PASTURE CONSTRAINTS TO SHEEP PRODUCTION

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ABSTRACT

Recommended feeding levels for a 55 kg ewe throughout the year total 630 kg DM ewe^{-1} $year^{-1}$. Winter and summer deficits in feed supply and the seasonal decline in pasture quality are discussed. A standard feed profile for the breeding ewe flock is matched with seasonal pasture production for the Waikato, Southland, Wairarapa and Central Otago areas. For maintenance purposes supplement quality is unimportant but for live-weight gains highly digestible feeds are required. Soluble carbohydrate levels are important in late pregnancy and protein quality or quantity during mating.

INTRODUCTION

Pasture grazed *in situ* is the cheapest and most widely used livestock feedstuff in New Zealand. The major disadvantages of pasture is its variability of supply between seasons of the year, between years and between areas within New Zealand. Problems are also caused by changes in feed quality throughout the year.

Because of the changing physiological status of the breeding ewe during the year, there is also a seasonal variability in feed requirement. High levels of utilization of the pasture grown, and minimization of periods of feed shortage and surplus must be aimed for.

RECOMMENDED FEEDING LEVELS

Physiological Status

During the year the ewe has several physiological states each of which has a different feed requirement, which Jagusch and Coop (1971) and Rattray (1978) specify. Gestation lasts 21 weeks. In early- and mid-pregnancy the requirements are low and the ewe can be fed at maintenance or even submaintenance levels depending on feed supply and on ewe condition. Ewes in moderate to good condition can tolerate some live-weight loss. Low levels of feeding save pasture and reduce the likelihood of dystokia. In the last 4 to 6 weeks of gestation the requirements of the conceptus increase curvilinearly and average 1.5 x maintenance for a single-bearing ewe and 1.75 x maintenance for a twin-bearing ewe. During lactation (10 to 12 weeks) requirements reach a maximum in the second or third week post-partum and thereafter decline, however this is offset by the increasing intake of the lamb, so that the combined intake of ewe and lamb changes little during lactation. Feed requirement of a ewe suckling a single averages 2.5 to 3 x maintenance and that of a twin-suckling ewe averages 3 to 3.5 x maintenance. In early lactation some restrictions can be tolerated without too much penalty to lambs, especially singles as they do not consume all of the milk produced by the ewe at this stage. After weaning the recommended feeding level is at maintenance or above in order to improve ewe live weights and capitalise on the 'static' live weight advantage at mating. However a compromise must be reached between optimizing ewe live weight and the need for pasture control and finishing lambs. On easier country a mating live weight of 55 kg is recommended. Three weeks prior to mating, flushing is recommended, the level of feeding being 1.5 x maintenance to ensure gains of 70 to 80 g day^{-1} so as to capitalize on the 'dynamic' effect of flushing.

Recommended feeding levels are summarized in Table 1. They assumed good quality pasture (75-80% digestible; 11 MJ ME kg^{-1} DM) for a ewe of 55 kg conceptus-free live weight. For more than half the year the ewe can be fed at maintenance or less.

TABLE 1: Recommended feeding levels for the breeding ewe[a] throughout the year

		Recommended Feeding Levels	
Status	Weeks	X Maintenance	kg DM ewe^{-1} day^{-1} [b]
Dry	18	1.0	0.9
Flushing, Mating and Conception	6	1.5	1.4
Early-mid Pregnancy	14	0.5 - 1.0	0.5 - 0.9
Late Pregnancy	4	1.5[c] - 1.75[d]	1.4 - 1.6
Lactation	10	2.2[c] - 3.2[d]	2.0 - 2.9

a 55 kg conceptus-free live weight.
b Feed 11 MJ ME/kg DM.
c Single lamb.
d Twin lambs.

The feed requirement of a weaned, finishing lamb growing at 150 g day^{-1} is 1.2 to 1.5 kg DM $head^{-1}$ day^{-1} and that of a hogget growing at 50 g day^{-1} is 1.0 to 1.3 kg DM $head^{-1}$ day^{-1}.

