Pasture improvement using biological strategies

Somers 2017

Demonstrating Sustainable Farm Practices

Australian Government

National Landcare Program

Mornington Peninsula

wpcln Western Port Catchment Landcare Network

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Introduction

The aim of this three-year demonstration was to assess different strategies to improve pasture management utilising biological methodologies, and share the learnings with other small rural landholders.

The 40ha farm is situated in Somers and has been run by the current owner for 16 years. The 40ha is comprised of 20ha which was purchased in 2002 (Original Farm) and 20ha purchased in 2014 (New Farm). The Original Farm has 4.5ha set aside for conservation purposes, leaving 15.5ha of usable grazing area.

Figure 1 John Surveying his flock

The New Farm has 7.5ha set aside for conservation purposes, leaving 12.5ha of usable grazing area. Both farms combined are 40ha, with 28ha of usable grazing area. John is currently running 140 Wiltshire ewes that are set stocked. They are sold as fat lambs at 40kg live weight (4-5 months old) direct to a local butcher. The carcasses dress out at about 20kg. The ewes are joined generally at the end of February for Spring lambing.

Soils in the area are light to dark brown clay loams with areas of finer sandy clay loams. They generally overlie Tertiary basalts. At depth, a bleached zone can occur with iron oxide concretions (buckshot gravel). Beyond 300-400mm a heavy grey-brown to yellow clay can be found. The original vegetation was swampy ti-tree and John believes it was drained and cleared in the late 1800s when it was part of the original 'Coolart Estate'. Grazing is now the main agricultural activity.

Figure 2 Field day participants examining the sheep at a field day

Figure 3 John (right) and David Stewart (left) addressing participants at a field day

Biological soil improvement methods were used to raise the fertility and production on the original 20ha, referred to as the Original Farm. These include:

- soil aeration every Autumn from 2002 through to 2017
- Petriks green manure foliar fertiliser (made from plant matter with algaes, roots, plus cobalt sulphate and sodium molybdate)
- composted pig manure
- poultry manure
- lime.

A further 20ha (referred to as the New Farm) was purchased in 2014. The New Farm had been run down over 30 years with no fertiliser being applied, hence its low fertility status.

The New Farm was used as the demonstration farm and the Original Farm acted as a control.

Trial design and set-up

The New Farm was relatively unimproved land with a poor fertiliser history and poor pasture species. Strategies for the improvement of pasture were to increase the legume content, rehabilitate bent grass pasture and the sowing of improved pasture species such as rye, cocksfoot, chicory and plantain. The site was monitored using soil analyses, pasture composition, and pasture yield.

Figure 4 Some of the Wiltshire sheep

A similar range of methods previously used on the Original Farm was used to improve the fertility of the New Farm. **Soil management on the New Farm** included soil aeration and additions of the following inputs:

- Composted pig manure spread at 2.47tonne/ha (2016)
- Lime spread at 2.47tonne/ha (2016)
- Poultry manure spread at ½ tonne/ha (2016)
- Petriks green manure and foliar fertiliser (2014 & 2016)
- Brown coal spread at ½ tonne/ha (2016)
- Aeration in Autumn (2014-2017) including three passes of the Soilkee aerator (2016-2017)

Figure 5 Pasture monitoring with the cages

Soil management on the Original Farm during the demonstration period included:

- Composted pig manure spread at 2.47tonne/ha (2014 & 2016)
- Lime spread at 0.5tonne/ha (2014 & 2016)
- Petriks green manure and foliar fertiliser (2014 & 2016)
- Aeration each autumn (2014 & 2017)

Comment on the analysis of the various soil organic inputs

Pig manure

Pig manure is an excellent source of macro and minor plant nutrients as well as supplying valuable organic matter. Research has demonstrated the increase in microbial biomass and nitrogen mineralisation utilising this organic fertiliser (Dambreville, et al, 2006). The pig manure sourced was well composted. The analysis is illustrated in Figure 6 below.

