Techniques Applicable to Grazing Intake Studies

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SUMMARY

TWO methods of estimating pasture intake from total faecal output are discussed. Dry matter indigestibility co-efficients (apparent) are useful where the range of inter-species digestibility is relatively narrow in any one seasonal period. A relationship between total faecal nitrogen excretion and dry matter intake is illustrated and the biological principles upon which this type of relationship depends are discussed. It is concluded that a number of separate regression relationships may improve the accuracy of the estimation.

Preliminary data from a grazing intake experiment at present in progress at Roseworthy is presented to illustrate these principles.

I. INTRODUCTION.

A sound assessment of the nutritional state of pasture fed animals is impossible in the absence of some knowledge of the nutrient intake derived from their grazing activities. The consideration of the composition of pasture alone is inadequate because it overlooks the animal's desire or capacity to ingest the material available.

There are major problems in animal production whose definition depends upon an assessment of grazing intake. These include the so-called "weaner problem", seasonal restrictions in beef cattle weight gains, milk production and wool production.

In most Australian environments there are wide seasonal differences in the productivity of grazed, unsupplemented animals and it can be inferred that seasonal differences in grazing intake must also be large. Thus although present methods are imperfect, it is considered that their use could provide important data.

Furthermore, the errors involved in different methods are by no means similar in type or extent, and it is considered that the design of experiments should include several methods which would permit comparisons of technique and a more reliable general estimate of grazing intake.

The most satisfactory group of methods involve the measurement of the faecal output of grazed animals and the subsequent application of an appropriate digestibility "constant" to estimate intake. This group of methods can be conveniently subdivided into techniques where total faecal collections are made using harnessed animals or, alternatively, where a marker technique (e.g., chromic oxide) is used to determine total faecal output indirectly. The second approach is useful for cattle where the quantity and physical state of the faeces makes collection and sampling difficult. It is considered that direct collections from the harnessed animal are preferable when using sheep.

The experimental plan which has been adopted in a grazing intake trial with sheep at Roseworthy is outlined. The limitations and underlying principles in the two methods chosen are discussed. Some preliminary data are used to illustrate these principles.

II. EXPERIMENTAL.

The two methods were based on total faecal collections from grazing animals together with either-

(i) The estimation and use of dry matter digestibility co-efficients for pasture cut from the grazing area; or

(ii) The development and use of suitable regression relationships involving total faecal nitrogen and intake.

Six Merino wethers were grazed on a typical Roseworthy pasture consisting of brome, barley and wimmera rye grasses, burr and barrel medics, and annual weeds, notably prickly jack. Consecutive six week grazing intervals were

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employed. During each period three three-day faecal collections were made at suitable intervals. At the same time, for a central 17 days of each period, digestibility trials were carried out, using three additional Merino wethers fed on material cut from this pasture. Between cage periods all sheep were grazed together. Seasonal changes in wool production were determined for each six-week period from mid-side tattooed patches.

In the initial period, faecal collections were made during ten consecutive days. A considerable reduction of grazing activity due to harnessing was implied from the decline in faecal output (Figure 1). To overcome this effect a shorter collection period of three days was introduced.

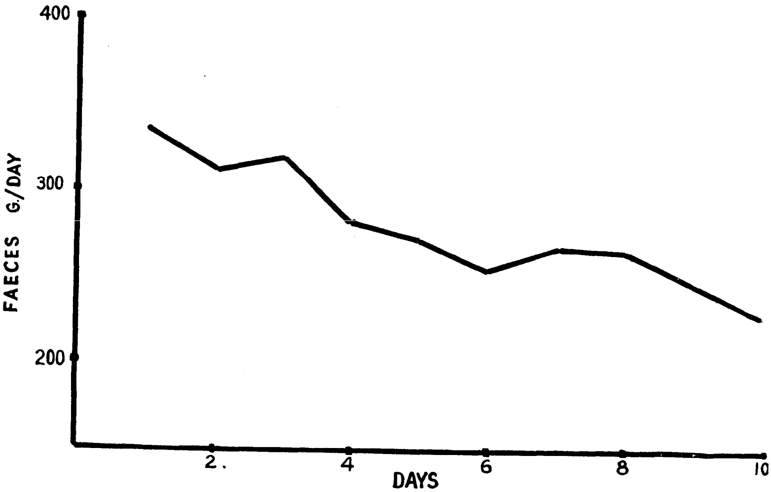

FIGURE 1: Showing the decline in faecal output (dry matter) of Merino wethers fitted with harness and bags, and grazing spring pasture at Roseworthy.

In the first method apparent dry matter digestibility co-efficients (A.D.M.D. %) were determined in metabolism cage experiments and intake estimated as follows:

$$\text{D.M intake of grazing animals} = \text{Faecal output of grazing animals (D.M.)} \times \frac{100}{(100 - \text{A.D.M.D. \%})}$$

The estimation of intake by the second method was based on a linear relationship between total faecal nitrogen and dry matter intake (see below).

III. RESULTS AND DISCUSSION.

(a) The Use of Apparent Dry Matter Digestibility %.

A serious limitation to the use of this method is that small errors in the estimation of the co-efficient will be enlarged because the per cent indigestibility (100 — A.D.M.D. %) is used in calculating intake. A second error arises because selectively grazed material may have a different A.D.M.D. % to that used in the calculation. However, this limitation is less serious if interspecies differences in A.D.M.D. % are small for any one season.

The Roseworthy pasture is based on annual species which in a strictly Mediterranean climate have a similar growing season with a very abrupt and complete maturation. Limited digestibility data on the components of meadow hay conserved from this type of pasture showed relatively small differences in A.D.M.D. %, e.g., 69, 57, and 66 per cent. for wimmera rye, barley grass, and medics respectively.

In a pasture based on perennial species, with a less clearly defined growing season, the limitations of this method would be considerably greater.

(b) The Relationship between Faecal Nitrogen and Dry Matter Intake.

Various relationships between faecal N and intake have been reported (Gallup and Briggs, 1948; Lancaster, 1949 a, b; Forbes, 1949; Homb and Brierem, 1952; Raymond, Kemp, Kemp, and Harris, 1954). Interest has centred upon the constancy of faecal N output per unit intake of dry matter or organic matter. This index is the regression co-efficient of any relationship involving total faecal N output as the dependent variate and intake as the independent variate. Two such relationships are illustrated in Figure 2.

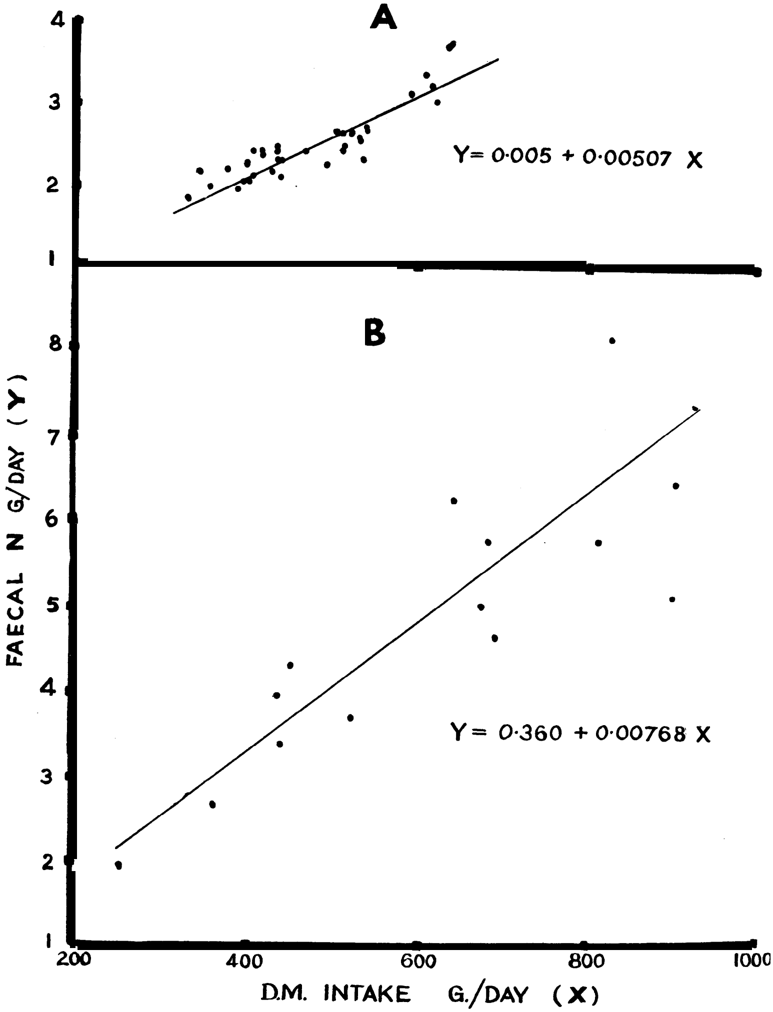

FIGURE 2a: Metabolism data for a series of wheaten hays and wheaten straw fed alone or with various supplements.
2b: Preliminary metabolism data for Roseworthy pasture (September-April).

The observed regression co-efficient of 0.507 g. faecal N per 100 g. D.M. intake agrees with observations by Gallup and Briggs (1948) on low grade hays. The index of 0.768 g. faecal N per 100 g. D.M. intake for pasture cut between September and April is in reasonable argreement with other published figures. It should be emphasised that an essential requirement for this technique is the initial development of regression equations based on metabolism data for the particular pasture to which they are to be applied.

Biologically the linear relationship is to be expected for **any one feed,** as it only implies that the apparent digestion co-efficient for N is constant at varying levels of intake. However, the above relationship has been shown to be adequate for a range of diets.

As a biological fraction, total faecal nitrogen represents the intractible nitrogen arising from or attributable to the diet and, in particular, the nitrogen intake. Thus it is best expressed as the product of N intake and the **apparent** N indigestibility. Nitrogen of metabolic origin is included in the latter term. The relationship can be further broken down to:

$$\text{Total faecal N} = \text{Total intake} \times \frac{\%\ \text{N in feed}}{100} \times \frac{\text{Apparent indigestibility of N}}{100}$$

The adequacy of any general relationship for different feeds at the **same level of intake** depends upon the constancy of the product;

$\%$ N in feed $\times$ Apparent N indigestibility $=$ k.

Furthermore, the increment in faecal nitrogen output per unit intake depends upon the constancy of this product.

The observation (e.g., Figure 2) that the relationship does hold for a series of feeds has its origin in the association of high nitrogen level with high digestibility (or low indigestibility) for nitrogen. On the other hand, various authors have reported that the faecal N index (regression co-efficient) increased directly with the nitrogen content of the diet (Lancaster, 1949 a; Homb and Brierem, 1952; Gallup and Briggs, 1948). Most of these relationships have been recorded for a series of feedstuffs characterized by a narrow range in digestibilities but a wide range in protein contents. Under these conditions the value of k. increases with feeds of higher nitrogen content.

Forbes (1949) records the opposite effect with blue grass fed to steers. In this case the material was collected over the reproductive stage where changes in digestibility are large, in comparison with change in total N content. Hence the k. values increased as the nitrogen content declined. A similar effect was observed in preliminary Roseworthy data. It would appear that any such trend which may be observed is explained by the relative rates of change in nitrogen content as opposed to apparent nitrogen digestibility.

With a clearer understanding of the issues involved, it is hoped that accurate regression relationships can be derived which will improve estimates of grazing intake by this method. If the values for the product 'k'. vary greatly between seasons within the pasture year, greater accuracy might be achieved by the development and use of separate seasonal regression relationships,

It'. REFERENCES

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DISCUSSION

Mr. MILFORD: We have been doing similar work at Lawes, Queensland, for Tropical and Sub-Tropical pasture species. We have found that the relationship between dry matter intake and total faecal N output is highly significant for individual grasses fed at all stages of growth and maturity (crude protein levels varying from 2 % -15 %). Furthermore, the individual regressions were statistically similar.

Has Mr. Hutchinson tried any other techniques for measuring pasture forage digestibility?

ANS.: No.

Mr. MOULE: Considerable difficulty has been encountered in applying Lancaster's faecal nitrogen relationship to sheep grazing pastures at the Toorak Field Station, Julia Creek, North Queensland, where growing seasons are short.

ANS.: It seems essential to examine the faecal N relationship for the pasture being studied by conducting digestibility trials.

Miss TURNER: Do you think that separate seasonal relationships would have. a greater field application than the general one?

ANS.: Yes. By restricting the range of pasture change considered there should be less deviation observed from the regression. This approach, however, could only be used in areas with a clearly defined pasture year.

Mr. DAVIES: What allowance has been made for metabolic faecal nitrogen?

ANS.: The varying amounts of this fraction are included in the expression of **apparent** nitrogen digestibility.

Mr. MILFORD: We have found that the regression holds for grasses ranging from 2% to 10% crude protein. Have you any comment?

ANS.: Possibly under your conditions change in apparent N digestibility is more closely related to decreasing protein level than it is in the South Australian climate which brings about a rapid maturation.

Dr. REID: Methods with general application are required. When dealing with pastures containing one dominant species, estimates of intake can be up to 30 per cent. in error. In this respect, Raymond's and Lancaster's formulae may give widely differing estimates for certain pastures. With the degree of selective grazing for which sheep are noted on Australian natural pastures it is often impossible to obtain a true sample of what they are actually eating.

ANS.: I agree that selectivity is a problem, especially where there are widely differing species in a pasture.

Mr. SOUTHCOTT: (a) Is it necessary to empty faecal bags twice daily? (b) Is there any reason for the decline in faecal output due to the harness?

ANS.: (a) Sometimes the bags have to be emptied twice daily, but usually only once. (b) It could not have been a change in digestibility in this case since the latter was declining. Thus it could only have been an indication of the restrictive effect of the harness upon normal grazing activity.

Prof. McCLYMONT: What type of pasture was being grazed when faecal output declined so markedly?

ANS.: The sheep were grazing spring pasture.

Mr. WESTON: We have harnessed sheep for long periods at Prospect with no ill effects after an initial "settling-in" period of six weeks. Over a seven month period faecal output did not vary beyond the range of 12-1,400 g. per day, though consideration must be given to faecal water.