

Impact of feeding maize silage on dairy production

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Abstract

A farm system study was run on the Waimate West Demonstration Farm in south Taranaki during the 1996/97 and 1997/98 dairying seasons. The aim was to investigate the effect of time of feeding purchased maize silage on milksolids production. Three times of feeding purchased maize silage: spring (fed, July–September); summer, (fed, December–March); Autumn, (fed, February–May), were compared with feeding maize silage grown on-farm. The five treatments, control, spring, summer, autumn and grown, each comprised 26 mixed-age Jersey cows grazing on a 6.9 ha farmlet at a stocking rate of 3.8 cows/ha. Inputs differed between the two years; in 1996/97 calving began on 20 June, 250 kg N fertiliser/ha was applied, the grown treatment was fed in summer, 500 kg DM/cow of maize silage was fed to each treatment group and the maize grown on-farm occupied 12% of the farm. In 1997/98, calving began on 5 July, N fertiliser was reduced to 100 kg/ha, the grown treatment was fed in autumn, 300 kg DM/cow of maize silage was fed to each treatment and the maize grown occupied 6% of the farm. Total pasture DM production was 14.2 and 13.8 t DM/ha in 1996/97 and 1997/98 respectively. The milksolids (MS) response to feeding maize silage differed markedly between years. In 1996/97, feeding maize silage increased MS by 76, 32, 66 and -32 g/kg DM maize silage for the spring, summer, autumn and grown treatments respectively. In 1997/98, MS increased by 157, 82, 179 and 76 g/kg DM maize silage for the spring, summer, autumn and grown treatments respectively. With feeding maize silage, lactation length increased for each treatment each year. On average, lactation length increased by 37, 30, 36 and 8 days for the spring, summer, autumn and grown treatments. The reason for the poorer response to feeding maize silage in summer was not identified. In 1996/97, the growing of maize silage on-farm reduced MS production, but in 1997/98 a response similar to the summer treatment was recorded. In these systems with high stocking rates and early calving (average pasture deficit for the control

herd of 1.9, and 1.14 t DM/ha for 1996/97 1997/98 seasons respectively), good responses were recorded to feeding in spring (early lactation) and autumn (late lactation) owing mainly to an increase in lactation days. The feeding of maize silage in summer or the growing of maize silage on-farm did not produce as large responses.

Keywords: dairying, maize silage, milksolids production, pasture production

Introduction

Past research has shown poor milk yield responses to feeding maize silage (Hutton & Rattray 1976; Bryant & Cook 1977) and to the growing and feeding of maize silage in dairying systems (Campbell *et al.* 1978). More recent farm systems studies by Penno (1998) have shown that feeding purchased maize silage throughout lactation (1280 kg DM/cow) increased milksolids (MS) by 566 kg/ha. However, at a cost for maize silage (purchase, transport, storage and feeding) of \$0.20/kg DM, this response was unprofitable at a \$3.50/kg milksolids payment. A study conducted on the Waimate West Demonstration Farm (WWDF) by Thomson *et al.* (1987a) showed the response to supplements was greater in autumn than spring. Penno *et al.* (1995) also reported that the MS response to high inputs of supplements fed throughout lactation increased as lactation advanced from spring to autumn. In these studies the time when responses occurred was confounded by previous feed inputs and the periods when maximum responses occurred could not be truly established. This present study was designed to measure the response to strategic feeding of purchased maize silage in early (spring) mid (summer) or late (autumn) lactation. The study also investigated the MS response to maize silage either grown on-farm or purchased off-farm.

Method

WWDF is situated in south Taranaki on free-draining Egmont black loam soils. Climate and pasture production for the farm have been described by Roberts & Thomson (1984). In summary, the farm is situated within 10 km of the sea, has a relatively mild winter

with few frosts and the main limitation to pasture production identified by Roberts & Thomson (1984) was low summer rainfall.

Previous trials conducted on WWDF had shown that profitable levels of MS production up to 1160 kg/ha resulted from adopting a stocking rate of 3.8 Jersey cows/ha, applying 100 kg/ha of N fertiliser, and the planned start of calving (PSC) on 20 July (Thomson *et al.* 1992). Further increases in production, up to 1580 kg MS/ha, were possible with the change in PSC to 20 June, increased N fertiliser to 250 kg N/ha and the feeding of 650 kg/cow of a cereal-based concentrate (Thomson *et al.* 1997a). From this previous experience, a PSC of 20 June, a stocking rate of 3.8 Jersey cows/ha and the application of 250 kg/ha N fertiliser formed the bases for planning the maize silage trial (Table 1).

