South West Goulburn Landcare Network Healthy Soils Report May 2017

In 2012 Brenton Byerlee, Managing Director of Soil Management Systems was approached to help conduct trials on the property of Paul Fleming at Broadford, Victoria. The property conducts a commercial beef cattle operation in good rainfall (670 mm AAR) in the Goulburn River Catchment area. Funding was available to conduct the trials over four years with the object of learning about their soils and what makes a healthy soil while assessing actual results over the period of the trial. The trial was carried out with the assistance of the Goulburn Broken Catchment Management Authority

The trials were conducted on two very different soil types on the property; a light clay silty loam (Healy's), and a heavier black basalt clay (Zwars) (Appendix 2 Trial layout). Comprehensive soil analysis was taken of each site to be treated and adjacent control areas. (Appendix 1 APAL soil test results).

In 2015 rainfall was well below average, particularly in Mar-Jun period when 132.5 mm of rain fell (Appendix 3 Monthly rainfall 2014 and 20145)

Aim

The emphasis at Soil Management Systems is on the chemical, physical and biological facets of soils which are interdependent, changes to one effects the others. By focusing on balancing soil cations and keeping nutrients in balance the soil physical condition or structure will enhance biological activity in all its forms. The main focus is living soils with consideration given to management and inputs that encourage the life in the soils.

Treatment

Applications were based on the soil reports and were applied over the four-year period. Products applied were concentrated in first two years to fit in with short period of the trial. A combination of lime, gypsum, dolomite, SMS guano, ammonium sulphate and trace elements were applied at rates according to the soil tests (insert table of fertiliser applications).

Normally for both agronomic and economic reasons applications would have been extended over a longer time span. Biological activity is enhanced as a result of these applications which mineralise and release nutrients into an available form. The results are accumulated over future seasons. Chemical sprays and fertilisers such as urea are to be avoided due to their detrimental effect on the biological life in the soil.(Appendix 4 Fertiliser and soil amendment applications)

Base Assessment

The first year concentrated in understanding where the soils are at before any remediation work. Core samples were taken at the trial and control areas for analysis at APAL

Laboratories complete with comprehensive report and reccomendations. These reports were presented at the first information day in spring of 2012. The imbalance of nutrients, the cation balance, total exchange capacity (TEC), and macro and micro nutrient availability of these reports were discussed and their impact on the soil life and pasture productivity.

These results were complimented with Visual Soil Assessments during the day. Several aspects of the soil are assessed to describe its present condition which can be monitored in future seasons for visual changes from the applied mineral nutrients. The aspects of the Soil description include: -

1. Soil Texture – percentage of clay, silt and sand. (Sausage test)
2. Soil Structure – crumb size and hardness, macro and micro pores in crumbs, water infiltration, aeration, aerobic depth.
3. Smell – a good or slight earthy smell or sour putrid smell.
4. Soil Water Infiltration – surface ponding or hard pans
5. Biological Activity – both macro and micro organisms (Soil Life). Rhizosphere activity.
6. Soil Rooting Depth and health of Roots – potential of root depth.
7. Pasture composition and Plant Performance – weed spectrum, disease symptoms, mineral deficiency symptoms, clover nodulation, brix.

Each of these aspects are scored for future reference.

In subsequent years, these were all reassessed and monitored for improvements from the applied treatments.

Figure 1 Brenton and Paul with Landcare Group members at teh 2012 Field Day

Results

It was cautioned from the beginning that patience is required to build a healthy living soil. From the soil analysis and visual assessments in the first year I indicated with confidence and from experience that the applications applied would result in the soils coming alive with a change in pasture composition, greatly increased production and hence higher stocking capacity. After the first year only very minor improvements could be observed to the experienced eye but by the third and fourth year very impressive gains had been made.

In years three and four a casual walk over the treated and control areas by the Landcare members; it was quite a contrast to the first year.

Composition of the pasture had improved significantly; this being achieved without the high cost of pasture resowing and the long period of lost grazing opportunity. Weed populations of Capeweed and Silver Grass were very much reduced. Grasses were more vigorous and productive as also the clover. Healthier nodulation of clover roots was occurring. Paul was slowly increasing stocking rates.

