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Increasing milksolids production with supplementary feeds

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ABSTRACT

Four farmlets were established at a stocking rate of 4.41 Friesian cows per hectare to compare rolled maize grain, maize silage and a nutritionally balanced ration as supplementary feeds for grazing dairy cows, for three complete seasons. Supplements were offered whenever it was estimated the herds were eating less than 15 kg DM/cow/day or were leaving a post-grazing residual herbage mass of less than 1800 kg DM/ha.

Offering 1.3 to 1.5t DM/cow/year of supplement increased net herbage accumulation from 18.3 to 19.2 t DM/ha, however, this did not result in higher annual herbage intake. The use of rolled maize grain, maize silage, and balanced ration supplements increased production from 1188 kg milksolids (MS)/ha to 1763, 1602, and 1769 (± 69.6) kg MS/ha/year, with responses of 98, 77, and 99 g MS/kg DM, respectively. The magnitude of the response to the supplementary feed was directly proportional to the increase in metabolisable energy supplied by the supplement.

Full lactation responses to supplementary feeds were two fold greater than those measured in short term feeding trials. Responses of 7.5g MS/MJME can be expected over the complete lactation when supplements are offered to dairy cows grazing restricted pasture.

Keywords: Supplementary feeding; milksolids; complete lactation; maize grain; maize silage; balanced ration.

INTRODUCTION

The quantity and nutritional value of pasture supplied to the herd limits total milksolids (MS) output of pastoral dairy farming systems (Bryant 1990). Many researchers have investigated the effects of offering supplementary feed to grazing dairy cows in an attempt to overcome pasture deficits, or increase animal performance beyond levels achievable on pasture alone. Leaver *et al.*, (1968) reviewed supplementary feeding experiments and concluded that the use of supplements resulted in only small and uneconomic increases in milk yield when cows were grazing generous amounts of pasture, however, at that time insufficient information was available to predict responses when pasture was restricted. Recently, Kellaway and Porta (1993) reviewed the use of supplementary feeds in Australia and concluded that when pasture was restricted, offering energy concentrates was likely to result in an immediate effect of 0.5 kg milk/kg concentrate. Further, it was estimated that carry-over effects of additional cow condition herbage mass could result in an additional 0.5 kg milk/kg concentrate during the remainder of lactation.

Few full lactation studies investigating the impact of supplementary feeds on the whole farm system are available. Penno *et al.*, (1996a) offered rolled maize grain to grazing dairy cows in a two year farmlet experiment designed to investigate intensification of pasture-based dairying systems. Annual yield was increased by 37g milkfat and 39g milk protein when rolled maize grain was used to increase per cow performance at 3.24 Friesian cows per hectare, and 50g milkfat and 38g milk protein/kg DM when stocking rate was increased from 3.24 to 4.48 cows/ha. However, at current costs and prices, feeding concentrate supplements was uneconomic (Penno *et al.*, 1996b).

Stockdale (1994) demonstrated that the response of grazing dairy cows to supplementary feeding with maize silage was similar to that expected from cereal grain supplements. Maize silage is an attractive source of additional feed energy for dairy farmers because in New Zealand it is often available at half the cost of cereal grain supplements. Nevertheless, both cereal grain supplements and maize silage may not provide the best mix of nutrients for lactating dairy cows (Edwards & Parker 1994).

The experiment described in this manuscript was designed to compare the effect of maize grain, maize silage and a nutritionally balanced supplementary feed on the yield of milksolids within an intensive pastoral dairying system.

MATERIALS AND METHODS

Four 5.6 ha farmlets were established on the Dairying Research Corporation No2 Dairy in June 1995 and were maintained for three complete seasons. Each farmlet received 200 kg N/ha/year and was stocked with 4.41 high genetic merit Friesian cows/ha balanced for age, genetic merit, calving date and previous treatment. Experimental treatments were either no purchased supplementary feed (control), or supplements of either rolled maize grain, maize silage or a nutritionally balanced ration (Table 1). The balanced ration was formulated using the Cornell Net Carbohydrate and Protein System (Fox *et al.*, 1992) to provide an appropriate balance of readily fermentable carbohydrate, fiber and protein considering the predicted chemical composition and dry-matter intake (DMI) of pasture. Mineral supplementation within the balanced ration was formulated by a similar process using Spartan (van de Haar *et al.*, 1992). The supplements were offered when the herd was restricted to a pasture DMI of less than 15kg/cow/day, or was grazing below a post-grazing herbage mass thought to impair

herbage regrowth (approximately 1800 kg DM/ha). Rolled maize grain was fed individually in the farm dairy at milking. Maize silage and balanced ration supplements were offered in fiberglass feed trolleys at pasture. The amount of supplement offered was adjusted to avoid wastage and keep refusals to a minimum. All farmlets were managed to maximize performance according to the decision rules of Macdonald & Penno (1998).