Table 1 Basic trial layout and changes to inputs for 1996/97 and 1997/98.

Base system				
Treatment	Feeding Dates	Area (ha)	No cows	SR (cows/ha)
Control	—	6.9	26	3.8
Spring	June–Oct.	6.9	26	3.8
Summer	Dec.–Feb.	6.9	26	3.8
Autumn	March–May	6.9	26	3.8
Grown: year 1	Dec.–Feb.	6.9	26	3.8
Grown: year 2	March–May	6.9	26	3.8

Inputs	Maize silage (kg DM/cow)	N fertiliser (kg/ha)	PSC	Area sown in maize (ha)
1996/97	500	250	June 20	0.86
1997/98	300	100	July 5	0.43

A feed budget showed a deficit in the base system for the first year of 500 kg DM/cow (or 1.9 t DM/ha). With that knowledge it was decided to feed 500 kg DM/cow of maize silage to the spring, summer, autumn and grown treatments. To grow this amount of maize silage on-farm, required 10%, or 0.7 ha of the WWDF farmlet to be cropped (estimated maize silage yield of 22 t DM/ha). This was not practical as each paddock was 0.86 ha and for ease of management for the 1996/97 season, one paddock or 12% of the farmlet area was sown into maize. In both years of the trial the maize variety Pioneer 3905 was sown. Cultivation and sowing was in late October and harvest in late March.

During the operation of the first year of the trial, 1 June 1996 to 1 June 1997, a policy decision was made to change the PSC for the 1997/98 season from 20 June to 5 July. To balance the feed budget at the later calving, N fertiliser was reduced to 100 kg N/ha and the maize silage supplement to 300 kg DM/cow (or 1.14 t DM/ha). As a result, the area required to be sown into maize for the grown treatment reduced to 6% (0.43 ha) or half a paddock which was a manageable option.

The 40 paddocks were randomly allocated to each of the five treatments within two blocks (effluent and no-effluent) according to previous annual DM production. Cows were randomly allocated to treatment in a balanced manner according to age, calving date, PI, BW, liveweight and body condition score. Twenty percent of replacement rising two-year-olds were brought into the herds on 1 June each year. These were allocated to treatment according to BW, liveweight and CS. A standard management, based on previous trial work was adopted over all farmlets. The management policy was to maintain full pasture utilisation through a high stocking rate, early calving and achieving maximum lactation days. Cows were dried off from 200 days of lactation onwards to ensure each herd maintained a set of standard criteria, were at a condition score of 5.0 at calving, and had sufficient pasture and supplement available to meet the requirements of early lactation. These targets were achieved through weekly monitoring of pasture on all paddocks and assessing monthly cow body condition. Early identification of surplus growth in spring and early summer (Hainsworth & Thomson 1997), conversion of that surplus to high quality silage, and feeding back that silage during periods of pasture deficit were keys to standardising management across all farmlets. From February to May a fortnightly feed budget for each farmlet was prepared. The feed budget was calculated from the amount of supplements available, average pasture cover, average cow condition score and projected pasture growth based on past records (Roberts & Thomson 1984). Herds were dried off when feed required equated to feed available.

Measurements

Pastures

At weekly intervals from the start of calving to drying off and fortnightly during the winter dry period, the herbage mass of all paddocks was assessed visually by two trained and regularly calibrated visual assessors. The assessors were calibrated weekly at the WestpacTrust Agricultural Research Station (WTARS) on similar pastures and in close proximity to WWDF. From the weekly assessment of the herbage mass, pre- and post-grazing herbage mass, rate of pasture DM disappearance and annual pasture production for each paddock and farmlet were calculated.

Milksolids

Throughout lactation, milk yield and composition (fat and protein) for individual cows were assessed 2-weekly. Production data were accumulated for each cow and total production/cow (milk, fat, protein and MS) and for each farmlet were determined at the end of each season. Cow condition score was assessed monthly.

Statistical analyses

The data for milk production and composition were analysed using cows as replicates. Pasture production and grazing data were analysed by using paddocks as replicates.

Results

Annual DM production differed little between the two years (Table 2). In 1996/97 the growing of maize silage on-farm depressed total pasture production when compared with the autumn treatment. The average pre-grazing herbage mass for the summer and grown treatments was lower in both years. This was reflected in 1996/97 in lower rates of DM disappearance (Table 2). The average post-grazing herbage mass levels were similar both between treatments and between years. Residual herbage mass levels recorded on the treatment and control farmlets during each period of feeding (Table 3) also show for the control herd a similarity between years. The residual herbage mass for the supplemented and unsupplemented herds were similar in 1996/97, but in 1997/98 the autumn and grown treatments had greater residual herbage mass levels than the control for the duration of the feeding periods.

