Using nitrogen fertiliser to increase dairy farm profitability

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ABSTRACT

Five farmlets were established to investigate the profitability of using nitrogen fertiliser (N) to increase pasture supply and milksolids production. Farmlets were stocked with 3.34 (low) or 4.42 (high) Friesian cows/ha and received 0, 200 or 400 kg N/ha/year. Total annual pasture production was increased by 1.76 and 0.97 t DM/ha when 200 kg N/ha was applied and by 3.2 and 3.6 t DM/ha using 400 kg N/ha at the low and high stocking rate, respectively. Annual milksolids production increased by 142 and 218 kg MS/ha after the application of 200 and 400 kg N/ha, respectively. Increasing stocking rate from 3.34 to 4.42 cows/ha reduced milksolids production by 99 kg MS/cow. Applying 200 kg N/ha at the lower stocking rate increased economic farm surplus by $148/ha. Increasing stocking rate reduced total milksolids production and profitability at both rates of N.

Keywords: nitrogen, stocking rate, milksolids production, economic farm surplus.

INTRODUCTION

Annual feed supply limits milksolids production and therefore potential profit on dairy farms. Increased farm productivity relies on increasing the amount of feed grown. However, to improve profitability the extra feed supplied must be produced and/or purchased and fed for much less than the value of the extra milksolids produced.

Nitrogen fertiliser (N) provides a potentially cheap way of increasing pasture production on New Zealand dairy farms. N fertiliser has increased both pasture and milk production in farmlet trials, (Holmes, 1982; Bryant *et al*., 1982; Harris *et al*., 1994). Pasture production responses ranged from 8 to 16 kg DM/kg N applied and milksolids responses from 0.41 to 0.47 kg MS/kg N applied.

Recent research (Thomson *et al*., 1991; 1997; Clark, 1993; Penno *et al.*, 1995) showed milksolids response to extra feed was greatest when days in milk were increased. Days in milk, defined as cow milking days per hectare per annum, can be increased by increasing the number of cows milked per hectare or by increasing the number of days each cow in the herd is milked. Previous research has not described the effect of using extra feed to increase days in milk on the profitability of a whole farm system as described by an economic farm surplus (EFS) calculation. The current work allows the effect of increasing feed supply on EFS to be identified within a whole farm system.

This paper reports on the pasture and milksolids production, and change in profitability, of farmlets with different stocking rates and receiving contrasting rates of N fertiliser from June 1995 to June 1997.

MATERIALS AND METHODS

Five, 5.6 ha farmlets, balanced for soil type and previous treatment were established on No. 2 Dairy, at the Dairying Research Corporation, Hamilton, in June 1995, (table 1). Each farmlet was stocked with either 20 (3.34 cows/ha, LS) or 25 (4.4 cows/ha, HS) high genetic merit Friesian cows. Each herd was balanced for genetic merit, age, calving date and liveweight. Farmlet 1 (control) received no N fertiliser. Farmlets 2 and 4 received 200 kg N/ha/yr (200N) and farmlets 3 and 5 received 400 kg N/ha/yr (400N). N was applied as urea after grazing at 20 and 40 kg N/ha until 200 and 400 kg N/ha was applied for the 200N and 400N treatments respectively, except during periods of summer dry.

Milk yield and concentrations of fat, protein, and lactose were measured at two consecutive milkings each week. Cow liveweight and condition were measured fortnightly. The herbage intake of each herd was estimated from weekly drymater (DM) disappearance (Stockdale, 1984). Net herbage accumulation, as defined by Campbell (1966), was obtained for each farmlet from weekly eye assessments of the increase in herbage mass on ungrazed paddocks. Data were analysed using the SAS 6.12 Mixed Models procedure. Individual cows were used as the experimental unit and calving date was included as a covariate. Profitability was determined by using an EFS calculation for each farmlet (LIC Advisory Farm Facts 47).

RESULTS

Applying 200 kg N/ha/yr to the lower and higher stocked farmlets increased net herbage accumulation by 1.76 and 0.97 t DM/ha, respectively, and by 3.2 and 3.6 t DM/ha when 400 kg N/ha was applied (Table 1). During winter and spring the mean pasture response on the LS200N, LS400N and HS400N farmlets was 75% of the total annual response, despite only 56% of the annual N rate being applied. The HS200N farmlet achieved 50% of it's total annual increase pasture production over the same period. At the lower stocking rate this increase in pasture production resulted in 268 and 491 kg DM/cow harvested as pasture silage for each of the 200N and 400N treatments, respectively. The pasture silage was harvested between 18 October and 20 December. From February to May, 103 and 138 kg DM/cow of this pasture silage was offered to the lower stocked 200N and 400N treatments, respectively, and in June and July another 100 kg DM/cow was offered to the lower stocked N herds. At the higher stocking rate pasture silage was offered at 200 and 100 kg DM/ cow during August 1996 to overcome poor pasture growth and ensure the cows were fed at their maintenance levels.

