FACTORS AFFECTING ANIMAL PRODUCTION : INTAKE AND UTILIZATION BY EWES GRAZING GRASS/CLOVER AND LUCERNE PASTURES

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Abstract

The total productivity from a ewe/lamb system on grass/clover and lucerne pastures stocked at 15 and 20 ewes/ha, respectively, over a 12-month period was compared. Intensive monitoring of yield, botanical, and chemical composition of total available and residual pasture enabled factors associated with production efficiency — *i.e.*, intake and utilization — to be determined and factors critically affecting these identified.

Lucerne pastures produced less liveweight of lamb/hectare at weaning (lucerne 552 and grass/clover 583 kg/ha) but more wool (lucerne 95 and grass/clover 70 kg greasy wool/ha) from an increased annual DM production of 7000 kg/ha above 13 040 kg DM/ha produced from grass/clover.

The single grazing utilization of pasture during lactation (grass/clover 53%, lucerne 63%) was relatively high compared with utilization recorded during maintenance (grass/clover 61%, lucerne 57%) considering the apparent intakes (grass/clover 2 x and lucerne 2.2~ maintenance) and lamb growth recorded. High utilization of pastures whilst meeting the high nutrient requirements of lactation was attributed to the high digestibility and proportion of green matter of pasture during this period compared with low values during maintenance.

Apparent intake of ewes grazing grass/clover pasture was correlated with yield of green matter (r = 0.85) and percentage green (r = 0.57) in available pasture. On lucerne, apparent intake was not correlated with green yield but yield of DOM (r = 0.61) and % DOM (r = 0.61) .

High selection by ewes for green matter resulted in the composition of intakes being similar in percentage green matter on both pasture types irrespective of physiological state of the animal or composition of available pasture.

The composition of pasture and the percentages of DOM and of green matter were found to be critical factors affecting intake and utilization and the overall production efficiency of ewe/lamb pastoral system.

INTRODUCTION

In the evaluation of pasture species, dry matter yield is a criterion commonly used for comparative purposes. The assumption usually made is that the most productive species will produce the greater return of animal product.

A critical factor affecting animal production is the amount of DM actually consumed and the efficiency with which consumed DA4 is converted to salable animal product — i.e., the intake and the quality of the intake are both important factors in the productivity of an individual animal. In the pastoral system to which a particular plant species is to apply the overall efficiency is affected by individual animal performance and the total amount of DM consumed. Dry matter that is not consumed senesces and decays, thus having little value for animal production.

Under grazing conditions, the intake of animals has been reported to be affected by pasture yield, quality, height, and density (e.g., Willoughby, 1959; Arnold and Dudzinski, 1967; and Hodgson, 1976), and the effects of these pasture factors are modified by animal factors such as physiological state, age, liveweight, and breed.

The relative importance of these and the possibility of interaction between plant factors and animals at different physiological stages whilst grazing have received little attention.

Lucerne under most New Zealand environments, given suitable soil conditions, has been reported (e.g., Stewart, 1967) to have a higher annual yield than the conventional grass/clover pasture. As a plant for haying or for specific animal production — i.e., fat lamb production (e.g., Mclean et *al.*, 1962) — lucerne has been well researched, but the suitability of lucerne as a total plant system for fat Iamb production has not.

In the evaluation of a pasture, annual DM yield or animal productivity achieved over a short term under constant defoliation may not accurately depict what may occur within a productive system. Factors other than DM yield may also bc critical if an overall increase in the efficiency of conversion of pasture to salable animal product is to bc achieved.

EXPERIMENTAL

TRIAL DESIGN

The apparent intake, utilization and productivity of ewes grazing grass/clover and lucerne pastures were assessed from a 12-month grazing trial conducted at Lincoln in Canterbury from March 1975 to late February 1976. The trial design as previously reported by Thomson and Jagusch (1976) was a 2 **x** 2 factorial, comparing early lambing, August 20, with late lambing, September 20, for ewes grazing grass/clover or lucerne pastures.

