The Interaction Between Factors That Affect The Daily Time Spent Grazing By Ruminants

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Key words: herbivores; intake; bite rate; sward height; bulk density

The animal-plant interaction between grazing ruminants and the grasses and forbs that make up temperate pasture swards is complex. The interaction is ultimately expressed in each mouthful of herbage (bite) ingested by the grazing animal. Each bite is characterised by quantity (bite weight), quality (species composition, plant part, plant maturity), and the time taken to apprehend, crop, chew and swallow (bite rate). The sum of all bites taken during a 24-hour period defines both the quantity and quality of total nutrient intake by the animal for that day.

The length of time which a ruminant animal spends grazing each day (min), can be described as daily forage intake (g DM), divided by the product of bite weight (g DM $bite^{-1}$) and bite rate (bites min^{-1}), where bite weight is determined as the product of bite area (cm^2), bite depth (cm), and the bulk density (g DM cm^{-3}) of the herbage grazed [Gordon and Lascano, 1993; Hodgson, 1990]. The major factors that affect the components of this relationship are live body weight (kg) of the grazing animal, and the height (cm), bulk density (g DM cm^{-3}), and energy content (net energy for maintenance, Mcal kg DM^{-1}) of the pasture sward [Laca et al., 1992; Laca et al., 1994; NRC, 1996; Ungar et al., 1991].

The way in which daily time spent grazing, by beef cattle in a temperate environment, may be affected by changes in each of these factors (live body weight, sward height, bulk density, net energy for maintenance), was investigated using the relationship:

$$\text{time spent grazing} = \text{forage intake (bite depth x bite area x bulk density x bite rate)}^{-1}$$

Three values that represent the normal range (low, intermediate, high) for each factor were used in the calculations. These values were: live weight 200, 400, 800 kg, sward height 8, 15, 30 cm, bulk density 300, 1000, 3000 g DM m^{-3}, and net energy for maintenance 1.0, 1.5, 1.9 Mcal kg DM^{-1}. Daily time spent grazing was then determined by calculating daily forage intake as a function of body weight and net energy for maintenance, bite depth and bite area as

functions of sward height and sward bulk density, and bite rate as a function of bite weight [Laca et al., 1992; Laca et al., 1994; NRC, 1996; Ungar, 1991].

Time spent grazing is shown plotted against the three chosen values for each of the four factors investigated (Fig. 1 live body weight, Fig. 2 sward height, Fig. 3 bulk density, Fig. 4 net energy for maintenance). For each figure the data shown was calculated using only the intermediate value for the other three factors, so Fig. 1 is based on calculations using three values for live body weight (200, 400, 800 kg), but only the intermediate values for sward height (15 cm), bulk density (1000 g DM m^{-3}), and net energy for maintenance (1.0 Mcal kg^{-1} DM). Each figure also includes six smaller graphs to show how bite depth, bite area, and their product bite volume, and bite weight, bite rate, and their product instantaneous intake rate, were affected as the value for the main factor increased.

Over the range of cattle live weights considered (Fig. 1), the daily time spent grazing ranged from 7.05 to 10.46 h, associated with increasing bite depth, bite area, bite weight, and instantaneous intake rate, and decreasing bite rate. As net energy for maintenance increased from 1.0 to 1.9 Mcal kg dm^{-1} daily time spent grazing ranged from 7.2 to 8.2 h (Fig. 4) which also fell within the normally observed range (5-13 h) [Arnold and Dudzinski, 1978]. Bite depth, bite area, bite weight, bite rate, and instantaneous intake rate, all remained constant because changes in net energy for maintenance only affected the calculation of herbage intake.

A different result was seen with sward height (Fig. 2), and bulk density (Fig. 3). The daily grazing times at the lowest sward height (8 cm), and at the lowest sward bulk density (300 g dm m^{-3}) were both considerably above normally observed values (Fig. 2, 18.9 h; Fig. 3, 23.9 h), while daily grazing time at the highest sward height (30 cm) was below normal values (Fig. 2, 3.6 h). Bite weight, and instantaneous intake rate increased both with increasing sward height, and with increasing bulk density, while bite rate decreased. Bite depth and bite area increased with increasing sward height, but decreased with increasing bulk density.

Two levels of compensatory response that have been described as part of the grazing response are illustrated by these results [Ungar, 1996]. A short-term, physically-imposed, compensatory relationship was seen between bite weight and bite rate, and a longer-term relationship as daily time spent grazing increased as short term intake decreased. It has also been reported that when pasture herbage availability drops below a certain level, or when sward heights are very low, time spent grazing may actually decrease, possibly representing a response to a situation in which more energy is expended in locating and consuming forage than is supplied when that forage is eaten [Gordon and Lascano, 1993].

