Diet selection of steers grazing *Stylosanthes hamata* cv. Verano-grass pastures in north Queensland and its potential influence on botanical composition

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Abstract

The diets of steers grazing 3 *Stylosanthes hamata* cv. Verano-grass pastures, each stocked continuously at 0.65, 0.95 and 1.25 steers/ha, were studied over a 3-year period. Dietary C_4 (grass) and C_3 (legume) components were estimated using $\delta^{13}C$ measurements of the faeces and pasture components on 14 occasions. In May each year, pasture yield and botanical composition were also measured. The % legume in the pastures of Verano–*Urochloa mosambicensis* cv. Nixon (Nixon) and Verano–*Bothriochloa pertusa* cv. Bowen (Bowen) were then compared with the % legume in the diets on the dates closest to the May pasture sampling to calculate a selection index (SI) for legume.

Associated grass species had a greater effect on dietary legume content than did stocking rate (SR) and there was no species × SR interaction ($P > 0.05$). Overall, steers on Nixon pastures consumed diets with a lower proportion of legume (25%) than those on Bowen pastures (47%), with marked differences in the first year of the study, smaller but still significant differences in the second year and no differences in the third year. Diets of steers on rhodes pastures were intermediate (37%). Dietary legume percentages of steers at high SRs were generally lower than those at the other SRs, but on only 3 of 14 sampling occasions were the differences significant ($P < 0.05$).

Dietary legume content varied widely over the year on all treatments, with highest values in the late wet–early dry season (May–July) and lowest in the late dry–early wet season (November–February).

Although, overall, the SI for legume was higher (more legume) with Bowen, only in the final year was the difference significant ($P < 0.01$). This index appeared to be related to pasture composition and not, as its name suggests, to animal preference.

It is concluded that the associated grass had a greater effect than stocking rate on diet selection, and that the trend for steers on Bowen pastures to select a diet higher in Verano over a longer period of the year than those on Nixon pastures, could lead to botanical changes that favour the grass component.

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Introduction

In a long-term grazing study comparing 3 grass treatments in association with *Stylosanthes hamata* cv. Verano (Verano) at 3 stocking rates (0.65, 0.95 and 1.25 steers/ha), Verano in association with *Urochloa mosambicensis* cv. Nixon (Nixon) had a more stable, but lower contribution to botanical composition over time at low and medium SRs than when grown in association with the other 2 grass treatments. At the high SR, Verano's contribution was generally similar for all grass treatments resulting in a grass species × SR interaction ($P < 0.01$) (Jones 2003; R.J. Jones, unpublished data). For the 3-year period from 1990 to 1992, Verano's contribution was higher with Nixon than with Bowen at this high SR (Jones and Kerr 1993).

Earlier studies (Hu and Jones 1997; 1999; 2001; 2004) sought to understand reasons why Verano declined more under heavy stocking when associated with *Bothriochloa pertusa* cv. Bowen (Bowen) than with Nixon over this period (Jones and Kerr 1993). These earlier studies were conducted with seedlings in pots or as experimental swards in boxes, and cutting treatments were identical across grass treatments. Under grazing, the sward components may not be grazed similarly in different pastures, and any differential grazing of the grass component could greatly influence performance of the associated legume component. In an earlier small sward study, cutting only the grass in mixed swards favoured the associated Verano and this treatment had important residual effects even when swards were subsequently cut uniformly (Hu and Jones 2004).

In the present study, diets of steers grazing mixed grass-Verano pastures were measured at intervals through the year and the selection indices for legume estimated when pastures were sampled in autumn (May). The measurements were used in an endeavour to explain the decline in Verano in association with Bowen compared with its performance with Nixon at high SR.

