata	green stem	Rose	18/08/94	0.40	0.13	0.07	2.5	52.9	4.1	24.3
Aristida	platychaeta	dead leaf	Euth	18/08/94	0.71	0.04		4.4	41.4	5.3	33.0
Aristida	platychaeta	dead leaf	Euth	9/05/94	0.64	0.04		4.0	43.8	5.3	31.0
Aristida	platychaeta	dead stem	Euth	18/08/94	0.33	0.01		2.0	53.7	4.7	20.7
Aristida	platychaeta	green leaf	Euth	18/08/94	1.23	0.10		7.7	33.2	7.6	41.8
Aristida	platychaeta	green leaf	Euth	19/03/94	1.16	0.06		7.2	38.9	6.6	43.7
Aristida	platychaeta	green stem	Euth	18/08/94	0.70	0.05		4.4	48.6	5.8	28.4
Aristida	platychaeta	green stem	Euth	19/03/94	0.69	0.04		4.3	53.4	5.3	41.5
Aristida	platychaeta	green stem	Euth	9/05/94	0.52	0.04		3.2	52.1	4.9	31.8
Astrebla	elymoides	dead leaf	Euth	9/05/94	0.84	0.03		5.3	40.9	6.1	41.8
Astrebla	elymoides	green leaf	Euth	20/03/94	2.11	0.10		13.2	36.0	8.6	63.5
Astrebla	elymoides	green leaf	Euth	9/05/94	1.83	0.07		11.5	37.4	7.9	55.0
Astrebla	elymoides	green stem	Euth	20/03/94	1.29	0.06		8.1	44.2	7.0	48.8

Genus	species	Plant part	Site	Sample Date	% N	% P	% Ca	% PROT	% ADF	MJ/kg ME (A)	% IVDMD
Astrebla	elymoides	green stem	Euth	9/05/94	1.18	0.08		7.4	47.9	6.0	42.9
Astrebla	elymoides	inflors	Euth	9/05/94	1.30	0.12		8.1			43.3
Bothriochloa	bladhii	dead leaf	Euth	9/05/94	0.45	0.03		2.8	42.3	5.5	38.0
Bothriochloa	bladhii	dead stem	Euth	9/05/94	0.34	0.02		2.1			31.5
Bothriochloa	bladhii	green leaf	Euth	7/03/94	1.42	0.07		8.9	40.9	6.9	56.5
Bothriochloa	bladhii	green leaf	Euth	9/05/94	1.01	0.09		6.3	40.0	6.5	44.8
Bothriochloa	bladhii	green stem	Euth	7/03/94	0.56	0.03		3.5	45.6	5.9	52.7
Bothriochloa	bladhii	green stem	Euth	9/05/94	0.42	0.04		2.7	48.9	5.8	40.4
Bothriochloa	decipiens	dead leaf	Euth	9/05/94	0.40	0.03		2.5	40.2	6.1	37.8
Bothriochloa	decipiens	dead stem	Euth	9/05/94	0.32	0.02		2.0	54.4	4.8	26.2
Bothriochloa	decipiens	green leaf	Euth	7/03/94	1.79	0.09		11.2	37.1	7.9	53.2
Bothriochloa	decipiens	green leaf	Euth	9/05/94	0.98	0.09		6.1	35.0	7.4	52.4
Bothriochloa	decipiens	green stem	Euth	7/03/94	0.52	0.03		3.3	53.8	5.2	40.2
Bothriochloa	decipiens	green stem	Euth	9/05/94	0.37	0.03		2.3	46.0	5.9	39.4
Cenchrus	ciliaris	dead leaf	Euth	18/08/94	0.42	0.03	0.83	2.6	41.2	4.6	42.3
Cenchrus	ciliaris	dead leaf	Rose	18/08/94	0.35	0.04	0.76	2.2	39.8	4.4	38.1
Cenchrus	ciliaris	dead leaf	Euth	9/05/94	0.77	0.03		4.8	36.6	6.0	46.6
Cenchrus	ciliaris	dead stem	Euth	9/05/94	0.44	0.02		2.7	50.4	5.0	36.2
Cenchrus	ciliaris	dead stem 1 yo	Euth	18/08/94	0.28	0.03		1.7	54.8	4.5	25.0
Cenchrus	ciliaris	green leaf	Euth	19/03/94	1.86	0.14	0.39	11.6	32.2	8.1	69.7
Cenchrus	ciliaris	green leaf	Rose	19/03/94	1.14	0.12	0.43	7.1	32.7	6.9	64.8
Cenchrus	ciliaris	green leaf	Euth	9/05/94	1.53	0.07		9.6	28.4	8.0	64.5
Cenchrus	ciliaris	green leaf	Rose	9/05/94	0.74	0.23		4.6	32.3	5.9	52.4
Cenchrus	ciliaris	green shoot	Rose	23/10/94	2.81	0.39	0.98	17.6			71.6
Cenchrus	ciliaris	green stem	Euth	18/08/94	0.46	0.10	0.04	2.9	53.5	4.2	21.4
Cenchrus	ciliaris	green stem	Euth	19/03/94	0.75	0.07	0.69	4.7	45.7	5.8	55.2
Cenchrus	ciliaris	green stem	Euth	9/05/94	0.63	0.05		4.0	39.0	7.0	50.0
Chloris	divaricata	dead leaf	Euth	9/05/94	0.81	0.06		5.0	41.4	6.1	36.1
Chloris	divaricata	dead stem	Euth	9/05/94	0.40	0.02		2.5			23.9
Chloris	divaricata	green leaf	Euth	20/03/94	2.21	0.14		13.8			58.5
Chloris	divaricata	green leaf	Euth	9/05/94	1.26	0.08		7.9	37.2	7.3	42.8
Chloris	divaricata	green stem	Euth	20/03/94	1.44	0.12		9.0	42.3	7.1	49.7
Chloris	divaricata	green stem	Euth	9/05/94	0.82	0.06		5.1	44.0	6.6	30.8
Chloris	divaricata	inflors	Euth	9/05/94	0.82	0.06		5.1	47.4	6.4	35.7
Chloris	ventricosa	dead leaf	Euth	9/05/94	1.14	0.07		7.1	41.0	6.4	32.3
Chloris	ventricosa	dead stem	Euth	9/05/94	0.64	0.03		4.0	49.9	5.3	23.6
Chloris	ventricosa	green leaf	Euth	20/03/94	2.22	0.15		13.9	35.0	8.6	53.5
Chloris	ventricosa	green leaf	Euth	9/05/94	1.85	0.11		11.5	36.6	7.7	41.8
Chloris	ventricosa	green stem	Euth	20/03/94	1.20	0.09		7.5	47.3	6.3	36.9
Chloris	ventricosa	green stem	Euth	9/05/94	0.89	0.06		5.6	44.5	6.2	32.4
Chrysopogon	fallax	dead leaf	Euth	18/08/94	0.64	0.04		4.0	44.9	5.8	39.4
Chrysopogon	fallax	dead leaf	Euth	9/05/94	0.59	0.03		3.7	43.9	6.0	42.1
Chrysopogon	fallax	dead stem	Euth	9/05/94	0.28	0.02		1.8	54.5	4.7	30.2
Chrysopogon	fallax	green leaf	Euth	18/08/94	0.98	0.07		6.1	40.8	7.1	49.8
Chrysopogon	fallax	green leaf	Euth	20/03/94	1.77	0.14		11.0			52.5
Chrysopogon	fallax	green leaf	Euth	9/05/94	1.05	0.05		6.6	40.1	7.0	53.8
Chrysopogon	fallax	green stem	Euth	18/08/94	1.13	0.12		7.0			
Chrysopogon	fallax	green stem	Euth	20/03/92	0.94	0.12		5.9	49.9	5.9	39.6
Chrysopogon	fallax	green stem	Euth	9/05/94	0.32	0.02		2.0	51.3	5.2	32.4
Cymbopogon	obtectus	dead leaf	Rose	18/08/94	0.37	0.07		2.3	39.5	5.9	26.7
Cymbopogon	obtectus	dead stem 1 yo	Rose	18/08/94	0.22	0.02		1.3	61.7	3.9	19.9
Cymbopogon	obtectus	green leaf	Rose	18/08/94	0.72	0.13		4.5	36.7	8.4	47.1
Cymbopogon	obtectus	green stem	Rose	18/08/94	0.20	0.07		1.2			

