Liming acid soils for livestock production – a new business case using timeless production research

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Farm managers with acidic (low pH) soils can be thankful for the government funded investment in acid soils research. Soil science can be a complex area of research, but many historical studies did an exceptional job at investigating the impact of applying lime to acid soils to ameliorate soil pH. Many trials compared multiple treatments which allowed for a greater understanding of the rates of change in acidity over time with different rates of lime on soils meeting specific criteria. Importantly, many of these trials also assessed differences in production between limed and unlimed treatments.

These measured differences in production allowed for a critical financial assessment of the business case for investment in lime. This research was always destined for success because the ownership of the results extended beyond those with direct involvement to those with expertise in disciplines beyond pure soil science research. Technical and extension agents who worked with farm managers, had buy-in and did an exceptional job of delivering key outcomes with widespread adoption and uptake based on findings.

One of the current problems surrounding that extension campaign is that the messages, that were appropriate for the time, are no longer applicable due to significant changes relating to the costs and benefits associated with the changes in production. The messages appear to have been so well delivered that the messages have stuck without consideration to the changes in economic circumstance since the research was conducted. This article outlines the changes to the business case between the past and the present and demonstrates that the investment case for lime in grazing enterprises, based on current circumstances, is solid.

The MASTER trial, an acronym for managing acid soils through efficient rotations, located near Wagga Wagga in southern NSW which ran for 12 years from 1992 yielded some brilliant data. This trial showed a 25 percent increase in livestock production with the application of lime when compared to unlimed treatments. The trial site had a soil pH of 4.1 with soil aluminium levels of 31 percent of the effective cation exchange capacity in the top 10 centimetres prior to liming. At the time, due largely to low livestock prices and returns, investment in lime applied to annual or perennial pastures took over ten years to break even.

The financial analysis of the MASTER trial results, authored by Li et al, can be found in the CSIRO journal, Crop and Pasture Science, 2010, 61, 12-23 (the Li analysis). A partial budget is typically used in financial analysis of results to compare the marginal costs and benefits of additional production from limed treatments with production levels from unlimed treatments. A partial budget only includes any changes relative to the base case.

Outputs of the partial budget can then be used to conduct an investment analysis which calculates the marginal return on investment. Key components of the initial investment in this case includes lime and the capital costs of additional livestock required to generate value out of the additional pasture production and associated quality improvements. The business case for or against the investment can then be assessed when accompanying information around risk and hurdle rates is known.

The updated partial budget and associated cashflow and financial analysis provided in this article (the Agrista analysis) uses the same production data delivered in the Li analysis. The analysis uses some small changes to assumptions and slightly shorter liming intervals and liming rates. The difference in methodologies appear to deliver only minor differences in outcome relative to the initial analysis conducted by Li et al. The key differences between analysis assumptions follows:

The Agrista analysis calculated the marginal benefit of lime treatments by multiplying a gross margin per dry sheep equivalent (DSE) by the marginal difference in stocking rate between limed and unlimed treatments. The marginal cost of livestock was included with the up-front lime investment as a capital cost in the initial investment year. Livestock are sold in the final year of the analysis at a value indexed at 5% per annum.

Li et al, in their analysis used the precise production and price metrics for each treatment to calculate the gross profit per DSE and then deducted a common enterprise expense cost per DSE for all treatments. It appears that the marginal cost of livestock was not included with the up-front lime investment as a capital cost in the initial investment year.

The Agrista analysis assumes lime is applied at 3.7 tonnes per hectare in year 0 followed by 4 applications of 1.8 tonnes of lime per hectare every 6 years thereafter. This delivers a total lime application of 10.9 tonnes per hectare over the 25 year timeframe. There are no additional production benefits assumed despite the additional lime applied. Li et al, in their analysis apply 3.7 tonnes per hectare in year 1 followed by 1.8 tonnes per hectare in year 7 and two further applications of 1.5 tonnes per hectare in years 13 and 19.