Other factors not considered here may also affect the daily time spent grazing by cattle on temperate pastures. The results reported here indicate that the relationship used to calculate time spent grazing did not always effectively or completely describe this component of grazing behaviour, even when all individual values used in the calculation fell within the normal range. One such factor would be the need for cattle to spend between 5 and 9 h each day ruminating to reduce food particle size, allowing passage of food out of the reticulo-rumen [Arnold and Dudzinski, 1978]. Incorporation of this and other constraints into the calculations will lead to a more effective characterization of the grazing response.

REFERENCES

Arnold GW, Dudzinski ML. 1978. Ethology of Free-ranging Domestic Animals. Amsterdam: Elsevier Scientific Publishing Company. 198 p.

Gordon IJ, Lascano C. 1993. Foraging strategies of ruminant livestock on intensively managed grasslands: potential and constraints. In: Baker MJ, Crush JR, Humphreys LR, editors. Proceedings of the XVII International Grasslands Congress. New Zealand, Australia. p 681-89.

Hodgson J. 1990. Grazing Management. Science into Practice. New York: Longman Scientific & Technical. 203 p.

Laca EA, Ungar ED, Seligman N, Demment MG. 1992. Effects of sward height and bulk density on bite dimensions of cattle grazing homogeneous swards. Grass Forage Sci 47:91-102.

Laca EA, Ungar ED, Demment MG. 1994. Mechanisms of handling time and intake rate of a large mammalian grazer. Appl An Behav Sci 39:3-19.

[NRC] National Research Council. 1996. Nutrient Requirements of Beef Cattle, 7th rev. ed. Washington DC: National Academy Press. 242 p.

Ungar ED. 1996. Ingestive behaviour. In: Hodgson J, Illius AW, editors. The Ecology and Management of Grazing Systems. Wallingford, Oxfordshire, England: CAB International. p 185-218.

Ungar ED, Genizi A, Demment MG. 1991. Bite dimensions and herbage intake by cattle grazing short hand-constructed swards. Agron J 83:973-978.

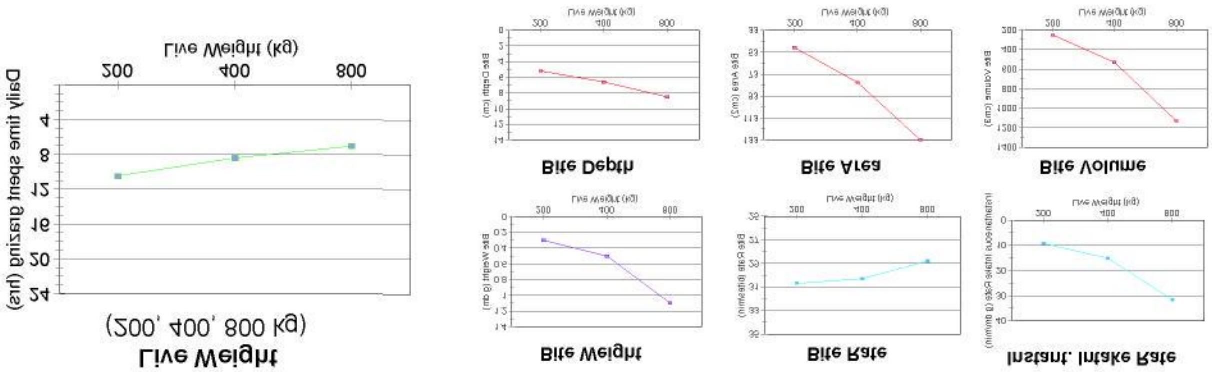

Fig 1. The relationship between animal live weight and daily time spent grazing.

