ECONOMICS OF FERTILISER APPLICATION ON HILL COUNTRY

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Abstract

The profitability of hill country farming within New Zealand has been relatively poor over the last decade, as evidenced by a (nominal) average Economic Farm Surplus per Hectare of $105, and a (nominal) average Farm Surplus for Reinvestment (the funds available after all costs including tax, interest and personal drawings have been made) of approximately $38 per hectare – available for development, capital spending, and debt reduction.

A major driver of pasture growth, which flows directly through into profitability, is fertiliser use. On hill country fertiliser usage dropped off through the decade due to a combination of poor profitability, drought, and the rising cost of fertiliser, although application rates have risen in the last 2 years.

The study investigated the economic returns from a capital application of fertiliser, and subsequent increased maintenance dressings, on two hill country sites; a low production potential site (7.5TonnesDM/Ha) and high production potential site (11 TDM/Ha), in order to lift Olsen P levels by 5 and 10 units respectively, up from a base P level of 8 and 15. The analyses on these scenarios were conducted on both a sedimentary and volcanic soil type.

The potential levels of pasture production relative to Olsen P are based on the generic calibration curves for Olsen P, as calculated by the AgResearch PKSLime econometric fertiliser model.

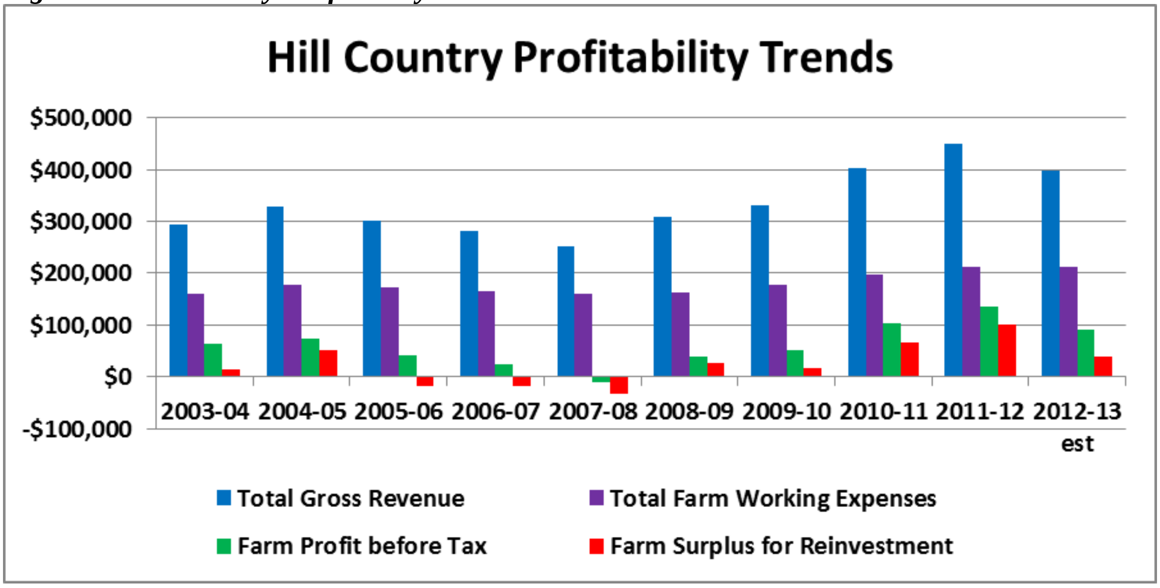
The results show a positive economic return from the increased fertiliser application, more so for the volcanic soil type relative to the sedimentary, given the greater responsiveness of volcanic soils to increasing P applications, notwithstanding the greater requirements of fertiliser P to achieve these lifts. Greatest returns were obtained from lifting P levels from relatively low levels (8) up to higher levels (13-18), compared with lifting levels above the base of 15. The lift in fertility was obtained via a capital and increased maintenance fertiliser input. At the margin, returns were negative above an Olsen P level of 20.

The analysis assumed that the farm was in a position to utilise the extra dry matter grown (e.g. with respect to subdivision). If capital stock were required to be bought in, the analysis still showed a positive result.

Background

The profitability of hill country farming has fluctuated significantly over the last 10 years, but over-all has been relatively poor, as illustrated in Figures 1 and 2.

