

Do cattle exhibit a preference for white clover?

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Abstract

Attaining a predictable and stable composition of white clover in pasture is affected by selective grazing and inter-species plant competition. This paper reports an experiment which demonstrates that when given a free choice between monocultures of ryegrass and white clover, cattle did not selectively graze only clover but chose a mixed diet. Ten young heifers were stocked for 3 weeks on 2 ha, comprised of adjacent 1-ha monocultures of each of ryegrass and white clover. Animals were given 1 week to adjust to the spatial separation and then on 2 consecutive days in each of 2 consecutive weeks, cattle were observed at 10-minute intervals during daylight hours. Behaviour (grazing or not) and location (ryegrass or white clover) were recorded. This procedure was conducted in December, February and May to assess seasonal variation in the species preference. At each occasion cattle choose a mixed diet by eating both ryegrass and white clover, but their preference for white clover changed with season. In February they exhibited a partial preference for white clover, by spending approximately 65% of grazing time on white clover and 35% on ryegrass. In December and May the partial preference for white clover was lower, with cattle allocating approximately 47% of grazing time to white clover and 53% to ryegrass. Results are discussed in relation to the extent of preference for white clover when limitations to selection are removed and how this information could be used to enhance white clover proportion in the diet to better match animal preference.

Keywords: diet selection, grazing behaviour, perennial ryegrass, preference, *Trifolium repens* L.

Introduction

The potential of white clover to enhance liveweight gain and milk production compared with grass diets has been clearly demonstrated (Gibb & Treacher, 1984; Rogers et al. 1982). These benefits are related to the greater nutritive value that animals derive from white clover (Beever et al. 1986).

Exploiting the potential benefits of white clover growing in traditional mixed-species arrangements, depends on the proportion of white clover in both the

pasture and in the diet selected during grazing. The proportion in the pasture is influenced by the competitive balance between the clover and the associated grass, in addition to the normal seasonal variation, but for most pastures the proportion of clover is low (Clark & Ulyatt, 1985). Animals may increase the proportion of clover in their diet by grazing selectively. However, it has been argued (Hodgson et al. 1994) that cattle can select only through choice of patches which differ in clover proportion from the pasture mean, rather than at a finer level of discrimination among intermingled species. Consequently there maybe limited opportunity for them to increase the proportion of legume in the diet, even if preference would drive them to do so. In addition, selective grazing generally involves a cost to the animal through increased time spent grazing or reduced intake (Parsons et al. 1994a). Theoretically, if an animal could meet its dietary preferences more easily, the cost of selective grazing should be reduced.

Alternatives to conventional intermingled-species pastures, such as spatially separated monocultures, offer scope to increase clover content in the forage offered by reducing inter-specific competition, and in the diet by making selection easier (Parsons et al. 1994b). Such arrangements also provide scope to test preference, the diet an animal chooses to eat when the major physical constraints to obtaining such a diet are removed. The trial reported here was designed to determine preference of young cattle when offered monocultures of ryegrass and white clover, and how this preference varied with season.

Materials and methods

This experiment was conducted at the AgResearch, Flock House Research Area near Bulls. Monocultures of perennial ryegrass (cv. Yatsyn), and white clover (cv. Kopu), were sown in April 1994 into adjacent one-ha areas to form a 2-ha plot. A maintenance fertiliser dressing of P, K, and S was applied in spring, and the ryegrass monoculture received 250 kg N/ha during spring and summer.

Young spring-born Friesian and Friesian-cross dairy heifers were used for each experimental period. In December these were approximately 4 months old, with an estimated liveweight of 120 kg, and having been

weaned about 6 weeks previously. For this period, 8 of 13 heifers in the group were identified for observation. For the experimental periods in February and May, a group of 10 heifers were identified and observed. For each period, the 10 heifers grazed the 2-ha contrast plot for 3 weeks. The first week was considered as an adjustment period, both to the pair of species being offered and to the spatially separated arrangement. The subsequent 2 weeks were considered as the experimental period for all measurements made. Heifers were weighed, unfasted, at the start and finish of this experimental period, and the mean of these 2 weighings was used to describe animals. The mean liveweight of heifers was 167 kg in February and 218 kg in May.