The contrast between treated and control areas. *(insert copy of Field day notes)*

As expected improvements on Zwars heavier soil was at a slower rate but still very significant. Soil structure was much improved from a hard-lumpy soil to a

more friable nature with improved root development and penetration, although much more improvement is desired. The aerobic depth which was initially virtually non-existent had extended some 50mm into the soil indicating biota becoming active from the improved physical structure. The odd earthworm was seen also. Soil smell has noticeably changed from putrid to more neutral and expected to be more earthlier as progress continues.

Healy's lighter soils improved at a much faster rate. Pasture production increases were more than double Zwars. Physical structure on Healy's was better at the beginning than Zwars and improved more each year. The aerobic zone doubled from about 50mm to 100mm indicating greater depth of biological activity and earthworms were plentiful. Root systems were healthy with a lot of fine root hairs and rhizosphere activity. Soil smell has changed from neutral to an earthlier smell.

These outcomes combined will mean more water use efficiency from rainfall and extended growing seasons. (See Appendix 5 Pasture production)

Soil Test Analysis

The above Visual Assessments Results and Pasture Yield results can clearly be seen in the proceeding changes that have occurred from the soil test done in 2012 and again in 2016.

These changes are very significant and shows conclusively the improvements in the laboratory tests.

Firstly, we wanted to balance the cations to improve the physical structure of the soil. The Calcium/Magnesium ratio in Healy's improved to the desired level of 6.35 from 3.5. Zwars improved from around 1.5 to 2.5. Further improvements will continue as the lime applications are mineralised. Organic Matter has a large increase which will slowly become Organic Carbon further improving soil structure. These changes are why we are seeing more Biological activity.

Secondly, particularly in Zwars pH has increased by more than one pH unit.

Thirdly, overall mineral nutrition is more balanced with an increase in potassium, nitrogen, trace elements, total phosphorus and Olsen phosphorus. Calcium levels has big increases and there are less Hydrogen ions.

Conclusion

These are very significant changes and what we were seeking to achieve. The result is a more comfortable environment for biology to be active as oxygen is able to more easily penetrate the soil. As the soil becomes more biologically active mineralising nutrients in an available form for the pasture less reliance is needed on fertiliser inputs which when applied are more efficiently utilised. In short, the soil is coming alive!

Further recommendations

To help speed up the responses in the soil I have suggested particularly for Zwars to source an Aerator to regularly in the right conditions aerate the soil. By doing some short trial strips alongside control we can monitor the effects of this over next couple of seasons. I believe we will see this as a very worthwhile activity and will be good to show these results at a field day.

A trial of biological enhancement products would be interesting now that the soil is more receptive to such products.

In finishing I would like to thank all those involved in the project and Paul for his efforts. I always enjoy helping farmers to understand their soils are a living environment.

