Case study on use of compost for pasture growth & species composition

Nayook and Neerim farms 2017

Australian Government
National Landcare Program
Bass Coast Landcare Network
Neerim District Landcare
Mornington Peninsula Shire
wpcln Western Port Catchment Landcare Network
South Gippsland Landcare Network
Demonstrating Sustainable Farm Practices

Comparing the impact of surface compost application and sub soil compost application on pasture production, species and root growth on properties at Nayook and Neerim South – Extension to project

Introduction

The aim of this three-year sustainable agriculture project was to increase the understanding of how surface applied and sub surface applied compost might be used to benefit both pasture growth and species composition.

This report focuses on a two-year extension to the on farm demonstrations to determine if there are longer term benefits, which might indicate the potential for these pasture improvement strategies.

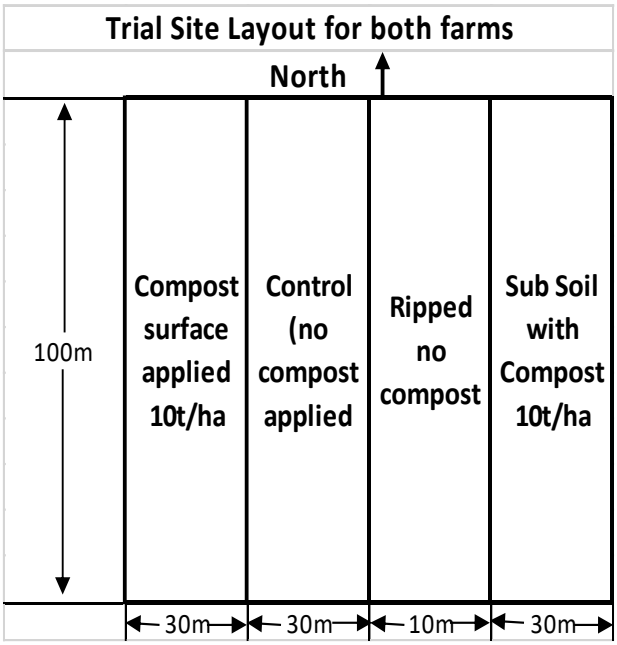
It was anticipated that the sub soil application of compost would provide food for soil biology while increasing oxygen and moisture penetration to the soil thus enhancing plant root growth and element availability, while surface applications would provide readily available nitrogen, phosphorus and valuable organic matter. Research indicates that increasing soil fertility should lead to improved pasture composition.

Historical information

The demonstration sites are situated on 2 farms; a dairy farm at Neerim North (Bransgrove) and a beef grazing property at Nayook (Harington-Hawes).

Both demonstration sites were established in November 2013 with 1-hectare areas identified and photo points established. The sites were divided into surface applied compost, sub surface applied compost, ripping without compost and a control strip where no compost was applied. Surface application to pastures has been the normal approach to the addition of compost or organic matter. The comparison with sub surface applied compost was thought to be an interesting and innovative approach to incorporate compost into the soil.

Trial set-up Bransgrove dairy farm



- Strip 1 - Sub surface compost (10t/ha) (compost inserted at a depth of 15-25cm
- Strip 2 - Deep ripping no compost (machine ran through soil with no compost inserted)
- Strip 3 - Control (no applications of compost)
- Strip 4 - Surface applied compost (10t/ha)

Field days were held illustrating both surface and sub surface compost application with discussion on the use compost. A final report for the first 2 years of information can be found at www.wpcln.org.au

The project monitored pasture productivity and a range of soil physical characteristics and soil chemistry.

In the two-year extension to these projects both trial sites had 10t/ha of compost applied on the surface annually. There was no sub surface compost applied in this trial.

The soils on both farms are Ferrosols described as dark brown gradational soils generally being friable, well-structured clay loams with high levels of organic matter. Derived from Tertiary basalts (20-40 million years in age) they are deeply weathered with a high ability to fix phosphorus. Their pH ranges from moderately to strongly acidic. On both farms they are mainly used for grazing. The depth of the A-horizon is >350mm.

Background to properties

Bransgrove dairy farm

The Bransgrove property is a 179ha dairy property + 10ha agistment at Neerim North. Brett & his mum Sue currently milk 250 Friesians. They keep around 70 young stock for herd replacers each year and sell off Angus/Friesian crosses at about 12-18 month of age. They decided to trial compost when another landholder told them about it and they had been making their own compost too. Brett said the delivery of their fertiliser & lime fitted in well with compost deliveries for the trial.

