IMPROVED GRAZING PRODUCTION ON NON-WETTING SANDS

DEEP TILLAGE & COMPOST CASE STUDY

This case study explores the effectiveness of deep ripping, soil mixing and nutrition on fodder growth.

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 aged animal manure.

We've had a lucerne stand in this paddock gradually declining over time, so it was due for renovation. We've used the Plozza plow on deep sand before, with varied success.

This demonstration will help us work out which machine is best suited to the job and whether there are additional benefits with adding manure.

Arran Loechel
Manager, Booderoo, Coomandook

BACKGROUND

An 24ha pasture paddock at Coomandook was selected to demonstrate strategies to overcome sandy soil constraints. The paddock is characterised by deep sandy soils (Image 1) and a heavy loam flat on the southern end, where limestone is intercepted from 30cm.

Soil sampling in 2021 confirmed the paddock to be moderately water repellent and deficient in potassium. 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 tillage strategies to treat high soil strength along with implements that invert or intensively mix the soil profile to treat water repellence, which is a very common constraint in the district. Aged piggery manure + bedding straw is available locally and there was interest in its use to boost nutrient fertility and lower erosion risk post-amelioration.

In autumn 2022, treatments were applied on plots 0.4 ha in size to:

- Dilute water repellent surface soil layers.
- Treat deep soil compaction.
- Treat nutrient deficiencies using both mineral fertiliser and aged piggery manure.

These treatments are tested against 3x no-tillage controls (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

Sulphate of potash was applied across the whole trial site prior to tillage at 125 kg/ha supplying 50K and 20S kg/ha ($220/ha).

Aged piggery manure + bedding was surface applied prior to tillage @ 10 t/ha supplying 322N, 80P, 202K, 49S and 134Ca kg/ha (sourced at no cost).

Inversion: a John Shearer one-way plough fitted with 9 'Plozza Plow' discs was used to invert the surface 30 cm of sand. Approx. $50/ha.

Chisel plough: a Bednar Terraland Chisel Plough was configured with 15 tines on 43cm spacings (6.2m working width) and fitted with Active-Mix tines for the 'mix' treatments; the shape of these tines provides easy soil penetration with optimised loosening to 55cm with some bottom-up and top-down mixing. 'Deep rip' treatments were applied using a narrower shank tine and tip, with no plates. De-compaction and levelling is achieved in one pass using hydraulic spiked roller packers. Approx. $150-165/ha contactor rate.

Image 2. Trial map (10 treatments x 0.4ha).

AGED MANURE

INVERSION

CHISEL PLOUGH

ACTIVE MIX

DEEP RIP

Measurements: Normalised difference vegetation index was measured annually using a Trimble Greenseeker by recording 5 transects across the dune crest in each plot.

In 2022, dry matter was assessed by harvesting 0.5m2 quadrats to ground level in 12 locations per treatment. In 2023, a rising plate meter was used, recording 15 dry matter measures across three transects in each plot, calibrated with pasture cuts. Composite subsamples were retained for moisture and quality assessment.

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; black dotted line, Figure 1).

- PR in the No tillage control showed soil strength increasing down the profile from moderate to severe, exceeding 2,500 kPa below 35cm (grey line, Figure 1).
- Inverting the soil with the one-way plough reduced the PR in the profile to 40cm (blue line).
- Chisel ploughing the soil with the Bednar Terraland reduced the PR throughout the top 50 cm of soil; both tines had the same impact on reducing PR (2x green).

A ribbed roller was used to firm the surface of all tillage plots prior to sowing a mixed species pasture on 27th May, comprised of 30kg/ha cereal rye, 30 kg/ha vetch, 2 kg/ha grazing brassica and 1 kg/ha of Balansa clover.

