BRIEF COMMUNICATION: Conventional or Albrecht-Kinsey fertiliser approach in a commercial-scale dairy farm systems comparison

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Abstract

Long-standing questions around application of nutrients other than N, P and K (such as Mg and Ca), to meet either plant or soil requirements have been tested for the first time at a commercial dairy-farm-scale. Two dairy farms with similar soil type and soil management history were used to compare physical and financial productivity when the fertiliser regime followed either a conventional plant requirement approach (CON) or an Albrecht-Kinsey soil requirement approach (A-K). A longitudinal study commencing in 2012/13 included measurements of pasture and animal production, fertility and quality, and animal health. After six years there are no apparent impacts of fertiliser regime on milk yield or pasture growth, although less N fertiliser was applied on the A-K farm and this farm grew more clover. Though not statistically significant, there were more in-calf cows and fewer metabolic problems pre- and post- calving in the A-K farm system compared with the CON system. Setting up and maintaining the soils at target parameters cost more (+$532/ha fertiliser costs in the first year; +$197 in the last two years), but animal health costs were on average $56/ha/yr lower.

Keywords: biological; base cation saturation ratio

Introduction

In 2012 Methven farmers Casey and Solly converted cropping land into two irrigated dairy farms. With environmental constraints looming and a strong desire to farm healthy and productive animals the farmers wanted to adopt an appropriate farming system which would equally attend to financial, environmental and social best practise goals. For Methven farmers it was the promise of improved animal health and lower, long term, fertiliser inputs that inspired the risk to convert one of their two dairy farms into using an Albrecht based fertiliser regime. William Albrecht hypothesised that the links between soil, plant, animal and ultimately human health were inseparable (Albrecht 2013). Albrecht believed that fertilisers should not simply focus on feeding plants, as this approach was too short sighted (Kinsey and Waters 2013). The Albrecht, and later Kinsey, system of soil fertility (A-K), uses the relationship between the physical structure of a soil and its exchange capacity and base saturation percentage (cations calcium, magnesium, potassium and sodium) for optimum plant growth. Since Ca and Mg are the influential cations for soil structure, they are addressed first in their A-K fertiliser policy. However, it was the lack of independent information supporting Albrecht's hypotheses, particularly for pastoral farming systems, which prevented Methven farmers from converting the entire area into a single fertiliser approach. Instead, they chose to adopt both fertiliser approaches to better understand whether differences between the two farm systems would emerge. The purpose of this study is to compare the effect of soil fertiliser management on animal production and health on two commercial dairy farms.

Materials and methods

The properties, Waiora (conventional fertiliser, CON) and Whakapono (Albrecht-Kinsey fertiliser, A-K) are situated on Lyndhurst Silt Loams near Methven in Canterbury and before they were purchased for dairy conversion had been used for arable production under the same ownership/management and with similar cropping history for many years. Whakapono is 165 hectares in area and Waiora 221 hectares. The comparison of the two farms commenced in 2012 as a longitudinal, non-replicated study. Both farms have carried a similar stocking rate throughout, which was reduced from 3.6 to 3.3 cows per ha to increase the proportion of pasture in the diet. The herds were initially stratified to ensure that age structure, body condition score (BCS), liveweight (LW), productive worth (PW) and breeding worth (BW) of animals on each property were as similar as possible. Replacement heifers are grown off-farm, but rejoin the treatment farm on which they were born. Farm staff rotate between both farms to ensure that differences in performance do not reflect differences in staff capability. An advisory committee was appointed in 2013 to support farm decision rules and consider variables which may influence the outcomes and conclusions made.

Soil testing takes place annually in August (in July in 2016) with samples collected to 15 cm depth from three paddocks in each system (balanced by physical, chemical and previous management similarities) and are subsequently sent to Hills Laboratories in New Zealand. Fertiliser recommendations, for each farm, are based on separate farm soil test results collected from individual paddocks and sent to NZ and overseas (USA) testing labs, and are provided by soil consultants representative of each regime. Initial applications for the A-K treatment were large to rapidly meet soil target specifications for Mg and Ca content and cation/anion proportions.

In addition to annual soil fertility tests, measurements included pasture production from weekly pasture walks, seasonal botanical composition, milk production, animal health records for number of metabolic issues and reproductive performance. An independent farm consulting business collated the results and compared the physical and economic performance of the farms each year. The impact of fertiliser regime on soils, plants and animals were compared by performing a t-test across years.

Results and discussion

In the first three seasons after the farms were converted, large inputs of fertilisers were applied to the A-K farm to alter the soils to their desired status as quickly as possible for the purpose of the farm comparison (Table 1). Normally this change would be more gradual to pose less of a financial burden to the land owners. The extent to which altering nutrient management impacts on fertiliser cost will depend on soil type and previous management history. In this comparison, soils had been previously cropped under regular tillage which required some adjustment to a dairy pastoral set up on both farms with their respective fertiliser regimes. This led to higher fertiliser costs in the first two seasons on the A-K farm compared with the CON farm ($1,337/ha and $805/ha, respectively). Over time, on average 30 kg N/ha/yr more N fertiliser has been applied to CON than A-K (Table 1) though the overall rates of N (130-190 kg N/ha on CON; 80-150 on A-K) are low by regional standards on both farms. Soil results based on conventional soil test methods are presented for each farm in Table 1. Soil pH, Ca, K and cation exchange capacity are similar for both farms. For the A-K farm, Mg is considerably higher and Olsen P values are 10% lower compared with the CON farm, with more recent soil tests showing a greater divergence in Olsen P levels. American laboratory results using Kinsey Albrecht methods for monitor paddocks in the CON and A-K farms measured a total cation exchange capacity of 11% for both farms, with respectively 73 and 69% for Ca, 8 and 14% for Mg and both 3% for K. In the last two seasons the difference in fertiliser costs has been smaller: $628/ha for A-K and $431/ha for CON.

