The effect of date of cut and barley substitution on gain and on the efficiency of utilization of grass silage by growing cattle

1. Gains in live weight and its components

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(*Received 21 December 1987 – Accepted 25 April 1988*)

1. A primary growth of perennial ryegrass (*Lolium perenne*) was cut early or late to produce silages of high and low digestibility. The crops were wilted for 2–4 h and preserved with formic acid at 2·4 litres/t fresh weight. The resulting silages were well preserved with a pH of 3·9 and 3·8, lactic acid content of 108 and 73 g/kg dry matter (DM) and total nitrogen content of 24·6 and 18·4 g/kg DM for early- and late-cut silage respectively.

2. Forty-two British Friesian male castrates (steers) initially 12 months of age and 305 kg live weight (LW) were used, of which ten were slaughtered at the start of the experiment. The remaining steers were divided into four groups of eight animals and were given the early-cut silage alone (H) or the late-cut silage alone (L) or with barley at either 280 (LC1) or 560 (LC2) g DM/kg total DM. The intake of total DM was restricted to a daily allowance of 18 g DM/kg LW and the steers were slaughtered in two groups after 119 and 140 d on experiment.

3. Both earlier cutting of herbage and substitution of late-cut silage with barley significantly ($P < 0{\cdot}001$) increased the apparent digestibility of gross energy (H 0·748, L 0·619, LC1 0·668, LC2 0·705), whereas earlier cutting increased the digestibility of acid-detergent fibre from 0·638 (L) to 0·777 (H) and substitution with barley resulted in a significant ($P < 0{\cdot}001$) depression to 0·595 (LC1) and 0·519 (LC2). Substitution of late-cut silage with barley significantly ($P < 0{\cdot}001$) increased metabolizable energy (ME) intake from 58·9 (L) to 69·5 MJ/d (LC2) and crude protein ($N \times 6{\cdot}25$; CP) intake from 688 (L) to 779 g/d (LC2), but the highest intakes of ME and CP (73·5 MJ/d and 952 g/d respectively) were achieved with the early-cut silage.

4. Earlier cutting resulted in significant ($P < 0{\cdot}001$) increases in body-weight gain from 292 to 696 g/d, fat gain from 121 to 260 g/d, protein gain from 31·1 to 86·9 g/d and energy retention from 5·5 to 12·2 MJ/d for silages L and H respectively. However, substitution of the late-cut silage with barley increased gains to a greater extent. Thus, empty-body gain was increased to 552 and 800 g/d, fat gain to 189 and 302 g/d, protein gain to 76 and 116 g/d and energy retention to 9·2 and 14·6 MJ/d for diets LC1 and LC2 respectively. The difference in gains between diets H and LC2 achieved significance ($P < 0{\cdot}05$) for all components except fat.

5. It is concluded that although earlier cutting of herbage for silage results in increased gains of protein and energy, the amounts retained are less than those from a similar increment of ME and CP achieved by substituting a late-cut silage with barley.

High rates of live-weight (LW) gain of approximately 1·0 kg/d have been achieved by steers given early-cut silage of high digestibility as the only feed (Thomas *et al.* 1980). Delayed cutting has resulted in lower levels of performance although the response in LW gain to supplementary concentrates has been markedly greater with late-cut rather than early-cut herbage, conserved either as silage or hay (Leaver, 1973; Steen & McIlmoyle, 1982). This differential response to concentrate has been ascribed to both a lower substitution rate and greater increases in digestibility with late-cut rather than early-cut material (Blaxter & Wilson, 1963; Vadiveloo & Holmes, 1979).

Differences in the performance of steers given early-cut silage alone or later-cut silage supplemented with concentrate could also be influenced by a lower efficiency of utilization of the metabolizable energy (ME) in a diet of forage alone compared with a mixed diet (Agricultural Research Council, 1980). This difference, although relatively small, when combined with the varying yields of herbage associated with different cutting regimes (Corrall *et al.* 1982) could have important implications on animal production per unit area of grassland and on financial returns from a beef enterprise.

The objective of the present experiment was to examine the effect of LW gain and its components of increasing the supply of nutrients either through an increase in the digestibility of silage or by increasing the proportion of rolled barley given with a low-digestibility silage made from late-cut herbage. Values for nutrient supply and energy partition by calorimetry are given in a following paper (Beever *et al.* 1988).

