USE OF CONTROLLED RELEASE DEVICES AS A TECHNIQUE TO ESTIMATE PASTURE INTAKE BY GRAZING SHEEP

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INTRODUCTION

Feed intake by grazing sheep has an important effect on the productivity of a grazing enterprise. As a measurement, it can make a valuable contribution to investigations in animal nutrition and pasture utilisation as well as genetic evaluations. However, it is obviously not a simple parameter to measure directly.

Chromic oxide has been used for many years to estimate faecal output (and therefore feedintake) of grazing ruminants. Organic matter intake is calculated as :-

$$OMI = R \cdot (C \cdot (1\text{-}OMD))^{-1}$$

where

OMI = organic matter intake (g/d)
R = the amount of chromic oxide administered daily (ug/d)
C = concentration of chromic oxide in faeces (ug/g OM)
OMD = proportion of food organic matter digestibility

The most common method of administering chromic oxide has been twice daily in gelatin capsules for at least 10-12 days, including a 5 day sampling period. Thus it is very expensive in terms of labour costs and only practicable for relatively small numbers of animals. In addition, pulse dosing would increase variation in faecal chromic oxide concentration.

The recent availability (Ellis and Rodden 1987) of controlled release devices (CRDs) to deliver chromic oxide (Captec Chrome; Nufarm Ltd, Auckland) over 3 to 4 weeks, reduces many of the problems associated with gelatin capsules as well as increasing flexibility in sampling times and use of labour. It is now possible to produce estimates of faecal output (and hence feed intake) which are both precise and unbiassed for relatively large numbers of grazing sheep (Lee et al. 1988). To determine whether the technique is appropriate to a given situation will require a knowledge of the within- and between-animal components of variation.

WITHIN-ANIMAL VARIATION UNDER CONTROLLED FEEDING

Faecal chromic oxide levels will be influenced by feed intake and pattern of feeding (eg pulses in feeding). Feeding patterns of grazing sheep are not uniform (Lynch and Alexander 1973) and this is reflected in digesta flows, at least in the small intestine (Corbett and Pickering 1983).

The extent of diurnal variation in chromic oxide content of faeces when using Captec Chrome CRDs is important in determining the number of animals to sample, the number of samples collected per animal during a sampling period and possibly the time at which samples are collected. We conducted an experiment to determine the effects of feeding pattern on diurnal variation in faecal chromic oxide content under uniform feeding.

Fifty six individually penned sheep were fed one of six feeding patterns in each of two periods. These feeding patterns ranged from six meals at four hourly intervals to once daily feeding. The total food offered daily (600g/day of a 45% cracked wheat:50% lucerne chaff:5% cottonseed meal pellet) was the same for every animal and meal sizes were equal within each feeding pattern. This diet was fed for 13 days and the treatments for 7 days prior to sampling. All feed was consumed before the subsequent meal. Faecal grab samples were collected at 4 hourly intervals over 2 days in each period (days 6-8 and 16-18 respectively after the CRD was administered).

Table 1 Least square deviations (± s.e.) from the mean faecal chromic oxide level (1195± 7.6 ug/g OM) at each sampling time (within period 2) in sheep administered with a controlled release device

	Faecal chromic oxide (ug/g OM)					
Time:	10am	2pm	6pm	10pm	2am	6am
Day 1	-20 (23.7)	-6 (24.1)	119 (25.4)	-10 (27.9)	29 (25.1)	-134 (23.9)
Day 2	27 (24.6)	-77 (25.1)	-59 (25.7)	59 (24.6)	63 (26.8)	9 (23.9)

Faecal chromic oxide levels in grab samples taken during period 1 were low (mean 854± 6.5 ug/g OM) for the amount of food eaten, and increased throughout the collection period, indicating that the release rate of the the device had not stabilised and/or chromic oxide had not equilibrated in the digesta. Our analysis of diurnal trends and the effects of feeding pattern was therefore confined to samples collected in period 2 (mean 1195± 7.6 ug chromic oxide/g faecal OM).

There was a significant ($P<0.01$) day x time of day interaction on faecal chromic oxide levels (Table 1). However, differences between sampling times were not systematic as the trends across sampling times differed between days. Feeding pattern showed no interaction with sampling time, implying that the time at which samples are taken, regardless of the feeding pattern, is not critical.

Feeding pattern did have a significant ($P<0.01$) effect on faecal chromic oxide levels. Less frequently fed sheep had lower faecal chromic oxide levels, and hence higher faecal output than frequently fed sheep,indicating differences in digestibility possibly associated with ruminal outflow patterns. However, only 10% of the total variation in faecal chromic oxide levels was accounted for by feeding pattern and sampling time effects, resulting in a high repeatability across sampling times of 0.6.

