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Nitrogen use and farm performance on Wairarapa sheep and beef farms

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Abstract

Seventy-eight sheep and beef farms on the east coast of the North and South Islands were surveyed in August/September 1991 on the use and benefits of nitrogen (N) fertiliser. The survey covered the years 1987/88-1990/91 and included 16 sheep and beef farms in Wairarapa. Farms with high N use (>5 kg/ha/year on average over the whole farm area in pasture and crop) received 20 (Wairarapa) or 28 (other east coast regions) kgN/ha/year on 83 or 53% of the farm area respectively. Diammonium phosphate (DAP) was the major form of N used in Wairarapa. Urea and DAP/ammonium sulphate mixes were the major forms used in other east coast regions. Most of the N was applied from May to August in all regions. High use of DAP in Wairarapa was associated with higher rates of phosphorus but lower rates of sulphur applied compared with other regions. Survey farmers identified feed demand as the major factor influencing amount of N applied and the timing of application. Soil moisture and temperature at application were ranked as the major factors affecting the response to N. Benefits of N were listed as lower susceptibility to drought, higher calf weaning weights, longer winter grazing rotation and greater pasture cover at lambing. Over the whole survey, N use was associated with significantly higher animal and financial performance. N use on easy land on the North Island survey farms was associated with a significantly lower presence of browntop, other perennial grasses (mainly Yorkshire fog and crested dogstail), white clover, annual legumes (mainly suckling and cluster clover) and flatweeds. On steep hills, N use was associated with a significantly lower presence of other perennial grasses and annual legumes.

Keywords: animal performance, financial performance, nitrogen fertiliser, pasture species, sheep and beef farms

Introduction

Until recently, most New Zealand pastures have relied entirely on fixation by legumes to supply nitrogen (N). N supply from this low cost source is often limited by lack of legume persistence and growth during periods of low rainfall and temperature. In order to reduce seasonal variation in pasture production, east coast sheep and beef farmers have increased the use of N fertiliser. For example, during the 1980s, up to 20% of the fertiliser used in the Wairarapa contained N. Previous farmlet trials at Lincoln and Ballantrae showed that N fertiliser increases sheep production (Hoglund & Pennell 1989; Clark & Lambert 1989). Results from a survey of sheep and beef farmers in Wairarapa (Rich 1984) showed that N use was associated with higher stocking rate and farm income.

Since information on the benefits of N fertiliser use to east coast sheep and beef farms in low rainfall areas was limited, a joint Ravensdown Fertiliser/MAF Technology research programme was initiated. As a first stage, 78 east coast sheep and beef farms were surveyed to determine current N fertiliser practices and investigate the relationship between N use and farm performance. This paper presents the main results from the survey with emphasis on Wairarapa survey farms.

Methods

Farm selection

The east coast of New Zealand from East Cape to Central Otago was divided into 11 regions based on old county boundaries and a number of survey farms were selected in each region according to livestock numbers. Control farms that had received no N fertiliser during the preceding 4 years were randomly selected from Ravensdown shareholder lists to make up 25% of the survey farms in each region. The remaining farms selected had received N fertiliser on at least 20 ha in 3 of the 4 years from 1987/88 to 1990/91. All survey farms had a minimum area in pasture of 100 ha with no more than 20% irrigated and no less than 70% of stock units as sheep and beef cattle. In total 78 farms were selected, with 16 in Wairarapa.

Farm information

Information collected from each survey farm in August/September 1991 included farm characteristics, stock and financial performance, and fertiliser history. Key farm performance parameters, inputs and management factors

were selected on the basis of their importance in an earlier survey of Gisborne hill country (Fitzharris & Wright 1984). The survey included questions on reasons for the amount of N used and timing of application, factors affecting the response, and perceived benefits of N fertiliser.