Figure 1. Hill Country Profitability trends

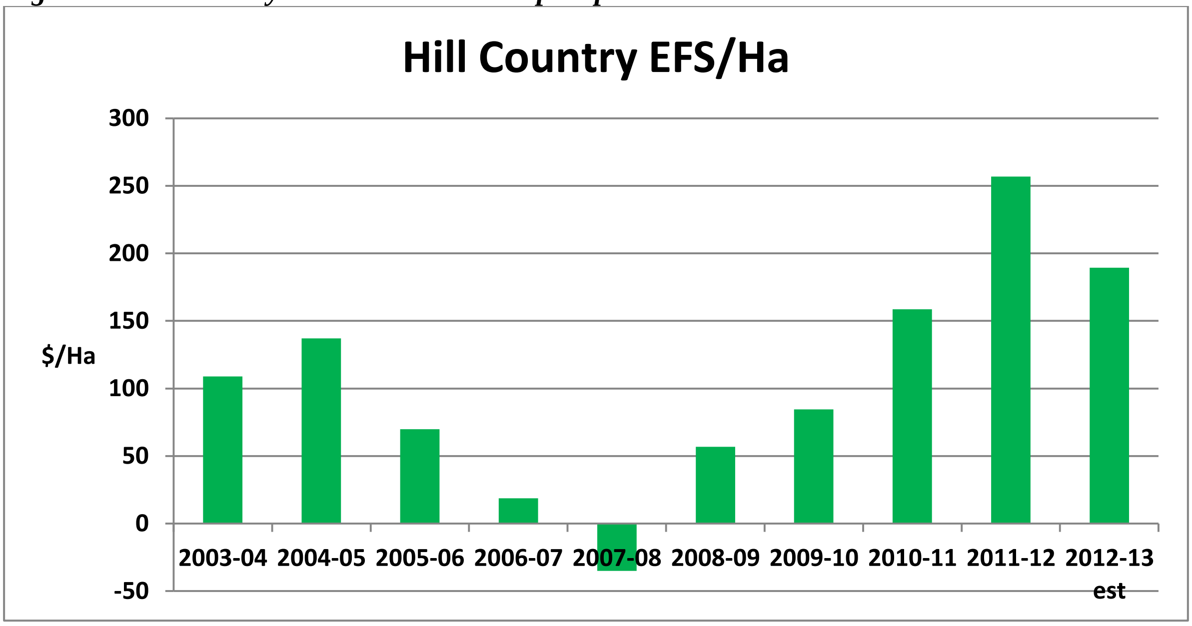


Source: Beef + Lamb Economic Service, MPI Farm Monitoring

This is a weighted average across all New Zealand hill country. Perhaps the best indicator of the relatively poor profitability is the Farm Surplus for Reinvestment (FSR) figure. This is the amount of money available after all expenses (farm working expenses, debt servicing, tax and drawings) which is available for "reinvestment" into such areas as capital spending, debt reduction, and further farm development. The average over the period shown is $25,000 per farm per year, or $38 per hectare.

Another indicator of farm profitability is the Economic Farm Surplus (EFS), defined as; gross revenue plus change in livestock values less farm working expenses less depreciation less wages of management. This has fluctuated over the last 10 years as shown in Figure 2.