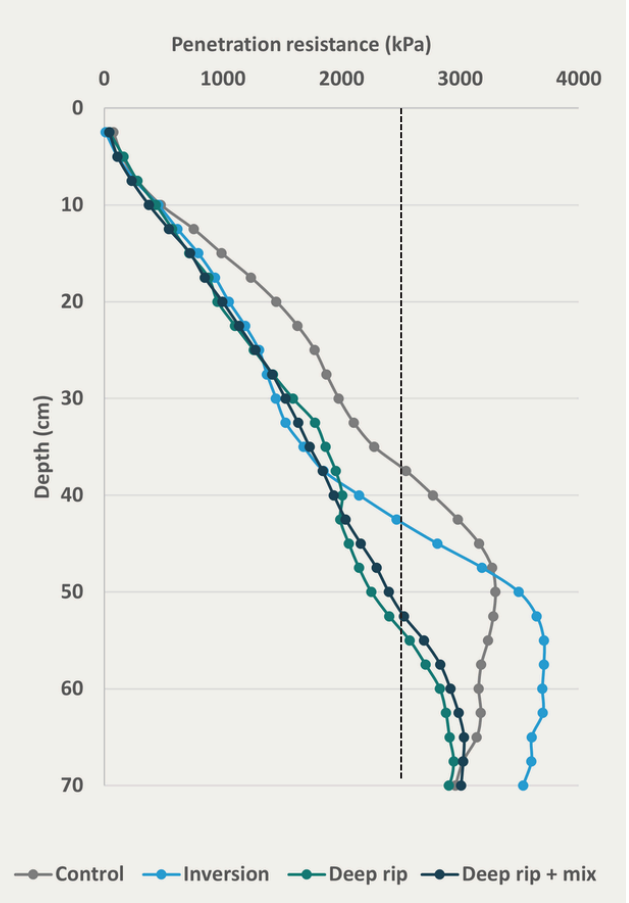

Figure 1. Penetration resistance (kPa) measured in 2022 for each deep tillage type.

Table 1. 2022 production measures: Normalised Difference Vegetation Index (NDVI); dry matter (DM; t/ha) in September; 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	NDVI July	DM t/ha September	DM t/ha November	DMD %	CP %	ME MJ/kg
No tillage	0.37 b	1.48 f	4.19 cd	52.6	8.7	7.4
Deep rip + mix	0.31 b	1.36 f	6.55 a	51.4	9.0	7.2
Deep rip + mix + manure	0.49 a	3.66 b	7.23 a	58.1	11.1	8.4
No tillage + manure	0.36 b	1.66 ef	3.63 de	54.5	9.8	7.8
No tillage (control)	0.31 b	1.40 f	3.19 e	62.9	11.3	9.2
Inversion	0.31 b	2.16 de	4.56 bc	63.6	13.0	9.3
Inversion + manure	0.46 a	4.09 ab	6.59 a	53.9	10.6	7.7
Deep rip + manure	0.49 a	4.35 a	5.34 b	59.6	12.5	8.6
Deep rip	0.44 a	2.98 c	3.47 de	61.0	12.5	8.9
No tillage	0.30 b	2.56 cd	3.14 e	61.8	12.2	9.0
LSD (p=0.05)	0.065	0.47	0.34	-	-	-

YEAR 1 RESULTS

Normalised difference vegetation index (NDVI) results indicated enhanced growth in all of the manure treatments in July, but only when combined with deep tillage (Table 1 and Images 3-5). Deep rip was the only deep tillage treatment that performed better than the three controls in the absence of manure.

Dry matter (DM) measured in September also showed the three deep tillage + manure treatments to be the highest yielding, adding between 1.8 and 2.5 t/ha of additional DM above the average of the three controls (1.8 t/ha; Table 1).

The pasture recovered well from grazing, owing to high spring rainfall. The cereal rye was at early grain fill when DM was assessed in early November (4 weeks post grazing). The Deep rip + mix +/- manure treatments were the highest producing at this sampling time, yielding >6.5 t/ha of DM (3 t/ha more than the average of the three controls = 3.5 t/ha). This additional yield often came at the expense of dry matter digestibility, but there were no consistent trends in crude protein or metabolisable energy (Table 1).

