Subsoil amelioration – three years on

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Key findings

- The highest yielding treatments at five of the seven sites were the standard paddock practice where no additional nutrition or deep ripping has been applied.
- Placing the amendment in the subsoil did not provide any benefit over placing the amendment on the surface.
- There was little difference in response to applying chicken litter at 20 t/ha or matched rates of synthetic fertiliser.

Why do the trial?

Subsoil constraints are known to have a large impact on grain yields in the Mid-North of SA. Trials in other regions including south western Vic have reported large yield responses (up to 60% yield increase in the 1st year) from treatments of deep ripping and deep placement of high rates (up to 20 t/ha) of chicken litter. The grain yield response is thought to be coming from increasing the plant available water holding capacity of these soils, by improving the structure of the subsoil. Although the cost associated with implementing these treatments is high, with these reported yield gains it is possible to pay for the treatments in the first season.

How was it done?

Seven randomised complete block design trials with three replicates of the same eight treatments were established in March 2015. The trials were located in three different geographic areas including two near Clare at Hill River, two at Hart and three at Bute. At each location the trials were located on different soil types which are described below.

Plot size:	2.5 m x 12.0 m
Seeding date 2017:	**Hill River:** 7th May **Hart:** 7th May **Bute:** 11th May
Seed & fertiliser 2017:	**Hill River:** 110 kg/ha Samira beans, 80 kg/ha DAP kg/ha IBS
	Hart: 90 kg/ha Scepter wheat, 80 kg/ha DAP IBS, 75 kg/ha post emergent urea
	Bute: 60 kg/ha Jumbo 2 lentil, 77 kg/ha MAP IBS

Sites and soil types

Hart east	Calcareous gradational clay loam
	High pH and moderate to high ESP below 30 cm
Hart west	Calcareous loam
	High pH, Boron and ESP below 30 cm
Bute northwest	Calcareous transitional cracking clay
	High pH, Boron and ESP below 30 cm
Bute mid	Calcareous loam
	High pH, Boron and ESP below 60 cm
Bute southwest	Grey cracking clay with high exchangeable sodium at depth
	High pH, Boron and ESP below 30 cm
Hill River east	Black cracking clay
Hill River west	Loam over red clay
	Moderate ESP below 60cm and moderate Boron below 90 cm

The initial treatments (Table 1) were established prior to sowing in 2015. Ripping and subsoil treatments were applied with a purpose built trial machine loaned from Victoria DPI. The machine is capable of ripping to a depth of 60 cm and applying large volumes of product to a depth of 40 cm. Chicken litter was sourced from three separate chicken sheds for ease of freight, the average nutrient content is shown in table 2. After the treatments were implemented the plots at all sites were levelled using an offset disc. Since 2015 only seed and district practise rates of fertiliser have been applied to the plots.

At Hart, in all three years, the trials were sown using narrow points and press wheels on 250 mm spacing. The exception was in 2015 when the Hart west trial was sown with a John Deere 1980 disc. At Bute the three sites were sown using a plot seeder on 225 mm spacing with knifepoints and press wheels in 2015 and in 2016 and 2017 they were sown using a concord seeder on 300 mm spacing with 150 mm sweep points and press wheels. At Hill River the sites were sown using parallelogram knifepoint and press wheel seeder on 250 mm spacing in all three years.

Commercial rates of seeding fertiliser, post emergent urea and pesticides were applied by the growers in their standard paddock operations over the top of all trial treatments to provide adequate nutrition and crop protection for the control treatments.

The rate of chicken litter (20 t/ha) used in these trials was based on work in south western Victoria where large yield responses have been observed. To assess if the results are coming directly from the nutrition in the chicken litter a synthetic fertiliser treatment was applied to replicate the level of nutrition that is found in 20 t/ha of chicken litter at the time. This treatment is made up of 800 kg/ha mono ammonium phosphate (MAP), 704 kg/ha muriate of potash (MoP), 420 kg/ha sulphate of ammonia (SoA) and 1026 kg/ha urea.

Table 1. Treatment list for the seven subsoil manuring sites established pre-seeding 2015.