Spreading compost on Bransgrove farm

They believe that the trial paddock appears greener when looking down from the dairy and probably has improved the paddock overall marginally. Brett has oversown improved pasture species of ryegrass & clover across the farm and will likely do this with the trial paddock now the demonstration is complete.

Harington-Hawes beef property

The property is a 131 ha property + 49ha agistment on the Powelltown Road Nayook. The property carries 330 Angus beef cows and calves, which are rotationally grazed. Bruce & Dell recently were recognised in top 100 MSA graded beef out of 5,500 producers. He attributes the farm's success to good grass & good breeding.

They decided to trial compost after a Landcare field day visit to Dutson Downs recycling facility & wanted to try something different to see if compost was commercially viable for their farm. The trial site had previously been cropped for potatoes and was considered to be less productive than other areas on the farm. The paddock had a lot of dock weed and was one of their worse performing paddocks. The Harington-Hawes' are currently benefitting from good beef prices and regularly fertilise & lime, whilst being aware and careful to use fertiliser responsibly because their farm is located in a drinking water catchment.

Background to compost use

Past research has demonstrated that compost can have beneficial effects on soils, soil health and plant productivity through providing a source of nutrients, increasing moisture absorption, increasing soil organic carbon, and inoculating the soil with a wide range of microorganisms. Increased availability of plant nutrients can be expected (Termorshuizen et al, 2004, Hoitink, & Fahy, 1986, Compost Case Study, 2012).

The application of sub surface compost has been used in cereal cropping areas but it is a relatively new concept in a pasture situation. A modified implement supplied by Southern Farming Systems was used to insert the compost into the sub-soil zone.

Compost has been used widely in trials across the Gippsland catchment. The compost applied had an analysis of 1.40% nitrogen. Approximately 14kg of nitrogen is contained per tonne and with a C/N ratio of 15.4:1 approximately 10% of this will be mineralised after application. The balance is released over time. Potassium is more readily available than nitrogen, while 30-40% of phosphorus is available within two years of application (Compost for Soils, 2011).

Compost analysis			
	23/11/14 Harington-Hawes	23/11/14 Bransgrove	9/10/15 Bransgrove & Harington- Hawes
Ph (1:5 water)	5.8	7.8	7.1
Organic carbon %	27.5	15.6	22.0
C/N ratio %	17.5	13.3	15.4
Nitrogen	1.57	1.18	1.41
Phosphorus %	0.23	0.37	0.26
Potassium %	0.81	0.48	0.90

It should be remembered that although the Phosphorus levels were low in this compost compared to some composts, the addition of organic matter/organic carbon to the soil and a range of minor and trace elements is a positive strategy along with the microbial inoculation that accompanies it. (Termorshuizen, A.J. et al, 2004),

Farmer Bruce Harington-Hawes (r) with consultant Chris Alenson (m) and project officer Sandra McPhee (l)

Testing Protocols

Initial benchmarking of the soil's physical, chemical and biological characteristics was an essential part of understanding the current status of the pasture/soil base. Observation was made of a number of soil characteristics (Rapid Soil Assessment Test- RSAT) across the physical, biological and chemical attributes of a soil. These included organic matter depth, root depth and development, earthworm count, leaf color, soil compaction, aggregate stability and soil structure.

Solvita Soil Health tests were used to provide semi quantitative data on soil biological health. The Solvita soil test is a technology and method that allows the soil CO2 respiration of microorganisms to be measured in the field.

Machine used to place the compost in the sub-soil

As biological activity increases and organic matter cycles, CO^2 is released. The rate of release is regarded as an indicator of soil health.

Monitoring of pasture yield, feed quality and field observations was undertaken throughout the trial period with comprehensive analysis repeated at the end of the trial.

Analysis of Results

It should be noted that dairy cows and beef cattle have grazed the trial sites and have deposited their dung and urine on the pasture surface. Soil analytical results therefore must be interpreted with caution.

Soil spit illustrating structure and root activity on Bransgrove farm

Individual Results - Bransgrove Dairy Farm

Physical observations

The Benchmark Rapid Assessment Tool (RSAT) scored highly at 8.4 (out of 9) with the soil having good structure, water stable aggregates, water infiltration and reasonable root growth. There was no great change in these characteristics across the 4 strips over the two years. Pasture species and quality remained variable across all strips.

