

Managing rhodes grass (*Chloris gayana*) cv. Callide to improve diet quality.

1. Effects of age of regrowth, strip grazing and mulching

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Abstract

Two experiments assessed grazing management strategies for irrigated and nitrogen-fertilised rhodes grass (*Chloris gayana*) cv. Callide pasture. In Experiment 1, the 4 treatments were: (i) open grazing of the entire paddock on a 2-week cycle (Open); (ii) grazing on a 2-week, daily strip-grazing rotation (2); (iii) a 4-week, daily strip-grazing rotation (4); and (iv) a 6-week, daily strip-grazing rotation (6). For treatments (ii), (iii) and (iv), pasture was allocated at 15 kg green leaf dry matter (DM)/cow/d and grass was mulched to a stubble height of 10 cm after grazing. Stocking rates attained were 1.7, 3.7, 3.5 and 3.4 cows/ha for Treatments (i), (ii), (iii) and (iv), respectively. In Experiment 2, pastures were grazed on a 2-paddock 2-weekly rotation [Open (O) and Open + mulching (OM)] or 28-day rotational cycle without mulching (28) or with mulching (28M) after grazing.

There were substantial differences in yield of pasture on offer to cows with different grazing management, but total leaf yield appeared similar, with a mean growth rate of 42 kgDM/ha/d. There were small, but significant differences in pasture quality between treatments, though pastures in unmulched paddocks had lower crude protein and higher NDF levels than those in mulched paddocks. Animals selected strongly for leaf (78%) across all treatments, though stem content increased from 13% in February to 25% in April. Milk yield was not altered by age of

regrowth or open grazing, but was reduced ($P < 0.05$) where rotationally grazed pastures were not mulched. This was attributed to the presence of stem impeding access to leaf when pastures were grazed in narrow strips.

The results demonstrate that intensive management of Callide rhodes grass pastures can support a stocking rate up to 3.7 cows/ha, but there are only small animal production differences associated with radically different grazing management routines. Additional operational costs associated with more intensive management of pastures ranged from AUD30 to AUD80/ha for the 18 weeks of the experiment compared with open grazing. In Experiment 2, net marginal returns were AUD0, -38, -145 and 66/ha for the four treatments O, OM, 28 and 28M, respectively.

Introduction

It is often difficult to maintain milk production during late summer and autumn in subtropical and tropical dairy systems. Even when total dry matter (DM) yield of grass is high, the leaf percentage and digestibility of the diet can be low, reflecting the selection of a diet low in leaf, crude protein and metabolisable energy (ME). In addition, grazing time is reduced substantially once daily maximum temperatures exceed 27°C, reducing intakes (Davison *et al.* 1994). The net effect is a rapid fall in milk production during the period December–May.

Attempts to maintain milk production on tropical pastures during this period have often been unsuccessful. Strip grazing forces cows to consume a high proportion of stem in the diet (Ottofen *et al.* 1975), and this was assumed to be the reason for a lower level of milk and beef production from tropical grasses under rotational compared with continuous grazing at comparable stocking rates (Thurbon *et al.* 1971; Chopping *et al.* 1978). Other techniques such as put-and-take stocking,

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slashing after grazing and combinations of these with rotational grazing were also unable to maintain milk production above that of cows under continuous grazing of unmanaged grass at comparable stocking rates (Davison *et al.* 1981). However, in an experiment by Lowe *et al.* (2000), examining a 4-paddock rotational system of grazing, buildup of stem appeared to restrict access by the cow to leaf. When Lowe *et al.* (2000) grazed cows on pangola grass (*Digitaria decumbens*) pasture where grass was allocated daily at 15 kg/cow green dry leaf, milk production was maintained at 12 L/cow/d.

Despite conflicting experimental evidence, there remains a strong belief in industry that milk production from tropical grasses would be higher if managed to avoid high levels of standing stem.

Two experiments were designed to obtain more specific information on the effects of different management options on pasture production, diet selection by the cow and milk production. To ensure continual growth of the grass, irrigation was provided, thus enabling management treatments to be applied consistently throughout the experiments. The management treatments controlled the age of the grass on offer to the cows, compared daily strip grazing with a paddock-based system, and assessed the effects of removing residual pasture following grazing.

Materials and methods

The experiments were carried out in 1992–1994 on Mutdapilly Research Station, south-east Queensland (27° 45'S, 152° 40'E; elevation 40 m), where the climate is subtropical with a mean annual rainfall of 850 mm, of which 60% falls between December and March. Mean maximum and minimum temperatures are 31 and 18°C in December and 20 and 5°C in July, respectively. Frosts can occur from May to September, but are most common in June, July and August.

The experiments used 7.2 ha of mixed black and brown cracking clay soils, classified as endohypersodic, self-mulching black and grey vertosols (Isbell 1996).