Genus	species	Plant part	Site	Sample Date	% N	% P	% Ca	% PROT	% ADF	MJ/kg ME (A)	% IVDMD
Cymbopogon	refractus	dead leaf	Euth	9/05/94	0.59	0.03		3.7	37.0	6.8	38.3
Cymbopogon	refractus	dead stem	Euth	9/05/94	0.30	0.07		1.9	60.0	4.2	18.5
Cymbopogon	refractus	green leaf	Euth	20/03/92	1.91	0.14		11.9	33.5	8.9	52.6
Cymbopogon	refractus	green leaf	Euth	9/05/94	1.12	0.09		7.0	31.5	8.0	49.2
Cymbopogon	refractus	green stem	Euth	20/03/92	1.49	0.06		9.3	57.4	5.5	33.2
Cymbopogon	refractus	green stem	Euth	9/05/94	0.25	0.01		1.5	58.5	4.4	21.5
Dichanthium	sericeum	dead leaf	Euth	18/08/94	0.55	0.04		3.4	45.0	5.1	37.5
Dichanthium	sericeum	dead leaf	Euth	9/05/94	0.58	0.06		3.7	42.5	5.4	40.1
Dichanthium	sericeum	dead stem	Euth	18/08/94	0.25	0.01		1.5	57.8	4.0	26.8
Dichanthium	sericeum	green leaf	Euth	18/08/94	1.16	0.10		7.2			
Dichanthium	sericeum	green leaf	Euth	7/03/94	1.30	0.07		8.1	38.6	7.2	57.5
Dichanthium	sericeum	green leaf	Euth	9/05/94	0.75	0.08		4.7	39.5	6.2	45.1
Dichanthium	sericeum	green stem	Euth	18/08/94	0.40	0.03		2.5	53.5	4.6	27.3
Dichanthium	sericeum	green stem	Euth	7/03/94	0.43	0.02		2.7	51.1	5.1	46.3
Dichanthium	sericeum	green stem	Euth	9/05/94	0.33	0.03		2.1	51.9	4.7	35.6
Digitaria	coenicola	dead leaf	Euth	9/05/94	0.44	0.06		2.7	54.6	4.4	42.4
Digitaria	coenicola	dead stem	Euth	9/05/94	0.28	0.04		1.8			25.0
Digitaria	coenicola	green leaf	Euth	7/03/94	1.37	0.11		8.6	48.7	6.0	57.8
Digitaria	coenicola	green leaf	Euth	9/05/94	0.95	0.14		6.0			49.2
Digitaria	coenicola	green stem	Euth	7/03/94	0.70	0.10		4.4	50.5	5.4	47.0
Digitaria	coenicola	green stem	Euth	9/05/94	0.42	0.07		2.6	46.9	6.0	42.0
Digitaria	coenicola	inflors	Euth	9/05/94	0.42	0.06		2.6	52.4	4.8	28.8
Enneapogon	gracilis	dead leaf	Euth	9/05/94	0.86	0.06		5.4	41.4	6.5	50.1
Enneapogon	gracilis	dead stem	Euth	9/05/94	0.59	0.06		3.7	47.0	5.9	40.9
Enneapogon	gracilis	green leaf	Euth	19/03/94	2.13	0.16		13.3	34.3	8.5	64.3
Enneapogon	gracilis	green leaf	Euth	9/05/94	1.17			7.3	39.5	7.3	57.8
Enneapogon	gracilis	green stem	Euth	19/03/94	1.12	0.11		7.0	45.1	6.6	49.4
Enneapogon	gracilis	green stem	Euth	9/05/94	0.76	0.07		4.7	44.7	6.5	46.3
Enneapogon	gracilis	inflors	Euth	9/05/94	1.65	0.06		10.3	44.3	7.2	41.9
Enneapogon	sp.	dead leaf	Euth	18/08/94	0.89	0.05		5.6	40.6	6.5	31.4
Enneapogon	sp.	dead stem	Euth	18/08/94	0.50	0.02		3.1	51.2	5.5	29.9
Enneapogon	sp.	green leaf	Euth	18/08/94	1.56	0.13		9.7			56.9
Enneapogon	sp.	green stem	Euth	18/08/94	0.82	0.06		5.1	46.4	5.9	33.8
Enneapogon	(aff. avenaceus)	dead leaf	Euth	9/05/94	0.95	0.06		5.9	42.6	6.4	48.6
Enneapogon	(aff. avenaceus)	dead stem	Euth	9/05/94	0.65	0.04		4.0	47.6	5.8	37.3
Enneapogon	(aff. avenaceus)	green leaf	Euth	7/03/94	2.12	0.13		13.3	37.7	7.9	62.9
Enneapogon	(aff. avenaceus)	green leaf	Euth	9/05/94	1.22	0.11		7.6	41.6	7.0	57.0
Enneapogon	(aff. avenaceus)	green stem	Euth	7/03/94	1.10	0.07		6.9	46.8	6.6	46.6
Enneapogon	(aff. avenaceus)	green stem	Euth	9/05/94	0.80	0.05		5.0	42.3	6.8	42.9
Enneapogon	(aff. avenaceus)	inflors	Euth	9/05/94	0.70	0.05		4.4	47.6	5.9	40.7
Enneapogon	(aff. polyphyllus)	dead leaf	Euth	9/05/94	0.57	0.04		3.6	45.1	5.1	32.9
Enneapogon	(aff. polyphyllus)	dead stem	Euth	9/05/94	0.28	0.02		1.7	53.7	4.8	26.9
Enneapogon	(aff. polyphyllus)	green leaf	Euth	20/03/94	1.58	0.16		9.9	41.5	7.3	59.8
Enneapogon	(aff. polyphyllus)	green leaf	Euth	9/05/94	1.13	0.09		7.1	43.2	6.4	50.7
Enneapogon	(aff. polyphyllus)	green stem	Euth	20/03/94	0.70	0.11		4.4	49.7	5.8	38.6
Enneapogon	(aff. polyphyllus)	green stem	Euth	9/05/94	0.55	0.05		3.4	48.7	5.6	32.9
Enteropogon	ramosus	dead leaf	Euth	9/05/94	0.98	0.04		6.1	39.9	6.6	22.9
Enteropogon	ramosus	dead stem	Euth	9/05/94	0.95	0.03		5.9	46.6	5.9	14.7
Enteropogon	ramosus	green leaf	Euth	7/03/94	1.31	0.05		8.2	35.3	8.0	44.4
Enteropogon	ramosus	green leaf	Euth	9/05/94	1.87	0.11		11.7	32.2	8.8	37.1
Enteropogon	ramosus	green stem	Euth	7/03/94	0.74	0.04		4.6	41.4	6.7	41.3
Enteropogon	ramosus	green stem	Euth	9/05/94	1.01	0.07		6.3	43.1	6.9	29.2
Enteropogon	ramosus	inflors	Euth	9/05/94	0.76	0.04		4.7	50.6	5.9	17.3

