2022 was a good year for barley growing on an ameliorated deep repellent sand at Murlong

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Location
Murlong
Mark & Amy Siviour and family

Rainfall
Av. Annual: 332 mm
Av. GSR: 248 mm
2022 Total: 471 mm
2022 GSR: 295 mm

Yield
Potential: Wheat - 4.8 t/ha (French/Schultz)
Actual: 4.0 t/ha in best treatment

Paddock History
2021: Wheat
2020: Vetch
2019: Barley
2018: Wheat
2017: Barley

Soil type
Deep white siliceous sand over clay

Soil test
Low fertility throughout for P, N and trace elements. Severely water repellent and compacted

Plot size
25 m x 6 rows x 4 reps

Trial design
RCBD

Yield limiting factors
Late start, dry July

Key messages

- **Deep tillage boosted crop growth and yield five years after implementation. Spading was the most effective tillage type, closely followed by deep ripping (to 40 cm) with inclusion plates.**
- **Incorporated organic and nutrient amendments had not provided additional yield after the first year, until 2022 when they increased wheat yields by at least 300 kg/ha when incorporated by spading.**
- **Only low cost soil amendments will be viable.**

Why do the trial?

Deep tillage can deliver large yield increases in compacted sandy soils. However, in 2018 when this trial was established, it was uncertain whether thorough mixing/dilution of the topsoil or adding amendments during this operation would be effective and profitable. It was also a time when inclusion plates were relatively new and their ability to increase mixing of surface applied amendments and/or topsoil, potentially with less risk of soil erosion compared to spading, was largely untested.

This trial aimed to:

- Determine if soil mixing and loosening improves yield in a sandy soil on the eastern EP (using a rotary spader).
- Compare deep ripping with inclusion plates to spading.
- Identify if the addition of fertilisers or organic material provided additional benefits.

This article summarises crop growth responses from treatments in the fifth crop post amelioration and the accumulated grain yield benefit over five years. For details of past trial results, see the article in the 2021 EPFS Summary: Ameliorating a deep repellent sand at Murlong four years ago still improved wheat performance in 2021.

How was it done?

The trial is located on a broad sand dune at Murlong on the eastern Eyre Peninsula and comprises eleven treatments by 4 replicates. Constraints at the site include severe water repellence, compaction (bulk density >1.7 at 12 cm), low organic carbon and poor nutrient fertility. Spartacus CL barley was seeded in 2022 (Table 1).

Crop performance in an unmodified control has been compared to spading to 30 cm or ripping with inclusion plates to 2 depths (30 cm or 41 cm) with and without the addition of high rates of mineral fertiliser or lucerne pellets (Table 1). All amelioration treatments were applied in 2018 and have not been re-applied since except for a new treatment in 2022 which was ripping to 41 cm with inclusion plates.

Plant measurements included crop establishment, biomass at flowering and grain yield and quality (quality yet to be assessed). Data was analysed using standard ANOVA models in Statistix 8.

Table 1. Trial establishment and cropping details for 2022 (trial was sown with Razor CL wheat in 2018, Scope CL barley in 2019, RM4 vetch in 2020, Hammer CL wheat in 2021 and Spartacus CL barley in 2022).

Date		
19 April 2018	Amendments applied	Organic Matter: Lucerne pellets at 5 t/ha. Nutrient Package: nutrients applied to match lucerne (N 167, P 14, K 105, S 12, Cu 0.03, Zn 17, Mn 0.18 kg/ha). NPKS applied as granular and trace elements as fluids. Amendments were applied evenly across the surface on spaded plots or in bands to align with ripper tine spacings, immediately prior to spading and ripping.
19 April 2018	Deep tillage details	• Spading to 30 cm at 5 km/hr • Ripped: 4 tines at 64 cm spacings, with inclusion plates positioned 10 cm below the soil surface and operated at 5 km/hr. • Shallow ripped (corresponding to the depth of spading) to 30 cm with 20 cm tall inclusion plates. • Deep ripped to 41 cm with 30 cm tall inclusion plates.
31 May 2022	Sowing, adjacent to 2021 crop rows	60 kg/ha Maximus CL barley at 25.4 cm row spacing + DAP at 60 kg/ha and 63 kg SOA/ha banded below seed rows (all treatments). SE14 wetter sprayed into all seed rows at 4 L/ha.