Rhodes grass (*Chloris gayana*) cv. Callide was established on the area in 1982, and in the 3 years preceding the present experiment, the area received 150 kg/ha N and 250 kg/ha superphosphate annually, and 125 kg/ha potassium

chloride in alternate years. In 1992–1994, the maintenance applications of phosphorus and potassium were continued, and urea was applied at 300 kg N/ha/yr, on a schedule of 50 kg/ha N each month from October–March, inclusive. Urea was applied within the 24 h before irrigation. The rhodes grass area was divided into 2 blocks, and each block further subdivided into four 0.9 ha paddocks. In each year, treatments were allocated at random to the 4 paddocks in each block. Paddocks were irrigated with 25 mm water from a travelling, high pressure irrigator each fortnight unless 25 mm of rain was received in the previous week. In each year, pastures were mulched during November and December, at a frequency that reflected the treatment to be imposed.

Holstein-Friesian cows were used in the experiments and remained on the pasture day and night, alternating weekly between blocks. Cows entered the experiment in early January and remained in the treatments for 18 weeks. Drinking water and shade were available in all paddocks, and animals received 5 kg of a cereal grain-based concentrate daily. The crude protein concentration in this concentrate was adjusted to 16% using cottonseed meal or meat and bone meal, and a mineral premix was added. No other supplements were given.

Experiment 1 (1992)

Twelve cows calving in October or November 1992 were blocked into 3 groups on milk yield and liveweight during December, then allocated at random within groups to the following 4 treatments: grazing the full area of each of the 2 paddocks on a 1 week grazing, 1 week spelling cycle at a constant and relatively low stocking rate of 1.7 cows/ha (Open); or by allocating a fresh pasture area daily to provide 15 kg DM of green leaf/cow/d at an age of 2, 4 or 6 weeks. This was achieved through daily movement of both front and back electric fences, with the area allocated being adjusted weekly based on rate of grass growth in the 2, 4 and 6-week rotations. All treatment groups of cows alternated weekly between the 2 pasture blocks. In the 2, 4 and 6-week treatments, grass was mulched to a stubble height of 10 cm after grazing, and areas of the paddocks not used within each rotation were also mulched to 10 cm stubble height at the end of the rotation. In the Open treatment, cows grazed the entire paddock and no mulching was carried out.

Milk yield was recorded at 2 consecutive milkings each week (pm/am), and a composite sample taken for analysis for fat, protein and lactose (Fossomatic-Milkoscan 203). Cows were weighed fortnightly following morning milking.

Pasture on offer was determined each week by cutting 12 randomly selected 0.25 m² quadrats to 10 cm stubble height from each of the 4 paddocks to be grazed for the next week. Within each quadrat, a measure of height (cm) to the top fully expanded leaf was also recorded. Pasture from the 12 quadrats was bulked, weighed and 2 subsamples of 500 g taken for determination of DM by drying at 80°C for 24 h in a forced-draught oven, and for estimating leaf, stem and dead proportions in the DM by hand sorting and drying as above. Leaf and stem samples were bulked over 3-week periods, ground through a 1 mm screen and analysed for: *in vitro* DM digestibility (IVDMD) using the modified technique of Goto and Minson (1977); neutral detergent fibre (NDF) (Van Soest 1967) using a Fibretec Analyser (Tecator AB, Sweden); and crude protein (CP) using a Leco FP-428 Nitrogen Determinator.

Diet selection by cows was estimated using oesophageally fistulated animals to sample the 2 pasture blocks in February and April. The animals, 2 steers and 2 cows, were yarded overnight with access to water but not feed. Between 07.00 and 08.00 h each treatment was sampled by each of the 4 animals using the following method. To avoid confounding animals with treatments, the animals were divided into 2 groups of 1 cow and 1 steer in each group and each group sequentially grazed the treatments with 1 group starting at 1 end of the 4 treatment paddocks and the other at the opposite end. Each animal was fitted with an oesophageal plug and collection bag (Cowan *et al.* 1986). Animals grazed the treatment freely for 15 minutes, were then caught and the extrusa collected, divided into 2 and frozen for later analysis.

Experiment 1A

To allow intensive sampling and analysis of pasture growth in a representative area of the 2-week treatment, an area 3 × 2 m was mulched to 4 cm stubble height on March 12 and protected from grazing by steel mesh enclosures. This area was then sampled weekly through to May 11 by

cutting one 0.25 m² quadrat to 4 cm stubble height, and the cut material weighed, hand sorted and chemically analysed as above.

Experiment 2 (1993)

The pastures used in Experiment 1 were mulched, fertilised and irrigated from October 1993. Mulching to 10 cm stubble height was repeated at 28-day intervals for all paddocks until cows entered the experiment in the first week of January 1994.

Twenty Holstein-Friesian cows and heifers calving in October-November were blocked into 5 groups on milk yield and liveweight during December and within groups allocated at random to the following 4 treatments: (i) open grazing of the entire paddocks on a 1 week grazing and 1 week spelling cycle (O); (ii) as for (i) but with mulching of the paddocks to 10cm stubble each 4 weeks (OM); (iii) a 28-day rotation with daily strip grazing and a back fence (28); and (iv) as for (iii) but with mulching following grazing (28M). Paddock areas were modified to give a stocking rate of 3.3 cows/ha in all treatments, a level achieved in Experiment 1.