Genus	species	Plant part	Site	Sample Date	% N	% P	% Ca	% PROT	% ADF	MJ/kg ME (A)	% IVDMD
Enteropogon	ramosus	dead leaf	Euth	18/08/94	0.67	0.03		4.2	39.9	6.8	31.3
Enteropogon	ramosus	dead stem 1 yo	Euth	18/08/94	0.55	0.03		3.5	51.7	5.3	14.8
Enteropogon	ramosus	green leaf	Euth	18/08/94	0.99	0.09		6.2	34.1	8.1	40.4
Enteropogon	ramosus	green stem	Euth	18/08/94	0.77	0.08		4.8	41.7	7.1	33.9
Eragrostis	lacunaria	dead leaf	Euth	9/05/94	0.57	0.05		3.5	42.5	6.0	37.3
Eragrostis	lacunaria	dead stem	Euth	9/05/94	0.35	0.04		2.2	52.5	5.0	27.5
Eragrostis	lacunaria	green leaf	Euth	7/03/94	1.59	0.15		9.9	35.4	8.2	58.5
Eragrostis	lacunaria	green leaf	Euth	9/05/94	0.90	0.09		5.6	42.6	6.8	46.7
Eragrostis	lacunaria	green stem	Euth	7/03/94	0.78	0.11		4.9	46.8	6.4	40.4
Eragrostis	lacunaria	green stem	Euth	9/05/94	0.52	0.06		3.3	48.9	6.0	35.2
Eragrostis	lacunaria	inflors	Euth	9/05/94	0.62	0.07		3.9	49.6	5.7	34.3
Eriochloa	pseudoacrotricha	dead leaf	Euth	18/08/94	0.66	0.04		4.1	41.0	6.0	43.0
Eriochloa	pseudoacrotricha	dead leaf	Euth	9/05/94	0.54	0.03		3.4	36.5	6.3	43.1
Eriochloa	pseudoacrotricha	dead stem	Euth	18/08/94	0.38	0.03	0.10	2.4	54.5	4.6	34.3
Eriochloa	pseudoacrotricha	green leaf	Euth	18/08/94	1.80	0.18		11.3			
Eriochloa	pseudoacrotricha	green leaf	Euth	7/03/94	3.09	0.11		19.3			62.5
Eriochloa	pseudoacrotricha	green leaf	Euth	9/05/94	1.59	0.16		10.0	31.0	8.3	55.2
Eriochloa	pseudoacrotricha	green stem	Euth	18/08/94	0.55	0.06		3.4			76.0
Eriochloa	pseudoacrotricha	green stem	Euth	7/03/94	1.68	0.08		10.5	41.4	7.1	52.9
Eriochloa	pseudoacrotricha	green stem	Euth	9/05/94	0.61	0.06		3.8	43.6	5.9	51.0
Eriochloa	pseudoacrotricha	inflors	Euth	9/05/94	0.78	0.09		4.9			46.7
Sclerolaena	birchii	green leaf	Euth	18/08/94	2.70	0.08	1.43	16.9	19.7	12.2	67.0
Sclerolaena	birchii	tip of stems	Euth	18/08/94	1.24	0.06		7.7	43.7	6.8	31.7
Heteropogon	contortus	dead leaf	Euth	9/05/94	0.56	0.06		3.5	41.5	5.3	34.4
Heteropogon	contortus	green leaf	Rose	18/08/94	0.48	0.13	0.42	3.0	38.1	6.6	29.8
Heteropogon	contortus	green leaf	Euth	7/03/94	1.30	0.11		8.1	42.7	6.9	50.4
Heteropogon	contortus	green leaf	Euth	9/05/94	0.84	0.01		5.2	36.9	6.2	40.4
Heteropogon	contortus	green stem	Rose	18/08/94	0.25	0.03		1.6	53.2	3.8	34.7
Heteropogon	contortus	green stem	Euth	7/03/94	0.56	0.09		3.5	49.5	5.4	46.9
Heteropogon	contortus	green stem	Euth	9/05/94	0.37	0.03		2.3	50.3	5.0	36.4
Ruellia	australis	dead leaf	Euth	18/08/94	1.16	0.04		7.3	33.0	6.4	56.9
Ruellia	australis	green leaf	Euth	18/08/94	1.71	0.07		10.7	29.0	9.9	67.1
Ruellia	australis	green stem	Euth	18/08/94	1.93	0.06		12.1	32.0	7.7	55.0
Sporobolus	caroli	dead leaf	Euth	9/05/94	1.53	0.08		9.6	37.4	7.6	44.4
Sporobolus	caroli	dead stem	Euth	9/05/94	1.10	0.04		6.8	44.2	6.6	30.2
Sporobolus	caroli	green leaf	Euth	7/03/94	2.52			15.8			55.7
Sporobolus	caroli	green leaf	Euth	9/05/94	2.04	0.10		12.7	32.5	9.0	52.9
Sporobolus	caroli	green stem	Euth	7/03/94	1.39	0.08		8.7			40.5
Sporobolus	caroli	green stem	Euth	9/05/94	1.32	0.07		8.2	36.2	8.1	40.3
Stipa	scabra	dead leaf	Euth	18/08/94	0.72	0.04		4.5	42.1	6.2	30.1
Stipa	scabra	dead leaf	Euth	9/05/94	0.45	0.03		2.8	47.9	5.4	28.0
Stipa	scabra	dead stem	Euth	18/08/94	0.45	0.03		2.8	57.1	4.5	19.9
Stipa	scabra	green leaf	Euth	18/08/94	1.45	0.08	0.19	9.1	36.7	8.3	32.9
Stipa	scabra	green leaf	Euth	7/03/94	1.43	0.06		8.9	40.7	7.3	36.8
Stipa	scabra	green leaf	Euth	9/05/94	0.98	0.10		6.1	46.1	6.4	34.2
Stipa	scabra	green stem	Euth	18/08/94	0.53	0.04	0.05	3.3			18.2
Stipa	scabra	green stem	Euth	7/03/94	0.74	0.06		4.6	52.7	5.5	31.6
Stipa	scabra	green stem	Euth	9/05/94	0.49	0.06		3.0	53.0	5.3	22.4
Themeda	triandra	dead leaf	Euth	9/05/94	0.44	0.03		2.7	43.4	5.2	28.0
Themeda	triandra	dead leaf	Euth	18/08/94	0.40	0.02		2.5	44.5	4.9	32.7
Themeda	triandra	dead stem	Euth	18/08/94	0.24	0.01		1.5	57.4	4.0	17.7
Themeda	triandra	green leaf	Euth	18/08/94	0.95	0.08		6.0			
Themeda	triandra	green leaf	Euth	7/03/94	1.25	0.11		7.8	42.3	7.2	44.8

Genus	species	Plant part	Site	Sample Date	% N	% P	% Ca	% PROT	% ADF	MJ/kg ME (A)	% IVDMD
Themeda	triandra	green leaf	Euth	9/05/94	0.94	0.10		5.9	37.8	6.6	41.3
Themeda	triandra	green stem	Euth	18/08/94	0.18	0.01		1.1	55.2	4.2	20.8
Themeda	triandra	green stem	Euth	7/03/94	0.42	0.09		2.6	52.5	4.9	42.7
Themeda	triandra	green stem	Euth	9/05/94	0.23	0.03		1.5	55.7	4.2	24.9
Tragus	australianus	dead leaf	Euth	9/05/94	1.51	0.05		9.4			42.7
Tragus	australianus	dead stem	Euth	9/05/94	0.95	0.03		6.0	47.6	6.0	32.0
Tragus	australianus	green leaf	Euth	20/03/94	2.66	0.16		16.6	34.0	7.7	63.7
Tragus	australianus	green leaf	Euth	9/05/94	1.82	0.08		11.3			
Tragus	australianus	green stem	Euth	20/03/94	1.47	0.10		9.2	45.3	6.7	42.2
Tragus	australianus	green stem	Euth	9/05/94	1.09	0.03		6.8	46.5	6.2	34.1
Tripogon	loliiformis	dead leaf	Euth	9/05/94	0.65	0.07		4.1	51.8	5.3	29.4
Tripogon	loliiformis	dead stem	Euth	9/05/94	0.56	0.08		3.5	51.0	5.5	24.6
Tripogon	loliiformis	green leaf	Euth	19/03/94	1.15	0.11		7.2	42.0	6.6	39.7
Tripogon	loliiformis	green stem	Euth	19/03/94	0.75	0.09		4.7	50.3	5.8	35.4
Tripogon	loliiformis	inflors	Euth	9/05/94	0.88	0.10		5.5	49.2	6.1	28.2
Urochloa	mosambicensis	green leaf	Euth	7/03/94	2.27	0.20		14.2			62.2
Urochloa	mosambicensis	green stem	Euth	7/03/94	1.07	0.13		6.7	48.2	5.3	51.4
Verbena	tenuisecta	green leaf	Euth	18/08/94	2.79	0.14	1.63	17.5	14.6	11.8	75.4
Verbena	tenuisecta	green leaf	Rose	18/08/94	2.06	0.23		12.9	15.4	10.3	75.6
Verbena	tenuisecta	green stem	Euth	18/08/94	1.38	0.10		8.6	34.0	8.4	56.5
Vittadinia	sp.	green leaf	Rose	18/08/94	1.92	0.28	1.98	12.0	13.2	11.0	66.4
Vittadinia	sp.	stem tips	Rose	18/08/94	0.83	0.19		5.2	36.4	7.4	54.6