Materials and methods

The study was conducted on a long-term grazing experiment at the CSIRO pasture research station, Lansdown, 50 km south of Townsville, north Queensland. The experiment initially compared 3 grass treatments: *Urochloa mosambicensis* cv. Nixon

(Nixon), *Chloris gayana* cv. Callide (rhodes) and native pasture, each sown with a mixture of legumes, at 3 stocking rates (SR; 0.65, 0.95 and 1.25 steers/ha). The native grasses and most of the rhodes died out with heavy stocking and drought and were replaced by Bowen after a phase of Verano dominance (Jones and Kerr 1993; Jones 2003). There were 2 replicates of all treatments in a fully randomised design. Three steers grazed continuously on each paddock. Pastures were established 11 years before the measurements described here commenced. Of the 3 legumes sown, only Verano persisted in all paddocks.

Faecal samples from the animals were collected on 14 occasions over a 3-year period (July 1988–July 1991) (Figure 1). Each sample was a composite from 10 recently voided (within 24 h) faecal pats in each paddock. The grass and legume components in each pasture were sampled at the same time by plucking to simulate material eaten by the cattle. Both faecal and pasture samples were dried at 100°C, finely ground and analysed for $\delta^{13}C$ (Le Feuvre and Jones 1988). Dietary grass and legume contents were estimated from the $\delta^{13}C$ values for the faeces and the pasture components (Jones *et al*. 1979). Pastures were sampled for yield and botanical composition in May each year (1988–1991) using the BOTANAL technique (Tothill *et al.* 1992). The dietary legume content (estimated from faecal samples collected near to the time of pasture sampling) was compared with pasture legume % to calculate a selection index (SI) for legume (Hodgson 1979; McLean *et al*. 1981) for all paddocks over the 3 years. Values greater than unity indicate selection for legume; selection in favour of grass is indicated by values <1. For calculation of this index, data from only 2 of the 3 grass treatments were used, namely Bowen (formerly the native pasture treatment) and Nixon. The grass component of the rhodes treatment was highly variable and, in addition to rhodes, contained Bowen and Nixon as well as other annual grass species, so the data were not included.

Statistical analysis

The $\delta^{13}C$ data and the pasture yield data were analysed as a 3 × 3 factorial with 2 replicates in a fully randomised design using GENSTAT IV. For the analysis of SI, the data were analysed with STATISTIX version 4 using years, grass species and SR in a 4 × 2 × 3 factorial combination since results from only 2 of the grass treatments were used.

Results

Effects of treatments on cattle diets

On none of the 14 sampling occasions was there a significant species × stocking rate (SR) interaction for % legume in the diet ($P < 0.05$), so results are presented as mean grass treatment effects and mean SR effects.

On most sampling occasions, dietary legume % was lowest on Nixon paddocks and highest on Bowen paddocks with rhodes intermediate. Mean values were 25, 37 and 47% for the Nixon, rhodes and Bowen treatments, respectively ($P < 0.01$). Differences between grass treatments were greatest in 1988 and least in 1991, and were significant ($P < 0.05$) on 7 occasions (Figure 1A). In general, the significant differences occurred at times of the year when the legume content in the diet on Nixon treatments was low in the June–November period (Figure 1A).

Stocking rate had far less effect on legume content in the diet than did grass species. Overall, mean values were 38, 41 and 31% for the low, medium and high SR treatments, respectively. On 9 occasions, dietary legume content was lowest with high SR, particularly in the mid-dry season of 1990 (Figure 1B), but on only 3 occasions, (June 1989, August and September 1990), were differences significant ($P < 0.05$).

Seasonal variation in dietary legume content was large, ranging from <10% to >50%. There were peaks in the May–July period from 1989-1991 and troughs in the November–February period in 1989–90 and 1990–91 (Figures 1 A, 1 B), but no marked drop in dietary legume content in the 1988–89 summer when values remained above 30% at all SRs.

Selection indices

Year ($P < 0.001$) and grass ($P < 0.01$) effects on SI were significant as was the grass × year interaction ($P < 0.001$) (Table 1). SR had no significant effect on SI for legume ($P > 0.05$) and there were no significant interactions involving SR ($P > 0.05$). For both grasses, the SI for legume increased each year from 1988–1991, whereas over the same period the % Verano in the pastures declined (Table 1). In 1991, when % legume and pasture legume yields were lowest, SI for legume was higher than in any previous year, particularly with Bowen (Table 1).