WITHIN-ANIMAL VARIATION FOR GRAZING EWES

As part of a study to measure differences between Merino bloodlines in pasture intake of grazing ewes (described by Lee et al. 1988), faecal grab samples were collected from 300 ewes on 5 occasions over a period of 16 days in early pregnancy (6-11 weeks). The ewes grazed a mixed sward of irrigated pasture, including white clover and rye grass. Sampling commenced 6 days after CRDs were administered to each ewe. This was within the day 5-25 period recommended for faecal sampling by the manufacturers of Captec Chrome. The release rate used was that supplied with the CRDs.

As with the study of diurnal and feed pattern effects, the mean faecal chromic oxide level of grab samples taken on day 6 after CRD administration was much lower than that recorded on the other four occasions (Table 2), so subsequent analyses are based on the latter four samplings. Variation between sample days (within-animal) was relatively greater leading to a repeatability across sample days of only 0.35.

Table 2 Mean faecal chromic oxide level (±s.e.) at each sampling of grazing Merino ewes administered with a controlled release device

	Days after CRD administered				
	6	9	13	16	21
Faecal chromic oxide (ug/g OM)	573 (12.4)	846 (16.0)	724 (14.4)	802 (13.9)	772 (11.8)
n	272	253	258	256	265

BETWEEN-ANIMAL VARIATION FOR GRAZING EWES

The between-animal component alone represented 32.9% of total variance in faecal organic matter output, and flock differences were significant. However, flock differences were removed when faecal organic matter (FOM, g/day) was expressed per unit of liveweight. Between-animal variation still accounted for 34.1% of the variation, and the total model (also including age, flock, sire and sample day) had a coefficient of determination of 55%. When liveweight was included as a covariate in the model for FOM (unadjusted for size), the flock mean square was reduced by 40%.

At both the between-animal and between-flock levels, the effects of liveweight on faecal organic matter output were significant. The effects of ultrasonically determined fat depths on faecal organic matter output, were significant when the effects of liveweight were also considered. The relationship between fat depth and FOM was similar at the between-animal and between-flock levels (the regression coefficients being -24.0±4.62 and -19.7±7.62 g FOM/mm fat respectively), while the effects of liveweight were less between-animal than between flock (4.0±0.69 and 9.5±1.03 g FOM/kg respectively). The partial correlations between FOM and liveweight were 0.94 and 0.34, for the between-flock and between-animal levels respectively, and between FOM and fat depth were -0.602 and -0.31 respectively.

DISCUSSION

CRDs have potential to measure relative differences in intake between groups of animals. The large within-animal component of the variance (approximately 45%) would suggest that individual animal comparisons will not be precisely estimated. In this paper we have presented preliminary estimates of variance components for some environmental (within-ewe), phenotypic (between-ewe) and genetic (between-flock) sources of variation.

Implications for sampling

Within-animal variation includes real differences in intake between samplings, fluctuations in faecal chromic oxide levels, changes in rumen function and analytical errors. The data from grazing animals suggest large differences between samplings in the intake of individual ewes. Our experience suggests caution should be exercised concerning the timing of early samples. Because both studies reported here used CRDs from the same manufacturing batch, it is not possible to determine whether problems encountered with early samplings in the life of the device (around days 6-8) are a problem generally or peculiar to the batch.

Between-animal variation in grazing animals will include differences in digestive ability, variation in selected herbage consumed, differences between devices in release rate and true animal variation in appetite. The magnitude of variation in digestibility and selectivity relative to variation in actual intake is not known. Variation in digestibility by ruminants on the same feed has been observed (Hutton and Jury 1964; Dove et al. 1989). For example, among ewes grazing a phalaris pasture, the range of digestibilities for individual ewes was approximately 25% about the estimated mean (Dove et al. 1989). Most of this variation is probably related to rumen function, pattern of feeding, level of feeding and herbage selection. An analysis of naturally occurring plant alkanes in faeces would give some indication of the extent of between-animal variation in herbage selection (Mayes et al. 1986). The manufacturers of Captec Chrome indicate that a maximum coefficient of variation of 8% in chromic oxide release rate for a batch can be expected.

A balance is therefore required between the number of samples per animal and the number of animals per group in order to minimise the sampling variance between groups, whether the groups are sire families or flocks. Repeated measurements at time intervals over the life of the CRD are warranted, but within-day fluctuations are unlikely to be critical.

Genetic and phenotypic variation

Variation between Merino bloodlines in faecal output (and hence intake) were largely associated with variation in liveweight. At the phenotypic level, though, liveweight and ultrasonic fat depth, a probable indicator of body condition, were almost equally associated with variaion in faecal output, and hence pasture intake.

ACKNOWLEDGEMENT

This work is supported by the Australian Wool Corporation through a grant from the Wool Research and Development Fund. Captec Pty Ltd provided some of the labour costs associated with the animal house experiment.

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