NOTES: ADF = Acid Detergent Fibre analysis
IVDMD = *in vitro* DM Digestibility

ME = Metabolisable Energy (MJ / kg) based on the ADF and protein values

Common names

Aristida jerichoensis	Jericho wiregrass
A. latifolia	Feathertop wiregrass
A. leptopoda	Whitespear
A. muricata	Rough wiregrass
A. platychaeta	Curly wiregrass
Astrebla elymoides	Hoop Mitchell grass
Bothriochloa bladhii	Forest bluegrass
B. decipiens	Pitted bluegrass
Cenchrus ciliaris	Buffel grass *
Chloris divaricata	Slender chloris
C. ventricosa	Tall chloris
Chrysopogon fallax	Golden-beard grass
Cymbopogon obtectus	Silkyheads
C. refractus	Barbwire grass
Dichanthium sericeum	Qld bluegrass
Digitaria coenicola	Finger panic
Enneapogon gracilis	Slender bottlewashers
Enneapogon sp.	Bottlewasher grasses
Enteropogon ramosus	Twirly windmill grass
Eragrostis lacunaria	Purple lovegrass
Eriochloa pseudoacrotricha	Early spring grass
Heteropogon contortus	Black speargrass
Ruellia australis	Blue trumpet
Sclerolaena birchii	Galvanised burr
Sporobolus caroli	Fairy grass
Stipa scabra	Rough speargrass
Themeda triandra	Kangaroo grass
Tragus australianus	Small burrgrass
Tripogon loliiformis	Five-minute grass
Urochloa mosambicensis	Sabi grass *
Verbena tenuisecta	Mayne's pest *
Vittadinia sp.	Fuzzweed

* = not native

2. PASTURE COMPOSITION vs. SHEEP PRODUCTION

Aim

To put an economic cost on having a high proportion of unpalatable wiregrass in pastures.

Methods

Two small trials (29 and 17ha) were set up on Euthulla and Roselea where adjacent areas of pasture had very different proportions of wiregrass but in other respects were very similar and on the same soil type. At each site the ‘good” pasture was divided into 4 paddocks, two small and two large (approx. double area) and the ‘poor” (high wiregrass) pasture was subdivided exactly the same. Each paddock was grazed by 4 two-tooth wethers. Sizes were meant to produce stocking rates at about the rated long-term carrying capacity of the country and double that stocking rate. Thus the trial design was 2 pastures x 2 stocking rates x 2 replicates at each site.

The trials were set up and fenced in early 1993 but severe drought conditions discouraged us from putting in the sheep until a decent fall of rain occurred. This did not happen until Christmas 1993. In the meantime, kangaroos were kept out by an electric fence outrigger. Newly shorn sheep eventually went on in early February 1994. About every 2 months they were weighed, midside wool samples taken and dyebands applied. Faecal samples were taken for worm egg counts.

In mid-December 1994, the Flock 1 sheep were shorn and returned to the paddocks. Their fleeces were weighed and samples sent away for Aust. Wool Testing Authority (AWTA) testing for yield, fibre diameter, length and strength. An extra 4 two-tooth wethers with short wool were added at this time to each paddock, effectively doubling the grazing pressure. This was done because negligible differences were evident due to pasture composition during 1994 and all paddocks had a large body of standing feed - more than 4 sheep could consume in many months. The new sheep (Flock 2) also had a longer fleece in the hope that significant vegetable fault from late summer seeding would be more likely to occur.

Unfortunately, 1995 had a very similar rainfall pattern to 1994, summer rains ending early and abruptly (Figure 3) and so the results were very similar. By August 1995, available feed was getting low in some paddocks, so all Flock 1 sheep were removed from both sites and shorn. Fleeces were skirted and weighed and samples sent away for AWTA testing. The Flock 2 sheep stayed on the trial until mid-December 1995, when they too were shorn and their fleeces weighed, skirted and sampled.

Results

2.1 Sheep Growth

The results presented concentrate on the Roselea site because the botanical composition of the “good” pastures at Euthulla deteriorated late in the drought, minimising the differences between pastures at the trial start and hence the treatment effects. We analysed this data differently to see if “real” effects could be ascribed to other pasture composition parameters, eg. % forbs, % palatable grasses. However no strong trends emerged to offer alternative measures that correlated with animal performance.

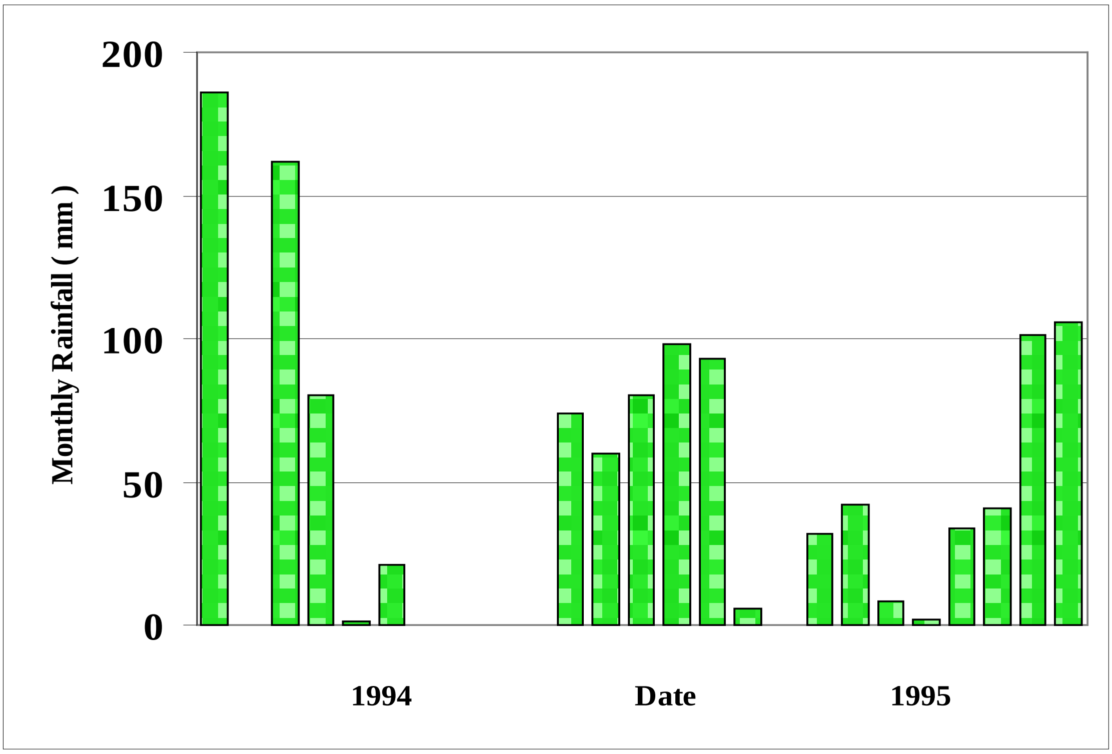

Figure 3. Monthly rainfall at Roselea from Dec '93 to Dec '95.

