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FERTILITY STATUS OF DRYSTOCK PASTURE SOILS IN NEW ZEALAND, 2009-2015

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Abstract

The fertility status of topsoils (0-7.5 cm) from drystock farms in New Zealand was assessed with respect to Olsen P, Quick Test K (QTK), sulphate-S (SO_4-S), and pH for the period 2009-2015, focusing on the proportion of farms under optimal soil test categories. The soils were grouped according to soil types namely: Sedimentary, Ash, Pumice and Peat (Organic). The proportion of farms with optimum soil test values during the 7-year period fluctuated as follows: QTK [Sedimentary (32-36%); Ash (23-28%); Pumice (11-20%); Peat (15-30%)]; Olsen P [Sedimentary (26-30%), Ash (25-28%), Pumice (11-20%), Peat (8-25%)]; SO_4-S [Sedimentary (7-10%), Ash (9-11%), Pumice (11-20%), Peat (<10%)]. For pH, between 18-26% of the farms are in the optimum range for inorganic soils and quite similar to the Peat soils (15-33%). More than 30% of the inorganic soil types are below the optimum pH range while it was only 10% or less for Peat soils. Considerable opportunities exist for optimising levels of the nutrients P and S, and pH values in drystock inorganic soils which have been historically underfertilised/unlimed.

Introduction

Monitoring of historical soil test data over time allows us to track changes in soil fertility levels and determine if fertility is being maintained, improving or declining (either deficient or excessive status). Managing nutrient levels at or close to the optimum range is economically and environmentally justifiable because at these levels, optimum pasture growth from the nutrient applied is realised. On the other hand, if soil test levels are below the optimum, this under-fertilisation leads to low productivity while over-fertilisation results in a waste of money and environmental pollution. Wheeler et al. (2004) reported trends in soil test data for New Zealand pastoral farms over a 14-year period (1988-2001) with respect to pH, phosphorus, potassium, calcium and magnesium. They concluded that, on average, soil fertility levels are not being depleted with the exception of the nutrient magnesium. They suggested that maintenance magnesium applications should become part of the farmer's regular fertiliser programme so that depletion is avoided. Since drystock (sheep and beef) farms are generally underfertilised, they suggested raising phosphorus levels on these farms. On the other hand, dairy farms which are heavily fertilised should reduce their phosphorus application without reducing production. This report aims to provide an evaluation of how well soil nutrient levels are being managed by Ballance drystock customers throughout New Zealand over a 7-year period (2009-2015) focusing on the proportion of farms in the optimum soil test range.

Methods

Ballance customer soil test data of drystock farms from 2009 to 2015 which consist of topsoil (0-7.5 cm) quick test potassium (QTK), Olsen phosphorus (Olsen P), sulphate sulphur (SO_4-S) and pH were obtained from Hill Laboratories in Hamilton. The data sets were grouped according soil type (viz. Sedimentary, Ash, Pumice and Peat (Organic)). Soil test units are as follows: QTK (MAF units, mg/kg); Olsen P (mg/L); SO_4-S (mg/kg) and pH (unitless). Yearly summary statistics for each soil type grouping were computed (but not shown due to space limitations). These include the number of samples, mean, median, standard deviation, minimum, maximum and coefficient of variation (CV). Soil test categories with appropriate ranges for each soil type were used (Table 1). These classes are: low, below optimum, optimum, above optimum and high. Optimal soil test category ranges were based on Morton and Roberts (2009) and Anonymous (2016) with slight modifications. For each year, the percentage of farms within each soil test category was computed. One of the limitations of the data set was it covered only a 7-year period (2009-2015). Also, within each year, the number of soil tests conducted varied which means some are repeat analysis from the same property and some tests are only conducted on a particular year, or both.

Table 1. Soil test categories used for QTK, Olsen P, SO_4-S and pH by soil type.

Soil test category	QTK	Olsen P	SO_4-S	pH
		Sedimentary		
Low	<3	<15	<5	<5.5
Below optimum	3-5	15-25	5-10	5.5-5.8
Optimum	5-8	25-40	10-12	5.8-6.0
Above optimum	8-13	40-50	12-15	6.0-6.3
High	>13	>50	>15	>6.3
		Ash		
Low	<4	<15	<5	<5.5
Below optimum	4-7	15-25	5-10	5.5-5.8
Optimum	7-10	25-40	10-12	5.8-6.0
Above optimum	10-15	40-50	12-15	6.0-6.3
High	>15	>50	>15	>6.3
		Pumice		
Low	<4	<25	<5	<5.5
Below optimum	4-7	25-35	5-10	5.5-5.8
Optimum	7-10	35-50	10-12	5.8-6.0
Above optimum	10-15	50-60	12-15	6.0-6.3
High	>15	>60	>15	>6.3
		Peat		
Low	<3	<25	<5	<4.5
Below optimum	3-5	25-35	5-10	4.5-5.0
Optimum	5-7	35-50	10-12	5.0-5.5
Above optimum	7-12	50-60	12-15	5.5-6.0
High	>12	>60	>15	>6.0

