

Evaluation of nitrogen fertiliser in a beef production system

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ABSTRACT This paper reports and discusses the results of 4 years of trials (1985-1988) involving 2 farmlets, one receiving 3 nitrogen applications (50 kg/ha) in autumn, winter and spring (+N) and one receiving no N fertiliser (-N). Stocking rates were 3.3 animals/ha on -N farmlet and 4.3 animals/ha on the +N farmlet for the first 3 years, with the objective being to utilise the extra N-boosted grass with extra animals/ha but not to sacrifice individual animal performance. In the fourth year the stocking rates were kept the same on each farmlet (3.3 animals/ha) in an endeavour to utilise the extra grass grown on the +N farmlet by way of increased per head performance. In 2 of the 3 years (1985 and 1987) where the +N farmlet supported the higher stocking rate, liveweight gain (LWG) did not differ between animals. In 1986 the extra animals on the -N farmlet had a lower LWG, whereas in 1988 the LWGs were similar for the 2 farmlets stocked at the same rate. The apparent DM responses (kg DM/kg N applied) ranged from 2 to 12. The rates of N fertiliser used in this trial do not appear to result in economic increases in pasture production for the beef production system reported here. Nitrogen fertiliser did not reduce the clover content of pastures rotationally grazed by beef cattle.

Keywords beef production, nitrogen fertiliser, pasture composition, liveweight gain, economics.

INTRODUCTION

Bull beef production systems, like the one implemented at Massey University's Tuapaka Farm, where animals reach carcass weights of 240 kg at 15-20 months of age (McRae 1988), are well accepted by commercial beef farmers. While some scope may exist for changing stocking rates and per head performance levels, further increases in production and profit from these systems appear to depend on increases in the annual available feed supply. Regular application of nitrogen (N) fertiliser is one strategy which may increase annual feed supply. In the past, New Zealand pastures have relied on the symbiotic N fixation by white clover in particular. Little N fertiliser has been used.

It is well established that plants require more N than any other nutrients derived from soil (Syers 1982). Recent research indicates the amount of N fixed in grazed swards is much less than first thought (Hoglund et al. 1979). Field & Ball (1981) reported that the more intensively utilised dairy farms may be in negative N balance. Their data suggested that clovers must fix upwards of 350 kg N/ha each year to keep up with N losses. It seems doubtful that this is achieved, especially during years of poor clover growth, e.g. a cold wet spring. A similar situation probably exists on the more intensively farmed beef farms. This paper reports on a series of trials involving two farmlets, one receiving N and one not.

TRIAL DESIGN

Animals were allocated to either a N (-N) farmlet or a control no-N (-N) farmlet of 7 ha each year for 4 years. Animals entered the trial in November at 3 months of age (80 kg). They were grazed through one winter (starting in 1985) and the trial finished each December when slaughter began with the animals at 18 months of age. The animals used were Friesian bulls in 1985, Friesian steers in 1986 and 1987, and Charolais x Angus and Friesian steers in 1988. Stocking rates in the first 3 years were 3.3 animals/ha on the -N farmlet and 4.3 animals/ha on the +N farmlet. The objective in these years was to utilise the extra N-boosted grass with the extra animal/ha but not to sacrifice individual animal performance.

The stocking rates in 1988 were kept the same, 3.3 animals/ha, on each farmlet in an endeavour to utilise the extra grass grown in the +N farmlet by way of increased per animal performance.

The results reported here relate to extra pasture grown as a result of 3 N applications (50 kg N/ha) in May, July and September. The +N farmlet did in fact receive an additional dressing (50 kg N/ha) in December. However, decisions made on pattern and rate of animal kill in part to satisfy the needs of work reported elsewhere (Purchas in press), prevent the response to that dressing being reported in the form used here.

The timing of N application coincided with Ball & Field's (1982) observations that autumn, late winter/early spring and late spring/early summer were the times that pasture was most responsive to N fertiliser. The whole area received annual dressings of 125 kg of superphosphate. The soil type

of the area was Tokomaru silt loam and the pastures were predominantly **ryegrass** and white clover.

