Variable rate lime and fertiliser for grazing enterprises

Background

Precision agriculture is becoming more common in cropping circles but Precision Agriculture has had limited uptake in grazing systems. In theory the concept should work for graziers but is it practical and cost effective to do so? Agriculture Kangaroo Island received funding through Caring for Our Country to undertake a variable rate grazing trial in pastures. The establishment and monitoring of a demonstration site will show at a paddock scale, the benefits of intensive soil testing of pH and phosphorus and the use of variable rate technology for the application of lime and fertiliser to match inputs to soil/pasture needs.

What was done?

The demonstration site is located on R & A Morris's property (corner Mt Taylor and South Coast Rds.). It's an 11 ha paddock with variable soil types.

The site was intensively mapped for:

- Soil $pH_{(H_2O)}$ - using a specifically designed machine that allows for rapid pH measurements in the field, (refer to FIGURE 2) 63 samples were taken.
- Soil nutrients - phosphorous, potassium, sulphur, phosphorus buffering index (PBI), salinity, organic carbon and texture. These samples were taken the old fashioned way (with an auger and a bucket!), then sent to the lab for analysis. In total 38 samples were taken.

FIGURE 1: **Mapped soil pH variation in the demo paddock.**

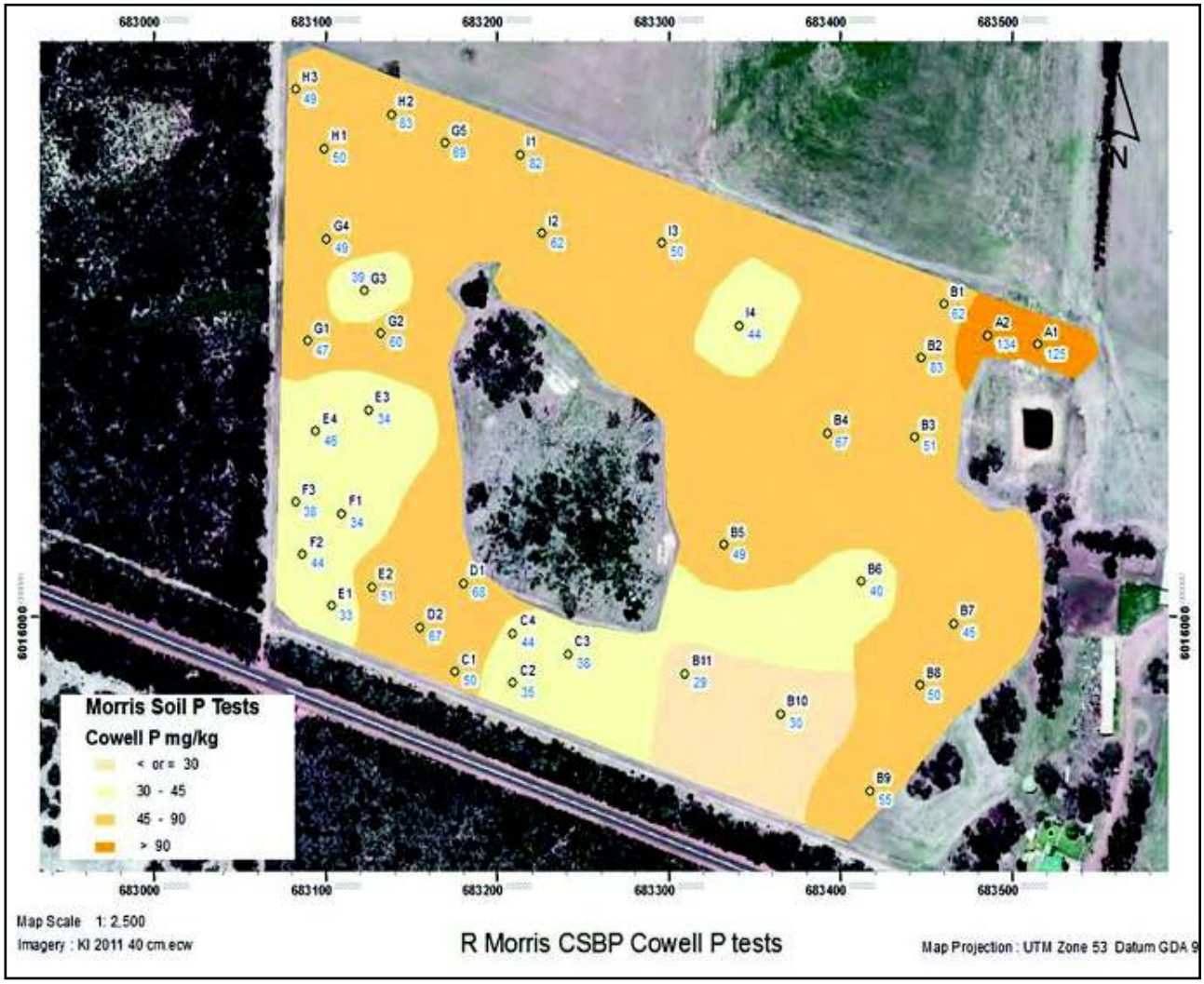

FIGURE 2: **Mapped soil phosphorus variation in the demo paddock.**

Results

The $pH_{(H_2O)}$ varied from 5.4 to 7 across the paddock (refer to FIGURE 1). Remember that $pH_{(H_2O)}$ gives a higher reading than $pH_{(CaCl_2)}$. These readings would equate to approximately $pH_{(CaCl_2)}$ of 4.9 to 6.5 i.e. some parts of the paddock would respond to lime whilst other sections would not. In fact liming some parts could lead to over liming and a potential loss in production.