Results and Discussion

Proportion of farms under the various soil test categories

Figures 1 to 4 show the temporal trends in the proportion of farms under the various soil test categories for drystock soils by soil type. Figure 1 shows that for QTK in drystock **Sedimentary soils**, about 32-36% of the farms are in the optimal range while between 15-23% are below the optimum range. For Olsen P, the proportion of farms in the optimal range fluctuated narrowly (26-30%) which is similar to the fluctuation in the proportion of farms below the optimum (36-39%). The proportion of farms above the optimum was minimal (5-6%) which means that excessive soil phosphorus is not a concern on this soil type. For SO_4-S, the proportion of farms in the optimal range was only 7-10%. In contrast, the proportion of farms below the optimum range was quite high (40-45%). The proportion of farms above the optimum was only 5-10%. For pH, the proportion of farms in the optimum range increased from 18% to 25% indicating a good trend. However, between 28-32% of the farms belong to the below optimum range. The proportion of farms above the optimum range increased from 20% to 25%.

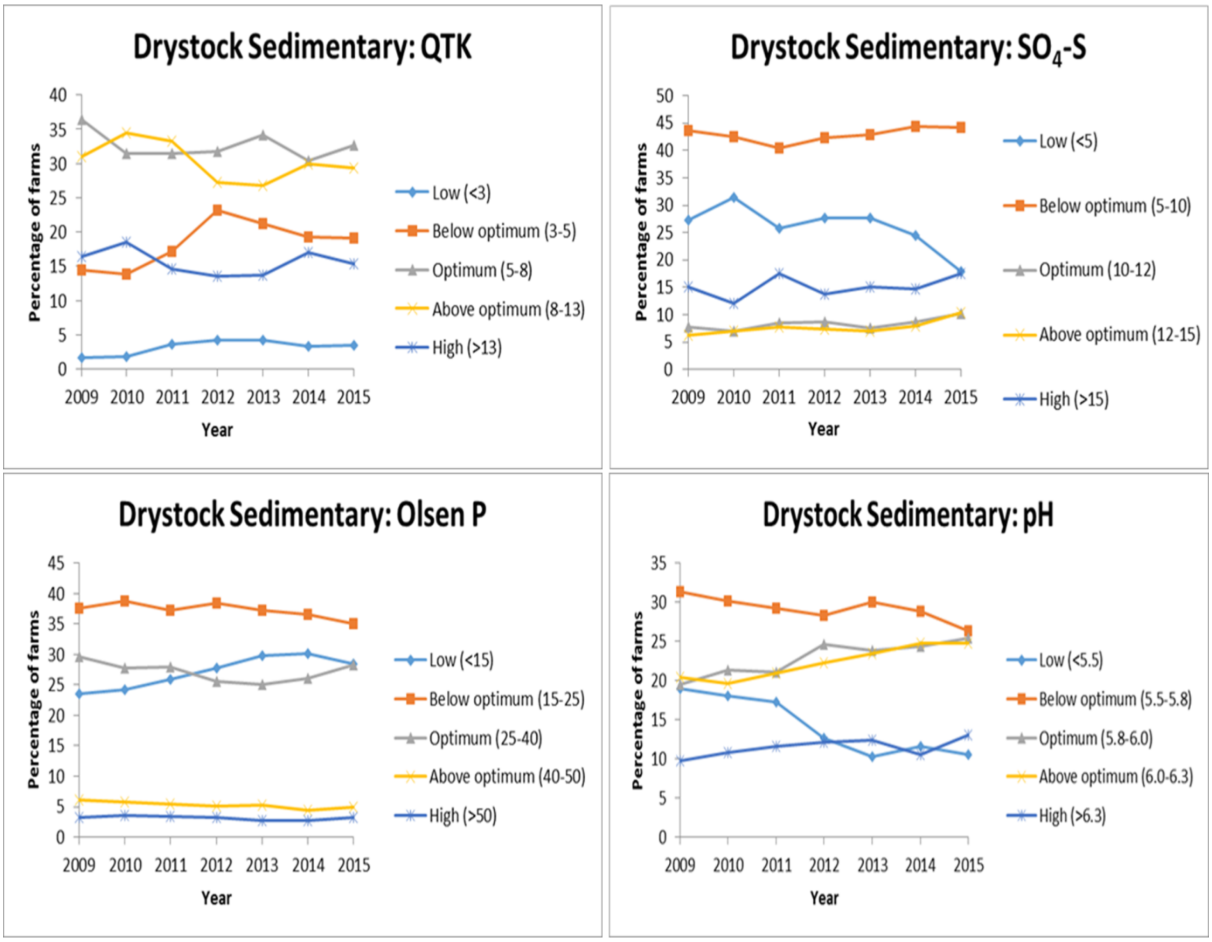

Figure 1. Percentage of drystock farms under various soil test categories for QTK, Olsen P, SO_4-S and pH: Sedimentary soils.

Figure 2 shows that for QTK in drystock **Ash soils**, the proportion of farms in the optimum range declined over time from 28% to about 23%. The proportion of farms in the below optimum category fluctuated greatly (28-40%) while the proportion above the optimum range fluctuated narrowly (17-23%). For Olsen P, little change in the proportion of farms in the optimum range was observed (25-28%) while it was largely constant (32-33%) for the below optimum category. The proportion of Olsen P in the above optimum category was between 5-8% only. For SO_4-S the proportion of farms in the optimum range was low but stable (9-11%). Considerable fluctuations (28-40%) were observed for the proportion of farms below the optimum range. These percentages are on the high side. The proportion of farms above the optimum range lies between 10-12% only. For pH, about 23-26% of the farms are in the optimum range while a considerable proportion (36-41%) is in the below optimum range indicating a need for lime. About 17-21% of the farms are in the above optimum range.

