

Long term effects of withholding phosphate application on North Island hill country: Economics

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ABSTRACT Results from fertiliser cessation experiments at Ballantrae, Te Kuiti and Whatawhata, on yellow-brown earths, were used to evaluate the fertiliser cessation compared to continued application on hill country breeding ewe systems. At Ballantrae, on farmlets previously receiving 125 kg superphosphate/ha/yr, continued fertiliser application generated a positive cash flow after 8 years. On farmlets previously receiving rates of 200-375 kg superphosphate/ha/yr positive cash flows were generated by continued fertiliser application after 4, 5 and 6 years at Te Kuiti, Whatawhata and Ballantrae respectively. Fertiliser cessation is a sound strategy to survive periods of low product price:fertiliser cost ratio. However, it will decrease sustainable productivity and hence farm resale value. Fertiliser recommendations cannot remain constant over time but must consider: animal enterprise, product and fertiliser price, soil P status, and level of pasture utilisation.

Keywords fertiliser cessation, superphosphate, Olsen P, economics, hill country, pasture production

INTRODUCTION

The decline in fertiliser use on New Zealand's sheep and beef farms has been well documented (NZMWES 1988). From 1970-1980, use was 20 kg fertiliser/stock unit (SU), with subsequent declines to 15 (1981-84) and 8 (1985-88). In 1980 4.4 million ha were aerially topdressed with 1.3 million tonnes of fertiliser (0.3 t/ha), in 1988 1.4 million ha received 0.33 million tonnes of fertiliser (0.23 t/ha). This implies that 30% of New Zealand's previously fertilised hill country pastures are still receiving maintenance levels of fertiliser, but that 3.1 million ha (70%) received no fertiliser in 1988.

From 1980-1985 export lamb slaughterings increased from 27.2-39.2 million, but have since decreased to 28.5 (27.2%) in 1988. In the North Island total sheep numbers have declined by 11.7 % from 1985-87. It is difficult for industry surveys to estimate the quantitative effect of fertiliser cessation on animal output. The lag effects of fertiliser and other farm

inputs, changing product prices and climatic variation may obscure important relationships.

This paper uses information from fertiliser cessation experiments at Whatawhata (Gillingham *et al.* 1990), Te Kuiti (O'Connor *et al.* 1990) and Ballantrae (Lambert *et al.* 1990) to assess the likely economic consequences of fertiliser cessation compared with continued applications.

METHODS

The economics of fertiliser cessation are assessed using calculations based on the decline in pasture production at Ballantrae and Whatawhata and in animal production at Te Kuiti. At all 3 sites pasture production was considered to give a better estimate of changes in system productivity, but full records of pasture production were not available for the Te Kuiti site. Animal production data from all sites were considered unreliable for assessing the effects of withholding fertiliser because level of utilisation was not kept constant across treatments. All data refer to hill country pastures carrying only breeding ewes.

Three options relevant to hill country are compared. The effect of changes in product prices (25 or 50% increases) on the time taken to reach a positive cash flow from fertiliser application is also examined. The options considered were:

1. Farm with a history of fertiliser inputs either continuing at the same level or stopping.

Initial input	Site	Superphosphate (kg/ha/yr)	P retention
(a) Low (LF)	Ballantrae	0,125	Low
(b) Moderate (MF)	Te Kuiti	0,250	Low-mod
(c) Moderate (MF)	Whatawhata	0,200	Mod-high
(d) High (MF)	Ballantrae	0,375	Low

2. Net benefits of purchasing HF v. LF farms then continuing the same option.
3. Net benefits of purchasing HF v. LF farms and then stopping fertiliser on the former but continuing on the latter.

Assumptions

1. That stocking rate remains the same after cessation.
2. That fertiliser cessation results in annual DM losses of 175,480 and 650 kg/ha on LF (Ballantrae), MF (Whatawhata) and HF (Ballantrae) farmlets respectively.

3. That ewe requirements are 800 kg DM/year, based on frame cut data that overestimate ewe consumption by approximately 20% (Field et al. 1981). An extra 160 kg DM yields 'an extra 1 kg greasy wool and 4.4 kg lamb liveweight at weaning (based on 8 years' data from 4 farmlets at Ballantrae).
4. Interest rate on borrowed money = 20 % .
5. Variable costs associated with charged stocking rate = \$1 1.00/su.
6. Fertiliser cost = \$250 t super-phosphate spread.
7. Prices *used were: \$4.50/kg greasy wool and \$0.45 kg lamb liveweight gain.