The stocking rates on the two pastures were calculated from previously recorded annual dryland DM productions at Lincoln (7000 kg DM/ha, grass/clover and 10 000 kg DM/ha, lucerne) and the ewe's annual requirements as reported by Jagusch and Coop (1971). Ewes on both pastures were stocked to provide a similar pasture allowance per ewe to meet the requirements for full productiori. Stocking rates of 15 ewes and 20 ewes/ha were employed on the two pastures, respectively. A four-paddock system (0.84 ha/paddock) was adopted for each treatment, thus stocking the grass systems at 52 ewes and the lucerne systems at 68 ewes.

Grazing management was governed by the following aims:

(1) To achieve an adequate level of available herbage before grazing to meet the nutritional requirements (Jagusch and Coop, 1971) of the ewe for maintenance, growth or lactation.

(2) To graze pastures at an intensity and duration known not to affect subsequent production (e.g., grass/clover, Brougham, 1970; lucerne, Jansen, 1975).

(3) To allow pastures sufficient time to recover such that near-maximum DM was produced prior to each grazing (grass/clover, Brougham, 1959; lucerne, Langer, 1968).

(4) To feed supplements sufficient to meet requirements when there is a shortfall in pasture.

The capacitance meter and the "paddock mean" method as described by Jones and Haydock (1970) was used to measure total pasture available and residual pasture. The full description and evaluation of the technique adopted is described by Thomson (in press).

No significant effects of early or late lambing as either main effects or interactions were observed on the components of pasture and animal performance measured. This then enabled the lambing treatments within pasture types to be combined and allow for sufficient data to establish factors critically affecting intake, utilization and performance of ewes grazing the two pasture types.

MEASUREMENTS MADE

At two-weekly intervals and whenever stock were moved on to a new paddock, yield assessments were made for total available pasture (by cutting to ground level pasture within cages

placed prior to grazing) and residual pasture (cut outside cages to ground level). Ewe and lamb liveweights were recorded at the same time, enabling the pasture measurements made to be related to liveweight and liveweight change over each grazing period. Measurement of chemical and botanical components of both total available and residual pasture was done to identify factors in pasture which may critically affect apparent intake and performance of ewes grazing grass/clover or lucerne pastures. Pasture components measured were:

(1) Chemical components: %DM, % protein, % acid detergent fibre (ADF), and the *in vitro* digestibility of the organic matter (% DOM) .

(2) Botanical components: proportion of lucerne, grass, clover, weeds (giving the proportion of total green material), and dead matter.

(3) Apparent intake, calculated as the difference between total available DM and residual DM proportioned on a daily basis/ewe grazing during the period of measurement (approximately 2-weekly intervals) .

(4) The "selectivity" of the ewes for the measured components was calculated in the following way:

e.g., selectivity for protein (SP)

% Protein in pasture apparently consumed = P.I.

$$P.I. = \frac{(\%\ P \times \text{DM yield}) \text{ available DM} - (\%\ P \times \text{DM yield}) \text{ residual DM}}{\text{DM yield available} - \text{DM yield residual}}$$

SP = P.I. – % P in available DM.

To enable comparisons between treatments at different lambing dates, analysis was conducted between pasture types when ewes were at similar physiological states. The stages in the ewe's annual productive cycle used for comparison were:

(1) Maintenance — 3 weeks post-mating to 5 weeks before lambing (winter) and post-weaning to 3 weeks before mating (summer) .

(2) Flushing — a 6-week period commencing 3 weeks prior to putting the ram out (summer/autumn).

(3) Lactation — lambing to weaning at 12 weeks (spring).

Information on the critical period 5 weeks before lambing was lost because a wind storm on August 1, 1975 blew over all pasture cages and insufficient information was available for a true Comparison.