Figure 2 Pauls cattle grazing in Zwars trial areas

Appendices

Appendix 1 APAL soil test results

Paddock Name	Healeys 1+		Healeys 22+		Healeys Control		Zwars 1 & 2		Zwars 22 & 23		Zwars Control	
	6-Sep-12	18-Sep-15	6-Sep-12	18-Sep-15	6-Sep-12	18-Sep-15	6-Sep-12	18-Sep-15	6-Sep-12	18-Sep-15	6-Sep-12	18-Sep-15
pH [1:5 CaCl2]	NR	5.22	NR	6.24	NR	4.88	NR	5.99	NR	5.5	NR	5.53
pH [1:5 H2O]	6.06	6.07	5.35	6.6	5.82	5.82	5.68	6.61	5.44	6.17	5.65	6.18
Organic Carbon (%)	2.45	2.72	1.62	2.26	2.78	2.54	3.9	3.47	3.95	4.29	4.88	4.13
CEC (meq/100g)	7.8	6.68	4.77	8.93	7.73	6.93	24.68	21.2	35.01	29.3	38.34	26.2
Phosphorus [Olsen] (ppm)	10	10	10	12	7	6	5	6	5	6	6	5
Phosphorus [Bray 2] (ppm)	59.63	33	42.28	32	44.5	10	30.71	15	20.03	16	25.37	19
NO3-N (ppm)	NR	10.9	NR	5	NR	5.7	NR	5	NR	2.1	NR	10.6
NH4-N (ppm)	NR	10.9	NR	10.7	NR	12.2	NR	18	NR	11	NR	29.6
Calcium[Am. Acet.] (meq/100g)	4.93	4.97	1.92	7.01	4.08	4.51	11.34	14.39	12.79	17.81	15.21	15.89
Magnesium[Am. Acet.] (meq/100g	1.03	0.93	0.73	1.49	1.14	1.55	5.58	5.72	7.96	10.51	10.07	9.27
Potassium[Am. Acet.] (meq/100g)	0.28	0.51	0.12	0.21	0.29	0.49	0.36	0.68	0.28	0.46	0.27	0.53
Sodium[Am. Acet.] (meq/100g)	0.12	0.18	0.12	0.14	0.17	0.14	0.32	0.33	0.27	0.41	0.25	0.38
Aluminium[KCl] (meq/100g)	NR	0.07	NR	0.03	NR	0.2	NR	0.04	NR	0.04	NR	0.04
Hydrogen (meq/100g)		<.02	NR	0.05		0.05	2.01	2.51		0.04		0.09
Ca:Mg Ratio	4.85	5.34	2.66	4.69	3.61	2.91	13.67	23.2	1.62	1.69	1.53	1.71
Sulphur [MCP] (ppm)	6	18.6	11	86.1	6	13.3	0.46	0.8	14.67	27.9	7.33	31.7
Boron[CaCl2] (ppm)	0.22	0.36	0.23	0.28	0.22	0.45	75.91	26	0.41	0.67	0.45	4.79
Manganese [DTPA] (ppm)	31.67	7.5	14.11	4.6	31.45	30	1.47	3.03	73.04	15	91.66	26
Copper [DTPA] (ppm)	0.34	0.62	0.27	0.76	0.43	0.95	178.11	202	1.21	3.23	1.24	2.47
Iron [DTPA] (ppm)	799.55	326	1,036.15	429	675.37	288	2.85	3.44	617.29	262	560.7	283

Zinc [DTPA] (ppm)	1.3	2.09	1.31	1.66	1.21	2.16			1.82	2.48	2.7	1.91
Molybdenum (ppm)	0.77		0.59		1.1		44.9	67.9	1.46			
Ca base saturation (%)	63	74.5	40.2	78.5	52.7	65	22.3	27	36.5	60.8	39.6	60.6
Mg base saturation (%)	13	13.9	15.1	16.7	14.6	22.4	1.5	3.2	22.5	35.9	25.9	35.4
K base saturation (%)	3.6	7.6	2.5	2.3	3.8	7	1.3	1.6	0.8	1.6	0.7	2
Na base saturation (%)	1.6	2.8	2.6	1.5	2.2	2	1	0.2	0.8	1.4	0.7	1.5
Other Bases/Al base saturation (%)	5.3	1	6.6	0.3	5.7	2.9	24	0.1	6.4	0.1	6.1	0.2
Hydrogen saturation (%)	13.5	-	33	0.6	21	0.3	30	NR	33	0.1	27	0.3
Calcium (ppm)	985	994	384	1,402	815	902	2,268.00	2,878	2,557.00	3,562	3,042.00	3,178
Magnesium (ppm)	124	112	87	179	137	186	669	686	955	1,261	1,208.00	1,112
Potassium (ppm)	108	199	46	82	114	191	142	265	110	179	105	207
Sodium (ppm)	28	41	28	32	39	32	73	76	61	94	58	87
Aluminium (ppm)	NR	6	NR	3	NR	18	NR	4	NR	4	NR	4
Grass Tetany risk		0.09	NR	0.02		0.08		0.03		0.02		0.03
P Buffering Index	NR	61	NR	77	NR	83	NR	135	NR	180	NR	135
EC [1:5 H2O] (dS/m)	0.05	0.09	0.05	0.2	0.05	0.06	0.08	0.12	0.09	0.11	0.05	0.12
ESP	0.02	0.03	0.04	0.02	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
For a description of the analytes see: http://www.apal.com.au/images/uploads/resources/Soil_Test_Interpretation_Guide_1.pdf												