Table 17. Forage available during the experiment at Roselea

	Dry weight proportion				Total standing feed kg/ha	Basal Area %
	Buffel	Wiregrass	Other grass	Non-grasses		
Jan 1994						
Poor composition (P)	47.0	37.0	8.2	7.8	1465	6.7
Good composition (G)	95.5	0.4	1.3	2.8	1505	6.1
May 1995						
Poor composition (P)	40.5	41.5	12.7	5.3	2250	2.6
Good composition (G)	95.7	0.5	2.1	1.7	3165	2.8

The mean sheep liveweight changes at Roselea over time were presented (Figure 4) for each combination of pasture type and stocking rate. Stocking rates had a negligible effect on liveweight or wool production for most of 1994, except in mid-winter when green feed was virtually nonexistent. This indicates that the sheep had ample feed to select from in all paddocks. In 1995, when stocking rates were doubled, there was a small stocking rate effect and a significant effect of pasture composition. The only difference was that the younger sheep performed much worse on the wiregrass dominated pastures than did the older full-mouth sheep at such high stocking rates. At Roselea, the mean composition of the "good" buffel grass and "poor" pastures in January 1994 and March 1995 is shown in Table 17. This shows how strongly grass dominant they were which should have exaggerated feed quality differences.

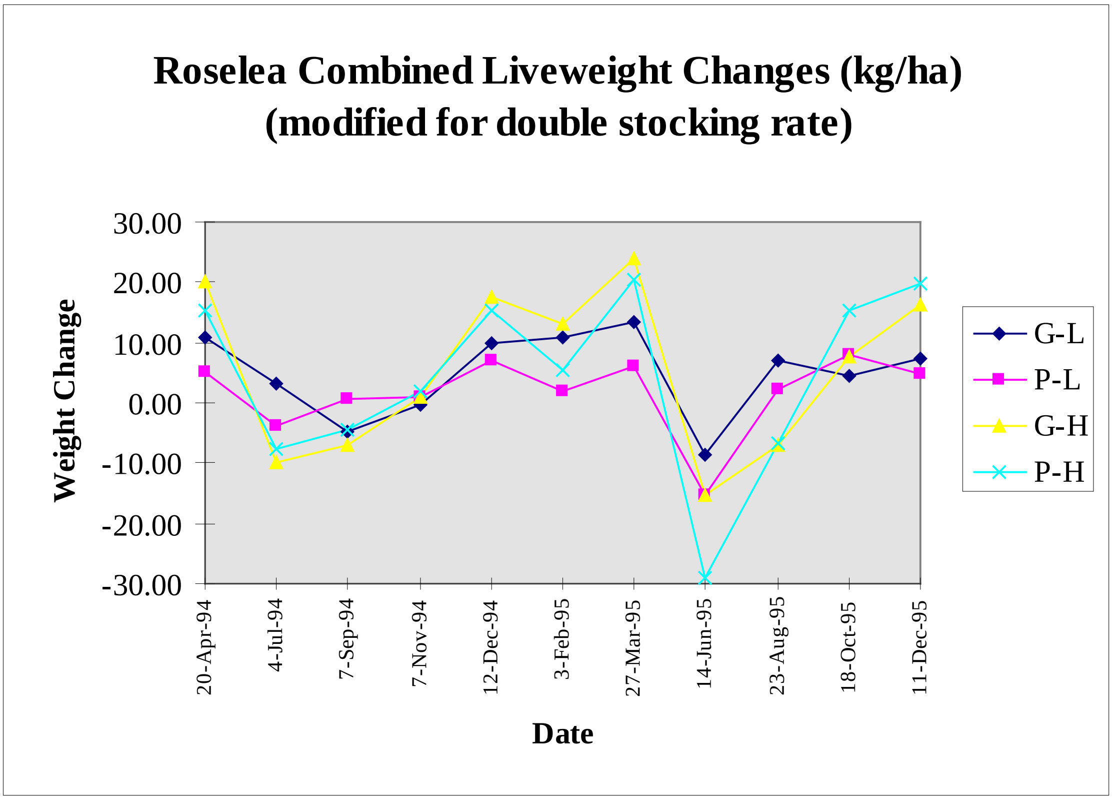

Figure 4. Liveweight change per hectare during the trial at Roselea

2.2 <u>Wool Growth and Quality</u>

Relative wool production (clip-patch data) between treatments tended to follow sheep liveweight gain/loss except that wool growth was always positive. The greasy fleece weights are a summation of all the seasonal growth rates. Three fleeces are available for comparing the pasture effects - Dec 1994 (10.5 mths), Aug 1995 (8 mths) and Dec 1995 (12 mths). The first two are from the same Flock 1 animals.

The fleece data can be interpreted in several ways - on a per head basis or on a per hectare basis. The value of the fleece can be averaged over the whole greasy fleece or calculated using separate values for fleece wool and skirtings and summing the two. The results can be evaluated for each fleece and also as the average of all 3 fleeces. The latter submerges the effects of stocking rate changes, which were minimal, and avoids seasonally specific results which may be misleading to producers if used in isolation, eg. market values shift dramatically and so do premiums for finer micron wool.

Our price calculations are based on the mean eastern Australian market values and discount rates for the last quarter in the 1995 season. The AWTA data from our samples provided length, fibre diameter, yield and strength information in conjunction with an assessment by a Roma wool assessor of the basic fleece type and colour. The assessor felt that all fleeces fell within the one style (5) and that fleece vegetable fault was quite low (mostly <1%).

International Wool Secretariat (IWS) data for the Maranoa region showed that in 1994, the average discount for fleece with 1-3% vegetable matter (VM) fault was 15% and for fleece with 3-7% VM it was 24%. Maranoa fleece with <1% VM incurred no penalty for VM and price was determined by fibre diameter, length and strength.

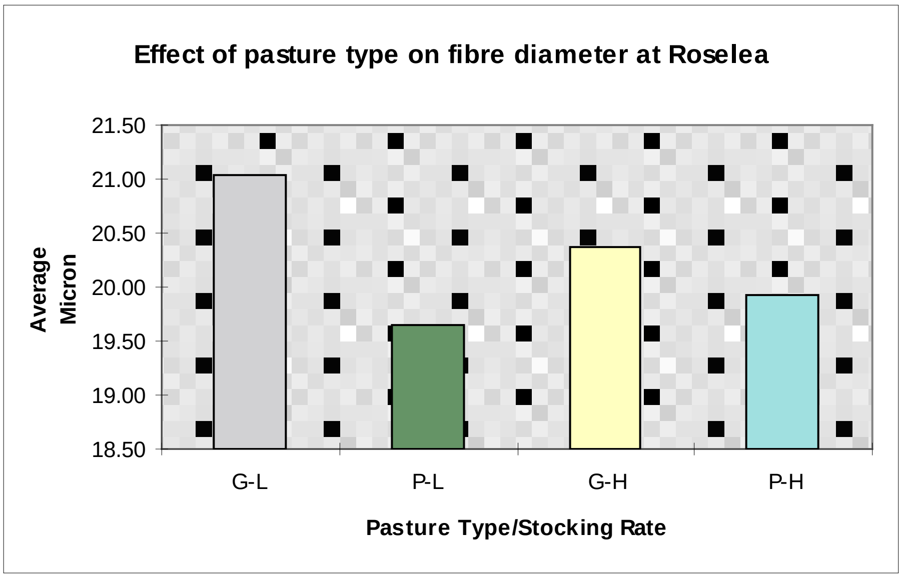

Figure 5. Effect of pasture type on mean fibre diameter of 3 fleeces at Roselea

Thus, in valuing fleeces, the primary consideration was fibre diameter, then strength and to a small degree VM and length. The "poorer" wiregrass dominated pastures at Roselea produced significantly finer and thus more valuable wool (Figure 5). However, fleece weights were lighter on the wiregrass pastures (Figure 6) and counteracted the benefits of finer fibre diameter. Figure 7 shows that the nett effect of all these factors on shorn wool value was primarily controlled by stocking rate rather than pasture quality. Wool strength was generally greater than 30 Nktex, which is considered adequate, but some means were lower in the wiregrass pastures,– 21-22 compared to 32-35 Nktex.