Figure 2: Hill Country Economic Farm Surplus per Hectare

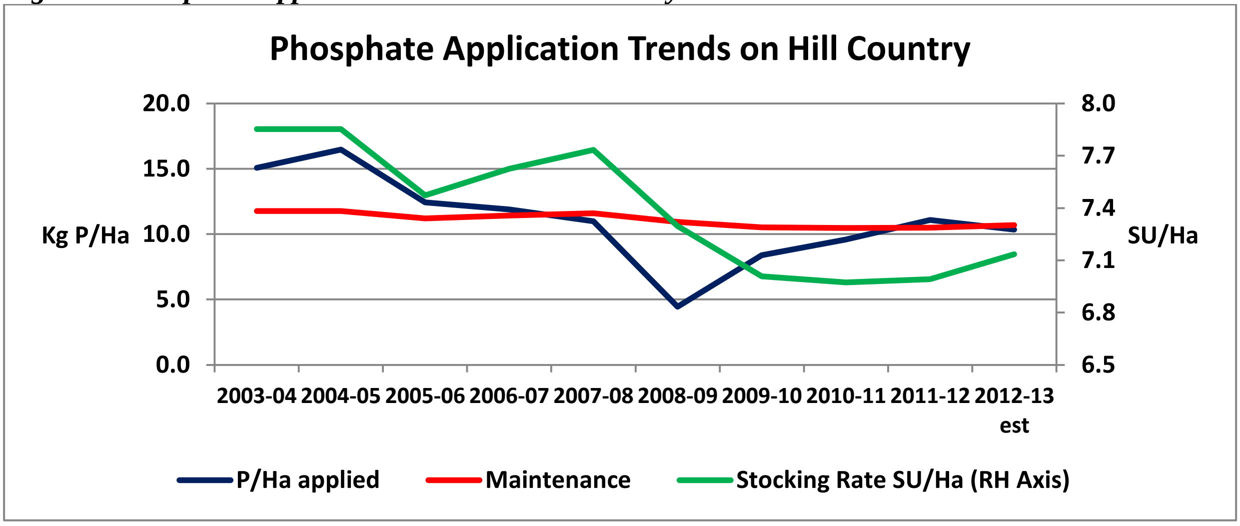


Source: Beef + Lamb Economic Service, MPI Farm Monitoring

The nominal average over this period is $105 per hectare – if 2011/12 is excluded the average drops to $88 per hectare. The average for dairying over the same period is $1,690/Ha.

Fertiliser usage over this period has also fluctuated, directly relative to farm profitability, as reflected in Figure 3.

Figure 3. Phosphate Application trends on Hill Country

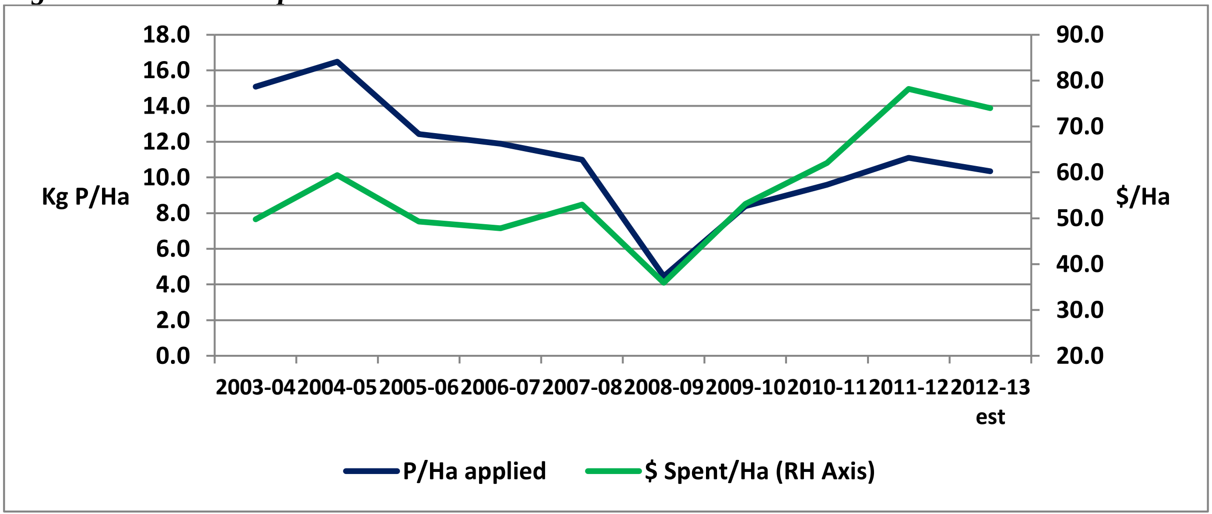


Source: Beef + Lamb Economic Service

This figure shows phosphate applications declining, reaching a low in 2008/09 (post the nation-wide drought of 2007/08), which coincided with a significant lift in fertiliser cost. Stocking rates have also dropped, by 10 percent, with the 2007/08 drought a major triggering factor, and which have only recently started to increase again.
The "maintenance" line is a calculated figure, based on 1.5 Kg P per SU.

The amount of money farmers are spending on fertiliser has increased in recent years, although the amount of fertiliser applied is still below applications earlier in the period.

*Figure 4. Fertiliser Expenditure Trends**



Source: Beef + Lamb Economic Service.
* Excludes cropping fertiliser and lime.