TABLE 1: Seasonal and annual net herbage accumulation (kg DM/ha), on farmlet treatments, pasture silage harvested and offered (kg DM/cow)and days-in-milk, averaged over two years.

Farmlet	**1**	**2**	**3**	**4**	**5**
Treatment	Control	LS200N	LS400N	HS200N	HS400N
Stocking Rate (cows/ha)	3.34	3.34	3.34	4.40	4.40
Actual nitrogen applied (kg N/ha)	0	204	428	204	424
Net herbage accumulation (kg DM/ha)					
Winter (Jun - Aug)	2075	2415	2745	2096	2723
Spring (Sept - Nov)	6760	7823	8314	7221	8675
Summer (Dec - Feb)	5801	5813	6105	5941	6113
Autumn (Mar - May)	3090	3435	3774	3438	3814
Total	17726	19486	20938	18696	21325
Extra Pasture Production		1761	3213	970	3599
Pasture response (kg DM/kg N)		8.6	7.5	4.7	8.4
Pasture silage harvested (kg DM/cow)	0	268	491	0	65
Pasture silage offered (kg DM/cow)	0	198	243	100	62
Days-in-milk (days/cow)	263	277	290	221	226

For the lower and higher stocking rates respectively, applying 200 kg N/ha increased milksolids production by 156 and 126 kg MS/ha, whereas applying 400 kg N/ha resulted in increases of 232 and 205 kg MS/ha, (Table 2). Milksolids responses were 0.79 and 0.63 kg MS/kg N for the lower and higher stocking rate, respectively, at 200 kg N/ha and 0.58 and 0.53 kg MS/kg N at the lower and higher stocking rate, respectively, at 400 kg N/ha.

TABLE 2: Annual milk fat, milk protein and milksolids production averaged over two years.

Treatment	Control	LS200N	LS400N	HS200N	HS400N	SED
Milk fat (kg/cow)	187	209	224	156	167	9.1
Milk fat (kg/ha)	624	698	748	686	735	
Milk protein (kg/cow)	138	163	170	119	126	6.6
Milk protein (kg/ha)	460	544	568	524	554	
Milksolids (kg/cow)	325	372	394	275	293	15.3
Milksolids (kg/ha)	1084	1242	1316	1210	1289	
Production to 31/12 (kg MS/ha)	680	801	821	883	947	

Milksolids production per cow was 26% less on the higher stocked N farmlets compared with the lower stocked N farmlets. The lactation length of the higher stocked farmlets were 56 and 65 days shorter than the lower stocked treatments for 200 kg N/ha and 400 kg N/ha, respectively (Table 1). Production per cow at the high stocking rate to 31 December was 14% less than that at the low stocking rate, while production per hectare was 11% higher. Average daily milksolids yields to 31 December were 1.31, 1.55 and 1.35 kg MS/cow/day for the control, lower stocked and higher stocked farmlets, respectively. The number of days-in-milk per cow to 31 December was similar for all farmlets, however, as a result of the extra 1.1 cows/ha, the higher stocking rate created an extra 152 days in milk per hectare.

The EFS, shown in table 3, of the lower stocked farmlets were greater than the higher stocked farmlets.

TABLE 3: Economic farm surplus of farmlets averaged over 1995/96 and 1996/97.

Treatment	Control	LS200N	LS400N	HS200N	HS400N
Income ($/ha)[1]	4048	4645	4868	4596	4894
Expenditure ($/ha)[2]	2206	2654	3001	3024	3297
EFS ($/ha)[3]	1842	1991	1867	1572	1597

[1] Assumes a $3.50/kg MS payment and net income from stock of $75/cow.

[2] Expenditure was calculated from the average cost per cow or hectare for direct farm working expenses as reported in the LIC Economic Farm Survey 1997. Nitrogen cost $1/kg, silage $0.20/kg DM offered and CIDR's $20/annoestrus cow.

[3] EFS calculation used is according to the LIC Advisory Farm Facts no. 47.

DISCUSSION

Application of N increased pasture and milksolids production of the farmlets at the low and high stocking rates compared to the control. Pasture responses to N were 8.6, 7.5, 4.7, and 8.4 kg DM/kg N for the LS200N, LS400N, HS200N, and HS400N farmlets, respectively. These responses were smaller than the 10 - 17 kg DM/kg N reported by Penno *et al*., (1996), but were similar to the 7.4 - 10.5 kg DM/kg N reported by Holmes (1982).