Milk yield and concentrations of fat and protein were measured at two consecutive milkings each week. Liveweight and condition score were measured fortnightly. The herbage intake of each herd was calculated as the difference between calibrated visual estimates of pre- and post-grazing herbage mass on three occasions each week. Net herbage accumulation and average herbage mass were calculated from calibrated weekly visual estimation of the herbage mass in each paddock. Data are presented as the means of the three seasons. Yields of milkfat and protein were analysed by analysis of variance using the season totals for each year and treatment, where year was treated as a blocking factor in the model.

RESULTS

Total supplement eaten by each herd, averaged across the years, ranged from 1279 to 1458 kg DM/cow/year (Table 1). Differences in supplement DMI primarily resulted from refusals of maize silage when large daily allowances were offered (>7 kg DM/cow/day). Mean composition of the balanced ration supplement was 44% Maize silage, 31% rolled maize grain, 21% protein concentrates, 2.5% tallow, and 1.5% minerals. The amount of supplementary feed consumed by non-lactating herds ranged from 2 to 4 kg DM/cow/day during winter. Supplement consumed by lactating herds ranged from 2 to 6.5 kg DM/cow/day from July to October and 2 to 7.5 kg DM/cow/day from January to May. November and December were the only months when no supplement was offered.

Offering large amounts of supplementary feed resulted in small differences in both net herbage accumulation and herbage intake (Table 1). Annual net herbage accumulation on the treatment farmlets averaged 19.2 t DM/ha/year compared to 18.3t DM/ha/year on the control

TABLE 1: Net herbage accumulation, and herbage and supplementary feed intake.

Farmlet	Control	Maize Grain	Maize Silage	Balanced Ration
Pasture				
Net herbage accumulation (t DM/ha)	18.3	18.9	19.2	19.6
Herbage intake (tDM/ha)	17.9	17.3	16.8	17.1
Herbage intake (t DM/cow)	4.1	3.9	3.8	3.9
Total intake (t DM/cow)	4.2	5.3	5.1	5.4
Supplementary feeds (kg DM/cow)				
Maize Grain		1247		445
Maize & Pasture silage	67	148	1279	651
Other feeds				362
Total	67	1395	1279	1458
Total (MJME/cow)	685	18720	13005	18320

farmlet. The extra annual herbage accumulation resulted from higher net herbage accumulation rates on the treatment farmlets during September, October and November. Despite reduced annual net herbage accumulation, the control herd tended to have a greater annual herbage intake than the herds offered supplementary feeds.

Offering supplementary feed increased lactation length from 217 to 284 lactation days/cow (Table 2), and increased the annual yields of milk, milkfat and protein relative to the unsupplemented control. Offering maize grain, maize silage, and the balanced ration supplements increased milksolids production from 1188 kg MS/ha by the control to 1763, 1601 and 1797 kg MS/ha, respectively. The balanced ration treatment resulted in greater yields of milk, milkfat and protein than the maize silage treatments, but similar yields to the maize grain treatment. Feeding maize grain resulted in milk with a higher protein content than the other treatments. While differences in liveweight were apparent during the season, no differences were measured between treatments groups before calving, or at the conclusion of each season.

TABLE 2: Mean annual yields of milk, milkfat and protein, liveweight and body condition score, and responses to supplementary feeding treatments

Farmlet	Control	Maize Grain	Maize Silage	Balanced Ration	SED
Annual milk Production					
Lactation (days/cow)	217	283	277	291	
Milk (kg/cow)	3351 ^a	4746 ^{bc}	4396 ^b	5092 ^c	206
Milkfat (g/kg)	45.7 ^a	47.7 ^b	47.6 ^b	45.0 ^a	0.8
Protein (g/kg)	34.6 ^a	36.6 ^b	34.9 ^a	35.0 ^a	0.3
Milkfat yield (kg/cow)	153.3 ^a	226.2 ^{bc}	209.5 ^b	229.3 ^c	8.8
Protein yield (kg/cow)	116.1 ^a	173.5 ^b	153.5 ^c	178.2 ^b	7.1
Milksolids (kg/ha)	1188 ^a	1763 ^b	1601 ^c	1797 ^b	69.6
Liveweight and body condition score					
Pre-calving (kg/cow)	500 ^a	507 ^a	497 ^a	491 ^a	19.6
Season end (kg/cow)	510 ^a	522 ^a	512 ^a	517 ^a	17.0
Calving condition	4.6	4.8	4.8	4.9	
Season end condition	4.3	4.7	4.5	4.7	
Responses to supplements					
Milksolids (g/kg DM)		98	77	99	
Milksolids (g/MJME)		7.2	7.6	7.8	

Means differing in superscript letters are significantly difference (P<0.05)

DISCUSSION

Pasture DMI is often reduced when supplementary feeds are offered to grazing dairy cows (Leaver 1985). This substitution of supplementary feed for pasture manifests itself as a higher post-grazing herbage mass during the period of supplementary feeding. Higher herbage mass resulting from feeding supplements may subsequently increase net herbage accumulation. In this experiment the extra net herbage accumulation occurred only in spring. Bryant (1990) suggested that low herbage mass on the farm in September reduced net herbage accumulation, and average herbage mass for several months. In this experiment, high stocking rates and an early mean calving date resulted in a large feed deficit in September. Thus it is likely the extra net herbage accumulation during spring, was a result of reduced grazing pressure in early spring due to the use of supplementary feeds.