The overall supplementary feed situation presented in Table 4 shows there was more pasture silage conserved on the spring and summer treatments. Similar amounts of pasture silage were conserved on the autumn, grown and the control treatments. The reserves of pasture silage declined during the two years for all treatments except summer. The decline was greatest for the autumn, grown and control treatments.

The feeding of maize silage increased milk, fat and protein yields for all treatments except for the grown treatment in 1996/97 (Table 5). The greater increases in both years were recorded to feeding maize silage in spring and autumn. Of the purchased maize silage treatments, summer feeding gave the poorest response. The grown treatment produced less MS than the control in 1996/97, but in 1997/98 produced similar MS to the summer treatment. Feeding maize silage had no effect on milk composition and the MS response to feeding was due almost entirely to increased milk yield.

Table 2 Annual DM production, average pre and post-grazing herbage mass levels (kg DM/ha) and rate of pasture DM disappearance (intake, kg DM/cow) for the two years of the trial.

	1996/97				1997/98			
	Total	Pre	Post	Intake	Total	Pre	Post	Intake
Control	14440	3450	2110	11.7	13980	3410	2170	10.2
Spring	14270	3420	2100	11.5	13600	3350	2180	10.3
Summer	14140	3300	2120	10.1	13910	3290	2190	9.6
Autumn	15310	3440	2110	11.9	13820	3330	2170	10.1
Grown	13030	3280	2030	10.6	13520	3230	2130	10.3
SED	1011	65	49	0.38	612	45	28	0.51
P value	0.29	0.03	0.44	<0.001	0.93	0.006	0.26	0.66

Table 3 Residual herbage mass (kg DM/ha) for treatment and control herds during the period when maize silage was fed.

	1996/97				1997/98			
	Control	Treatment	SED	Sig.	Control	Treatment	SED	Sig.
Spring	1940	1995	46	NS	1970	2020	43	NS
Summer	2290	2322	60	NS	2370	2490	66	NS
Autumn	2280	2270	106	NS	2230	2390	57	*
Grown	2340	2270	86	NS	2310	2430	54	*

NS not significant, $P > P 0.05$, * $P < 0.05$

Table 4 Supplementary feed balance (kg DM/cow).

	Control	Spring	Summer	Autumn	Grown
1996/97					
Pasture silage – start	180	180	180	180	180
Harvested – pasture silage	180	340	370	270	250
Total available	360	520	550	450	430
Pasture silage fed	294	382	396	273	323
Maize silage fed		500	500	440*	500
Total fed	294	882	896	713	823
Pasture silage carried forward; 1997/98	66	138	154	177	107
1997/98					
Pasture silage – start	66	138	154	177	107
Harvested – pasture silage	220	380	400	320	220
Total available	286	518	554	497	327
Pasture silage fed	246	393	305	408	251
Maize silage		300	293	290	288
Total fed	246	693	598	698	539
Pasture silage carried forward; 1998/99	40	125	249	89	76
Balance – pasture silage	-120	-55	+69	-91	-104

* Less maize silage fed than planned

Discussion

The 1997/98 season was less productive in terms of MS, producing on average 20% less than the previous season. The later calving may have been partly the reason for the poorer production, but the delay of 15

days in the PSC would not explain the average lactation days for 1997/98 being 27 days less than in 1996/97 (Table 5). The poorer MS production in 1997/98 could not be explained by poorer pasture production, lower pre-grazing herbage mass (Tables 2 and 3), or the amount of surplus pasture conserved as silage (Table 4). During the 1997/98 season there was actually more pasture silage conserved on four of the five farmlets, supporting the conclusion that pasture production and pasture grazing conditions were similar in 1997/98 and 1996/97. This conclusion is important because although there was similarity in pasture conditions, the response to feeding maize silage differed markedly between the two years. Less maize silage was fed in 1997/98 but the absolute response in terms of extra MS/cow (36 kg) was nearly double that recorded in 1996/97 (17 kg). In addition the average marginal response to feeding maize silage (g extra MS/kg DM from maize silage) was higher in 1997/98 than in 1996/97; 140 and 58 g MS/kg DM for the two years respectively. This was an extremely variable result considering the similarity of the two years in terms of pasture production and grazing characteristics. One possible reason for the difference was the different amount of maize silage fed each year; 500 kg DM/cow in year one and 300 kg DM/cow in year two. Also, MS production from the control herd in 1996/97 was 365 kg/cow, compared with 285 kg/cow in 1997/98. The variability of the response to maize silage suggests caution when recommending the practice. By assuming a \$3.50/kg MS payout and a purchase price for maize silage of \$0.20/kg DM, the feeding of maize silage in either spring or autumn would have been of marginal benefit in 1996/97 (return of \$0.25/kg DM) but profitable in 1997/98 (return of \$0.59/kg DM). This showing a variable return even under conditions of high pasture utilisation.

