ERRORS ASSOCIATED WITH HERBAGE DISSECTION ANALYSES

1. A Survey of Errors in Subsampling Plots in the Field

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Abstract

Errors in field subsampling of pasture plots for herbage dissection are presented from nine different sites. There were marked site differences in error level. Two different basic methods of sampling were employed at the sites included in the survey. Subsamples were either taken from a mown herbage sample or were cut to ground level with a motorized shearing machine from the uncut plot areas following mower cuts. Standard error was compatible with an approximate parabolic relationship with percentage herbage dissection values and was symmetrical about 50%. Percentage errors associated with herbage components constituting up to 5% of the sample were unacceptably large.

INTRODUCTION

HEKBAGE DISSECTION (HD) analysis consists of the hand separation of a pasture sample into its component species or 'convenient groups of species and the drying and weighing of each component. This is done to estimate the, dry matter (DM) production of a species or group of species from an experimental pasture. Herbage dissection analyses are second only to dry matte? analyses in numbers handled by the various botanical servicing laboratories in New Zealand and they are probably the most time consuming.

In recent years, studies have been conducted in the botanical services laboratories associated with Ministry of Agriculture and Fisheries research centres at Ruakura, Palmerston North, Winchmore, and Invermay, and DSIR Grasslands Division at Palmerston North, in order to measure the errors associated with sampling techniques for herbage dissection analysis. Variation is likely to be introduced in field sampling, subsampling in the

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laboratory, and in the actual dissection analysis. This paper reports a survey of the errors associated with field subsampling of herbage for HD analysis. A second paper in the series (Ritchie et al., 1978) is concerned with the errors associated with plant identification, while laboratory subsampling errors were considered by Ritchie and Dyson (1977).

Field sampling for HD analysis of pasture is usually done in the following ways:

(1) A sample taken from mown herbage — i.e., from the catcher of a mower or from herbage raked up following cutting.

(2) A sample taken by hand-cutting at random locations within plots before mowing,

(3) A sample taken by hand-cutting from the median unmown strip after mowing.

In the first case the herbage may be finely chopped (e.g., into lengths of 5 to 8 cm) if mowing is with a I-bladed reel mower, or in greater lengths if a sickle bar mower is used. A rotary-mown sample is too severely macerated for herbage dissection analysis. In the second and third cases, the herbage is usually longer than in the first and tends to reduce the time required for species identification.

Some of the different methods ‘of field subsampling practised in New Zealand and the errors associated with them are reported in this survey. Sampling was conducted in grazed pastures or mown plots classified either as "even" or "patchy" in terms of pasture height and/or composition.

METHODS

Nine groups of field technicians sampled herbage for herbage dissection analysis according to their standard practice. Six subsamples instead of the normal one were taken from each of three of four replicated plots of an even or a patchy pasture.

The experiments were conducted at Woodlands Experimental Area, Hindon Experimental Area, Invermay Agricultural Research Centre, Winchmore Irrigation Research Station, Masterton Field Research Area, Flock House Field Research Area, Takapau Field Research Area, Taranaki Research Station and Rukuhia Soil Research Station. Details of plots and sampling methods at the sites are given in Table 1.

TABLE 1: DETAILS OF SAMPLING AT NINE SURVEY SITES

Site	Plot Size (*m*)	Area Cut (*m*)	Mower*	Pasture Mown (*M*) or Grazed (*G*)	Pasture Even (*E*) or Patchy (*P*)	Other Comments
1	3.3 × 1.5	3.3 x 0.9	Ro	G	E	
	3.3 × 1.5	3.3 x 0.9	Ro	G	P	
2	3.3 × 1.5	3.3 x 1.22	Re	G	E	
	3.3 x 1.5	3.3 × 1.22	Re	G	P	
3	3.3 x 1.5	3.3 × 1.22	Re	G	E	
	3.3 x 1.5	3.3 × 1.22	Re	G	P	
4	3.3 × 1.5	3.3 x 1.22	Re	G	E	frame (plot) areas pre-trimmed
	3.3 × 1.5	3.3 x 1.22	Re	G	P	
5	8 x 4.5	8.0 x 1.0	Re	M	E	
	0.1123 ha, 0.1042 ha	3.0 × 1.0	Re	G	P	
6	4x2	3.5 x 1.01	Re	M	E	
	8 × 1.5	6.7 x 1.01	Re	G	P	
7	8 x 1.5	6.8 × 1.01	Re	G	E	frame (plot) areas pre-trimmed
	8 × 1.5	6.8 × 1.01	Re	G	P	
8	6 × 1.5	4.8 × 0.61	Re	G	E	
9	small paddocks	1 × 0.5 (× 5 quadrats/paddock)	Ms	G	E	

*Ro, rotary; Re, reel 3 blades; Ms, motorized shears.