What happened?

The season at Murlong in 2022 was the best we have experienced in the five years at the site, with barley yields between 2.5 and 4 t/ha (Figure 1). Spading and ripping continued to improve crop production even though they were originally applied in 2018 (Table 2). Barley yields increased by nearly 1 t/ha with either deep ripping or spading in 2022. Shallow ripping was less effective but still better than the unmodified control. Barley growing in plots deep ripped 5 years ago performed similarly to barley growing in plots deep ripped just prior to seeding in 2022 which shows that the benefits of physical intervention on these sands persist for a long time (noting that the trial has not been trafficked by heavy vehicles over those 5 years).

Barley established well in all treatments, averaging 80 plants per m^2 across the site. Numbers were slightly lower in shallow ripping treatments compared to spading, suggesting that the extra mixing with spading is still having a small and positive impact on water repellency. Deep ripping had plant populations in between shallow ripping and spading.

For the first time since 2018, amendments increased crop yields over and above the impact of soil loosening and mixing, but only where they had been incorporated by spading. Both types of amendments increased barley yields by more than 0.3 t/ha.

The accumulated benefits in grain yields over 5 crops at this site are now large (Table 2). The unmodified control produced a total of only 4.3 t/ha over the 5 crops but amelioration by either deep ripping or spading increased this total by an extra 3.5 t/ha or 4.3 t/ha, respectively. The increase in accumulated grain over the 5 crops was much smaller but still 2.1 t/ha with shallow ripping. Incorporating a package of mineral fertilisers or lucerne hay in the ripping or spading operations only produced substantial increases in accumulated grain production where they had been incorporated by spading. Mineral fertilisers and lucerne amendments resulted in 2 t/ha of more accumulated grain when incorporated by spading but these increases largely came in the first year with another useful increase only in the fifth year (Table 2).

The cost of spading is commonly between $150 and $180/ha, whereas deep ripping with inclusion plates is estimated at $55 to $120 per hectare, depending on the depth of ripping (Davies *et al*. 2019). Given its cheaper implementation cost and lower erosion risk, with more than 3 t/ha of extra grain over the 5 years, deep ripping with inclusion plates was a competitive alternative to spading. Even shallow ripping resulted in more than 2 t/ha of extra grain over the 5 years. However, amendments only produced substantial increases in grain production when they were incorporated by spading which suggests that spading was a more effective tool than ripping if amendments are involved in the amelioration operation.

