# DROUGHT, STOCKING RATES AND SOIL LOSS

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# SUMMARY

Destocking of pastures when plant cover has been reduced to a defined minimum was examined in relation to stocking rates. Perennial and annual pastures in 7 locations were considered. On average about 1 DSE per ha per 100 mm annual rainfall will lead to destocking on about 1 month in 12, if 1 t/ha of plant dry matter gives the signal to destock.

Keywords: pastures, soils, stocking, erosion, destocking.

# INTRODUCTION

Heavy grazing causes soil erosion. Losses of soil and nutrients result from reduction of both surface cover and of the root systems which protect and bind the soil, and also from the trampling and formation of tracks, especially near watering points. If grazing systems are to be sustainable strategies must be developed to prevent such losses.

Estimation of optimum stocking rates (OS) has almost invariably focussed on gross margins per hectare as the objective. Unfortunately such optima may well fail to allow for hidden costs from losses of soil and nutrients. These costs must be included in budgets of management systems, whether short or long term.

This paper develops a method of estimating *optimum stocking rates* of pastures in south east Australia by analyses of 100 years of monthly rainfalls. This method is then used to estimate **OSs** at 7 locations in Victoria and N.S.W. The optimum stocking rate was defined here as that at which plant cover is reduced to a defined level at which destocking of pastures is required, by the rules of the system, for a defined number of months in 12.

Daniel (1987) reviewed the requirements of plant cover needed to keep losses within acceptable limits. At least 1 t/ha of plant surface dry matter seems to be necessary for annual pastures, and about 0.5 t/ha for dense, well established perennials. These parameters must vary with topography, soil type and intensity of rainfall. White *et al.* (1980) discussed relationships between soil erosion and stocking rates for improved perennial pastures in Victoria, and Whalley and Lodge (1987) for semi-arid pastures. Most discussions on grazing management have paid little more than lip service to methods of management to prevent erosion.

## MATERIALS AND METHODS

Long-term rainfall data were analysed by a spreadsheet model. The critical level (C) for removal of stock was either 1 t/ha of plant residue, as might be appropriate for annual pastures, or 0.5 t/ha for well established perennial pastures. These values were reduced for the cooler months, when rainfall intensity would be lower. The stocking rates at which the weight of plant residues fell below C values were estimated iteratively for each situation, using the following functions.

# $P_{e} = P_{p} \cdot (1 - S.D/1000)(1 - R_{t}.DK) \dots \text{ pasture present } (t/ha) \text{ less losses from trampling and decay}$ $- S.D(1 - exp(-P_{p})/1.3)D_{g} \dots \text{ pasture eaten } (t/ha)$

+ IF( $R_t < RL$ , 0, MIN[G\*D/1000,( $R_t - RL$ )/E)] ... pasture grown (t/ha)

where Pc is pasture available (t/ha) at end of current month, Pp is pasture available (t/ha) at end of previous month, S is stocking rate (wethers/ha), D is number of days in month, DK is percentage pasture decay per month (%Pc), G is potential pasture growth (kg/ha.day), Dg is digestibility of pasture on offer, Rt is rainfall total for month (mm), RL is minimum ('lag') rain necessary for growth, E is evapotranspiration ratio (t  $H_2O/t$  DM).

Monthly rainfall records for about 100 years were obtained in Victoria and New South Wales from (years in parentheses) Balmoral (102), Bendigo (100), Geelong (91), Holbrook (104), Sale (82), Trangie (104) and Tumbarumba (94).

The analysis was based on 'consensus' estimates from models and results such as those of White *et al.* (1980, 1983) and Bowman (1989). Pasture growth was predicted as a function of rainfall from 'evapotranspiration' ratios estimated from a pasture growth study in Argentina (Morley 1977). The estimated requirements ranged from 500 to 1000 t of soil water per tonne of pasture dry matter grown.

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A 'lag' level of rainfall was assumed to have been required to initiate pasture growth. This made negligible any responses to occasional showers. The potential growth of pastures (G) at each location followed the models of growth in White *et al.* (1983) Examples of E, RL, G, and **DK** for twelve 12 of the year at Bendigo, an important pastoral region in North-Central Victoria, are given in Table 1.