Appendix 2 Trial layout

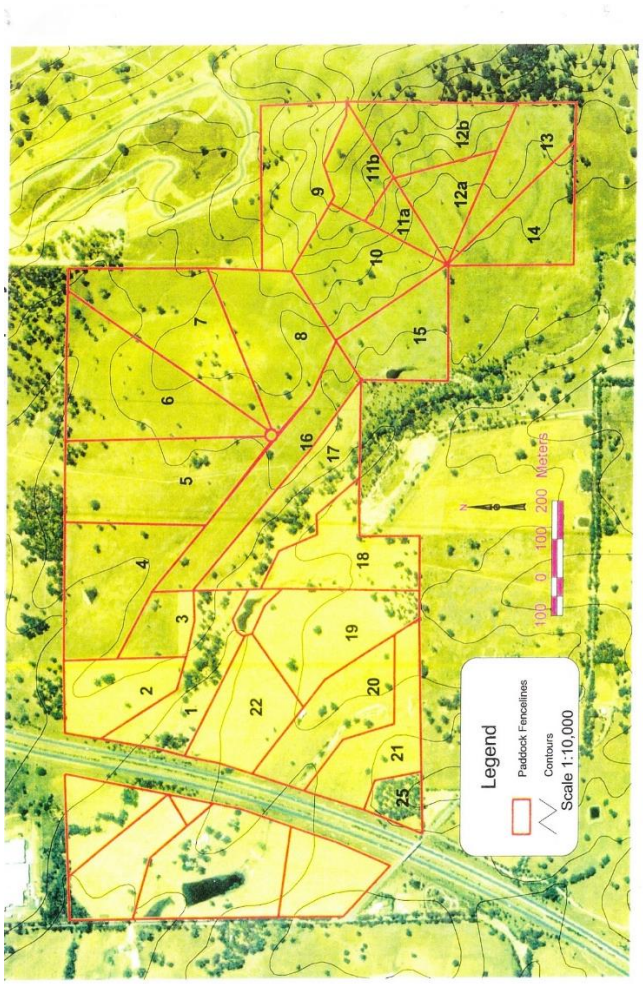

Figure 3 Trial layout, Zwars is on the left and Healy's on the right

Appendix 3 Monthly rainfall 2014 and 20145

MONTH	2014	2015
JAN	15.6	35
FEB	8.3	40.5
MAR	33.4	16.5
APR	83.5	44
MAY	57.9	36
JUN	72.4	36
JUL	58.5	85
AUG	7.8	47.5
SEP	42.2	
OCT	21.2	
NOV	35	
MAR-JUN	**247**	**132.5**

Appendix 4 Fertiliser and soil amendment applications

Year	Landholder	Paddock	Ammonium sulphate	Dolomite	Gypsum	Lime	Manganese oxide	P.Guano	Potassium sulphate	SuperPerfect & potash	Trace element spray	TE Spray K + Bo, no Mn, extra P, N
2013												
	Paul Fleming											
		Healy's 2 & 4				500				250	2.5	10
		Healy's 22 & 19		3000						250	2.5	10
		Zwars 1 & 2				2000				250	2.5	10
		Zwars 22 & 23				2000				250	2.5	10
2014												
	Paul Fleming											
		Healy's 2 & 4					10	0	100			
		Healy's 22 & 19					10	50	100			
		Zwars 1 & 2						120	160			
		Zwars 22 & 23						120	160			
	Rod Caplehorn											
		Rod Caplehorn	200	2500	500				100			
2015												
	Paul Fleming											
		Healy's 2 & 4					10	0	100			
		Healy's 22 & 19					10	50	100			
		Zwars 1 & 2				2000		120	160			

		Zwars 22 & 23				3000		120	160			
	Rod Caplehorn											
		Rod Caplehorn	200	0	0	2000		100	100			
Grand Total			**400**	**5500**	**500**	**11500**	**40**	**680**	**1240**	**1000**	**10**	**40**

Appendix 5 Pasture production

Winter production benefits

		Average kg/ha/day			
Paddock	**Cell**	**Treated**	**Control**	**Difference**	**Percentage change**
Healey's	**2 & 4**	11.275	5	6.275	126%
	22 & 19	11.25	4.2	7.05	168%
Zwars	**1 & 2**	9.25	6.2	3.05	49%
	22 & 23	9.25	7.2	2.05	28%

Spring production benefits

		Average kg/ha/day			
		Treated	**Control**	**Difference**	**Percentage change**
Healey's	**2 & 4**	36	10.3	25.7	71%
	19	33.8	17.9	15.9	47%
Zwars	**1 & 2**	20	14.2	5.8	29%
	22 & 23	23.5	17.9	5.6	24%