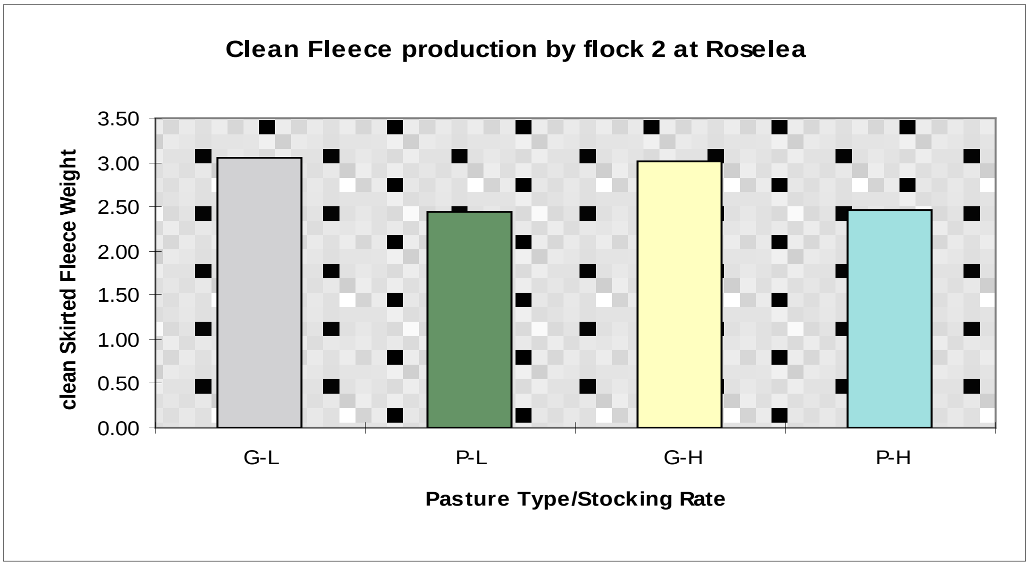

Figure 6. Clean fleece production by flock 2 from good buffel (G) and poor wiregrass (P) pastures at two grazing pressures (H and L) at Roselea.

2.3 Wool Value

Gross return per sheep at Roselea, averaged over three fleeces, was 28 cents per head better on the good buffel pasture at the lower stocking rate and only 97 cents better at the high stocking rate. The nett effect, averaged over 3 fleeces, and calculated on a per hectare basis was a benefit of $5.24 per hectare (7.9%) at high stocking rates and $1.78 per hectare (4.7%) at the lower stocking rate for the buffel grass dominant pastures. There was no advantage to the better pasture in the first year, a $4.06 (7.9%) advantage to buffel pasture for fleece 2 of flock 1 and a $6.28 (7.8%) advantage to the buffel pastures for the fleeces from flock 2. The mean advantage to the better grass pastures, combining both stocking rates, was $3.50 per hectare at Roselea and much less ($1.30) at Euthulla.

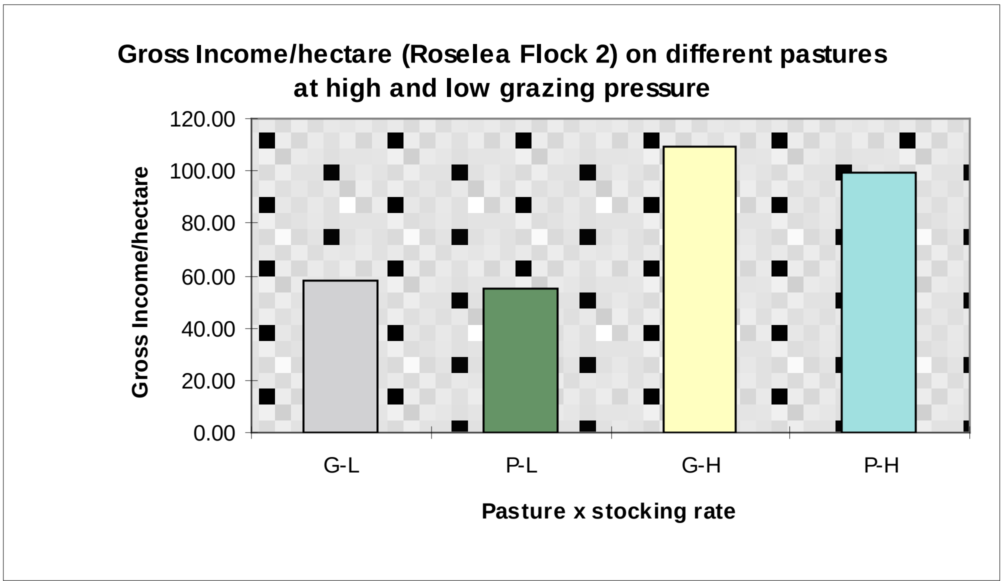

Figure 7. Gross income per hectare (Flock 2) on different pastures at high and low grazing pressure at Roselea.

We speculate that this shift in relative advantage was due to a comparatively low grazing pressure initially in year 1, due to a 9 month pre-trial period without sheep. During the spell, small amounts of other palatable species probably accumulated and were used to advantage by the sheep in the wiregrass-dominated pastures. By comparison, the buffel-dominated pastures had very little diversity, especially of broad-leafed herbs which could enhance the animals' diet. Pure buffel grass has always been regarded as a "maintenance-only" diet which allows little scope for high animal production compared to mixed pastures of palatable plants. The much better performance of flock 2 on buffel relative to wiregrass pastures is believed to more truly reflect what happens when very little other than wiregrass exists for animals to eat. Midwinter performance of the animals (see Figure 4) also reflects the poorer quality of stalky wiregrass (<30% IVDMD) compared to stalky buffel (37% IVDMD for green stem).

Other data shows that, despite relatively low levels of vegetable matter fault in the wool during the 2 years of the trial, the levels were significantly higher in neck samples from the wiregrass dominated pastures. Thus in years of heavy wiregrass seeding, we expect this difference would be exaggerated via much heavier skirting rates (normally 20-25% of the fleece) and a bigger price discount for high VM in fleece wool.

2.4 Economic Implications of Wiregrass Dominance

When pasture composition is poor and dominated by wiregrasses, wool growers have the option of either not running long-wool sheep in that area, or trying to use grazing management and fire to change it, or to sow improved pasture. Buffel grass is the only sown species generally suitable for poplar box country, so we did some calculations to determine whether it might be economically sensible to substitute wiregrass with buffel grass.

This is done in the knowledge that greasy fleece weight was not often statistically greater from the better pasture. However, fibre diameter, staple strength and vegetable matter fault were often very different and future shifts in price discounts may alter their importance in determining pasture management strategies.

(a) Cost of replacing wiregrass with buffel grass

Our other studies showed that tall Jericho wiregrass could be readily removed by shallow ploughing. We also know that oversowing grasses into an undamaged existing pasture will not rapidly improve pasture composition. Hence we calculated what economic return might accrue from a rough ploughing of dense wiregrass and sowing it to buffel grass in a 1-pass operation.

Assumptions were –

Cost of buffel seed	\$6.00 /kg
Sowing rate	2.5kg / ha
Ploughing plus sowing costs	\$12.00 /ha
Area treated	1000 - 4000 ha
Financial period involved	20 years
Discount rate for Net Present Value	8%
Period without grazing after sowing	4 months
Additional annual return	\$3.50 / ha (Roselea)
from buffel pasture	\$1.30 / ha (Euthulla)

The result is a total reseeding cost of \$27 per hectare. A similar cost will apply to a range of different operators but using slightly lower seeding costs and higher ploughing costs, depending on the individual's circumstances.

The cost of destocking the sown area for 4 months has not been included as it would be very small. Because only 5-20% of the whole property is being resown, the sheep will have other pasture to graze for this period with little effect on either the condition of the pasture or the sheep. It is further assumed that the new pasture would probably take about 4 years to settle at an equivalent animal productivity level to the trial pastures and then produce the better quality and quantity of wool for the remaining 16 years.