YEAR 2 RESULTS

A mixed species fodder crop was sown across the whole paddock on 25 April 2023, following early autumn rain, composed of 15 kg/ha of cereal rye, 1 kg/ha Balansa clover, 2 kg/ha grazing brassica and 30 kg/ha vetch.

Germination was enhanced on the plots that had been inverted in 2022, and also on another test site within the paddock that was inverted in 2021. This response could be seen in satellite **normalised difference vegetation index** (NDVI) imagery collected in early May (Image 6). NDVI measured with Greenseeker on 25 May showed an average 0.18 across the three controls, improving to 0.24 for the deep rip+mix, 0.25 for the deep rip and 0.41 for the Inversion treatments. The 2022 application of pig manure did not improve NDVI in the control, but improved for all tillage types, recording 0.27, 0.36 and 0.52 for the rip+mix, deep rip and inversion treatments respectively (Images 7 and 8).

Dry matter (DM) was measured in August and September (4 weeks post grazing), showing the Inversion treatments to be the highest yielding, adding between 1.9 and 2.3 t/ha of additional DM above the average of the three controls (3 t/ha; Figure 1). Deep rip was the next best performing.

Image 3. No tillage control - NDVI 0.31

Image 4. Inversion - NDVI 0.31

Image 5. Deep rip + mix + manure - NDVI 0.49

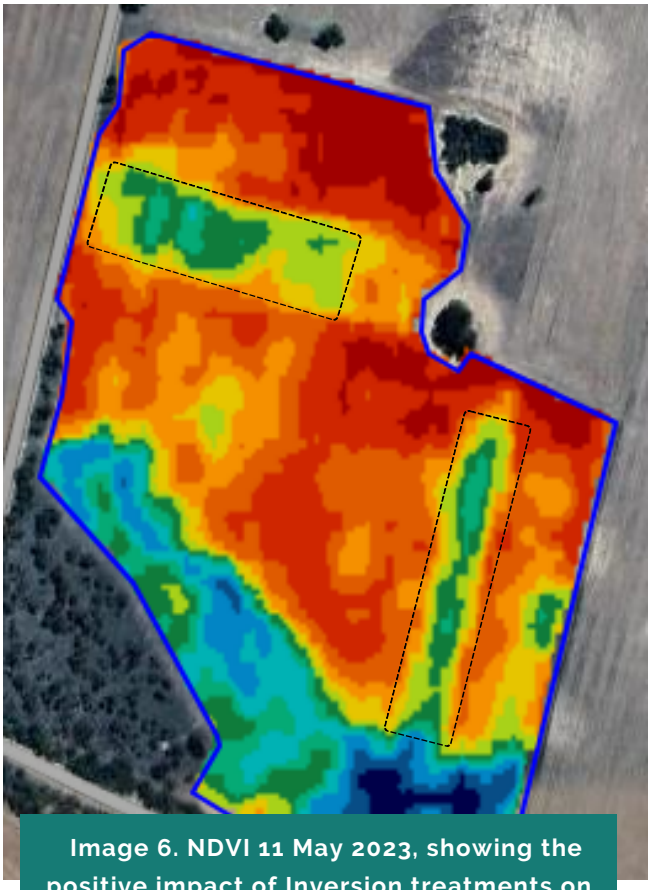

Image credit: PCT-AgCloud

Image 6. NDVI 11 May 2023, showing the positive impact of Inversion treatments on pasture germination (dashed shapes).

