The Animal/Pasture Interface in Deer Grazing Systems

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Abstract

Pasture characteristics influencing herbage intake and diet selection by grazing deer are outlined, and related to comparative information for other animal species. The use of this information in developing sward target guidelines for pasture management in deer grazing systems is discussed. Emphasis is placed on the importance of sward targets designed to ensure near-maximal levels of herbage intake in growing weaners and lactating hinds.

Introduction

In dealing with this topic I was asked to concentrate on my own interests in the ecology of grazing systems, with particular reference to the influence of pasture conditions on grazing behaviour and herbage intake, and the reciprocal effects of selective grazing on pastures. I also want to take a little time to show how we can use understanding of the basic ecology of animal/plant interactions to improve the objectivity of grazing management. There is limited information on the grazing behaviour of deer, particularly in a comparative context, so I will be drawing some analogies with the results of studies on other ungulate species, mainly sheep.

Control of forage intake

It is helpful to think of herbage intake by grazing animals as the outcome of three interacting sets of drives (McClymont, 1967), as follows:

- A positive drive, associated primarily with energy demand and reflecting the size, maturity, physiological state and productive potential of the animal concerned, as well as the current and previous level of feeding.
- A negative (inhibiting) drive, associated with the bulk limitations of food and food residues in the digestive tract and often (perhaps rather simplistically) related to the digestibility of the diet.
- A further negative drive, associated with the difficulties of harvesting herbage under grazing conditions and related to the effects of pasture structure on rates of herbage intake.

This conceptual model helps to make the point that ingestive and digestive functions are clearly linked. Despite this, and the fact that the two sets of functions are often related to similar herbage characteristics, there have been very few attempts to understand and rationalise their relative importance in specific grazing conditions. This is just as true for the deer studies at Massey University as for most other circumstances. There is a real need for collaborative studies between ecologists and nutritionists in this area if we are to progress in our understanding of the control of forage intake in grazing animals.

It has been conventional to focus on the components of the grazing process as a basis for explaining behavioural limits to herbage intake

Thus: Herbage intake (kg DM/ha) = Rate of intake (g DM/min) x Grazing time (min/day)

and: Rate of intake (g DM/min) = Intake per bite (g DM) x Bite rate (bites/min).

Intake per bite is seen as the primary determinant of herbage intake, with compensating changes in bite rate and grazing time usually being insufficient to prevent a reduction in daily herbage intake when sward conditions depress intake per bite. The relationship between intake rate (usually measured over short periods of time) and herbage mass (g DM/m^2 or kg DM/ha) has been called the Functional Response, and shows a remarkably consistent pattern of behaviour in a wide range of grazing animal species (Hodgson *et al.*, 1997).

We can take the analysis of the components of ingestive behaviour one stage further, and write:

Intake per bite (g DM) = Bite volume (cm^3) x Herbage bulk density (g DM/cm^3)

and: Bite volume (cm^3) = Bite depth (cm) x Bite area (cm^2).

This is a classical reductionist approach, but it results in a series of behavioural parameters which can be related directly to sward characteristics and to the structure of the ingestive apperatus – lips, teeth and tongue. It also provides a basis for direct comparison of the grazing behaviour of different animals species.

Comparative studies of deer and sheep

Studies at AgResearch and Massey University (Mitchell, 1995) have provided a detailed comparative evaluation of the effects of sward canopy structure on the ingestive behaviour of sheep and deer. Mitchell used seedling swards grown in trays in the glasshouse to create contrasts in sward height and resulting from manipulation of tiller population density and cutting treatment, and measured bite parameters when these mini-swards were offered to trained sheep and deer housed in metabolism crates. The results of one series of studies are illustrated in Figures 1 and 2. Briefly, the results showed that patterns of behaviour were remarkably similar in sheep and deer Both showed a greater response in intake per bite and rate of intake to variations in sward height than to variations in herbage bulk density, linked to the observation that bite depth, as a function of sward height, showed much greater variation across treatments (Figure 1) then did variations in bite area.

