Case study to improve soils and pasture affected by salinity

Longwarry North 2017

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Salinity Management on a dairy farm at Longwarry North

Introduction

The aim of this one-year sustainable agriculture project was to increase the understanding of managing sodic and saline soils through drainage, soil chemistry modification and the planting of salt tolerant pasture species.

The demonstration consisted of improving drainage to remove water from the salinity area, improving soil chemistry balance and sowing salt scalds with a salt tolerant fescue species.

The trial site is situated on a 140ha dairy farm at Longwarry North. The two paddocks suffering salinity problems are approximately 3.5ha each in size and are divided by a nine year old native shelterbelt. The shelterbelt was designed to assist in lowering the water table, however to date, the trees haven't been able to do this. A salinity test well was drilled in 2007 and is located within the plantation. Rocky Murdica (farm owner) monitors the salt and water table levels on an irregular basis.

Initial assessment of the paddock displayed a variable pasture with only moderate productivity. In the most salt affected areas, there was either bare ground or salt indicator species such as buckshorn plantain and yellow buttons. It was also observed that root growth was inhibited at 120mm.

The soils in this area are described as magnesic grey to yellow kurolsols and are derived from recent geological sediments. These loam based soils have a poor structure with low-lying areas prone to water ponding. They tend to have high levels of organic matter. They are generally used for grazing of both dairy and beef herds.

Rocky and Greg Murdica in the trial paddock

Demonstration site establishment

One of the 3.5ha paddocks was divided with an electric tape to separate the most salt affected areas (1.5ha) and a soil test was taken to determine benchmark nutrient levels. In August 2014 several shallow drains were dug to remove water that was ponding on the surface. In Feb/March 2015 8m^3/ha of poultry (broiler) manure and 250kg/ha of DAP was applied to the 1.5ha salinity area of the paddock as recommended by DEDJTR. Buchan lime was also applied at 2.5t/ha and the paddock disced and then Fescue was sown at a rate of 25kg/ha. After sowing Broadstrike herbicide was used to control chickweed and Amicide 700 applied to control stinging nettles.

Rocky measuring ground water table depth

Buckshorn plantain, yellow buttons and bare ground in the trial paddock

Waterlogging in the paddock before the drainage lines were established

One of the drainage lines working well

Cultivation and sowing of the fescue

Peter Ronalds (project manager) and Rocky Murdica (dairy farmer) inspecting the new fescue pasture

Soil analysis

The initial pH of 5.69 (soil water) is moderately acid which indicates reasonably high levels of hydrogen in the soil complex. The final analysis indicated a significant rise of pH to 6.41.

Conductivity as a measure of salinity initially analysed at 0.850d/Sm which is regarded as moderately high, at the end of the trial it had decreased markedly to 0.241dS/m, which is regarded as low to moderate salinity.

The exchangeable sodium as a measure of sodicity analysed initially at 27.9% but decreased markedly to 6.6% at the end of the trial. Sodic soils are defined as having exchangeable sodium 6% or above.

Benchmark phosphorus levels were 86mg/kg (Olsen P) and 285mg/kg (Colwell P) with the final analysis indicating 79mg/kg (Olsen P) and 276mg/kg (Colwell) respectively. Both Olsen P and Colwell levels are at levels where trial data suggests no response from further fertiliser additions.

Total nitrogen benchmark analysis was at 0.45% with a significant increase to 0.62% seen at the end of the trial.

Organic matter initially analysed at 10.5% with end of trial analysis indicating an increase to 13.2%.

The Effective Cation Exchange Capacity (CEC) benchmark was 15.22 with end of trial analysis indicating an increase to 16.20 at the end of the trial.

The calcium to magnesium ration initially analysed at 1.6 with the end of trial ratio indicating an improvement to 3.9. The suggested ratio is between 3-6. The low initial calcium/magnesium ratio could be partly responsible along with high sodium for the observed poor soil structure.

Key results Murdica Demostration Site		
	Benchmark Dec 2014	Trial end Dec 2016
Conductivity dS/m	0.85	0.241
pH (1:5 water)	5.69	6.41
Olsen P mg/kg	86	79
Colwell P mg/kg	285	276
Organic matter %	10.5	13.2
Effective CEC cmol+/Kg	15.22	16.2
Total nitrogen %	0.45	0.62
Nitrate N mg/kg	14.7	19
Carbon %	5.93	7.53
Ca/Mg ratio	1.6	3.9
Ca CEC %	41.7	71.2
Mg CEC %	26.1	18
K CEC %	2.7	3.5
Na ESP %	27.9	6.6

Poultry Manure

The below table is an average analysis from a number of batches supplied to farmers across the Western Port Catchment and we have used these results to calculate the rate of nutrients applied on this site.