Visual observation of heifer location (i.e. on grass or clover) and activity (i.e. grazing or not grazing) at 10-minute intervals during daylight hours was made as the primary description of preference. Daylight, during which heifers could be identified, was approximately 15.8 hours in December, 13.5 hours in February and 11 hours in May. Partial preference was calculated as the ratio of observations grazing grass:grazing clover. Daily grazing time was calculated from the total number of observations for which grazing was recorded divided by the number of observations made per hour. Grazing time on each species was derived from the partial preference multiplied by the daily grazing time. Binoculars were used from a central, elevated viewing platform to identify individual heifers, their location and activity. Activity at the instant at which the animal was sighted, was recorded, however where there was doubt (e.g. head-up chewing, momentary disturbance, or walking), the heifer was viewed for a short period to determine the predominant activity over that interval.

The basic assumption in this phase of the programme was that preference for a species within the pair be tested under conditions of equal herbage availability. The plot, comprised of equal areas of grass and clover (1 ha each), was managed to ensure that canopy surface height of each species was the same. Canopy surface height was measured with a modified rising-plate meter, in which a perspex plate (300 mm × 300 mm) was lowered on to the canopy and height recorded when the plate touched the majority of leaves within its perimeter. Fifty readings were taken randomly along plot diagonals at regular intervals during the experimental period. Herbage mass above ground level was recorded by cutting quadrat samples of 300 mm × 300 mm at six sites within each plot at the start, mid-way and end of each experimental period. At 3 sites (2 sites in February),

selected as the mean of the canopy surface height on that day, additional stratified cuts were made to partition the canopy herbage mass into 2 strata of above, and below, half of the mean canopy height. Herbage mass of both strata was calculated. The proportion of dead material in the upper stratum sample was visually scored, and adjusted based on a regression of visual dead on actual dead determined from a subset of dissected samples. This stratification procedure was done to describe in detail the canopy conditions in the grazed strata which might affect preference. No pasture sampling was conducted in December.

Data analysis in this report is based on group mean daily behaviour. Activity (i.e. grazing or not x grass or clover) was analysed by ANOVA, with season, activity and the interaction tested against the day × activity interaction. There was no spatial replication, and the data from each of the 10 animals was used as replicates during each measurement period.

Canopy data were analysed by regressing total mass, upper and lower strata mass, and canopy surface height on time within the 2-week observation period as a check on the objective of maintaining uniform canopy conditions for the duration of the experimental period and to describe changes in the herbage on offer. The power of regression analyses to detect trends over time was limited by the number of samples taken.

Results

Partial preference

Preference was influenced by season (Table 1). In February, heifers exhibited a significant partial preference for white clover over ryegrass, of 65:35. The partial preferences of 49:51 in December and 45:55 in May were not significantly different from neutrality (50:50). Further work is required to describe more precisely whether this situation is a result of indifference (i.e. they graze species in proportion to their relative abundance) or a preference for a 50:50 mixed diet.

Table 1: Partial preference, and time allocation to grazing and non-grazing by dairy heifers as influenced by season.

Season	Activity	Partial preference (clover:ryegrass)	Grazing time (hours)	Time ratio (clover:ryegrass) (hours)
December	Grazing	49 : 51	8.3	4.0 : 4.3
	Non-grazing		7.5	3.3 : 4.2
February	Grazing	65 : 35 **	7.2	4.7 : 2.5
	Non-grazing		6.3	2.7 : 3.6
May	Grazing	45 : 55	5.2	2.3 : 2.9
	Non-grazing		5.8	1.3 : 4.5

** Ratio significantly different ($P < 0.01$) from 50:50

Daily grazing time and grazing ratio

Heifers grazed for longer each day in December (8.3 hours) than in February (7.2 hours) or May (5.2 hours). In February, they reduced time spent grazing ryegrass to 2.5 hours compared with 4.3 hours in December. In May the reduction in total grazing time resulted from a reduction in the time spent grazing white clover from 4.7 hours to 2.3 hours, but little change in the time spent grazing ryegrass, which was 2.5 hours in February and 2.9 hours in May.