Option 1

(a) Low input (Ballantrae) . The extra pasture benefit derived from continuing fertiliser application is 175 kg DM/ha/yr/yr. This should yield an extra 1.1 kg wool/ha and 4.9 kg lamb LW/ha (\$7.15/ha). The extra cost for superphosphate is \$3 1.25/ha/yr. It is important to note that while the cost is constant each year, the benefits are cumulative, i.e. in year 2 the benefit is (2 x \$7.15/ha). Positive cash flow occurs in year 8 (Figure 1) and profits generated by continual fertiliser application exceed those for fertiliser cessation by year 12. However, by year 8 the LFNF option is predicted to produce 1400 kg DM/ha/yr less (equivalent to 1.8 su/ha). If the assumption of constant stocking rate is to be met then some P application may be required. This will tend to shorten the period before the LFLF option becomes the more profitable.

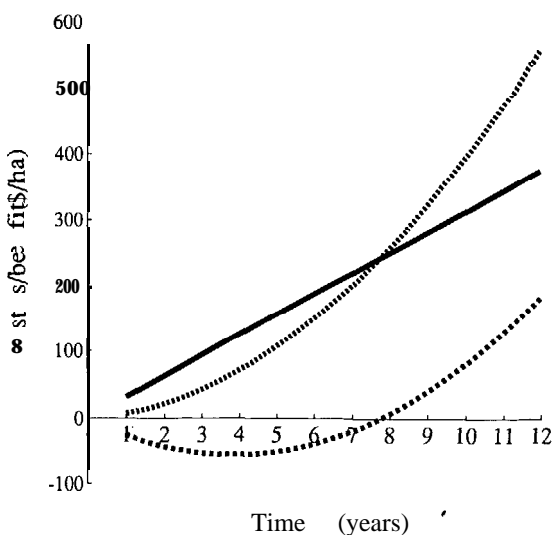


Figure 1 The cumulative cash flow over time of continued low fertiliser application (125 kg superphosphate/ha/year) v. fertiliser cessation using Ballantrae data (Lambert et al. 1990). Fertiliser cost —; Gross benefit to fertiliser; Net benefit (Gross-Cost) -.-.-.

(b) Moderate input (Te Kuiti). Over the 5 years when stocking rate was constant, the benefit to topdressing was equivalent to 2.9 kg wool/ha/yr/yr and 20.9 kg lamb LW/ha/yr/yr. Positive cash flow occurs in year 4 (Figure 2). In 1988 the stocking rate on the farmlet receiving fertiliser was increased to 15 ewes/ha, and decreased to 11 ewes/ha on the farmlet receiving no fertiliser. This was justified on the basis of a 10 kg LW advantage to HF ewes in November 1987; by November 1988 ewe LW differences were negligible.

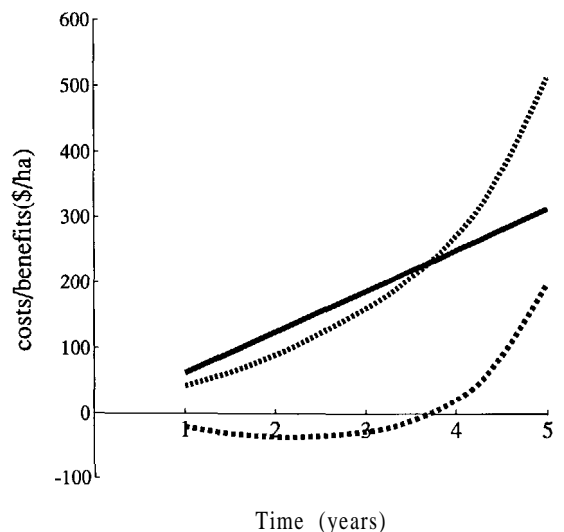


Figure 2 The cumulative cash flow over time of continued fertiliser application (250 kg superphosphate/ha/year) v. fertiliser cessation using Te Kuiti data (O'Connor et al. 1990). Fertiliser cost —; Gross benefit to fertiliser; Net benefit (Gross-Cost) -.-.-.