So while expenditure has risen, the average amount of fertiliser applied over the last 3 years (2010-2013) is still only 70 percent of that applied in the years 2003-2006.

The issue therefore is the economic viability of increasing soil fertility through fertiliser applications on hill country.

Scenario
The scenario used in this analysis considered two production potential sites on hill country; a low potential dry matter (DM) production site, and a high potential site. In both cases the starting point was at two differing Olsen P levels (8 and 15), with fertiliser applied to lift both of these by 5 and 10 Olsen P units. Both cases were also considered on both a sedimentary and a volcanic soil type.

This is summarised in Tables 1 and 2.

Table 1: Sedimentary Scenario

Potential Pasture Production	7.5 TDM/Ha		11TDM/ha	
Current Olsen P level	8	15	8	15
Current Pasture Production	6.5	7.1	9.6	10.5
Units of P Req'd to lift Olsen P by 5 units (Kg/Ha)	25	25	25	25
New Level of pasture grown	7.0	7.3	10.2	10.7
Units of P Req'd to lift Olsen P by 10 units (Kg/Ha)	50	50	50	50
New Level of pasture grown	7.2	7.4	10.6	10.8

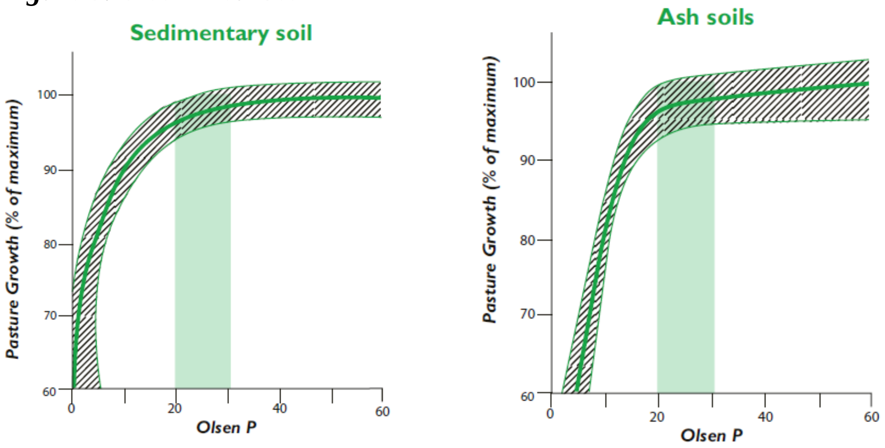
Table 2: Volcanic Scenario

Potential Pasture Production	7.5 TDM/Ha		11TDM/ha	
Current Olsen P level	8	15	8	15
Current Pasture Production	6.0	7.0	8.8	10.2
Units of P Req'd to lift Olsen P by 5 units (Kg/Ha)	50	50	50	50
New Level of pasture grown	6.8	7.3	10.0	10.7
Units of P Req'd to lift Olsen P by 10 units (Kg/Ha)	100	100	100	100
New Level of pasture grown	7.2	7.4	10.6	10.8

Key Assumptions

Feed Grown
The potential pasture production figures shown relative to Olsen P are based on the generic calibration curves for Olsen P as shown below in Figure 5, as calculated by the AgResearch PKSLime econometric fertiliser model.

Figure 5. Olsen P curves



Source: FertResearch 2009

Stock Units

It was assumed that the extra feed grown supported extra stock units; the original definition of a stock unit was a 55Kg ewe producing 1 lamb, requiring 550 Kg DM per year (Woodford and Nicols, 2004). Given that stock are now generally heavier, with ewes around 65Kg liveweight, and the weighted average lambing percentage on hill country over the last 10 years is 120 percent (Beef + Lamb, 2012), the assumption was made that 1 stock unit consumed 660Kg DM (i.e 550 x 1.2).

Average utilisation of extra pasture grown was assumed at 70 percent.

Extra stock units carried, relative to the extra feed grown as shown in Tables 1 & 2, is summarised in Table 3 below.