Shallow hole illustrating slow water infiltration

Solvita soil health test end of the trial (CO^2 respiration)

The initial benchmark reading of 3.5-4 (out of 5) indicated medium to good levels of microbial soil activity.

Readings taken at the end of the trial registered either similar or lower. Both the ripped strip and the sub surface compost registered the same level as the benchmark test. The control registered the lowest reading. No test was available for the surface applied compost.

Observations of pasture yield

In the first two years of this trial the highest pasture yield was recorded on the surface applied strip, followed by the control, with significantly less yield on the subsoil compost and ripped strips. In this additional two-year extension to the trial, again the surface applied compost demonstrated the highest pasture yield, followed by the ripped strip and the control. The sub surface compost strip indicated the lowest yield. There was good clover growth on both the surface applied strip and the sub surface strip and significant growth of sweet vernal across the control strip.

At the end of the trial pasture was observed to be still of variable quality across all strips. Pasture monitoring records showed that; Surface applied compost had least amount of bare ground, Sub Soil compost & ripped strips had the least amount of rye, and control had the least amount clover

Bransgrove - Pasture Yield Kg/DM/Ha for each strip				
	Sub Soil Applied Compost	Sub Soil Rip No Compost kg/ha	Control	Surface Applied Compost
Previous trial 5/12/13 - 12/12/14	6451	7097	9701	11255
Current Trial 4/8/15 - 22/8/16	3936	4703	4400	5197
Total	10387	11800	14101	16452

Feed analysis observations

Pasture was sampled each spring for nutrition with FEEDTEST. There was no significant difference in the pasture nutritional analysis (Protein & M.E.) between the strips.

Soil analysis Bransgrove

Bransgrove results					
	Benchmark 2013	Sub Soil Compost 2017	Sub Soil no compost 2017	Control (Nothing) 2017	Compost Surface Applied 2017
pH (1:5 Water)	5.32	5.49	5.46	5.46	5.81
Nitrate nitrogen mg/kg	4.8	4.9	5.7	5	4.8
Ammonium nitrogen mg/kg	36.9	17	22	36	16
Total nitrogen %	0.53	0.54	0.52	0.51	0.52
Phosphorus Colwell mg/kg	119	148	132	149	157
Carbon %	6.42	6.96	7.38	6.91	6.99
Organic matter %	11.2	12.2	12.9	12.1	12.2
Exchangable aluminium %	4.7	6.6	8.9	8.4	1
CEC	11.72	10.41	10.18	10.04	13.96

The control pH of 5.46 (soil water) was strongly acid which indicates reasonably high levels of hydrogen in the soil complex. In the surface applied compost strip the pH increased to 5.81. Colwell P registered 149mg/kg in the control analysis and increased to 157mg/kg in the surface applied compost strip. There was an increase in the Effective Cation Exchange in the Surface Applied compost (13.96) compared to the Control strip (10.04), which might be expected from the addition of organic matter. The ammonium nitrogen measured 36mg/kg in the control strip and 16mg/kg in the surface applied compost strip. High ammonium nitrogen can indicate low biological activity where the nitrogen cycles activity is reduced.

Summary of results from Bransgrove dairy farm

The benchmark visual assessment indicated that the soil was of good quality with soil compaction and varying pasture composition being the most noticeable constraints to production. Soil analyses indicated all major nutrient elements at satisfactory levels, however aluminium is at a level that could impact pasture production. Adjustment of pH should rectify this problem. It is significant that the surface application of compost lowered the level of aluminium held in the exchange complex. Compost analysis indicates a 1.6% calcium content and this addition to the trial strip has increased soil available calcium and Base Exchange levels. Organic matter did not vary greatly over the trial period. Although soil results indicated good levels of total nitrogen and ammonium nitrogen, the conversion of this nitrogen to nitrate nitrogen is not appear to be occurring. This is taking into account lower biological activity due to low soil temperatures when the test was taken. Conditions such as compacted soil, low pH, lack of moisture and lower temperature at the time of sampling, may all combine to restrict the activity of the required nutrient cycling microorganisms.

The surface applied compost strip yielded 16,452kg/DM/Ha over the two-year extension whereas the control yielded 14,101kg/DM/Ha. Pasture composition of rye grass, cocksfoot and clover was consistent across all strips.

Brett mentioned “The trial paddock still feels a bit bumpy because of the subsoil method of applying compost but I am keen to rejuvenate another old potato paddock by spreading compost and manure on the surface rather than in the subsoil.” However, this is not a top priority as Brett and his mum are currently concentrating on refilling their hay sheds and rejoining the herd and feel it’s a very difficult time because of the uncertainty surrounding their milk processor Murray Goulburn.