Non-grazing time allocation

Non-grazing time was generally spent more on the less preferred species of the grass-white clover contrast. As a result of this different allocation of grazing and non-grazing time, the total time on each species in February tended to be similar, but more time was spent on ryegrass in total than on white clover in December and May.

Species canopy height and herbage mass

Canopy height was similar for both species during February, but in May white clover had a greater canopy height than ryegrass (Table 2). In December, canopy height was 15.8 and 16.4 cm for ryegrass and white clover, respectively. Mass in the upper stratum, where it was assumed bites were obtained from, and total herbage mass, was similar for both species in May. However, in February, ryegrass had a greater total herbage mass than white clover. While strata mass in February were not statistically compared, white clover appeared to have the greater upper stratum herbage mass.

Discussion

Measurements of relative grazing time were used as the primary indicator of preference on the grounds that choice of grazing location (i.e. on grass or on clover) is

an active decision by the animal. Consequences to the plant or to the animal ultimately depend on the amount of herbage ingested, a function of both time spent grazing a particular species and intake rate per unit time. Large differences in the intake rate derived from each species could mean that preference based on grazing time would not accurately reflect diet composition. However, for cattle, differences in intake rate from ryegrass, or from white clover, maintained with high availability, are unlikely to be a large determinant of preference (Newman et al. 1994) and relative grazing time provides the simplest assessment.

Availability of each component monoculture was high, such that had heifers wanted to eat a monospecific diet they could have done so. In this case, availability refers not only to conventional parameters such as mass per unit area, or height, but also to the spatial separation where once an animal has chosen which species to eat, there is no constraint on it obtaining that species. Heifers demonstrated a partial preference for clover by spending approximately 65% of grazing time on clover and 35% on ryegrass in February. This ratio is consistent with that recorded for sheep both in studies using turves (Newman et al. 1992), and in studies using field monocultures (Parsons et al. 1994b), also in summer. Similar results have subsequently been shown for cattle (Penning et al. 1995b) and goats (Penning et al. 1995a), and suggests a general applicability to ruminants of a preference for a mixed diet over a monospecific one. However partial preference was influenced by season. While the ratio in December and May was not significantly different from 50:50, it is not possible to distinguish this as a preference for a 50:50 mixed diet (c.f. 65:35 in February) from indifference where animals obtain their diet in proportion to component species availability, in this case 50:50 on an area basis. In either case the heifers partial preference for white clover was

lower in December and May than in February. Reasons for this change are not clear. Ryegrass contained more reproductive stem and dead material during the dry conditions in February (27% dead material in upper strata) than in May (8% dead material) and this may have reduced its palatability. However, this change in partial preference in May was based on a reduction in the time spent grazing white clover, not an increase in time spent grazing ryegrass. The possibility of reduced palatability of white clover in May cannot be excluded. Further work to separate the independent changes

Table 2: Regression means and standard errors for canopy height, total herbage mass and vertical distribution of herbage mass in component monocultures in February and May.

Season	Species	Height (cm)	Herbage mass		
			Total kg DM/ha	Upper stratum	Lower stratum
February	Ryegrass	10.1 (\pm 0.02)	2980 (\pm 215)	550	2830
	White clover	11.3 (\pm 0.70) NS	2200 (\pm 115) *	820 NA	2660 NA
May	Ryegrass	11.3 (\pm 0.13)	2025 (\pm 190)	480 (\pm 11)	1610 (\pm 35)
	White clover	13.7 (\pm 0.94) *	1640 (\pm 280) NS	574 (\pm 30) NS	1200 (\pm 140) NS

* = significantly different intercepts ($P < 0.05$) based on regression of height or mass on time

NS = not significant

NA = not analysed by regression because only 2 points in time

in the component species, for example in palatability, from other motivations for animals to vary their preference with season, is required.

Given that heifers seek a diet comprising between 50–65% white clover, a large increase in the proportion of white clover in conventional pasture is required to meet this. Attempts by cattle to graze selectively to increase the proportion of white clover in their diet above that in the canopy being grazed, involve some trade-off between the cost of doing so (i.e. smaller bites, lower biting rate, increased grazing time) and the benefits derived (increased nutritive value, diet more closely matching preference). With conventional mixed pasture, a selective grazing strategy is unlikely to be successful in matching preference, even in the short-term. In the longer term, selective grazing for white clover will deplete that species as competitive advantage favours the non-selected species, ultimately forcing the diet further from preference (Parsons et al. 1991). A knowledge of dietary preference provides a basis on which to now develop new ways to offer the pasture composition which the animal desires.

