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PASTURE PROBE CALIBRATION

A Progress Report

by

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Introduction

Many indirect dry matter assessment techniques have been developed including visual estimation, height and density measurements (i.e., ruler, rising plate meter), and non-vegetative attributes (capacitance, beta attenuation, and radiometry). The use of a capacitance meter for estimating herbage mass has been under development for several years. Most early models were very sensitive to sample water content. An earth plate capacitance probe developed by V ery and Nicol (1982) has largely overcome this problem.

The Pasture Probe is a version of the earth plate capacitance probe developed by Design Electronics of Palmerston North, New Zealand and marketed by Snell Systems of San Antonio, Texas. The Pasture Probe has become a useful tool for estimating herbage mass in ryegrass-white clover pastures in New Zealand. This single probe capacitance meter is mainly responsive to the surface area of the herbage, and it is less sensitive to variations in moisture content of the pasture than previous meters. Thus, it can be calibrated to measure the mass of herbage dry matter to ground level, reducing the need to collect dry herbage samples for frequent recalibration of the instrument.

Herbage mass readings taken by the probe are saved in an electronic control box and can be downloaded to a microcomputer. There is space for before and after grazing readings from ninety pastures. Date, time, and pasture size information are also saved in the control box. Computer programs for downloading to a text file or spread sheet are available from the author. Programs for feed budgeting are under development.

The control box can be carried over the shoulder or around the waist with a belt. Readings are taken with the Pasture Probe by walking across a pasture as if the probe were a cane and taking a herbage mass reading each time the probe touches the ground. The average of the capacitance meter readings is converted to dry matter yield using a linear equation developed during calibration. The equations below estimate kg/ha, but the probe is set to convert these estimates to lbs/a. The pasture probe's electronic control box contains several equations developed in New Zealand. These equations are programmed into the pasture probe so that the conversions occur instantly as you sample in the field. The following equations are programmed in the probe:

1. General use when the pasture is not moist:

   $Y = -609 + 4.82\ CMR + 163\ \sqrt{CMR}$ (Curvilinear)

2.	Early Autumn (before rains but forage is green)	$Y = 11\ CMR + 353$
3.	Autumn (after rains)	$Y = 11.9\ CMR + 608$
4.	Winter to Early Spring	$Y = 10.9\ CMR + 212$
5.	Late Spring to Early Summer	$Y = 15.1\ CMR + 341$
6.	Summer	$Y = 19\ CMR + 854$
7.	Tropical Grasses	$Y = 25.8\ CMR + 232$

8. Corrected Meter Reading (CMR)

Because these equations were developed on perennial pastures dominated by perennial ryegrass and white clover, it was not clear whether any of them would work on annual range pastures. During the 1986-87 growing season the Design Electronics Pasture Probe was calibrated on annual rangeland.

Method

Calibration was conducted on open grasslands at the O'Connell Ranch in Tehama County with supplemental data collected at the U.C. Sierra Foothill Range Field Station. A double sampling procedure was used to determine the linear relationship between CMR and herbage mass (forage dry matter). A one square foot quadrat was probed 9 to 12 times depending on the amount of variation in herbage mass within the quadrat. The plot was then clipped close to ground level and probed again to determine the residual CMR. Regression was used to compute the linear relationship for the difference between the probe readings before and after clipping (X) and the dry matter weights (Y).

Sampling was done six times at the O'Connell Ranch from February 18 to May 1, 1987, and two times, February 26 and April 28, at SFRFS. Due to a dry fall and early winter, green forage was not sufficient for measure with the probe until February. Cold winter temperatures also reduced forage productivity. A late January attempt to begin calibrating the probe was aborted because herbage mass was inadequate.

The first calibration was done in an ungrazed paddock of O'Connell's original cell. Most clipped plots contained filaree and drill rows of annual ryegrass. Annual clovers were generally not present. On close inspection a few newly germinated clover plants could be found, but their contribution to the standing crop was negligible. The highest standing crops and probe readings were measured in a spot where fertilizer and ryegrass seed had apparently been spilled. Filaree was not a significant contributor to these samples.

The second calibration was conducted on March 10, 1987, in the hardinggrass field surrounding the O'Connell house, Hay Field and West Big Field Flat. Heavy rainfall in the early afternoon forced an end to the calibration sampling. Hardinggrass, ryegrass, and clover were the dominant species in the hardinggrass field by the house. The ryegrass was in drill rows. The other fields had ryegrass in drill rows to a height of 3-5 inches. Clover, star thistle, and fiddleneck seedlings were also present in these fields. In later sampling clover and other forbs became more important components of the sample so that the calibration samples taken from late March to May were mixtures of grass, forbs, and clover. On the last sampling date at SFRFS an attempt was made to collect pure grass, clover, and filaree samples.

Results

The yields, dry matter content, and calibration equations for each sampling date at the O'Connell Ranch and SFRFS are presented in Table 1. Before the forage began to mature, when plant moisture was high (78% to 85%) the CMR correlated well within dry matter production ($r > 0.95$). However, as the plant moisture began to decline in April the CMR correlation with dry matter decreased ($r < 0.9$).

The March 10 sample was small because rainfall aborted completion of the sampling. No herbage mass samples were collected in the upper end of the herbage mass range and many of the clipped plots contained hardinggrass, potentially producing the significant decrease in slope of the calibration curve for that date. Therefore, the March 10 samples were excluded from the pooled calibration curve for the entire season at the O'Connell Ranch.