RESULTS AND DISCUSSION

TOTAL PRODUCTION

To enable an evaluation of the systems from which the data for this paper were drawn, a brief summary of total pasture production and animal performance is presented (Table 1).

The main effect of grazing ewes on lucerne was the significant ($P < 0.01$) reduction in lambing percentage. Although fewer lambs were born per ewe on the lucerne treatments, lamb growth

TABLE 1: TOTAL PRODUCTION FROM PASTURES AND EWES RECORDED OVER 12 MONTHS ON GRASS/CLOVER AND LUCERNE GRAZING SYSTEMS

	Grass/Closer	*Lucerne*
Total DM production (kg/ha)	13 040	20 120
Total utilization (%)	82.2	79.1
Ewe liveweight gain (kg/ewe)	6.7	10.9
Lambing (%)	166	114
Liveweight (kg/ha) lambs weaned	583	552
Liveweight gain (kg/lamb) birth-weaning	23.3	22.2
Wool yield (kg/ha)	70	95
Supplementary feeds (kg DM/ha) :		
Consumed	290	2 250
Conserved	700	1510

TABLE 2: THE DM AVAILABLE/EWE/DAY AND THE COMPOSITION OF PASTURE ON OFFER

	Total Pasture on Offer (kg DM/ewe/day)	*% D O M*	*% Green*
Grass/clover:			
Maintenance	3.67	58.7	51.0
Flushing	3.23	72.7	69.2
Lactation	6.70	73.8	82.3
Lucerne:			
Maintenance	4.26	47.6	65.9
Flushing	5.06	52.4	70.8
Lactation	7.48	64.7	*86.9*
LSD:			
$P < 0.05$	1.18	4.1	6.7
$P < 0.01$	2.16	7.6	16.0

rates from birth to weaning were only similar to lambs reared on grass/clover. Ewes grazing lucerne gained liveweight over lactation, but over the same period ewes on grass/clover pasture lost liveweight. This indicated, considering the amount of pasture available per ewe during lactation on each plant system (Table 2), a greater efficiency of conversion of available DM to salable product (lamb) over lactation on grass/clover than lucerne. On the two-week grazing duration adopted on lucerne over the lactation period, it was observed that the ewes competed with lambs for quality leafy material. O'Connor (1970) noted that ewes strip-grazed, compared with a rotational grazing duration of up to two weeks on lucerne, gained liveweight in preference to lamb growth. The report by McLean et *al.* (1962) of superior weight gains of lambs grazing lucerne was for weaned lambs not suckling lambs as measured in this trial.

The annual DM production from lucerne was 7000 kg/ha greater than grass/clover, 13 040 kg/ha. Considering that the requirements for the additional ewes on lucerne would at a maximum have been only 3800 kg DM, it could be assumed that a greater lamb production would have been achieved if a higher stocking rate had been adopted.

This may not have resulted because, at the stocking rate employed, ewes on lucerne consumed 2.4 times more conserved feed over winter to maintain a similar liveweight to ewes grazing grass/clover. On lucerne only 67% of the winter requirement for conserved feed could be provided for from within the system, whereas, on grass/clover, surplus pasture to winter requirements was conserved.

Although lucerne produced more annual DM than grass/clover, difficulty was encounted in efficiently converting the available DM to lamb production.

Intake and Utilization of Pasture

An increase in the utilization of pasture is normally associated with a decline in individual animal intake and performance (Thomson and Jagusch, 1976). The results presented for grass/clover pasture in Fig. 1 show that there is only a small, though significantly ($P < 0.01$) higher utilization of available DM, DOM and green matter during maintenance feeding when compared with flushing or lactation. On lucerne, ewes at maintenance utilized more of the available green matter only. Utilization of DOM was similar at each physiological state, whilst, utilization

of DM was, significantly higher during lactation than during flushing or maintenance feeding.