The assumptions used in the economic analysis of the experimental results of the MASTER trial in the Li analysis included:
- marginal increases in stocking rate of approximately 2.85 DSE per hectare equating to a 25 percent increase from lime treatment relative to unlimed treatments in both annual and perennial pastures.
- gross margins of approximately $16 per DSE (Gross profit $36/DSE less enterprise costs $20/DSE).
- applied lime costs of $70 per tonne.
- no apparent allocation of the costs of the marginal livestock or easily referenced capital cost of livestock thus the Agrista analysis assumes $35 per DSE was appropriate at that time.

The updated Agrista analysis, which reflects current commodity prices and costs, uses the same production assumptions but the following gross margin and cost assumptions assumptions:
- gross margins of $60 per DSE (Gross profit $85 per DSE less enterprise costs of $25 per DSE).
- applied lime costs of $85 per tonne.
- capital livestock costs of $185 per dry sheep equivalent.

A summary of the assumptions in each analysis is shown in Table 1.

Table 1. Investment in lime on pastures - assumption comparison

	Li et al	Agrista	Difference
Analysis year	**2007**	**2021**	**2021 v 2007**
Lime cost ($/t)	$70	$85	21%
Gross profit ($/DSE)	$36	$85	139%
Enterprise costs ($/DSE)	$20	$25	26%
Gross margin ($/DSE)	$16	$60	284%
Lime applied (t/25 years)	8.5	10.9	28%
Livestock capital ($/DSE)	$35	$185	429%

The analysis outcome

The investment analysis, which uses the production responses shown in the analysis of Li et al but 2021 cost structures and commodity pricing, shows a significant improvement in investment returns in 2021 relative to 2007.

When examined over a 25 year time horizon, the net present value of the investment in lime and additional livestock on highly acid soils is $1,236 (Figure 1). This compares with a net present value of $46 when using 2007 cost structures and commodity pricing.

The net present value is a calculation of the net earnings of the investment discounted to reflect the value of future earnings to today's dollar terms. The discount rate can be based on the opportunity cost of earnings from equity or debt or from a weighted average of the two. In this analysis, a discount rate of 6% per annum was applied to estimate the present value of benefits and costs. This is consistent with the discount rate applied in the Li paper.

The analysis shows that it takes 20 years to breakeven on the initial investment in lime and livestock when using the 2007 costs and commodity pricing but this declines to 7 years when using 2021 costs and commodity pricing assumptions. The reason that the 2007 return is lower than that shown in the Li paper is that an additional lime application has been applied over the 25 year period in the Agrista analysis. The return on investment (internal rate of return) in lime is shown in table 2.

Figure 1. Cumulative marginal discounted cashflow from investment in lime using MASTER trial production assumptions