MATERIAL AND METHODS

Diets

Silages were made from a primary growth of perennial ryegrass (*Lolium perenne* cv. S23) which had received 130 kg nitrogen, 30 kg phosphorus pentoxide and 30 kg potassium oxide/ha. Grass was cut either on 27 May (early) when it had a dry matter (DM) content of 233 g/kg fresh weight, a N content of 21·8 g/kg DM and a digestible organic matter (DOM) content in the DM (DOMD) in vitro of 0·684 kg/kg DM, or on 23–27 June (late) when DM, N and DOMD contents were 215, 14·6 and 0·565 respectively. The crops were wilted for 2–4 h and were harvested by means of a precision-chop forage harvester and ensiled with an additive containing formic acid (Add-F; BP Nutrition International plc; 850 g formic acid/l) at 2·4 litres/t fresh weight. The harvested yields were 4·15 and 7·66 t DM/ha for the early and late cuts respectively. The silages were stored in covered bunker silos, sealed with plastic sheets. The early-cut silage was given alone (H), and the late-cut silage alone (L) or with rolled barley at either 280 (LC1) or 560 (LC2) g DM/kg total DM. Total DM intake was restricted to an estimated value of 18 g DM/kg LW per d.

Livestock and management

Forty-two British Friesian male castrates (steers) which had previously been uniformly grazed at pasture were loose-housed for 21 d, in pens on sawdust. They were offered silage *ad lib.* and 2 kg DM rolled barley, and fed individually through transponder-controlled-access doors (Calan-Broadbent; Amcal, USA). This was followed by a 14 d period during which the animals received a restricted daily diet of silage at 13·5 g DM/kg LW and rolled barley at 7·5 g DM/kg LW. At the end of this period when the cattle were 12 months of age and 305 kg LW, they were blocked by weight in groups of five, excluding the heaviest animal and lightest animal which were allocated to the initial slaughter group. One animal from each group was then allocated at random to one of the four treatments or to the initial slaughter group. This latter group was weighed before slaughter. At slaughter the weights of the body components, including gut contents and blood, were recorded, a sample of the latter being frozen immediately and later freeze-dried and ground. Four fractions consisting of (1) viscera, (2) alimentary tract, (3) head, hide and feet and (4) the left side of the carcass, including kidney, were later transferred to a blast freezer.

During the experiment the steers had free access to water. They were individually fed on the treatment silages and barley twice daily in approximately equal meals, and a mineral mix was added to the silage to meet the requirements proposed by the Agricultural Research Council (1965). The cattle were weighed once weekly and the quantity of food adjusted to achieve a daily intake of 18 g DM/kg LW. Five groups of four animals at a time, one per treatment on each occasion, were moved to individual stalls for a 9 d period, and digestibility of the diets, was determined by the total collection of faeces using a harness and bag method over the last 7 d.

At the end of the experiment the steers were slaughtered in two equal groups, after 119 and 140 d on experiment. The procedures at this final slaughter were the same as those for the initial slaughter group.

Sampling and chemical analysis

Samples of the feeds were taken daily and bulked over 1 week. The weight of the fresh faeces produced daily was recorded and portions of 100 g/kg of the fresh daily faecal production were stored, bulked over the collection period for each animal. Silage samples were finely chopped in a bowl chopper (Lynhakker Model 6H; George Hansen, Copenhagen, Denmark) and oven- and freeze-dried samples of feed and faeces were processed in a laboratory mill. Fresh samples of silage and faeces were stored at −15° before processing.

On removal from the blast freezer for processing, the body fractions were weighed in order to record changes in moisture content. After cutting into cubes of approximately 7·5 cm^3 with a band-saw, and mincing a maximum of four times, depending on type of sample, subsamples of all fractions were taken for analysis.

The concentration of DM in the silage was determined by distillation with toluene (Dewar & McDonald, 1961) and corrected for the concentration of alcohols. Organic acids and alcohols were extracted from fresh samples of silage using sulphuric acid (0·3 mol/l) and estimated quantitatively by gas–liquid chromatography. The concentration of ammonia-N in silage was determined by a specific ion electrode. A micro-Kjeldhal digestion technique, modified for use with an autoanalyser, was used for dried samples of barley and fresh samples of silage, faeces and animal tissue to determine total N. Ash concentration was determined by heating a sample to 550° for 16 h. The concentrations of ash-free neutral- and acid-detergent fibre (NDF and ADF) were determined on freeze-dried samples by the method of Van Soest & Wine (1967). The gross-energy content in fresh samples of silage was determined according to the method described by Terry & Osbourn (1980). The concentration of water and ash in animal tissue was determined by methods of the Association of Official Agricultural Chemists (1965). Fat was extracted into tetrachloroethylene and measured as the fall in specific gravity of the solvent using the Foss-let technique (Foss Electric UK Ltd, The Chandry, Bishopthorpe, York). Gross-energy values of 39·3 MJ/kg fat and 23·6 MJ/kg protein were adopted, as suggested by the Agricultural Research Council (1980).

