IMPROVED GRAZING PRODUCTION ON NON-WETTING SANDS

DEEP TILLAGE CASE STUDY

This case study explores the effectiveness of deep ripping and nutrition on soil fertility and biomass production.

AT A GLANCE

Challenges

- Sandy soils are naturally deficient in most essential plant nutrients and are prone to compaction.

Opportunities

- Deep tillage can overcome compaction and reduce water repellence.
- Nutrient deficiencies can be addressed with fertilisers and organic amendments such as compost.

This paddock of veldt grass and lucerne was due for renovation. We were worried about establishing a new pasture as the soil is severely water repellent.

The demonstration lets us see and measure pasture response to different strategies at the paddock scale.

Nigel Williams

Owner Manager, Karwin Nominees - Field

BACKGROUND

An 18ha pasture paddock at Field, near Coonalpyn SA, was selected to demonstrate strategies to overcome sandy soil constraints. The paddock is characterised by deep sandy soils (Image 1) and a heavier flat on the northern end, where clay is found at 40cm.

Soil sampling in 2021 confirmed the paddock to be severely water repellent and deficient in potassium, with marginal sulphur and phosphorus. The deep sand had high soil strength below 25cm, indicating compaction and had low nutrient retention capacity throughout.

Consultation with local farmers confirmed they were interested in testing deep ripping strategies to overcome high soil strength and to treat water repellence, which is a very common constraint in the district. There was resistance to testing implements that invert or intensively mix the soil profile, as these practices can increase the risk of wind erosion.

In autumn 2022, treatments were applied on plots 1.6 ha in size to:

- Treat nutrient deficiencies using both mineral fertiliser and compost.
- Treat deep soil compaction.
- Dilute water repellent surface soil layers.
- Incorporate topsoil and nutrients into the subsoil.

These treatments are tested against a no-tillage control (Image 2) and will be monitored until 2025.

Image 1. Soil profile from the deep sand dune prior to any treatment being applied.

TREATMENT DETAILS

1) Custom Fertiliser: a blend of mono-ammonium phosphate, muriate of potash and sulphate of ammonia ($1596/t ex Meningie) was spread at 325 kg/ha to supply 30N, 33P, 50K and 20S kg/ha ($519/ha).

2) Custom Compost: 50% mushroom compost, 25% aged chicken manure and 25% cultured compost ($50/t landed) was spread at 4 t/ha, supplying 67N, 19P, 52K, 30S and 126Ca kg/ha ($200/ha).

3) Bednar Terraland Chisel Plough with Active-Mix tines: 6.2m working width, 15 tines on 43cm spacings. Tine shape provides easy soil penetration with optimised loosening to 55cm. Mixing and levelling in one pass, using hydraulic spiked roller packers. Approx. $150-165/ha contactor rate.

4) Agrowplow AP91 Deep Ripper with inclusion plates: 6m wide, 16 shanks on 54.5cm spacings. The shank is straight with a narrow profile to shatter compacted soil down to 60cm. Shallow leading edge tines work in-line with deeper rear tines to reduce draft force. Inclusion plates were fitted to funnel topsoil into the rip line. Approx. $90-120/ha.