Soil nutrients also varied considerably across the paddock. Nutrient levels (especially phosphorus) would be limiting growth in some parts of the paddock and are excessive in other parts (refer to FIGURE 2).

A cost benefit analysis was then undertaken of the cost of conventionally treating the paddock (i.e. the application of lime and single super at the same rate across the whole paddock) compared to applying lime and fertiliser according to soil test results.

Fertiliser application

A few assumptions were made in this exercise. A stocking rate of 12 DSE/ha with a maintenance application rate of 1kgP/DSE if soil P is between 30 and 45 ppm. If soil P levels are below 30 then maintenance rate is increased to 1.3 kgP/ha, when soil P is greater than 45 the rate is reduced to 0.75kgP/DSE and at greater than 90 no P is applied. Fertiliser used – single super, at a cost of $300/t plus $70/t freight and spreading costs of $5/ha.

1. Fertiliser cost if applied conventionally (at 1kgP/DSE @ 12DSE/ha). Application rate of 135kg/ha across the whole paddock:

   135kg single @$300/t + freight + spreading costs = $54.95/ha x 11 ha = **$604.45**

Compared to:

2. Fertiliser applied to match soil test results as per TABLE 1. below

TABLE 1: **Cost to apply single fertiliser according to soil test results**

Soil P (ppm)	Area (ha)	Recommended application rate	Cost ($)
<30	0.78	1.3 kg P/DSE (177 kg single/ha @ $70.49/ha)	54.98
30-45	2.24	1 kg P/DSE (135 kg single/ha @ $54.95/ha	123.09
45-90	7.75	0.75 kg P/DSE (102 kg single/ha @ $42.74/ha)	331.31
>90	0.23	0 kgP/ha	0.00
		Total	**$509.38**

The figures in TABLE 1 show a total saving in fertiliser cost of $95.07 or $8.64 per ha. Whilst this cost becomes more significant on a farm scale i.e. 1,000 ha @ $8.86 = $8,860. The cost of the initial soil testing (Soil P $16/test plus time) may negate this cost saving.

It all comes down to how many soil tests are taken, at 1 per ha the cost of the tests outweighs the saving in fertiliser costs. At one per 5 ha, for example, it becomes more viable (depending on the cost of labour to take the soil samples – might need to invite the grandkids over for the school holidays and set them to work!). Obviously soil testing will not be required every year, but in reality until a more rapid, lower cost option for monitoring soil P levels becomes available, it's possibly not a feasible option.

AgKI has received funding for a new project which will use "Pastures from Space" technology to map areas of higher pasture growth rates within paddocks. These areas will then then be soil tested (the theory being that higher pasture growth rates will correspond with areas of higher soil fertility) and fertiliser application rates adjusted accordingly. If this reduces the number of soil tests from say 1 per 5 ha to 1 per 25 ha, then it becomes economically worthwhile.

pH

The paddock used in this example is not typical of many acidic paddocks on KI, but it does highlight how variable paddock pH may be. The costs below are based on the following assumptions: limesand $7/t + $8/t freight +$8.50/ha spreading.

Note also the mapping is done in pH(H_2O) so you need to deduct about 0.4 unit off the readings to get to pH($CaCl_2$). Liming on KI is recommended once pH falls below 5. In this case we are applying a maintenance rate of 1t/ha between 5 and 5.4 and 2.5t/ha once pH falls below 5.

1. If you had taken a sample in the south-west portion of the paddock (refer to FIGURE 1) and then assumed the rest of the paddock was the same (i.e. all below pH($CaCl_2$) 5.0) and then limed the whole paddock:

   11ha @ 2.5t/ha = $506.00

vs

2. Lime applied to match soil test results as per TABLE 2 below.

TABLE 2: **Cost to apply lime according to soil test results**

pH($CaCl_2$)	Area (ha)	Recommended lime application rate (t/ha)	Cost ($)
>6.5	0	0	0.00
6 -6.5	2.72	0	0.00
5.5 – 5.9	6.85	0	0.00
5.0 - 5.4	1.67	1t/ha	39.25
<5.0	0.42	2.5t/ha	19.32
		cost to map area 11ha @ $6/ha	66.00
		Total	**$124.57**

The above figures show a total saving in lime costs of $381.43 or $34.68 per ha. Taking this up to a farm scale, for example 1000 ha equals a potential saving of $34,680.

Take home messages

- Without this intensive mapping the paddock would have been either under or over limed and fertilised resulting in either a loss of productivity or a waste of fertiliser/lime dollars and possibly both.
- Whilst it's economically beneficial to apply variable rate technology for a liming program, until more cost efficient soil testing methods are developed, the economic justification may not be there for soil nutrients.

Funding/Sponsors

- Agriculture Kangaroo Island (through Caring for Our Country funding).
- R & A Morris for providing the demo site.

For further information contact

Lyn Dohle, Rural Solutions SA, Kingscote, on 8553 4999 or email lyn.dohle@sa.gov.au