Annual Feed Profile

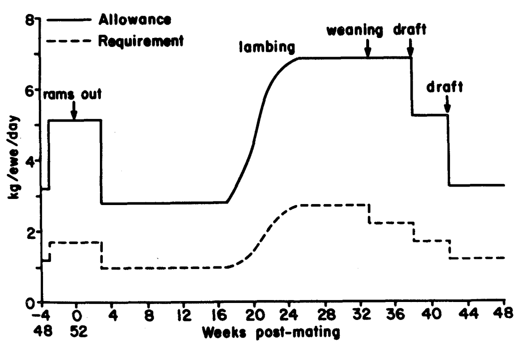
The annual feed requirement curve is shown in Figure 1. Assumptions: ewe 55 kg at mating; 6 weeks spread of lambing; 125% lambs born; 105% lambs weaned; average age at weaning 10 weeks; average weaning weight 20 kg; 40% of lambs sold or slaughtered at both 16 and 20 weeks of age; 25% replacements carried through the winter as hoggets. This profile includes the intake of the finishing lambs and hoggets. Total annual requirements are approximately 630 kg DM ewe^{-1} $year^{-1}$. The ewe can buffer changes in feed supply by either gaining or losing weight, with changes in productivity (Table 2) (Rattray *et al.*, 1978a). This paper for simplicity uses a standard feed profile curve as shown in Figure 1, and it is this curve or multiples of it that the sheep farmer is required to match to his feed supply curve.

TABLE 2: Mating live weights, weaning percentage and pasture intake[a]

Mating Weight (kg)	Lambs Weaned/ Ewes Mated (%)	Pasture Intake (kg DM ewe^{-1} yr^{-1})
45	83	515
50	93	580
55	103	645
60	113	710
65	123	775

a From Rattray *et al* (1978a)

Figure 1. Annual patterns of feed requirements (kg DM ewe^{-1} day^{-1}) and pasture allowance (kg DM ewe^{-1} day^{-1}) for the breeding ewe plus replacements.



PASTURE ALLOWANCES

Feed requirements of different classes of sheep or feeding levels for different levels of production are well documented. Not so well known are the allowances necessary to give the required intakes. Pasture allowance is a measure to ground level of the amount of pasture offered per grazing animal per day. Because the grazing animal can only harvest a portion of the pasture available, allowance is always greater than intake. Current research at Ruakura aims at defining the optimum and minimum allowances for various classes of stock at critical times of the year, thereby providing information on which to base feed budgeting. Definition of the relationships between allowance and performance will also allow an estimate of expected levels of animal performance if optimum allowances cannot be achieved; or indicate when it is desirable to offer supplementary feeds or crops. Table 3 shows, some pasture allowances which gave intakes close to recommended requirements.

The seasonal allowance profile, is also shown in Figure 1.

QUALITATIVE CONSTRAINTS

Partly as a consequence of the seasonal nature of pasture growth there is also a seasonal trend in pasture digestibility. It declines during late spring and summer to reach a minimum in late summer. This is in part due to ryegrass maturing and attempting to go to seed, partly to changes in botanical composition, changes in carbohydrate components and to an increase in dead material. Even in closely controlled pasture some decline occurs (Fig. 2) which may lower ewe and lamb performance (Rattray, 1977). Dead material can build up under situations of poor pasture management, low grazing pressure (Campbell, 1964; Jagusch *et al.*, 1978), or where surpluses cannot be conserved as hay and silage (as on much of the hill country). The importance of restricting the accumulation of dead material is shown in Figure 3. Pasture *in vitro* digestibility and proportion of green material are closely related (Y = 0.48 X + 32.6, n =