Chicken litter

Chicken litter has been widely used across all forms of agriculture in Australia. It provides valuable nutrients as well as organic matter. Figure 6 notes the average analysis from many samples supplied to farmers across the Western Port Catchment.

Figure 6 Analysis of inputs used

	Pig manure	Chicken litter *	Brown coal
Nitrogen %	1.74	3-4.7	0.52-0.62
Phosphorus %	4.95	1.5-2.1	
Potassium %	0.755	1.89-1.97	
Sulphur %	0.71	0.6	0.14-5.36
pH	6.15	6.7-7	
Organic matter %	25.46	56.4-63.6	43-67
Organic carbon %	14.8	32.8-37.0	25-39
Carbon/nitrogen ratio	8.51	10.8	

Brown coal

Brown coal sourced from Victoria called leonardite can contain up to 85% Humic acid, which is a valuable soil amendment. As well as adding carbon to the soil, useful quantities of sulphur, calcium and magnesium may also be contained in the coal. The Humic acid component in brown coal is a chelating material, which can unlock soil mineral elements.

** Analyses from a range of inputs used in farm trials across the Western Port Catchment*

Testing protocols

Benchmark soil testing and on-going pasture monitoring of yield, species and composition were key elements of the trial. Pasture species were monitored through the use of pasture cages (due to the sheep being set stocked) and an electronic pasture meter. Soil tests were taken at the beginning and end of the trial.

Figure 7 Consultant David Stewart taking soil samples

Figure 8 Measuring pasture with the electronic pasture meter

Analysis of results

Physical observations

Original Farm

The visual soil assessment indicated a dark brown clay loam topsoil >300mm in depth with good structure and excellent water infiltration. Strong aggregation was further illustrated by a water stable aggregate test.

Grass and weed roots penetrated to a depth > 200mm. Pasture coverage was good with species such as rye, cocksfoot, clovers and plantain dominating. These characteristics satisfy the criteria for a soil of high quality (Doran, Parkin, 1994).

Figure 9 John holding a well-structured soil sod from the Original Farm

Figure 10 Soil aggregates from Original Farm maintained their clumping and shape after shaking in

New Farm

The visual soil assessment at the New Farm indicated a lighter brown clay loam topsoil >300mm in depth with good structure and excellent water infiltration. Strong aggregation was further illustrated by a water stable aggregate test. The aggregate size was smaller than seen on the Original Farm. Grass and weed roots penetrated to a depth > 200mm. Pasture coverage was good with species such as rye, cocksfoot, clovers and plantain dominating.

Figure 11 Well-structured soil with good root penetration on New Farm

Soil analyses

The table below presents the results of the benchmark analyses for both properties, and the analyses at the conclusion of the trial. Initial soil analyses were taken from both the Original established farm and the new 20ha property (the New Farm).

Figure 12 Soil analyses from the Old and New properties				
Nutrient	**Benchmark Original Farm 2015**	**Final Original Farm 2017**	**Benchmark New Farm 2015**	**Final New Farm 2017**
pH (1:5) water	5.85	6.35	5.87	6.17
Available Calcium mg/kg	1455	2028	1013	1385
Available magnesium mg/kg	435	496	478	474
Available Potassium mg/kg	141	109	82	104
Olsen P mg/kg	11	20	12	16
Colwell P mg/kg	56	75	47	54
Nitrate N	20.3	2.3	2.8	1
Sulphur	18.9	22	18.3	15
Total Nitrogen	0.69%	0.7	0.56	0.7
Organic matter	15.90%	14.5	13.2	14.5
Total Carbon %	9.07	8.31	7.52	8.31
Effective Cation Exchange Capacity (ECEC) cmol+/kg	30.76	28.95	22.8	22.9
Calcium/Magnesium ratio	2.5	2.8	1.5	2.1
Calcium CEC %	66.4	67	55.1	61.4
Magnesium CEC %	26.4	24.3	36.2	29.5
Potassium CEC %	3.3	2.3	2.6	2.4
Sodium – ESP %	3.1	2.8	4.6	3.8
Aluminium CEC %	0.1	0.1	0.2	0.1
Carbon/Nitrogen ratio	13.1	11.8	13.5	11.8

Original Farm

This report focuses on the New Farm, however soil test results from the Original Farm have been included to detail the changes that took place over the three year demonstration.