Three different pasture establishment scenarios were examined: Best case, Average and Worst case. The Best case scenario (good summers) would be to have the full benefit of the pasture improvement by the second year and 25% in the first year. The average scenario is 10%, 50%, 80% and 100% of the benefit in the first to fourth years respectively. The worst situation presumes none of the improvement is available until year 3, when 100% benefit is received. The average difference between the two pasture types ($3.50 at Roselea) is assumed to be the extra annual income derived.

The two tests of profitability used were Net Present Value (NPV) and the Internal Rate of Return (IRR). A NPV greater than zero is considered a profitable investment. The results show a likely NPV of $3 per hectare at Roselea from the investment in pasture improvement. On a 20 000 hectare property with 20% poor pasture, this would be an improvement in gross income of $12 000 over the 20 years. The mean IRR in this case is 9% and therefore the project can be considered profitable by that measure too, under all three scenarios. At Euthulla, pasture improvement is not profitable for any of the scenarios due to the small difference in returns.

Table 18: Results of discounted cash flow for pasture improvement over 20 years at Roselea

Establishment Scenario	NPV/ha	IRR
Best Case (1995 wool prices)	$4.99	10%
Worst Case (1995 prices)	$1.18	8%
Average (1995 prices)	$3.00	9%

If lower establishment costs were possible, the exercise would become more profitable by a similar amount, ie. a $1 cut in costs would increase the NPV by $1.

(b) Price sensitivity analysis

The sensitivity of the results to prices was tested using 1993 and 1994 wool prices. The 1995 prices provide a bigger wool value difference ($3.51 /ha) than either 1993 ($2.51) or 1994 ($2.27) between good and poor Roselea pastures. The smaller differences in 1994 occurred despite higher base wool prices than in 1995. This emphasises the importance of the quality discounts and premiums, particularly finer fibre diameter, on clip value in the Roma district.

At 1993 and 1994 prices, the pasture improvement investment of $27 /ha would yield negative NPVs and the internal rates of return would have been 4-5% instead of 9%. To break even, an average annual improvement in income of $3.16 per ha would be needed and only the Roselea sheep at 1995 prices exceeded that amount. Lowering establishment costs by $3-4 /ha could counteract the reduced margin between poor and reasonable pastures.

The relative contribution of fleece length, strength and VM fault to fleece value was also tested. After fibre diameter, fibre strength contributed the most. The difference in fleece weight would have been more than counterbalanced at Roselea by the finer wool from poorer pasture had the loss of strength at finer microns not been so price sensitive.

3. MANAGEMENT STRATEGIES

3.1 Tabulated Data and Species Ratings

We have attempted to summarise our findings about the main species studied in tables showing strengths and weaknesses (Tables 19 and 20). These are the major species at the 2 grazing trial sites and hence tie the ideas to a definite practical situation. Table 19 relates mainly to the regeneration capacity of species while Table 20 covers aspects about their resistance to damage by various agents. It is mostly the relativities between species which provide means by which graziers can selectively target species. The option used depends on individual circumstances and prevailing seasonal conditions.

Table 19. Plant Characteristics of the Major Species

	SEED PRODUCTION		*SEED DORMANCY*	*SEEDLING RECRUITMENT*			*MATURITY*	*PLANT LONGEVITY*
SPECIES	Frequency	Numbers		No's	Freqcy	Season		
	Roselea							
A. jerichoensis	B	M	S	H	B	E	2	p
A. latifolia	B	M	S			E	4	p
B. decipiens	B	M	N	L	P	H	3	l
B. piligera	A	L		L	A	S	2	s
C. lappulacea	A	M	6	M	A	C	3	w
C. ciliaris	B	M	S	MH	P	H	6	l
C. divaricata	B	H		H	R	H	3	p
C. apiculatum	B	H	N	L	P	W		l?
C. obtectus	A	L		L		S	18	p
C. dactylon	P	M	6?	M	A	S	3	p
D. sericeum	B	M	S	L	B	E	3	p
D. coenicola		M	9?	L	P	S	4	l
E. gracilis	P	M	S	M	R	H	2	w
H. contortus	A	L	6	V	A	S	18	p
M. americanum	P	M	L	L	P	H	5	w
P. trichostachya	A	H	S	M	A	C	2	s
S. birchii	P	M	L	M	2	C	2	w
T. australianus	A/R	M		M	A	H	1	s
V. tenuisecta	A	M	S	H	A	C	3	w
V. sulcata	P	H	S	M	A	C	3	w

CODES:

SEED PRODUCTION: Frequency A (annual), B (biannually), P (prolonged periods), R (in response to rain),
Numbers / year H (high), M (medium), L (low), V (very few)

SEED DORMANCY: N (nil), S (short), 6 (approx. 6mths), 12 (approx. 12mths), L (longer than 1 year)

SEEDLING RECRUITMENT:
Numbers H (high), M (medium), L (low), V (very few)
Frequency A (annual), B (biannually), P (prolonged periods), R (in response to rain), 2 (2-yearly), 5 (5-yearly), I (infrequently, say 1 year in 10)
Seasonality S (summer -Oc_Ap), W (winter - Ap_Oc), E (equinox - Mr_My, Se_No), H (hotter months - Se_My), C (cooler months - Mr_No), A (anytime)

MATURITY: Months to 1st seeding

PLANT LONGEVITY: s (strict annual), a (mostly annual), w (short-lived perennial), p (perennial), l (long-lived perennial)

Table 19. (cont.) Plant Characteristics of the Major Species

SPECIES	SEED PRODUCTION Frequency	SEED PRODUCTION Numbers	SEED DORMANCY	SEEDLING RECRUITMENT No's	SEEDLING RECRUITMENT Freqcy	SEEDLING RECRUITMENT Season	MATURITY	PLANT LONGEVITY
	Euthulla							
A. jerichoensis	B	M	S	H	B	E	2	p
A. latifolia	B	M	S	H	B	E	4	p
A. platychaeta	B	M	6?	M	B	E	2	p
B. decipiens	B	M	N	L	P	H	3	l
C. lappulacea	A	M	6	M	A	C	3	w
C. ciliaris	B	M	S	MH	P	H	6	l
C. sieberi	R	H		V	5	W	24?	l
C. divaricata	B	H		H	R	H	3	p
C. fallax	A	L	N	V	I	H		l
C. obtectus	A	L		L		S	18	p
D. sericeum	B	M	S	L	B	E	3	p
D. coenicola		M	9?	L	P	S	4	l
E. gracilis	P	M	S	M	R	H	2	w
E. ramosus	R	L		M			4	l
E. molybdea	B	H	L	M	R	H	3	
E. pseudoacrotricha	B	M	12	M	B	E	3	p
F. dichotoma	R	M		M	R	A	4	
S. birchii	P	M	L	M	2	C	2	w
T. loliiformis	R	M		M	R	H	5	p
V. tenuisecta	A	M	S	H	A	C	3	w

CODES: As before

3.2 Discussion

Normal-sized paddocks in rangelands are large; hundreds or thousands of hectares. The vegetation within is a mosaic reflecting the combination of soil type, available moisture and recent management. In the absence of fertiliser and water harvesting schemes, management is all that is available to encourage desired species and discourage unwanted one. However, you cannot apply the same management tool to a mosaic of microsites and expect the result to be the same everywhere. We believe the **appropriate management** should only be used on those **sub-paddock areas** most needing improvement.

It is important to point out that, **despite quite high stocking rates and small paddocks (1 - 3 ha) in our trials, sheep still strongly patch grazed the pastures**. They preferred green stem and tiny shoots on stalky buffel grass in mid-winter instead of dry buffel leaf. They also avoided mature plants of wiregrasses and twirly windmill grass at all times, yet those in wiregrass dominant pastures did not suffer much in their weight gains due to restricted intake. Thus to force animals to consume unpalatable grass requires very high stocking pressures, maybe 10 - 20 times the normal, and this is possibly beyond the total resources of a single property (8000 sheep for a 1000ha paddock). Conversely, if a small area of a paddock contains preferred plants, they will be extremely heavily grazed even if the overall stocking rate is low. A 5ha sweet patch in a 1000ha paddock could suffer up to 200 times the nominal grazing pressure of the paddock. Such pressure will inevitably eliminate those species from that area. Stock would then tend to repeat the effect on the next preferred patch, unless they are removed deliberately or shifted indirectly by seasonal plenty in a big paddock.

