The application of visual estimation procedures for monitoring pasture yield and composition in exclosures and small plots

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Abstract

The BOTANAL procedures for calibrated visual estimates of yield and botanical composition of grazed pastures were compared with cutting and sorting when estimating pasture growth in ungrazed exclosures.

Estimates of yield and composition derived from BOTANAL were very similar to those obtained with cutting and sorting in exclosures and small plots. The BOTANAL procedure allowed pasture growth to be monitored over time without the destruction of cutting and took only 10% of the time required to cut and sort the same number of quadrats.

Introduction

The BOTANAL package for measuring the presentation yield and botanical composition of grazed pastures is based on calibrated visual estimation techniques for both yield and botanical composition (Tothill *et al.* 1978; Hargreaves and Kerr 1978). Different methods can be selected from this package, but those most commonly used are the dry-weight-rank method for measuring composition (Mannetje and Haydock 1963) and the comparative yield technique for dry matter yield (Haydock and Shaw 1975). The package was originally developed for the extensive sampling of large paddocks of grazed pasture but the procedures have potential use for measuring yield and composition in small plot experiments and in small exclosures in grazing experiments. The major advantage of BOTANAL in these conditions is that it would allow for rapid and non-destructive measurements of the yield and composition of regrowth material. This paper reports estimated pasture yield and composition assessed by BOTANAL and by cutting and sorting.

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Materials and methods

The study was made within a grazing experiment, described by McLean and Kerridge (1987), at the CSIRO Narayen Research Station, Mundubbera in south-east Queensland. The area had been sown to Siratro (*Macroptilium atropurpureum*) and buffel grass (*Cenchrus ciliaris* cv. Biloela) in 1981, but by 1986, botanical composition and yield were markedly affected by fertility level, stocking rate and soil type (Coates *et al.* 1990).

Fifteen cages of 1.5 m × 1.5 m, enclosing a pegged quadrat of 1 m^2, were erected in each of 6 paddocks in September 1986. Pasture in the exclosures was clipped to 5 cm and regrowth was measured at frequent intervals, using BOTANAL, to establish a growth curve. In December 1986, yield and composition of material in the exclosures were assessed first by BOTANAL and then by cutting to 5 cm and sorting the harvested material from each 1 m^2 plot. The area was sampled again by both BOTANAL and cutting in May 1988. In the interim, the cages had been moved twice. These results will be reported elsewhere. The 1987–88 season was very dry and most of the growth occurred following good rains in early April 1988.

For BOTANAL estimates, the yield and composition of material on each 1 m^2 plot was estimated as 4 quadrats of 50 × 50 cm. The estimates were made while leaning over from the outside of the 1.5 m high exclosure, using a long handle attached to the quadrat. Composition was estimated by dry-weight-rank using cumulative ranking (Jones and Hargreaves 1979). Some 20% of quadrats had tied rankings (Tothill *et al.* 1978) in 1986 but only 10% in 1988. These estimates were made independently of subsequent cutting and sorting, and in all cases, 100% of the area in the study was sampled.

Results and discussion

Means on a whole paddock basis (60 quadrats or 15 exclosures) for estimated and cut yields, and botanical composition of material from the exclosures are given in Tables 1 and 2. There was a good correlation at both sampling dates between estimated and cut values for both total yield and percentage composition, except for Siratro in 1988, where it was present in minute proportions (<3%). The botanical composition was more diverse on the first sampling date.

The estimation of total yields demonstrated precision, with correlation coefficients of 0.96 and 0.98. In 1986, there was some bias, with lower yields being over-estimated and higher yields being under-estimated. In 1988, the lower yields were under-estimated and the higher yields tended to be over-estimated. However, if the 2 years are considered as a group, it is evident that there is no systematic or consistent bias. The results reported here represent the typical variation one would expect from estimation techniques. BOTANAL is adequate to estimate relative differences between grazing treatments and appears also to adequately estimate differences between plots.

The data were examined further, in groups of 5 consecutive exclosures (20 quadrats) for yield and botanical composition to better validate the procedure for application to small plot trials: firstly, to see if the reduction of quadrat numbers would influence the efficacy of the dry-weight-rank algorithms; secondly, to provide a larger number and a better distribution of points over the yield range. These results are given in Tables 3 and 4. Compared with the results for full paddocks (Tables 1 and 2), there are only minor reductions in the r^2 values, particularly in 1988 when the pasture was less diverse. The standard errors, included in Tables 1 and 3, are similar for both estimated and cut yields.

Errors in the field use of BOTANAL can arise in a number of ways:

(i) The standard multipliers can be inappropriate for the pasture concerned. However, in view of the good results obtained by using these multipliers on a wide range of pasture types (Jones and Hargreaves 1979), this is not a likely source of error.

(ii) Estimations may not be made to the same height as would be used if the quadrat was cut.

(iii) The observer may incorrectly allocate ranks.

(iv) Insufficient quadrats could be used for the dry-weight-rank algorithms to operate correctly.

(v) In this particular study there was an extra source of operator error in that the estimations were made from outside the exclosure, leaning over it.

Despite these possible sources of error, the results obtained from this study indicate that visual estimation procedures have a useful role in measuring yield and botanical composition in exclosures and small plots where relative difference is the major consideration. Accuracy of

Table 1. Mean yields estimated (est.) by BOTANAL and by cutting (cut) of 15 exclosures within 6 (1986) and 5 (1988) paddocks.