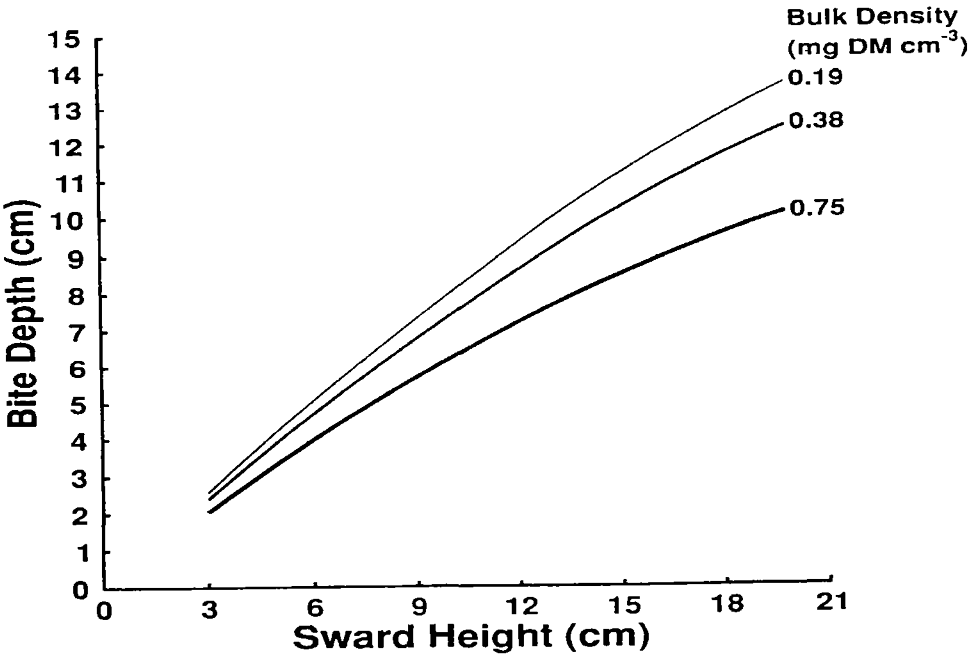

Figure 1. *The influence of variations in pasture height (cm) and bulk density (mg DM/cm^3 on bite depth in sheep and deer grazing experimental seedling swards (from Mitchell et al, 1991).*

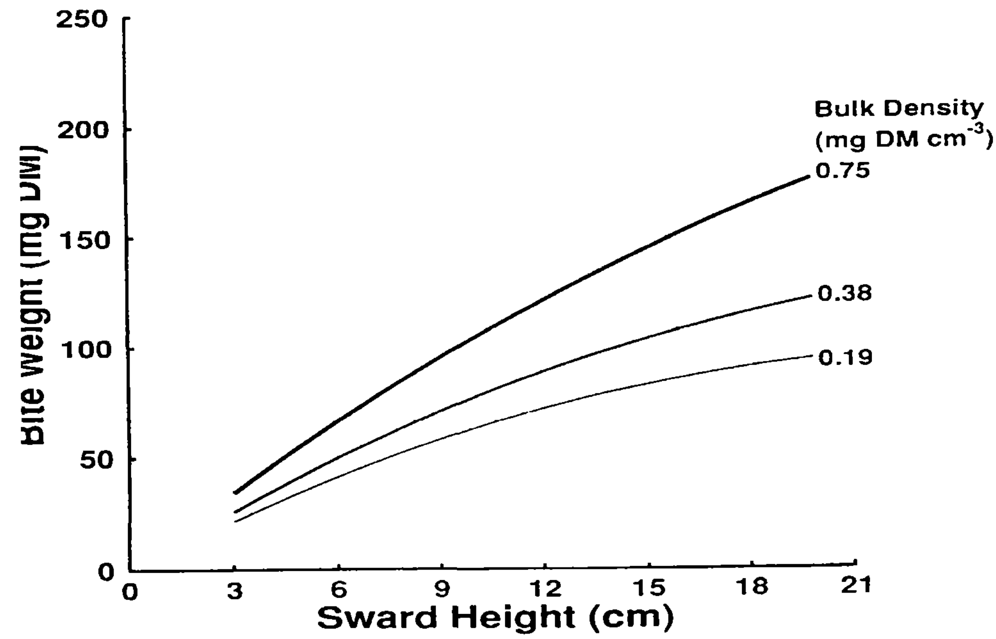

Figure 2 *The influence of variations in pasture height (cm) and bulk density (mg DM/cm^3 on bite weight in sheep and deer grazing experimental seedling swards (from Mitchell et al, 1991)*

The only real difference between the two animal species was that sheep, with a flatter incisor arcade than deer, were better able to sustain rate of intake on swards shorter than 3 cm. The combined influence of sward height and herbage bulk density on intake per bite is clearly illustrated in Figure 2. In these controlled studies bite depth, intake per bite and intake were all still increasing at sward heights in excess of 20 cm (Figure 1). Other studies with sheep, cattle and goats have shown that bite depth can continue to increase to a sward height of 80 cm (Gong *et al.*, 1996).