FIELD SUBSAMPLING TECHNIQUES

At Sites 1 and 2, six subsamples were hand-cut with motorized sheep shears from the median unmown strip of herbage within each plot after mowing. The subsamples were taken from along the whole length of the strip. At Sites 3 to 8 the six subsamples were taken from the mown samples following hand mixing. At Site 9, five subsamples were hand-cut with motorized sheep shears before grazing. Subsamples (1.0 m × 0.1 m) were cut adjacent to quadrats used to measure pasture production.

LABORATORY PRACTICE

In the botanical services laboratories the samples were each subsampled to a standard 400-piece sample by a quartering technique which is in general use in the Ministry of Agriculture and Fisheries laboratories (Ritchie and Dyson, 1977). To reduce further variability, one technician subsampled all material from one site. and species were usually separated by a single technician also. In some cases dissection samples were shared equally between two technicians on a replicate basis.

Dissected herbage fractions were dried for 15 hours at 95" C and all percentage composition values were calculated on a DM basis.

RESULTS

The between-sample standard deviations (SD) and coefficients of variation (CV) are presented for each site in Table 2. The variation contains components from field subsampling and laboratory sources. At Sites 1 (patchy) and 8, the herbage was dominated by two species so that within sites the species SDs must be very similar.

There was little difference in the sampling errors associated with even or patchy pastures at the same sampling sites. Therefore data from both types of pasture have been combined for all subsequent considerations in regression relationships.

Within each site the standard deviations Y were plotted against the percentage herbage compositions X for each component. The results in Fig. 1 show the generally expected parabolic shape symmetrical about 50%. Thus, the variation in a species representing 10% of the sward would be expected to be comparable with that of a species representing 90%.

There were large between-site differences. These could be partly explained by the different field sampling techniques employed. At Sites 1 and 2, hand-cutting the median uncut strip after mowing produced larger errors than the subsampling of mown herbage which was used at all other sites except Site 9 where samples were hand-cut before sampling.

Graphical plots of species SDs against percentage occurrence showed that "weeds" was more variable than other botanical components. Weed data have been excluded from further analysis.

The overall site effects were removed in order to simplify the comparison of regression of species SDs on percentage composition, and a transformation was carried out to give regressions