Table 1. Pasture presentation yields in May each year and selection indices calculated for cattle grazing 2 grass-legume pastures over 3 years. (Values are the means of 3 stocking rates and 2 replicates).

Bowen–Verano pasture				Nixon–Verano pasture				Selection index[1]		Faeces sampling date
Grass		Legume		Grass		Legume		Bowen–Verano	Nixon–Verano	
(kg/ha)	(%)	(kg/ha)	(%)	(kg/ha)	(%)	(kg/ha)	(%)			
770	26.6	2460	73.4	3150	65.0	1690	35.0	0.89a[2]	0.37a	July 1988
3020	47.6	3470	52.4	5000	67.7	2390	32.3	1.40ab	1.68b	June1989
2240	70.9	1120	29.1	2720	82.3	586	17.7	1.78b	2.01b	June1990
1660	88.9	254	11.1	1600	83.5	342	16.5	5.71d	2.95c	May1991

[1] Selection index = (legume % in diet)/(legume % in pasture) calculated in May.
[2] Within columns for selection index, values followed by different letters are significantly different ($P < 0.05$).

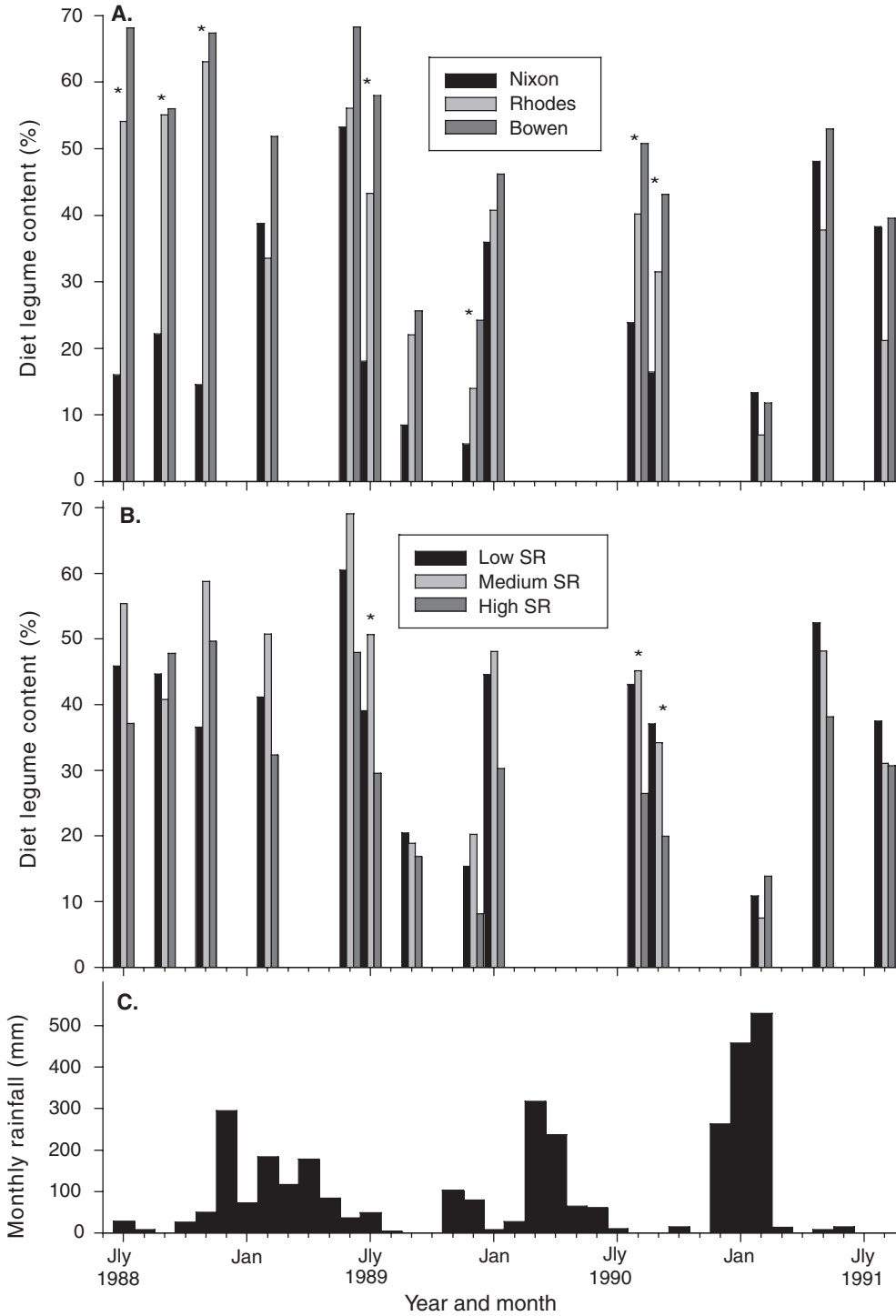

Figure 1. Dietary legume content of steers grazing 3 stylo-grass pastures in relation to: **A.** Major grass species component of the pasture; and **B.** Stocking rates of 0.65 (low), 0.95 (medium) and 1.25 (high) steers/ha. **C.** Monthly rainfall for the sampling period.
⋆ represents a significant difference between treatments ($P < 0.05$).

Within years, there was no consistent difference between grasses. Only in the final year was the SI for legume with Bowen greater than that with Nixon ($P < 0.01$).

Discussion

The preference for legume at the end of the wet season and into the early dry season is in general accord with results from other studies on stylo-based pastures (Hunter *et al*. 