Statistical analysis

Values were subjected to analysis of variance. After the removal of effects due to blocks and treatments, 21 df remained for error in the analysis of body components and 16 df for digestibility.

RESULTS

Chemical composition of the silages and of the barley

The silages had a similar concentration of DM and although total fermentation acids were lower with the late-cut silage the pH, NH_3-N concentrations and proportion of fermentation acids in the form of lactic acid were similar between the silages (Table 1). The gross-energy contents of the silages were higher than that of the barley. The NDF and ADF concentrations were higher in the late-cut than in the early-cut silage; the barley had the lowest fibre content. The total N concentration of the barley was intermediate between that of the early- and late-cut silages (Table 1).

Apparent digestibility of the diets and food intake

Increasing the proportion of the barley supplement in the diets containing the late-cut silage led to a progressive increase in the digestibility of the DM and gross energy but to

Table 1. *Chemical composition of the perennial ryegrass* (Lolium perenne) *silages and of the barley (g/kg dry matter (DM) unless otherwise stated)*

	Silage		
	Early cut	Late cut	Barley
DM concentration (g/kg fresh weight)	244	233	841
Ash	80·2	60·0	23·4
Gross energy (MJ/kg DM)	19·2	19·0	18·4
ADF	262	347	62
NDF	441	585	172
Total nitrogen	24·6	18·4	21·0
Ammonia-N (g/kg total N)	121	124	
pH	3·9	3·8	
Lactic acid	108·4	72·8	
Acetic acid	13·6	15·2	
Total fermentation acids	122·0	88·0	
Ethanol	10·0	27·7	

ADF, acid-detergent fibre; NDF, neutral-detergent fibre.

Table 2. *Apparent digestibilities of dietary constituents, and daily intakes of dry matter (DM), metabolizable energy (ME) and crude protein (nitrogen × 6·25) of growing cattle fed on grass-silage-based diets*

	Early-cut silage	Late-cut silage			
Diet...	H	L	LC1	LC2	SE of means
Apparent digestibility:					
DM	0·748	0·630	0·674	0·710	0·0047***
Gross energy	0·735	0·619	0·668	0·705	0·0059***
NDF	0·798	0·653	0·610	0·562	0·0099***
ADF	0·777	0·638	0·595	0·519	0·0126***
Intake:					
DM					
kg/d	6·21	5·96	6·13	6·31	0·053**
g/kg LW per d	18·3	18·1	18·3	18·2	0·07
ME†					
MJ/d	73·5	58·9	65·3	69·6	0·58***
MJ/kg LW per d	0·217	0·179	0·195	0·200	0·0007***
Crude protein					
g/d	952	688	732	779	7·1***
g/kg LW per d	2·81	2·09	2·19	2·25	0·008***

H, early-cut silage alone; L, late-cut silage alone: LC1, late-cut silage with 280 g barley DM/kg total DM: LC2, late-cut silage with 560 g barley DM/kg total DM; ADF, acid-detergent fibre; NDF, neutral-detergent fibre; LW, live weight.

** $P < 0·01$, *** $P < 0·001$.

† Calculated from the observed intakes of digestible energy (DE) and ME: DE value of 0·84 (from Beever *et al.* 1988).

Table 3. *Live weight and its components at slaughter of growing cattle fed on grass-silage-based diets*

Diet...	Early-cut silage H	Late-cut silage L	LC1	LC2	SE of means
Live wt (kg)	393	354	382	408	4·8***
Empty-body-wt (kg)	335	282	316	346	4·1***
Carcass wt (kg)	220	185	212	230	3·4***
Fat (kg)	68·3	50·0	59·2	73·4	2·47***
Protein (kg)	56·1	48·8	54·6	59·5	0·86***
Ash (kg)	16·1	13·8	15·1	15·6	0·71 NS
Energy (MJ)	4009	3117	3617	4291	95·4***

H, early-cut silage alone; L, late-cut silage alone; LC1, late-cut silage with 280 g barley dry matter (DM)/kg total DM; LC2, late-cut silage with 560 g barley DM/kg total DM; NS, not significant.
*** $P < 0{\cdot}001$.

a reduction in NDF and ADF digestibility (Table 2). The digestibilities of the dry matter, gross energy and in particular NDF and ADF were higher in the early-cut silage (H) than in the diet containing the late-cut silage with the highest proportion of barley (LC2).