Samples exceeding 3500 lbs/a were dropped from the analysis in an effort to exclude those samples exceeding 12 inches in height; after completing the seasons sampling it was learned that the pasture probe would only measure forage up to 12 inches in height. We are currently testing a new pasture probe that measures forage to a 24 inch height.

The calibration equation Y=14.95 CMR + 114 for the O'Connell Ranch is very close to equation 5 contained in the control box for late spring to early summer. Further testing in 1988 may confirm that equation 5 is a satisfactory estimator for feed budgeting.

The pasture probe is a useful research and management tool. When used for research, site specific and seasonal calibrations may be necessary to reduce experimental error. Depending on the nature of the research, a sequence of two or three equations may be adequate as forage matures and dry matter increases. As a management tool, a greater sampling error is acceptable. A single calibration equation for the entire annual range green season may suffice for many situations. John O'Connell used the pasture probe and the pooled equation to budget forage in a break grazing or daily ration grazing program on annual range seeded to annual ryegrass and crimson clover last season. The stocker cattle gained 3 to 3.75 lbs. per day.

Based on New Zealand's experience and our preliminary experiences on annual range, the pasture probe may make it possible for the ranch manager to measure how much forage he has very quickly at any time. This fundamental piece of information has been unavailable to many ranchers, and its lack is at the root of inefficient forage management on rangelands and pastures. With this information short and long-term planning becomes more precise and economic control is strengthened.

Literature Cited

Vickery, P.J. and G.R. Nicol. 1982. An improved electronic capacitance meter for estimating pasture yield: construction details and performance tests. CSIRO Anim. Res. Lab. Tech. Paper No. 9.

Table 1. Dry matter yield (lbs/a) and herbage dry matter (%) correlation with CMR for eight sampling dates at two locations in 1987.

	Yield				Dry Matter	
Location & Date	lbs/a	b	a	r	%	r
O'Connell Ranch						
February 18	1015	14.33	-235	0.98	15	-0.31
March 10	1090	9.93	142	0.95	15	-0.28
March 27	1443	15.05	- 71	0.97	22	-0.85
April 9	1552	16.82	-215	0.96	19	-0.7
April 20	1784	15.56	521	0.86	25	-0.65
May 1	1711	14.50	748	0.73	33	-0.08
TOTAL	1538	14.40	107	0.84	21	-0.33
TOTAL (excluding March 10)	1312	14.95	114	0.85	22	--
SFRFS						
February 26-27	630	14.39	-71	0.94	--	--
April 28 (grass)	1019	7.33	450	0.7	28	-0.76
April 28 (filaree)	1213	15.62	633	0.78	30	-0.33
April 28 (clover)	1127	9.98	637	0.73	32	-0.47
April 28 (all)	1112	4.72	844	0.43	29	-0.62
TOTAL	954	8.73	481	0.61	--	--

Table 8. Inches precipitation (US Forest Service, about 20 miles NNW of experiment site).

Year	J	A	S	O	N	D	J	F	M	A	M	J	Total
1964-65	.22	.14	.24	.45	1.61	4.15	2.95	.16	.23	1.76	1.63	2.34	15.88
65-66	.38	3.00	.01	.17	1.91	1.47	1.15	.61	.57	.67	.79	.47	11.20
66-67	.63	--	.59	.15	2.78	1.48	3.05	.15	.94	1.58	1.05	.87	13.27
67-68	.25	.10	.11	.26	.88	1.53	1.88	1.39	.61	.20	1.46	.47	9.14
68-69	--	1.97	--	.42	2.17	.98	4.24	.93	.53	1.11	.29	3.35	15.99
69-70	.09	--	--	1.77	.70	2.85	3.65	.59	1.46	.84	.64	2.61	15.20
70-71	--	--	.17	.65	3.18	3.33	.27	.20	3.34	.92	2.99	1.56	16.61
71-72	.42	.03	1.70	.73	1.36	.90	1.53	2.48	.91	.99	.64	.24	11.93
72-73	.04	.19	1.42	.87	1.71	1.03	1.49	.56	.57	1.61	.68	--	10.17
73-74	.01	--	.65	.62	1.91	1.23	1.72	.86	1.71	.50	.03	--	9.24
74-75	.73	--	--	.63	.66	1.54	.59	2.47	1.24	1.45	.15	.80	10.26
75-76	.19	.54	.04	.39	.61	.42	.39	1.38	1.12	.16	.21	.50	5.95
76-77	.46	.99	1.14	--	.17	.02	1.06	.48	.49	.11	2.59	1.36	8.87
Mean	.26	.54	.47	.55	1.51	1.61	1.84	.94	1.06	.92	1.01	1.12	11.82

It must be noted that the grazing pressure was fairly intense, from cows from about April 15 to June 15, and possibly deer and antelope all year. The improved palatability of fertilized forage is well known, and was probably a significant factor in encouraging heavy grazing use. The best remaining stands were in the fenced treatments which did not receive atrazine and the grazed check which never received fertilizer or atrazine.

A dramatic result of this decline in wheatgrass numbers and vigor, is the invasion by big sagebrush. The establishment of sagebrush in this 1958 wheatgrass seeding has been minimal, probably because of the thrift of the wheatgrass plants which generally excludes even cheatgrass. Observations in 1988 show sagebrush well established in all of the atrazine treatments of both the grazed and formerly fenced experiments (Figure 1).

Literature Cited

1. Kay, Burgess L., and Raymond A. Evans. 1965. Effects of fertilization on a mixed stand of cheatgrass and intermediate wheatgrass. J. of Range Management 18:7-11.

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3. Kay, Burgess L. 1971. Atrazine and simazine increase yield and quality of range forage. Weed Science 19:370-372.