A farmer's experience with high N fertiliser inputs on grass/clover pastures

STEPHEN BARR
Nopera Rd, RD 32, Opunake

Abstract

A dairy farmer's experiences in managing various levels of fertiliser nitrogen (N) inputs over the 1991–95 seasons is discussed and compared to previous years when very little N fertiliser was used. N requirements were assessed by regular herbage tests. Fertiliser N increased pasture growth in spring, early summer and autumn. Animal intakes were greater on N-boosted pasture. Higher rates of N fertilisers (450 kgN/ha/yr) generated large spring surpluses which were harvested as silage. Several changes in management were required to maintain pasture quality and effectively utilise these surpluses. Feed costs vs milk returns are compared for a number of seasons. Moderate fertiliser N usage (200–300 kg N/ha/yr) is considered likely to give the most profitable balance.

Keywords: clover, dairying, grazing management, milksolids, nitrogen, pasture growth, pasture quality

Introduction

Nitrogen (N) fertiliser has traditionally been viewed in New Zealand as a strategic feed input, as opposed to the source of an essential plant nutrient. This is despite N being the nutrient required in the largest amount for pasture growth and our pastures being deficient in N for much of the year (Ledgard et al. 1994). Also, increasing pasture utilisation could lead to the need for regular N inputs to maintain a N balance (Field & Ball 1982).

The use of N fertiliser in a farming system throughout the year is not new. Responses of 0.1–0.45 kg milkfat/kg N applied, were obtained in 1971–74 by Holmes (1982) and in 1979–81 by Bryant et al. (1982). The ability to effectively utilise the extra feed had a large effect on the economic response achieved. At that time the value of the extra production in relation to the cost of the N meant the system was unprofitable. However since then, N prices have remained relatively static while milk returns have increased.

N fertiliser has also been profitably used to boost spring growth, to allow earlier calving and generate surplus pasture for silage production. The silage was then fed to milking cows either in the dry summer period or at the end of the milking season to extend lactation (Thompson et al. 1991).

The use of N fertilisers by dairy farmers has increased in the last few years (Kidd & Howse 1994). In Taranaki, some farmers are using N fertiliser throughout the year in an effort to satisfy pasture N requirements (Gazzard & Bint 1992). This has resulted in improved levels of output and economic performance.

Balanced against this high use of N, there is concern about the environmental impact of intensive N fertiliser use (Ledgard et al. 1994) and the concern about the effect of high N applications on clover (Harris 1994, Harris et al. 1994)

It is against this background that we have become involved in the use of N fertilisers throughout the year on our farm. Our aim is to increase the farm's economic performance, but we are mindful of any adverse effects on the environment which may be caused.

Farm details

Location:	Pihama, South Taranaki	
Milking area:	112 ha (effective)	
Soil type:	Egmont Black Loam	
Soil tests:	Olsen-P = 38 S = 13 K = 12	
	pH = 5.7	
Fertiliser applied	1993/94	60t DAP (100kgP/ha)
	1994/95	11t Superphosphate, 33t DAP (60kg P/ha)
Stock:	400 cows Breeding Index = 132	
Stocking rate	= 3.6 cows/ha	
Calving:	Start 25 July End 15 September	

Nitrogen fertiliser use

Our experience with N fertilisers between 1991–93 is detailed in Barr (1993). Interest in mineral N came because we were not able to feed our cows adequately throughout the year. Tests showed herbage N levels to be 2–3%. Clover was not supplying sufficient N to the pastures for much of the year. Table 1 shows the relevant N usage and production details for the 1989–95 seasons.

Table 1: Nitrogen application and milksolids production 1989–1995.

	No. Cows	kgN/ha	kg Milksolids	kgMS/ cow	kgMS/ ha	Feed Conserved kgDM/ha	Bought in Feed (kgDM/ha)
1989/90	370	20	111607	302	996	991	1346
1990/91	380	20	111683	294	997	763	1346
1991/92	380	82	118233	311	1056	509	1346
1992/93	400	200	135800	340	1213	482	2180
1993/94	400	453	144381	361	1289	1339	2052
1994/95	400	446	136509	341	1219	1607	1344

* Bought in feed is hay, proliq and winter cow grazing.