Milk, liveweight and pasture yield measurements were taken as in Experiment 1. In addition, during the second and third 4-week cycles (February and March), pasture sampling was carried out post-grazing on the current week's pasture area in Treatments 28 and 28M, and also from each area used for one week's grazing for the previous 3 weeks in Treatment 28M. These data were used to assess pasture utilisation and growth rates using sequential presentation yields.

Statistical analysis

Milk yield and composition and liveweight were analysed by analysis of variance using the interaction of cow block by treatment as the error term. Pasture on offer was analysed by analysis of variance using pasture block × treatment × period as the error term. Diet selection data were analysed separately for February and April, using analysis of variance with animal × pasture block × treatment as the error term. Linear regression was used to relate diet selection to pasture yield on offer.

Results

Experiment 1

Pasture. Presentation yield of pasture was high in the Open treatment, and contained a relatively high proportion of stem (69% in the green DM; Table 1). Yields of leaf and stem were significantly higher than for strip-grazed treatments ($P < 0.05$). For the strip-grazed pastures, leaf and stem yields were directly related to age of regrowth ($P < 0.05$), but treatments had a similar grass leaf percentage (46% in green DM).

Mean yield of leaf decreased with time in all treatments (Figure 1). Stem yield in the Open treatment increased through to Week 12, whereas there was no change in the strip-grazed treatments. Across all pastures, leaf yield (L, kg/ha DM) was closely associated with height (H, cm) (Figure 2), the equation being:

$$L = -210 + 35.43H \\ (P < 0.01; R^2 = 0.62; RSD = 613)$$

Crude protein and IVDMD values were consistently higher, and NDF values lower, for strip-grazed compared with open-grazed pastures (Table 2). Age of regrowth affected quality of stem but not leaf, with stem from the 2-week treatment being of better quality than that from 6-week regrowth ($P < 0.05$).

Crude protein concentration in grass leaf increased from February to April, mean values being 13.8 and 15.7%, respectively ($P < 0.05$), while CP in stem did not change and averaged 8.8%. NDF and IVDMD remained constant throughout.

Milk yield and composition. Milk yields are presented for Weeks 7–18 only as treatment differences in pasture yield and quality were not evident until the second period beginning in

Table 1. Mean presentation yields of total pasture, and green leaf and stem during Weeks 7–18 of Experiment 1.

Component	Treatment ¹				Significance of linear effect for age of regrowth LSD ($P < 0.05$)
	Open	2-week	4-week	6-week	
	(kg/ha DM)				
Leaf	2559	784	1501	2170	193
Stem	5757	1001	1652	2553	1667
Dead	1014	666	667	586	NS
Total	9330	2451	3820	5309	1726

¹ Open = 2 paddocks grazed on a 1 week grazing, 1 week spelling cycle.

2-week = 15 kg green DM/cow allocated daily with front and back electric fences, using a 2-week cycle.

4-week = as for 2-week, with a 4-week cycle.

6-week = as for 2-week, with a 6-week cycle.

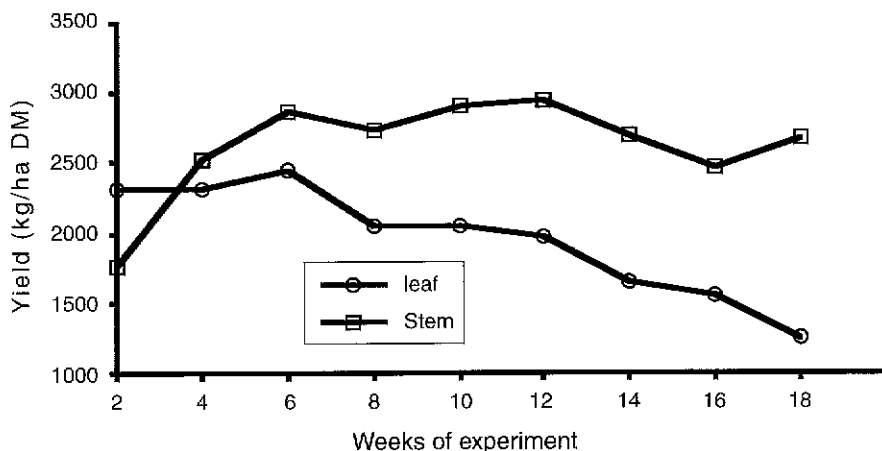


Figure 1. Change in average yield of leaf and stem on offer to cows during Experiment 1.

Table 2. Mean crude protein and neutral detergent fibre concentrations and *in vitro* dry matter digestibility (IVDMD) of grass leaf and stem during Weeks 7-18 of Experiment 1.