Grazing management decisions were based on projected pasture growth rates and animal liveweight targets set out for the Tuapaka farm (McRae 1988). If pasture cover declined below 1200 kg DM/ha during the slowest pasture growth rate months (June/July) then hay was fed in equal amounts to both treatments.

Pasture cover was monitored using the Ellenbank pasture meter (Earle & McGowan 1979). Pasture composition was determined at the beginning of the trial (December 1984) and the end of the trial (December 1988). Animals were weighed straight off pasture at strategic intervals. Normal animal health maintenance measures were carried out.

Animal liveweight gains (LMG) were calculated for each **farmlet**. A statistical comparison of LWG between **farmlets** requires an estimate of variation in LWG between farmlets. Such an estimate could be obtained by replicating farmlets. The objective of this experiment was to obtain preliminary estimates of the likely benefit of N fertiliser before dedicating resources to a replicated investigation.

RESULTS

Liveweight gains

In 2 of the 3 years (1985, 1987), where the +N **farmlet** supported a higher stocking rate, LWG did not differ between the treatments (Table 1). In 1986 however, the extra animals/ha carried on the +N **farmlet** resulted in lower LWG. In 1988, the animals in the +N **farmlet**, stocked at the same rate as those on the -N **farmlet**, did not achieve the extra per head performance expected from extra pasture boosted by N application.

The apparent response to N within these particular management systems is derived in Table 2. Animal intakes, based on NRC feed tables

Table 1 Effect of treatment on animal liveweight gains and pasture cover.

	1985		1986		1987		1988	
	+N	-N	+N	-N	+N	-N	+N	-N
No. animals	30	23	30	23	30	23	23	23
stocking rate (animals/ha)	4.3	3.3	4.3	3.3	4.3	3.3	3.3	3.3
Sex class	B ¹	B	S	S	S	S	S	S
Start LW	267	211	193	202	182	187	197	205
Finish LW	410	422	398	440	386	392	393	391
Days on trial	234	234	242	242	253	253	239	239
LWG	0.87	0.90	0.85	0.97	0.81	0.81	0.81	0.78
Pasture cover								
Start kg DM/ha	1401	1332	1200	1650	1412	1724	2191	2276
End kg DM/ha	1612	2282	1245	1488	2010	1943	2065	2013

¹B Bull S Steer

(Journeaux 1986) and calculated for the level of performance achieved, were combined with the changes in pasture cover (kg DM/ha) over the duration of the trial. The difference in apparent DM production was then expressed as kg DM/kg N applied. Only in 1987 does this response exceed 10:1.

Table 2 Derived animal intake and pasture responses to N fertiliser.

	1985		1986		1987		1988	
	+N	-N	+N	-N	+N	-N	+N	-N
kg DM intake/animal	1555	1601	1546	1772	1540	1578	1518	1477
stocking rate (animals/ha)	4.3	3.3	4.3	3.3	4.3	3.3	3.3	3.3
kg DM intake/ha	6687	5283	6648	5848	6622	5207	5009	4874
q pasture cover (kg DM/ha)	+211	,950	+45	-162	+598	+219	-126	-263
kg DM/ha produced	6898	6233	6693	5686	7220	5426	4883	4611
Response to N (kg DM/ha)	665		1007		1794		272	
kg DM/kg N	4		7		12		2	

Pasture composition

The clover content of both **farmlets** was considerably reduced at the end of the trial, owing to a cold wet and cloudy spring (Table 3). However, the decline is as great on the -N **farmlet** as on the +N **farmlet**.

Table 3 Pasture composition change (December 1984 to December 1988) (%).

	Treatment			
	Nitrogen		• Nitrogen	
	Start	End	Start	End
Grass (leaf + stem)	59.4	68.7	56.0	72.7
Clover	28.1	19.4	32.3	15.5
Weed	11.8	5.9	10.0	4.2
Dead matter	0.7	6.0	1.7	7.6

Economic value of N application

An economic value was assigned to the production achieved on each of the **farmlets** (Table 4). The carcass weight gain over the period of the trial was valued at \$2/kg, with the production off the +N **farmlet** having to meet the costs of the N fertiliser, and the interest costs associated with an extra animal/ha in the first 3 years.