Table 3. Increased number of stock units per hectare

		Low potential site		High potential site	
Current Olsen P		8	15	8	15
Sedimentary	5 units	0.53	0.21	0.64	0.21
	10 units	0.74	0.32	1.06	0.32
Volcanic	5 units	0.85	0.32	1.27	0.53
	10 units	1.27	0.42	1.91	0.64

Economic Returns

Given that farm returns fluctuate, and in the hill country situation there are 3 main income streams; lamb, wool, and beef, it was decided to use a gross margin (GM) approach in determining economic returns. This was based on gross returns less some variable costs – while there would be an increase in stock numbers, most costs would remain the same. Those variable costs that would alter, and included in the GM were: animal health, shearing, feed, and cartage. Extra fertiliser costs would also be incurred, but these were calculated separately.

The GM was based on the Beef + Lamb economic survey from 2003/04 through to the 2012/13 estimate, and was a weighted average across hill country farm classes; Class 2South Island Hill Country, Class 3 North Island Hard Hill and Class 4North Island Hill. These were then inflated through to 2012 values using the sheep and beef cattle primary producers index (StatsNZ, 2012).

The average GM produced was $70.15 per stock unit, or $498 per hectare.

Fertiliser Costs
Fertiliser costs were assumed as:

Table 4. Applied fertiliser cost

	$/Tonne
Super	355
Cart	30
Spread	90
	$475

Capital Fertiliser Costs
The amount and cost to lift the Olsen P levels by the required amount is shown in Table 5.

Table 5. Amount and cost of fertiliser required

	Sedimentary		**Volcanic**
Kg Super required/Ha			
5 units	278		556
10 units	556		1,111
Capital cost per hectare			
5 units	$132		$264
10 units	$264		$528
Interest cost/Ha at		7%	
5 units	$9.24		$18.47
10 units	$18.47		$37.94

Maintenance Fertiliser Costs
The increase in Olsen P levels would also require an increase in maintenance fertiliser inputs in order to maintain the new levels. These were assessed as:

- Lifting from Olsen 8 to Olsen 13-18: 1.3kg P/SU for sedimentary soils, and 1.5 kg P/SU for volcanic soils
- Lifting from Olsen 15 to Olsen 20-25: 2.0kg P/SU for sedimentary soils, and 2.2 kg P/SU for volcanic soils

The resultant cost of this is shown in Table 6:

Table 6. Cost of increased maintenance fertiliser ($/Ha)

	Low potential site		**High potential site**	
Base Olsen P	8	15	8	15
Sedimentary				
5 units	$15.59	$11.99	$15.59	$17.99
10 units	$23.39	$11.99	$23.39	$17.99
Volcanic				
5 units	$17.99	$13.19	$17.99	$19.79
10 units	$26.99	$13.19	$26.99	$19.79

Cost of increased stock numbers

An important caveat with respect to the value of increased fertiliser inputs is that it is assumed that the farm/farmer is in a position to utilise the extra feed grown. An obvious example of this is sufficient subdivision to allow for good grazing management.

A second example is sufficient stock numbers to consume the extra feed. It may be the case that no extra stock is required, and the extra feed grown is reflected in increased performance – e.g. increased slaughter weights, increased lambing/calving percentages. The extra feed may well also allow farmers to tailor finished stock to particular market requirements.

In the current analysis it is assumed extra stock are required in order to utilise the extra feed grown, in which case there is an extra cost involved as represented by the interest cost on the capital cost of the extra stock.

The assumption in this analysis was for a capital value of $120 per stock unit, which was costed at an interest rate of 7 percent. The $120 figure is based on a weighted average over the last 10 years of the Inland Revenue livestock tax values (IR, 2012), across 2 tooth and mixed age ewes, and rising 2 year beef heifers and beef breeding cows.

Down on the farm, the farmer may well look at a combination of increased production and increased stock numbers in order to utilise the extra feed grown – say $^{2}/_{3}$ extra stock, $^{1}/_{3}$ extra production. In this situation, the costs would be less than those assumed in this analysis.

Results

The results of the analysis is summarised in Tables 7 and 8.