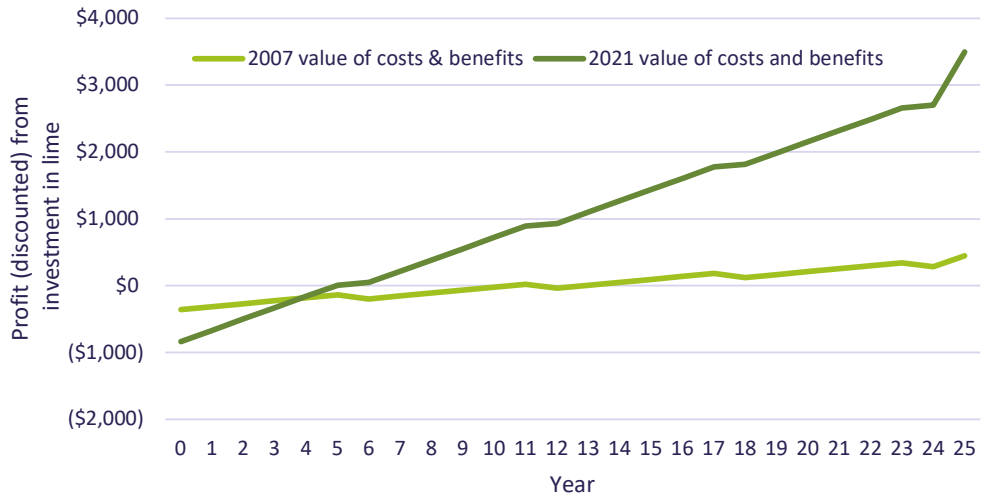


Table 2. Investment in lime on pastures - return comparison

	Li et al	Agrista	Difference
Analysis year	**2007**	**2021**	**2021 v 2007**
Net present value	$46	$1,236	2606%
Return on investment	7%	19%	153%

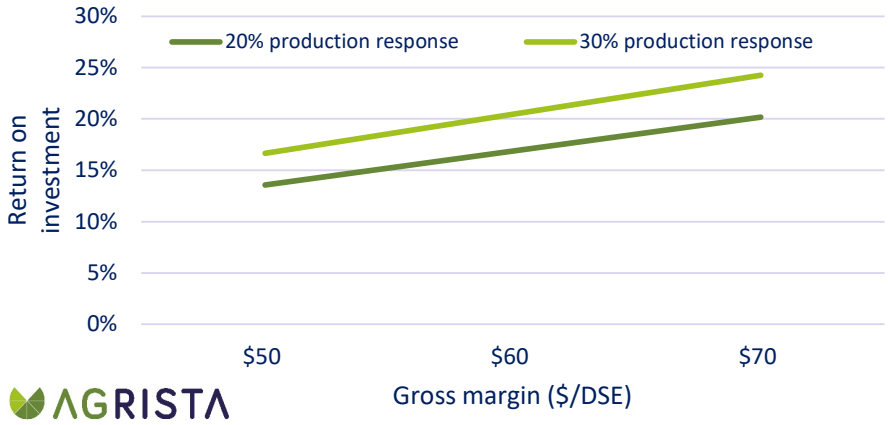
The reason for the magnitude of the difference between analyses is that the key costs, lime and livestock enterprise expenses, only increase by 20-25 percent over the period. This is equivalent to

an annual compounding growth rate of 1.4 to 1.7 percent. On the other side of the equation, the value of the production benefits increase by a far greater magnitude at 284 percent. This equates to an compounding growth rate of 10 percent per annum. It is the greater rate of value of production benefit relative to the rate of growth in costs that drives a more rapid return to break even and a greater rate of return.

Sensitivities

Figure 2 demonstrates that the returns on investment in lime are sensitive to gross margin return per DSE and the extent of the production response. If gross margin returns fall to a $50 per DSE average and production responses decline to 20 percent, then returns on investment fall to 14 percent, still well above the current cost of debt.

Figure 2. Sensitivity of return on investment to gross margin per DSE and production response



The fine print

In 1992, when the experiment started, the 0-10 centimetre soil layer had an average soil pH in $CaCl_2$ of 4.0 (highly acidic) and Colwell Phosphorus levels were 23 milligrams per kilogram. The point of highlighting this is that production responses in the trial were specific to these circumstances. Higher starting soil pH levels may deliver lower production responses. They would also typically require less lime in the initial instance to change soil pH to 5.5 in $CaCl_2$.

The production responses from the perennial pastures in the experiment were achieved after incorporating lime and establishing the perennial pastures prior. It is plausible, given the nature of movement of lime through the soil profile that production responses, particularly in the early stages after initial lime application, may be lower than delivered in the trials where lime is unable to be incorporated.

What this means to you

It is important to regularly re-assess the financial consequences of research involving production responses. The costs and benefits can change over time due to any number of factors. Being flexible and adaptive and taking the approach of assessing all investment opportunities on a regular basis helps to ensure opportunities are not overlooked.