Treatment	Nutrition	Ripping	Placement
1	Nil	No	Nil
2	Nil	Yes	Nil
3	20 t/ha chicken litter	No	Surface
4	20 t/ha chicken litter	Yes	Surface
5	20 t/ha chicken litter	Yes	Subsoil
6	3 t/ha combo*	No	Surface
7	3 t/ha combo*	Yes	Surface
8	3 t/ha combo*	Yes	Subsoil

* 3 t/ha combo includes MAP, MOP, OA, Urea

Table 2. Average nutrient concentration from the three sources used in the Bute, Hill River and Hart subsoil manuring trials 2015.

Nutrient		Nutrient concentration dry weight	Moisture content	Nutrient concentration fresh weight	Kg nutrient per tonne fresh weight
N	Nitrogen	3.8 %	8%	3.50 %	35.0
P	Phosphorus	1.72 %		1.58 %	15.8
K	Potassium	2.31 %		2.13 %	21.3
S	Sulfur	0.55 %		0.51 %	5.1
Zn	Zinc	0.46 g/kg	8%	0.42 g/kg	0.4
Mn	Manganese	0.51 g/kg		0.47 g/kg	0.5
Cu	Copper	0.13 g/kg		0.12 g/kg	0.1

Measurements in 2017 include grain yield and quality at the Hart sites and grain yield at the Bute and Hill River sites. All results were analysed using ANOVA in the statistical package R.

Results and discussion

Hill River sites

The average bean grain yields for the Hill River sites were 2.89 and 2.11 t/ha for the west and east sites, respectively. The application of chicken litter on the surface in 2015 increased grain yield in 2017 at the east site by 0.64 t/ha but there was no difference at the west site in the absence of ripping (Table 3).

Where the amendments (chicken litter or matched fertiliser) were applied to the surface and the treatments were ripped, chicken litter was higher yielding compared to the matched synthetic fertiliser. However, when the plots were not ripped or if the amendment was placed in the subsoil there was no difference at either site between amendment types.

Deep ripping did not affect grain yield at the east site, however at the west site a negative response in grain yield was generally observed. The addition of the chicken litter at the west site to the ripped plots was able to overcome this negative affect.

Table 3. Faba bean grain yield for Hill River subsoil manuring trials 2017.

Treat.	Chicken litter (t/ha)	NPKS	Ripping	Grain yield (t/ha)	
				Hill River East	Hill River West
1	0	No	None	1.84	3.04
2	0	No	Deep rip	1.96	2.75
3	20	No	None	2.48	3.21
4	20	No	Deep rip	2.48	3.13
5	20	No	Deep rip & place	1.89	2.87
6	0	3t/ha combo	None	2.31	2.97
7	0	3t/ha combo	Deep rip	2.03	2.40
8	0	3t/ha combo	Deep rip & place	1.86	2.76
LSD (0.05)				*0.27*	*0.31*

Hart sites

Average wheat grain yields at the west and east sites were 5.00 t/ha and 3.18 t/ha respectively. Frost events in late August explain some of the difference in grain yield between the sites with the lower yielding site (East) situated lower in the landscape. This may also have contributed to the lack of response to amendments and placement within the east trial.

The application of either chicken litter or synthetic fertiliser generally increased grain yields and protein by 0.19 t/ha and 0.9% when applied to the surface at the west site (Table 4a). At the east site the additional nutrition did not affect grain yields but protein was increased by an average of 2.5 percentage points (Table 4b). Screening levels across two Hart trials were low, with all treatments falling below the 5% level. This is in contrast to previous season where high screening levels have been observed in treatments with additional nutrients.

Deep ripping at Hart did not improve grain yield compared to the nil (district practice) treatment. However, in both trials there was an increase in grain protein with ripping, on average 0.4% in the west trial and 0.7% in the east trial.

The placement of the amendment, either on the surface or in the subsoil did not change the response to grain yield or quality. There was no significant difference in test weight within a site, with the west and east sites averaging 74.5 kg/hL and 73.8 kg/hL respectively.

Table 4a. Wheat grain yield and quality for Hart west subsoil manuring trial in 2017.

