Impact of intensive maize silage supplementation on milksolids production, mastitis and profit

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Abstract

Over four dairy seasons (2000/2001 to 2003/2004) the input of maize silage was evaluated at the Waimate West Demonstration Farm. Two systems were evaluated with Jersey cows: Control (3.8 cows/ha, no maize silage) and High stocked (HS) Maize (5 cows/ha, up to 1.5 t dry matter (DM)/cow/yr as maize silage). Both farmlets received 190 (±5) kg nitrogen (N)/ha/yr in split applications throughout the season, and calving commenced on 9 July for both herds.

Only small differences between treatments in annual milksolids (MS) yield/cow were recorded. The Control herd averaged 310 kg MS/cow in 260 days compared with 316 kg MS/cow in 277 days for the HS Maize herd. The HS Maize herd produced 34% more MS/ha than the Control herd, viz. 1566 and 1172 kg/ha/yr respectively.

Milksolids response to the additional DM and higher stocking rate (SR) on the HS Maize system averaged 80 g MS/kg extra DM consumed. The annual economic farm surplus (EFS) averaged over 4 years for the Control herd was $2784/ha and the HS Maize herd was $2551/ha, however greater between year variation in EFS was noted for the HS Maize system.

Incorporation of maize silage into a pasture-based dairy system does increase production/ha, however the profitability of the system will be more vulnerable to MS payout and maize silage price than the traditional pasture-based system.

Keywords: dairy, economic farm surplus, maize silage, pasture production

Introduction

The dairy industry has set a target to achieve a 4% productivity increase on an annual basis. Current thinking has it that management techniques have honed the New Zealand pasture-based dairy system to near its limit, and the only way to increase production is to use cost-effective feed inputs.

Previous research has shown that large MS responses can be achieved where extra feed is used to extend lactation length and fill feed deficits (Thomson *et al.* 1997; Penno *et al.* 1995, 1996). A response of 100 g MS/kg DM fed (reported by Penno *et al.* 1995; Pinares & Holmes 1996) will return $0.40/kg DM fed, at a payout of $4/kg MS. Therefore, it could be assumed that feed offered to the herd for less than $0.40/kg DM will generate a profit. Maize silage has been identified as a high quality feed source, which can be purchased and fed to the herd for less than $0.40/kg DM.

Milksolids responses of 100 g/kg DM have been generated where large feed deficits are created by using very high SRs, 1 cow per hectare above the optimum on pasture only, and extending lactation by 30-60 days. These systems have used extra feed whenever pasture has been limiting DM intake/cow. This results in feed being used to fill spring, summer and autumn feed deficits. Clark (1993) showed that offering extra feed in spring, summer or autumn resulted in a similar total MS response/kg DM.

Thomson *et al.* (1991) reported a 10% increase in MS production by shifting calving date 15 days earlier and using N fertiliser to supply extra early spring pasture. Simply moving calving date did not increase MS production. This demonstrates that where a system is already utilising available pasture, extra feed must be supplied to increase MS output.

The research reported in this paper was carried out to determine the profitability of farm systems using maize silage to increase total MS production by extending days-in-milk (DIM) and milking more cows per hectare.

Materials and methods

On 15 June 2000, two herds of 65 (Optimum Stocked (Control)) or 85 (High Stocked Maize (HS Maize)) Jersey cows were established at the Waimate West Demonstration Farm (WWDF), South Taranaki (Table 1). The herds were balanced for age, genetic merit, calving date and previous treatment. Comparative SR for the two herds was the same (Table 1). The Control

Table 1 Stocking rate, calving date and maize silage supplementation for the Control and HS Maize farmlets.

	Control	HS Maize
Cows	65	85
Area (ha)	17.2	17.2
SR (cows/ha)	3.8	5.0
Comparative stocking rate (kg LW/t DM available)	85	84
Planned start of calving	9 July	9 July
Maximum maize silage available (t DM/cow/yr)	0	1.5

Table 2 Farm expenses used for the calculation of EFS. Actual figures are indicated by an asterisk, all others are from the Dexcel Economic Survey of New Zealand Dairy Farmers 2003-04.