(c) Moderate input (Whatawhata). The extra benefit from using fertiliser in the Whatawhata experiment was assessed for the 200 kg superphosphate/ha/yr strategy. This level was estimated to produce an extra 480 kg DM/ha/yr/yr and yield an additional (3 kg wool/ha/yr/yr and 13.3 kg lamb LW/ha/yr/yr (\$19.50/ha/yr/yr). Positive cash flow for the fertiliser option occurs in year 5 (Figure 3).

(d) High input (Ballantrae). The extra benefit derived from continuing fertiliser application is 650 kg DM/ha/yr/yr. This should yield an extra 4.2 kg wool/ha and 17.8 kg lamb LW/ha (\$26.95/ha). The extra cost for superphosphate is \$93.75/ha/yr. Positive cash flow occurs in year 6 (Figure 4) for the HFHF option. By year 6 the HFNF option is predicted to produce 3900 kg DM/ha/yr less (equivalent to 4.9 su/ha). It is likely that an input of P will be required shortly after year 6 to sustain per head performance at a common stocking rate. This is supported by the poor lambing performance in 1988, 62 v. 94% for HFNF and HFLF options, respectively (Lambert et al. 1990).

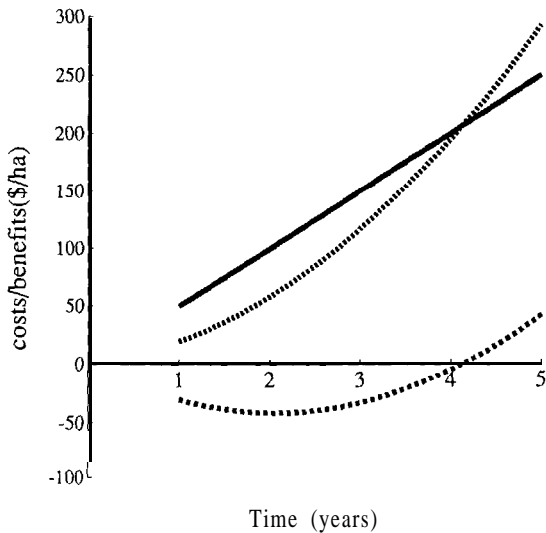


Figure 3 The cumulative cash flow over time of continued fertiliser application (200 kg superphosphate/ha/year) v. fertiliser cessation using Whatawhata data (Gillingham *et al.* 1990). (Fertiliser cost —; Gross benefit to fertiliser; Net benefit (Gross-Cost) -.-.-).

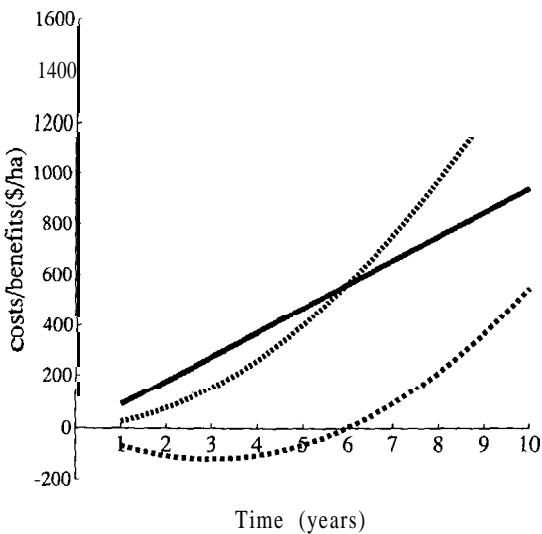


Figure 4 The cumulative cash flow over time of continued high fertiliser application (375 kg superphosphate/ha/year) v. fertiliser cessation using Ballantrae data (Lambert *et al.* 1990). (Fertiliser cost —; Gross benefit to fertiliser; Net benefit (Gross-Cost) -.-.-).