Individual Results - Harington-Hawes Beef Farm

Physical observations

The Benchmark Rapid Assessment Tool (RSAT) scored a moderate 6.9 (out of 9) indicating a soil of medium to good quality. Minor soil constraints were considered to be soil structure, with slight compaction indicated by slower water infiltration and resistance to the insertion in the soil of a metal rod. Pasture varied but was comprised primarily of higher quality pasture species.

At the end of the trial extension there were no significant changes in the observations of the pasture species between the strips.

Soil spit Harington-Hawes property

Solvita soil health test end of the trial (CO^2 respiration)

An initial reading of 3.5-4 (out of 5) indicated medium to good levels of microbial soil activity.

Readings taken at the end of the trial registered 2.5 for all strips. As soil temperatures were below 11c it is expected that soil microbial populations would be less active than if the soil temperature was above 15c, consequently registering lower on the Solvita measuring scale.

Observations of pasture yield

In the first two years of this trial the highest pasture yield was recorded on the surface applied strips followed by the control with significantly less yield on the subsoil compost and ripped strips.

In this additional two-year extension to the trial, again the surface applied compost demonstrated the highest pasture yield, closely followed by the sub surface compost strip. Then followed the ripped strip, with the control producing the lowest yield.

Harington-Hawes - Pasture yield Kg/DM/Ha for each strip				
	Sub Soil Applied Compost	Sub Soil Rip No Compost kg/ha	Control	Surface Applied Compost
Previous trial 23/12/13 - 12/12/14	9278	9251	10632	12501
Current Trial 28/9/15 - 6/12/16	9835	8896	8462	9937
Total	19113	18147	19094	22438

At the end of the trial it is significant that the surface applied compost had the least amount of bare ground on both trial sites. Pasture composition varied over the sites with more cocksfoot noted on the surface applied strip. The Sub Soil compost & ripped strips had higher levels of ryegrass. They also had higher weed counts (dock and cats ear) which is possibly caused by disturbing the weed seedbank when the ground was ripped. Since the completion of the trial Bruce and Del mentioned that “the trial paddock is now one of our better paddocks with balanced pasture and less weeds”. They were unimpressed with the results from the early trial as they didn't see much difference, but now 4 years from the initial trial they feel there is a huge difference in pasture productivity. Bruce said it was worthwhile sticking to it as the trial paddock is now one of their better paddocks with a balanced pasture, hardly any dock and a lot more clover.

Feed analysis observations

Pasture was sampled each spring for nutrition with FEEDTEST. There was no significant difference in the pasture nutritional analysis (Protein & M.E.) between the strips.

Harington-Hawes results					
	Benchmark 2013 Pasture	Compost Sub surface applied 2017	Sub surface no compost 2017	Control (Nothing) 2017	Compost Surface Applied 2017
Ph (1:5 water)	5.53	5.63	5.71	5.65	5.63
Olsen P mg/kg		44	39	45	51
Colwell P mg/kg	147	185	159	193	219
Ammonium nitrogen mg/kg	33.9	17	22	36	16
Nitrate N mg/kg	10.6	15	7.5	14	17
Total Nitrogen %	0.49	0.5	0.49	0.49	0.51
Organic matter %	10.8	11.1	11.1	11.5	12.2
Effective CEC	13.28	11.51	12.18	12.78	13.44
Carbon %	6.16	6.36	6.53	6.6	6.98

Soil analysis

It is to be noted that applications of 4:1 potash and single superphosphate were applied across all strips during the period of this trail. Any change in soil nutrient levels from the benchmark, particularly in P and K are discussed but should not necessarily be seen as a result of the compost trial.

The initial pH of 5.53 (soil water) was strongly acidic which indicates reasonably high levels of hydrogen in the soil complex. There was a slight increase in pH over the two-year trial period. Both Olsen P (51mg/kg) and Colwell P (219mg/kg) registered marginally higher in the surface applied compost strip compared to the control with Olsen P (45mg/kg) and Colwell P (193mg/kg). Both Olsen P and Colwell P are at levels where trial data suggests no response from any further Phosphorus fertiliser additions. There was no change in Total nitrogen. Organic matter increased from the control pasture of 11.5% to 12.2% in the Surface Applied compost strip and the Effective Cation Exchange did not alter significantly.