Table 1 Fertiliser history, (sum of nutrients applied between 2012 and 2018), soil chemistry and physical performance of a commercial dairy farm operated using a conventional fertiliser management regime (Waiora – CON) or an alternative Albrecht-Kinsey fertiliser management regime (Whakapono – A-K). Means and standard errors (in brackets) for four years: 2014/15 to 2017/18.

	Waiora – CON	Whakapono – A-K	P value
Effective Area	210	155	
Nutrients applied (kg/ha)			
Nitrogen	946	770	
Potassium	323	428	
Phosphorus	251	187	
Sulphur	381	970	
Magnesium	133	328	
Calcium	486	1106	
Soil chemistry			
Soil pH	6.3 (0.1)	6.2 (0.1)	0.267
Total C (%)	2.9 (0.1)	3 (0)	0.171
CEC (me/100 g)	14.4 (0.2)	14.7 (0.1)	0.238
AMN (μg/g)	91.8 (6.8)	93.8 (4.7)	0.823
K (MAF)	5.2 (0.4)	5.4 (0.6)	0.734
Olsen P (mg/L)	14.9 (0.6)	12.6 (0.4)	**0.015**
Sulphur (mg/kg)	9.9 (0.9)	17.2 (2.3)	**0.008**
Mg (MAF)	14.8 (1.1)	26.9 (0.3)	0.000
Ca (MAF)	9.1 (0.4)	8.2 (0.2)	0.067
Stocking Rate (cows/ha)	3.3 (0.1)	3.3 (0.1)	0.881
Peak Cows	691 (22.9)	516 (14.5)	
Total milk solids (kg MS/ha)	1563 (85)	1609 (68)	0.691
Total MS/Cow (incl. calf milk)	483 (12)	491 (12)	0.653
Total N Applied (kg/ha)	151 (15)	115 (14)	0.126
Total Pasture Grown (T DM/ha)	14.3 (0.4)	14.2 (0.3)	0.834
Clover (% DM)	10.1 (1.3)	16.3 (0.3)	**0.004**
Supplements offered (kg DM/cow)	774 (114)	766 (75)	0.952
N Leaching (kg/ha)	35 (3)	33 (3)	0.628
Empty Rate %	13.3 (1.2)	11.5 (1.3)	0.362
Downer cows %	7.2 (0.9)	5.5 (1.3)	0.319

Where AMN is anaerobically mineralisable nitrogen, CEC is cation exchange capacity, DM is dry matter, and MAF is the MAF quick test. Note: soil test results from conventional soil test methods taken at 15 cm depth from three monitor paddocks on each farm.

A noticeable difference between the two farms for farmers/owners over the past two to three seasons has been the improved reproductive performance and fewer health issues at calving for A-K (Table 1). The greater soil Mg level on the A-K farm is likely to explain some of the differences in animal health. Generally plant Mg requirements are met at soil Mg levels of 8-10, but meeting animal Mg requirements would require soil Mg levels of 25-30 (Edmeades 2004) which is reflected in the Mg values observed for the A-K farm. The difference in percentage of cows affected is not statistically significant, but more preventative and reactive treatments have been required on the CON farm to treat a greater proportion of cows struggling with mineral imbalances at calving. For instance, on both farms, cows are supplemented with a Mg supplement which is dusted on the pasture of the pre-calving cows. Yet, once cows on the A-K farm have calved the cows no longer require the additional Mg, in contrast to the CON farm which continues dusting to avoid metabolic problems. Consequently, the health and reproductive costs are between $50-100/ha/yr less for A-K than for CON.

Using common production benchmarks, the two farms are remarkably similar in productivity (Table 1) with similar pasture and milk production on both farms. Botanical composition of pastures revealed dominance of ryegrass in both farms with few weeds (data not shown) and more clover on the A-K than the CON farm (Table 1). The greater clover content in the A-K could be explained by the lower N fertiliser rate on this farm.

This is the first farmer-driven farm systems comparison at this scale (>1000 cows and >300 ha) in New Zealand, and perhaps globally. Although conclusions about the impact of soil fertiliser regime on animal health are premature, at the farm scale any differences in pasture and animal productivity associated with fertiliser policy, are not apparent from current measures.

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References

Albrecht WA 2013. Soil fertility and human and animal health. The Albrecht Papers, Volume 8. Ed. Walters C. Published by Acres USA, Austin, Texas U.S.A.

Edmeades DC 2004. The magnesium requirements of pastures in New Zealand: A review, New Zealand Journal of Agricultural Research, 47: 363-380.

Kinsey N, Waters C 2013. Hands-on Agronomy: Understanding soil fertility and fertiliser use. 3rd Ed. Greeley, Colorado, Acres USA. 352pp.