Income	
Milksolids @ actual milk price/kg ($)	3.63-5.30*
Net stock income ($/cow)	102
Expenses	
Wages/ management allowance ($/cow)	187
Animal health ($/cow)	57
Breeding and herd testing ($/cow)	27
Shed expenses ($/cow/100 DIM)	8.68
Electricity ($/cow/100 DIM)	8.68
Freight ($/cow)	9.22
Silage harvesting costs ($/bale)	25*
Silage bought ($/bale)	65*
Maize bought ($/kg DM)	0.25*
Wintering-off ($/cow/week)	15*
Replacements ($/cow)	160
Fertiliser ($/ha)	200
N fertiliser ($/kg)	1.00
Weed & pest ($/ha)	17
Repairs and maintenance ($/cow)	77
Vehicles ($/cow)	48
Administration ($/ha)	70
Standing charges ($/ha)	194
Depreciation for both herds ($/ha)	215
Depreciation for HS herd only ($/cow)	19.32

SR of 3.8 cows/ha was deemed to be the most appropriate for an all-grass system on the farm. It was based on results of 10 years previous research conducted on the farm under various SRs. Simulations using the UDDER model were used to determine the SR and level of maize silage supplementation for the HS Maize herd. During the season 20% of animals from both herds were culled and in May of each season the corresponding number of heifers was used to replace these animals. Heifers entering the herd were balanced for breeding worth (BW) and liveweight. The treatments remained the same and the trial was continued in the subsequent three years.

The Control farmlet was managed as a closed system however maize silage, winter grazing and a protein supplement if needed during summer were brought into the HS Maize system. Surplus pasture silage for each farmlet was carried forward into the next season. In the first year of the trial spoilage to the tube wrapped maize silage required the purchase of 460 kg DM/cow of pasture haylage for the HS Maize herd. The maximum level of maize silage available to the HS herd was 1.5 t DM/cow/yr. Maize silage was offered to ensure the intake of lactating cows did not fall below 12 kg DM/cow/day. Daily levels of maize silage were calculated to ensure maize silage did not exceed 40% of the total diet. Maize silage was ceased or reduced when lactating cows were offered more than 15 kg DM/cow/day as pasture. The maize was offered in trolleys on a stand-off area or in the paddock if soil and weather conditions allowed. From year two, 20 cows from the HS Maize herd were wintered off farm for eight weeks.

Cows were dried-off so that they reached the target calving condition score of 4.5-5 by 1 June. Individual cows producing less than 5 l/day for 2 consecutive weeks in late lactation (post-April) were dried-off and all cows were dried-off to ensure a 50-day interval between their last milking and their expected calving date. The timing of culling decisions was determined by feed supply following pregnancy diagnosis 8 weeks after the last mating. Culls were removed from the herd when DM intake of the herd fell below 8 kg/cow/day.

Pasture mass was visually assessed in each paddock during a weekly farmwalk, and calibrated against actual mass cut from 12 quadrats (each 0.2 m^2), six post-grazing and six pre-grazing. The quadrats were cut to ground level with an electric handpiece, washed and oven dried for 48 hours at 105^0 C. The visual pasture mass assessments from each paddock were used to determine the rotation length and supplementary feed requirement. Cows were weighed and their condition score determined on a monthly basis. Milk from each herd was collected into separate vats and from daily factory records, milk yield and composition for each herd was obtained. Pre-mating heats were recorded for each cow from calving onwards, with tail paint used as an aid for heat detection. Detection of clinical mastitis was reliant on observations made by the farm manager. Individual somatic cell counts (SCC), milk fat and milk protein concentrations were determined from monthly herd testing.

An EFS was generated for both farmlets for each year of the trial. Because of the nature of the farm accounts many actual expenses could not be accurately apportioned to each herd, therefore in these instances the figures used have been based upon data collected by Dexcel (Economic Survey of New Zealand Dairy Farmers 2003-2004, Table 2). There has been no allowance made for extra staff in the HS Maize system as in some situations existing staff could be utilised to meet the demands of the increased workload from feeding the supplement. In the current trial, a very low labour system was implemented with the maize silage being fed in mobile trolleys. The EFS does not include provision for interest on capital, the purchase of additional shares/peak notes if required or for a feed pad for optimising maize silage feeding. However, a higher cost has been included for the HS Maize system for depreciation and the additional capital required for this system.

Table 3 Summary of key physical and financial parameters for the Control and HS herds for four seasons.