New Farm

At the conclusion of the trial positive results in soil chemistry on the New Farm included:

- An increase in pH from 5.87 to 6.17
- An increase in available calcium from 1013mg/kg to 1385mg/kg
- An increase in potassium from 82mg/kg to 104mg/kg
- An increase in Olsen phosphorus from 12mg/kg to 16mg/kg
- An increase in Colwell phosphorus from 47mg/kg to 54mg/kg
- An increase in total nitrogen from 0.56% to 0.70%
- An increase in organic matter from 13.2% to 14.5%

- An increase in exchangeable calcium from 55.1% to 61.4%
- A decrease in magnesium from 36.2% to 29.5% (a positive move)
- A decrease in ESP sodium from 4.6% to 3.8% (a positive move)

Pasture yield and quality

Pasture yield was measured with an electronic 'GM Pro' Pasture Meter. Pasture cages were used due to the sheep being set stocked (see Figure 12). After measurement, the caged area was mown to grazing height, and the pasture cage was placed over the cut grass. The cutting interval varied from between 30 days in high growth periods and stretched out to over 120 days in lower growth times. The pasture yield data indicates that the Original Farm out-produced the New Farm over the period of the trial. There appeared to be uniformity of colour across pasture on the Original Farm but patchy colour on the New Farm. Aeration and sowing of a range of species (field peas, oats, chicory, rye and clovers) by the Soilkee in May 2016 and February 2017 did not appear to provide any noticeable change in pasture production. John commented "*the pasture on the Original Farm was more resilient and bounced back quicker after heavy grazing*".

Figure 13 Pasture Yield

Date	Original Farm kg/ha	New Farm kg/ha
2015	4,953	4,283
2016	10,037	6,216
2017	10,224	6,721
Total	**26,214**	**17,220**

Meat quality

Both the butcher purchasing John's lambs and the customers purchasing single prepared carcases have commented on the high quality of the meat coming from his properties.

Improvement Costs

John outlined the costs of the range of inputs used on the New Farm over the 3 years of the demonstration and these are detailed below.

Figure 14 Costs to improve the nutrient profile of the New Farm (over 3 years)

Input	kg/Ha	Cost/t	Cost per ha	Notes
Pig manure 2016	2472	$100	$240	Spread price
Lime 2016	2472	$100	$240	Spread price
Poultry litter 2016	2472	$20	$49	4.9m3 per ha
Petriks (2014 & 2016)			$40	Applied twice
Soilkee Soil aeration x 3 2016			$1,700	4ha with SoilKee 3 times
Brown coal 2016	2472	$116	$280	Spread price
		Total per Ha	**$2,549**	**(over 3 years)**

Summary

In terms of increased pasture production and species quality from the 20-hectare New Farm, results over the trial period were not what John expected, when compared to the results he'd seen on the Original farm. Examination of the soil chemistry, however, indicates a number of positive changes that might in the future result in increased production and species quality. A positive rise in pH, organic matter, total nitrogen levels and an increase in Olsen phosphorus levels indicate that the soil on the new farm has responded to the range of inputs supplied. In addition, higher levels of magnesium and sodium, which might be seen as negatively effecting soil structure, have decreased.

Soil analyses taken from both farms at the commencement of the trial indicated that the New Farm had lower fertility levels than the Original Farm. It therefore may take longer to reach a soil fertility level where pasture production is comparable to the Original Farm.

Key learning's from demonstration

- The New Farm had lower nutrient levels than the Original Farm at the commencement of remediation and improvement will take longer than initially expected.
- Adding a range of biological inputs has raised a number of key soil plant nutrients and decreased those that may negatively impact soil health
- Pasture species composition and yield did not respond as quickly as initially thought
- The New Farm still used set stocking management throughout the demonstration which could have impacted on pasture growth.

References

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