When high rates of nitrogen fertiliser are used herbage availability generally exceeds feed requirements in late spring, even at high stocking rates (McGrath *et al.*, 1998). The inability of the treatment herds to make use of the additional herbage by increasing annual DMI is probably a result of the extra herbage being available during a period of plentiful herbage supply.

Maize silage resulted in lower total DMI, and subsequent yields of milk, milkfat and protein than the other forms of supplementary feed. The lower milk yield was predominantly caused by 30% lower metabolisable energy (ME) intake from maize silage as a consequence of the lower DMI and lower ME content of the maize silage relative to the maize grain or the balanced ration supplements. However the lower protein content of the maize silage may also have contributed to the lower response. Macdonald *et al.*, (1998) demonstrated that the low protein content of maize silage limited milksolids yield in summer and autumn when maize silage comprised half the diet of cows grazing pasture.

Offering maize grain, maize silage and balanced ration supplements resulted in responses of 98, 77, and 99 g MS/kg DM, respectively (Table 2). However, when the differences in energy yield of the supplements are accounted for, the responses to the different forms of supplements were similar. This agrees with the findings of Penno *et al.*, (1998) who demonstrated responses of 4.6 and 4.2 g MS/MJME to supplements of rolled maize grain and nutritionally balanced ration supplements, respectively, in short term feeding studies. Hoffman *et al.*, (1993) also demonstrated that offering grazing cows a supplement that was regularly formulated to complement the nutrients provided by pasture did not increase milk yield beyond that achieved by offering a standard concentrate.

The responses demonstrated in this study equate to 0.9 to 1.2 kg milk/kg supplement and therefore agree with the estimates of total lactation response suggested by Kellaway and Porta (1993). Likewise, they are almost two times greater than the responses reported by Penno *et al.*, (1998) when rolled maize grain and nutritionally balanced supplements were offered to grazing dairy cows in short term studies.

Few full lactation grazing or indoor feeding studies have been undertaken. Summaries of six long-term supplementary feeding studies are presented in Table 3. In addition to the responses being greater than those generally reported in short-term studies, they appear to demonstrate greater consistency. Responses measured in complete season studies range from 62 to 134 g MS/kg DM. These compare to a range of -20 to 152 g MS/kg DM reported for short-term studies reviewed by Kellaway and Porta (1993). Remaining variation can be further explained by the relative energy contents of the supplementary feeds, with concentrate based supplements generally demonstrating a larger response than those from pasture and maize silage. Penno *et al.*, (1998) suggested milksolids responses are related to the level of underfeeding of the herd. Therefore, the large responses achieved in these systems trial must be consid-

TABLE 3: Mean milkfat and protein response to supplementary feeding of grazing dairy cows measured in long-term experiments.

Reference	Duration	Supplement	Milkfat (g/kg DM)	Protein (g/kg DM)
Hoden <i>et al.</i> , 1991	2 x 6 months	Concentrate pellets	17	12
Leaver & Campling 1993	2 x 6 months	50:50 NaOH treated straw:brewers grain	43	34
Clark 1993	1 season	Pasture silage	40	22
Penno <i>et al.</i> , 1996a	2 seasons	Rolled maize grain	47	38
Thomson <i>et al.</i> , 1997	3 seasons	Concentrate pellets	76	58
Thomson <i>et al.</i> , 1998	2 seasons	Maize silage	55	37
Mean response			46	36
This study	3 seasons	Maize grain	51	40
	3 seasons	Maize silage	46	31
	3 seasons	Balanced ration	52	42

ered relative to the high stocking rates (3.2 – 4.4 cows/ha) and early calving dates (20 June – 15 July).

CONCLUSIONS

Full lactation responses of 7.5g MS/MJME can be expected when supplements are offered to dairy cows grazing restricted amounts of pasture. Substitution resulting from supplementary feeding in early lactation may increase post-grazing herbage mass and subsequent net herbage accumulation, however, because the extra herbage is likely to be available during a period of surplus herbage, intake may not increase. Farmers should continue to purchase and offer supplements on the basis of metabolisable energy. Supplements should only be used when the income derived from 7.5 g MS is sufficient to cover the costs of purchasing and feeding the supplement, the extra days in milk, and the required profit margin.

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