TABLE 3: Recommended pasture allowances for sheep

Status	Pre-grazing Pasture Yield (kg DM ha^{-1})	Pasture Allowance (kg DM $head^{-1}$ day^{-1})	Pasture Intake (kg DM $head^{-1}$ day^{-1})
Ewe:			
Mid-Pregnancy	1000 - 1500	2.1	0.9
	2000 - 2500	1.2	0.8
Late Pregnancy	2000 - 3000	2.0[a] - 3.5[b]	1.4 - 2.2
Early Lactation	3000 - 4000	4.5[a] - 6.5[b]	2.1 - 3.2
Flushing – Mating	2000 - 3000	6.0[c] - 4.0[d]	1.7 - 1.4
Weaned Lamb	3000 - 4000	5.0	1.5
Hogget	1800 - 2000	4.0	1.2

a,b Ewes with singles or twins, respectively.
c,d High proportion or low proportion of dead matter in pasture, respectively.

12, $S_b = \pm 0.033$, $r = 0.98$). Extrapolation shows the dead material averages 32.6% digestibility and the green material 80.6%. It has been shown recently that sheep tend to select mainly the green material (Table 4) and the proportion of green material in the pasture appears critical in affecting live-weight gain and ovulation rate during summer and autumn (Rattray *et al.*, 1978b; Thomson, 1977).

Figure 2. Annual pattern of *in vitro* organic matter digestibility of pasture grazed by sheep (Rattray, 1977).

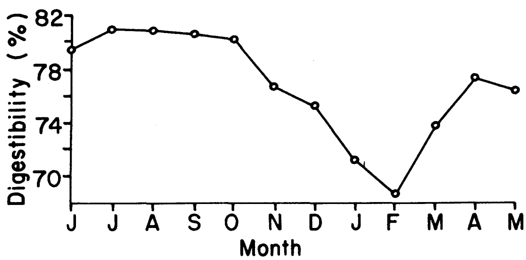


Figure 3. Relationship between *in vitro* digestibility and proportion of green material in autumn pasture.

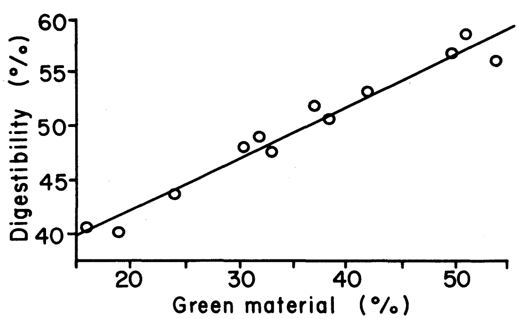


TABLE 4: Proportions (%) of green[a] material in pre- and post-grazing pasture (DM basis)[b]

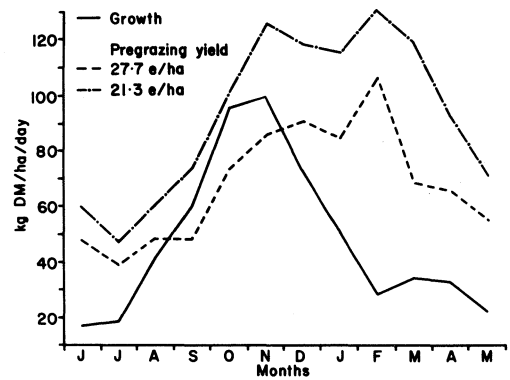
Year		1977		1978	
Yield (kg DM ha^{-1})		4310	2710	3250	1810
		%	%	%	%
Pre-grazing		52	34	57	40
Post-grazing Allowance:					
(kg ewe^{-1} day^{-1})	10	42	32	46	22
	6	37	24	38	19
	2	19	16	22	4

a Dead material (%) = 100 - Green material (%).
b From Rattray *et al* 1978b.