The extra production covered these costs in only 2 of the 4 years (1985, 1987).

Table 4 Physical and financial responses of N fertiliser.

	1985		1986		1987		1988	
	+N	-N	+N	-N	+N	-N	+N	-N
stocking rate (animals / ha)	4.3	3.3	4.3	3.3	4.3	3.3	3.3	3.3
Closing LW / ha (kg)	1763	1393	1711	1452	1660	1294	1297	1290
Opening LW / ha (kg)	890	696	830	667	783	617	650	677
LWG/ha (kg)	873	697	881	785	883	677	647	613
GWG ¹ / ha (kg)	436.5	348.5	440.5	392.5	441.5	338.5	323.5	306.5
Value CWG ² /ha less fertiliserN ³	\$873	\$697	\$881	\$785	\$883	\$677	\$647	\$613
Interest on ⁴ extra animals	\$ 19	\$ 19	\$ 19	\$ 19	\$ 19	\$ 19	\$ 19	\$ 19
Margin ha	6729	\$697	727	\$785	729	677	493	\$613

¹Carcass weight gain (CWG) is 50% of liveweight gain (LWG)

²1 kg beef = \$2

³N fertiliser = 90 c/kg N applied

⁴Purchase price of replacements = \$2.00 head

⁴Interest on extra animals charged at 15% p.a.

Breed comparison

While the details are not reported in this paper, the LWG of the two breeds (Angus x Charolais, and Friesian) used in the 1988 trial did not differ.

DISCUSSION

The use of N fertiliser to fill temporary or projected feed gaps in intensive grazing systems is generally well accepted by the farming community. However, if N fertiliser is to be used to increase annual pasture production as a profitable means of further increasing the overall profitability of farming systems, then it must be expected to give higher and more consistent responses than those reported in these trials. Only in 1987, where overall a 12:1 response (Table 1) was measured, can the N applications be seen as profitable.

The N responses (Table 2) of 7:1 and 2:1 for 1986 and 1988 respectively do not generate enough extra beef to cover the costs of the N fertiliser (Table 4).

In 1985 the N response (4: 1) is intermediate to that in these later two years, and the extra production achieved in the +N farmlet more than covers the extra costs of that system. (\$719/ha for +N versus \$697/ha for -N). However, the pasture cover data (Table 2) for 1985 shows the -N farmlet finished the trial with a considerable build-up of pasture (+950 kg DM/ha). The extra beef production achieved on the +N farmlet is therefore due to the extra animals on that treatment harvesting more feed, i.e. a stocking rate effect. However, care

must be taken in imputing too much of this result to stocking rate alone. Experience at Tuapaka (McRae 1985) and our observations on other commercial farms suggest that where higher stocking rates have led to feed shortages in late winter, spring growth rates can be reduced. The data reported here do not allow this factor to be investigated further.

The very low response to N in 1988, when the stocking rate was held constant on the two farmlets, can probably be explained by climatic conditions in the spring, in particular (cold and water-logged soil), rather than N limited pasture growth rate.

The apparent lack of effect of N on pasture composition at a rate of 200 kg N/ha¹ is consistent with the findings of Ball & Field (1982), who showed that given adequate nutrition and adequate spells between grazing, clover growth need not be affected by N applications.

CONCLUSIONS

1. Nitrogen fertilisers at rates up to 200 kg N/ha/yea for 4 years do not appear to reduce the clover content of pastures rotationally grazed by beef animals.
2. Three dressings of N fertiliser (50 kg N/ha), in autumn, winter and early spring, do not appear to result in economic increases in pasture production for the beef production system reported here.
3. These findings do *not* necessarily rule out the use of autumn and winter N as an economic means of boosting pasture growth rates. This can have two benefits:
 - (i) preventing late winter pasture cover from falling to critical levels where subsequent regrowth is reduced, and
 - (ii) allowing more and/or heavier animals to be on hand to better utilise high spring pasture growth rates.

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¹The effect of 3 dressings (150 kg N/ha) is reported here, but a further dressing of 50 kg N/ha was applied each December.

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