A PRECISION FERTILISER PLAN:
REAL MEASUREMENTS, REAL COSTS, REAL RESULTS

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Abstract
Precision agriculture often refers to the use of a new technology rather than the adoption of a precision farming philosophy. This paper demonstrates how using the precision farming philosophy of: Plan, Measure, Manage, Review has been used to create and implement a fertiliser plan and decision support system over the past four seasons on a 85ha South Taranaki dairy farm. The plan was to achieve a consistent range of soil test values for Olsen P (40-50), Quick Test K (10) and Sulphate S (10) at the paddock scale from land that has historically had both different levels of fertiliser input and land use. Ten geo-referenced soil samples were taken from every paddock, every year in order to obtain paddock scale results. Variation in results was managed using 6 different fertiliser mixes including nil application. Results have shown a reduction in farm average Olsen P from 62 to 49 (within target range), Quick test K from 10 to 8 (below target range), and Sulphate S from 11 to 7 (below target range) over the four year period. The latest reduction of Quick Test K levels has lead to 67% of the farm this season receiving capital K compared to 41% and 52% in the two previous seasons respectively. Sulphate S levels are now controlled in the autumn as a standalone program due to the number of mixes already present using the current decision support system. Dairy farm fertiliser expenditure on average in NZ equates to $507/ha/yr, undertaking this program has had direct costs of between $50/ha/yr and $114/ha/yr ($83/ha/yr avg) over the previous four seasons whilst pasture growth has increased from 14.54 T DM/ha to 18.68 T DM/ha indicating that the programs cost savings have had no negative impact on pasture production. This program demonstrates that a adopting a precision farming philosophy rather than just using a standalone precision tool will have a much greater positive impact for the use of fertiliser on New Zealand farms.

Introduction
Nutrient replacement is a critical part of continual pasture production on a dairy farm. Nutrient sources include chemical fertilisers, stock effluent, brought in supplementary feed and stock dung and urine distribution, all of which can change on a season by season basis depending on weather, stocking rate, cropping rotation or farm system. The spatial distribution of these nutrients is not equal across a farm; therefore, because fertiliser is one of the single largest farm working expenses it makes both financial and environmental sense to spatially manage this unequal nutrient resource.

This four year project aimed to reduce variation at the paddock scale by both mining and applying the required nutrients based off soil test data. The project followed the precision farming philosophy of plan, measure, manage, and review.

Plan

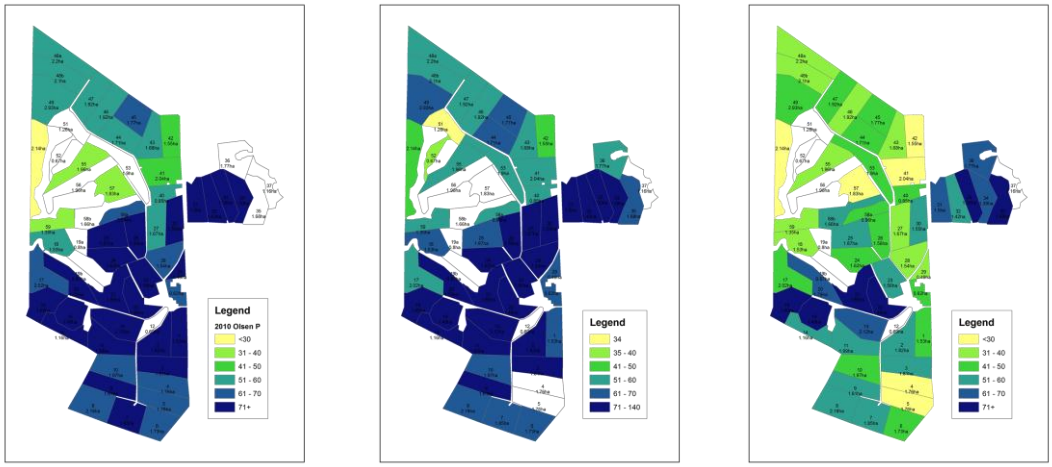
The nutrient application plan involved taking 10 geo referenced soil samples from every paddock on the 85ha farm, the farm was three blocks of land that had been put together over time and previously were under different farming types, therefore within paddock variation was high (Table 1). The target ranges were set at or slightly above optimum levels for pasture production. Olsen P in particular was given a target range of 40-50 (recommended optimum = 30), this was due to the current high level on the farm that did not want to be completely mined back.

Table 1. Initial soil test value ranges at start of project and set target ranges for individual paddocks.