The pasture production response to 200 kg N/ha/yr was lower at the higher stocking rate than the lower stocking rate, confirming the results of Thomson *et al*., (1997). They reported that pasture response to N declined from 9.6 to 6.7 kg DM/kg N when stocking rate was increased from 3.6 to 4.2 Jersey cows/ha. The same trend did not occur in the current study when 400 kg N/ha was applied. The lower pasture production on the HS200N farmlet compared to the LS200N farmlet was reflected in poor milksolids yield per cow, possibly because of periods of over-grazing, especially in winter and spring (Table 1). Stockdale and King (1980) estimated pasture losses of 1.6 t DM/ha/year because of over-grazing when stocking rate was increased from 4.4 to 8.6 cows/ha. In the same experiment, responses to N decreased from 17 to 3 kg DM/kg N as the stocking rate was increased. Over-grazing in these studies is a result of the high stocking rate systems having a feed demand that is greater than the feed supply for much of the year.

Applying 200 and 400 kg N/ha resulted in milksolids responses at the lower stocking rate of 0.79 and 0.58 kg MS/kg N, respectively, and 0.63 and 0.53 kg MS/kg N, respectively, at the higher stocking rate. At the lower stocking rate, 69% of the increase in milksolids production occurred before the end of December, (Table 2), a result of increased daily milksolids production per cow due to higher dry matter intakes (DMI). The rest of the increase, (ie 31%), in milksolids production was associated with an extra 14 and 27 days-in-milk per cow on the 200N and 400N farmlets, respectively. The increased milksolids production at the higher stocking rate was effectively a result of increased days-in-milk per hectare by the end of December.

The difference in the timing of the milksolids response between the lower and higher stocking rates reflects a different pattern of DMI through the season. In early spring extra pasture grown increased daily per cow performance at both stocking rates relative to the control. In late spring, at the lower stocking rate, the additional pasture exceeded cow requirements and therefore more silage was made, but this extra pasture was all eaten by the higher stocked herds. Greater milksolids production by the 31 December for the HS200N (82 kg MS/ha) and HS400N (126 kg MS/ha) reflected this trend. However, the extra pasture silage harvested and fed back to the lower stocked cows allowed them to be milked longer in the autumn.

Thus, cows on the LS200N and LS400N farmlets produced 114 and 153 kg MS/ha more than the HS200N and HS400N farmlets, respectively, from 1 January to drying off. Overall stocking rate made little difference to total milksolids production of the farmlets.

This study, and the poor biological and economic performance of the higher stocked farmlets, supports recent reviews suggesting that total farm efficiency is being compromised through low per animal productivity in an attempt to maximise pasture utilisation (Edwards and Parker, 1994; Lean *et al*., 1996). In a recent modelling study, McCall and Clark, (1998), predicted that farm profit at No 2 dairy would be optimised with 2.8 cows/ha producing 430 kg MS/cow over a 280 day lactation. As well as higher pasture allowances, the success of the proposed system was dependent on harvesting large amounts of surplus spring pasture to provide a high quality supplement to be fed mid to late lactation. This suggests that the lower stocking rate used in this study is already above the optimum.

At the lower stocking rate applying 200 and 400 kg N/ha/year increased EFS, (by $148 and $24/ha, respectively, (Table 3)), compared with the control. The combination of N and a higher stocking rate reduced EFS by up to $271/ha. Conserving and feeding pasture silage has been considered a cost to low stocked dairy systems. However, many of the variable costs of milk production are directly linked to the number of cows being farmed (LIC Dairy statistics, 1997). The lower EFS of the higher stocked farmlets demonstrates that the additional costs associated with farming extra cows, may outweigh the disadvantages of using pasture conservation to transfer pasture from periods of surplus to periods of deficit at lower stocking rates. This is particularly true where increased stocking rate does not result in an increased total milksolids production.

CONCLUSIONS

Nitrogen fertiliser can increase pasture production, and if this pasture is utilised by the dairy herd, can increase milksolids production. The profitability of nitrogen fertiliser usage depends upon the method used to utilise the extra pasture produced. The opportunity to improve profitability is to provide feed which results in an increased lactation length and therefore per cow milksolids yield. Increasing stocking rate without increasing total milksolids output per ha or per cow will not increase profit. As feed allowance per cow increased there was a diminishing marginal return to the extra pasture supplied by nitrogen fertiliser.

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