Measurement	Component	Treatment ¹			
		Open	2-week	4-week	6-week
				(%)	
Crude protein	leaf	12.5a ²	15.6b	15.2b	15.5b
	stem	6.5a	10.8d	8.7b	9.7c
NDF	leaf	65.3	64.1	63.7	63.1
	stem	72.4a	66.3c	68.5b	68.8b
IVDMD	leaf	53.3a	56.4b	55.9b	55.9b
	stem	51.8a	59.2c	56.5bc	54.4ab

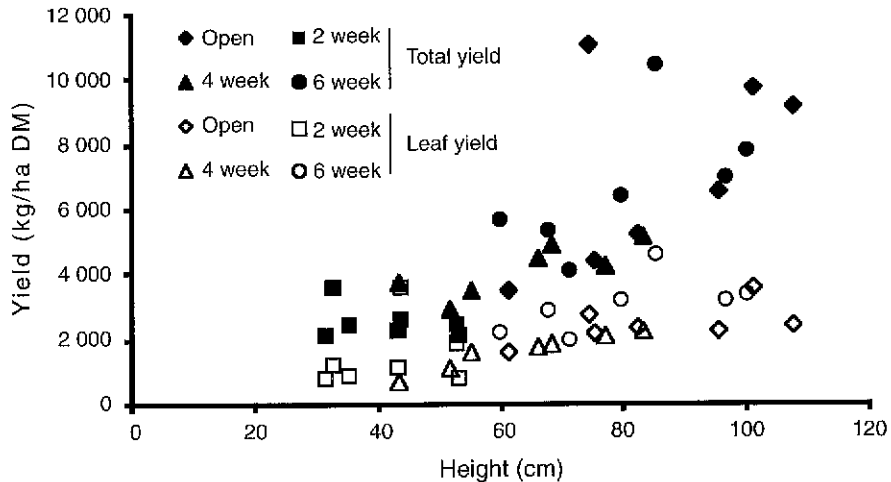
¹ Open = 2 paddocks grazed on a 1 week grazing, 1 week spelling cycle.

2-week = 15 kg green DM/cow allocated daily with front and back electric fences, using a 2-week cycle.

4-week = as for 2-week, with a 4-week cycle.

6-week = as for 2-week, with a 6-week cycle.

² Within rows, means followed by different letters are significantly different ($P < 0.05$).

**Figure 2.** Relationships between pasture height and total and leaf yield of pasture on the four management systems during Experiment 1.

Week 7. During Weeks 7-18, milk yield averaged 14.9, 13.1, 14.0 and 15.1 kg/cow/d for 'Open', 2-week, 4-week and 6-week treatments, respectively, with the value for 2-week being lower than those for other treatments ($P < 0.05$). Corresponding milk fat levels were 3.5% for the 2-week treatment and 3.9% for other treatments ($P < 0.05$). Milk protein averaged 3.16% and lactose 4.9%, with no differences between treatments.

The stocking rates which applied for each treatment, as calculated from distances electric fences were moved daily, were 1.7, 3.7, 3.5 and

3.4 cows/ha (Table 3) and milk output 25, 48, 48 and 51 kg/ha/d for Open, 2, 4 and 6-week regrowths, respectively.

Liveweight. During January and February, cows in the strip-grazed treatments lost 20 kg while those in the Open treatment maintained weight ($P < 0.05$), but by the end of April, overall weight changes were the same in all groups.

Experiment 1A

Regrowth rates of leaf and stem were similar for the first 6 weeks of regrowth, with stem growth

Table 3. Stocking rates used in Experiment 1 as calculated from the distances electric fences were moved daily.

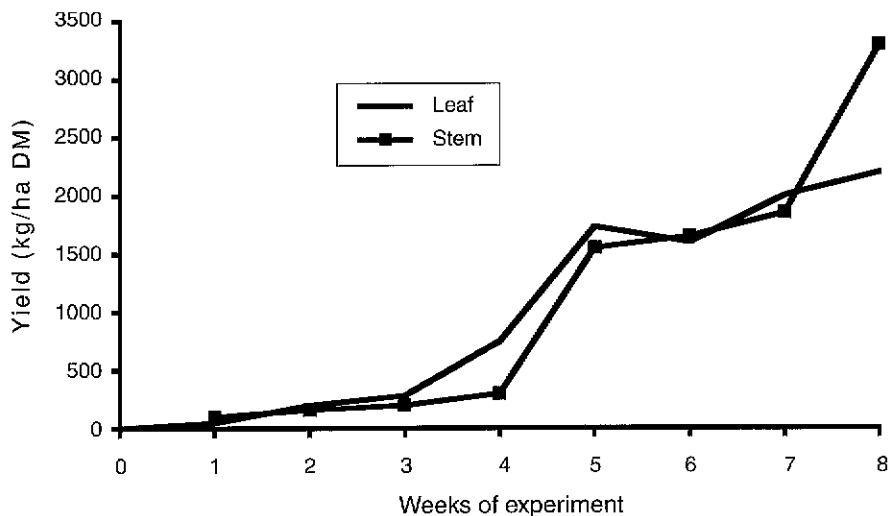
Time period	Treatment ¹			
	Open	2-week	4-week	6-week
	(cows/ha)			
Period 1 (Jan 4-Feb 14)	1.7	5.1	4.5	4.3
Period 2 (Feb 15-Mar 28)	1.7	3.8	4.0	3.9
Period 3 (Mar 29-May 9)	1.7	3.5	2.9	2.8
Mean - Periods 1, 2 and 3	1.7	4.1	3.8	3.7
- Periods 2 and 3	1.7	3.65	3.45	3.35

¹ Open = 2 paddocks grazed on a 1 week grazing, 1 week spelling cycle.