1991–93

In the 1991/92 season, we applied 80 kg N/ha from calving until 20 November. Following each grazing 14kg N/ha (Urea) was applied. There was a 6% lift in performance and little silage was made.

In the 1992/93 season, 200 kg N/ha (Urea) was used. This was applied following grazing at 23 kg N/ha through August and September, 18 kg N/ha through October and 14 kg N/ha from November until 20 January when soil moisture became limiting. Herbage N levels were lifted to 3–3.5%. In mid-March 300 kg/ha of DAP was applied. Only a small amount of pasture was conserved as silage, because cows consumed approximately 2 kg DM/cow/day more of the N boosted pasture than they had previously eaten of normal spring pastures. Peak per cow production was 10% ahead of previous years. This advantage continued throughout the season.

The season produced a 21% increase in MS/ha compared to before N use started although other feed inputs were also increased. This bought in feed consisted of purchased hay, Proliq (a by product of lactose manufacture) and winter cow grazing. Three quarters of this improvement in milksolids production was attributable to N usage. Other farms in the district achieved similar production to the 1991/92 season.

1993/94

The objective was to apply sufficient urea after each grazing to maintain the herbage N level at 4.5–5.5%. This is the "normal" range quoted on AgResearch herbage tests. We wanted pastures to grow unrestricted by N availability. Growth and animal intakes were monitored weekly using a rising plate meter. Surplus pasture was conserved as silage to be fed in the summer dry spell, and to extend the end of lactation.

Until moisture became limiting in mid January, 46 kg N/ha was applied after every grazing (as either urea or a DAP/Urea mix when P was also required). Herbage N levels were monitored by monthly herbage tests and were held in the desired range. Over the season 400 kg N/ha was applied to the grazing area. Extra N was applied to silage paddocks to bring the total N used to 453 kg N/ha.

There were dramatic increases in pasture growth which required several management changes to maintain pasture quality. These will be discussed later. Large amounts of surplus pasture were generated, although not all was conserved because we were slow to correctly identify the surpluses. Two cuts of silage were taken, 21 ha in early November and 16 ha in early January. Milk production lifted 6% on the previous year and other bought in-feed was reduced by 6%.

1994/95

The system used was similar to the previous season. N application rates were the same, but we used growth information from the previous year to improve pasture management. Cows calved one week earlier. Milk production for this season was down 5.5% on the previous year. This was normal for the district due to a dry summer.

Silage production increased 20% due to better identification of spring surpluses with 28 ha harvested on 10 November, 12 ha on 5 January and a further 6 ha on 18 April. Unfortunately, the large spring cut of silage was of poor quality due to wet weather at harvest. This will be discussed later but had a significant impact on performance when the silage was fed in the dry summer period. Cows were dried off three weeks earlier than the previous year. Other purchased feeds were reduced by 35% largely due to no spring feeding of Proliq and all the cows being wintered on the farm.

Managing pastures with clover vs fertiliser N

Figures 1 and 2 show the growth patterns of our pastures in 1993/94 and 1994/95 respectively, where N was applied compared to the Taranaki Agricultural Research Station (TARS) where no fertiliser N was applied. The feed requirements of our milking herd are also shown. TARS is located some 30 km from our farm on a similar soil but at slightly higher altitude. TARS figures are based on a 28 day grazing interval whereas our pastures were grazed every 15–18 days.

It can be seen from the graphs that the two seasons were quite different. 1994/95 had a slower start to the spring and a more severe summer dry spell. Nevertheless, in both seasons, the early season pasture production was improved by N fertiliser. N also helped to delay the onset of the dry spell by about 2 weeks in the summer of 1995. Late season production was improved by the N fertiliser to the point that cow requirements could be satisfied.

Overall, pasture production on our farm was 22% ahead of TARS in 1993/94 and 43% ahead of TARS in

Figure 1: Pasture growth 1993/94.