	Control					HS				
	00/01	01/02	02/03	03/04	Average	00/01	01/02	02/03	03/04	Average
Milk yield										
Days in milk	239	278	239	285	260	280	282	267	280	277
Milk yield (kg/cow)	2738	3102	2606	3293	2935	2937	2883	2785	3354	2990
Fat yield (kg/cow)	165	197	165	212	185	184	183	175	208	188
Protein yield (kg/cow)	115	132	111	142	125	125	125	120	144	128
MS (kg/cow)	280	330	276	353	310	309	308	295	352	316
MS (kg/ha)	1065	1246	1043	1335	1172	1544	1522	1457	1740	1566
Mastitis and milk quality										
Infected cows (%)	-	8	5	12[b*]	8	-	17	13	2[a]	11
Infected quarters (%)	-	3.5[a*]	1.5[a*]	4[b***]	3	-	8.5[b]	4.1[b]	0.6[a]	4.4
Mean SCC (1000 cells/ml)	-	67	62	74	68	-	73	59	65	66
Pasture production										
Growth (kg DM/ha)	16589	17698	16051	18657	17249	15735	18171	16578	20171	17664
Conserved (kg DM/ha)	827	1953	2233	1591	1651	209	440	272	73	249
Supplements consumed										
Maize silage (kg DM/cow)	-	-	-	-	-	1027	1126	1080	810	1011
Pasture silage (kg DM/cow)	210	517	463	437	407	502	136	218	15	218
MS response to the HS system (g/kg DM)						80	57	79	102	80
Economic analysis										
EFS ($/ha)	3446	4453	742	2494	2784	3920	3826	-101	2559	2551
Milk price ($/kg MS)	5.00	5.30	3.63	4.15	4.52	5.00	5.30	3.63	4.15	4.52
Maize silage price ($/kg DM)						0.22	0.27	0.27	0.25	0.25

Values for corresponding years with different superscripts are significantly different * $P<0.05$, *** $P<0.001$.

Results

Over the four years of the trial, there were only small differences between treatments in per cow milk yield, fat and protein yield (Table 3). The Control cows averaged 310 kg MS/cow in 260 days compared with 316 kg MS/cow in 277 days for the HS herd. Because of the difference in stocking rate between the treatments the HS herd produced more MS/ha than the Control herd.

For the first three seasons, the HS herd had more cows with udder infections and a higher percentage of infected quarters, however, there were no differences in bulk milk SCC between treatments (Table 3).

Reproductive performance for the 2 herds was similar throughout the trial however there was considerable variation between seasons for both herds. Annual empty rates ranged from 0% to 15% for the HS Maize farmlet and 1% to 12% for the Control farmlet.

Monthly average pre- and post-grazing pasture mass values for each farmlet are presented in Table 4. Pasture production was similar across the farmlets, however there was variation from year-to-year (Table 3). The major difference between the treatments was in the amount of pasture conserved as silage. The control herd conserved on average 1651 kg DM/ha compared with only 249 kg DM/ha conserved on the HS farm. Pasture haylage was fed with the maize silage and pasture during the summer of 2001 to ensure the diet contained 16% crude protein.