2-week = 15 kg green DM/cow allocated daily with front and back electric fences, using a 2-week cycle.

4-week = as for 2-week, with a 4-week cycle.

6-week = as for 2-week, with a 6-week cycle.

**Figure 3.** Regrowth pattern of grass leaf and stem following defoliation to 4-cm stubble on March 12 (Experiment 1A).

accelerating in Week 8 (Figure 3). The differences between leaf and stem in crude protein and NDF concentrations were evident throughout, though there were no differences in IVDMD (Figure 4). The pattern of increase in NDF concentration in leaf and stem closely paralleled that of DM accumulation. IVDMD values showed the reverse pattern, decreasing rapidly after 4-weeks regrowth.

Diet selection. Animals selected a higher percentage of leaf in the diet than was on offer in the pastures (Table 4), and a lower stem percentage. Dead material was consistently below 7% of the diet and not affected by treatment.

Leaf percentage in the diet was higher, and stem percentage lower, in February than in April (Table 4). CP concentration of the diet of cows in the Open treatment declined slightly from February to April, whereas for other treatments, CP increased. There were only minor changes in NDF concentration in the diet, and a consistent decrease in IVDMD from February to April.

In February, although leaf and stem percentages in the diet were similar for all 4 treatments (Table 4), crude protein and IVDMD were lower, and NDF higher, for animals in the Open treatment than for those in the remaining treatments.