Image credit: Google Earth

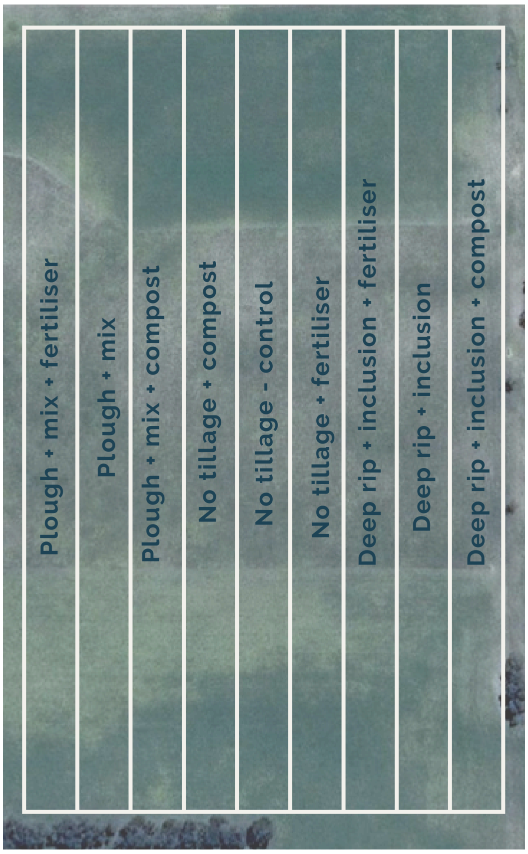

Image 2. Trial map (9 treatments x 1.6ha).

1.CUSTOM FERTILISER

2.CUSTOM COMPOST

3.CHISEL PLOUGH + MIX

4. DEEP RIP + INCLUSION

YEAR 1 RESULTS

Penetration resistance (PR) is a measure of soil strength, indicating the presence of compacted or hard set soils. Plant root growth is restricted in soils with high strength, particularly when the PR exceeds 2,500 kilopascals (kPa; blue dotted line, Figure 1).

- PR across the deep sand was measured in spring 2021, showing the soil strength increased down the profile, exceeding 2,500 kPa below 25cm (grey line, Figure 1).
- Deep ripping with the Agrowplow in Autumn 2022 reduced the PR throughout the profile to 45cm (green line, Figure 1).
- Chisel ploughing the soil with the Bednar Terraland also reduced the PR throughout the top 50 cm of soil (blue line, Figure 1).

Molarity of ethanol droplet test (MED) is a laboratory test that assesses the severity of water repellence. Samples collected after deep tillage showed:

- Control (no tillage) and the Deep rip + inclusion were both severely repellent in the 0-5cm layer and moderately repellent in the 5-10cm layer (MED 2.5 and 1.5 respectively).
- Chisel plough + mix showed some dilution, being moderately repellent in both depths (MED 1.5).

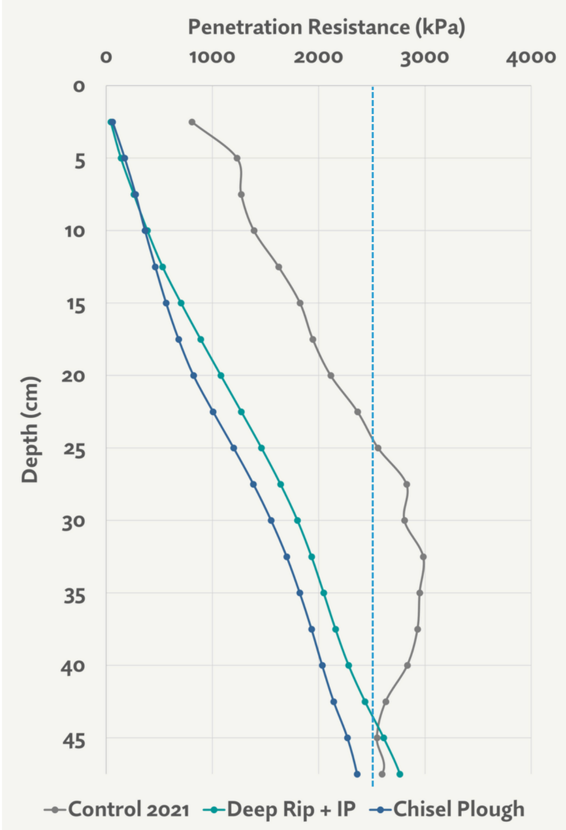

Figure 1. Penetration resistance (kPa) before and after deep tillage.

Table 1. 2022 plant production measures: barley crop establishment (plants/m2); dry matter (DM) yield (t/ha) in September, prior to grazing; DM in November, following recovery from grazing; dry matter digestibility (DMD); crude protein (CP); metabolisable energy (ME). Treatments with the same letter are not significantly different.