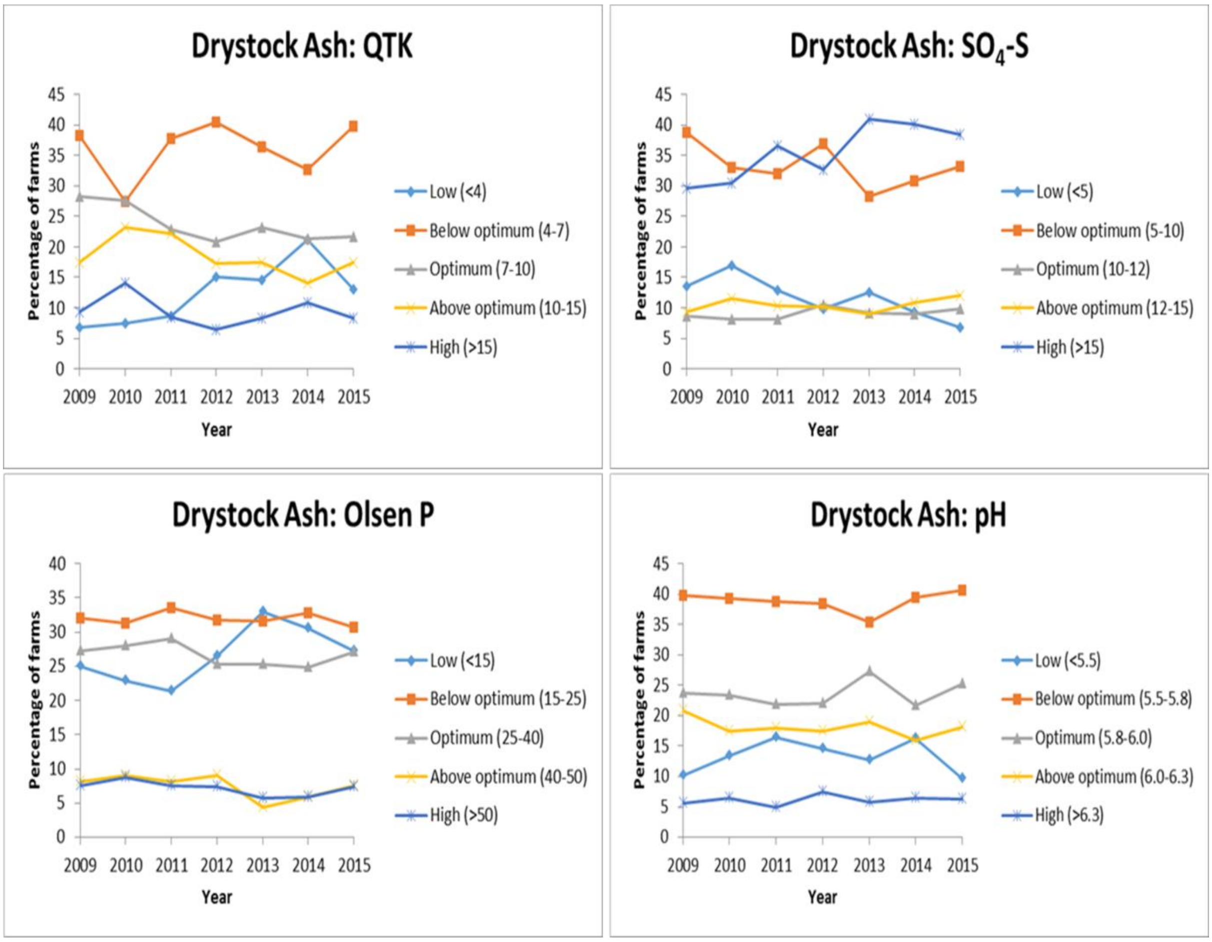

Figure 2. Percentage of drystock farms under various soil test categories for QTK, Olsen P, SO_4-S and pH: Ash soils.

Figure 3 shows that for QTK, the proportion of farms in drystock **Pumice soils** within the optimal range fluctuated through the years and varied from 11-20%. The proportion of farms below the optimum declined considerably from 55% in 2009 to 37% in 2012 which represents an improvement. However, it started to increase again reaching 43% in 2015 which is substantial. The proportion of farms above the optimum ranged from 5-7% only. For Olsen P, the proportion of farms in the optimal ranged from 16-20% while the proportion of farms below the optimum ranged from 18-21%. The proportion of farms above the optimum range was a mere 5-7%. For SO_4-S, the proportion of farms in the optimal range was low (1-8%) while a considerable proportion of the farms (47-57%) belong to the below optimum range. For pH, the proportion of farms in the optimal range varied from 18-24%. A gradual increase in the proportion of farms in the below optimal range occurred from 2009 (39%) to 2014 (50%) then decreased later in 2015 (45%). The proportion of farms with pH above the optimum range was in the range of 10-18%.

