Effect of date and length of closure and post grazing residual on pasture quality for silage

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Abstract

The nutritional value of pasture silage made in New Zealand is often sub-optimal for lactating dairy cows. As farming systems require more pasture silage to be used in an attempt to increase lactation lengths and milksolids production per cow, the quality of this silage becomes more important. In spring 1995, pastures were closed for silage at weekly intervals from 11 September to 17 October, representing six distinct closure dates, to determine the effect that date and length of closure has on pasture quality. In spring 1997 pastures were grazed to different residuals (1.2–1.4, 1.8–2.0, 2.1–2.4 and 2.5–2.9 t DM/ha) and then closed for silage to determine the effect that post grazing residual has on pasture quality. In both experiments pasture dry matter (DM) yield and chemical and botanical composition was monitored over the 63 day closure. Pasture closed on 11 or 17 September had higher metabolisable energy (ME) ($P<0.05$), organic matter digestibility (OMD) ($P<0.01$) and DM yields at 70% OMD than pasture closed after 9 October. Pasture closed on 11 September remained above 70% OMD for the 63 day closure while pasture closed on 17 October reached 70% OMD after only 49 days. Pasture grazed to 1.2–1.4 t DM/ha accumulated significantly less DM to 42 days post grazing than all other grazing treatments ($P<0.001$), but had higher crude protein (CP), OMD and ME contents ($P<0.001$). The low post-grazing residual resulted in pasture with more vegetative ($P<0.001$) and less reproductive ($P<0.05$) material at 42 days post grazing. These results suggest that in order to maximise the yield of pasture silage of suitable feed quality for lactating cows pasture should be last grazed before 15 September, harvested before the end of November and have a post grazing residual of approximately 1500 kg DM/ha.

Keywords: closure date, closure length, herbage accumulation, organic matter digestibility, pasture quality, pasture silage, perennial ryegrass, post-grazing residual

Introduction

Efficient and profitable dairy farm systems harvest a high proportion of pasture grown directly for milk production. In New Zealand's pastoral dairying system this has been achieved by farming at high stocking rates to ensure high levels of pasture utilisation and milksolids (MS) production per hectare. Traditionally, the primary objective of dairy farmers making pasture silage has been to maintain pasture quality in late spring. The quality of pasture silage has been of secondary importance. Survey data (Howse *et al.* 1996) showed New Zealand silage had an average organic matter digestibility (OMD) of 66%, metabolisable energy (ME) of 9.4 MJME/kg DM and a crude protein (CP) content of 14.8%.

By farming at lower stocking rates and allowing higher levels of MS production per cow or by using nitrogen fertiliser to increase pasture production and therefore MS production, farm profitability can be increased (Penno 1998; McGrath *et al.* 1998; Thomson *et al.* 1997). Under these farming systems the amount of pasture grown in the late spring is well in excess of herd requirements. Large amounts of pasture silage must be harvested so pasture quality and animal performance are maintained (Butler & Hoogendorn 1987). The pasture silage harvested can then be fed in late lactation to ensure high MS production by extending lactation length (Penno & Clark 1997). Using large amounts of silage in this way means its quality becomes important. Recommended quality parameters are >70% OMD, >10 MJME/kg DM and 16–20% CP, respectively, (National Research Council (NRC) 1989).

Previous New Zealand research by Browse *et al.* (1984) suggested date of removal from grazing, closing time and the herbage mass after the last grazing were important parameters affecting silage quality. This paper presents two experiments that examine the effect of these factors on silage quality.