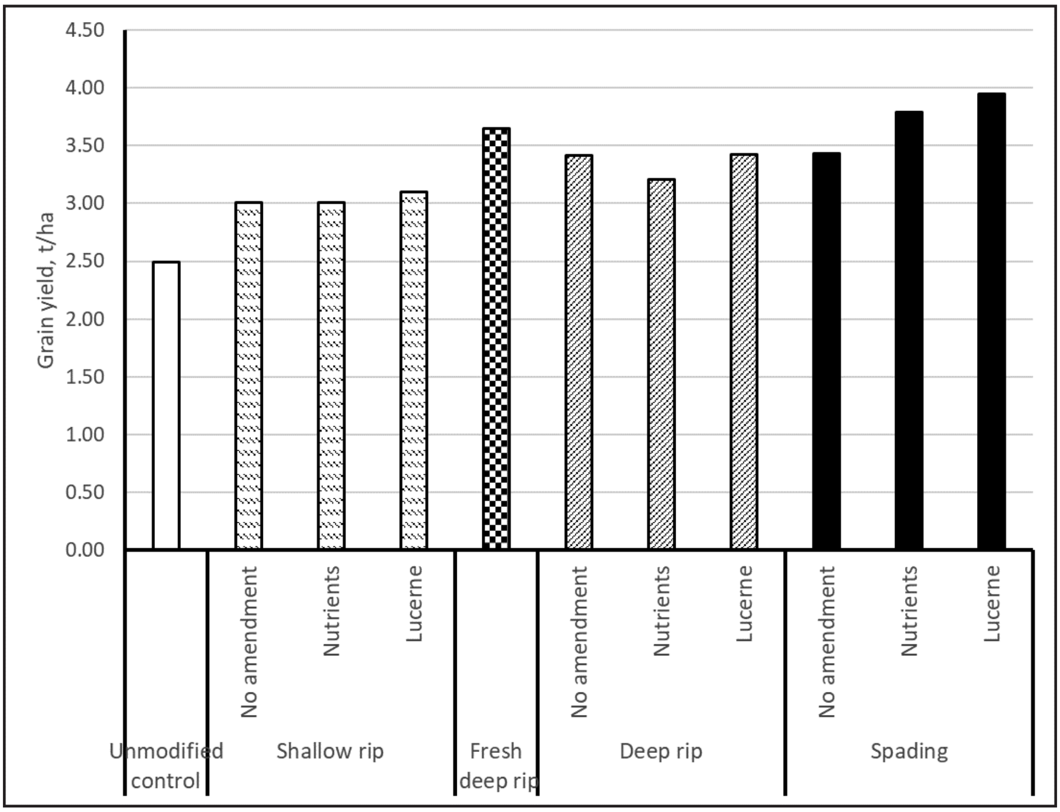

Figure 1. Effects of deep tillage and incorporated amendments on grain yield of barley at Murlong in 2022 (LSD, P = 0.05 is 0.25).

Table 2. Cumulative grain yield of crops (t/ha) with various amelioration strategies at Murlong from 2018 to 2022.

Physical intervention	**Amendment**	**Wheat in 2018**	**Barley in 2019**	**Vetch in 2020**	**Wheat in 2021**	**Barley in 2022**	**Cumulative grain yield**
None	None	0.48	0.72	0.19	0.45	2.49	4.33
Shallow Ripping	None	0.99	1.33	0.47	0.62	3.00	6.41
	Nutrients	1.2	1.37	0.52	0.57	3.00	6.66
	Lucerne	1.19	1.25	0.48	0.62	3.10	6.64
Deep ripping in 2022						3.65	
Deep Ripping	None	1.41	1.62	0.56	0.8	3.41	7.8
	Nutrients	1.9	1.52	0.49	0.72	3.20	7.83
	Lucerne	1.8	1.74	0.66	0.8	3.42	8.42
Spading	None	1.9	1.64	0.76	0.84	3.43	8.57
	Nutrients	3.22	1.83	0.72	0.98	3.79	10.54
	Lucerne	3.12	1.81	0.84	0.97	3.97	10.71
LSD (P=0.05)						*0.25*	*0.78*

Note: LSD for cumulative yield was calculated for a factorial analysis of disturbance x amendment (i.e. controls excluded).

