The consequence for feed dry matter intake of grazing sheep, cattle and goats to the same residual herbage mass

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ABSTRACT

Mixed grazing experiments require decisions on the equivalence or interchangeability of grazing species. Often equivalence is based on an assumption of the relative feed intake of the species concerned. Another approach is to equate the species in terms of the effect they have on the pasture e.g. removal of herbage mass. In this experiment the species response to given sward conditions was investigated by controlling the rate of disappearance of herbage mass so that the equivalence of the species in terms of intake was derived rather than assumed.

An autumn/winter ryegrass/white clover sward was grazed separately by growing castrate cattle (320kg), sheep (28kg) and goats (17kg). Plot area and animal numbers were adjusted as necessary (on a daily basis) to achieve the same rate of dry matter (DM) disappearance for each species. The 2 rates of DM disappearance for each species were achieved over 4 and 10 days and were 522 (±23) kgDM/ha/d (Fast) and 215 (±33) kgDM/ha/d (Slow). Initial herbage mass was 3100 (±220) kgDM/ha. Final residual herbage mass was 860 (±310) kgDM/ha.

The relative rate of decline of apparent intake (/kgW $^{0.75}$) with decreasing herbage mass was lowest for cattle and highest for goats, meaning the apparent intake of cattle was less affected by lowering the residual herbage than that of sheep or goats. The difference between species was greater when the herbage mass was being slowly depleted than when it was depleted rapidly. This difference between species in the rate of decline of apparent intake at different herbage masses and allowances markedly alters the "stock equivalence" (the number of animals required to remove a given quantity of herbage) of a species. For example at 2 herbage masses, the ratios of "stock equivalence" were calculated as 1 : 5.5 : 8 (at 2800 kg DM/ha) and 3.3 : 44 : 407 (at 1500 kg DM/ha) for cattle : sheep : goats respectively where unity was the stock equivalent of a 320 kg steer grazing pasture of 2800 kg DM/ha.

Keywords Intake; sheep; cattle; goats; relative stocking rate; herbage mass; rate of herbage disappearance

INTRODUCTION

Mixed grazing is the practice of grazing more than one animal species, either concurrently or sequentially, on the same pasture. Increases in animal production (live weight gain) are commonly found from mixed, compared with single species grazing (Dickson *et al.*, 1981; Boswell and Cranshaw, 1978; Hamilton, 1976).

Before the reasons for such complementarity can be understood, detail of the intake and diet selection exhibited by each species grazed separately on the same pasture is required. Defining the basis for comparison of species is a problem inherent to such studies. Any animal-based criteria for comparison may pre-determine the result since they involve decisions about the relativity of different species which may or may not be appropriate. Relative stocking rate which is often based on live weight or relative intake, (e.g. Boswell and Cranshaw, 1978), while commonly used for comparisons between species, may confound the comparison. Stocking rate is known to be highly influential in pasture/animal interactions and therefore relative stocking rate may change with changes in sward characteristics.

One alternative would be to equate species in terms of a single and common effect on the grazed pasture. This paper reports the use of the pasture based characteristic, rate of disappearance of herbage mass (RDHM) as the parameter standardised across species. Not only is RDHM measurable and therefore controllable, but it is also of practical significance since it is in these (or similar) terms that feed budgeting decisions are made.

METHODS

Five Hereford steers (18 months of age, 320 kg live weight (W)), 30 Coopworth wether sheep (8 months, 28 kg W) and 26 feral cross wether goats (8 months, 17 kg W) were grazed during winter on separate plots of a ryegrass/white clover pasture of initial herbage mass of approximately 3000 kgDM/ha. The initial plot sizes ranged from 0.2 ha to 0.08 ha.

The objective was to achieve, by all animal species, 2 rates of disappearance of herbage mass (Fast and Slow) of approximately 500 and 250 kgDM/ha/d over periods of 4 and 10 d, respectively. This was achieved by regularly adjusting the stocking rate, independently for each species, by either reducing plot size with movable fences or by reducing animal numbers (sheep and goats only).

Herbage mass (HM) was visually assessed in each plot 10 times during the experiment (at half and 1 day intervals for the fast and slow rates respectively) by random and simultaneous placement of two 0.2m quadrats approximately 25 times/plot with visual estimation of the herbage mass in each. On a daily basis, 19 of the quadrats covering the range of HM present were cut to

ground level, washed, dried and weighed to calibrate the visual assessment. The apparent dry matter intake (ADMI in gDM/kgW $^{0.75}$) for each species was then calculated on a daily (or half daily) basis from the daily change in HM and the area grazed during each day. The ADMI was calculated directly from the 6 sets of estimates of HM (3 species x 2 RDHM) which were smoothed using a 3 point running average (Ryan *et al.*, 1982).