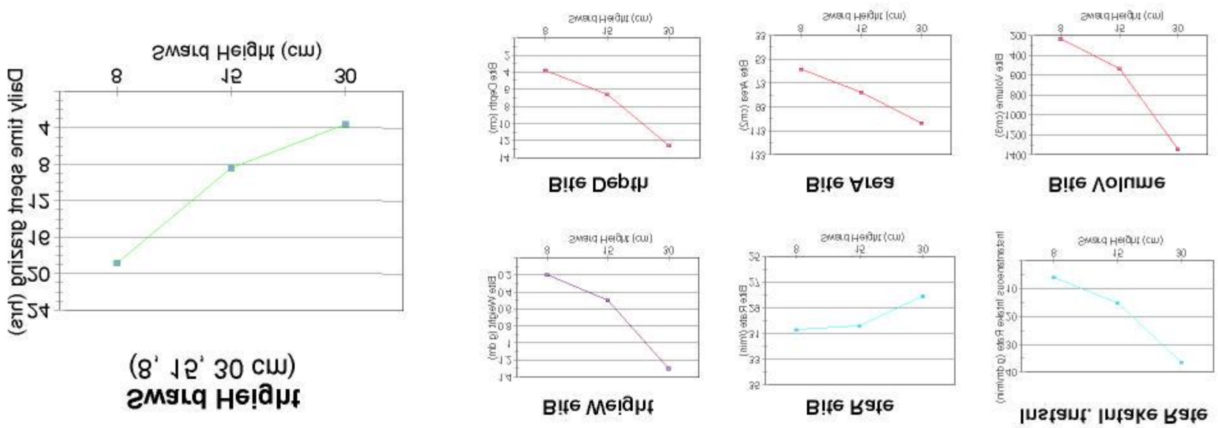

Fig 2. The relationship between sward height and daily time spent grazing.

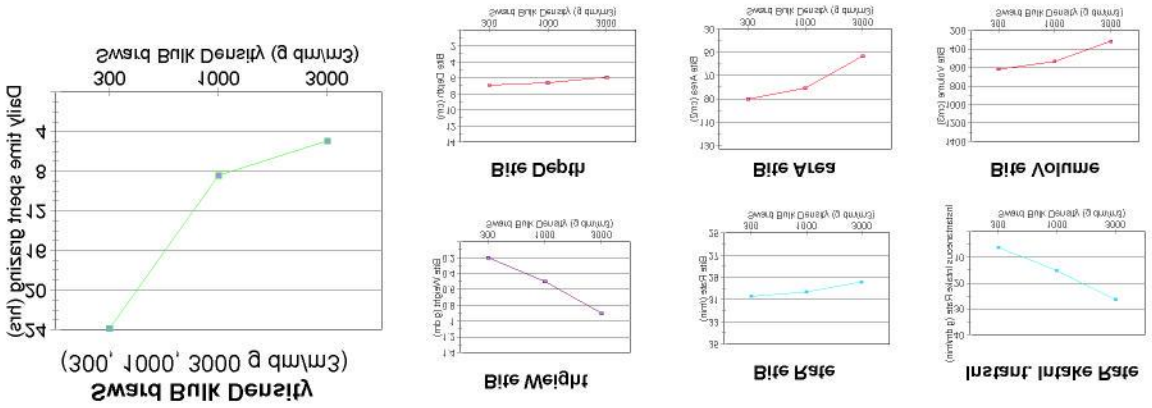

Fig 3. The relationship between sward bulk density and daily time spent grazing.

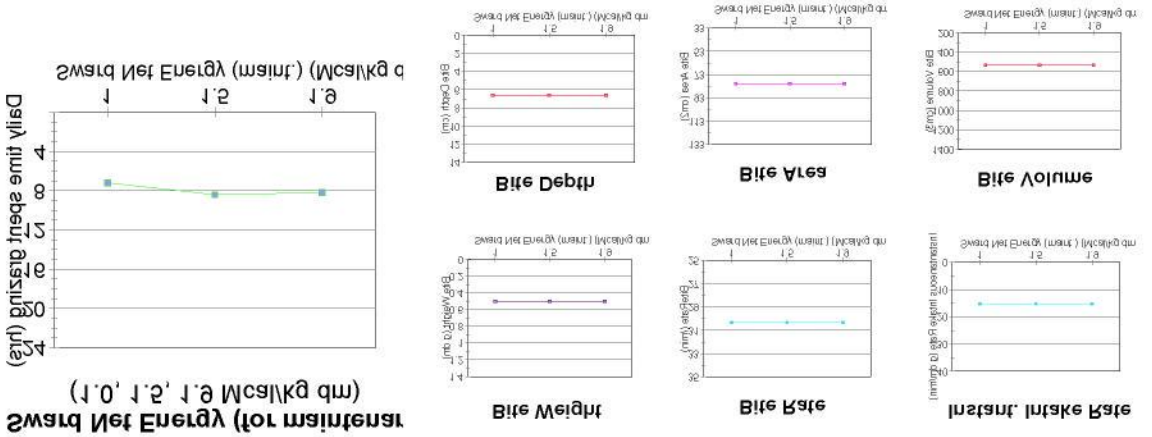

Fig 4. The relationship between sward net energy for maintenance and daily time spent grazing.