The feeding of maize silage increased lactation days at the end of the season, irrespective of when it was fed. The average increase to feeding maize silage in spring or autumn was 36 days and to feeding in summer, 30 days. These results are similar to previous findings by Penno *et al.* (1995) and Thomson *et al.* (1997a), who reported the main reason for a MS response to supplementary feeding was an increase in lactation days resulting from being able to milk more cows on for longer in autumn.

The response to feeding maize silage was smallest in summer. The reason for this was not obvious. There were only small differences in the residual herbage mass values between the summer and control farmlets

Table 5 The yields (kg/cow) of milk and milksolids and the response (g MS/kg DM) to feeding maize silage in 1996/97 and 1997/98.

	Control	Spring	Summer	Autumn	Grown	SED	P value
1996/97							
Lactation days	257	289	288	297	257	—	—
Milk	3474	3872	3594	3761	3329	157	0.006
Fat	217	239	227	232	208	11.5	0.074
Protein	149	164	154	162	141	7.2	0.010
Milksolids	365	403	381	394	349	18.4	0.032
Response	—	76	32	66	-32	—	—
1997/98							
Lactation days	228	268	256	259	243	—	—
Milk	2733	3169	2915	3183	2910	158	0.023
Fat	170	196	185	201	183	10.2	0.034
Protein	115	136	124	136	124	6.7	0.007
Milksolids	285	332	309	337	307	16.7	0.017
Response	—	157	82	179	76	—	—

during the December to February feeding period. This suggests there was little or no substitution of pasture for maize silage occurring at this time. Pasture substitution, however, did occur with autumn feeding in 1997/98 when a large MS response to maize silage was recorded (Table 5). The lower pre-grazing herbage mass levels recorded in both years for the summer treatment (Table 2) also suggests that the poor response to feeding maize silage in summer was not due to an excess of pasture at the time of feeding.

Hutton & Rattray (1976) showed that maize silage contained low concentrations of N, Ca and P, because of these differences Hutton & Douglas (1977) recommended that maize silage should not exceed 30% of the diet. In both years, maize silage was fed in summer at 5 kg DM/cow/day and from the estimated rate of pasture disappearance during summer (data not presented), maize silage was 34-38% of total DM intake. N and P concentrations are normally low in summer (Ross *et al.* 1978) and levels are possibly further depressed when drought occurs (Thomson 1996). Supplementing maize silage with urea and minerals increased milk yield by 12% (Hutton & Rattray 1976). The greater response was to the urea plus minerals compared with urea alone. Macdonald *et al.* (1998) also found a poor response to supplementing maize silage with urea. However, these authors reported that supplementation of the maize silage/pasture diet with fishmeal as a protein source increased MS production by 12 and 14% in summer and autumn respectively. No chemical analyses of pasture were conducted at WWDF, so it can only be surmised that the poorer response to feeding maize silage in summer was owing to nutrient imbalances.

Growing maize silage on-farm showed a poor response when compared to the response to feeding, at a similar time, maize silage purchased off-farm. In

1996/97, 12% of the farmlet was sown into maize for silage. The result of this was to effectively increase the stocking rate from late October to mid July (270 days from cultivation to first grazing) to 4.3 cows/ha. Owing to the increased grazing pressure the production and intake of pasture declined (Table 2) and the loss of pasture almost equated to the 1.9 t DM/ha of maize silage fed in summer. This result was similar to that reported by Thomson *et al.* (1997b) for turnips grown on farm. In 1997/98, when only 6% of the farmlet was taken out for maize, the penalty effect was less severe and the extra feed created had a beneficial effect on MS production. The benefit to the grown treatment in 1997/98 may also have resulted from feeding in autumn rather than in summer as occurred in 1996/97.

Conclusions

The strategic input of maize silage purchased off-farm and fed in either spring or autumn for two dairying seasons, produced a similar MS response within years but a markedly different response between years. The average marginal response to feeding in spring and autumn within each year was 71 and 168 g MS/kg maize DM fed for 1996/97 and 1997/98 respectively. These results were, however, obtained under a situation of intensive pasture utilisation and would represent the maximum responses obtainable to feeding maize silage. The feeding of maize silage in summer without added nutrients, or growing of maize silage on-farm, did not produce consistent, worthwhile responses.

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