Table 7. Summary of results for a Sedimentary Soil ($/Ha)

		Low potential site		High potential site	
Starting Olsen P		8	15	8	15
Gross return $/Ha	5 unit increase	37.20	14.88	44.64	14.88
	10 unit increase	52.08	22.32	74.40	22.32
Costs $/Ha					
Interest on capital fertiliser	5 units	9.24	9.24	9.24	9.24
	10 units	18.47	18.47	18.47	18.47
Increased maintenance fertiliser	5 units	3.64	2.24	4.37	2.24
	10 units	5.09	3.36	7.28	3.36
Interest on capital stock	5 units	4.45	1.78	5.35	1.78
	10 units	6.24	2.67	8.91	2.67
Net return $/Ha	5 units	$19.87	$1.62	$25.69	$1.62
	10 units	$22.28	-$2.18	$39.74	-$2.18

Table 8. Summary of results for a Volcanic Soil ($/Ha)

		Low potential site		High potential site	
Starting Olsen P		8	15	8	15
Gross return $/Ha	5 unit increase	59.52	22.32	89.28	37.20
	10 unit increase	89.28	29.76	133.92	44.64
Costs $/Ha					
Interest on capital fertiliser	5 units	18.47	18.47	18.47	18.47
	10 units	36.94	36.94	36.94	36.94
Increased maintenance fertiliser	5 units	4.20	2.46	5.04	2.46
	10 units	5.88	3.69	8.40	3.69
Interest on capital stock	5 units	4.45	1.78	5.35	1.78
	10 units	6.24	2.67	8.91	2.67
Net return $/Ha	5 units	$32.40	-$0.40	$60.43	$14.48
	10 units	$40.22	-$13.55	$79.67	$1.33

Sensitivity Analysis

A sensitivity analysis was carried out on various factors;

(i) Varying the gross margin return;
(ii) The percentage utilisation of the extra feed grown; and
(iii) If no extra capital stock are required.

These are shown in Tables 9 - 13 below.

Table 9. Sensitivity analysis around varying Gross Margin levels: Sedimentary Soil - Net Returns ($/Ha)

		Low potential site		**High potential site**	
	Base Olsen P	8	15	8	15
GM: $80/SU $568/Ha					
	5 units	$25.10	$3.71	$31.96	$3.71
	10 units	$29.59	$0.95	$50.19	$0.95
GM: $60/SU $462/Ha					
	5 units	$14.49	-$0.53	$19.23	-$0.53
	10 units	$14.74	-$5.41	$28.98	-$5.41
GM: $50/SU $355/Ha					
	5 units	$9.19	-$2.65	$12.87	-$2.65
	10 units	$7.32	-$8.59	$18.37	-$8.59
GM: $40/SU $284/Ha					
	5 units	$3.88	-$4.77	$6.51	-$4.77
	10 units	-$0.11	-$11.78	$7.77	-$11.78
GM: $30/SU $213/Ha					
	5 units	-$1.42	-$6.89	$0.14	-$6.89
	10 units	-$7.53	-$14.96	-$2.84	-$14.96

Table 10. Sensitivity analysis around varying Gross Margin levels: Volcanic Soil - Net Returns ($/Ha)

		Low potential site		**High potential site**	
	Base Olsen P	8	15	8	15
GM: $80/SU $568/Ha					
	5 units	$40.75	$2.74	$72.96	$19.71
	10 units	$52.76	-$9.37	$98.48	$7.60
GM: $60/SU $462/Ha					
	5 units	$23.78	-$3.63	$47.51	$9.10
	10 units	$27.31	-$17.86	$60.30	-$5.13
GM: $50/SU $355/Ha					
	5 units	$15.30	-$6.81	$34.78	$3.80
	10 units	$14.58	-$22.10	$41.20	-$11.49
GM: $40/SU $284/Ha					
	5 units	$6.81	-$9.99	$22.05	-$1.50
	10 units	$1.85	-$26.34	$22.11	-$17.86
GM: $30/SU $213/Ha					
	5 units	-$1.67	-$13.17	$9.33	-$6.81
	10 units	-$10.88	-$30.58	$3.02	-$24.22

Table 11. Sensitivity analysis around pasture utilisation levels: Sedimentary Soil - Net Returns ($/Ha)

		Low potential site		High potential site	
	Base Olsen P	8	15	8	15
Pasture Utilisation					
75%	5 units	$21.95	$2.40	$28.19	$2.40
	10 units	$25.19	-$1.02	$43.90	-$1.02
65%	5 units	$17.79	$0.85	$23.20	$0.85
	10 units	$19.37	-$3.35	$35.59	-$3.35
60%	5 units	$15.71	$0.07	$20.70	$0.07
	10 units	$16.46	-$4.51	$31.43	-$4.51