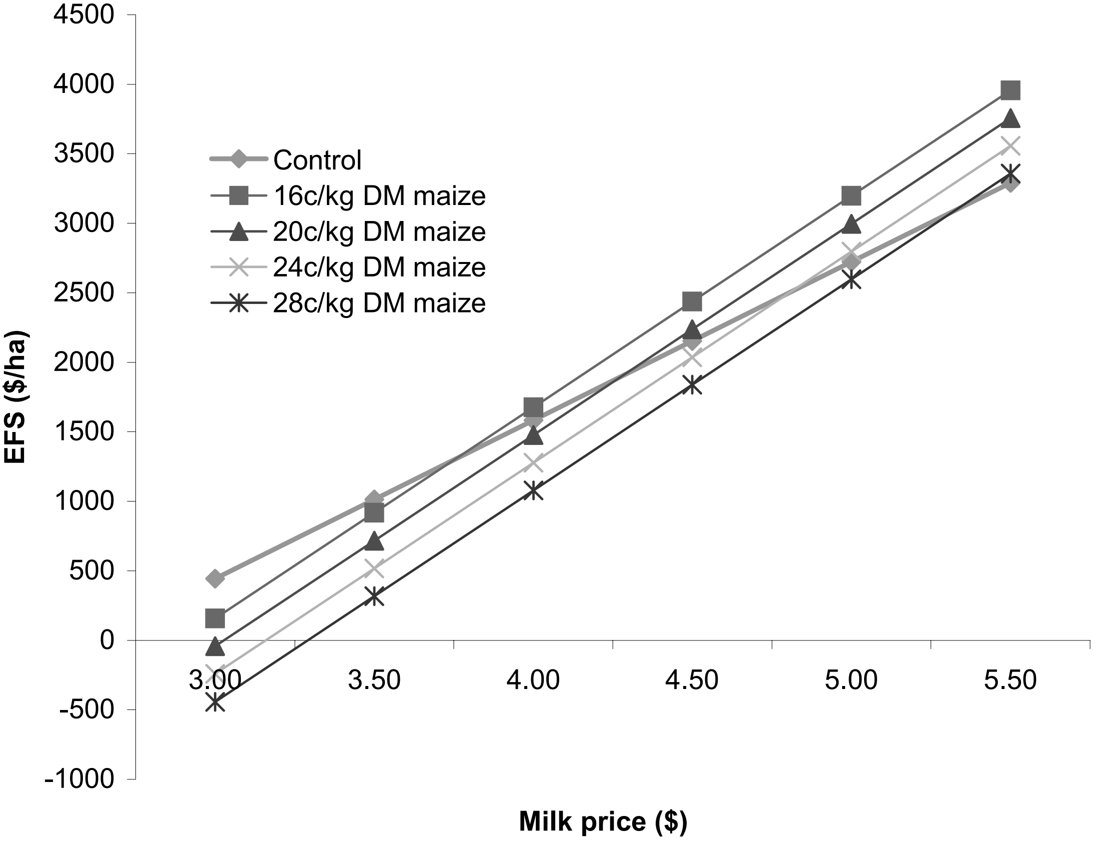
The 2000/2001 year was noted for the drier conditions over summer with only 54% of the average rainfall for the December to April period while the 2002/2003 season experienced only 33% of the average rainfall for January and February.

Milksolids response to the additional DM provided and the higher SR on the HS Maize system ranged from 57 to 102 g/kg DM. The highest response was observed in the 2003/2004 season when the requirement for

Table 4 Mean (±SE) monthly pre- and post-grazing pasture mass (kg DM/ha) for the Control and HS Maize farmlets.

	Control		HS Maize	
	Pre-grazing	Post-grazing	Pre-grazing	Post-grazing
June	3800 (39)	1540 (38)	3860 (9)	1540 (38)
July	3650 (48)	1880 (49)	3720 (25)	1870 (47)
August	3730 (105)	1900 (67)	3540 (38)	1860 (58)
September	3370 (23)	2150 (23)	3480 (168)	2130 (29)
October	3280 (54)	2200 (5)	3580 (178)	2180 (19)
November	3390 (63)	2250 (48)	3480 (189)	2280 (43)
December	3700 (58)	2430 (159)	3540 (72)	2420 (161)
January	3750 (100)	2480 (178)	3540 (106)	2490 (172)
February	3780 (246)	2550 (136)	3610 (279)	2570 (156)
March	3760 (135)	2330 (229)	3670 (145)	2360 (239)
April	3600 (131)	2180 (242)	2550 (154)	2160 (244)
May	3700 (40)	1970 (30)	3730 (92)	2020 (42)

Figure 1 Effect of milk price and maize silage price on EFS.



maize silage supplementation was reduced because of excellent pasture growing conditions throughout the season. Record production was achieved for the farm in this season.

Economic analysis showed considerable variation between farm systems and betw een years (Table 3). The highest EFS of $4453/ha was achieved by the Control herd in the 2001/2002 season while the lowest EFS of -$101/ha was achieved by the HS Maize herd in the 2002/2003 season. The impact of maize silage price and milk price has been calculated using average production and intake figures for the four years of the trial (Figure 1).