Methods

Experiment 1 – Effect of post-grazing residual on subsequent pasture quality

This trial was established on high-fertility dairy pasture on the WestpacTrust Taranaki Agricultural Research

Station (WTARS) in spring 1997. On the 14 and 27 October, six replicates of four post-grazing herbage mass treatments were randomly allocated to 625 m^2 blocks which were grazed and then closed for 63 days. Nitrogen fertiliser was applied to all areas at 60 kg N/ha on 14 August and 23 kg N/ha on 20 October. Treatments were imposed by grazing groups of lactating dairy cows on the blocks until different post-grazing herbage mass remained: hard (1.2–1.4 t DM/ha), moderate (1.8–2.0 t DM/ha), lax (2.1–2.4 t DM/ha) and very lax (2.5–2.9 t DM/ha). On days 1 and 63 after grazing, total DM was estimated by taking four ground-level cuts per treatment. Four 0.25 m^2 quadrats were cut to 30–40 mm from each plot on days 1, 7, 21, 42 and 63 after grazing; within plot samples were bulked and used to estimate harvestable DM yield, chemical and botanical composition. Chemical composition of pasture was determined using near infra-red reflectance spectrometry (NIRS) analysis (Shenk & Westhaus 1994). Botanical composition was determined by dissection of cut herbage into ryegrass (vegetative and reproductive tillers), white clover, other grasses, weeds and dead matter. Reproductive tillers were categorised as either nodal stem, developing seedhead or fully emerged seedhead. The data were analysed as a split plot design using Genstat version 5.3 (ICAR-Rothamsted), with closure date the main plot treatment and post grazing residual the sub plot.

Experiment 2 – Effect of date of last grazing and closure period on pasture quality

This trial was established on high-fertility dairy pasture at the Dairying Research Corporation (DRC), Hamilton, in spring 1995. Four replicates of six closure dates 11, 17 and 25 September and 1, 9 and 17 October 1995, were randomly allocated to small plots (10 m × 10 m) in 24 paddocks of No 2, 3, 4 and 5 Dairy farms at DRC. These plots were fenced off from grazing on the predetermined dates and remained ungrazed for 9 weeks. During closure weekly pasture samples were cut to 30–40 cm from 10 sites in each plot; within plot samples were bulked and used to assess chemical and botanical composition of pasture. Chemical composition of pasture was determined using NIRS and botanical composition was determined as for Experiment 1. Total DM/ha was assessed by cutting six 0.25 m^2 quadrats in each plot to ground level on the date of closure and 3, 5, 7 and 9 weeks later. Harvestable ME was calculated by subtracting a residual DM of 1100 kg DM/ha from the estimated total DM yield and multiplying by the ME content of the pasture. Data collected at each sampling time were analysed as a randomised block design using the SAS (version 6.12) mixed models procedure. A repeated measures model was also used to test for effects of treatment over time and for any time by closure date interaction.

In both experiments, measured variables were plotted against time and a linear regression analysis was used to determine the rate of change of the variable over time. The time taken for each treatment to reach 70% OMD was calculated from a linear regression of OMD and time, and the herbage accumulated was used to estimate potential silage yield. Where pasture was still above 70% OMD at the conclusion of the measurement period then the yield at 63 was taken as the potential silage yield. According to NRC recommendations a 450 kg cow consuming DM at 3.6% of liveweight requires an OMD of 70% to produce 20 kg of milk (4.5% milkfat).

Results

Experiment 1

Post-grazing residual affected both the DM yield per ha at 42 days post grazing and the pattern of DM accumulation over the 63 day measurement period. The hard grazing treatment resulted in the lowest harvestable herbage mass at 42 days post grazing ($P<0.001$) (Table 1). By day 63 the DM yields were 8.1, 8.2, 9.4 and 8.7 t DM/ha for the hard, moderate, lax and very lax treatments, respectively, but there were no treatment differences (SED = 0.71). The lax and very lax grazing treatments had higher rates of herbage accumulation up to day 42 post grazing and the hard post grazing residual had a higher rate of accumulation than the very lax from day 42 to 63 (Table 1). The average net herbage accumulation over 63 days was similar for all treatments.

The pasture ME of the hard grazing treatment was higher ($P<0.001$) than the lax or very lax grazing at day 42 even though it had been lower immediately after grazing (Table 1). Crude protein declined over time for

Table 1 Harvestable herbage mass (t DM/ha), organic matter digestibility (OMD) (%), metabolisable energy (ME) (MJME/kg DM), crude protein (CP) (%) and neutral detergent fibre (NDF) (%) on day 42 post grazing. Net herbage accumulation above 30 mm (kg DM/ha/day) from day 7–42 and day 42–63. Data are means for both closure dates in experiment 1.