	Olsen P	Quick Test K	Sulphate-S	pH
Farm Value Range	**32-106**	**5-18**	**6-17**	**5.9-6.5**
Farm Target Range	**40-50**	**10-12**	**10-12**	**6.0**

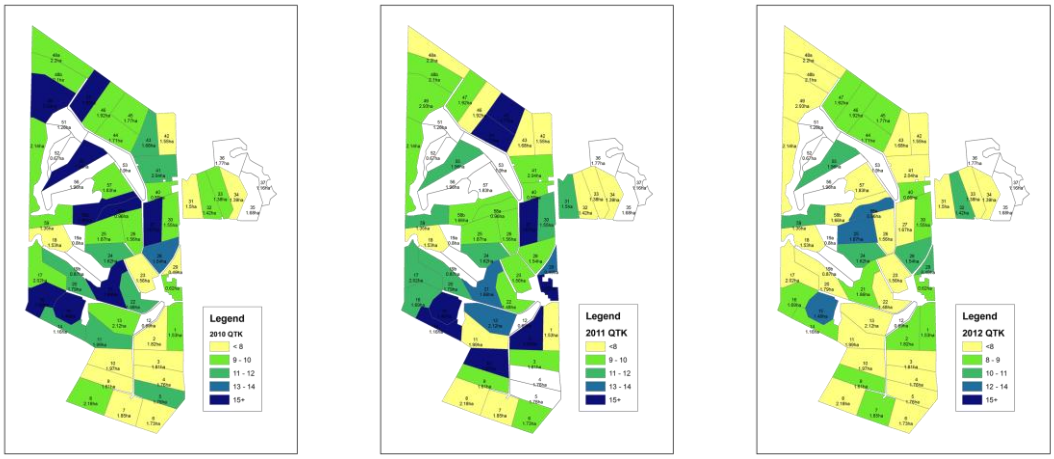
Measure

Soil test measurements were taken in October every year between 2009 and 2012 with the help of Ravensdown staff and processed at the ARL laboratory. Measurements showed the high values of Olsen P (Figure 1) across the farm existed as well as moderate Quick Test K levels (Figure 2). Individual soil test values were used to make individual paddock nutrient recommendations.



2010 2011 2012

Figure 1. Spatial distribution of Olsen P values from soil testing in 2010, 2011 and 2012



2010 2011 2012

Figure 2. Spatial distribution of Quick Test K values from soil testing in 2010, 2011 and 2012

Manage

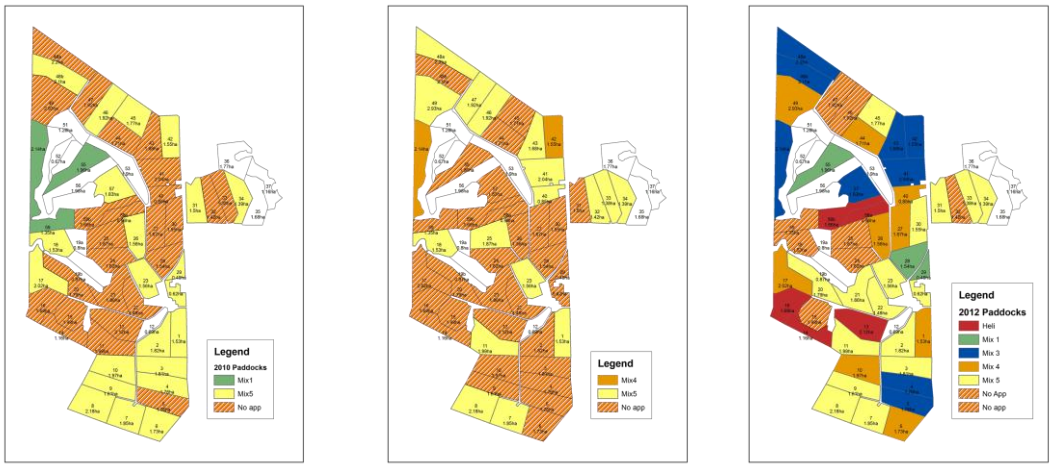
In order to manage the variation found within individual paddock soil sampling seven nutrient application programs were developed, this meant that no matter what the Olsen P or Quick Test K values were there was a fertiliser recommendation to match that aimed at achieving the target ranges set in Table 1 over time. There was a certain area of the property where heifers are grazed that had to be blanket applied using a helicopter, therefore this area was always given maintenance levels unless all paddocks in this area required no application as measured during soil sampling. If a soil test resulted in not fitting into any of the application programs it was deemed to have above optimum requirements for both P and K and therefore no application been required. Phosphorus requirements were applied using Super Phosphate (9% P) and Potassium requirements were applied using Potassium Chloride (50% K).