The intake of DM was similar between treatments when scaled for LW but the intake of ME and to a lesser extent crude protein ($N \times 6{\cdot}25$; CP) increased with increasing proportion of barley (Table 2). However, the highest intakes of ME and in particular CP were attained with diet H and these were significantly higher ($P < 0{\cdot}05$) than those achieved with diet LC2 (Table 2).

LW and its components at slaughter

Substitution of the late-cut silage (L) with an increasing proportion of barley resulted in increases in LW, and empty-body and carcass weights at slaughter and in the weight of fat and protein (Table 3). The respective weights achieved with diet H, although higher than those of steers given diet L, were lower than those achieved with diet LC2 and this trend achieved significance for LW, empty-body, carcass and protein weights ($P < 0{\cdot}05$).

Gains in LW and the components of LW

Gains in the components of LW were calculated as the difference between the measured component at slaughter and the initial value estimated from regression analysis on the values derived from the initial slaughter group. These equations are shown in Table 4. Significant relations were found for all components except that for fat where the regression approached significance ($P < 0{\cdot}10$).

Gains in LW and in the components of LW, apart from gut fill, increased with increasing proportions of barley given with the late-cut silage (Table 5). The gains achieved with diet H, although higher than those by steers given diet L, were lower than those achieved with diet LC2. This difference achieved significance ($P < 0{\cdot}05$) for all components except fat.

The gain in the gut fill was highest with late-cut silage and was reduced by the inclusion of barley. A negative increment in gut fill was observed with diet H (Table 5).

The composition of empty-body-weight at slaughter and of empty-body gain

The composition of the empty body at slaughter and of empty-body gain was assessed by regression analysis in order to separate the effects of diet *per se* from the influence of diet

Table 4. *Relations between empty-body-weight (EBW; kg), carcass weight (CW; kg), gut contents (GC; kg), fat (kg), protein (kg), energy (MJ) and the live weight of the initial slaughter group (ILW; kg) of growing cattle fed on grass-silage-based diets*
(Mean values for ten determinations)

Equation	*r*	RSD	Statistical significance
EBW = 23·2+0·722 ILW	0·96	3·87	***
CW = −21·8+0·577 ILW	0·97	2·80	***
GC = −34·2+0·270 ILW	0·68	5·58	*
Fat = −0·550+0·115 ILW	0·61	2·87	NS
Protein = 17·7+0·088 ILW	0·67	1·87	*
Energy = 397+6·59 ILW	0·75	112·4	*

NS, not significant; RSD, residual standard deviation.
* $P < 0·05$, *** $P < 0·001$.

Table 5. *Daily gains in live weight and components of live weight by growing cattle fed on grass-silage-based diets*

Diet...	Early-cut silage H	Late-cut silage L	LC1	LC2	SE of means
Gains					
Live wt (g)	661	369	582	798	36·4***
Empty-body-wt (g)	696	292	552	800	31·7***
Carcass wt (g)	504	234	443	587	26·0***
Gut contents (g)	−29·0	74·9	18·8	29·3	4·36***
Fat (g)	260	121	189	302	18·7***
Protein (g)	86·9	31·1	76·0	116·1	6·65***
Energy (MJ)	12·24	5·48	9·23	14·58	0·7348***

H, early-cut silage alone; L, late-cut silage alone; LC1, late-cut silage with 280 g barley dry matter (DM)/kg total DM; LC2, late-cut silage with 560 g barley DM/kg total DM.
*** $P < 0·001$.

on rate of gain. The relations between chemical components and empty-body-weight at slaughter are shown in Table 6. They are expressed as allometric equations of the $\log_{10}$ form to conform with Agricultural Research Council (1980) recommendations, although a simple linear relation accounted for a similar proportion of the variance. A single relation for each component was found to be an adequate description of the values and the intercept values of the regression equations were not significantly different from zero.

The relations between fat, protein and energy gains and gain in empty-body-weight over the experiment are shown in Table 7. For each component a single relation was an adequate description of the values since no reduction in residual mean square was observed by considering treatment groups or each treatment separately. Intercept values were not significantly different from zero.

