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ZONAL DIFFERENCES IN SOIL FERTILITY ON CANTERBURY DAIRY FARMS

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Abstract

During the past two decades there has been an exponential increase in the number of dairy conversions in Canterbury. Many factors have been considered when creating the design and layout of these farms. These considerations have led to the majority of recently converted farms being designed to have large, long and sometimes narrow paddocks. In recent times Ravensdown Agri Managers and their customers have observed that pasture quality, persistence, composition, growth rate, fertiliser response, irrigation response, drought tolerance, insect and disease pressure can vary greatly within these paddocks. These paddocks often performing better at the cow laneway (front) ends and under performing at the ends furthest from the cow laneways (back).

Grazing practices and animal behaviour mean animals are spending more time in the front ends of these paddocks which results in disproportionate distribution of excreta. Nutrient transfer from the back to the front is the likely cause of differences observed in pasture performance between the front and back of the paddocks.

Soil samples were collected from two farms to quantify nutrient transfer. Paddocks were split into back, middle and frontal zones and sampled accordingly. Over the two farms significant differences between zones were observed for pH, Ca, Mg, K and Na in the 0 – 7.5 cm soil layer. Olsen P showed a trend on one farm but data from the second were not utilised since zonal differential P fertilisation is already practiced to counter effects of nutrient transfer. Subsurface 7.5 – 15 cm soil samples from one property showed zonal differences established for P, K, Mg and Na over a period of 10 years.

Mean differences between back and frontal zones for the 0 – 7.5 cm soil layer are 25 kg/ha Mg and 42 kg/ha K, while the gradient in the 7.5 – 15 cm soil layer are 17 kg/ha Mg and 17 kg/ha K.

Economic and environmental considerations necessitate these changes over time be taken into account in order to optimise nutrient management under these intensive farming systems. This may require zonal sampling within paddocks to guide variable rate fertiliser applications within dairy paddocks.

Introduction

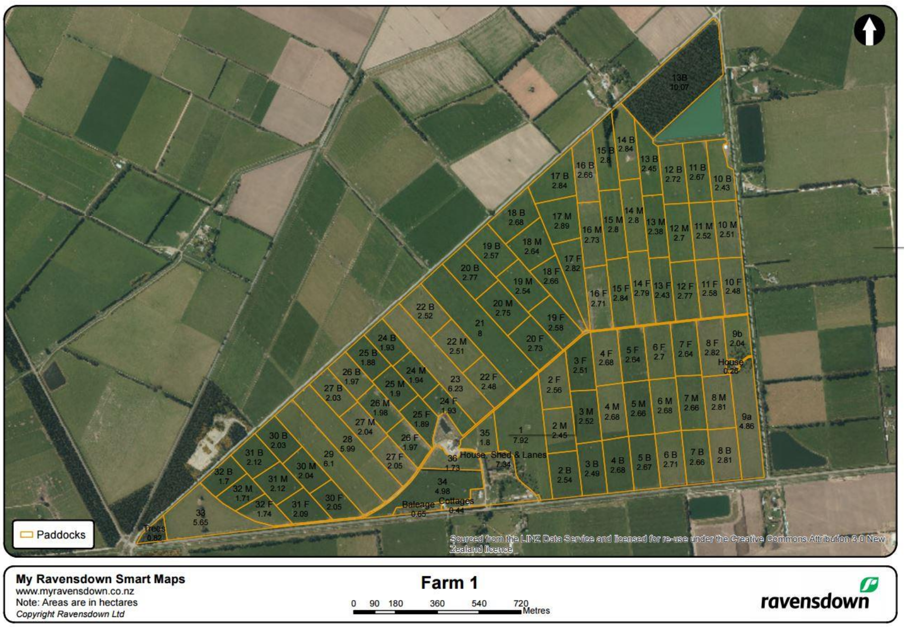
Plant nutrient transfer through animal dung and urine between grazing paddocks and within paddocks with different topographical features have been reported (Goodall, 1951; Weeda, 1979; Williams & Haynes, 1990). During the past two decades there have been an exponential increase in the number of dairy conversions in Canterbury on the plains where topography has no role to play in animal behavior. Many factors have been considered when creating the design and layout of these farms resulting in the majority of recently converted farms being designed to have large, long and sometimes narrow paddocks. In recent times Ravensdown Agri Managers and their customers have observed that pasture quality, persistence, composition, growth rate, fertiliser response, irrigation response, drought tolerance, insect and disease pressure can vary greatly within these paddocks. These paddocks often performing better at the cow laneway (front) ends and under performing at the ends furthest from the cow laneways (back).