Table 2. Fertiliser application decision table based off individual paddock soil test values

Olsen P	QT K	Fert Mix	Nutrient Values
<40	>10	Full maintenance P, No K	50 P,0 K
<50	>10	Half maintenance P, No K	25 P, 0 K
<40	<10	Full maintenance P, Full maintenance K	50 P, 50 K
<50	<10	Half maintenance P, Full maintenance K	25 P, 50 K
>50	<10	No P, Full maintenance K	0 P, 50 K
N/A	N/A	Heifer maintenance P, Heifer maintenance K	30 P, 35 K
N/A	N/A	No Application	0 P, 0 K

Individual paddock application maps were created in a GIS system every year and loaded into Ravensdown's computer system that generated the required files to be downloaded into Sanford's Spreading trucks for on farm application. Six, three, three and six fertiliser mixes were used in 09/10, 10/11, 11/12 and 12, 13 seasons respectively. Initially in

2009/10 23% of the farm received no application of nutrients, in the 10/11 and 11/1 seasons this dramatically increased to 44% and 53% respectively, however, in the 12/13 seasons this was reduced to 9%, mainly due to the increased area that required capital Potassium.



2010 2011 2012

Figure 3. Nutrient application maps for 2010, 2011 and 2012

Review

The precision fertiliser program has delivered significant cost savings over the four year period, originally the fertiliser cost to the business was $279/ha, this has dropped to between $50 and $114 per ha, when considering the extra cost of soil sampling (nil to $34/ha) this equates to an annual saving of between $131 and $195/ha. (Table 1).

Table 3. Fertilser usage (T and $) over the four years of using the individual paddock testing and application approach

	2009/10	2010/11	2011/12	2012/13
Fertiliser apllied using current program				
Super P (T)	10.31	7.75	2.05	11.73
KCL (T)	5.12	4.1	4.05	6.47
$ Value	$8,027	$6,251	$4,213	$9,689
$/ha	$94	$74	$50	$114
Fertiiser aplied under old blanket program				
$ Fert/ha	$279	$279	$279	$279
Less aditional costs				
Soil tests ($/ha)	$34	$34	$34	$34
Program savings				
Annual Savings($/ha)	$150	$171	$195	$131
Total Savings	**$12,756**	**$14,532**	**$16,570**	**$11,094**

Both pasture and milk production over the period of the program have increased, initially at the inception of the program production was 90,000kg MS and annual pasture production was 14.54T/ha, in four years this has increased to 124,000kgMS and 18.68T/ha using similar amounts of brought in supplements (Figure 4).

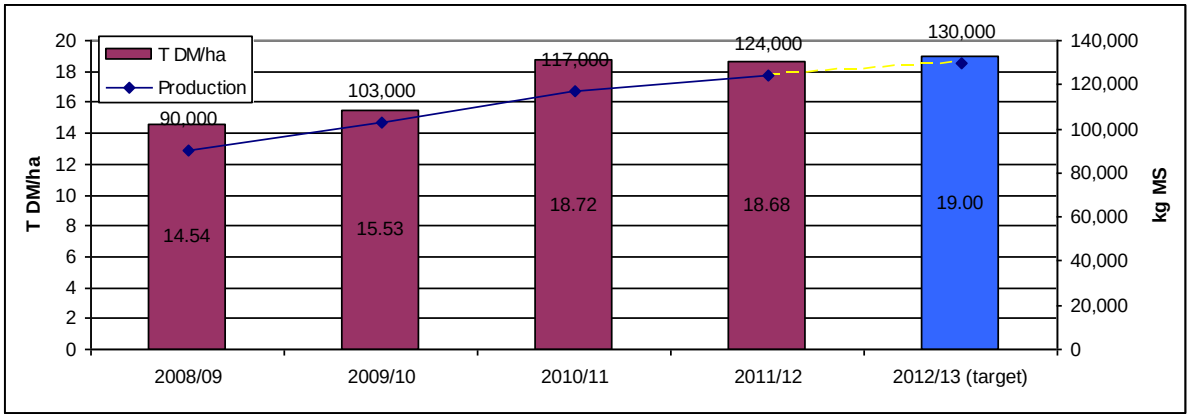


Figure 4. Pasture and Milk Soilds production over the period of the individual paddock fertiliser management program.

Discussion and Conclusion

The approach to manage nutrient status at the paddock level has had positive impacts financially with an average annual saving of $162/ha. One issue of the program that has arisen is that there is now only a limited amount of Sulphur being applied due to the lack of Super Phosphate application which has in turn seen a decline in both Sulphate S and Organic S soil test values, it was believed that this wouldn't occur due to the physical nature of the volcanic ash soils farmed on. In order to negate this issue Ammo 31(14.4% S) is blanket applied in autumn instead of urea, this ensures that Sulphur won't limit the winter/early spring growth.

Because of the high initial nutrient status of the soil it was expected that saving at the start of the program would be higher than what they would be year on year as soils became closer to achieving their target ranges for nutrient status, however, it is expected that this program will still deliver financial benefits greater than that achieved using the standard blanket application program.

The adoption of this program over a period of time has lead to less fertiliser been applied, as well as the financial benefits of this it is also seen as environmentally responsible.