Table 20. **Management Options for Suppressing Established Plants**

SPECIES		Fire (dry season)	Herbicide (selective)	Toxic chemical	Ploughing (shallow)	Heavy Grazing	Summer Drought
		Euthulla					
Aristida	jerichoensis	-2	N		-4	-2	0
Aristida	latifolia	-3	N		-5	-1	-3
Bothriochloa	decipiens	0	N			4	1
Brachiaria	piligera	1	U		-2	-3	-5
Calotis	lappulacea	-1	U		-3	-2	-2
Cenchrus	ciliaris	2	O	glyphosate	-1	1	4
Chloris	divaricata	-3			-4	2	0
Chrysocephalum	apiculatum	0	U		0	1	2
Cymbopogon	obtectus		U		-5	-5	-2
Cynodon	dactylon	-2	N		1	3	-2
Dichanthium	sericeum	-1	O	atrazine	-2	-3	-3
Digitaria	coenicola	0			-2	-1	
Enneapogon	gracilis	-3	U		-5	3	2
Heteropogon	contortus	3	U		-3	-2	-2
Malvastrum	americanum	-1				3	
Pimelea	trichostachya		O	allay	-5	5	3
Sclerolaena	birchii		O	2,4-D	-5	3	3
Tragus	australianus	-1			-5	4	2
Verbena	tenuisecta	-1	O	Tordon 50D	-4	1	-2
Vittadinia	sulcata	-1	U		-5	-2	-1
		Roselea					
Aristida	jerichoensis	-2	N		-4	-2	0
Aristida	latifolia	-3	N		-5	2	-3
Aristida	platychaeta		N		-4	-3	
Bothriochloa	decipiens	1	O	glyphosate	-2	4	1
Calotis	lappulacea	2	U		-1	0	-2
Cenchrus	ciliaris	2	O	glyphosate	-1	1	4
Cheilanthes	sieberi	2	U		-5	4	0
Chloris	divaricata	-3			-4	2	0
Chrysopogon	fallax	3	U		2	2	0
Cymbopogon	obtectus		U		-3	-3	-2
Dichanthium	sericeum	-1	O	atrazine	-2	-3	-3
Digitaria	coenicola	0			-2	-1	
Enneapogon	gracilis	-3	U		-5	3	2
Enteropogon	ramosus		U		-4	2	
Eragrostis	molybdea				-1	3	
Eriochloa	pseudoacrotricha		N		1	0	1
Fimbristylis	dichotoma	1	U			2	0
Sclerolaena	birchii		O	2,4-D	-5	3	3
Tripogon	loliiformis		U		-2	3	3
Verbena	tenuisecta	-1	O	Tordon 50D	-4	1	-2

CODES:

Fire (dry season**)** -5 (killed easily) ...... 0 (no effect) .... +5 (strongly encouraged)
Herbicide (selective) N (none useful), O (1 or 2 can kill), U (unknown responses)
Ploughing (shallow) -5 (killed easily) ...... 0 (no control) .... +5 (spreads vigorously after)
Heavy Grazing -5 (eliminated) .... 0 (no effect on population) ...... +5 (increased)
Summer Drought -5 (can be killed) ..... 0 (no effect on population) ...... +5 (big increase)

 # Blank Cells mean that knowledge is presently inadequate to allow a reasonable estimate

Thus, if excessive wiregrass is a problem on a sandy rise in a paddock, that rise needs the specialised management. Other parts of the paddock can normally be ignored or over-used for some time without undue detriment while the problem area is treated. In this way, complete destocking of the whole unit is unnecessary while remedial action is taken. If the whole of a very ‘spatially even’ paddock needs treatment then the task is much bigger and should probably be done on parts of the paddock at a time. In this way risks and costs are minimised.

Where **overgrazing is the problem**, no sophisticated management of parts of the property will overcome this basic imbalance. There are no hard and fast rules about how many stock a property unit can run - it varies with the amount of recent rain. The long-term average can be prophesied but may be an inappropriate figure to stick rigidly to year in, year out. In really wet winters, woody weeds may establish thickly and demand control via fire, chemicals or heavy grazing. The option used will be determined by the owner’s management style, market profitability and the particular weed involved.

Early intervention is the key for weed control. A long-term, broad strategy is needed to remedy chronic problems such as poisonous native plants or soil erosion. The best weapon is a good knowledge of what plants occur on the property. If you know that, the next step is to be able to identify them as young as possible and to have reference sources which catalogue the strengths and weaknesses of all major plants. Progress is being made in producing reference material which allows graziers to fairly readily identify major plants in most rangelands in Queensland, eg. Henry *et al*. 1995. The greatest limitation is adequate documentation of what young plants look like and their strengths and weaknesses, particularly the ease with which they establish in different seasons and their longevity once established.

Replacement of degraded pasture by oversowing has a ‘good feel’ about it to many people but, as our earlier calculations showed, the longterm economic benefits are often less satisfying than the short-term flush of new pasture. There are significant risks in the Maranoa of establishment failure and the initial costs can be large ($27/ha) unless the grazier has a natural price advantage, such as producing his own seed or owning cultivation equipment. Replacing one grass with another is the least beneficial of all pasture enhancement options.

<u>Annual plants</u>

Annual plants depend entirely on recent rain and appropriate temperatures for their existence in a pasture. They are encouraged by being allowed to regularly seed freely and to a lesser extent by being given biological room to establish. **To control annuals, stop them from seeding**. To eliminate them stop them establishing as well.

<u>Perennial herbs</u>

With perennial herbs, controlling seeding is not as important. Its importance is inversely proportional to the mean lifespan of an established plant. Lovegrasses are generally hardseeded with a persistent seedbank in the soil while seed of *B. decipiens* and *C. refractus* does not last long in the paddock. All can be potentially weedy plants. Short-lived plants like Queensland bluegrass need to re-establish some plants from seed in most years to ensure a range of plant ages exists, thereby minimising the risk of a catastrophic event eliminating an even-aged population. Long-lived, rhizomatous plants like golden beard grass have no need to recruit seedlings if they have a reasonable presence in a pasture already. In fact, it does not seed freely and seedlings are rarely seen in the field (M^c Ivor and Gardener 1994). Possibly a bigger threat to it comes from kangaroo rats and pigs digging up the crown for food. Heavy grazing will not readily control golden beardgrass because it has a deep, robust crown.

Woody trees and shrubs

For woody trees and shrubs (perennials by definition) regular recruitment is not essential to their existence but periodic seed inputs are needed to ensure a catastrophic event does not eliminate adult plants while there is no seed reserve in the soil. Intense fires have the potential to do this for sensitive species such as cypress pine and many wattles. Seed reserves of many woody plants are transient but temporarily large, eg. eucalypts, but for some they are persistent but small, eg. wattles. Wattles often drop many seeds but they are sought after as food by insects and animals and most are destroyed soon after falling. The persistent ones usually number only a few per square metre one year after seed ripens. Hardseededness and induced secondary seed dormancy complicate the issue in a few cases.

There are exceptions to these generalisations but our style of research will quickly identify them via seed germination and soil seedload studies. Acquiring data on the longevity of plants takes much longer but a general idea can be gained in 3 - 4 years.

Putting the ideas into practice

Our management proposals will need fine tuning in response to operational imperatives but should be a solid basis on which sustainable production from our native pastures can be built. The important starting point is an ongoing, systematic assessment of pastures in every paddock. Doing that will foster a better awareness and understanding of the main/key species and their response to climate and recent management. From there, timely weed control should occur along with a better matching of grazing pressure (livestock numbers) to feed supply.

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