RESULTS

Correlation coefficients for the calibration of visual estimate of HM with herbage DM were in the range of 0.83 to 0.98 and residual standard errors in the range of 50 to 300 kgDM/ha. While these are less consistent than some figures reported in the literature, accuracy was of the same order as that described by Piggot and Morgan (1985) of approximately 200 kgDM/ha.

Initial HM was 3100 (±220) kgDM/ha. HM declined linearly with time at mean rates of 522 (±23) kgDM/ha/day (Fast) and 215 (±11) kgDM/ha/day (Slow) (Table 1). Final HM was 860 (±310) kgDM/ha. There was no significant difference between species in the regressions describing RDHM on the Fast treatment. Those describing the Slow RDHM differed ($P<0.05$) from one another (Table 1).

ADMI for all species decreased with decreasing HM at both rates of disappearance of herbage mass. The progressive decline of ADMI with declining herbage mass was best described by quadratic relationships for all species (Table 2). The quadratic term significantly reduced the residual variance in every case and all relationships differed from one another ($P<0.05$). For example, over a range of HM from 2800 to 2000 kgDM/ha the rate of change of ADMI was 6.4, 9.9 and 10.9 gDM/kgW $^{0.75}$/100kg HM for cattle, sheep and goats respectively. Over an equivalent range of HM, ADMI for all species was higher (by approximately 40 to 60 gDM/kgW $^{0.75}$) on the Slow rate of disappearance of herbage mass than on the Fast.

When the ADMI for each species is expressed as a percentage of the initial figure (day 1), cattle maintained a higher ADMI to lower HM than did sheep or goats (Fig. 1). This is confirmed by the mean ADMI of 65 (±7.6), 52 (±10.2) and 47 (±5.4) gDM/kgW $^{0.75}$ on the Slow rate and 34 (±4.6), 27 (±4.5) and 18 (±7.2) on the Fast rate for catle, sheep and goats respectively.

DISCUSSION

Rate of Disappearance of Herbage Mass

It was technically possible to control and equate the RDHM for all species and therefore to compare intake behaviour of species on a common basis. Although statistically significant differences in RDHM were shown between species on the Slow rate, they represented a maximum difference (goats-cattle) of 96 kgDM/ha/day (3 to 12% of the range of HM) and were therefore considered to be within the acceptable limits of pasture measurement. The technique will allow further comparison of the species in single and concurrent mixed grazing experiments to identify the causes of complementarity between the species. To our

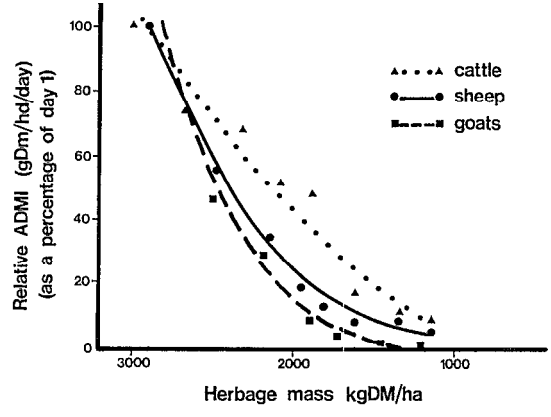

FIG. 1 Apparent dry matter intake (ADMI) of cattle, sheep and goats, expressed as a percentage of the initial ADMI of each species. (ADMI mean of 2 RDHM).

TABLE 1 Regressions of herbage mass (kg DM/ha) on interval from beginning of grazing (measured in half-days for Fast and days for Slow treatments).

	Intercept		Regression Coefficient		r^2	RSE
	Value	SE	Value	SE		
Fast						
All species	3283	64.5	-216	11.5	0.952	153.8
Slow						
Cattle	3372	40.6	-254	6.0	0.994	62.8
Sheep	3014	37.5	-235	5.5	0.994	58.0
Goats	2828	104.0	-158	15.3	0.913	160.8

TABLE 2 Quadratic equations relating apparent DM intake (g/kgW $^{0.75}$) to herbage mass (HM in kg DM/ha) for goats, sheep and cattle at 2 rates of disappearance of herbage mass (RDHM)

	Intercept		Coefficient of HM		Coefficient of HM^2 x 10^{-4}		r^2	RSE
	Value	SE	Value	SE	Value	SE		
Fast RDHM								
Goats	119.9	29.4	-0.160	0.031	0.51	0.079	0.941	7.2
Sheep	67.8	17.7	-0.096	0.017	0.35	0.040	0.985	4.5
Cattle	109.4	18.2	-0.146	0.019	0.51	0.046	0.989	4.6
Fast RDHM								
Goats	-25.0	32.9	-0.027	0.035	0.33	0.087	0.990	5.4
Sheep	55.6	17.4	-0.085	0.024	0.44	0.075	0.947	10.4
Cattle	-81.7	17.4	0.121	0.020	-0.19	0.054	0.962	7.6

knowledge this technique has not been used before to make direct comparisons between grazing species.

