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ESTIMATION OF HERBAGE MASS IN RYEGRASS/WHITE CLOVER DAIRY PASTURES

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Abstract

The pasture probe, rising plate meter (RPM), sward height and visual assessment methods were compared for the estimation of the herbage mass of dairy pastures. The pasture probe and calibrated visual assessment were slightly more accurate than others. Visual assessment without calibration was less accurate than all other methods. There was little difference between operators of the pasture probe and RPM, but operator variation was large with visual assessment.

Variation between calibrations from different days, seasons, and sites was large. Only dead material content was identified to influence this variation. Pooling of calibrations, double sampling procedures, and derivation of different calibration slopes for each day from an equation fitted lo calibration data are procedures discussed for the estimation of herbage mass by farmers, advisors and researchers. Wide adoption of methods such as the pasture probe or RPM with "universal" calibrations could reduce inconsistent advice offered to farmers, and can be used with confidence.

Keywords: capacitance probe, rising plate meter, visual assessment, sward height, grassland management, pasture composition, pasture assessment.

INTRODUCTION

In grassland research and farming, pasture herbage mass is measured for the derivation of herbage accumulation, allowance, consumption and for measurement and prediction of animal performance (Frame 1981). Herbage mass can be measured directly by cutting, but this is labour intensive and often costly (Thomson 1983). As a consequence, methods have been developed based on the double sampling procedure, whereby the results obtained from a small area by cutting are used to predict values derived indirectly from larger areas (Vilm et al. 1944). In this paper four such methods were compared: the New Zealand electronic pasture probe (Crosbie et *al.* 1987), Ellinbank rising plate meter (Earle & McGowan 1979), sward height and visual assessment.

A strong linear relationship has been found with individual methods and herbage mass for a given pasture on a particular day. These relationships or calibrations, however, can be influenced by factors such as dead herbage (Currie *et al.* 1973), herbage dry matter content (Jones & Haydock 1970), pasture species (Stockdale 1984) (Crosbie et *al.* 1987), and sward compaction through trampling and lodging (Campbell et *a/.* 1962). As a result, the calibrations used to derive herbage mass have been found to vary widely between days at a particular site (Stockdale 1964). This paper compares the methods for the estimation of herbage mass and examines variation between and within calibrations.

MATERIALS AND METHODS

The experiments were conducted at the Ruakura Dairy Research Centre, Hamilton and the Taranaki Research Station, Normanby. Pastures were perennial ryegrass (*Lolium perenne* L.)/white clover (*Trifolium repens* L.) dominant and had been intensively stocked (254.0 cows/ha) with dairy cattle over the past 5 years.

Measurements and procedures

The influence of operator, meter repeatability, season and site on the estimate of herbage mass was examined. The experimental details of the three independent studies are in Table 1.

Table 1: Summary of experimental details for each of four variables examined.

	Variables		
	operator	Repeatability throughout the day	Season and site
Date	15 & 21-10-84	15-10-84 & 6-4-85	4-10-85 to 3-3-87
Procedures	Calibrations derived for each operator on 2 dates	Calibrations derived on 2 dates at 6 times throughout each day	A calibration derived every 7-14 day at each site over 2-2½ years
Methods	Probe, RPM, visual	Probe. RPM	All methods
Number of variables	5 Operators (3 for visual)	2 climatically contrasting days	9 seasons 2 sites (Ruakura, Taranaki)
Measurements	Herbage mass herbage mass	Herbage mass, green and morphological composition	Herbage mass, botanical
Number of calibrations	16	36	220
Number of Quadrat cuts	160	288	2604

The field procedures used were common across studies. Each study was made up of a number of calibrations and each calibration was made up of 6-15, 0.25 m^2 quadrat cuts. These quadrat areas were selected to cover the range in herbage mass likely to be experienced at the time under dairy cow grazing (i.e. winter, 500-3000 kg DM/ha; summer, 1500-4000 kg DM/ha). Each quadrat area was measured in sequence starting with the probe (10 readings/quadrat), followed by the RPM (two readings/quadrat), height (20 readings/quadrat) and visual assessment (one reading/quadrat). Herbage within the quadrat was then cut to ground level with an electric shearing handpiece, collected, subsampled for dissection (depending on the study) washed, dried (100°C for 36-46 hours) and weighed.

Data analysis

Regression analysis was used to derive an equation for each calibration. The closeness of fit of the calibration equation to the actual data points was determined (residual standard deviation, RSD) and used as a measure of accuracy of the methods to estimate herbage mass.

RESULTS AND DISCUSSION

Comparison of methods

The pasture probe and calibrated visual assessment were slightly more accurate than either the RPM or sward height, although the differences between methods were small (Table 2). The wide range in RSD indicates that the variation in accuracy amongst individual calibrations was large. Errors due to the operator of the cutting equipment may have contributed to this large variation in accuracy amongst calibrations (Smeaton & Winn 1981).

Choice of a method for herbage mass estimation should be based more on factors such as cost, convenience and personal preference rather than differences between methods in accuracy. For example the pasture probe converts meter readings to kg DM/ha automatically, but visual assessment is faster in the field than other methods. Sward height measurements with a ruler can be time consuming and a "back breaking" task.