Single grazing utilizations of available DM on both pasture types during maintenance were similar but the utilization of available DOM and green matter on lucerne was significantly ($P < 0.01$) higher at each physiological state than for grass/clover.

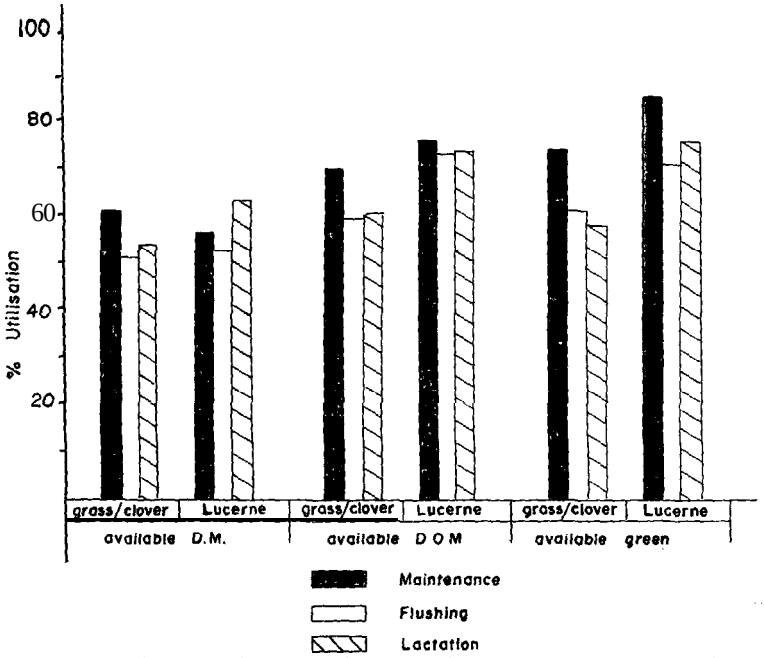

FIG. 1: *The influence of pasture fype and fhe physiological state of the ewe on the* single *grazing utilization* of *pasture* components.

For the drawing of Fig. 1, the following information was used:

	Available D M	*% Utilization Available D O M*	*Available Green*
Grass/clover:			
Maintenance	60.4	69.8	74.3
Flushing	51.0	58.9	61.3
Lactation	53.0	59.5	56.8
Lucerne:			
Maintenance	55.9	74.9	85.0
Flushing	52.9	73.2	71.3
Lactation	63.7	74.2	75.8

The relatively small differences in pasture utilization recorded at the different physiological states is of interest considering the markedly different levels of animal productivity achieved during these periods. Factors affecting pasture utilization have normally been associated with management — *e.g.*, Campbell (1966), Bryant and Parker (1971) —but the results presented suggest that there are also animal and plant factors involved.

Ewes were able to consume a significantly ($P < 0.01$) higher amount of pasture DM during lactation (Table 3), 2 **x** the apparent intake recorded during maintenance on grass/clover and 2.2 **x** that recorded on lucerne. High intakes during lactation, on both pasture types, are gained at similar levels of pasture utilization to that recorded during flushing.

On grass/clover pastures, a relatively high ievel of utilization of availabie DM was recorded during lactation. Associated with this was a loss in ewe liveweight (Table 3), but a high level of

TABLE 3: THE EFFECT 0 THE EWE'S PHYSIOLOGICAL STATE ON THE APPARENT INTAKE AND LIVEWEIGHT GAIN RECORDED ON GRASS/CLOVER AND LUCERNE PASTURE

	Apparent Intake (g DM/kg liveweight)		*Liveweight Gain Recorded* **Over** *Period*	
	Grass/Clover	*Lucerne*	*Grass/Clover*	*Lucerne*
Maintenance	25.7 cC	33.8 cC	0.7 B	0.5 B
Flushing	27.5 cc	36.1 cC	7.3 A	6.9 A
Lactation	49.9 bB	73.9 aA	— 1.3 D	3.5 c

For each group of results, Intake and Liveweight gain, means without a letter in common differ significantly at the 5% level (lower case) or 1% level (upper case) according to Duncan's Multiple Range Test.

lamb production was maintained, suggesting that ewes grazing grass/clover pastures can utilize body reserves to achieve high pasture utilization and maintain lamb growth. This factor was not apparent for ewes grazing lucerne during lactation.

