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FEEDING VALUE OF LUCERNE

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SUMMARY

Wairau lucerne was harvested at four different stages of growth and fed to 7-month-old hoggets in a comparative slaughter trial. At the same time a standard 60% grass meal-40% barley meal pelleted ration was fed to similar groups of sheep.

Changes in stage of plant growth have been related to chemical composition, digestibility, and energy and nitrogen balance. All lucerne diets were inferior to the grass meal-barley meal ration in promoting body growth.

A grazing trial, comparing pasture and lucerne as sole diets for unweaned and weaned lambs showed that lucerne was again inferior in promoting liveweight gain in young sheep.

IN the past decade the area of lucerne grown on the pumice country of the central North Island has increased six-fold and it is anticipated that this trend will continue into the forseeable future. Trials conducted in the South Island (McLean, *et al.*, 1965; Jagusch, *et al.*, 1971) have demonstrated the superiority of lucerne to many other pasture species in promoting liveweight gains in lambs.

The trials discussed in this paper were conducted to verify the superiority of lucerne as a feedstuff compared with other pasture species when grown under soil and climatic conditions applicable to a large area of the North Island.

EXPERIMENTAL

COMPARATIVE SLAUGHTER TRIAL

During the summer period 1970-1 four cuts of lucerne (Wairau variety) were harvested at the Wairakei Experimental Station, Taupo. These cuts represent four distinct stages of growth—early vegetative, late vegetative, bud formation, and 10% flowering. The lucerne was stored under a CO_2 atmosphere, transported to the Ruakura Agricultural Research Centre, quick frozen and stored at $-18°$ C until required for feeding. At the same time a standard comparative pelleted ration was compounded using a 60% grass meal-40% barley meal mixture (pellet).

Perendale wethers of approximately 7 months of age were randomized into one group of 12 animals (slaughtered Day O of trial) and ten groups of 6 animals (slaughtered Day 76) on the basis of their 24-hour fasted liveweights. All animals were drenched with thiabendazole at the commencement of the trial and weighed at 7-day intervals. Total faecal and urine outputs were measured for each sheep.

The ten groups of six animals were fed one of the five feeds either *ad libitum* or at a maintenance level. All animals were housed indoors in metabolism crates and individually fed daily, at 0900 hr, pellets or thawed herbage. *Ad libitum* groups were fed 20% more than they consumed the previous day.

The slaughtering, sampling and analytical procedures were similar to those used by Joyce and Newth (1967).

GRAZING TRIAL

One hundred and fifty mixed-age Romney ewes, mated to Romney rams, were randomized at lambing on a liveweight basis into three groups (50 lambs/group). Two groups of ewes were grazed on lucerne (lambs weaned at 16 and 6 weeks) and the third on pasture (weaned at 16 weeks). Each group was rotationally grazed, remaining on average 7 days in each 0.4 ha paddock. In the early-weaned lucerne group the ewes, after weaning, were allowed to graze each paddock after the lambs had been shifted into a fresh paddock. After all the lambs had been weaned (16 weeks of age) the ewes were removed from the trial area and the lambs remained until slaughter at 20 weeks of age. All lambs were weighed at approximately fortnightly intervals from birth until slaughter.

On each of the two lucerne treatments, lucerne growth and apparent intake were estimated, using a cage technique.

RESULTS

Comparative Slaughter Trial

Chemical Composition of Feeds

Table 1 shows the chemical composition of the five feeds. While the crude protein content of the lucerne decreased with increasing stage of maturity, the acid detergent fibre and lignin contents increased. The calorific value of all feeds was similar. The grass meal-barley meal ration had a 50% lower crude protein content but a 60% higher soluble sugar content than the average of the four lucerne diets.

TABLE 1: CHEMICAL COMPOSITION OF FEEDS (DM BASIS)

	Lucerne				*Pellet*
	EV	*LV*	*BF*	*FL*	
% Crude protein	29.8	26.4	24.8	22.1	13.8
% Acid detergent fibre	28.2	29.7	33.3	31.4	—
% Lignin	4.25	5.85	6.55	6.40	—
% Soluble sugars	5.58	4.85	4.54	5.81	8.27
% Ash	14.5	12.3	12.7	10.5	8.7
Calorific value (kcal/g)	4.165	4.310	4.110	4.225	4.077

EV—early vegetative; LV—late vegetative; BF—bud formation; FL—flowering.