Chicken Litter Analysis		
		Nutrient applied @ 8m3/ha (kg/ha)
Nitrogen %	3.58	103
Phosphorus %	1.5	43
Potassium %	2.02	58
Sulphur %	0.63	18
Carbon %	37.4	1081
Calcium %	2.78	80
Magnesium %	0.55	16
Sodium %	0.52	15
Cu mg/kg	108	0.310
Zn mg/kg	372	1.075
Mn mg/kg	501	1.447
Iron mg/kg	2601	7.516
Boron mg/kg	30	0.087
Molybdenum mg/kg	6.8	0.020
Cobalt mg/kg	2	0.006
pH (1:5 water)	6.9	
Moisture %	34.3	

Before and after photo showing the cultivated fescue area on the left and the original pasture on the right

Costs and benefits

The pasture was not measured for yield during the trial because there wasn't a control that it could be compared against. However there is no doubt that the paddock produced significantly more pasture growth than before the trial began. The fescue established very well and was outstanding in the first year. It grew very fast in early summer and needed to be grazed hard before it grew too long and became less palatable. In the second year, the fescue started to thin and was replaced by natural regeneration of ryegrass and clover. In the third year it became hard to identify any fescue. Ryegrass had re-established and had replaced the fescue. It was disappointing that the fescue only lasted 2 years as it survived the waterlogged and sodic site well for the first 18 months. It would be expected that pasture production would continue to improve in the future as the benefits of improved soil chemistry are realised. This can be observed as there are now less salt indicator species in the paddock compared to before the trial began. However, the trial has shown that saline paddocks and sodic soils can be managed to improve productivity.

Establishment Costs per 1ha	
DAP fertiliser 250kg/ha	$213.00
Poultry manure 8m3/ha	$176.00
Lime 2.5t/ha	$308.00
Sowing of pasture	$372.00
Total for 1ha	$1,069.00

In addition, Carbon contained in poultry manure can contribute to increased soil carbon levels and improved soil moisture holding capacity.

Poultry manure 37.4% C = 374kg/t x 8m3/ha (est. 2.89t/ha) =1,080kg/ha.

Farmers inspecting the fescue establishment at a discussion group farm walk

Summary

The initial visual soil assessment illustrated a poorly structured soil with a chemical analysis that indicated major problems with both salinity and sodicity. These constraints were reflected in the production of poor quality pasture and variable species composition.

Soil chemistry indicated low pH, low calcium and high sodium and magnesium in the exchange complex.

After the incorporation of lime, poultry manure and the DAP fertiliser there has been significant improvements in the soil chemistry. Although gypsum is considered quicker acting than lime to counter sodic soils, the incorporation of the lime through cultivation has increased the soil contact and hastened the response.

The pH has risen to an acceptable level with improved calcium levels. Although the soil is still classed as sodic the exchangeable sodium levels reduced from a high of 27.9% to an improved 6.6% (desirable 3%). Exchangeable magnesium initially 26.1% (desirable 16%) reduced to 18%. Increases in organic matter and total nitrogen can be attributed to the addition of poultry manure and the DAP.

It is to be expected that the lowering of the sodium and magnesium in the soil exchange complex may result in an improvement in soil structure.

The sowing of a salt tolerant pasture fescue initially gave quite promising establishment results. Over the length of the trial however the fescue did not persist and rye and native grasses and weed species tended to dominant the pasture mix.

Although pasture variety did not establish as required it remains a possibility that with the dramatic improvement in soil chemistry future sowings could prove to be more effective.

In terms of managing a salinity and sodic soil problem the trial has indicated that the incorporation of the lime and inputs into the soil profile provided immediate returns in terms of soil adjustment. It would be anticipated that the financial outlay would be offset by returns in improved pasture production in the future.

Key learnings from demonstration

- It is possible to remediate a sodic and saline soil in a short period of time
- Improving the drainage reduced waterlogging and pugging
- Incorporation of lime, poultry manure and the DAP fertiliser lifted the pH and calcium and reduced the ESP sodium levels
- Pasture yield improved at the conclusion of the demonstration
- The fescue pasture did not survive at the end of the second year, however due to the soil chemistry improvement and drainage more productive pasture species naturally replaced the fescue

References

RIRDC, 2014 Chicken litter: alternative fertiliser for pastures and ways to increase soil organic carbon, Publication N0. 14/067, September

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