The differences noted in the intake and utilization of grass/clover and lucerne pasture suggest that the physiological state of the grazing animal is a major factor affecting intake but the efficiency to which animals can achieve a desired intake level appears to vary in pastures between seasons and pasture type.

Effect of Composition of Pasture on Apparent Intake

Ewes grazing lucerne had a higher DM allowance with generally a higher proportion of green material throughout the year

than ewes grazing grass/clover pasture. (The availability of lucerne was less than grass/clover only through the late autumn/ winter maintenance period.) The digestibility of the available organic matter, though, was significantly ($P < 0.01$) lower for lucerne at each physiological period.

These differences in DM allowance, % DOM and % green may possibly explain the differences and similarities in utilization, apparent intake and animal performance between the periods of different physiological states and pasture type. The effects of these pasture parameters on apparent intake are presented in Table 4.

TABLE 4: THE INFLUENCE OF YIELD AND COMPOSITION OF AVAILABLE PASTURE ON THE INTAKE OF EWES GRAZING GRASS/CLOVER AND LUCERNE PASTURE (CORRELATION COEFFICIENTS PRESENTED)

	Grass/Clover	*Lucerne*
DM yield	0 795 **	0.242 NS
DOM yield	d.784 **	0.608 **
Green yield	0.846 **	0.311 NS
% DOM	0.465 *	0.614 **
% Green	0 .567 **	0.128 NS
Correlation between % green and % DOM	0.724 **	0.396 NS

As stated, the digestibility of available DM in lucerne is extremely low, while the DM allowance and the proportion of green material in the available DM are higher than recorded for grass/clover. For lucerne, the % DOM and yield DOM were found to be significant ($P < 0.01$) factors affecting intake.

Grass/clover pastures had a higher digestibility and lower pasture allowance and proportion of green material than lucerne. Correlation analysis (Table 4) shows that DM yield, yield green and percentage green were all significant ($P < 0.01$) factors affecting intake. Digestibility had the least effect of the parameters presented.

The proportion of green material and digestibility of the organic matter were highly correlated in grass/clover pasture but not in lucerne. In the determination of green matter, all plant material considered physiologically active was classified as green. For lucerne, this resulted in thick fibrous stems as well as leaves being included in the total green fraction. This factor must have greatly affected the relationship between intake and % green and digestibility and % green, as Fletcher (1976) reports that

digestibility of leaf remains high irrespective of maturity or season, but stem digestibility declines to low levels depending on maturity and season, suggesting that the ratio of leaf:stem, a factor not measured in the trial, may be a significant factor affecting intake and subsequent utilization of lucerne pastures.

In the overall analysis of trial results, all parameters measured in pastures and in animals were included in a correlation matrix for pasture type and physiological period. No effect of the botanical components — *i.e.*, percentages of grass, lucerne, clover, and weeds — other than composition of green material was observed. The chemical components measured were all highly correlated, especially for grass/clover (e.g., as the digestibility or % green increased, the % DM and % ADF declined and % protein increased,) making difficult the identification of factors affecting intake other than digestibility or % green.

SELECTIVITY OF THE EWE

Irrespective of the time of year or physiological state of the ewe, the available DM was found to differ considerably in chemical and botanical composition from that of residual pastures. From this it is assumed that the grazing ewe showed preference for some components of pasture and rejected others. The resulting effect was that residual pastures were higher in % DM, % ADF, and the proportion of dead matter, and lower in % DOM and % protein than the available pasture.