FEED SUPPLY

The seasonality of pasture growth is well documented and leads to some limitations in supply at various times of the year. Variations in rotation length allow rationing or allocation of the feed available, so that pasture produced during periods of peak growth can be conserved *in situ* for feeding during periods of poor growth. This is shown for a Ruakura experiment in Figure 4, where net pasture production averaged 17190 kg DM ha^{-1} over 3 years and ewes were rotationally grazed at either 21.3 or 27.7 ha^{-1}. This illustrates that the pattern of feed supply is not completely dictated by the seasonality of pasture growth. The effect of stocking rate is also shown.

Figure 4. Annual patterns of pasture growth and pre-grazing pasture yields under sheep rotationally grazed at either 21.3 or 27.7 ewes ha $^{-1}$ (Rattray, 1977).



MATCHING FEED SUPPLY AND DEMAND

To observe the constraints to sheep production pasture allowance profiles should be matched to pre-grazing yields. However, there are very few such data available and as can be seen from Figure 4, stocking rate can influence the feed supply. For simplicity feed requirements will be matched with pasture growth curves.

Stocking Rate

Annual pasture production dictates maximum stocking rate. Seasonality of production and level of stocking will determine the amount and duration of feed shortages and/or surpluses. This is illustrated in Figure 5 for pasture production at Ruakura under stocking rates of 16, 22 and 28 ewes ha^{-1}. A summary of the surpluses or deficits is shown in Table 5. At 16 ewes ha^{-1} there is no shortage and the surplus is 6680 kg DM ha^{-1}. At 28 ewes ha^{-1} major shortages exist in autumn, winter and early spring but small net surpluses in spring and summer result in a net deficit of -880 kg DM ha^{-1}. The situation with 22 ewes ha^{-1} is intermediate. Ideally spring and summer surpluses should be conserved as hay or silage or *in situ* to fill the deficits.

Figure 5. Annual patterns of net pasture production recorded under sheep grazing at Ruakura and of feed requirements of breeding ewes stocked at 16, 22 and 28 ewes ha $^{-1}$.

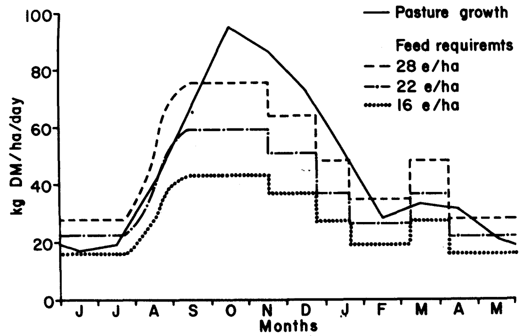


TABLE 5: Pasture production and feed requirements of 16, 22 and 28 ewes ha^{-1} at Ruakura

	kg DM ha^{-1}	Surplus/deficit
Pasture Production	16760	
Feed Requirements:		
16 ewes ha^{-1}	10080	+ 6680
22 ewes ha^{-1}	13860	+ 2900
28 ewes ha^{-1}	17640	- 880

Figure 5 shows that stocking to spring pasture production will result in major winter deficits, while stocking to winter production will result in a large spring/summer surplus, much of which will be wasted. Neither of these is satisfactory. A level between these extremes is desirable.

The extent of variation between years is also an important consideration in determining stocking rate. In regions where large differences occur between years it would be prudent to run fewer stock than could be successfully carried in the average year.

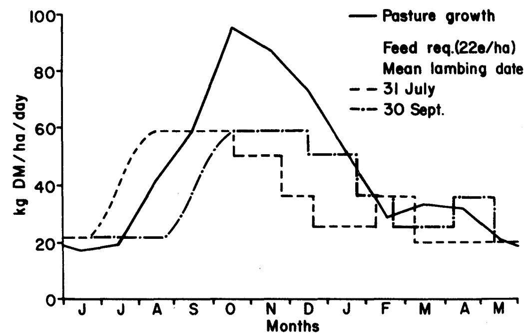
Date of Lambing

Matching the demand and supply curves also requires synchronization of the increasing feed requirements of late pregnancy and lambing with the onset of spring pasture growth. An example of this for the Waikato is shown in Figure 6. The feed profile for 22 ewes ha^{-1} has been shown for mean lambing dates 31 July and 30 September. A mean lambing date of 31 August for the same profile is given in Figure 5, and shows good synchrony between spring feed requirements and pasture growth; and mating and autumn growth. Lambing a month earlier results in a large spring deficit and summer surplus. Delaying lambing a month leads to qualitative restrictions. In areas of summer drought large summer deficits occur with difficulties in finishing lambs and flushing ewes.