DISCUSSION

Apparent digestibility and intake

Later cutting of the primary growth of perennial ryegrass led to a reduction in the digestibility of the DM and gross energy by 0·118 and 0·116 respectively and this reduction

Table 6. *Regressions of* $\log_{10}$ *chemical component* v. $\log_{10}$ *empty body-weight (kg) at slaughter* ($\log_{10} y = a + b \log_{10} x$) *of growing cattle fed on grass-silage-based diets*

(Mean values with their standard errors)

Independent variable...	*a*		*b*				
	Mean	SE	Mean	SE	*r*	RSD	Statistical significance
Fat (kg)	−2·55	0·441	1·74	0·176	0·87	0·043	***
Protein (kg)	−0·55	0·15	0·91	0·060	0·94	0·014	***
Energy (MJ)	−0·05	0·259	1·45	0·104	0·93	0·025	***

*** $P < 0.001$.

Table 7. *Regressions of total fat, protein and energy gains on empty-body-weight gain (kg) of growing cattle fed on grass-silage-based diets*

Independent variable...	*a*		*b*				
	Mean	SE	Mean	SE	*r*	RSD	Statistical significance
Fat gain (kg)	0·81	2·990	0·362	0·0369	0·87	5·89	***
Protein gain (kg)	−1·69	0·979	0·155	0·0121	0·92	1·93	***
Energy gain (MJ)	−7	108·0	17·8	1·33	0·93	212·6	***

*** $P < 0.001$.

was consistent with values derived from an earlier experiment (Thomas *et al.* 1981) where cutting was delayed for a similar period. Increasing the proportion of barley given with the late-cut silage led to a progressive increase in the digestibility of the DM and gross energy, similar to that observed by Vadiveloo & Holmes (1979) with hay-based diets. Further, the values determined with the present animals are close to those reported in the associated calorimetry study (Beever *et al.* 1988). The increases in overall digestibility from increasing the proportion of barley were, however, accompanied by marked reductions in the digestibility of the NDF (cell wall) and ADF fractions. Similar effects have been widely recorded (see Raymond, 1969) and have been ascribed to the influence of starch-based supplements on rumen pH and cellulolytic activity in the rumen (Terry *et al.* 1969; Osbourn *et al.* 1970).

The intake of DM was similar between treatments and close to the planned value of 18 g/kg LW. The differences in the intake of ME were therefore a reflection of the effect of treatment on the apparent digestibility of gross energy since the ME:DE value was shown to be constant across the diets (Beever *et al.* 1988). Thus the intake of ME increased from 58·9 to 69·6 MJ/d with increasing proportion of barley given with the late-cut silage and it was higher for silage H (73·5 MJ/d) compared with the late-cut silage given with the highest proportion of barley (diet LC2). Further, the contribution of plant-cell components to total ME varied considerably between diets both as a result of differences in concentration of cell walls and cell-wall digestibility. Using the energy values for plant-cell components given by Terry *et al.* (1973), the proportion of ME derived from cell walls was 554, 389 and 259 kJ/MJ for the late-cut silage alone and with increasing proportion of barley, and 424 kJ/MJ for the early-cut silage.

Gain in body components

Earlier cutting of herbage to increase digestibility resulted in higher LW gains compared with the late-cut herbage given alone. The response of 25 g gain per 0·01 increase in digestibility was at the lower end of the range of 25–50 g per 0·01 increase in digestibility derived from other values (McCarrick, 1965, 1966; Flynn, 1974; Thomas *et al.* 1980; Steen & McIlmoyle, 1982; Steen, 1984). This low response was probably a reflection of the restricted feed intake in the present experiment. When expressed in terms of empty-body-weight gain rather than LW gain the response was greater at 34 g per 0·01 increase in digestibility as a result of a reduction in the weight of gut contents over the experiment by steers given the early-cut silage. This demonstrates the inadequacy of LW gain as a measure of animal response. Gains in fat and protein were higher by steers given the early-cut silage rather than late-cut silage when they were given alone, and were increased with increasing substitution of barley. However, the gains in fat, protein and energy by steers given the early-cut silage were lower than those observed with the diet comprising late-cut silage and the highest level of barley. The findings for fat gain must, however, be treated with some caution. In this respect the relation between weight of fat and LW in the initial slaughter group was less precise than that achieved with other components and this may have resulted in higher errors in the estimation of fat gain. Also, the method of fat analysis adopted, namely the Foss-let technique, may result in an underestimate of fat concentration due to an incomplete extraction of structural lipids. Thus in an analysis of samples of mouse carcass, Woodward *et al.* (1976) found an average underestimate of fat content of 8·9 %. However, the fact that in the present experiment the estimates of body composition agreed relatively closely with those of the Agricultural Research Council (1980), argues against there being high errors in the estimate of fat gain. Also, there was some evidence of high rather than low fat:protein values associated with treatment. In this respect the ratio, fat:protein gain at 3·89 for steers given the late-cut silage alone was high and greater than the values of 2·48 and 2·60 for those given barley at 280 and 560 g/kg total DM respectively. The ratio of 2·99 for steers given the early-cut silage was intermediate and these values tend to confirm the results of McCarrick (1966) and Lonsdale (1976) showing a high proportion of fat and a low proportion of protein in the body of cattle given silages as the only feed. However, these apparent diet effects on the proportion of fat in the gain must be treated with caution since regression analysis did not demonstrate an influence of diet *per se*, apart from its effects on rate of gain. To some extent this was a reflection of the single level of feeding within each diet and the resultant lack of variation.