Post grazing treatment	**Hard**	**Moderate**	**Lax**	**Very lax**	**SED**
Post grazing herbage mass (t DM/ha)	1.37	1.91	2.39	2.70	0.21
Harvestable herbage mass	4.45	5.34	7.0	6.7	0.29
OMD	68.1	63.6	66.7	64.6	0.93
ME	10.1	10.0	9.5	9.6	0.14
CP	14.6	12.0	11.8	11.5	0.75
NDF	52.2	54.7	57.0	56.5	0.98
Herbage accumulation day 7–42	106	124	151	158	8.02
Herbage accumulation day 42–63	175	135	114	93	39.8

all treatments (Figure 1). At days 21 and 42 post grazing the hard grazed treatment had significantly higher ($P<0.001$) CP levels than the other treatments. However, the CP contents of all pasture closed for silage in this experiment were below the recommended 18% (NRC 1989) at 42 days post grazing. By day 63 post grazing no differences in pasture quality existed. There were no significant differences in the harvestable herbage mass, OMD, ME, CP or neutral detergent fibre (NDF) between the two closure dates.

The OMD of the pasture DM grown following the hard grazing treatment was above 70% until 35 days post grazing; the other treatments reduced to 70% digestibility within 20–29 days after grazing. Despite the hard grazing treatment maintaining higher levels of pasture digestibility for longer post-grazing the amount of harvestable energy was compromised by the low DM yields. The ME yield at 70% OMD was 37.7 GJME/ha for the hard grazing treatment compared to 49.9 GJME/ha for the very lax grazing treatment.

At 42 days post-grazing the hard grazing treatment had more vegetative ($P<0.001$) and less reproductive and flowering material ($P<0.05$) than the treatments with higher post-grazing residuals (Table 2). Differences in percentage of dead material between treatments were not significant.

Table 2 Percentage of dry weight as vegetative or reproductive tillers, or dead material at 42 days post grazing. Data are means of both closure dates in experiment 1.

Grazing treatment	Vegetative	Nodal stem	Developing seedhead	Fully emerged seedhead	Dead
Hard	35	16	30	17	8
Moderate	23	9	37	22	9
Lax	20	6	39	24	11
Very lax	15	6	44	25	10

Experiment 2

Early closure dates produced higher quality pasture for harvesting as silage than later closure dates. The pasture closed on 11 and 17 September had higher OMD ($P<0.01$) and ME ($P<0.05$) contents from 35 days after closure than pasture closed on 9 or 17 October (Table 3). This difference in OMD resulted in pasture closed on 11 and 17 September having higher DM yields of pasture at 70% digestibility than pasture closed on 9 and 17 October. The digestibility of pasture last grazed on 11 September remained above 70% for the 63 day closure while pasture last grazed on 17 October reached 70% digestibility after 49 days (Table 4). Closure date did not affect DM yield, NDF or CP over the 63 day closure.

Table 3 CP (%), NDF (%), OMD (%) and ME (MJME/kg DM) at 42 days and DM (kg/ha) and ME (GJME/ha) yield at 49 days post grazing for pasture last grazed on dates stated. Data from experiment 2.

Closure date	11 Sept	17 Sept	25 Sept	1 Oct	9 Oct	17 Oct	SED
CP	14.9	17.8	13.3	13.3	13.0	12.4	1.25
NDF	48.0	48.7	49.4	51.2	50.2	51.6	1.34
OMD	76.6	74.8	74.4	73.4	72.5	71.5	0.77
ME	11.4	11.2	11.1	11.0	10.8	10.7	0.12
DM	5030	5500	4650	5210	5010	4310	616
Harvestable ME	44.8	49.4	39.3	45.0	42.3	34.1	

Figure 1 Crude protein (%) over time for pastures grazed to hard, moderate, lax or very lax post-grazing residuals from day 1 to day 63 post grazing, data from experiment 1. (Error bars are standard errors of difference.)