YEAR 2 RESULTS

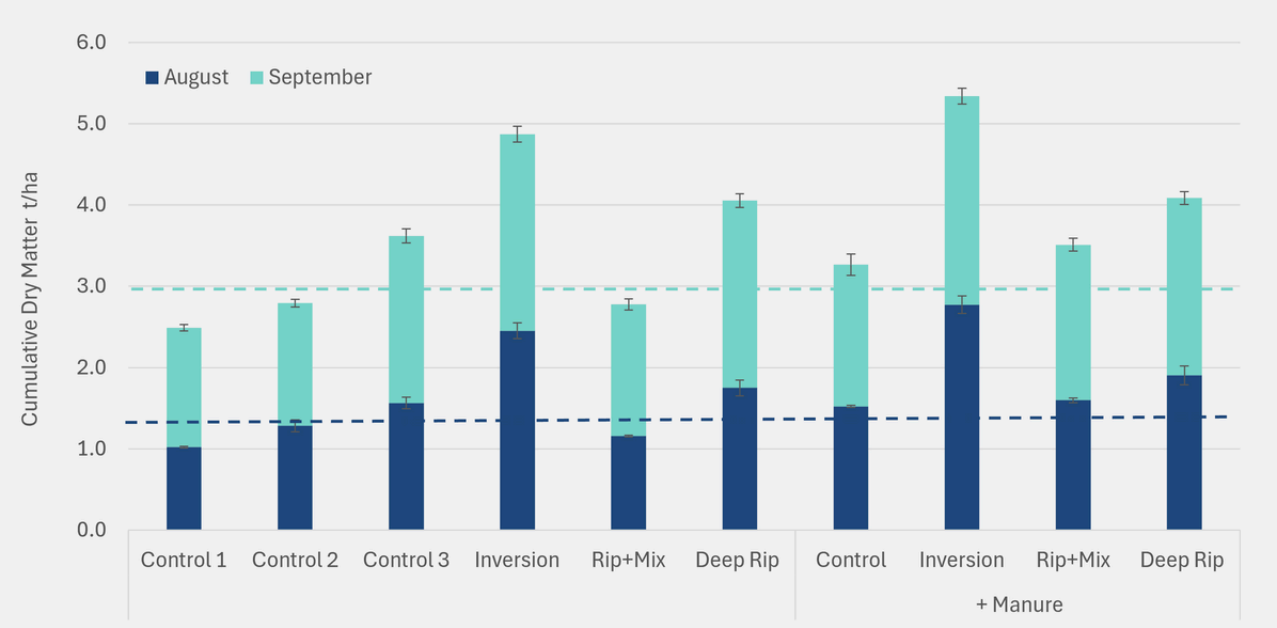

Figure 1. Cumulative pasture dry matter yield (t/ha) at Booderoo measured in August and September 2023. The dashed lines denote the average yield of the 3 control plots at each time of monitoring.

Image 7. NDVI 4 weeks post-sowing 2023.

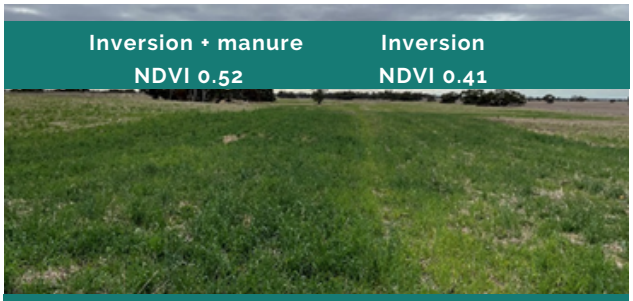

Image 8. NDVI 4 weeks post sowing 2023.

WHERE TO NEXT?

- A crop of barley will be sown across the paddock in 2024 and harvested for grain to demonstrate the value of amelioration in mixed grazing and cropping systems.
- In season monitoring will include establishment assessments, NDVI and grain yield and quality.

Acknowledgements: Many thanks to Tim and Cheryl Freak and Arran and Anika Loechel for access to paddocks, equipment and resources to deliver this case study. Thanks also to the project Steering Committee for ongoing support.

This project is supported by **Meat and Livestock Australia** and the **Coorong Tatiara Local Action Plan - Coorong and Tatiara District Councils**.

Project Duration: July 2019 to June 2026

Project manager: Dr Melissa Fraser, Soil Function Consulting. E:mel@soilfunction.com.au M:0407 773 369