For any area three considerations must be made when setting lambing date. These are the onset of spring growth, the timing and duration of a summer drought, and the timing and occurrence of autumn flush of feed.

Further examples of widely differing patterns of pasture growth will now be described.

Figure 6. Annual patterns of net pasture production recorded under sheep at Ruakura and of feed requirements of 22 ewes ha^{-1} with mean lambing dates of 31 July and 30 September.



Southland

Figure 7 shows the pattern of pasture growth at Winton on a silt loam (Radcliffe, 1974). Features to note are high annual production at 12,010 kg DM ha^{-1} (range 8,870-16,000), low winter growth, late onset of spring growth (late September), and a long growing period during the spring, summer and autumn. The feed profile curve is for 17.1 ewes ha^{-1} (to give 90% utilization) and a mean lambing date of October 7, which coincides with the onset of spring growth. There is a winter deficit and a large surplus over the summer. Other areas with similar pasture production patterns are shown in Table 6 with their potential carrying capacities. In some of these the growing season is not as long as in Southland.

Figure 7. Annual patterns of pasture growth at Winton (Southland) (Radcliffe, 1974) and of feed requirements of 17.1 ewes ha $^{-1}$ with a mean lambing date of 7 October.

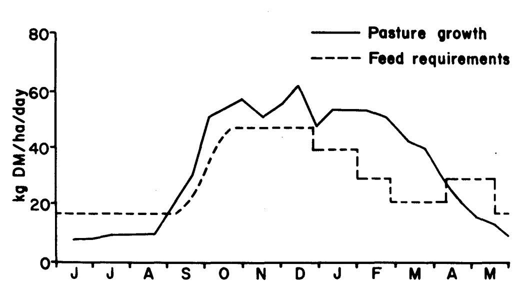


TABLE 6: Pasture production and carrying capacities for areas with extended summer growth

District	Annual Pasture Production (kg DM ha^{-1} yr^{-1})	Range	Recommended Carrying Capacity (ewes ha^{-1})
Westport[a]	10920	9970 - 11660	15.6
Winchmore[b] (irrigated)	10160	9050 - 12020	14.5
Manutuke[c]	11730	7240 - 16300	16.8
Taieri Plain[d]	10390	7520 - 12760	14.8
Invermay[d] (hill)	8890	3240 - 13500	12.7

a Radcliffe (1975a).
b Rickard and Radcliffe (1976).
c Radcliffe (1975b).
d Round-Turner *et al* (1976).

Wairarapa

The average annual pasture growth curve from Masterton on a silt loam is shown in Figure 8 (Radcliffe, 1975c). Noteworthy are the reasonable levels of winter growth, early spring onset (August), high October peak, marked summer-autumn drought and late autumn flush. In very poor years there may be virtually no growth from early January until mid-April. The average annual yield is 10,880 (range 8,970-14,970) kg DM ha^{-1}. A standard feed profile for 15.5 ewes ha^{-1} and a mean lambing date of September 7 is also shown. The biggest problem is the large summer/autumn deficit. In this case lambing date is critical. If it is too early major early spring deficits occur, and if late larger summer deficits result.

Some other areas with a similar summer drought problem are shown in Table 7. Frequently the spring peak is not so pronounced and winter production is lower, giving rise to both winter and summer feed deficits.