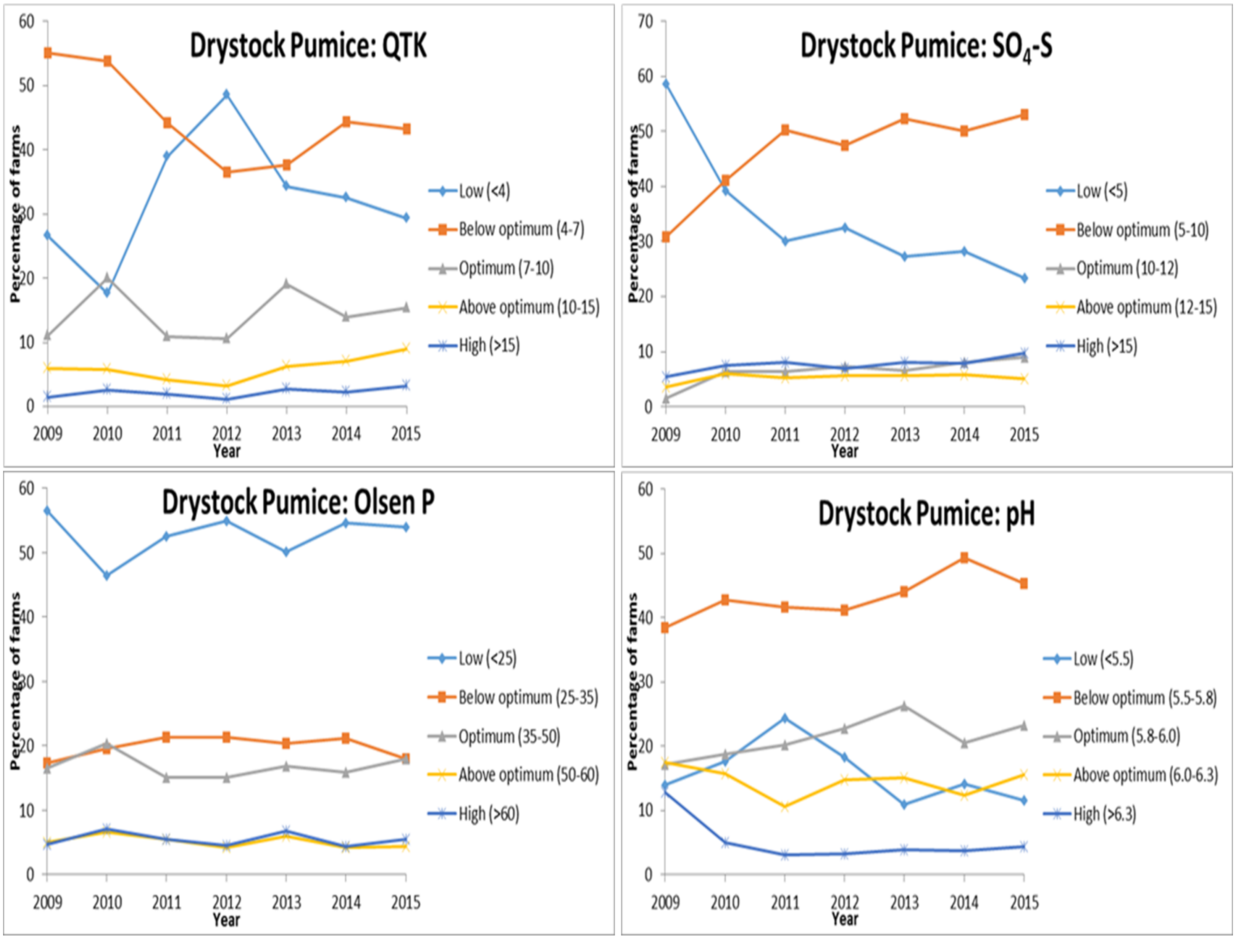

Figure 3. Percentage of drystock farms under various soil test categories for QTK, Olsen P, SO_4-S and pH: Pumice soils.

Figure 4 shows that the proportion of farms in drystock **Peat soils** in the optimum range for QTK fluctuated considerably (15-30%). The same is true for the proportion of farms below the optimum range which fluctuated from 30-48% in the first 3 years (2009-2011). Thereafter, it declined sharply to about 25% in 2015. The proportion of farms above the optimum QTK ranged from 18-30%. For Olsen P, the proportion of farms in the optimum range fluctuated greatly through the years (8-25%). The proportion of farms in the below optimum range was 17-23% which is lower relative to the mineral soils. The proportion of farms in the above optimum range varied from 5-13% which is good. For SO_4-S, the proportion of farms in the optimum range was below 10% throughout the 7-year period. The proportion of farms in the below optimum range fluctuated greatly (10-48%). The proportion of farms above the optimum range was less than 10% to 17%. For pH, there was considerable fluctuation in the proportion of farms in the optimum range throughout the 7-year period (15-33%). The proportion of farms in the below optimal range was 10% or less which is really good. The proportion of farms in the above optimum range was initially high (58%) but declined steadily towards the end (down to about 30%).