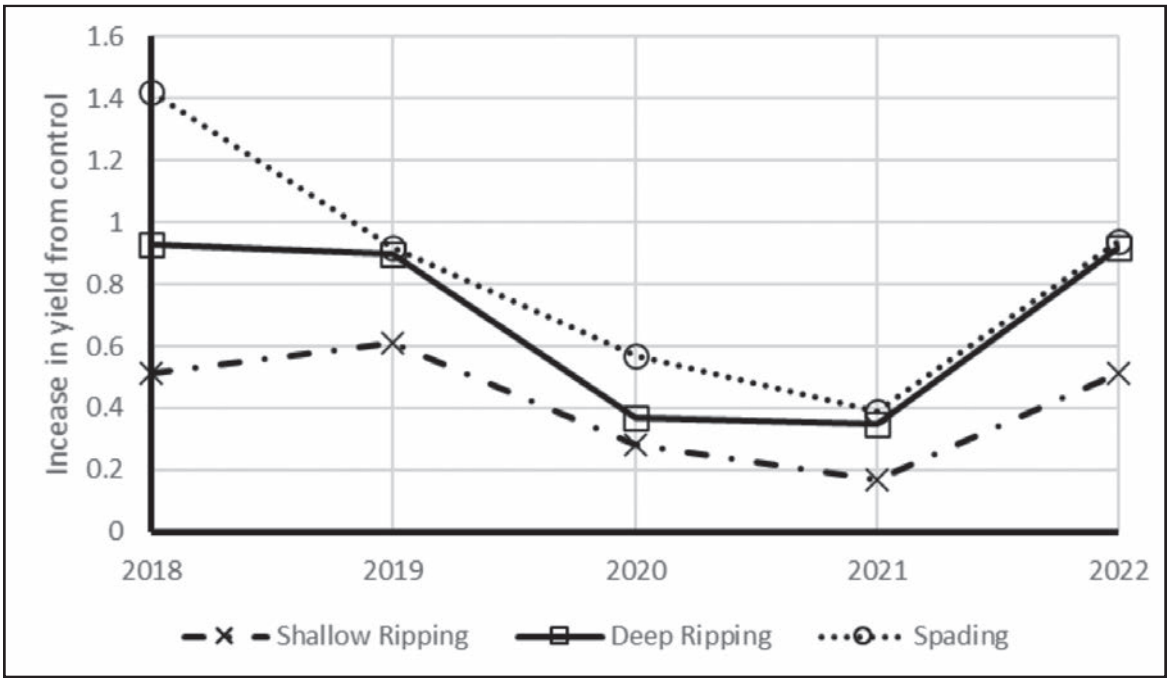

Figure 2. Benefits to grain yield of crops (increase in t/ha from unmodified controls) with 3 physical interventions at Murlong from 2018 to 2022 (amendments not included).

Soils

What does this mean?

Five consecutive crops have now been monitored on this deep, water repellent sand at Murlong. Figure 2 shows that there is a strong seasonal impact on responsiveness of crops to physical disturbance but a declining trend in yield benefits has now been reversed by the very good year in 2022. Benefits continuing beyond the fifth crop seems a likely prospect.

Spading has proven to be the most effective type of deep tillage for improved grain yield so far; even at a cost of $180/ha it has proven a good return on investment. Ripping to 40 cm with inclusion plates and wide rows (60 cm) is also providing very competitive economic returns. Additionally, soil erosion risk is a critical consideration when physically disturbing fragile sandy soils. Deep ripping interventions can be undertaken in a manner that does not leave the soil as vulnerable to wind erosion as can occur with operations like spading but spading appears to be a better tool for incorporating amendments if that is part of the amelioration strategy. However, our experiences with incorporating high rates of fertiliser or organic matter (OM) are that the economic returns rarely justify the effort. Even with an extra 2 t/ha of grain over 5 years as was the case at Murlong, the cost:benefit outcome seems marginal.

An opportunity for further research in this space is to identify management strategies which will improve and prolong the benefits of physical loosening of compacted sands.

The Sandy soils project which has supported the work at Murlong finalises in 2023 so 2022 was the last season for this trial.

Acknowledgements

Farmer Co-operator: Mark and Amy Siviour and family. Spader: University of South Australia, Groocock Soil Improvement.

This work is funded under the GRDC project "Increasing production on Sandy Soils in low and medium rainfall areas of the Southern region" (CSP00203); a collaboration between the CSIRO, the University of South Australia, the SA Government Department of Primary Industries and Regions, Mallee Sustainable Farming Inc., Frontier Farming Systems and Trengove Consulting. The authors acknowledge the expert support of the SARDI Agronomy teams at Pt Lincoln and Minnipa for delivery of the trials.

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