Survey paddocks

On each survey farm, 5 paddocks that represented the range of pasture, soil type, slope and aspect present were selected. The presence of pasture species was measured from 100 cores (5 cm diameter) taken from each paddock (Mitchell & Glenday 1958). Soil samples (20 cores at 75mm depth) were also collected from each paddock and analysed for soil Olsen phosphorus (P) and sulphate sulphur (S).

Results and discussion

Survey farms were divided into 3 approximately equal-sized categories depending on the average rate of N applied. These categories were nil use (O-l kg N/ha/year), low use (l-5 kg N/ha/year) and high use (>5 kg N/ha/year), calculated as the total amount of N applied over 4 years divided by the farm area in pasture and crop. Since low N users applied N to only 13% of their productive farm area, the results presented are for nil and high use farms.

N fertiliser use

High N users in Wairarapa applied a lower rate of N to a greater proportion of the farm than high users in other regions (Table 1). The major form of N applied in Wairarapa was DAP (diammonium phosphate), whereas in other regions it was urea and DAP/ammonium sulphate mixes.

The timing of fertiliser application also differed between Wairarapa and other regions (Table 2). In both Wairarapa and other east coast regions, fertilisers containing N but not P (urea and ammonium sulphate) were applied mainly in May. The application of N and P fertilisers (mainly DAP) was more evenly distributed from May to July in Wairarapa than in other east coast regions. A smaller proportion of N and P fertilisers was applied during August in Wairarapa compared with other regions.

The survey results indicate that in Wairarapa N was being used regularly in addition to P as a maintenance fertiliser nutrient rather than as a stop gap measure to overcome short-term feed shortages. Therefore, application of most of the N fertiliser in Wairarapa was in late autumn/early winter when maintenance fertiliser is normally applied rather than late winter/early spring as in other regions. DAP was first applied by John Daniel1 at Wairere Station in 1969 to help bridge a late-winter feed deficit, and the increase in year-round pasture production and the cost efficiency of DAP compared with superphosphate led to the continued use of DAP as a maintenance fertiliser (Daniel1 1993). This practice has been adopted by other Wairarapa sheep and beef farmers.

Table 1 N strategies on high N use farms in Wairarapa and other east coast regions.

	Wairarapa (5 farms)	Other regions (19 farms)
Mean rate of applied N (kgN/ha)	26	26
Proportion of farm treated (%)	83	53
Percentage of N applied in different products		
Urea	26	39
DAP[1]	65	21
Ammonium sulphate		6
Other[2]	7	34

[1] DAP is diammonium phosphate (18:20:0:2)
[2] Other forms were mainly DAP/ammonium sulphate mixes

Table 2 Timing of application of N fertiliser on high N use farms in Wairarapa and other east coast regions.

	Percentage of N applied in each month			
	May	June	July	August
N fertiliser[1]				
Wairarapa	76	-	-	17
Other regions	56	12	2	10
N & P fertiliser[2]				
Wairarapa	40	20	30	10
Other regions	6	4	23	27

[1] N fertiliser includes urea and ammonium sulphate.
[2] N & P fertilisers are mainly DAP (diammonium phosphate) and DAP/ammonium sulphate mixes.

Use of other fertiliser nutrients

The rate of P applied (Table 3) by high N users (15 kg/ha) in Wairarapa was near the rate of 14 kg P/ha recommended for maintenance of soil P levels at a stocking rate of 10 su/ha on steep hills (Comforth & Sinclair 1984). Nil N users in Wairarapa were applying P at rates below maintenance. For high N users at higher mean stocking rates (12.5 su/ha) in other regions, the lower rate of P application (11.5 kg/ha) would be just below the rate of P (13 kg/ha) required to maintain pasture production on land with less slope. The lower rate of P application by Wairarapa farmers in the ml N group was reflected in a significantly lower ($P<0.05$) mean Olsen P level. In contrast to P use, nil N users in Wairarapa applied higher rates of S than high N users. This differed from other regions where high N users applied higher rates of S. High N users in Wairarapa