Table 1. Average monthly evapotranspiration ratios (E, kg/t), rainfall lags (RL, mm), pasture grov	vths
(G, kg/ha.day) and decay rates (DK,%t/ha.m) for 100 years at Bendigo	

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Е	100	100	90	80	75	70	70	60	50	40	40	90
RL	25	25	20	18	10	8	8	8	8	10	12	20
G	0	5	25	35	20	10	10	35	60	130	130	70
DK	10	15	30	40	50	10	1	1	1	1	2	5

### Validation of model

The estimates of tonnes per ha of dry material on the surface were compared with those from 1965-67 from near Bendigo, as estimated by White *et al.*(1983) and Bowman (1989). The mean value for this study was 1.5 t/ha compared with 1.7 t/ha from Bowman( 1989). The correlation between our estimates and Bowman's field data was 0.78. Since this statistic must approach the likely repeatability of measurements of pasture availability, the model can be accepted with confidence as a fair approximation for sites similar to that of Bowman. Variations in soil type, topography, and water relations must however be considered before the model can be taken as a trustworthy guide for management.

## RESULTS AND DISCUSSION

The results are summarised in Table 2. for 2 frequencies (averaged for 1 or 2 months per year), and 2 critical levels (0.5 or 1 t/ha) of pasture dry matter. The stocking rates were dry sheep equivalents (DSE) per ha at 28 February, but this value would vary with the month.

Table 2.	Predicted	stocking	rates at	which	pastures	were	below	critical	levels	(C)	of 1.	0 or	0.5	t/ha fo	r 1 (	or 2
		months	per year	(m/y)	and ave	rage 1	ainfall	statisti	ics for	the	locat	ions				

Site C		Balmoral	Bendigo	Geelong	Holbrook	Sale	Trangie	Tumbarumba			
(t/ha)	(m/y)										
1.0	1	7.4	5.0	6.5	6.9	6.4	3.8	8.3			
1.0	2	8.6	5.9	7.3	8.0	7.5	4.5	9.5			
0.5	1	10.3	7.3	9.0	9.5	9.3	5.9	12.0			
0.5	2	11.9	8.7	10.9	11.6	11.2	7.2	15.0			
Average	Average values for rainfall										
Rain/y	ear (mm)	629	552	567	740	606	480	926			
C.V. (9	%)	19	26	24	20	22	38	24			
Nov. to	o Apr. (%)	33	32	39	39	50	54	40			
<b>S/100</b> :	mm rain	1.18	0.91	1.15	0.93	1.05	0.79	0.90			

S, Stocking rate predicted for 1 .0 t/ha on 1 month average/year

There is no clear association in this study between S and features of the rainfall, other than the total rainfall. However the predicted frequency of **destocking** is highly sensitive to the critical levels of pastures. This is not surprising. It follows that any measure to reduce these critical levels could be important to management. Thus the establishment of highly persistent perennial grasses, the design of subdivisions, soil amelioration, and the siting of watering points, should all be examined for their implications for site vulnerability.

Perennial pastures may not always produce more plant matter than annuals but, if they persist under heavy grazing, might confer greater soil protection, and hence higher carrying capacity, for given levels of risk. The roots of perennial pastures might well stabilise the soil. Hence annual pastures might require higher levels of protective cover than the perennials. A residue level of 1.0 t/ha for annuals, and 0.5 t/ha for perennials, could be appropriate, but facts are needed. The predictions estimated here were made **from** models of annual and perennial pastures. They are no more than simulations.

Pursuing this argument, the results of Table 2 suggest that for a given level of destocking, perennial grasses would carry, on **average,about** 45% more stock. The profitability of such management systems needs to be examined carefully. From a soil conservation viewpoint perennials might confer useful increases in productivity through higher stocking rates, at a given levels of soil and nutrient losses. Persistence under heavy grazing must be a critical requirement for higher stocking rates.

The OS estimated here for annual pastures are substantially lower than the 2 to 3 DSE/ha per 100 mm rain when estimated from maximization of gross margins per ha (Morley, in preparation), except at Trangie.

Prolonged heavy stocking has caused losses of perennial species at Trangie (Biddiscombe 1953; Campbell *et al.* 1973; Whalley and Lodge 1987). Similar consequences seem likely in more temperate climates (Morley 1966; White *et al.* 1980). Therefore the benefits of management might be reduced, or negated, if perennial species are lost because of heavy stocking. If destocking at or below critical levels of pasture enhances the persistence of **perennials,and** hence protection of the soil, it could be highly profitable. Costs and benefits must clearly be estimated in the appropriate circumstances. Some preliminary estimates suggest that if the cost of maintenance feeding is about \$A2.00 per head per month, destocking could be a worthwhile procedure at stocking rates slightly lower than those at which gross margins per ha are maximum.

The interactions of OS with rainfall amounts, intensities, and distribution, on different soils with different topographies, and for different pastures communities, using appropriate management strategies, deserve high priority in research. The long term survival and ecology of perennial pastures, and their economic performance, also require further investigation.

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