The implications of Figures 1 and 2 are that for equivalent levels of herbage mass and nutritive value (kg DM/ha) intake per bite and rate of intake will be substantially greater on a tall, open sward with an erect canopy than on a short, compact sward with high bulk density. It also means that we cannot expect to predict herbage intake without some measure of the vertical distribution of vegetation in the sward canopy; a simple measure of herbage mass is not adequate on its own.

The effects of restrictions in bite weight and rate of intake upon daily herbage intake depend upon the magnitude of compensating changes in grazing time. Figure 3 shows that compensation is likely to be complete in grazing sheep at a sward surface height of 5-6 cm, but below this height intake is restricted at a progressively increasing rate. There is limited comparative information for deer though Mitchell's evidence (Mitchell *et al.*, 1993) indicated that rate of intake was more sensitive to declining sward height in deer than in sheep. The practical implications of these relationships are considered in a later section.

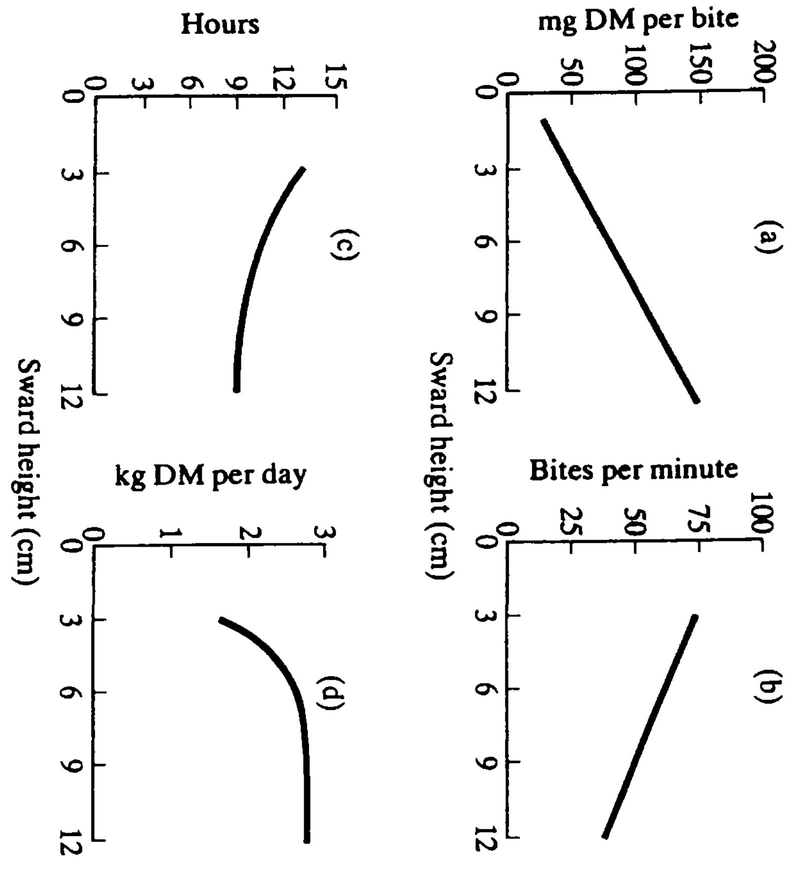

Figure 3. The influence of variations in sward height on (a) intake per bite (mg), (b) biting rate (bites/min), (c) grazing time (h/day) and (d) daily herbage intake (kg DM/day) in grazing sheep (from Penning, 1986)

Variations in herbage nutritive value may influence herbage intake independent of the effects of sward structure. Figure 4 shows the results of studies on grazing cattle which demonstrate clearly the simple recticlinear relationship between herbage digestibility and intake in field conditions, and emphasises the importance of maintaining a high level of pasture digestibility where high animal performance is the objective. The response for spring primary growth (line 1) indicates a consistent intake advantage of about 10% over that for summer regrowth (line 2), which can be explained in terms of the more erect growth of spring pasture (Hodgson *et al.*, 1977).