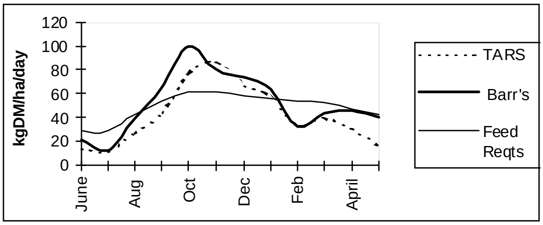
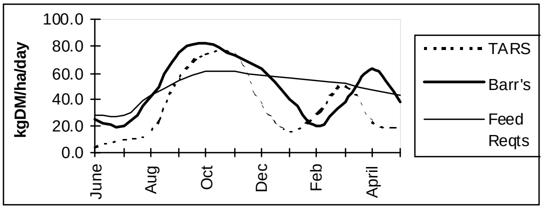


Figure 2: Pasture growth 1994/95.



the difficult 1994/95 season. Whereas TARS had a 20% reduction in pasture growth is 1994/95, compared to 1993/94 our farm only produced 6% less pasture. In neither season could the TARS growth rates have met the feed requirements of our herd.

These results highlight one of the major differences between managing pastures which rely on clover to supply their N, and pastures where fertiliser N is used. That is, with clover sourced N, pasture growth is more variable both between seasons and within a season. This makes both short-term and long-term planning more difficult. Pasture surpluses occur for a relatively short time so there is only a short time span for recognising and harvesting surpluses. Also, long-term planning, such as setting appropriate stocking rates and calving dates, is more difficult because of the greater variation between seasons. Conversely, if N fertilisers are used to maintain herbage N levels in the optimum range, pasture growth is relatively predictable so reliable surpluses can be generated. Making longer-term policy decisions can be done with more confidence.

Pasture quality

The most common perception of N fertilisers effect on pasture quality is its effect on the amount of clover in the pasture. Our experience is that at lower rates of N application (up to 200 kg N/ha/yr) clover growth was improved, and a more balanced pasture composition was maintained. Even at higher rates of N use, clover appears to have persisted well, providing pastures were not permitted to regrow more than 1200 kg DM/ha between grazings. If pastures became longer than this, clover was shaded out and the grasses dominated. It is our belief that clover persistence with N use is a grazing management issue, not an effect of the mineral N itself.

When relying on clover to supply pasture's N requirements we found that as N deficiencies worsened, (usually about mid-November) pastures produced stem instead of leaf. Despite maintaining close control of pasture residues, after grazing, pastures inevitably became stemmy, with rapid declines in milk production occurring. By contrast, using N fertilisers over the spring period to maintain better herbage – N levels resulted in leafier pastures, and an improvement in lactational performance.

The most important issue for maintaining pasture quality, especially with N boosted pastures, is the grazing interval and correct identification of surpluses. In October-November pastures with adequate herbage N levels grew at a very high rate. Typically, 1100–1200 kg DM/ha can be grown in 14–16 days. If pastures are not grazed at this stage however, they enter a period of rapid stem elongation. While this leads to growth rates of 120–150 kg DM/ha/day, it also causes a rapid decline in pasture digestibility. Therefore maintaining optimum grazing rotations and correctly identifying surpluses requires careful monitoring if the maximum benefits are to be obtained from N fertiliser. Clover-based systems do not achieve the same growth rates so the margin for acceptable error in management decisions is greater.

Silage quality

The profitability of using higher rates of N fertiliser is dependant on harvesting high quality supplements to maintain high levels of milk production. Table 2 shows the analysis of spring harvested silage made on our farm in 1993 and 1994.

Table 2: Silage analysis results.

	Harvest Date	
	7/10/93	10/10/94
pH	4.2	5.1
DM %	24.4	21
Metabolisable Energy(MJ/kgDM)	12.4	8.7
Crude Protein %	20.1	16.4

It can be seen that the 1993 harvest resulted in a very good quality silage which generated good levels of milk production when fed. However, the 1994 harvest was very poor, largely due to wet weather at harvest. Milk production was disappointing when this silage was fed. Also, large secondary fermentation losses occurred at feeding out. We estimated that 30% of the metabolisable energy that was harvested, was lost in the stack. This clearly had a severe impact on the profitability of using mineral N to generate silage in that year.

Table 3: Feed costs vs milk income 1989–95.