Yield and Digestibility of Feeds

Table 2 shows that all digestibility coefficients of the lucerne decreased with increasing maturity or later stage of growth. While the crude protein digestibility of the grass meal-barley meal ration was low, the digestibilities

TABLE 2: YIELD AND DIGESTIBILITY OF NUTRIENTS

	Lucerne				*Pellet*
	EV	*LV*	*BF*	*FL*	
% Digestibility					
Organic matter	76.4	71.8	65.9	62.5	68.0
Crude protein	80.7	77.4	77.3	74.9	59.3
Gross energy	72.1	69.1	61.8	59.9	63.5
Yield (kg/ha)					
Dry matter	2498	3469	4159	4650	—
Digestible organic matter	1631	2184	2392	2607	—
Crude protein	744	917	1030	1028	—
Digestible crude protein	600	709	796	771	—

of organic matter and gross energy were intermediate between those of the four lucerne diets. The digestibilities of diets fed at a maintenance level were 1 to 2 units higher than when fed on an *ad libitum* basis.

The yield of dry matter increased with increasing maturity so that 87% more dry matter was harvested at the flowering stage than at the early vegetative stage. However, owing to the lower digestibility of the later harvested material only 63% more digestible organic matter and 38% more digestible crude protein was harvested at the flowering stage.

Dry Matter Intake and Liveweight Gain

There were marked effects of feed type and feeding level on both the rate of liveweight gain (Table 3) and carcass weight. The highest rates of liveweight gain were obtained with those animals fed pellets *ad libitum*. While these were associated with highest levels of dry matter intake, on a digestible organic matter basis the intake of this group was not significantly different from those of the groups fed the early or late vegetative lucerne, yet the average growth rate was 31% higher. There was also a slightly lower DOM intake required for maintenance of the pellet-fed group.

Wool growth rates showed a similar trend in general except that the pellet-fed group showed no marked superiority over the groups fed early or late vegetative lucerne.

Feed conversion efficiency, defined as liveweight gain per unit dry matter intake, was superior in groups fed lucerne at the earlier stages of growth rather than mature. Animals fed grass meal-barley meal showed greatest food conversion efficiency, but relative to those fed lucerne at the bud formation and flowering stages comparisons are affected to a considerable extent by differences in voluntary intake.

Carcass weights of each group of hoggets showed a trend similar to those of liveweight gain.

Nitrogen Balance

Owing both to a decrease in nitrogen content of the herbage with increasing maturity and to differences in voluntary intake, the intake of nitrogen decreased by 46% between the groups of sheep fed *ad libitum* the earliest and latest cuts of lucerne. In all lucerne-fed sheep, irrespective of feeding level, 70 to 75% of the N intake was

TABLE 3: GROWTH RATE AND INTAKE DATA OF HOGGETS FED LUCERNE OR GRASS MEAL-BARLEY MEAL

	Fed ad libitum					*Fed Maintenance*				
	Lucerne				*Pellet*	*Lucerne*				*Pellet*
	EV	*LV*	*BF*	*Fl*		*EV*	*LV*	*BF*	*Fl*	
Liveweight gain (g/day)	91	85	48	36	115	16	3	13	16	21
Wool growth (g/day)	11	12	5	7	10	5	5	3	3	5
Dry matter intake (g/day)	724	770	593	571	825	434	418	441	492	385
Digestible organic matter intake (g/day)	484	488	375	310	500	288	265	251	271	240
Carcass weight (kg)	11.30	11.13	8.80	8.59	12.95	8.85	8.13	7.75	8.13	8.32
Efficiency of liveweight gain (g DM/g LWG)	8.2	9.6	18.4	18.6	7.4	—	—	—	—	—