Option 2

In this option we calculate the relationship between price per stock unit paid for land and interest rate on money borrowed to purchase land, such that the

marginal benefits for a HFHF and LFLF farm are the same. The 8 year average returns for the 2 options are:

LFLF = 53 kg wool and 11.2 lambs = \$372.90

HFHF = 80 kg wool and 18.5 lambs = \$583.80

The marginal gross return to HFHF = \$210.90

The extra variable cost for the HFHF option is

\$58.30/ha (250 kg superphosphate/ha/yr extra applied). Therefore, the marginal net return to both options will be equal when the extra cost of: variable expenses, fertiliser and borrowed money = \$210.90. Figure 5 shows the relationship between price per stock unit paid for land and interest rate on borrowed money at equal marginal benefits. Combinations of price per su and interest rate above the line mean that it will be more profitable to purchase a LF farm, combinations below the line favour a HF farm. Increases in product prices will obviously move the equi-benefit line upwards.

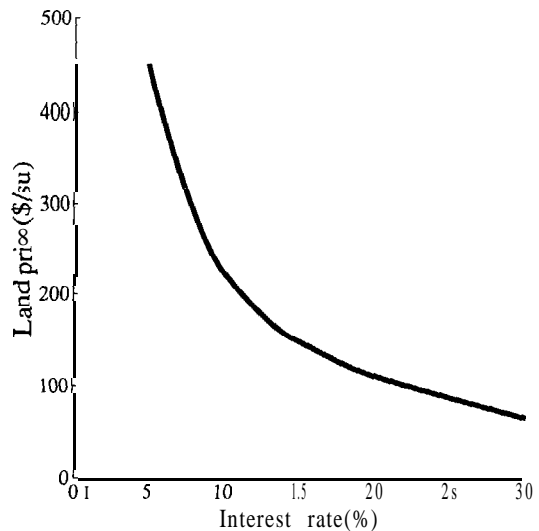


Figure 5 The relationship between price per stock unit paid for land and interest rate on borrowed money at equal marginal benefits for continued high fertiliser v. continued low fertiliser options.

Option 3

This option examines the net benefits of purchasing a HF farm and then stopping fertiliser application compared with purchasing a LF farm but continuing fertiliser. The gross benefit to the HFNF option in the first year is \$210.90 decreasing by \$26.95/yr as pasture production and hence lamb and wool yield declines. The extra cost incurred by the LFLF option is \$31.25/ha/yr for fertiliser, and for HFNF variable costs of \$58.30/ha/yr and \$90.10/yr for interest charges (based on paying \$112/su @ 20% interest). A net cost to the HFNF option of \$117.15. Positive cash flow occurs for the LFLF option in year 4 (Figure 6).

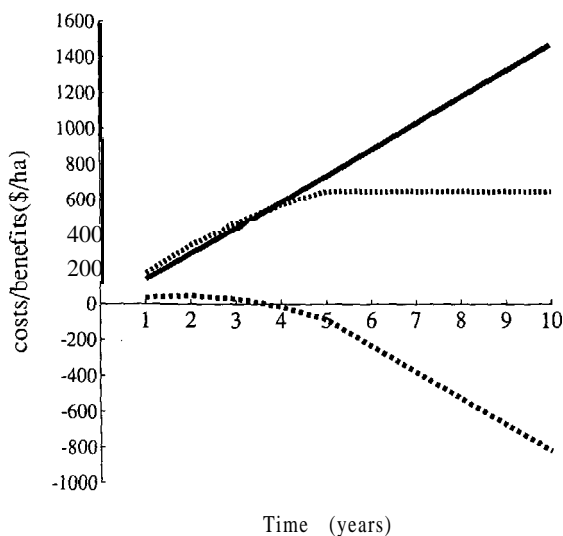


Figure 6 The cumulative cash flow over time of purchasing a farm with a high fertiliser history then stopping fertiliser inputs v. continuing low fertiliser inputs on a farm previously receiving low fertiliser. (Fertiliser cost —; Gross benefit to fertiliser; Net benefit (Gross-Cost) - . . .).

Effect of changes in product and fertiliser price

Generally, a 50% increase in product price is required to advance the time taken to reach positive cash flow by 2 years (Table 1). Although not shown here, decreases in fertiliser costs will reduce the deficit period.

Table 1 Tii (years) taken to reach a positive cash flow at the 3 experimental sites assuming no change in base product prices, a 25 % increases or a 50% increase in total price received. Base prices assumed are \$1.00/kg lamb carcass weight and \$4.50/kg greasy wool.”