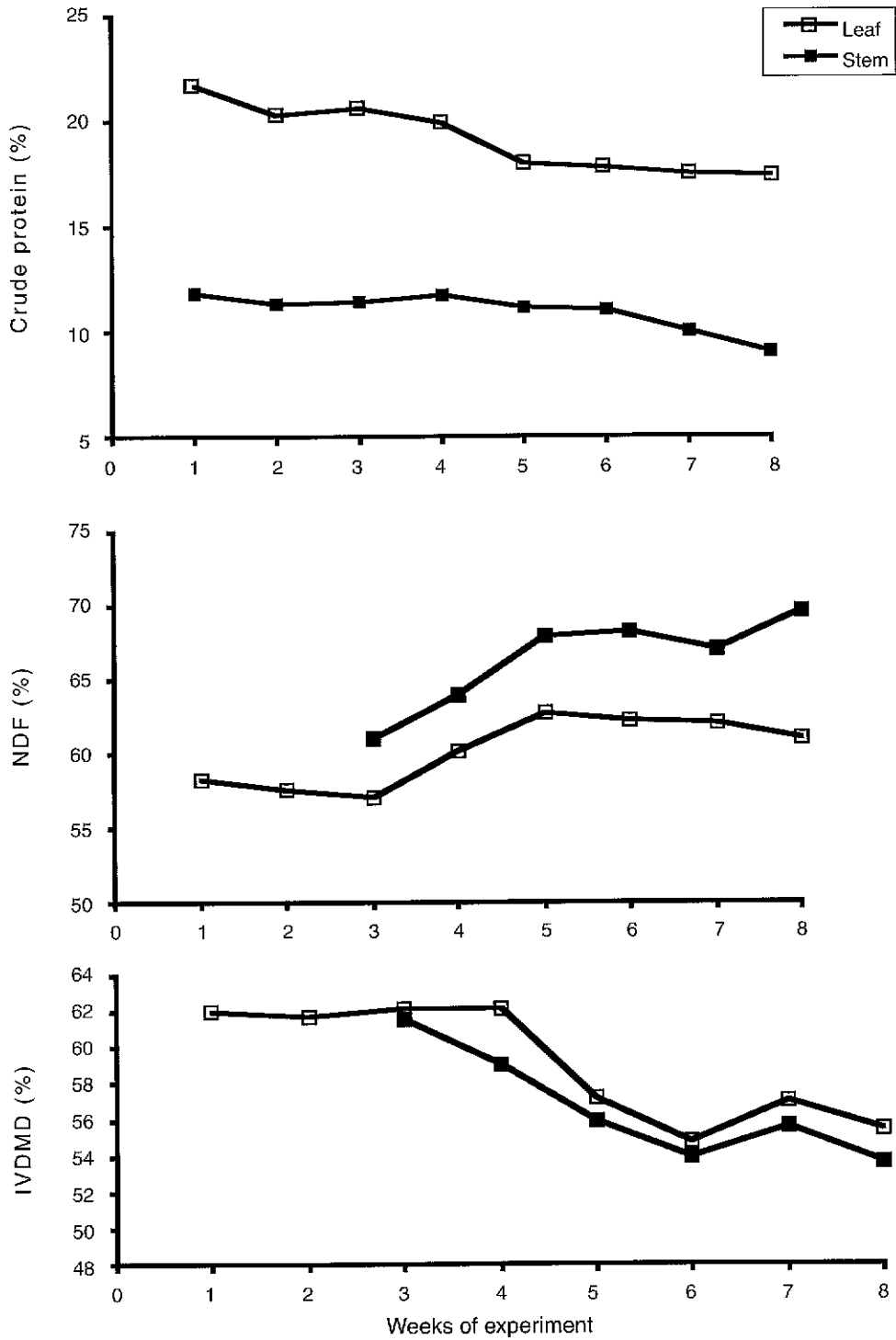


Figure 4. Changes in crude protein, NDF and IVDMD (%DM) of grass leaf and stem following defoliation to 4-cm stubble on March 12 (Experiment 1A).

Table 4. Leaf and stem percentages, crude protein and NDF concentrations and IVDMD of pasture on offer and of the diet selected by cows in February and April (Experiment 1).

Measurement	Treatment ¹					
	Open	2-week	4-week	6-week	LSD (P<0.05)	
(%DM)						
February						
Leaf	— pasture	32	33	39	48	—
	— diet	83	82	87	86	5
Stem	— pasture	61	39	49	45	—
	— diet	16	13	10	13	4
Crude protein	— pasture	8.3	10.7	10.0	11.7	—
	— diet	11.1	13.7	13.1	13.8	0.5
NDF	— pasture	70.3	67.4	68.0	66.5	—
	— diet	67.3	66.0	64.8	64.7	2.1
IVDMD	— pasture	52.5	54.7	55.3	55.7	—
	— diet	53.8	57.0	55.6	56.5	1.9
April						
Leaf	— pasture	21	29	35	38	—
	— diet	61	71	74	79	12
Stem	— pasture	63	43	42	46	—
	— diet	31	24	25	19	10
Crude protein	— pasture	7.6	12.1	11.6	13.1	—
	— diet	10.3	14.8	14.5	16.0	1.3
NDF	— pasture	72.2	67.3	67.5	66.8	—
	— diet	68.7	65.2	65.0	64.0	2.3
IVDMD	— pasture	47.6	52.1	52.5	52.5	—
	— diet	49.1	54.3	54.9	54.5	2.1

¹ Open = 2 paddocks grazed on a 1 week grazing, 1 week spelling cycle.

2-week = 15 kg green DM/cow allocated daily with front and back electric fences, using a 2-week cycle.

4-week = as for 2-week, with a 4-week cycle.

6-week = as for 2-week, with a 6-week cycle.

In April, leaf in the diet was lowest for animals in the Open treatment, and increased with age of pasture regrowth (linear trend significant $P<0.05$, Table 4). Stem percentage showed the reverse trend. Dietary crude protein showed a similar response to leaf percentage in the diet.

There were close linear relationships ($P<0.05$) between leaf (L), crude protein (CP), NDF and IVDMD concentrations (%DM) in the diet (D) and levels in pasture (P), and these were more evident in April than February. The regression lines for April were:

$$L_D = 43.9 + 0.89 L_P \quad (R^2 = 0.89)$$

$$CP_D = 1.9 + 1.08 CP_P \quad (R^2 = 0.99)$$

$$NDF_D = 9.4 + 0.82 NDF_P \quad (R^2 = 0.96)$$

$$IVDMD_D = 0.5 + 1.05 IVDMD_P \quad (R^2 = 0.94)$$

Pasture canopy structure. Frequent grazing followed by mulching (*i.e.* the 2-week treatment) resulted in a sward of a relatively low height (20 cm). With the longer rotations, both mean height (4-week, 50 cm; 6-week, 65 cm) and variation in height increased. These values increased

further in the Open treatment, where mean height was 90 cm, with a variation of 25–120 cm. However, in relative terms, the variation in height was similar across treatments, and the major effect of treatment was on height of pasture.

Experiment 2

Pasture on offer. The mean pasture DM on offer to cows was reduced ($P<0.05$) by mulching (Table 5), the mean percentage reduction being 51%.

Calculated pasture growth rates were similar for treatments OM and 28M, and averaged 105, 75, 53 and 70 kg DM/ha/d during Periods 1, 2, 3 and 4, respectively.

Leaf percentage was higher in mulched pastures, being maintained in the range 50–60% DM throughout, compared with 37–50% for unmulched pastures. Crude protein concentration in grass leaf was higher ($P<0.05$) in mulched than in unmulched pastures, and increased from

Table 5. Mean pasture yield on offer, leaf percentage, and crude protein and NDF concentrations in leaf during Experiment 2.

Measurement	Treatment ¹				LSD (P<0.05)
	O	OM	28	28M	
Pasture on offer (kg/ ha DM)	4435c ²	1943a	4287c	2305b	180
Leaf (%DM)	43.5a	56.8c	46.6b	59.4d	1.8
Leaf CP (%DM)	14.7a	16.9b	13.8a	17.4b	1.9
Leaf NDF (%DM)	65.6c	63.9b	66.3c	61.8a	1.5

¹ O = 2 paddocks grazed on a 1 week grazing, 1 week spelling cycle.