Table 2: Comparison of accuracy of pasture probe, rising plate meter, sward height and visual assessment.

	Correlation coefficient		Residual standard deviation		Coefficient of variation
	mean	range	mean	range	
Pasture probe	0.86	0.81-0.99	390	286-590	13
Rising plate meter	0.84	0.81-0.95	410	311-610	14
Sward height	0.81	0.75-0.94	415	340-655	16
Visual assessment	0.82	0.77-0.94	395	320-515	13

Meter repeatability throughout the day

Both the pasture probe and RPM were found to be repeatable throughout the day on a fine day without early morning dew. However, if weather conditions changed throughout the day (i.e. rainy or dewy morning, fine later) repeatability throughout the day was low (Fig. 1). Both the pasture probe and to a lesser extent the RPM overestimated high herbage masses (3000-5000 kg DM/ha) when the pasture was wet (Fig. 1). The use of calibrations appropriate to climatic and pasture conditions significantly reduced this effect. Thus in wet conditions a calibration derived for wet pasture or the winter calibrations should be used to convert meter readings to herbage mass (kg DM/ha).

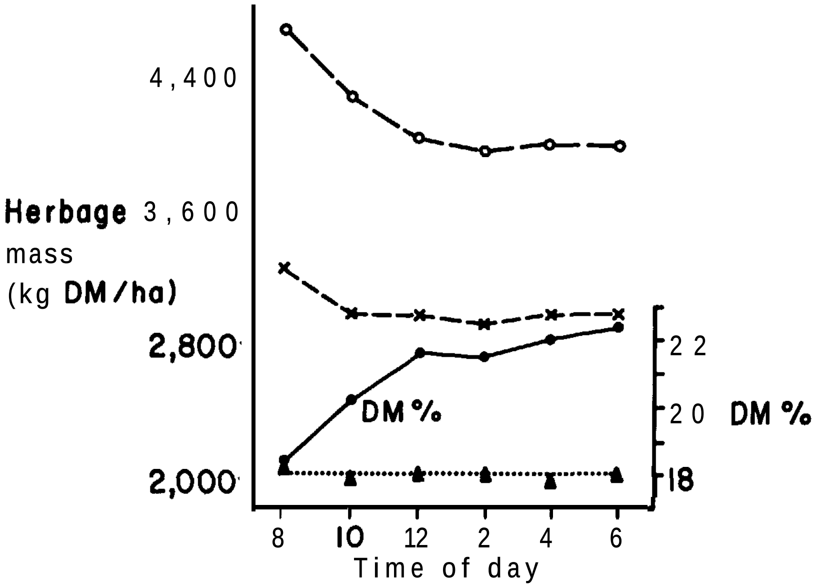

Figure 1: Change in herbage mass (HM) throughout the day (wet morning, fine later) for each of three levels of HM and mean dry matter content of herbage (•—•). Mean of probe and RPM methods.

Operator

Little difference was found between calibrations for different users of both the probe and RPM when the correct procedures were followed. Thus if an inexperienced operator held the meter in an upright position and cleaned and checked the meters regularly including waxing the probe, the results are likely to be similar to values obtained by an experienced operator.

In contrast, operator had some effect on the accuracy (measured by RSD) of herbage mass estimations by visual assessment (Table 3). Differences between operators using visual assessment were particularly large without calibration (RSD of 767 vs 398 without and with calibration respectively). Similarly, visual assessment in pastures containing species unfamiliar to the operators can introduce large errors (Thomson 1986).

Season and site

There was a large variation in calibrations between and within seasons (illustrated by probe calibration slopes, corrected for varying intercepts, Fig. 2). Dead material content or mass was the only factor which had any effect on calibration variation (ranged from 0.04-0.12). This suggested that green herbage mass was a more "measureable" component

Table 3: Seasonal calibration equations for pasture probe, rising plate meter and sward height.

	Pasture probe	RPM	Sward height
Winter-early spring (before stem growth)	9.9 CMR + 600†	125 CMR + 640	120 CMR + 590
Late spring-early summer (during stem growth)	9.5 CMR + 1200	130 CMR + 990	70 CMR + 1340
Mid summer	13.6 CMR + 1240	165 CMR + 1460	172 CMR + 1340
Early autumn (before autumn rain)	12.7 CMR + 1020	159CMR + 1180	195 CMR + 610
Late autumn (after rain)	10.4 CMR + 990	157 CMR + 970	300CMR + 400

† For example kg DM/ha = 9.9 X corrected meter reading (CMR) + 600.