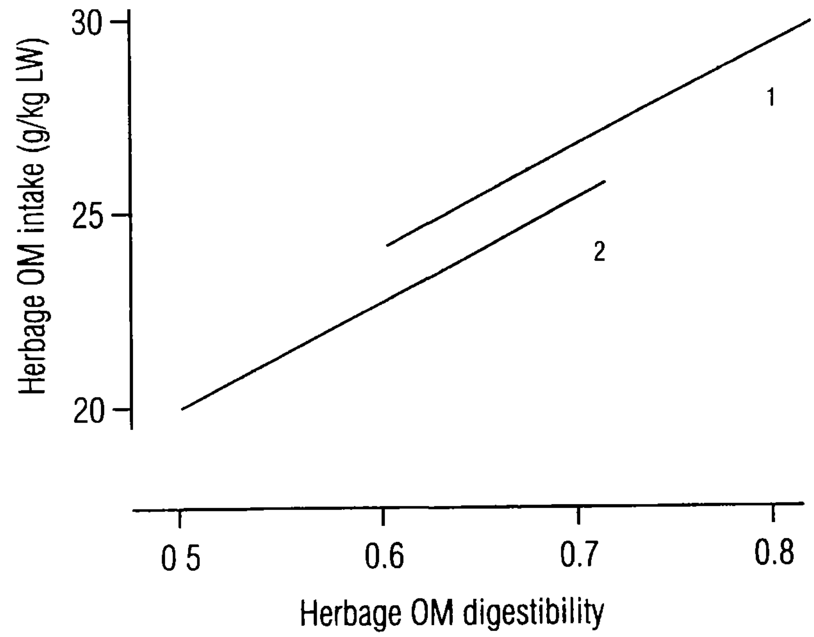

Figure 4. *The influence of herbage digestibility (OMD %) on the herbage intake (kg OM/day) of cattle grazing perennial ryegrass swards (from Hodgson et al, 1977) Line 1 relationship for primary spring growths Line 2 relationship for summer regrowths*

I do not know of any comparable information for grazing deer, though other speakers at this Conference have emphasised the importance of maintaining forage nutritive value for high performance animals (Barry, 1999; Valentine and Kemp, 1999).

Selective grazing behaviour

Deer have a reputation for selective grazing, but there is limited information on which to base comparisons with other species. Grazing preferences can be tested in free-choice trials where animals have uninhibited access to a range of plant species or cultivars, or evaluated in mixed swards where dietary preference may be compromised by variation in plant distribution and accessibility. Both situations are illustrated here.

In a series of grazing studies in which groups of animals were offered free choice of 16 plant materials in a checkerboard plant design (Hunt and Hay, 1990), deer grazing in summer demonstrated clear preference for legumes and some herbs over grass species with particular preference for low-oestrogen G27 red clover (Figure 5). In contrast, calves grazing in autumn showed a marked preference for grasses (Figure 5), though the nature of the data makes it difficult to disentangle species, age and seasonal effects.