were applying inadequate rates of maintenance S (7 cf. 17 kg/ha recommended by Comforth & Sinclair 1984) but adequate rates (15 kg S/ha/year) in other regions. This difference was not reflected in soil sulphate S levels (Table 3). Local research in Wairarapa has indicated S deficiency in pasture from prolonged use of fertiliser with low S content such as DAP (Smith pers. comm.). Because of S responses, some of the high N users in Wairarapa were adding S prills to their DAP in the later years of the survey. Since the survey was completed, there has been a major trend away from straight DAP towards a DAP/maxi sulphur super-phosphate blend (Watt pers. comm.).

Only low average rates of K (< 5 kg/ha/year) and lime (< 0.1 t/ha/year) were applied on survey farms.

Farmer experience

There were no major differences in farmer responses to survey questions between Wairarapa and other regions and responses are presented from the whole survey. Feed demand was identified as the major factor influencing farmer decisions on timing of application and amount of N fertiliser. Soil moisture and temperature were identified as important factors influencing decisions on timing of N and affecting the response to N. The pattern of N use suggested that farmers were using N according to the recommendations provided from research. The high ranking given to feed demand as a factor influencing the timing of N was supported by survey farmers applying most N from late autumn to early spring when feed demand is usually greater than pasture supply. Farmer decisions on the timing of application and amount of N applied were based on the amount of feed required plus the expected size of pasture responses. This practice is in line with the current recommendation to apply N 3-6 weeks before the extra feed is required (O'Connor 1982). The importance attached to soil moisture and temperature at application as critical factors influencing the response to N was consistent with the research findings of Ball & Field (1982).

The four most important benefits of N listed by survey farmers were: lower susceptibility to drought, higher calf weaning weights, longer winter grazing rotation and greater pasture cover at lambing. Lower susceptibility to drought was supported by the greater economic farm surplus on farms with high compared with ml N use. Longer winter rotation generally leads to a higher pasture cover at lambing. Parker & Townsley (1986) found that N use was associated with higher pasture cover at lambing in a survey of 30 Wairarapa farmers. The perceived benefit of higher calf weaning weights could not be verified directly from the survey results.

Animal performance

Over the whole survey high N use was associated with significantly greater stocking rate and lambing percentage but similar wool production and slightly higher calving percentage compared with nil use (Table 4). In Wairarapa, high N use was associated with higher wool production, lambing and calving percentage compared with nil use, but the difference was not significant owing to the small number of Wairarapa survey farms. N use on Wairarapa farms was associated with only a small increase in stocking rate. Since most Wairarapa survey farms were store rather than finishing properties, it was not possible to assess the association between N use and lamb and beef carcass weight in the region. Over the whole survey, high N use was associated with slightly higher lamb carcass weight (15.0 v. 14.4 kg/lamb) but lower beef carcass weight (253 vs 290 kg/head) owing to a lower age at slaughter (23.6 v 26.4 months).

Animal performance data from the survey farms suggested that Wairarapa farmers use N to maintain or improve stock performance. N could be used similarly to reduce risk in steep hill country where climatic variation is high and it is difficult to provide buffers such as conserved feed. Wairarapa survey farms had a much higher proportion of steep land (70%) than survey farms in other regions (31%). Farmlet research (Clark & Lambert 1989; Hoglund

Table 3 Use of other fertiliser nutrients and soil nutrient levels on nil and high N use farms.

	Wairarapa		Other regions		All regions	
	Nil N (3 farms)	High N (5 farms)	Nil N (21 farms)	High N (19 farms)	Nil N (24 farms)	High N (24 farms)
Other nutrients						
Phosphorus (kg/ha/yr)	9.7	15.0	9.0	11.5	9.1	12.3
Sulphur (kg/ha/yr)	12.4	7.0	12.5	16.9	12.4	14.0
Soil nutrient levels						
Olsen P	9.7	17.8 •	15.3	16.5	14.6	16.6
Sulphate S	6.7	7.6	6.7	7.8	6.7	7.0

• Significant difference between nil and high N users at P = 0.05. Significance tested by simple t-test between groups.

