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The effect of pasture silage quality on milk production and liveweight gain of dairy cows

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ABSTRACT

Farmers in NZ have recently been encouraged to increase the quality of pasture silage they harvest. However, there was no New Zealand information available to ascertain the benefits of improved silage quality when it was offered as a supplement to grazing cows. Identical twin sets were divided into three groups in the winter, spring, summer and autumn during the 1998/99 season. Each group was offered a low pasture allowance and in addition, were offered 3 kg (winter) and 5 kg (spring, summer and autumn) DM/cow/day, of High, Medium and Low-quality pasture silage (nominally 10.4, 9.4 and 8.3 MJ ME/kg DM, respectively) as a supplement to pasture. In spring, summer and autumn offering a High-quality silage increased milksolids yield from 1.57 to 1.78, 1.09 to 1.28 and 0.63 to 0.89 kg/cow/day, respectively ($P < 0.05$) relative to cows offered Low-quality silage**.** There were no consistent live weight responses due to pasture silage quality. The spring, summer and autumn measured milksolids response can be calculated as having a net return (at $3.50/kg MS) of 6.7, 5.1 and 8.3 cents per MJME/kg DM increase.

Keywords: Pasture silage quality; milksolids; live weight; dairy cow.

INTRODUCTION

New Zealand's dairying system is based on farming high numbers of cows per hectare to achieve high levels of pasture utilisation and, subsequently, high levels of milksolids (MS) production per hectare. Efficient and profitable milk production results when a high proportion of pasture grown is harvested by high genetic merit cows and used directly for milk production.

Pasture silage remains the predominant source of supplementary feed on NZ dairy farms. Pasture silage is made to remove surplus pasture growth that occurs over the late spring period. The identification of this surplus and harvesting it early to ensure high quality pastures during summer is critical for maximising milk production, particularly at lower stocking rates (Thomson *et al.*, 1984).

However, pasture silage made by NZ dairy farmers is usually of poor quality and does not usually meet the quality requirements of a lactating cow (Howse *et al.*, 1996). Therefore, farmers in NZ have recently been encouraged to increase the quality of pasture silage they harvest. However, there is no information available from New Zealand trials to ascertain the benefits of improved silage quality when it is offered as a supplement to grazing cows.

It is known that as the silage crop matures, yield is increased but the metabolisable energy (MJME/kg DM) decreases (Wrenn & Mudford, 1996; McGrath *et al.*, 1998). Therefore, a trade-off exists between dry matter (DM) yield and energy content of that dry matter. Currently it is assumed that cost per unit of dry matter decreases with increasing yield and that income per unit of dry matter increases with increasing energy. Though this does vary with the method of harvest, as pit silage and bale silage are generally costed on a per hectare and bale charge, respectively. However, the balance between yield and quality that allows profitability of a pasture-based dairying system to be maximised has not been defined.

The aim of this series of trials was to determine the animal production response (milk and live weight) to changes in pasture silage quality. This will quantify benefits commercial dairy farmers may receive from improving the quality of pasture silage made.

MATERIALS AND METHODS

A series of four grazing studies were conducted at the Dairying Research Corporation's No1 Dairy in the 1998/99 season. Fifteen sets of spring-calving identical twins were allocated to three groups of 10 cows in June (Winter) and January (Summer), seven cows in September (Spring) and eight cows in April (Autumn). The treatments imposed were, pasture plus either high- quality silage (High), medium-quality silage (Medium), or low-quality silage (Low).

The three groups of cows were balanced for age, calving date, genetic merit, live weight and their current milk yield. Cows were grouped together and grazed on pasture only, for a 7-day uniformity period. Live weight and milk yield measurements taken on day 7 were used for co-variate analysis. Cows were then divided into the three treatment groups and the feeding treatments were imposed for 21 days. The treatments were grazed separately but alongside each other in the same paddock. Milk yield was measured on two consecutive milkings on days 17 and 28 and a sub-sample analysed for milkfat, protein and lactose concentration. Live weight was measured on two consecutive days after the morning milking on days 6 and 7, 16 and 17, and 20 and 21. Silage and pasture intake measurements were collected on days 26, 27 and 28. Clipped pasture (to grazing height) and silage sub-samples were analysed by NIR. Cows were grazed together between treatment periods.