Dry Matter Disappearance

The maximum ADMI of 160 gDM/kgW $^{0.75}$ was exhibited by all species and is broadly comparable with other intake data recorded from pasture (e.g. 164 gOM/kgW $^{0.75}$ in calves and lambs, Jamieson and Hodgson (1979); 104 gOM/kgW $^{0.75}$ in cattle of varying weights, Zoby and Holmes (1983)). Mean intakes were comparable to intakes recorded by Jamieson and Hodgson (1979) (over a similar range of herbage mass to that used here) of 85.6 (±3.22) and 77.7 (±3.22) gOM/kgW $^{0.75}$ for calves and lambs respectively.

The 3 species clearly differed in their ability to maintain ADMI on a sward of declining HM. Cattle displayed the greatest tolerance (in terms of maintaining intake) of declining HM and goats the least. The results are in full agreement with those of Jamieson and Hodgson (1979) for calves and lambs grazed over a similar range of herbage mass (although the RDHM was not controlled) over which intake fell by 24% and 39% in calves and lambs, respectively. The implication is that the pasture characteristics determining ADMI differ between species, and that HM is not the only influential characteristic. These data do not offer an explanation for the differences between species, although differences in sward structure and composition, by allowing variable expression of selectivity to occur, may moderate differences in intake. In goats, intake declined markedly at levels of HM normally considered to promote adequate intake in sheep and cattle, with ADMI reaching zero at 1400 kgDM/ha.

The ADMI for each species was significantly lower, and the difference between species less marked, at equivalent HM on the Fast than on the Slow RDHM (Table 2). Achievement of the 2 different rates necessitated a 2-fold difference in herbage allowance. Reduced herbage allowance on the Fast RDHM reduced availability of certain pasture components, and possible selectivity, which could partially explain the lower average intake and the smaller difference between species on the Fast RDHM.

Relative Stocking Rate

The result of the difference between species in the rate of change of intake over a range of HM is that the numbers of stock required to remove equivalent herbage mass at the 2 rates change over that range. Table 3 shows the relative stocking rate equivalents (number of animals relative to one head of cattle at the lowest stocking rate) at 3 herbage masses.

This has implications both for mixed grazing experiments and for grazing management in the broader sense. Animal production data from experiments in which a single value for the interchangeability of species is used are likely to be biased if the species are grazed over a range of HM (assuming that the animal production is based, at least partially, on DMI). For example, Dickson *et al.*, (1981) reported an increase in total live-weight gain of 1.25 kgW/ha/day when sheep and cattle were grazed together (compared with cattle alone). Sheep were substituted for cattle on a 50:50 live-weight basis and the stocking rate was 10 steers (or 20 ewes plus lambs) / hectare. Our data suggest that at a HM of 3000 kgDM/ha, substitution on a live-weight basis would overestimate the number of sheep required by a factor of 2. Hence, the increase of 1.25 kgW/ha/day could be accounted for by the live-weight gain (say 200g/sheep) from the 5 additional sheep used. Further investigation of the basis for species substitution in grazing experiments is indicated.

Further, it is commonly true of mixed grazing experiments that the advantages occur in sheep rather than cattle production. In this experiment we have demonstrated that sheep are more sensitive to a change in herbage mass than are cattle. It follows that the removal of a herbage mass restriction on grazing species is likely to have a proportionally greater effect on sheep than on cattle production which may provide some explanation for the greater response of sheep to

mixed grazing.

In grazing situations where animals are used to control pasture (and graze to a low herbage mass), feed supply and therefore intake will be restricted. Maintaining live weight, or minimising its decline, in the animals concerned is an important consideration, so an understanding of the comparative tolerance of different species to given pasture conditions is valuable. Our data show that under the conditions of this experiment cattle would be the preferable species to graze to low herbage mass.

In this experiment we have established that it is possible to compare the behaviour of grazing species using the common basis of rate of disappearance of herbage mass, that the technique is feasible for research purposes and that the results highlight an important variability in species equivalence that occurs over a commonly used range of herbage mass on winter pasture.

TABLE 3 Calculated stocking rate equivalence of 3 species (cattle, sheep and goats) at 3 herbage masses. All figures are relative to 1 steer at the lowest stocking rate.

	Herbage mass (kg DM/ha)		
	2800	2100	1500
Cattle	1	1.8	3.3
Sheep	5.5	14.2	44
Goats	8	25	407

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