Table4 Animal and financial performance on nil and high N use farm.

N use	Wairarapa Nil N	Wairarapa High N	Other regions Nil N	Other regions High N	All regions Nil N	All regions High N
Animal Performance						
Stocking rate (SU/ha)	10.0	10.3	9.9	12.5	9.9	12.1"
Lambing %	103	106	103	113'	103	112'
Wool production (kg sheep SU/yr)	4.9	5.7	5.3	5.3	5.3	5.4
Calving %	88	92	88	91	as	91
Financial Performance						
Gross farm income ($/ha)	266	429	345	506"	337	491"
Farm working expenses ($/ha)	178	200	161	262"	180	265"
Economic farm surplus ($/ha)	106	229	164	226'	157	226'

*,** Significant difference between nil and high users, at P≤0.05 and 0.01 respectively. Significance tested by simple t-test between groups.

& Pennell 1989) has shown benefits of N use only through increased stocking rate.

Financial performance

High N use was associated with greater gross farm income, farm working expenses and economic farm surplus compared with nil N use (Table 4). Owing to number of observations, differences overall were statistically significant, but not for Wairarapa despite similar trends. Regression analysis indicated that a typical treatment of 25 kg N/ha applied to 50% of the farm was associated with an increase in economic farm surplus of $40/ha over and above the cost of the N fertiliser.

Pasture composition

Because differences in the presence of pasture species in Wairarapa and other North Island east coast survey paddocks were only small, they are not distinguished (Table 5). Results are presented for North Island survey paddocks rather than paddocks from both islands, since North Island paddocks had greater similarity in physical characteristics and climate to those in Wairarapa. Associations between N fertiliser use and pasture composition differed for easy (O-26" slope) and steep land (>26° slope) on North Island survey paddocks as shown in Table 5. High N paddocks were classed as those that had received greater than 10 kg N/ha per year. High N use was associated with a significantly lower presence of browntop, other perennial grasses, white clover, other annual legumes and flatweeds compared with nil N on easy land. On steep land high N use was associated with a significantly lower presence of other perennial grasses, sub clover and other annual legumes. The lower presence of clover on land receiving N was probably caused by shading from grasses, as

Table5 Species presence (% cores containing species) in North Island east coast paddocks (pasture age > 5 years)

	Easy land Nil N	Easy land High N	Steep land Nil N	Steep land High N
No. paddocks	42	39	36	23
Grasses				
Ryegrass	74	71	60	69
Browntop	46	26"'	51	44
Other perennials'	39	26'	44	30**
Other annuals[2]	16	19	19	17
Legumes				
White clover	43	32"	33	40
Sub clover	15	12	16	7'
Other annuals[3]	12	6	16	6**
Flatweeds	29	21"	30	23

*,**,*** Significant difference between nil and high N use levels (within land class) at P=0.05, 0.01 and 0.001, respectively. Significance of difference tested by simple t-test between groups.

1 Other perennial grasses were mainly Yorkshire fog and crested dogstail
2 Other annual grasses were mainly Poa annua
3 Other annual legumes were mainly suckling and clustered clover.

reported by O'Connor (1982). The lower presence of browntop associated with the use of N was also reported in earlier research in Wairarapa (Bircham 1977). This effect was attributed to the encouragement in ryegrass growth resulting in shading of browntop. In the reported survey, there was a non-significant association between N use and presence of ryegrass on steep land.

Conclusions

1. N use on east coast sheep and beef farms including Wairarapa farms was associated with higher animal and financial performance.
2. Sheep and beef farmers on the east coast of the North and South Island were generally following current technical advice on the use of N.

3. N use was associated with a lower presence of browntop and clovers.

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