Summary of results from Harington-Hawes farm

The benchmark visual assessment indicated that the soil was of good quality with some evidence of compaction. Pasture composition was considered fair to good with stands of clover and cocksfoot and newly germinated ryegrass evident.

Soil analyses indicated all major nutrient elements at satisfactory levels. Organic matter did increase in the surface applied strip compared with the benchmark and other strips. Although soil results indicated good levels of total nitrogen and ammonium, the conversion of this nitrogen to nitrate nitrogen appears to be restricted, even allowing for lower biological activity due to cool soil temperatures when the sample was taken. Conditions such as compacted soil, low pH, lack of moisture and lower temperature at the time of sampling, may all combine to restrict the activity of the required nutrient cycling microorganisms.

The surface applied compost strip had the highest pasture yield over the two-year extension followed by the sub surface applied compost strip and then the ripped strip.

Financial analysis

The pasture yields for this trial indicates an increase in pasture growth from both the surface applied compost and the sub surface applied compost. In addition there may be an added benefit from the addition of mineral elements contained in the compost, increased organic matter and organic carbon.

The cost of supply, delivery and spreading of the compost per hectare 10t (approximately $20m^3$) =$2,400. Two applications @ 10t/Ha (calculated at $20m^3$/ha) @ $60m3 which is spread annually = 2 x $1.200 = $2,400

$ Value of Nutrients in Compost that was applied					
Nutrient	**kg/tonne**	**kg/10tonne**	**$/kg ***	**$/tonne compost**	**$/10tonne compost**
Nitrogen	14.1	141	$ 1.27	$ 17.91	$ 179.07
Phosphorus	2.6	26	$ 4.40	$ 11.44	$ 114.40
Potassium	9	90	$ 1.68	$ 15.12	$ 151.20
Calcium	16.1	161	$ 0.50	$ 8.05	$ 80.50
Sulphur	2.1	21	$ 0.70	$ 1.47	$ 14.70
			TOTAL	**$ 53.99**	**$ 539.87**
* based on March 2010 fertiliser prices (calculate $/tonne by the % nutrient/tonne)					
Source: www.compostforsoils.com.au/images/pdf/cropping/pasture_cropping_web.pdf					

Benefit

Nutrient additions in compost *

Value of nutrients spread at 10t/ha annually over 2 years = $539.87 x 2years = $1079.74

Intangible benefits

Organic matter contained in compost contributes to increased soil moisture holding capacity. In addition, increased carbon is a benefit to soil productivity. Based on a C content of 21.7% and a spread rate of 10t/ha a total of 2,170 kg/ha of C was applied each application

Total carbon applied = 2,170kg/ha x 2 years = 4,340kg/ha

Summary

These further two-year trials continued to investigate the potential pasture response from the placement of compost below the root zone on two farms, whilst comparing this type of application with surface applications.

The sub surface application of compost although successfully trialed on shallow soils in cereal growing areas has had very little demonstrated work in pasture systems.

In the original trial it appeared that roots were accessing the sub surface compost and that a further benefit may have been seen in the following years, but this has not been realized in pasture production figures. It is evident that the surface application of compost has demonstrated benefits in pasture production and nutrient additions.

The initial compost sub surface applicator caused considerable pasture disturbance, which required both mechanical (roller) and manual turf or sod replacement and this could have adversely impacted pasture yield. This may have also impacted the potential to be had from the opening up of the soil where moisture and oxygen may have initiated a microbial response resulting in the further mobilisation of essential nutrients. Subsequent design modifications to the machine may cause less soil and pasture disturbance.

Both farms had good organic matter levels and perhaps consideration should be given to adopting strategies to increase nutrient cycling from this organic matter reserve thereby mobilising plant available nutrients, rather than adding compost below the level of the most active microbial populations.

The potential end result however still depends on the action of microorganisms to convert humus products into plant nutrients. Soil texture, soil temperature, moisture and open soil pores are essential components in the microbial degradation of the sub soil compost.

Key learnings from demonstration

- The sub surface application of compost did not result in any increased pasture yield
- The surface application of compost demonstrated benefits in pasture production and increased nutrient additions.
- The process of Sub surface compost ripping and application with the compost applicator prototype caused extensive pasture disturbance, which required extensive rolling and sod replacement. This may have impacted any potential benefits to be had from the sub surface compost and soil aeration with and without compost.

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This project is supported by Western Port Catchment Landcare Network through funding from the Australian Government's National Landcare Program