A Sustainable Dryland Community Achieved Through Proactive Research on Effective Management of the Soil Resource (Liebe Group Soil Health Project)

Aim: To evaluate the effect on wheat yield and quality of applying ameliorants at depth on a Wodjil soil (Graveyard Trial).

Research Officer: David Scholz, Gavin Bignell, Peter Bryant
Company: Liebe Group

Farmer: Peter Bryant
Location: Latham

Background: Sub soil acidity is a massive problem across the wheatbelt, with the deep sand (eg. Wodjil) the worst affected. Farmers have been concentrating on the top 10 cm of soil for the last century, however roots can travel below that depth to access water and nutrients. By combining a deep ripping effect and adding nutrients to the soil, the objective was to make these subsoils less hostile for root growth.

Trial Details:

Plot size and replication	12 plots of 1m x 0.5m, randomised, not replicated.
Soil type	Acidic sand
Sowing date	27th May 2003
Conditions at sowing	Moist
Machinery	FlexiCoil
Seeding rate	70 kg/ha Arrino
Fertiliser	60 kg/ha MAPSZC, 50 kg/ha Urea
Herbicides and Insecticides	1.4 L/ha Glyphosate, 0.25 L/ha Ester
Paddock History	2002 = Failed lupins, 2001 = Wheat.

Trial Design: Treatments were applied at depth (1-6) and on the surface (7-12) on the 2nd April. For depth applied treatments, the topsoil was removed, then a backhoe was used to remove the soil down to depth of 1 metre. The soil was replaced while mixing the ameliorants through the soil. The depth applied control was simply dug up and replaced to resemble a deep ripping effect.

Rates are high to account for every 10 cm layer down to 1 metre. The topsoil was then replaced and the plots were seeded with Peter's FlexiCoil. For the surface applied treatments, the rates were equivalent to the total amount of product going into the "grave", to investigate if higher rates on the surface will lead to higher yield. These treatments were placed directly behind their respective depth applied treatments.

Plot
1&7 Lime only at a rate of 10 t/ha
2&8 Muriate of Potash 200 kg/ha, plus trace elements (k+te)
3&9 Lime 10 t/ha, Muriate of potash 200 kg/ha, trace elements equivalent to 3.6kg Mg, 2.9kg Mn, 1.25kg Cu 1kg Zn, 4kg Mo, 6kg S (lime+k+te)
4&10 Gypsum 10 t/ha
5&11 10kg of sheep manure, rate of 100 t/ha
6&12 Control

Results: Simply digging up the soil and replacing it gave a dramatic increase in yield without adding any ameliorants (Table 1). A 208% yield increase was recorded for the deep ripped treatment compared to the control. This was also reflected in the harvest indices, which measures the efficiency of the crop to convert biomass into grain. All except for the manure treatment, the harvest index was increased in the depth treatment compared to surface applied.

There is a yield increase with every treatment when it was dug in, however it is hard to distinguish any increased nutrient availability from a deep ripping effect. This deep ripping effect would not only remove any compaction, but it would promote enhanced water penetration, which again may be the reason for the huge yield increases.

Table 1: Grain Yield, Protein and Harvest Index for the Graveyard Trial

TREATMENT	Surface Applied (T/Ha)	Depth Applied (T/Ha)	Surface Applied Protein(%)	Depth Applied Protein(%)	Surface Applied Harvest Index (%)	Depth Applied Harvest Index (%)
Lime	**2.48**	**3.91**	13.7	13	47.42	51.45
K+te	**3.59**	**4.14**	13	12.7	48.23	51.19
lime+k+te	**3.05**	**4.23**	13.4	12.8	47.19	50.03
Gypsum	**3.80**	**4.52**	13.3	13.7	47.62	49.82
Manure	**3.17**	**5.24**	14.3	16.5	47.64	44.00
Control	**2.82**	**5.87**	13.6	12.3	50.39	50.45

Protein was greatly increased with the depth applied manure treatment, indicating that N resources were probably adequate and the plants may have run out of water. This is confirmed by the lower harvest index showing that not enough biomass was converted into grain. Visually the surface applied manure treatment probably suffered from a haying off effect.

Measurements for pH and moisture were taken at harvest time. It is important to note that no product was applied to the top 10 cm of the depth treatments. Lime+k+te applied to the surface gave a pH of 6.49 in the top 10 cm (Table 2). Lime applied at the surface (10 T/ha) recorded a pH of 5.42, and it didn't appear to have moved down the profile. Manure surface applied returned a pH of 5.87.

Lime at depth was pH 5.16 in the 10-30 region, whereas lime+k+te applied at depth gave a pH of 6.49 in the 30-60 region. Because no initial pH measurements were recorded for each individual plot, the treatments cannot be compared, because any change may simply be a result of soil type variation.

Table 2: pH and Moisture measurements of surface and depth applied treatments, down to 60 cm

Treatments	Depth	Surface treatment pH	Depth treatment pH	Surface treatment moisture (%)	Depth treatment moisture (%)
lime	0 to 10	5.42	5.17	1.16	0.84
lime	10 to 30	4.47	5.16	3.50	3.03
lime	30 to 60	3.94	4.4	5.15	4.13
k+te	0 to 10	5.22	5.2	1.01	1.11
k+te	10 to 30	4.07	4.4	2.64	2.70
k+te	30 to 60	3.94	3.92	4.46	4.10
lime+k+te	0 to 10	6.49	5.09	0.60	0.91
lime+k+te	10 to 30	5.59	4.79	3.30	2.86
lime+k+te	30 to 60	4.37	6.52	4.69	4.08
gypsum	0 to 10	5.5	4.97	0.94	1.19
gypsum	10 to 30	4.28	4.36	3.31	2.85
gypsum	30 to 60	4.09	3.96	4.76	4.13
manure	0 to 10	5.87	4.87	1.22	0.82
manure	10 to 30	4.1	4.4	3.22	2.81
manure	30 to 60	3.94	3.97	4.75	4.17
control	0 to 10	4.63	5.11	1.64	0.98
control	10 to 30	4	4.67	4.52	2.64
control	30 to 60	3.81	3.89	5.26	4.08

The soil in the grave pits sank, which would have directed water into these pits. Table 2 shows there was less moisture left in the dug-up plots either due to more water leaching down the profile, plant roots extracting more water from that depth or the wilting point being reached (maximum amount of water a crop can extract from a soil).

This was really only a demonstration and although it shows that a combination of deep ripping and applying nutrients and ameliorants at depth could produce large increases in yield, these results need to be interpreted carefully. There was no replication in this trial, so any differences may be due to soil type variation or some other factor. The pits were also very thin, and taking measurements by hand may not have been accurate due to incorrect seed distribution and/or sampling error. A sly fox also decided to dig up one of the pits, which was not very nice.

Summary:

- This demonstration showed there may be a large deep ripping effect, given the control (simply dug up and replaced) gave the largest yield increase.
- Lime+k+te and lime applied to the subsoil gave high pH readings at depths 10-30 cm and 30-60 cm.
- This demonstration shows that deep banding of nutrients and ameliorants may be the answer to high wheat production off our acid soils, however a fully replicated and randomised trial is needed to reinforce, or discount, these results.
- It will be interesting to keep measuring these plots next year and the year after to compare those measurements, and see if the results are similar.

The Liebe Group would like to acknowledge Peter Bryant for the idea, Paul Jefferys for trial design and technical assistance, Nick Royal for the use of the backhoe and Steve Carr for advice and access to lime.