Improving pasture production by overcoming compaction and acidity

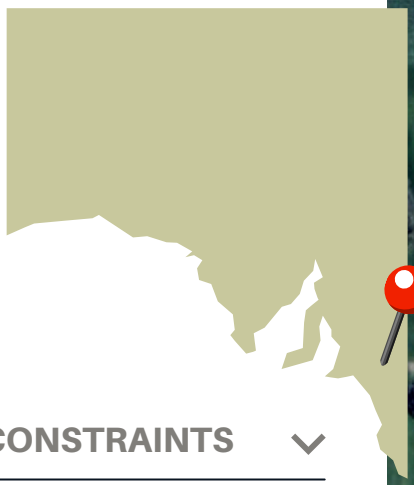
CASE STUDY 4

SNAPSHOT

Farmer name: Justin Hurrell
Location: Naracoorte, SA
Farm Size: 1000 ha
Enterprise: Grazing
Average annual rainfall: 515 mm

KEY MESSAGES

- Deep ripping and spading effectively re-distributed clay through the surface and subsurface layers and uniformly de-compacted the soil
- Water repellence was eliminated in the first year
- Incorporating lime helped neutralise acidity in the first year
- Deep ripping and spading improved crop establishment, NDVI and spring dry matter



SOIL CONSTRAINTS

Acidity, compaction and water repellence constrain pasture production, resulting in poor quality pasture and a 50% reduction in pasture growth. The subsoil clay is sodic from 30 cm depth.

SANDY SOIL CONSTRAINTS

Compaction | