Method of Measurement of Feed Consumption

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Introduction:

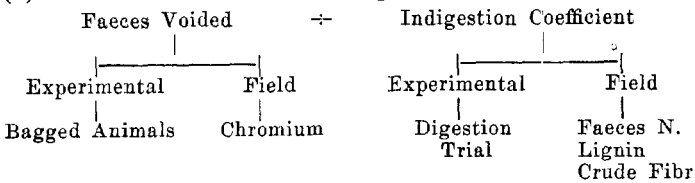
Methods we have used for estimating the feed consumption of animals are conveniently illustrated in the following layout:—

(Table 1).

Intake Methods.

(1) Direct—Groups only.
Frames.

(2) Indirect—Individuals or Groups



Methods used for the calculation of intake are classified under either (1) direct, or (2) the indirect, approach.

1. Direct Method:

Using moveable frames or cages a number of these covering a known area are randomly placed in the paddock before grazing. After grazing, the pasture protected by each frame is clipped down to the level of the surrounding grazed herbage. From the quantity of dry matter so removed, intake can be estimated. This method is applicable to a number of animals under natural grazing but provides an estimate of their average intakes only.

(2) Indirect Methods:

This implies an estimate of (a) the quantity of faeces voided by each cow and (b) the indigestibility of the feed consumed. The faeces excreted can be accurately determined by equipping the grazing animal with collection harness, an experimental approach suited to small numbers but impractical for measuring the faeces output of every cow in a normal sized herd under natural conditions. The first paper in this series dealt with the development of the use of chromium for estimating individual faeces outputs, designed here as a field method, because it can be applied extensively to the grazing cow. Outputs of faeces estimated from the chromium method were compared with the weighed outputs collected in bags.

The second paper discussed the development of a method applicable on a field scale to estimating indigestibility based on the nitrogen content of the faeces. This method considerably simplifies determinations of the indigestion coefficient as the experimental approach entails the tedious and time consuming digestibility trial procedure.

Thus there are two ways of estimating the amounts of faeces voided and two ways of estimating indigestibility, hence intake can be estimated by four possible combinations.

Since the aim of this work is to be able to estimate the individual intakes of a herd of cows, our main interest is the application of the practical field methods for the estimation of both faeces excreted and indigestibility.

This paper presents the results of two experiments in which intake was calculated by both the direct and indirect approach. Experiment 1 was carried out with three dry cows on an intensive field scale and Experiment 2 with a herd of 32 milking cows on an extensive field basis.

Experiment 1:

The object of this experiment was to measure the intake of three dry cows by three different methods.

Experimental Procedure

Three dry non-pregnant dairy cows were grazed on autumn saved pasture for a period of forty days. They were given a new break of approximately 1-10th of an acre each morning. Prior to their entering the break, ten frames, each covering approximately 1-1000th part of an acre were randomly placed throughout the grazing area. The following morning the pasture protected by the frames was manually clipped and plucked to simulate the condition of the surrounding grazed herbage.

The amount of pasture so collected was used to estimate the quantity consumed by the cows. The pasture cut from the frames was also fed to metabolism sheep to determine its digestibility.

Throughout the trial each cow was equipped with harness in order to determine the amounts of faeces actually voided. Throughout the trial also, each cow was dosed with chromium morning and evening. At the same time faeces samples were secured directly from the rectum. These samples were subsampled and the subsamples bulked over five-day periods. From the concentration of chromium in the bulked samples an estimate was made of the faeces voided by each cow. Likewise, from the concentration of nitrogen in the bulked samples, an estimate was made of the digestibility of the material grazed by the cows.

From the data so collected three estimates have been made of the level of intake of the cows during each of the eight five-day periods into which the trial was subdivided. Firstly a direct estimate provided by the frame cutting technique; secondly, an indirect estimate calculated from (a) the amount of faeces voided as weighed out of the bags, and (b) the digestibility of the pasture as fed to the sheep. And thirdly, a further indirect method calculated from (a) the amount of faeces voided as estimated by the chromium method, and (b) the digestibility of the pasture as estimated by the nitrogen method.

The second method, which involves bagging of the cows, has very restricted application in practice, whereas the third method, which involves little disturbance to the normal grazing or milking shed routine, is the procedure which we hope may prove suitable to extensive application in nutrition studies.

Experimental Results

DIGESTIBILITY MEASUREMENTS

(Table 2)

Dry Matter Digestion Coefficient %

5-day Periods	Sheep	Faeces N
1	—	68.6
2	72.3	71.7
3	79.9	73.0
4	73.4	73.2
5	73.5	73.4
6	76.1	73.7
7	77.6	74.3
8	76.9	75.0

The above Table shows the average digestibility of dry matter as determined by feeding the frame-cut pasture to two sheep and also by calculation from the faeces nitrogen of the three cows grazing similar pasture. No comparable sheep figure is available for the first period as the frame -cut pasture for the first five days was used as the feeding preperiod for the sheep digestion trials.

Considering that the periods are only of five days duration, there is reasonably good agreement between the two independent methods except for period 3. The high figure of 79.9% is inexplicable as both sheep were in excellent agreement and the pasture was of reasonably uniform composition throughout the experiment.

Table 3 shows the corresponding indigestion coefficients by the two methods.

(Table 3)

Dry Matter

Indigestion Coefficient %.

5-day Periods.	Sheep.	Faeces "N"	% Difference.
1	—	31.4	—
2	27.7	28.3	2.2
3	20.1	27.0	34.3
4	26.6	26.8	0.8
5	26.5	26.6	0.4
6	23.9	26.3	10.0
7	22.4	25.7	14.7
8	23.1	25.0	8.2

These indigestibility figures are simply obtained by subtracting the digestibility % from 100. By percentage difference is meant the difference in intake on a percentage basis, which would result if intake were calculated from the two series of indigestibility figures. Thus in period six a difference in indigestibility by the two methods of 2.4% results in a difference in intake of 10.0%. Therefore, very accurate estimates of indigestibility are required before converting faeces outputs to an intake basis.

Faeces Output Measurements.

Faeces outputs estimated by the chromium method were included in the data of experiment 4, as presented in Mr. Coup's paper.

INTAKE MEASUREMENTS

(Table 4)

Dry Matter Intake

(Average 3 Cows)

5-day Period.	Frames.	Bagged Cow/Sheep.	Cr/N.
1	8.3	15.6	13.9
2	11.6	14.1	15.4
3	13.9	24.3	17.5
4	16.0	17.9	17.1
5	19.6	19.9	19.3
6	21.0	20.3	19.6
7	22.9	22.6	20.4
8	24.6	22.2	21.1

Table 4 presents average intake estimates by the three methods in pounds of dry matter consumed daily.

1. Using frames.
2. Faeces collected quantitatively in bags and indigestibility determined by feeding the frame cut pasture to sheep.
3. Faeces voided estimated by chromium, and indigestibility estimated from the nitrogen content of the cow's faeces.

After period 3, the results obtained by the three methods are in good agreement. Period 1 at least can be considered as a settling down period. The high figure of 24.3 in the third 5-day period results from the high digestibility figure with sheep as previously noted. For uniform pasture conditions one could also expect the efficiency of sampling the sward by the operator to increase with succeeding five-day periods.

It is to be noted that, in general, one would expect under-estimation of intake by the frame method to be associated with over-estimation of intake by the bagged cow/sheep method. Under-estimation of intake with the frames would probably result in a higher leaf to stem ratio of the plucked material. Such leafier material would be more digestible than the pasture the cows were actually eating and therefore an estimate using sheep digestion figures would over-estimate intake.

In this experiment approximately 12% of the day's grazing was enclosed by frames—a much greater concentration than could ever be used in field practice. The chromium/nitrogen results in this experiment were of sufficient merit to warrant more extensive use. This was undertaken in the next experiment.

Experiment 2.

The object of this experiment was to measure the intake of a herd of cows by three different methods and to assess these levels of intake in relation to the requirements of the herd as calculated from feeding standards.

Experimental Procedure.

A dairy herd of sixteen sets of identical twin cows, the majority first calvers, were rotationally grazed around 19 paddocks, each of approximately 1.5 acres.

Each day prior to the herd entering a new paddock, eight frames were randomly placed throughout the grazing area. These were cut the following morning to estimate the average consumption of pasture by the herd.

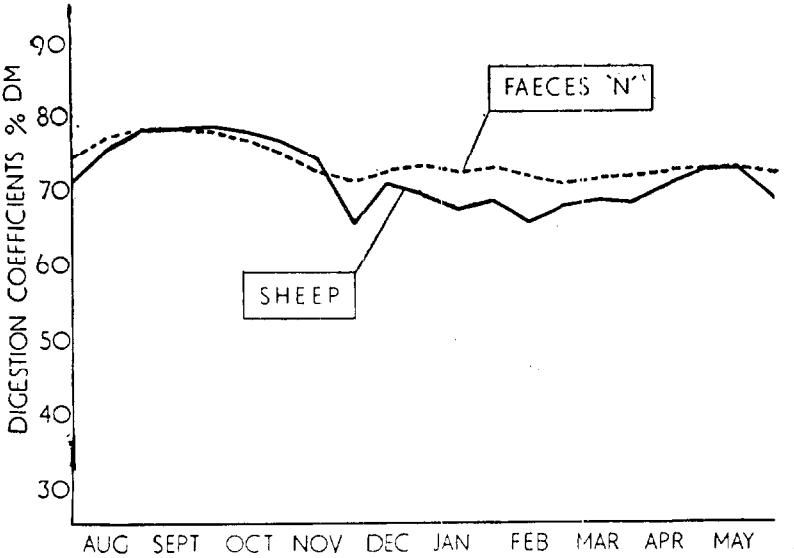
The pasture obtained from the frames was fed to stalled wethers to determine its digestibility over fortnightly periods.

Commencing four days post-calving and continuing throughout the season, each cow was fed ten grams of chromium after the morning and evening milkings. At the same time, samples comprising ½-1 lb. of faeces were obtained directly from the rectum of each cow. These grab samples were sub-sampled and the sub-samples were bulked over fourteen day periods by the procedure already described by Mr. Coup. The concentration of chromium in these samples was determined and used to estimate the amount of faeces voided by each cow. The concentration of nitrogen in these same samples was also determined and used to estimate the digestibility of the material eaten by each of the cows.

Experimental Results.

DIGESTIBILITY MEASUREMENTS.

(Figure 1)



In Figure 1 determinations of dry matter digestion coefficients by feeding cut pasture to sheep are compared with estimates based on the nitrogen content of the faeces of the cows grazing similar herbage. From August until February the eight frames provided sufficient grass to feed two wethers, thereafter, due to reduced pasture growth, the sheep estimates are based on only on animal. Digestibility estimates, as determined by the faeces nitrogen method, represent the mean digestion coefficient of 32 cows for each fortnight.

During the spring and autumn growth periods, similar estimates are obtained by the two methods. During the summer growth period from mid-December to mid-March, the faeces "N" method yielded considerably higher estimates. The maximum difference of 6.5 digestibility units appeared in February, which results in a 20% difference when applied to intake.

The following points are of interest in any interpretation of the accuracy of either method:—

(1) The samples of pasture as fed to sheep may not represent the type of pasture the cows are selecting: Qualitative sampling of pasture by the frame method is relatively more difficult during the summer than the spring or autumn periods due to the variable condition of the sward and the presence of seedhead and dead grass.

(2) Under the warmer summer conditions, some loss of the more soluble constituents of pasture occurs in the interval between the time the pasture is sampled and the time that all the grass is consumed by the sheep. Each of these factors would cause a lowering of digestibility as determined by the sheep method.

(3) The regression equation for estimating digestibility by faeces "N" is based on very little data derived from cow digestibility trials conducted during the summer growth period with a mixed pasture sward. The range in digestibility at this time of the year, however, has been covered with paspalum digestibility trials with cows and the resultant

regression employed for calculating digestibility is comparable with the regression as used throughout the season.

The two methods also indicate the seasonal variation in pasture quality.

Faeces Output Measurements (Figure 2).

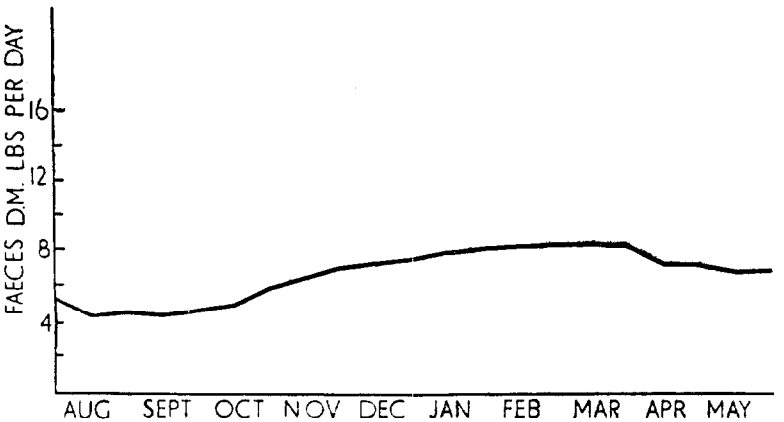


Figure 2 shows the seasonal trend in faeces output in pounds of dry matter per cow per day, as estimated by the chromium method. The quantity of faeces voided, steadily increases from calving and is at a maximum during February and March.

Intake Measurements (Figure 3).

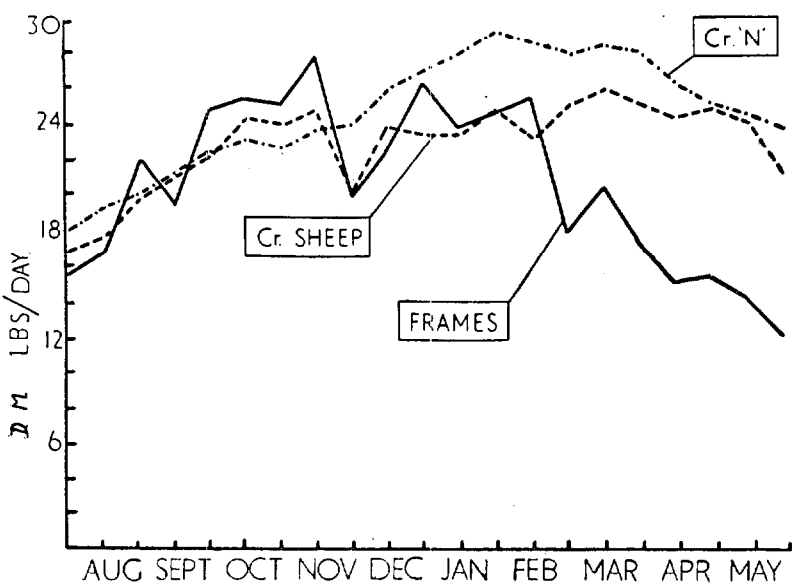


Figure 3 shows the intake of dry matter in pounds per cow per day as calculated by:—

(1) Frame Method.

(2) Faeces by chromium and digestibility by sheep.

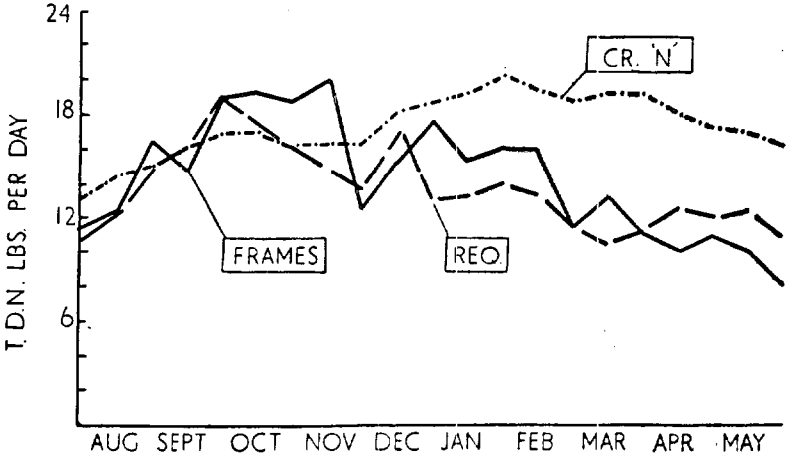
(3) Faeces by chromium and digestibility by nitrogen.

Differences in intake by the Cr./sheep and the Cr./"N" method are entirely due to the previously mentioned differences in digestibility as estimated by the sheep and the nitrogen method. From August to December the three methods show similar trends in intake estimates.

With the frame method peak consumption occurred in the spring months of October-November, whereas with the Cr./"N" method intake reached its maximum in January. During February and March, intake by the Cr./"N" method remains at a high level, which is in marked contrast to the falling level of intake as measured by the frame method. Discrepancies between the two methods are at a maximum at the end of the season when estimates of consumption by the Cr./"N" method are approximately double the estimates of consumption by the frame method.

The area sampled by the frames represented only .5% of the daily grazing area.

(Figure 4)



In Figure 4, estimates of intake by the frame method and the Cr./"N" method have been converted from a dry matter to a total digestible nutrient basis. The theoretical feed requirements of the herd are calculated from the Morrison feeding standard in which the following standards are adopted.

Maintenance	8 lb. T.D.N. per 1000 lb. live weight.
Milk Production	.32 T.D.N. per lb. of 4.0% fat corrected milk (F.C.M.)
Weight Gain	3.53 T.D.N. per lb. gain in live weight.
Weight Loss	2.73 T.D.N. released for each lb. loss in weight.

On the whole, the herd requirements are more in common with the frame estimates of intake. From the end of December the two methods of calculating intake have given very different results.

Over the productive season the frame method over-estimated theoretical herd requirements by 4%, whereas the Cr./"N" method over-estimated total digestible nutrient requirements by 26%. Finally it is obvious that a rather interesting situation has arisen.

The frame method is a subjective method of measuring intake. It is a method in which the nature and magnitude of its errors cannot be readily ascertained. For this reason it is conceivable that erroneous estimates may be made at all, or at particular times, of the year. Yet it has produced a set of intake figures much more in line with commonly accepted theoretical requirements than has the more objective chromium/nitrogen method.

All the experimental evidence that we have suggests that the errors involved in measuring faeces output by chromium and in measuring digestibility by nitrogen are unlikely to have been sufficiently large to account for the appreciable differences between the two sets of intake figures.