TABLE 4: NITROGEN BALANCE DATA (g/day) FOR HOGGETS FED LUCERNE OR GRASS MEAL-BARLEY MEAL

	Fed ad libitum					*Fed Maintenance*				
	Lucerne				*Pellet*	*Lucerne*				*Pellet*
	EV	*LV*	*BF*	*Fl*		*EV*	*LV*	*BF*	*Fl*	
Intake	34.4	32.8	26.4	21.1	18.4	20.4	17.7	17.5	17.5	8.2
Faeces	6.9	7.4	6.1	5.4	7.8	3.8	4.0	3.9	4.3	3.2
Urine	24.3	22.3	19.0	14.8	7.0	15.5	13.1	13.3	12.7	4.4
Retention	3.2	3.1	1.3	0.9	3.6	1.1	0.6	0.3	0.5	0.6

excreted in the urine (Table 4). In these same groups of sheep, those fed *ad libitum* retained 4 to 10% of the N intake and those on a restricted basis between 2 and 5%. The N balance of sheep fed grass meal-barley meal showed a completely different pattern from those of the lucerne-fed sheep. While the N digestibility of the pelleted diet was lower than that of the lucerne diet, only 40 to 50% of the N intake was excreted in the urine and 7% and 20%, respectively, of the intake was retained by the restricted and *ad libitum* groups.

Energy Balance

The energy balances for the groups of sheep are shown in Table 5. For sheep fed lucerne *ad libitum* the intake of gross energy was lowest for the most mature diet. Similarly the digestibility of gross energy fell from 72.5% to 58.6% with increasing maturity. Urinary energy accounted for 4 to 7% and 7 to 10% of gross energy intake for groups fed *ad libitum* and maintenance levels, respectively. Comparable figures for estimated methane losses of energy were 7% and 8 to 9%, respectively (Blaxter and Clapperton, 1965). Heat production (calculated by differences) of sheep fed lucerne *ad libitum* accounted for 45 to 59% of the gross energy intake with the highest proportion occurring in the group fed the flowering stage of growth; for the grass meal-barley meal diet heat production was only 39% of the gross energy intake. In the restricted groups heat production accounted for 48 to 54% of the gross energy intake irrespective of diet. Energy retention of *ad libitum* groups was highest for the pelleted ration and decreased with increasing lucerne maturity. Those sheep fed FL and BF lucerne were in a low positive energy balance. Excepting sheep fed pellets, all restricted groups were in slight negative balance.

The metabolizable energy (ME) of each of the feedstuffs is given in Table 5.

Data on the utilization of ME for several diets are given in Table 6. When the intakes of individual animals were regressed against metabolic body size and energy retention, no significant differences could be shown between the equations for the four lucerne diets at the two levels of feeding, hence the data were pooled. The regressions for white clover and perennial ryegrass have been calculated from the feeding trials of Rattray and Joyce (1969) in which sheep of similar ages and liveweights as those in the present experiment were used. These regression equa-

TABLE 5: GROWTH RATE AND INTAKE DATA OF HOGGETS FED LUCERNE OR GRASS MEAL-BARLEY MEAL

	Fed ad libitum					*Fed Maintenance*				
	Lucerne				*Pellet*	*Lucerne*				*Pellet*
	EV	*LV*	*BF*	*FI*		*EV*	*LV*	*BF*	*FI*	
Intake	3090	3370	2646	2401	3370	1685	1805	1818	2098	1526
Faeces	850	1045	995	993	1296	478	556	706	857	526
Urine	223	229	169	147	124	161	153	131	145	107
Methane	218	232	180	162	229	153	147	140	158	122
Heat	1530	1579	1244	1082	1310	855	977	908	946	732
Retention	269	285	58	17	411	38	—28	—67	—8	39

	Lucerne				*Pellet*
	EV	*LV*	*BF*	*FI*	
Metabolizable energy (kcal/g DM)	2.272	2.346	2.052	1.916	2.030

tions suggest that the ME from grass meal-barley meal rations was used almost 30% more efficiently for maintenance than from the other three diets. The utilization of ME fed above maintenance was similar for the lucerne and ryegrass diets but the grass meal-barley meal and white clover rations were 27% more efficient in promoting growth.