TABLE 7: Pasture production and carrying capacities for areas with summer droughts

District	Annual Pasture Production (kg DM ha^{-1} yr^{-1})	Range	Recommended Carrying Capacity (ewes ha^{-1})
Maraekakaho[a] (Hawkes Bay)	6740	4970 - 7800	9.6
Wairakei[b] (flats)	5740	4320 - 7900	8.2
Wairakei[b] (hill)	9000	6970 - 11050	12.8
Winchmore[c] (dry land)	5870	4240 - 7750	8.4

a Radcliffe (1975c)
b Baars *et al* (1975).
c Rickard and Radcliffe (1976).

CENTRAL OTAGO

The extreme case of a winter deficit is shown for dry-land pasture production at Poolburn in Figure 9 (Radcliffe and Cossens, 1974). In this area there is no grass growth for nearly 4 months over the winter period. A feed profile for 4.0 ewes ha^{-1} is also given showing the large winter deficit. Other irrigated pastures in this area similarly have no growth in winter, but the spring-summer-autumn production is three to four times greater (Radcliffe and Cossens, 1974).

Figure 8. Annual patterns of pasture growth at Masterton (Wairarapa) (Radcliffe, 1975c) and of feed requirements of 15.5 ewes/ha with a mean lambing date of 7 September.

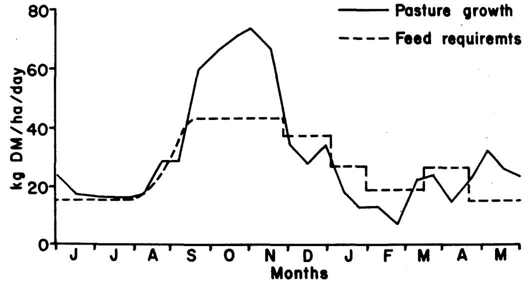
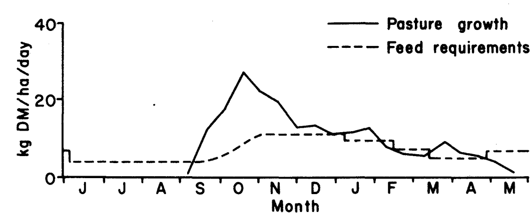


Figure 9. Annual patterns of pasture growth at Poolburn (Central Otago) (Radcliffe & Cossens, 1974) and of feed requirements of 4.0 ewes/ha with a mean lambing date of 15 October.



CONSTRAINTS ENCOUNTERED AND TYPE OF SUPPLEMENT SUITABLE

In the winter – early spring period the seasonality of growth may lead to quantitative restrictions, but in the summer and autumn both quantitative and qualitative problems in meeting sheep requirements may arise. Deficits and major fluctuations between years limit the number of sheep carried, while quality limitations restrict per head performance. Low quality feed will result in poor live weight gains of lambs, a high proportion of store lambs or lighter carcasses, low hogget weights, lowered ewe fleece weight and weight gain, and lowered ovulation rates and lambing performance.

The quality of the supplement required depends on the type of productive function for which it is used. For maintenance or for periods such as early- or mid-pregnancy, when some live-weight loss can be tolerated, quality of supplement is unimportant. Poor-average quality hay, silage or even straw can be used. For live weight gain, high quality (high energy, moderate protein) supplements are necessary e.g. brassicas, lucerne, grain or high quality hay or silage. With breeding ewes in late pregnancy high energy, high soluble carbohydrate feed is required to meet the increasing requirements of the conceptus and to prevent pregnancy toxaemia, especially in twin-bearing ewes. The quantity or quality of protein may be important in limiting ovulation rate. In one recent trial, although gains and intakes were satisfactory on pasture silage there was no response in ovulation rate (Rattray *et al* 1978b). Green material appears important at this time. High protein grains (lupins and peas) have also given ovulation responses in Australia (Croker *et al* 1978). However oestrogenic lucerne can depress ovulation rate (Jagusch *et al* 1977). During lactation, early spring or summer drought deficits necessitate the use of highly digestible high protein supplements.

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