Table 12. Sensitivity analysis around pasture utilisation levels: Volcanic Soil - Net Returns ($/Ha)

		Low potential site		High potential site	
	Base Olsen P	8	15	8	15
Pasture Utilisation					
75%	5 units	$36.03	$0.89	$66.06	$16.84
	10 units	$45.74	-$11.88	$88.00	$4.06
65%	5 units	$28.76	-$1.69	$54.79	$12.13
	10 units	$34.71	-$15.22	$71.34	-$1.40
60%	5 units	$25.13	-$2.98	$49.16	$9.78
	10 units	$29.20	-$16.89	$63.01	-$4.14

Table 13. Net returns assuming no capital stock are required

		Low potential site		High potential site	
Starting Olsen P		8	15	8	15
Sedimentary					
Net return $/Ha	5 units	$24.33	$3.41	$31.04	$3.41
	10 units	$28.51	$0.49	$48.65	$0.49
Volcanic					
Net return $/Ha	5 units	$36.85	$1.39	$65.77	$16.27
	10 units	$46.46	-$10.88	$88.58	$4.00

Discussion

1. Overall the analysis shows that a capital application of fertiliser can be very profitable.
2. This is particularly so when starting from a low base Olsen P level – the net returns from the base level 8 sites were significantly higher than from the base level 15 sites.
3. The returns on the volcanic soils were greater than on the sedimentary soils due to the lower initial production relative to the Olsen P level, resulting in a greater relative

increase in pasture production with increasing Olsen P levels, albeit requiring greater fertiliser P inputs.

4. On the base Olsen P15 sites, the marginal return from lifting the Olsen P level above 20 was negative; while the response curves as shown in Figure 5 are still increasing above Olsen P 20, they are doing so at a deceasing rate, which means that lifting Olsen P levels above this level is uneconomic; i.e. the cost of the fertiliser to lift fertility to this level is not matched by the amount of pasture grown and subsequent returns from product sold.
5. Lifting the Olsen P 8 sites to 18 gave a greater return compared to lifting the Olsen 15 sites to 20, which would tend to indicate that the optimal Olsen P level is around the 18 mark, given current cost:price relationships.
6. The sensitivity analysis would indicate a "breakeven" gross margin value of around $40 per stock unit for the sedimentary soil types and around $35-$40 per stock unit for the volcanic soil types, when starting from a low (i.e. Olsen 8) base, but around $60+ per stock unit if starting at a higher base level (i.e. 15).
7. A question could be raised as to whether all increased variable costs have been captured. The greatest response was from lifting the base level 8 sites up to an Olsen level of 18; a further 1.3 -1.9 stock units per hectare could be carried. If this is extrapolated out to the farm level, it equates to an extra 866 – 1,269 stock units. At this increase the farmer could well ask – is the extra work justified, and possibly look to employ further labour. However, these increases in stock would not be sufficient to cover the cost of a full labour unit, and there can be practical difficulties in arranging part-time labour. Similarly, there could well be an increase in some other variable costs, such as repairs and maintenance and vehicle costs. In noting this though, the sensitivity analysis does indicate there is some room to accommodate these costs.
8. The returns are conditional on the farm being in a position to capture the extra feed grown, particularly with respect to subdivision, grazing management, and stock numbers. Again potentially there may be some extra cost involved via the provision of more subdivision in order to utilise the extra feed grown, or extra subdivision could be carried out to lift the average utilisation rate. As can be seen in the sensitivity analysis, the extra margin accruing to the increase in utilisation rate is relatively limited, although greater on the high potential site compared to the low potential site.
   If a significant lift in utilisation can be achieved, say from 60% up to 75%, then the margin on the high potential site is in the order of $20-$25 per stock unit, which would go some way to paying for extra subdivision.

   If no extra capital stock are required, then the net returns improve, again allowing a greater margin for increased subdividion if necessary.

   If subdivision is not sufficient to capture the extra growth from increased fertiliser inputs, then the priority would be to improve subdivision before greater fertiliser inputs were considered.

Conclusion

Soil fertility is important for whole farm productivity, and increased fertiliser applications can be profitable, especially if starting from a low fertility base. This is naturally dependent on the relativity between costs and returns, but increased use of fertiliser can be a profitable long term investment when product returns improve.

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