TABLE 2: ERRORS OF -FIELD SLJBSAMPLING FOR HERBAGE DISSECTION ANALYSIS AT NINE SITES

Botanical Component	*Patchy Pasture* Mean Composition	SD	% CV	*Even Pasture* Mean Composition	SD	% CV
Site 1:						
Ryegrass	52.2	13.60	26.1	27.3	9.65	35.3
Other grasses	43.1	13.87	32.2	35.8	13.80	38.5
White clover	4.2	3.80	91.7	34.9	8.57	24.6
Site 2:						
Ryegrass	68.8	11.02	16.0	63.7	11.08	17.4
Cocksfoot	14.6	10.59	72.5	9.2	8.16	88.4
Other grasses	7.2	6.83	94.6	3.8	3.98	104.7
White clover	6.1	4.37	72.1	20.4	6.29	30.8
Weeds	3.3	5.43	165.6	2.9	3.52	122.0
Site 3:						
Ryegrass	41.0	4.00	9.8	55.8	3.30	5.9
Cocksfoot	35.6	3.04	8.5	20.1	2.70	13.4
Other grasses	17.1	4.50	34:1	9.8	2.39	24.4
White clover	9.0	3.40	37.6	11.6	3.64	31.3
Site 4:						
Ryegrass	32.2	5.39	16.8	40.5	5.17	12.8
Other grasses	8.1	2.41	29.8	3.7	1.07	29.2
White clover.	46.8	5.79	12.4	45.5	5.88	12.9
Weeds	12.7	4.24	35.5	9.8	3.05	31.3
Site 5:						
Ryegrass	59.2	11.04	18.6	90.2	6.10	6.8
Cocksfoot	28.0	13.40	47.9			
Other grasses	4.5	2.99	67.2	3.8	2.07	54.0
White clover	7.4	4.48	60.4			
Weeds				6.0	5.89	73.6
Site 6:						
Ryegrass	56.2	3.87	6.9			
Cocksfoot				78.8	3.52	4.5
Other grasses	4.9	1.54.	31.6	5.1	1.40	27.4
White clover	36.3	3.81,	10.5	8.7	2.02	23.3
Red clover				6.6	2.71	41.4
Weeds	1.7	1.32	77.3			
Site 7:						
Ryegrass	53.4	'5.47	10.3	93.1	2.04	2.2
White clover	5.3	1.84	34.8	3.5	1.21	35.1
Red clover	39.3	5.26	13.4			
Weeds .	1.6	1.48	93.3	2.5	1.94	77.8
Site 8:						
Cocksfoot				72.1	5.58	7.74
White clover				24.9	6.00	24.10
Site 9:						
Ryegrass				31.8	5.78	18.2
Paspalum				50.4	7.22	14.3
Summer grass				10.2	4.65	45.6
White clover				6.0	1.64	27.4

Note: For each site mean composition is expressed as a percentage of the dry matter. The standard deviation (SD) and coefficient of variation (% CV) of the mean are pooled within-paddock values for each type of pasture.

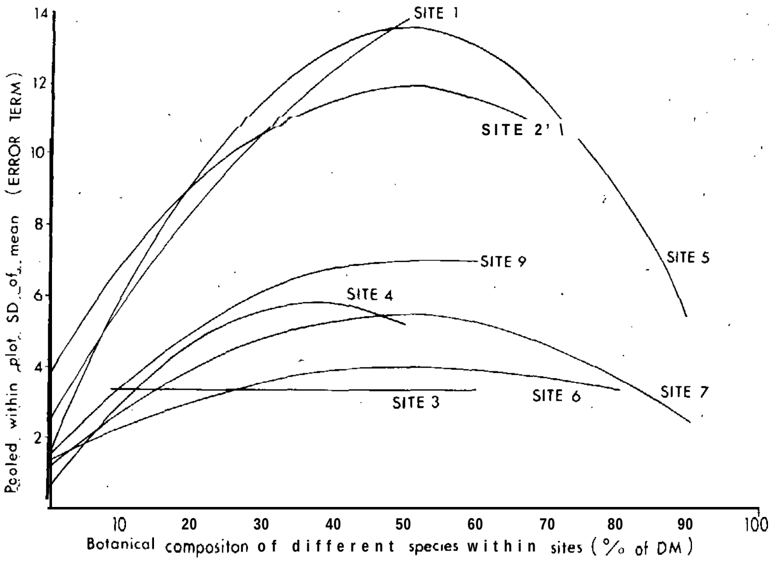

FIG. 1: *Relationship between error term and percentage botanical corn-position at nine sites.*

linear in $Z = (X - X^2/100)$ — i.e., the parabolic effect was "linearized". This still permits non-zero intercepts. Thus, the logarithms of the standard deviations were regressed on Z within each species, to compare 'variation among species. The results were somewhat ambiguous because a dearth of species percentages between 12 and 25 and between 70 and 90 did not permit. the adoption of a convincing statistical model. However, a very non-significant F test arose on adjusted species means. The pooled regression was highly significant ($F = 50.3$),

The adjusted means for the species at a common HD percentage value of 17.6% were:

	Adjusted Mean of Standard Deviations	*Corresponding % CV*
Ryegrass	4.21	24
White clover	3.97	23
Cocksfoot	4.67	27
Other grasses	3.92	22

The CVs for ryegrass and cocksfoot may be slightly inflated as the lower back-transformed Z value was used — *i.e.*, consideration was given to percentages below 50 only.

The pooled regression equation was:

$$Y - 4.63 = 0.26 \quad (Z - 14.5)$$

Thus $$Y = 0.26 \quad (X - X^2/100) + 0.86 \qquad (1)$$

Approximate errors at different percentage composition values regardless of site or species are shown in Table 3.