Treatment	Established plants /m2	DM t/ha September	DM t/ha November	DMD %	CP %	ME MJ/kg
Plough + mix + fertiliser	31 ab	1.25 bc	3.80 a	57.5	8.5	8.3
Plough + mix	33 ab	0.68 d	3.25 b	64.3	9.1	9.4
Plough + mix + compost	40 a	1.93 a	2.73 c	62.3	8.2	9.1
No tillage + compost	41 a	0.75 d	2.77 c	66.4	9.1	9.8
No tillage (control)	26 b	1.01 bcd	2.87 c	65.4	9.1	9.6
No tillage + fertiliser	33 ab	0.90 cd	2.88 c	64.6	9.0	9.5
Deep rip + inclusion + fertiliser	35 ab	1.46 ab	2.31 d	63.6	9.0	9.3
Deep rip + inclusion	27 b	1.02 bcd	1.88 e	67.2	8.9	10.0
Deep rip + inclusion + compost	33 ab	1.11 bcd	2.37 d	63.6	8.4	9.3
LSD (p=0.05)	11	0.47	0.34	-	-	-

YEAR 1 RESULTS

Scope barley was planted on 2 June 2022, following light cultivation with a speed tiller. Crop establishment was assessed on 5 July by counting 2x1m crop rows in 15 locations per treatment. Crop biomass was measured on 8 September by harvesting 2x0.5m crop rows to ground level in 12 locations per treatment. A second biomass assessment was conducted on 3 November, following recovery after grazing. A forage harvester was used on plots 1.3x10m in size; 9 plots were harvested per treatment. Subsamples from each plot were retained and dried to enable dry matter yields to be converted to 0% moisture. A composite sample was sent to FeedTest to assess pasture quality.

Crop establishment was poor across all treatments in 2022, only averaging 33 plants per square metre, owing to the expression of moderate to severe water repellence (Table 1). Plant population was best in the Plough + mix + compost and No tillage + compost treatments, exceeding 40 plants/m2. The No tillage control had the lowest population (26 plants/m2).

Dry matter (DM) assessed in September showed the Plough + mix + compost to be the highest yielding treatment, with >0.9 t/ha of additional DM produced above the control (1.01 t/ha; Table 1). DM varied across the site for all other treatments from 0.68 to 1.46 t/ha, but none of these yields were different to the control.

The crop recovered well from grazing, owing to high spring rainfall and was at early grain fill when DM was assessed in early November. Plough + mix treatments +/- fertiliser were the highest yielding at this sampling time, adding 0.4 to 0.9 t/ha of DM above the control (2.87 t/ha). This additional yield came at the expense of feed quality, with lower dry matter digestibility, crude protein and metabolisable energy (data not replicated). All Deep rip treatments had lower DM yields than the their no tillage counterparts.

Image 3. Plough + mix + compost in November 2022.

The crop was harvested for **grain yield** in December 2022, and whereas the Deep rip treatments had the lowest spring DM, they all produced more grain (Figure 2). The average yield across all Deep ripped treatments was 1.53 t/ha, in comparison to the ploughed and no-tillage treatments at 1.46 and 1.44 t/ha respectively.