It was clear from the present experiment that responses in gains of energy and protein to earlier cutting of silage were less than those achieved by substituting the late-cut silage with barley. Since the diets were fed only at a single restricted level of DM, it is not possible to calculate directly the extent of the implied depression in marginal efficiency of energy utilization above maintenance, and this aspect is considered in relation to calorimetric estimates and to the supply of non-NH_3-N in the following paper (Beever *et al.* 1988). Nevertheless, the present experiment allows estimates to be made of the efficiency of utilization of ME above an estimated maintenance requirement, and these observed values are compared with predicted efficiencies (k_f) in Table 8. Observed efficiency was higher for the early-cut compared with the late-cut silage and was increased with increasing substitution of the late-cut silage with barley. However, the observed efficiencies were markedly lower than those predicted for the silages fed alone (H and L). Substitution of silage with barley reduced the difference between observed efficiency and k_f, but the effect was relatively small at the low level of inclusion. Only the late-cut silage given with the highest level of barley was used with an efficiency close to that predicted. Further, the

Table 8. *Diet characteristics and efficiency of utilization of metabolizable energy (ME) of growing cattle fed on grass-silage-based diets*

Diet...	Early-cut silage H	Late-cut silage L	LC1	LC2
Metabolizability of diets (q)	0·62	0·52	0·57	0·60
Proportion of ME from digestible cell walls	0·42	0·55	0·39	0·26
Observed efficiency*	0·33	0·26	0·33	0·46
Predicted efficiency (k_f)†	0·49	0·41	0·45	0·47

H, early-cut silage alone; L, late-cut silage alone; LC1, late-cut silage with 280 g barley dry matter (DM)/kg total DM; LC2 late-cut silage with 560 g barley DM/kg total DM.

* Above maintenance. Maintenance calculated from Agricultural Research Council (1980).

† From $k_f = 0·78q + 0·006$ (Agricultural Research Council, 1980).

efficiency of utilization of this diet was greater than that observed for early-cut silage, despite the fact that they had similar metabolizabilities (q). The low efficiency of utilization of ME from silage as the only feed is in agreement with the conclusions of Thomas & Thomas (1985). Also, the Agricultural Research Council (1980) have proposed the use of separate relations between k_f and q for forage alone and mixed diets, although differences in k_f would not be expected at the relatively high q associated with the early-cut silage (0·62). The low k_f values noted when silages are given alone have been ascribed to the extent and type of silage fermentation (Thomas & Thomas, 1985). However, the fact that a reduced efficiency was also observed at the low level of barley inclusion suggests that a clear distinction in the effects of q on k_f cannot be made simply in terms of type of diet (e.g. forage *v.* mixed diets). Thus it would appear that q does not provide an adequate basis for the prediction of k_f and that the nature of the ME can have an influence on efficiency. In this respect it can be seen from Table 8 that the proportion of ME derived from digestible cell walls bore a close inverse relation to the observed efficiency, and this aspect is discussed further by Beever *et al.* (1988).

The results of the present experiment show that although the earlier cutting of herbage for silage results in increased gains of energy and protein by steers, the amounts retained are less than those from a similar increment of ME and CP achieved by substituting a late-cut silage with barley.

The authors wish to thank Dr J. Cobby for the statistical analysis of the diets and Mr R. J. Barnes and the staff of the analytical laboratories for chemical analyses. The Animal and Grassland Research Institute is financed through the Agricultural and Food Research Council and work forms part of a commission from the Ministry of Agriculture, Fisheries and Food.

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Printed in Great Britain