Discussion

This trial has demonstrated that although efficient use of maize silage in a pasture-based system will increase production/ha, the profitability of the system will be dependent on a number of factors. Often increased production associated with high levels of supplementary feeding is offset by increased costs resulting in no increase in profit. The EFS of the HS Maize system was more vulnerable to variations in seasonal conditions, maize silage price and milk payout. By conducting the trial over four seasons we have observed variation in all of these factors. The first two seasons of the trial were high payout years ($5.00 and $5.30/kg MS, respectively) but these were followed by two years of low ($3.63/kg MS) and average ($4.15/kg MS) payout. During the 2000/2001 and 2002/2003 seasons, the region suffered drought conditions, which impacted on feed supply and therefore DIM, especially with the Control herd. What the economic analysis does show is that when a drought year coincides with a poor payout (2002/2003) it is still possible to make money on an all-grass system. However, it is more difficult to make a profit with the HS maize system especially if you are paying more than $0.25/kg DM for maize and increased DIM cannot be achieved with supplementary feeding. Jensen *et al*. (2004) concluded that high input systems were more profitable and less affected by payout shift when maize silage could be purchased for $0.18/kg DM. The EFS for the Control farm in the current comparison ranged between $742 and $4453/ha compared with -$101 to $3920/ha for the HS maize system. Large profits can be made from the HS Maize system in high payout years if costs are contained, a finding supported by Jensen *et al*. (2004). Equally, high profits can be achieved from low input pasture-only systems under the same conditions.

Previous supplementary feeding research in NZ (Penno *et al.* 1996; Pinares & Holmes 1996; Thomson *et al.* 1997) has demonstrated that the key to profitable supplementary feeding is to use the additional feed to increase lactation length. Maize silage supplementation in the current work increased days in milk on average by 17 days. While 17 days may at first glance appear inconsequential over the 4 years of the trial, it equates to an additional 397 lactation days/ha.

Milk production responses to supplementary feeding from previous research have ranged from 82-91 g MS/kg DM maize grain (Penno *et al*. 1996) to 134 g MS/kg DM meal fed (Thomson *et al*. 1997). Average response in the current trial, 80 g MS/kg DM additional feed and increased SR, was similar to that reported by Penno *et al*. (1996). A key difference between previous work and the trial presented here is the absence of a true control in the current work. The HS Maize system incorporated both an increase in SR and maize silage supplementation. The higher response reported by Thomson *et al*. (1997) was attributed to the very early calving date (20 June) and the level of underfeeding experienced in early lactation. Thomson *et al.* (1997) concluded that high MS responses would only be achievable on commercial farms where constant pasture monitoring, feed planning and intensive pasture utilisation was practiced.

The amount of silage conserved on the HS farm was highest in the 2001/2002 season and declined steadily from there with only 73 kg DM/ha or 15 kg DM/cow being conserved in the final year of the trial. With this trend it would appear that the HS Maize system, over the four years, has become more effectively managed to utilise all the pasture grown without letting surpluses arrive and hence the need to make supplement.

The udder infection and SCC results in the current trial are supported by Lacy-Hulbert *et al*. (2002) who measured the incidence of mastitis in cows grazed on pasture or fed a total mixed ration (TMR) on a feed pad. More quarters of cows on TMR developed clinical mastitis compared with cows on grass. However, Lacy-Hulbert *et al*. (2002) also observed no differences in seasonal SCC between treatment groups. This was a reflection of the difference in types of pathogen predominantly causing mastitis. In the trial of Lacy-Hulbert *et al.* (2002) coliform mastitis frequently resulted in infected quarters in the TMR cows but only rarely caused sub-clinical mastitis, and in turn had a lessor effect on cow SCC (Lacy-Hulbert *et al.* 2002). The higher incidence of mastitis in the HS Maize could be explained by the increased exposure to environmental factors such as confinement of cows in a restricted area whilst consumption of maize is occurring.

Conclusion

This trial has demonstrated that incorporation of up to 22% of feed requirements as maize silage into a pasture-based system will increase production per hectare. However the profitability of the system will be more vulnerable to milk payout and maize silage price than the traditional pasture-based system. Farmers considering a higher stocked system need to ensure they have systems in place to maximize production and have risk management strategies in place to deal with years of high feed costs and/or low milk price.

ACKNOWLEDGEMENTS

The authors acknowledge the management and assistance given by the farm managers Alan and Joanne Mudgway and the support provided by the Waimate West Demonstration Farm Committee. Acknowledgement is also given to the technical assistance given by

Claire Cooper and Maree Tong and the advice on mineral supplementation provided by John Roche. We thank Warwick Prewer for his advice on the financial analysis and Barbara Dow for statistical analysis of the data. MAF Sustainable Farming Fund and Fencepost provided financial support for the trial.

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