1976; Anon 1979; Gardener 1980, 1984; Gardener and Ash 1994; Coates 1996). However, the pattern of change of stylo proportion in the diet in relation to season of the year was not as clear-cut as reported from some previous studies using fistulated cattle to assess diet preference (Hunter *et al*. 1976; Gardener 1984; Gardener and Ash 1994). Previous work on legume-based pastures, comparing the diets of resident cattle (using the $\delta^{13}C$ of their faeces) with those of transient oesophageally-fistulated cattle (using botanical analysis of the extrusa), showed a very poor correlation between the 2 methods and questioned the reliability of the latter method for estimating diet composition on these mixed pastures (Coates *et al*. 1987; Jones and Lascano 1992). This difference between the sampling methods may explain the observed differences between our results (plus those of Coates 1996) and those from the other studies.

It is significant that the dietary legume content on the Bowen treatment exceeded that on Nixon for most of the first 2 years of the study, with rhodes being intermediate. Why these differences were so pronounced during this period but virtually disappeared in the final year is unclear. Presentation yields of legume and legume % in the pasture were certainly higher on the Bowen treatments in May 1988, 1989 and 1990 but not 1991, which may have been a contributing factor. In an earlier study (Hu and Jones 2004), Nixon in association with Verano was taller than Bowen making the grass component more accessible to the grazing animal, so enabling a higher grass component to be selected. In addition, there were more small falls of rain between July 1988 and July 1989 than in the other 2 years, and Nixon produces new shoots in response to such falls of rain, which are avidly sought by cattle (Coates 1996).