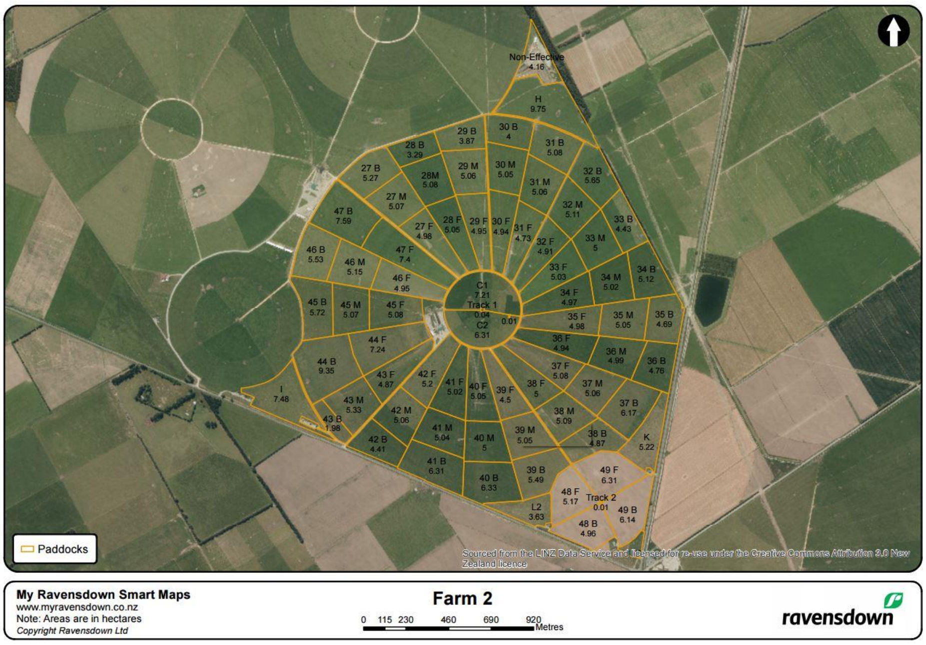
Grazing practices and animal behavior mean animals are spending more time in the front ends of these paddocks which results in disproportionate distribution of excreta. Nutrient transfer from the back to the front is the likely cause of differences observed in pasture performance between the front and back of the paddocks. Similar observations were made in Australia where nutrient transfer within dairy grazing paddocks created a nutrient gradient which resulted in higher nutrient levels recorded at the front or gate end of strip grazed paddocks (Aarons *et al.* 2015).

The objective of this investigation was to demonstrate and quantify nutrient transfer from the back to frontal zones of dairy paddocks in Canterbury.

Survey farms

Two Canterbury dairy farms which converted to intensive dairy enterprises 10 years ago were chosen to conduct a soil fertility survey on. Both have long narrow paddocks on level terrain ranging in size from 1.73 to 16.6 ha. Farm one has a stocking rate of 3.4 cows/ha, annual pasture production of 18.6 ton DM/ha and 1600 kg Ms/ha, while farm two has a stocking rate of 3.4 cows/ha, annual pasture production of 17.2 ton DM/ha and 1670 kg MS/ha.





Soil sampling methods and chemical analysis

Paddocks were divided in thirds, front, middle and back, with soil sampling transects running diagonally across each zone. Samples were collected from the 0 – 7.5 cm and 7.5 – 15 cm soil layers.

Soil samples were dried and ground to pass a 2 mm screen followed by measuring pH (water), Olsen P and the basic cations in 1 m ammonium acetate.

Results

Significant differences in nutrient status over the two farms between the back and frontal zones for the 0 – 7.5 cm soil layer were observed for Ca, Mg, K and Na indicating that intra paddock nutrient transfer is taking place on Canterbury dairy farms (Table 1). K and Na are mostly excreted in urine (Barrow, 1987) and with the small amount of these elements present in the soil and the high concentration of K in pasture relative small quantities transferred can create a nutrient gradient between back and frontal zones. Unlike with Ca where there are large quantities in the soil and low concentrations relative to K in pasture consumed it is unlikely that significant transfer of Ca will be observed over the short term. Olsen P showed a trend on one farm for the 0 – 7.5 cm soil layer but data from the second was not utilised since zonal differential P fertilisation is already practiced to counter effects of nutrient transfer.

Table 1. Summary of soil results for the 0 – 7.5 cm soil layer.

Zone	pH	MAF QT Ca	MAF QT Mg	MAF QT K	MAF QT Na
Back		11.0	16.4	4.6	5.1
Middle		11.5	20.1	6.8	5.6
Front		12.1	23.0	6.7	6.4
P		NS	<0.001	<0.001	<0.001
LSD$_{(p = 0.05)}$		-	2	1	0.5

Over the two farms it was also observed that gradients in concentrations of P, K, Mg and Na have been established in the 7.5 – 15 cm soil layer signifying that the pasture was either unable to intercept the additional nutrients deposited or that there is the possibility of leaching losses resulting in lost opportunity for nutrient utilisation (Table 2).

Table 2. Summary of soil results for the 7.5 – 15 cm soil layer.

Zone	pH	Olsen P mg/ml	MAF QT Ca	MAF QT Mg	MAF QT K	MAF QT Na
Back	5.8	17.2	10.3	11.4	3.7	2.8
Middle	5.8	20.5	10.8	14.4	4.7	3.1
Front	5.8	23.0	10.7	15.8	5.1	3.7
P	NS	0.002	NS	<0.001	0.01	0.01
$LSD_{(p = 0.05)}$	-	3.1	-	1.5	0.9	0.6

Calculated mean differences in nutrient content between back and frontal zones over the two farms were 25 kg/ha Mg and 42 kg/ha K for the 0 – 7.5 cm soil layer and 17 kg/ha Mg and 17 kg/ha K for the 7.5 – 15 cm soil layer. These differences in nutrient distribution support the observed differences in pasture production between back and frontal zones.

Recommendations and proposed future work

Economic and environmental considerations necessitate these changes over time be taken into account in order to optimise nutrient management under these intensive farming systems. This may require zonal sampling within paddocks to guide variable rate fertiliser applications within dairy paddocks.

Awareness and appropriate management of the nutrient transfer phenomenon can contribute to optimal utilisation of resources and improved environmental stewardship.

A limited number of pasture samples exhibited trends for nutrient differences between back and frontal zones. It is proposed that more intensive sampling similar to the extent for soil be done to quantify the differences in pasture production and nutrient content.

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