Conclusion

Spatial separation of pasture species, which removes the major physical constraints to selective grazing, has shown that heifers select a diet which ranges from 50% to 65% white clover. In addition, spatial separation, by eliminating interspecific plant competition, may provide one strategy by which to achieve the high white clover contents in the pasture, and diet, that the animal desires. Further work is necessary to examine the basis of this preference, and how manipulating preference can help meet the objectives of increasing the stability of pasture composition. This applies not only to traditional species, ryegrass and white clover, but also for incorporating species with novel nutritional characteristics (e.g. Lotus).

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References

Beever, D.E.; Losada, H.R.; Cammell, S.B.; Evans, R.T.; Haines, M.J. 1986. Effect of forage species and season on nutrient digestion and supply in grazing cattle. *British Journal of Nutrition* 56: 209–225.

Clark, D.A.; Ulyatt, M.J. 1985. Utilisation of forage legumes in ruminant livestock production in New Zealand. pp. 197–203. In: Barnes, R.F. et al. (eds).

Forage Legumes for Energy-Efficient Animal Production, USDA/CSIRO/DSIR.

- Gibb, M.J.; Treacher, T.T. 1984. The performance of weaned lambs offered diets containing different proportions of fresh perennial ryegrass and white clover. *Animal Production* 39: 413–420.
- Hodgson, J.; Clark, D.A.; Mitchell, R.J. 1994. Foraging behaviour in grazing animals and its impact on plant communities. pp. 796–827. In: Fahey, Jr., C. (ed.). *Forage Quality, Evaluation and Utilisation*. American Society of Agronomy.
- Newman, J.A.; Parsons, A.J.; Harvey, A. 1992. Not all sheep prefer clover: diet selection revisited. *Journal of Agricultural Science, Cambridge*, 119: 275–283.
- Newman, J.A.; Parsons, A.J.; Penning, P.D. 1994. A note on the behavioural strategies used by grazing animals to alter their intake rates. *Grass and Forage Science* 49: 502–505.
- Parsons, A.J.; Harvey, A.; Johnson, I.R. 1991. Plant-animal interactions in a continuously grazed mixture. II. The role of differences in the physiology of plant growth and of selective grazing on the performance and stability of species in a mixture. *Journal of Applied Ecology* 28: 635–658.
- Parsons, A.J.; Thornley, J.H.M.; Newman, J.A.; Penning, P.D. 1994a. A mechanistic model of some physical determinants of intake rate and diet selection in a two-species temperate grassland sward. *Functional Ecology* 8: 187–204.
- Parsons, A.J.; Newman, J.A.; Penning, P.D.; Harvey, A.; Orr, R.J. 1994b. Diet preference of sheep: effects of recent diet, physiological state and species abundance. *Journal of Animal Ecology* 63: 465–478.
- Penning, P.D.; Newman, J.A.; Parsons, A.J.; Harvey, A.; Orr, R.J. 1995a. The preference of adult sheep and goats grazing ryegrass and white clover. *Proceedings of the 4th International Symposium on the Nutrition of Herbivores, 1995, Clermont-Ferrand, Ann. Zootech*, 44, Suppl.: p. 113.
- Penning, P.D.; Parsons, A.J.; Orr, R.J.; Harvey, A.; Yarrow, N. 1995b. Dietary preferences of heifers for grass or clover, with and without rumensin slow-release anti-bloat boluses. *Animal Science*: (in press).
- Rogers, G.L.; Porter, R.H.D.; Robinson, I. 1982. Comparison of perennial ryegrass and white clover for milk production. pp. 213–214. In: Mac-Millan, K.L.; Taufa, U.K. (eds). *Dairy Production from Pasture*. New Zealand Society of Animal Production.
- Ulyatt, M.J. 1981. The feeding value of herbage: Can it be improved? *New Zealand Agricultural Science* 15(4): 200–205.