	Change in base price		
	0	25	50
Ballantrae (LF)	8	6	5
Ballantrae (NF)	6	5	4
Te Kuiti	4	3	1
Whatawhata	5	4	3

^aA marginal increase of 160 kg DM is assumed to produce 1 kg extra wool and 2.0 kg extra lamb carcass weight. Therefore, this quantity of DM would give gross returns of \$6.50, 8.12 and 9.75 for 0, 25 and 50% change in base price respectively.

DISCUSSION

The low input (LF) Ballantrae site showed the least decline in pasture production from fertiliser cessation and took 8 years to reach positive cash flow from continued fertiliser application. In contrast, the other sites with medium P status showed a larger decline to fertiliser cessation and a positive cash flow to

continued topdressing at year 4 (Te Kuiti) and year 5 (Whatawhata). The high input (HF) Ballantrae site took 6 years but Olsen P levels were increasing (Lambert *et al.* 1990), suggesting that decreased P use and hence a shorter deficit time would be possible.

Initial Olsen P levels in soil at Ballantrae, Te Kuiti and Whatawhata were 11, 14 and 13 respectively. All values are close to the level of 14.5, predicted to give 95% maximum yield on yellow-brown earths (O'Connor & Gray 1984) and hence were on the most sensitive part of the P response curve. Sites with a higher Olsen P level may show little effect from fertiliser cessation for a number of years (O'Connor *et al.* 1990). The declines in Olsen P at Ballantrae (Lambert *et al.* 1990) are not as large as predicted by Quin & Scobie (1988) using the model developed by Comforth & Sinclair (1982). This suggests that in soil no longer receiving fertiliser the value of 0.8, used by Quin & Scobie (1988) to calculate residual P, is too low. Further work is needed to quantify the nature of P losses from soils no longer receiving fertiliser.

Quin & Scobie (1988) suggested that farmers can counteract the effects of decreased fertiliser by increased subdivision to improve utilisation. This option is open only to under-stocked farms. Further, improved utilisation under fertiliser cessation obscures the comparison between cessation and continuation because a farmer continuing fertiliser application can also improve utilisation by subdivision or increased stocking rate.

At all sites there would be a short term improvement in cash flow from fertiliser cessation. However, there is a definite cost to withholding fertiliser in the long term, especially when stocking rate decreases become necessary to maintain performance. Those farmers committed to using some fertiliser should consider the price of alternative P fertiliser now available. They should also consider the animal enterprises they use — a more profitable class of animal will reduce the time taken to reach positive cash flow.

Farm purchase

The scenario outlined in option 2 probably penalises the HFHF option because it assumes that continued high inputs of P are needed to maintain stocking rate and animal performance. However, application of half the present level of 375 kg superphosphate/ha would lead to a gradual fall to a soil capital P of 95 kg/ha, sufficient to maintain 95 % of maximum pasture yield. Although tests of soil P status are useful information when considering farm purchase, a 5- to 10-year fertiliser history will enable the approximate soil capital P to be calculated and hence the likely consequences of future fertiliser decisions.

For option 3 fertiliser cessation rapidly becomes unprofitable after year 4, if high rates of fertiliser have not been applied for long enough to build up soil P. However, if soil P levels are high (e.g. Olsen P > 20) then fertiliser cessation should remain the more profitable option for much longer.

CONCLUSIONS

1. Fertiliser cessation is a sound strategy to survive short-term financial **difficulties** and periods of low product price:fertiliser cost ratio. It is justifiable only if the product **price:fertiliser** cost ratio is expected to increase. If not, **the** enterprise should be sold.
2. Fertiliser recommendations cannot be constant over time. They must take account of: animal enterprise, produce price, fertiliser price, soil P status and level of pasture utilisation.
3. Fertiliser cessation will decrease sustainable productivity and hence farm resale value.
4. Stock will buffer the effect of declining pasture production and hence mask the effect of fertiliser cessation for a number of years.
5. Soil losses of P during periods of nil application may be lower than during application, thus reducing the rate of decline of capital P.
6. In purchasing land, individual paddock fertiliser histories for **5-10** years, plus soil tests, are needed to give an accurate picture of soil capital P.

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