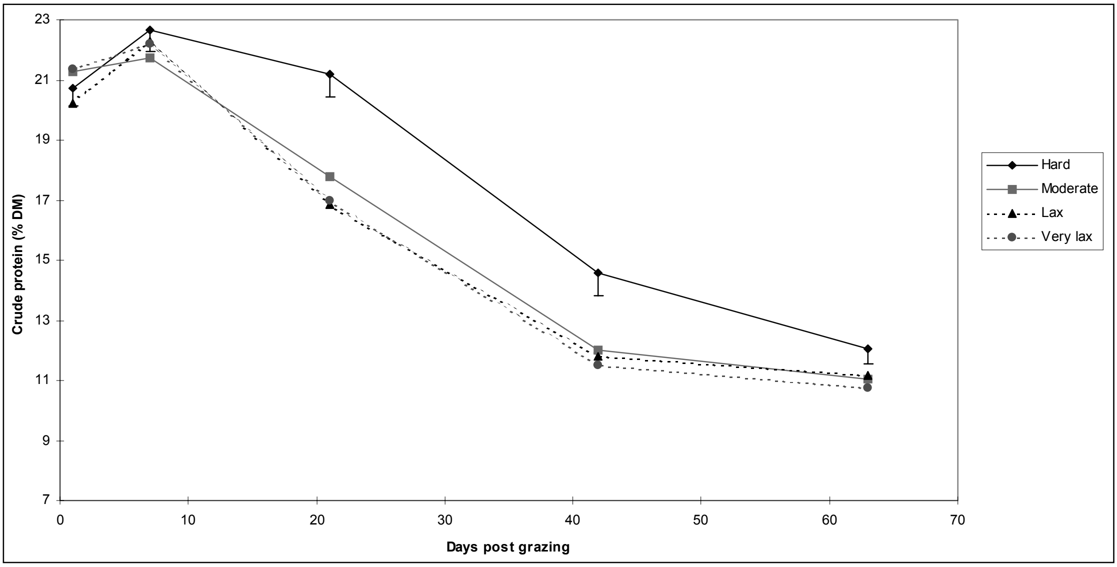

Table 4 Total DM (kg/ha) and harvestable ME (GJME/ha) yield and days post grazing when pasture OMD was 70%. Intercept and slope from linear regression equations. Data from experiment 2. (* at 63 days OMD was still above 70%).

Closure date	Yield at 70% pasture digestibility Total DM	Harvestable ME	Days post grazing	Intercept	Slope
11 Sept*	6130	50.3	63	83.0	-1.69
17 Sept*	5930	48.3	63	81.1	-1.54
25 Sept	5500	44.0	60	81.5	-1.82
01 Oct	5750	46.5	55	80.8	-1.85
09 Oct	5100	40.0	54	80.1	-1.74
17 Oct	4300	32.0	49	80.6	-2.03

The effect over time of decreasing feed quality with increasing DM yield is detailed in Table 5.

Table 5 CP (%), NDF (%), OMD(%), ME (MJME/kg DM) and DM (kg/ha) of pasture at weeks 3, 5, 7 and 9 after closure. Data are means of all closure dates in experiment 2.

Week post closure	3	5	7	9	SED
CP	20.9	15.1	12.6	10.4	0.48
NDF	44.9	48.1	51.9	55.7	0.52
OMD	79.5	75.9	72.1	68.9	0.30
ME	12.0	11.3	10.8	10.3	0.06
DM	2065	3315	4950	5930	153

Discussion

Post grazing residual

A post-grazing residual of less than 1500 kg DM/ha produced high quality herbage for harvest as pasture silage. CP and OMD of these pastures were higher at 42 days post grazing than those with higher post-grazing residuals (>1900 kg DM/ha); however, DM yields were lower. Grazing to low post-grazing residuals in October probably killed developing reproductive tillers (Woodward 1998). The resulting pasture, therefore, had a higher proportion of vegetative tillers and, as an inverse relationship exists between stem development and herbage digestibility (Browse *et al.* 1984), better quality after the hard grazing treatment.

Green leaf remaining after grazing (Matthew *et al.* 1995) affects the accumulation of new plant material. Grazing to low post-grazing residuals reduces the amount of green leaf remaining and therefore reduces herbage accumulation. This effect was demonstrated in the current study (Table 1).