During each experimental period treatment groups were allocated the same pasture allowance. Pasture silage was offered at 5 kg DM/cow/day during lactation (spring, summer & autumn) and 3 kg DM/cow/day during the dry period (winter). Pasture allowances were manipulated so they had a dry matter intake (DMI) of approximately 10 kg DM/cow/day during lactation and 5 kg DM/cow/day during the dry period. The High-, Medium- & Low-quality silages had an estimated metabolisable energy content of approximately 10.4, 9.4 & 8.3 MJME/kg DM, respectively.

The average rate of Dry Matter disappearace for each treatment group was estimated using a rising plate meter assessment of pre- and post-grazing herbage masses, and applying to these the regression equation developed for that particular time of year by L'Hullier and Thomson (1984).

The silages were selected to represent the likely chemical composition of silage conserved after a short, medium or long closure period (Wrenn & Mudford, 1996). The silages were all from plastic-wrapped bales and selected to ensure they had undergone similar fermentation processes as described by Howse *et al.* (1996).

During each treatment period, the cows were allocated their new pasture in the morning and the silage was offered in feed troughs within the paddock.

ANALYSIS

Treatment means adjusted for the run period are presented from a REML (Residual Maximum Likelihood) analysis with twin set as a random factor using Genstat.

RESULTS

The quality of the silage is described in Table 1. With decreasing ME (from high to low quality silage) there was a corresponding increase in % Neutral Detergent Fibre (NDF), and a decrease in digestibility.

TABLE 1: The mean pH, crude protein (CP), ammonia nitrogen (ammonia N), digestible dry matter (DDM), neutral detergent fibre (NDF) and metabolisable energy (ME) concentrations of the High, Medium and Low quality silage used in the experiment.

	Silage quality		
	High	Medium	Low
pH	4.7	5.0	4.6
Crude protein (g/100g)	17.6	15.1	11.8
Ammonia N (g/100g CP)	10.7	11.3	13.4
DDM (g/100g)	67.5	61.1	52.3
NDF (g/100g)	50	56	58
ME (MJ/kg DM)	10.4	9.4	8.3

Increasing silage quality from 8.0 to 10.2 MJME/kg DM in spring, increased MS yield (P<0.05) from 1.57 to 1.78 kg/cow/day (± 0.09) (Table 2). In summer, increasing silage quality from 8.3 to 10.9MJME/kg DM increased (P<0.05) MS yield from 1.09 to 1.28 (± 0.06) kg/cow/day. In autumn, increasing silage quality from 8.3 to 10.5 MJME/kg DM increased (P<0.05) MS yield from 0.63 to 0.89 (± 0.07) kg /cow/day.

TABLE 2: The metabolisable energy concentration (MJME/kg DM) offered as High-, Medium- and Low-quality silage during each experimental period, and the resulting milksolids (MS) and milk yield (l/cow/day) and rate of live weight change (g/cow/day).

	Silage quality	Silage MJME/kg DM	MS kg/cow/day	Milk l/cow/day	Lwt change g/day
Winter	Low	8.7			623
	Medium	9.2			395
	High	9.8			838
	SED				**96**
Spring	Low	8.0	1.57	17.2	546
	Medium	9.3	1.67	17.9	705
	High	10.2	1.78	18.4	1006
	SED		**0.09**	**0.53**	**383**
Summer	Low	8.3	1.09	10.9	682
	Medium	9.9	1.17	11.5	1215
	High	10.9	1.28	12.3	787
	SED		**0.06**	**0.44**	**229**
Autumn	Low	8.3	0.63	5.9	464
	Medium	9.3	0.77	6.1	-31
	High	10.5	0.89	6.9	-79
	SED		**0.07**	**0.30**	**279**