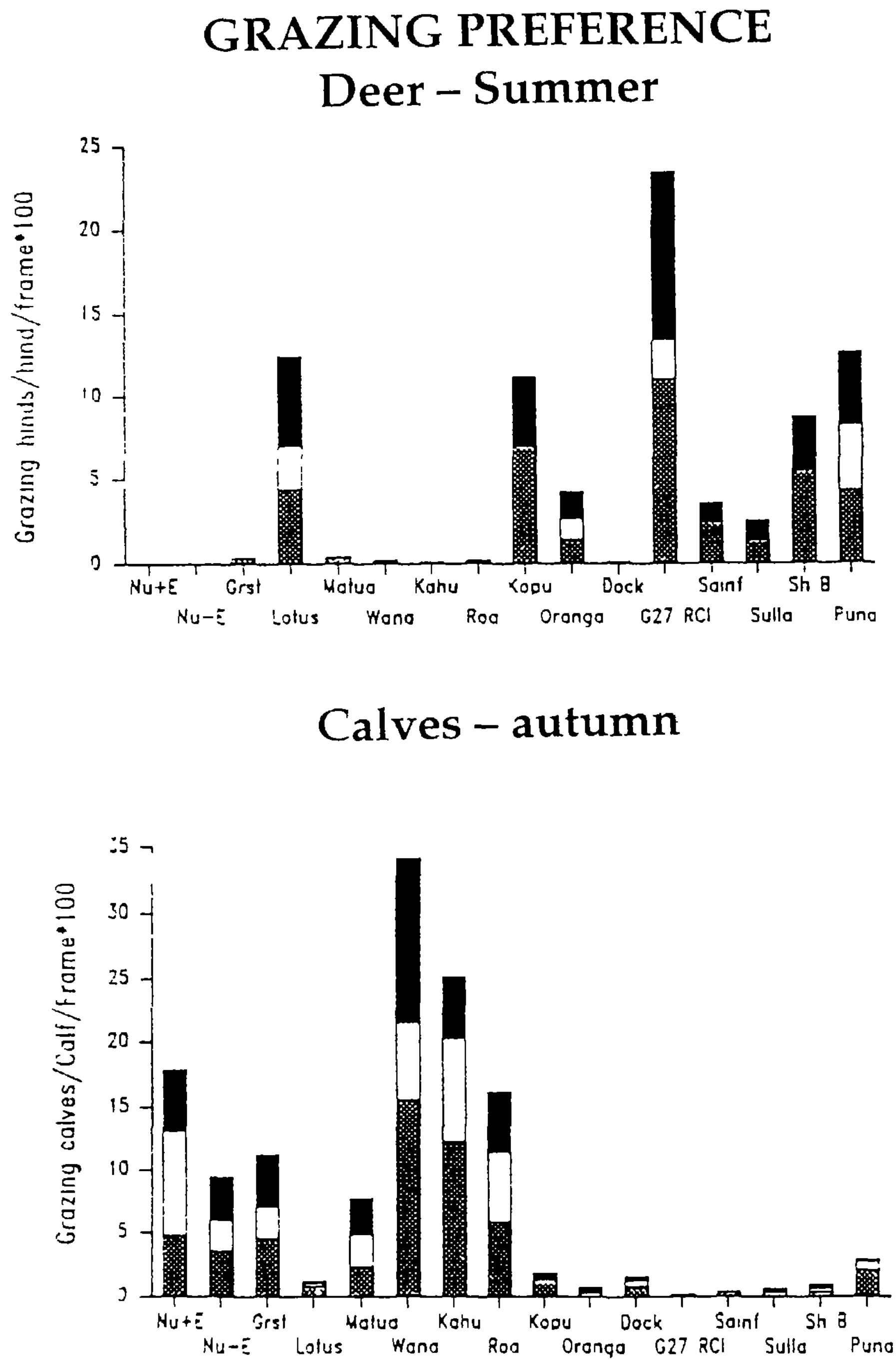

Figure 5. *Grazing preferences of deer and cattle (from Hunt and Hay, 1990)*

Deer behaviour on mixed pastures is illustrated in Tables 1 and 2, which summarise the results of a series of studies on sward and diet composition from the Massey University deer programme. The results in Table 1(a) suggest, somewhat surprisingly, that deer select for grass and against clover. However, if account is taken of the relative position of grass and clover leaf in the sward canopy, it is more appropriate to argue that deer actively select for white clover, and graze it closer to ground level, than they do the companion grasses (Table 2). The available evidence suggests that in the same circumstances sheep may be more selective than deer (Curll and Wilkins, 1982), though this is not always the case (Milne *et al.*, 1982).