TABLE 6: UTILIZATION OF METABOLIZABLE ENERGY IN FOUR DIETS

Diet	*Equation*	*% Utilization of ME Fed above Maintenance*
Lucerne	$Y = 133X_1 + 2.36X_2$	42
Pellet (grass meal-barley meal)	$Y = 99X_1 + 1.86X_2$	54
White clover*	$Y = 144X_1 + 1.90X_2$	53
Perennial ryegrass*	$Y = 143X_1 + 2.37X_2$	42

*Data from Rattray and Joyce (1969).
Y = ME intake (kcal/day)
X_1 = kg $LW^{0.75}$
X_2 = energy retention (kcal/day)

GRAZING TRIAL

Preliminary results indicate that lucerne feeding did not appear to stimulate the growth rates of lambs (Table 7). In those groups weaned at 16 weeks of age, lambs grazing pasture with a reasonable clover content were consistently 11 to 12% heavier than those grazing lucerne. These differences were predictable from the values calculated earlier for the efficiency of utilization of ME for growth.

TABLE 7: GRAZING TRIAL—LAMB LIVEWEIGHTS (kg)

Weight at	*Fed Pasture (late wean)*	*Fed Lucerne (early wean)*	*Fed Lucerne (late wean)*
Birth	4.5	4.6	4.5
6 wk	13.8	12.4*	12.4
16 wk	25.7*	19.4	23.0*
20 wk	29.6	22.0	27.1

*Weaned.

Early weaning of lambs at 6 weeks of age on to lucerne appeared to penalize their growth rates by comparison with both the late-weaned lucerne and pasture-fed groups. Early weaned lucerne-fed lambs were almost 17% lighter at 16 weeks of age compared with their late-weaned lucerne-fed counterparts.

DISCUSSION AND CONCLUSIONS

The results of dry matter yields cannot be considered as conclusive since they relate to only one season's growth, yet they conform to the general pattern of yields recorded at other sites in New Zealand (J. D. J. Scott, unpubl.). Such results indicate that not only is the yield at any one cut increased with advancement in the stage of maturity at harvesting, but that total annual yield per hectare is also increased. Consequently, the state of growth at which lucerne should be harvested will depend on the use contemplated for this feed. If it is to be used only for maintenance then harvesting at the later stages of growth will maximize the yield of feed units. If however it is to be used as a productive type ration then lucerne should be harvested at the vegetative state of growth.

Previous trials by McLean *et al.* (1965), Jagusch *et al.* (1970), Jagusch and McConnell (1971) and Jagusch *et al.* (1971), have shown that lucerne is capable of sustaining high growth rates in lambs. In the trials of McLean *et al.*, lucerne-fed lambs grew 82% faster than those fed perennial ryegrass, and at rates very similar to lambs fed white clover. Results of the present trials do not verify these findings. Previous feeding trials (Joyce and Newth, 1967; Rattray and Joyce, 1969) gave ME contents of white clover of 2.9 kcal/g DM whereas in the present trial those of lucerne ranged from 1.9 to 2.4 kcal/g DM. Again, lambs fed white clover gained at 40% faster rates than others fed the two vegetative stages of lucerne despite having identical DM intake. Furthermore, in the present grazing trial, lambs grazing pasture gained at a faster rate than those on lucerne.

In recent years it has been advocated that feeding standards for ruminants in New Zealand should be based on the metabolizable energy system. This system, as formulated by the Agricultural Research Council of Great Britain (ARC, 1965), is based on the concept that for each productive function and within certain intake limits the utilization of ME is constant, irrespective of the source of diet. On the basis of present and previous studies at this Station, the ME requirements for maintenance of sheep as laid down by the ARC (1965) appear now to be far too low for sheep being fed fresh pasture herbage and lucerne, since the only value for maintenance comparable with those of the ARC is of the dry-pelleted grass meal-barley meal ration. This large apparent maintenance requirement of pasture-fed animals has already been noted for dairy-beef cattle (Joyce, 1971). The large range in the efficiency of utilization of ME fed above maintenance for growth again suggests that further examination of the ME system is warranted before it is adopted for general use within New Zealand.

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