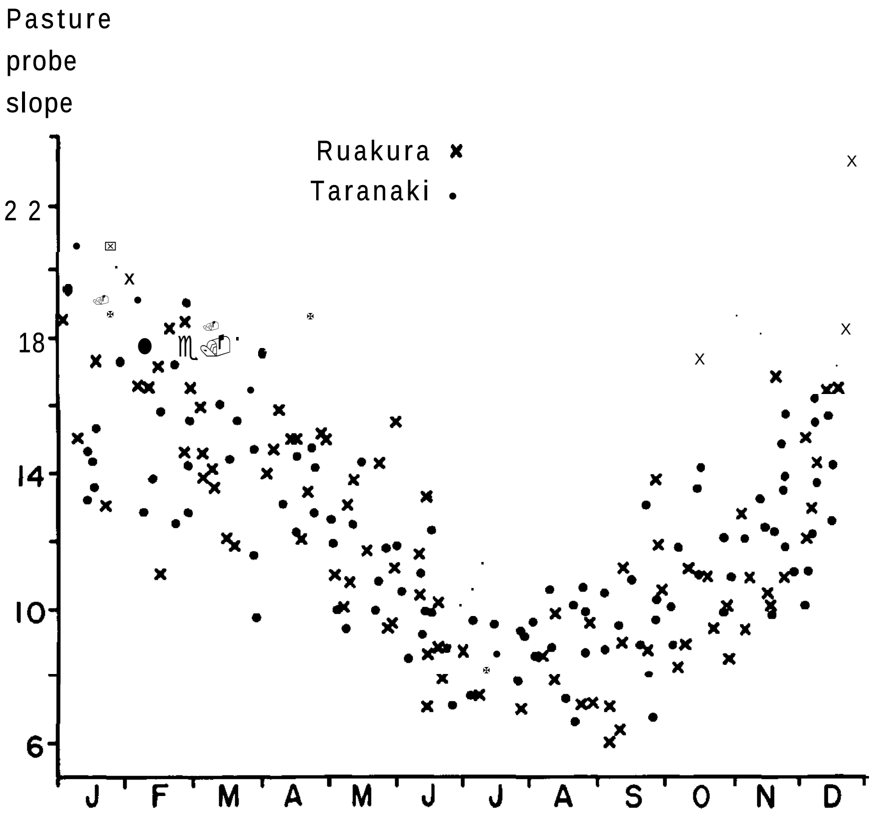

Figure 2: Corrected slopes for pasture probe calibrations for Ruakura (•) and Taranaki (x) during the year. All slopes corrected for a common intercept.

by methods such as the probe, RPM and height, than total herbage mass. Green herbage mass may also be more closely related to animal performance, Factors such as soil surface moisture and/or climate (temperature and humidity) may have some influence on variation among calibrations.

A distinct seasonal pattern was found with the calibration slopes (Fig. 2), and variation among calibrations within a season was least during winter-early spring and greatest during summer and autumn. Pooling these data into seasonal calibrations is necessary to make the methods applicable to dairy farmers and their advisors (Stockdale 1984). In this study, on the basis of minimising the increase in RSD from pooling the data, five seasonal calibrations were identified (RSD: 402 vs 497 for individual and pooled calibrations respectively). Similarly, comparison of calibrations within sites and pooled across sites showed that RSD values were increased also. Most of the variation observed between sites in this study is likely to be due to the different operators of the cutting equipment at each site (Smeaton & Winn 1983). Differences in actual calibration equations between sites were greatest during summer, possibly reflecting some differences also in dead material content in pastures.

An attempt was made to overcome the large decrease in accuracy through pooling by using more calibrations for a given time period. A method was developed whereby an equation was fitted to the data in Fig. 2 so that a slope could be calculated for any day of the year. This slope, together with a constant intercept, then forms the calibration (equation available upon request). This procedure has the advantage that the calibration changes gradually throughout a season in a similar fashion to the original data (Fig. 2) and is thus slightly more accurate than seasonal calibrations (RSD: 462 vs 497 respectively). This method, however, involves more calculations to derive the calibration equations. Seasonal calibration equations for the pasture probe, RPM and sward height are presented in Table 3 and are recommended for on-farm estimation of herbage mass in ryegrass/white clover dairy pastures.

For research purposes double sampling procedures as described by Jones & Haydock (1970) are likely to be more accurate, although often are more labour intensive. Similarly the pooling of calibrations over shorter periods (i.e. l-2 regrowth periods) and/or the use of a “rolling pool” of calibrations may also improve accuracy for research purposes. Where herbage accumulation is to be calculated a “rolling pool” of calibrations covering each regrowth period eliminates any differences between calibrations derived from the separate post and pre-grazing measurements.

CONCLUSIONS

In recent years there had been considerable variation in recommendations to farmers about residual grazing levels for high animal performance. This in part reflected differences in the methods used to estimate herbage mass, and variation in levels of herbage cutting height to which calibration quadrats are cut. Methods such as the pasture probe and RPM can eliminate much of the operator variation associated with visual assessent. Further, by pooling calibrations among research centres, such as in this study, “universal” calibrations can be derived. Thus both operator and cutter error can be reduced. This study shows that the RPM and more particularly the pasture probe reliably and accurately estimate herbage mass of ryegrass/white clover dairy pastures at Ruakura and Taranaki. Piggot (1986) concluded they were also accurate in Northland. Commercially available pasture probes have the additional advantage that conversion of meter readings to kg DM/ha is automatic. Pasture probes, as result of this automation, can also be readily operated by farmers without the need for associated resources. Adoption of these methods may be a means by which variation in advice offered to farmers can be reduced.

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