TABLE 3: APPROXIMATE ERRORS OF FIELD SAMPLING ASSOCIATED WITH DIFFERENT HERBAGE COMPOSITION

% Composition	SD	% CV
5	2.1	41
10		
20	3.2 5.0	32 25
30	6.3	21
40	7.1	18
50	7.4	15
60	7.1	12
70		9
80	6.3 5.0	6
90	3.2	4

DISCUSSION

The approximate parabolic pattern of the error term (SD) asso-cited with percentage botanical composition could be anticipated since beyond 50% the errors associated with the component that is left are comparable with the errors of components representing less than 50% of the herbage. However, the magnitude of the field subsampling error was unknown. It proved to be moderately large (Table 3). The errors represent the sum of field subsampling, laboratory subsampling, and identification errors associated with the survey. However, the laboratory sub-'sampling and identification errors were restricted to low and consistent levels by standardized laboratory procedures. No attempt has been made to separate the errors associated with field subsampling from the other errors but large differences between sites can be expected to be attributable to field subsampling errors.

The high CV% value of 41% recorded for components of up to about 5% of the DM in herbage dissections would suggest that dissection of such components is unlikely to be worth while at many sites.

Despite the reduction of all experimental values to a common equation (equation 1) , there were large differences in the errors between sites. Greater errors were recorded at Sites 1, 2 and 5 than at the other sites. Samples were obtained by hand-cutting the median unmown strip of herbage within each plot at Sites 1 and 2. It is probable that the greater sampling errors are more attributable to this method of subsampling in the field than to a specific site or technician effect. However, a more detailed comparison of field subsampling techniques is required within sites to accurately identify the sources of error.

While even and patchy pastures were compared at seven of the nine sites, there was no obvious effect on the sampling error. The patchy pasture at Site 5 was selected for the variability of its botanical composition and large errors were recorded from it. However, large errors were also recorded from even pastures at this site. At other sites, such markedly different even and patchy compositions were not available and patchiness was often based on the height of the pasture rather than the botanical composition.

The three subsampling techniques available to technicians required to take pasture samples for HD analysis were used at the nine sites. However, the data available for hand-cut samples taken before mowing are from only one pasture type at one site. There was greater inherent error in subsampling by hand-cutting after mowing than from mown samples. This was probably because the latter was sampling from a larger area (up to 80% of the plot or -frame area was mown) ; mown herbage was of uniform length and was thoroughly mixed by both the action of the reel mower and hand mixing. Hand-cut subsampling errors can be reduced either by taking the subsample before mowing (e.g., Site 9), or by increasing the number of samples taken for dissection. The latter is not feasible because of the increased time required for the greater number of analyses. Subsampling before mowing allows representative and larger samples to be taken from the plot as a whole. This should reduce errors compared with subsampling within the median strip of uncut herbage remaining after mowing.

Hand-cut samples consist of complete leaves and thus allow a more rapid (and probably more accurate) identification than mown samples, as more identifying features are likely to be present on individual pieces of herbage. However, the reduction in field sampling errors in mown samples is likely to outweigh any disadvantage in dissection analysis.

The values recorded in Table 3 can be expected to over-estimate the herbage dissection errors for sites where field sampling is from. a large' mown sample. 'and especially from areas which have been pre-trimmed. Pre-trimming reduces the pasture variability. This was employed at Sites 4 and. 7 and is a feature of rate of growth mowing trials and mown plot trials.

Although the.: results are only of a preliminary nature, they have shown that. field sampling for herbage dissection should be taken from a thoroughly mixed mown pasture sample. Where this is not Possible — e.g., where a rotary mower has to be used to sample for DM yields because a reel mower is not available or is impractical — hand-cut samples are necessary. The area hand sampled should be as' large and representative as is practical. It should therefore be cut before any mowing is done, placed in a weighed plastic. bag, and then weighed with the mown sample for estimation of the field weight of -the herbage. The accuracy of dissection analyses of species representing up to 5% of the DM is unsatisfactory. Groups of 'relevant species of such minor importance should be accumulated together into categories such as "other grasses", etc. This would reduce the analytical time for herbage dissection without reducing the scientific value of the analyses.

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