Paddock	5.12.86 est.		5.12.86 cut		18.5.88 est.		18.5.88 cut	
	kg/ha							
1	1580	(78)[1]	1580	(98)	1300	(130)	1780	(175)
2	1900	(60)	2020	(102)	3240	(211)	3160	(234)
3	2400	(114)	2620	(150)	3660	(282)	3520	(272)
4	2220	(158)	2640	(242)	3970	(96)	3990	(97)
5	1450	(63)	1170	(76)	1620	(192)	1810	(189)
6	1430	(65)	1320	(79)		nd[2]		nd
r^2	0.96				0.98			

[1]se of the mean ($SD/\sqrt{m}$) given in brackets.
[2]nd — not determined.

Table 2. Mean percent composition of exclosures within 6 (1986) and 5 (1988) paddocks at 2 sampling dates from visual estimation (est.) and from cutting and sorting (cut).

Paddock	Buffel		Siratro		Other grass		Broadleaf weed	
	est.	cut	est.	cut	est.	cut	est.	cut
					(%)			
(a) 5.12.86								
1	61	58	9	7	18	17	12	18
2	73	77	11	10	8	8	8	5
3	71	72	7	5	18	19	4	4
4	81	84	7	5	5	7	7	4
5	49	50	2	2	40	40	9	8
6	65	59	5	5	14	18	16	18
r^2	0.93		0.91		0.98		0.82	
(b) 18.5.88								
1	85	77	1	1	10	13	4	9
2	98	99	0	0	2	0	0	0
3	98	97	0	1	1	1	1	0
4	96	95	0	1	3	4	0	0
5	65	57	1	0	29	33	5	10
r^2	0.98		0.03		0.99		0.96	

Table 3. Mean yields estimated by BOTANAL (est.) and cutting (cut) of 5 exclosures (20 quadrats) groups within 6 (1986) and 5 (1988) paddocks.

Paddock	5.12.86				18.5.88			
	est.		cut		est.		cut	
				kg/ha				
1	1670	(140)[1]	1700	(147)	1290	(78)	2080	(139)
	1650	(118)	1530	(183)	1370	(126)	1950	(375)
	1410	(140)	1520	(202)	1240	(349)	1420	(316)
2	1840	(141)	1930	(303)	3190	(199)	3480	(251)
	1980	(95)	2090	(84)	3870	(310)	3650	(443)
	1880	(78)	2050	(84)	2670	(345)	2250	(158)
3	2510	(146)	2360	(163)	3630	(560)	3390	(464)
	2420	(127)	2790	(258)	4150	(252)	4300	(173)
	2260	(302)	2700	(339)	3200	(592)	2860	(516)
4	1910	(99)	1980	(145)	3770	(142)	3740	(105)
	2310	(174)	2880	(339)	4060	(76)	3950	(128)
	2440	(430)	3060	(558)	4090	(235)	4280	(185)
5	1220	(94)	930	(82)	1700	(457)	1850	(517)
	1560	(94)	1270	(61)	1810	(336)	1940	(214)
	1570	(59)	1300	(171)	1360	(206)	1640	(228)
6	1530	(95)	1580	(112)	nd[2]		nd	
	1460	(134)	1220	(99)	nd		nd	
	1290	(110)	1170	(133)	nd		nd	
r^2		0.90				0.93		

[1]se of the mean ($SD/\sqrt{m}$) given in brackets.
[2]nd — not determined.

yield estimation may be improved by having different calibration sets for different pastures. The appropriate coefficients should be factored into the data processing.

Visual estimations are non-destructive and lend themselves to following yield changes with time in exclosures. Similarly, they may help to minimise some of the problems associated with sampling small plots viz. better sampling of the variation through greater sample numbers; reduction of possible errors due to inconsistencies with cutting height and other procedures; elimination of damage to the plots caused by cutting, including removal of nutrients.

Finally, a most important point is that the time taken for visually estimating yield and botanical composition was only one-tenth of that required for cutting and sorting the same number of quadrats.

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Table 4. Mean percent composition, estimated and cut, of 5 exclosures (20 quadrats) groups within 6 (1986) and 5 (1988) paddocks.

Paddock	Buffel		Siratro		Other grass		Broadleaf weed	
	est.	cut	est.	cut	est.	cut	est.	cut
				(%)				
(a) 5.12.86								
1	66	65	9	6	12	15	13	14
	62	64	12	10	18	14	8	12
	52	44	8	6	26	23	14	27
2	81	88	7	5	2	3	10	4
	73	78	14	12	6	7	7	3
	67	65	11	13	14	15	8	7
3	85	90	4	2	6	6	5	2
	54	58	10	7	30	28	6	7
	72	72	7	8	18	19	3	1
4	75	80	9	6	9	8	7	6
	83	87	7	4	3	6	7	3
	82	83	6	5	6	7	6	5
5	49	47	3	2	45	47	3	4
	61	63	3	3	25	26	11	8
	37	40	1	1	49	50	13	9
6	69	66	10	10	1	5	20	15
	64	62	3	4	15	13	18	21
	63	48	2	1	25	39	10	12
r^2	0.89		0.83		0.93		0.67	
(b) 18.5.88								
1	87	90	1	1	6	5	6	4
	88	88	1	1	3	6	8	5
	68	75	2	2	22	19	8	4
2	98	98	1	1	1	1	0	0
	100	99	0	0	0	1	0	0
	98	96	1	1	1	2	0	1
3	100	98	0	0	0	1	0	1
	96	99	3	0	1	1	0	0
	97	96	1	1	1	2	1	1
4	97	98	2	1	1	1	0	0
	93	93	1	0	6	7	0	0
	95	99	1	0	4	1	0	0
5	69	72	0	0	24	23	7	5
	74	69	0	0	18	26	8	5
	50	54	1	1	38	39	11	6
r^2	0.96		0.16		0.95		0.96	

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