Length of closure

The trend for declining nutritional value as DM yield increased is consistent with published research (Murdoch 1965; Browse *et al.* 1984; Jacobs *et al.* 1998). The inverse relationship between stem development and digestibility (Browse *et al.* 1984) was probably the underlying reason for this trend.

Yield when pasture had an OMD of 70% was reduced by 660 kg DM/ha for each week delay in closure. The current study showed pasture last grazed on 17 October reached 70% digestibility 11 days earlier in the regrowth cycle than pasture grazed on 25 September which agrees with the results of Browse *et al.* (1984). These results would tend to suggest that the time taken for a pasture to fall to 70% digestibility was associated with the reproductive state of the plant rather than days post grazing. This seasonal effect was described by Woodward (1998) who suggested that the transition from vegetative to reproductive tillers occurred in the late winter and stem elongation started 6 weeks later, followed by ryegrass flower emergence after another 6 weeks. Holmes & Wilson (1984) recommended that to make silage of the required nutritional value for lactating dairy cattle, pasture must be closed and harvested early in the season and preferably before flower emergence in ryegrass, as our results show.

Farm management implications

The low digestibility of stem material means that both mass of vegetative material and time between last grazing and flowering must be maximised in order to meet crop yield and quality targets.

The relationship between pasture growth and herd requirements determines when a dairy farm has surplus pasture available for silage. Lower stocking rates or the use of N fertiliser advance the date that herd feed demand is met by pasture growth in spring.

New Zealand dairy farmers are not good at recognising surplus pasture (Hainsworth & Thomson 1997). Pasture surpluses are not identified early enough or enough area removed from the grazing rotation to rematch pasture supply with demand. This was the fundamental reason for low quality pasture silage reported by Howse *et al.* (1996). Pasture for silage was identified in October and would have been last grazed mid to late September when post-grazing residuals are usually above 1500 kg DM/ha. The date of closure was too late and the post-grazing residual too high to maximise the amount of vegetative material at harvest and hence the quality of pasture harvested for silage was compromised.

Farms stocked below 3 cows/ha or applying N fertiliser in the late winter/early spring are likely to have daily pasture growth rates above herd requirements by late August/early September. The paddocks grazed at this time when pasture growth equals herd demand are unlikely to be required again until early summer. By identifying when pasture growth exceeds herd requirements farmers can capture the benefits identified in this study. These include improved pasture quality (OMD and CP) from low post grazing residuals and improved DM yield of pasture at 70% OMD, as early closure dates increase the time between last grazing and flower emergence.

To maximise the yield of pasture at 70% OMD, last grazing needs to be before 15 September to post grazing residuals of approximately 1500 kg DM/ha. If pasture is closed later than this or post grazing residuals are high at the last grazing, the time of closure should be reduced so that pasture is still harvested at 70% OMD. In the current study, the date after closure when pasture declined to 70% OMD was around 25 November for pasture closed in September and 5 December for pasture closed in October. This study suggests that decline in pasture quality is more related to season than days post grazing.

Lactating cows require their diet to contain 18% CP (NRC 1989). At most times of year fresh pasture has more than 18% CP; however, during dry summers fresh pasture can have CP contents as low as 11%, which will limit MS production. The improved CP content resulting from the hard grazing treatment and early September closure dates, suggests pasture surplus intended for use as a summer supplement needs to be identified early in the season, and that grazing management has ensured post grazing residuals around 1500 kg DM/ha on paddocks to be harvested for silage. In the current study pasture closed in October produced pasture for silage with CP contents between 11.5% and 13.5% (excluding the hard-grazed, October closed treatment, which had a CP of 14.6%).

Conclusion

To maximise the yield of pasture at 70% OMD, pasture should be closed from grazing before 15 September. The last grazing should be to a residual of around 1500 kg DM/ha and the silage should be harvested before the 25 November. If date of closure is later or grazing residual high then the time between last grazing and harvest must be reduced.

For New Zealand dairy farmers to improve the quality of pasture harvested for silage they must be able to identify pasture surpluses early in the season. Surplus identification must be a priority decision, not a consequence of poor grazing management.

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