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
kgsMS/ha	996	997	1056	1213	1289	1219
Milk Income /ha @$3.40/kgMS	$3,388	$3,390	$3,589	$4,123	$4,383	$4,144
kgN/ha	20	20	82	200	453	446
Nitrogen Cost @ $1.10/kgN ($/ha)	$22	$22	$90	$220	$498	$491
Silage/Hay Making ($/ha)	$50	$38	$25	$24	$67	$80
Hay, Proliq, Cow Grazing ($/ha)	$245	$245	$245	$417	$365	$253
Milk Income Less Feed ($/ha)	$3,071	$3,085	$3,229	$3,462	$3,453	$3,320

Cost/benefits

Table 3 shows the costs of the various feed inputs used on our farm over the 1989–95 seasons. Costs and returns have been valued at present day prices. The costs of the hay, Proliq and cow grazing inputs have been adjusted for the differing proportions used each year. No account has been taken of any extra capital that has been required in stock, machinery and facilities.

Use of N fertilisers has been profitable. However the higher rates used in the 1993–95 seasons have been no more profitable than the 200 kg N/ha used in 1992/93. It has, however, reduced our reliance on outside feed sources. It must also be remembered that we have wasted grass in learning how to manage the N-boosted pastures and there have been problems with silage conservation.

Extra capital costs are not great with N fertiliser, unlike many other alternative feeds. In our case, no extra machinery and facilities were required and we now believe that the increase in cow numbers was not required.

Our plan for the future is to reduce N applications to 200–300 kg N/ha/yr and to reduce stocking rate slightly. In doing this, we aim to reduce costs but still generate surplus pasture for silage production. This will meet our goals of keeping cows well fed throughout the season and maximising profitability.

Summary

- N fertilisers significantly increase pasture growth compared to a clover-based system.
- Cows achieve higher intakes of N boosted grass. Pasture quality is improved as grasses stay leafier.
- N fertiliser can profitably lift milk production compared to a clover-based system, particularly at moderate rates.
- N boosted pastures require changes in management to maintain pasture quality and effectively utilise surpluses.
- Harvesting high quality silage is not always easy and has a large effect on the profitability of a N fertiliser farming system.
- Clover will persist even with high N fertiliser use, providing appropriate grazing management is used.

References

Barr, S.J. 1993. Farming with nitrogen fertiliser. *Dairyfarming Annual, Massey University 45*: 63–67.

Bryant, A.M.; McDonald, K.A.; Clayton, D.G. 1982. Effects of nitrogen fertiliser on production of milk solids from grazed pasture. *Proceedings of the New Zealand Grassland Association 43:* 58–63.

Field, T.R.O.; Ball, P.R. 1982. Nitrogen balance in an intensively utilised dairyfarm system. *Proceedings of the New Zealand Grassland Association 43*: 64–69.

Gazzard, J.; Bint, M. 1992. Experience with nitrogen – Is it feed or fertiliser? *Proceedings of the Ruakura Farmers' Conference 44*: 84–86.

Harris, S.L. 1994. Nitrogen and white clover. *Proceedings of the Ruakura Farmers' Conference 46*: 22–28.

Harris, S.L.; Penno, J.W.; Bryant, A.M. 1994. Effects of high rates of nitrogen fertiliser on dairy pastures and production. *Proceedings of the New Zealand Grassland Association 56*: 27–31.

Holmes, C.W. 1982. The effect of fertiliser nitrogen on the production of pasture and milk on dairy farmlets: 1971–1974. *Proceedings of the New Zealand Grassland Association 43*: 53–57.

Kidd, Y.; Howse, S. 1994. Farmer attitudes to nitrogen fertilisers. *Proceedings of the Ruakura Farmers' Conference 46*: 29–35.

Ledgard, S.F.; Crush, J.R.; Selvarajah, N. 1994. Nitrogen and the environment. *Proceedings of the Ruakura Farmers' Conference 46*: 15–21.

Thompson, N.A.; Roberts, A.H.C.; Judd, T.G.; Clough, J.S. 1991. Maximising dairy production using nitrogen fertiliser and early calving. *Proceedings of the New Zealand Grassland Assocation 53*: 85–90.

■