OM = as above, with mulching to 10 cm stubble after alternate cycles.

28 = 28-day rotation with daily strip grazing.

28M = 28-day rotation, with daily strip grazing and mulching after each grazing.

² Within rows, means followed by the same letter are not significantly different (P>0.05).

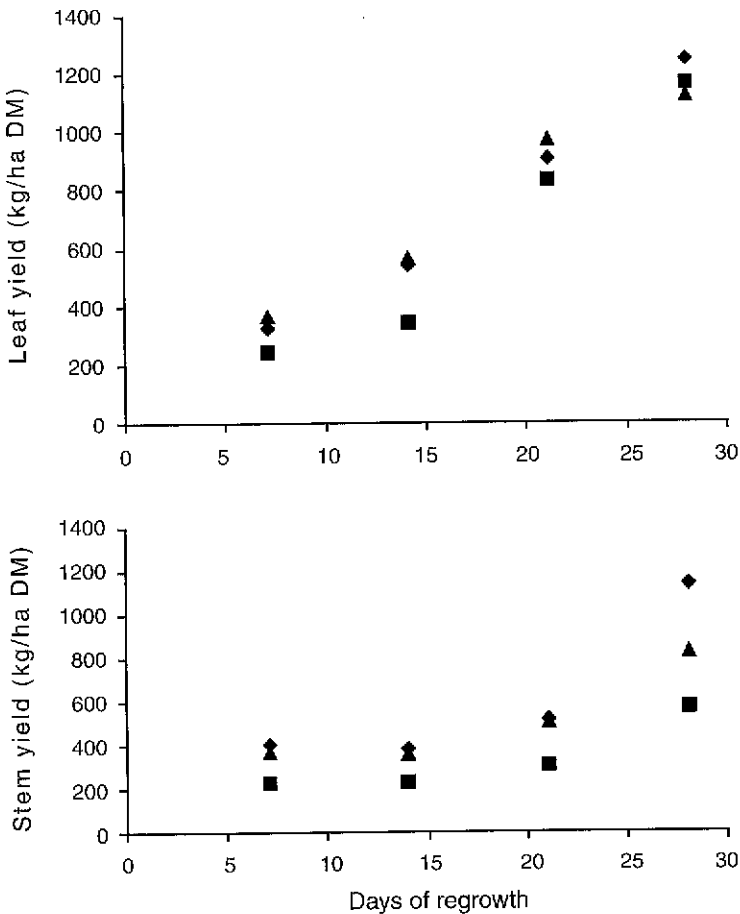


Figure 5. Weekly growth pattern of leaf and stem measured for three 4-week periods (Feb–Apr) in the 28-day grazing rotation, with mulching to 10-cm stubble after each grazing (Experiment 2).

Period 1 to Period 4, whereas mulching reduced ($P<0.05$) the NDF concentration in grass leaf. Mean ADF values for grass leaf did not differ between treatments (mean 35.8%, $P>0.05$). Stem averaged 9.4% CP, 73% NDF and 42.3% ADF, and differences between treatments reflected those shown in leaf quality.

In Treatment 28M, there was a strong linear relationship between leaf yield and days of regrowth (Figure 5). Stem yield did not increase in the first 21 days, but showed rapid growth between Days 21–28. As a consequence of these growth patterns, the leaf : stem ratio in grass increased from 1.0 at 7 days to 2.2 at 21 days, then declined to 1.4 at 28 days ($P<0.05$).

The equations describing these relationships were as follows:

$$T = 237 + 65.9D (\pm 9.9) \\ (P<0.01; \text{RSD} = 268)$$

$$L = -30.2 + 42.4D (\pm 3.6) \\ (P<0.01; \text{RSD} = 97)$$

$$S = 618 - 53.5D (\pm 37.1) + 2.2D^2 (\pm 1.03) \\ (P<0.01; \text{RSD} = 167)$$

$$L:S = -0.58 + 0.25D (\pm 0.08) - 0.0062D^2 \\ (\pm 0.0024) \\ (P<0.05; \text{RSD} = 0.38)$$

where

T is total pasture dry matter (kg /ha DM)

L is leaf dry matter (kg /ha DM)

S is stem dry matter (kg /ha DM)

L:S is leaf : stem ratio in terms of dry matter and D is days of the rotation (0–28).

Dead material in the pasture declined during regrowth and had a mean yield of 170 kg/ha DM.

Milk yields and liveweight. While cows were strip grazing, milk yield was higher ($P<0.05$) when pastures were mulched. However, mulching had no effect on milk yield in open-grazed pastures, with milk yields intermediate between the 2 strip-grazed treatments. Mean yields were 15.0, 14.9, 13.6 and 16.7 L milk/cow/d for Treatments O, OM, 28 and 28M, respectively ($P<0.05$, $\text{LSD} = 1.2$).