From these differences the selectivity of the grazing ewe for various pasture components was calculated (Table 5). Greater

TABLE 5: THE SELECTIVITY OF THE GRAZING EWE

	Grass/Clover	*Lucerne*
A. *The composition of pasture consumed compared with that on offer*		
Pasture component:		
% Protein	+ 3.0 dB	+ 4.6 dB
% ADF	— 4.2 eC	— 10.4 fD
% DOM	+ 11.4 CA	+ 17.5 bA
% Green	+ 14.7 bA	+ 20.2 aA
B. *The effect of physiological state of the ewe on the proportion of green material consumed*		
Maintenance	82.2 cA	87.0 bA
Flushing	71.4 cA	94.8 aA
Lactation	88.5 bA	98.3 aA

For each group of results, A and B, means without a letter in common differ significantly at the 5% level (lower case), or 1% level (upper case) according to Duncan's Multiple Range Test.

selection appeared to he towards green herbage, or the reciprocal, the rejection of dead matter. This apparent selectivity for green matter, despite marked differences in the % green in available herbage (Table 2), resulted in the proportion of green matter in the consumed pasture being consistently high through maintenance, flushing, and lactation.

This has some practical significance, considering the differences in apparent intake and animal productivity that were recorded during each productive stage, and especially the relatively large amounts of residual pasture shown to occur during maintenance feeding (Table 6). High residual yields at maintenance were associated with very low % DOM and low % green material in both pasture types. The result of this would be in the ewe being unable to select, or having great difficulty in selecting, a diet of desired composition to maintain an intake sufficient to meet requirements, especially if the pasture was grazed to any greater intensity. At this stage DM yield would not be a factor affecting intake and it would appear that quality factors would have an over-riding influence.

CONCLUSION

Comparisons made of farmlet systems for fat lamb production on grass/clover and lucerne pastures over a 12-month period resulted in a higher production of salable product, lamb and wool, per unit of DM consumed from grass/clover than from lucerne pasture. This resulted mainly from the reduced fertility (52% less lambing) and the high apparent intake during lactation of ewes grazing lucerne pasture. Difficulty also arose with lucerne in providing sufficient conserved feed from within the system adopted to meet ewe requirements over winter.

TABLE 6: YIELD AND COMPOSITION OF RESIDUAL PASTURE

	Residual Pasture Yield (kg DM/ha)	*% DOM*	*% Green*
Grass/clover:			
Maintenance	2 415	45.3	35.7
Flushing	1970	60.2	54.4
Lactation	2 300	66.3	73.0
Lucerne:			
Maintenance	3 080	31.0	25.2
Flushing	1840	31.5	46.2
Lactation	2 340	46.7	59.6
LSD:			
$P < 0.05$	639	4.8	8.0
$P < 0.01$	1 174	8.8	14.6

Lucerne digestibility was significantly ($P < 0.01$) less than grass/clover throughout the year. From the data presented, the low digestibility of lucerne was a major factor affecting intake and consequently the utilization achieved. The intake of ewes grazing grass/clover pastures was affected more by DM yield and the proportion of green matter in the available pasture than digestibility. This suggested that, if high production efficiencies are to be achieved on lucerne pastures, a greater emphasis will have to be placed on maintaining DM yield and improving quality. For grass/clover pastures, higher DM yields would be beneficial to total animal productivity before quality became a limiting factor.

Ewes grazing both pasture types selected a diet consistently high in green matter, irrespective of the level of intake, indicating a very marked "selectivity" for green or a rejection of dead herbage by grazing sheep. This factor must be critical and be given more attention if high intakes and utilization — i.e., high production efficiencies — are to be achieved from pastoral systems.

ACKNOWLEDGEMENTS

The invaluable guidance of Dr K. T. Jagusch in the initial planning and operation of the field trial, the assistance of N. Jay with field work, and the chemical analysis of pasture by K. J. Moore are gratefully acknowledged.

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