Treat.	Chicken litter (t/ha)	NPKS	Ripping	Grain yield (t/ha)	Protein (%)	Screenings (%)
1	0	No	None	4.84	12.0	0.8
2	0	No	Deep rip	4.80	12.5	0.8
3	20	No	None	5.21	13.5	0.8
4	20	No	Deep rip	5.08	13.7	0.7
5	20	No	Deep rip & place	4.86	13.0	0.9
6	0	3t/ha combo	None	5.16	12.7	0.8
7	0	3t/ha combo	Deep rip	4.97	13.0	0.9
8	0	3t/ha combo	Deep rip & place	5.09	12.6	0.8
LSD (0.05)				*0.19*	*0.9*	*ns*

Table 4b. Wheat grain yield and quality for Hart east subsoil manuring trial in 2017.

Treat.	Chicken litter (t/ha)	NPKS	Ripping	Grain yield (t/ha)	Protein (%)	Screenings (%)
1	0	No	None	3.18	13.0	0.8
2	0	No	Deep rip	3.10	13.4	1.0
3	20	No	None	3.29	15.8	1.3
4	20	No	Deep rip	3.06	16.2	1.3
5	20	No	Deep rip & place	3.03	15.3	1.0
6	0	3t/ha combo	None	3.51	14.7	1.2
7	0	3t/ha combo	Deep rip	3.07	15.9	1.6
8	0	3t/ha combo	Deep rip & place	3.19	15.9	1.2
LSD (0.05)				*ns*	*0.4*	*0.4*

Bute Sites

Treatments with no additional nutrition added in 2015 were the highest yielding at all sites at Bute in 2017, but particularly at the mid and south east sites (Table 5).

The inclusion of ripping in the treatment did not increase grain yield at two of the three sites, however at the south east site yield increased by 0.17 t/ha and was the single highest yielding treatment in the absence of increased nutrition at this site.

Placement of chicken litter in the subsoil produced marginal improvements in grain yield over surface placement at all three sites, however is was not significant at the mid site and both treatments were less than the control at all sites. The deep placement of the synthetic fertiliser was not significantly different to surface placement.

Table 5. Lentil grain yield for the Bute subsoil manuring trial in 2017.

Treat.	Chicken litter (t/ha)	NPKS	Ripping	2017 Lentil Grain yield (t/ha)		
				Mid	North west	South east
1	0	No	None	2.61	1.92	1.61
2	0	No	Deep rip	2.44	1.86	1.78
3	20	No	None	2.07	1.58	1.15
4	20	No	Deep rip	1.94	1.59	1.01
5	20	No	Deep rip & place	2.11	1.83	1.26
6	0	3t/ha combo	None	2.23	1.87	1.20
7	0	3t/ha combo	Deep rip	2.26	1.77	1.36
8	0	3t/ha combo	Deep rip & place	2.31	1.73	1.33
LSD (0.05)				*0.36*	*0.14*	*0.14*

Summary / implications

There have been large yield responses reported from subsoil manuring in high rainfall environments, particularly south western Victoria. However, in recent seasons with lower rainfall these yield responses have declined. The results from the first season of the Hart and Bute trials (2015) were negative with the high nutrition treatments and deep ripping producing lower grain yields than the nil. With better crop establishment, wetter and cooler spring conditions and high yield potential in 2016 there were positive yield responses to high nutrition (chicken litter or fertiliser) at three of five cereal sites, however no benefit was observed for deep ripping or deep placement of amendment (results not presented, see 2016 Hart Trial Results book).

In 2017, the results were not dissimilar to those observed in previous seasons, with the highest or equal highest yields coming from the nil (district practice) in four of the seven sites. However, the higher yielding wheat and pulse sites did benefit from some additional nutrition (applied in 2015) at Hart and Hill River.

Interestingly, in the two seasons where lentils have been grown (2016 Hart and 2017 Bute), there has been a negative response to surface applied chicken litter at all five sites. At three of the five lentil sites the negative chicken litter effect was negated by placement in the subsoil, however this was not better than the untreated control. A negative response to matched synthetic fertiliser applied to the surface was observed at three of five sites.

As in previous years there were very few positive responses to deep ripping treatments across the seven sites in 2017. Therefore, caution should be taken when considering deep ripping on these soil types and environments. It should be noted that other trials on sandy soil types located in close proximity to the Bute sites have shown large yield gains can be made in some areas with the implementation of deep ripping. The results presented in this report however, shows it is important to know your soil types and the areas where deep ripping could reduce grain yields.

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Establishing deep ripping treatments