Milk fat, protein and lactose concentrations were not affected by treatment, and averaged 4.5, 3.61 and 5.35%, respectively. Liveweight of cows was not affected by treatment, increasing during February–March (0.5 kg/cow/d), but decreasing in April (–0.2 kg/cow/d).

The additional labour and machinery costs associated with mulching and strip grazing were

estimated to be AUD0, 30, 30 and 80/ha for Treatments O, OM, 28 and 28M, respectively. This resulted in a marginal net return for 18 weeks of AUD0, –38, –145 and 66/ha at a milk price of AUD0.23/L with breakeven prices for milk being 23, 24, 26 and 22c/L for Treatments O, OM, 28 and 28M, respectively.

Discussion

Milk yields of cows were consistent with previous studies of grazing management on tropical pastures. With a modest level of concentrate feeding, cows were able to produce milk yields of 14–17 kg/cow/d. Milk yield was 9–12 L/cow/d after discounting for concentrate intake (Cowan *et al.* 1993), and would appear to have been limited by the digestibility of grass leaf rather than total pasture or leaf yield. Earlier studies showed that restricting access to pasture by strip grazing reduced milk yield (Thurbon *et al.* 1971; Ottosen *et al.* 1975; Davison *et al.* 1981), and removal of stem tended to increase yield (Davison *et al.* 1993). However, these effects were relatively small, and in our studies would not warrant the expense.

Age of grass regrowth did not have a substantial effect on grass leaf quality, as measured by CP, IVDMD and NDF percentages. Studies with a tropical grass crop showed that leaf reached mature levels of NDF percentage early in the growth period, before the crop was ready for first grazing (Chataway *et al.* 1994), and Minson (1990) and Wilson (1994) have also shown tropical grass leaf has a relatively high NDF concentration throughout the growing period. Only in very mature leaf, typified by the open-grazed treatment in Experiment 1, was there a decline in CP concentration, consistent with previous reports (Levitt and O'Bryan 1965; Minson 1990). The higher leaf quality parameters measured for mulched pastures in Experiment 2 may reflect the regular removal of the very mature leaf which forms part of the sward in pastures, which are not mulched. Previous experiments have also demonstrated relatively small differences in pasture leaf quality related to differences in grazing management (Chopping *et al.* 1978; Davison *et al.* 1981; Fulkerson *et al.* 1996).

The consistency of stocking rate across the 3 regrowth treatments of Experiment 1 suggests that leaf growth rate was similar, since a set

amount of leaf was offered daily to each cow. The results of Experiments 1 and 2 show that leaf growth rate was linear and apparently little affected by treatment. By contrast, rapid increases in stem yield were evident following a significant increase in leaf yield, typically after 3-weeks regrowth. Cowan *et al.* (1995a) showed that, with increasing levels of nitrogen fertiliser applied to a tropical grass, there was a linear increase in leaf yield, but an exponential increase in stem yield. Leaf growth rate is apparently not substantially altered by grazing method but the yield and makeup of the pasture are strongly influenced by the relative growth of leaf and stem.

Cows showed a very high selection for leaf, and this effect persisted through the autumn despite very high stem yields, particularly in open grazing at the low stocking rate (Experiment 1). Previous studies using similar sampling methods have also shown that cows select strongly for leaf (Stobbs 1971; Davison *et al.* 1985) and alter the time spent grazing in response to yield of leaf present rather than total pasture yield (Cowan *et al.* 1995b). While methods used (15 min selection by OF animals) may not represent selection over a full day, results indicate that leaf varied by no more than 4 units in any quality parameter tested, so it is probable that the diet selected by cows in the various treatments would have been of similar quality. This suggests milk yield would be altered more by changes in leaf yield on offer than quality. Leaf accessibility has been suggested to be a problem in some situations where stem yield is very high (Lowe *et al.* 1991; Davison *et al.* 1993), but in the present experiment, the method of mulching the regrowth treatments after grazing meant that leaf was always easily accessible to the cows, and the diet of fistulated animals was not different despite wide differences in age, yield and leaf content of pastures. In Experiment 2, the differences in milk yield also suggest small differences in the quality of the diet selected, despite large differences in pasture yield and leaf percentage.

The variability in sward height was relatively consistent across treatments, though the mean heights of the swards differed markedly. Taylor and Rudman (1966) have shown high variation in grazing intensity in open-grazed paddocks, leading to some "patches" being heavily grazed while other areas of the paddock are under-utilised. Under intensive grazing management,

temperate pastures have also been shown to be heterogeneous in height, an effect attributed to dung and urine deposition, soil changes and other factors (MacDiarmid and Watkin 1972; Hirata *et al.* 1989).

The present results demonstrate that tropical grasses are capable of supporting a stocking rate up to 3.7 cows/ha over the summer-autumn period with periods in summer up to 4 cows/ha, but milk yield will be restricted by the relatively low digestibility of grass leaf. There are only small variations in milk yield per cow associated with radically different grazing management options, such as rotational grazing and mulching and these are unlikely to warrant the expenses involved in performing these operations.

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