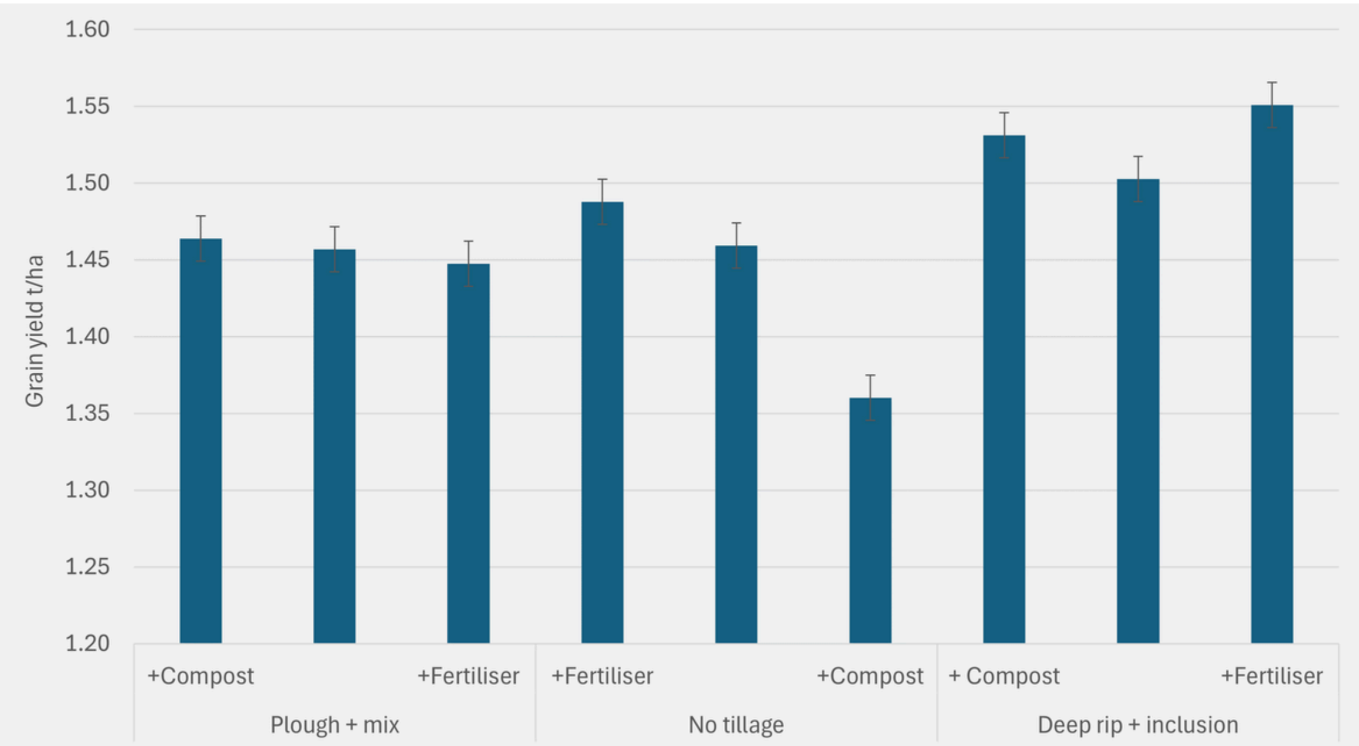

Figure 2. Barley grain yield (t/ha) at Midway in December 2022, following 2 in-season grazing events.

YEAR 2 RESULTS

A thick stand of skeleton weed proliferated across the control plots over the 2022/23 summer. A substantial reduction in weed pressure was seen in the Chisel plough plots (Image 4), suggesting that this tillage type is well suited to controlling these deep rooted perennial weeds in deep sandy soils.

Image 4. Skeleton weed was prolific in the controls in May 2023 (right side of photo), and substantially reduced with ploughing (left).

Water repellence was again assessed in June 2023 by collecting composite samples for each treatment plot, showing that moderate repellence still prevailed across the site in year 2 after amelioration via ploughing or ripping in year 1.

The ploughed plots recorded the best (lowest) MED test result of 1.5, increasing to 1.7 for the deep ripped and 2.0 for the control.

Lucerne was sown across the demonstration site in July 2023 and **crop establishment** was assessed 63 days after sowing (Image 5). The plots that had been ploughed with the Bednar recorded the best field establishment, with an average 34.7 plants/m2, followed by the non-tilled controls with 31 plants/m2, and then the deep ripped plots with 24.3 plants/m2; none of the compost or fertiliser treatments improved plant density.

Image 5. Aerial photo of the site in September 2023.

No further monitoring was conducted in 2023 owing to a very dry spring and summer, resulting in limited plant growth. Monitoring will continue throughout winter 2024.

WHERE TO NEXT?

- Pasture dry matter yield and quality will continue to be measured in 2024 across all treatments.
- Project learnings will continue to be shared via the dedicated project webpage: www.ctsoilhub.au

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