Table 1. **Comparison of relative proportions of grass and clover in pasture and in the diet of grazing deer (from Ataja, 1990; Kusmartono, 1996).**

(a) Ryegrass /white clover pastures

	Pasture		Diet	
	% grass	*% clover*	*% grass*	*% clover*
Ataja (1990)	95 2	4 8	99 1	0 9
	89 3	10 7	96 5	3 5
	95 1	4 9	96 4	3 6
	95 0	5 0	96 4	4 6
	85 8	14 2	96 8	3 2
	83 8	16 2	93 1	6 9
Kusmartono (1996)	88 1	10 6	90 8	8 1
	94 8	5 1	96 8	2 9
	86 2	13 3	91 2	8 5

(b) Chicory/ryegrass/white clover pastures

	Pasture			Diet		
Kusmartono (1996)	*%chicory*	*%grass*	*%clover*	*%chicory*	*%grass*	*%clover*
	90 2	6 6	1 7	95 0	3 5	1 5
	91 8	2 0	5 8	88 6	4 9	6 3

Table 2. **Comparison of the frequency and severity of defoliation of the ryegrass and white clover components of mixed pasture by grazing deer (from Bootsma *et al.*, 1990).**

	Ryegrass	White Clover	SED
Defoliation frequency			
(% of population per day)	6 3	5 5	0 80
Defoliation severity			
(% of leaf removed per day)	3 9	4 8	0 72
Leaf height (mm)			
before grazing	76	40	6 4**
after grazing	63	35	7 1 *

The results in Table 1(b) also suggests that there is little discrimination between the chicory, ryegrass and clover components of a mixed pasture. However, the balance indicated in this data set would be heavily dependent upon the maintenance of all components in a vegetative state.

Practical implications

Pasture management should focus on the control of sward conditions in order to meet requirements for specified levels of animal performance and at the same time to ensure a high level of utilisation efficiency. These requirements are not necessarily compatible, but there is increasing interest in the use of sward targets (sward height or pasture cover) to provide an objective basis for pasture management decisions which take animal and pasture requirements into account.

If young deer are to reach the market specification of 95-100 kg LW at one year of age, they need to grow at a rate close to maximum throughout. Work at Massey University has consistently shown that to achieve this young deer should graze pastures to a minimum target height of about 10 cm (equivalent to a herbage mass of 2000-2500 kg DM/ha) from weaning to slaughter. This standard applies to both conventional ryegrass/white clover pastures (Table 3) throughout the year and to special-purpose forage crops grazed in spring and summer (Kemp, 1996). It applies to continuous stocking management where sward height is maintained at this level and to the post-grazing residues in a rotational system. Swards held at this level will not maximise herbage utilisation, but the growth advantage gained by young deer will more than offset the stocking rate advantage of animals kept on shorter pasture (Table 3). For animals with lower nutrient requirements, mature hinds (except in lactation) and stags, a sward target height of 5 cm (1400-1500 kg DM/ha) should be sufficient. Within these limits, control of selective grazing would be expected to maintain adequate levels of clover in mixed pastures.

Table 3. Sward surface height and deer production (from Ataja, 1990).

Sward height	5 cm Pasture	Moata	10 cm Pasture	Moata
Herbage production (kg DM/ha/day)				
Winter	11	19	16	19
Spring	44	42	50	40
Stocking rate (deer/ha)				
Winter	12.4	15.4	10.5	13.1
Spring	14.3	14.8	12.4	9.4
Initial wt (kg)	60	60	57	61
Liveweight gain (g/head/day)				
Winter	74	79	153	131
Spring	147	211	234	209
Stags to slaughter end Nov at 92 kg (%)	0	21	42	50
Liveweight gain (kg/ha/day)				
Winter	0.92	1.22	1.61	2.74
Spring	2.10	3.12	2.90	1.96

Note that these sward targets specified for optimum growth are close to those specified for growing or lactating cattle (10 cm) rather than those specified for growing or lactating sheep (5-6 cm). Thus, although the indoor studies of Mitchell (1995) indicated close similarities between deer and sheep in grazing responses to changes in sward height, the marked discrepancy in sward height targets derived for the two species from field studies reflect the greater responsiveness of deer than of sheep to increases in sward height (Mitchell *et al.*, 1993).

Conclusion

In this paper I have tried to illustrate some of the principles involved in the control of forage intake in grazing animals, and to indicate the ways in which better understanding of the interactions between grazed swards and grazing animals can be used to improve the objectivity of grazing management decisions. It is salutory to note the production advantages achieved by keeping productive stock under relatively generous pasture conditions which generate high levels of herbage intake. The same principles are increasingly being applied to cattle and sheep systems in New Zealand with a view to enhancing both per head and per hectare output.

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