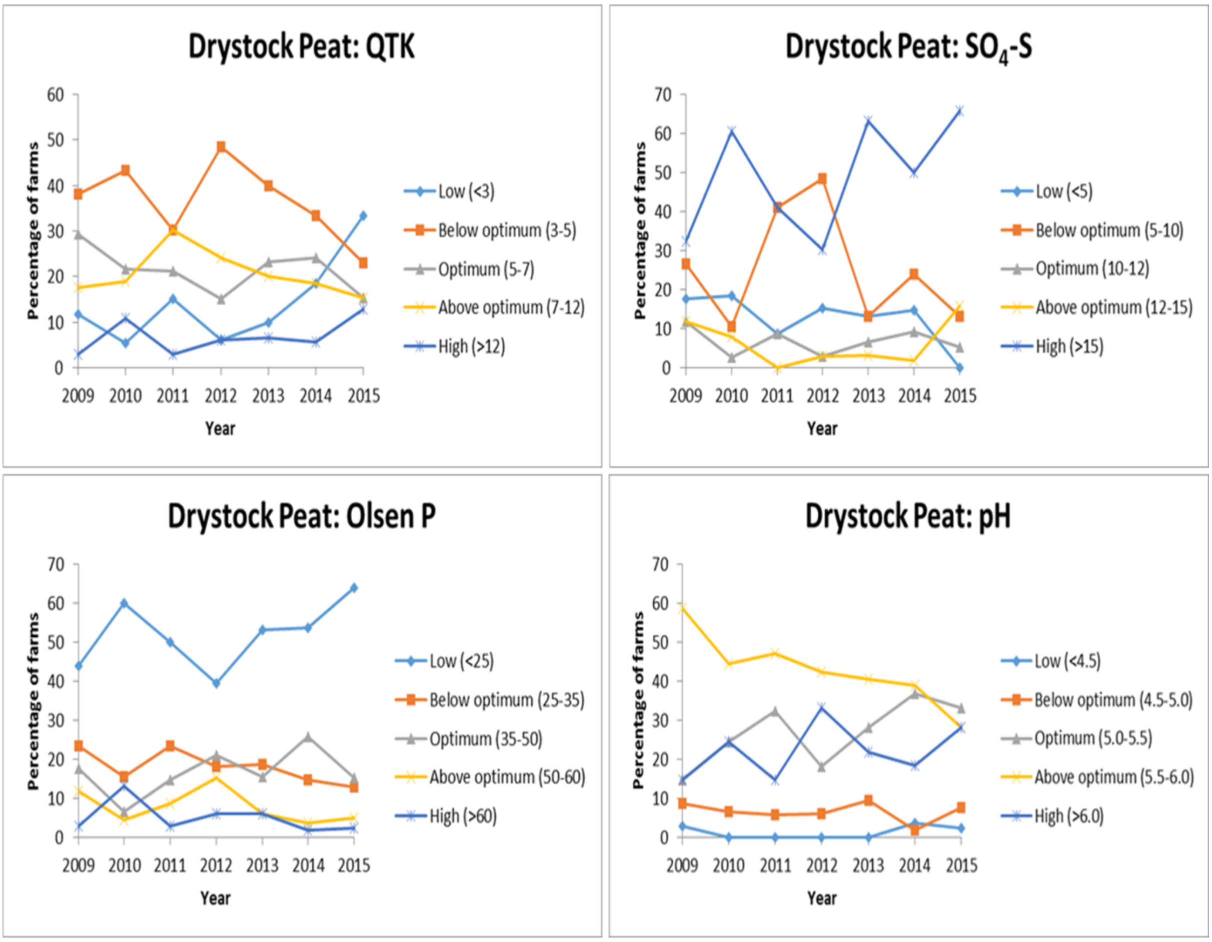

Figure 4. Percentage of drystock farms under various soil test categories for QTK, Olsen P, SO_4-S and pH: Peat soils.

Opportunities for optimising soil test values in drystock soils

It is a well-known principle that for a farming system to be sustainable, the nutrients leaving the farm must be replaced. On the other hand, if nutrients are accumulating in the soil above the optimum levels, fertilisation may have to be withheld for some time. The foregoing results indicate that as far as optimising soil test values, there is opportunity to optimise nutrient levels in drystock soils because they have been historically underfertilised especially with respect to P and S. Morton (2014) considers that within the drystock sector, it is hill country that is the most vulnerable. As measured in long term grazing experiments and observed on farms, annual fertiliser application is required on hill country pastures if productivity and profitability is to be sustained. The economic implication of optimising soil test values has been discussed by Mladenov (2016) who summarised the soil fertility sampling work done by Mackay and Costall (2016) of AgResearch on the Ballantrae Hill Country Research Station in southern Hawke's Bay, a long-term P trial established back in 1980. Average sulphate-S levels for the control, low and high P treatments were 6, 9 and 11 mg/kg, respectively reflecting the fact that the P-fertilised treatments received annual S inputs provided by the superphosphate application although the authors noted that high leaching losses of S in the P-fertilised treatments resulted in little S accumulating in the soil over the last 40 years. This reflects the low anion storage capacity of the soil. Soil pH did not differ significantly at 5.5, 5.4 and 5.2, respectively. Potassium has shown little change, except for increases on low slope areas in the high P treatment.

Annual applications of 125 and 275 kg/ha of single superphosphate increased annual pasture production by 40% and 63%, respectively in the 2015/16 period. Using the extra pasture produced, sheep stocking rates increased by 50% and 120%, respectively. Average Olsen P level in the control treatment were 6 mg/kg (well below the optimum range for Sedimentary and Ash soils) while Olsen P levels on P fertilised farmlets were 13 and 49 mg/kg, respectively. These results show that for drystock farming P fertilisation alone can increase soil fertility, pasture production and quality, and the carrying capacity of the land. This can mean a difference of tens, or even hundreds of thousands of dollars in profit between low and high performing drystock farms throughout New Zealand (Mladenov 2016).

Conclusion

Considerable opportunities exist for optimising levels of the nutrients P and S, and pH values in drystock inorganic soils which have been historically underfertilised/unlimed.

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