Silage quality differed between treatment periods (Table 2). The smallest difference occurred in the silages fed in the winter. The differences between the High-and Low-quality silages of 2.2 to 2.6 MJME/kg DM (a 20% difference in feed quality) were sufficient to increase milk and milksolids (MS) production of up to 41% (Table 2). The increases in MS were 0.21 (13%), 0.19 (17%) and 0.26 (41%) kg MS/cow/day in the spring, summer and autumn (P<0.05), respectively.

There was no consistent live weight response to increasing pasture silage quality (Table 2). Generally, the high-quality silage cows gained more live weight, except for during the autumn when they lost more than the other treatment groups.

DISCUSSION

These data demonstrated that increasing quality of silage, as measured by metabolisable energy (ME), increased MS yield when offered to cows grazing a restricted pasture allowance.

Murdoch (1965) and Gordon & Murdoch (1978) reported digestibility as the major factor influencing voluntary intake by cows offered only pasture silage while indoors. Castle (1975), however, showed that mean daily milk yields increased by 0.23 kg milk per unit change in digestible organic matter content in dry matter (DOMD). These increases in milk yield were primarily the result of increased intakes of digestible organic matter at a constant DMI. This is in agreement with Aston *et al.* (1994) who reported that for each unit change in pasture silage DOMD, milk yield increased by 0.24 kg while dry matter intake did not alter when silage was fed as a sole diet to lactating cows. In this trial, taking the average milk response and DOMD, the milk yield was increased by 79 g for each unit change in pasture silage DOMD

Using the Cornell Net Carbohydrate and Protein Model (CNCPS) as described by Kolver *et al.* (1998) and the described conditions under which the trials with lactating dairy cows were run, the authors predicted production responses of 14.6, 18.3 and 14.9 g MS in spring, summer and autumn respectively, with each unit ME increase in pasture silage quality. This is equivalent to 0.18, 0.23 and 0.19 kg of milk per unit change in ME for the spring, summer and autumn periods respectively. These results assume no substitution differences between the silages. These predictions are similar to the data presented where MS production increased by 19.1, 14.6 and 23.6 g per unit increase of ME in pasture silage quality for the spring, summer and autumn, respectively. This may suggest that the different silages offered did not alter DMI, but rather the additional MS is simply a result of additional ME intake.

Costs of ensiling pasture differ according to the methods used. For example, pasture ensiled in clamps or pits is charged on a per hectare basis and the higher the harvested yield the lower the cost per kg DM. However, for baled silage, costs are charged per bale, therefore silage costs per kg DM are the same irrespective of yield.

McGrath *et al.* (1998) reported that, as time of harvest was delayed, quality declined. A delay in harvest from 7 to 9 weeks increased yield by 20% but quality declined from 10.8 to 10.3 MJME/kg DM. Clark (1993) reported a response of 50 g MS/kg DM fed to feeding average quality silage to overcome a pasture deficit. Using the data collected in this paper on the effect of silage quality on MS production, the response to feeding silage to overcome a shortage of pasture reported by Clark (1993) and the effects of delaying harvest on silage quality reported by McGrath (1998), it was calculated that the 20% increase in DM yield resulting from delayed harvest, increased MS yield by only 1, 7 and –4% in the spring, summer and autumn respectively. This does not allow for the cost of the extra closure time, harvesting, storage and feeding out. This suggests it would be better to harvest silage crops earlier and maximise quality and not yield.

CONCLUSION

In spring, summer and autumn, the responses were calculated as having a net return (at $3.50/kg MS) of 6.7, 5.1 & 8.3 cents respectively, per MJME/kg DM increase in silage quality. Therefore, it is likely to be more economic to harvest several smaller yields of high-quality silage than one large yield of low-quality silage.

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