Although the pastures varied greatly in yield and botanical composition (Jones 2003), the similarity in dietary legume content across the SR treatments for most sampling occasions suggests that steers were seeking similar grass:legume proportions despite these pasture differences. Differences in dietary legume content between the low and medium SRs failed to attain significance ($P > 0.05$) on any sampling occasion, yet presentation total DM yields/head were 71–95% higher and legume yields/head 58–213% higher at low SR compared with medium SR (Jones 2003; R.J. Jones unpublished data). These results support the findings of Coates (1996), who concluded that 'the proportion of grass to stylo in the pasture does not exert a major influence on the composition of the diet except where selection for the preferred component is restricted by low DM on offer or extremes of pasture composition'. This conclusion is supported by the fact that overall SI was negatively and linearly related to pasture legume % for both pastures (Bowen, $R^2 = 0.713$; Nixon, $R^2 = 0.733$), with the highest SI for legume in 1991 when legume pasture yield and legume % were the lowest of the years studied. This index, therefore, appears more a function of the pasture than, as its name suggests, an animal preference.

The much lower total and legume presentation yields at high SR may explain the lower dietary legume content on these treatments at certain times of the year.

The large difference in preference for legume on the Bowen paddocks compared with the Nixon paddocks, for most of the period under study, suggests that the grazing pressure on the Verano was greater with Bowen. This pressure would be lower than the data on SI and dietary legume % suggest as presentation yields of legume and pasture legume % in the Bowen paddocks were much higher than in the Nixon paddocks for most of the study. However, at high SR with Bowen, when Verano in the pasture fell below about 15%, dietary Verano content was higher on Nixon paddocks that contained more Verano (R.J. Jones, unpublished data). Only in the final year did the SIs for legume in the 2 pastures differ significantly ($P < 0.01$), and it was only on this occasion that the pasture samplings made in May coincided with the faecal samplings.

The results support other findings that Nixon is a highly palatable species (Coates 1996), and suggest that it is more palatable than Bowen when grown with Verano. This difference may, in part, explain the lower pasture contribution of Verano in mixture with Bowen at high SR compared with its contribution in mixture with Nixon (Jones and Kerr 1993).

Conclusions

Since this is the last paper in a series that sought to explain the reduction in Verano at high SR in combination with Bowen compared with the maintenance of a higher proportion in association with Nixon (Jones and Kerr 1993), it is appropriate to synthesise the results of these studies.

Prior to the invasion of Bowen into native pasture previously oversown with Verano, Verano dominated the pastures at high SR. Following the ingress of Bowen, the Verano declined. This decline was not the result of allelopathy from Bowen, since neither germination nor seedling growth of Verano was adversely affected by leachates from Bowen or from Nixon (Hu and Jones 1997; 1999). Furthermore, competition from Bowen in the seedling stage was not greater than from Nixon; rather, Nixon tended to be more aggressive than Bowen (Hu and Jones 2001), and Bowen mixtures contained more legume than the Nixon mixtures. This result was in keeping with the higher Verano content of Bowen–Verano pastures under grazing at low and medium SR, though not at high SR. However, DM yields of Verano–Bowen mixtures were less than expected given the DM yields of pure

stands of the component species. Verano–Nixon mixtures showed improved yields over those of the components as expected in legume-grass mixtures (Hu and Jones 2001).

In small sward studies, seedling growth of Verano sown into established stands of both grasses was similarly lower than for Verano grown in bare soil (Hu and Jones 2004). In defoliation studies, Verano grown in association with Bowen was less productive than when grown in association with Nixon, especially with frequent defoliation (3-weekly). At this cutting frequency, yields of the 2 grasses were similar over 6 cycles but Verano yield was 50% higher with Nixon (Hu and Jones 2004). The higher sulphur (S) concentration in Bowen compared with Nixon, and the lower S concentration in Verano grown with Bowen than in Verano grown with Nixon, suggested that competition for S may have contributed to the lower yields of Verano in mixture with Bowen (Hu and Jones 2004). In the grazing trial, Verano at high SR in association with Bowen often had paler green leaves and lower S concentration than Verano with Nixon at this SR (R.J. Jones, unpublished data). This occurred despite applications of 10 kg/ha S every second year as single superphosphate. The results from the present study suggest that preferential grazing of Verano over Bowen, combined with an induced, though marginal, S deficiency resulted in reduced competitive ability and yield of Verano at high SR.

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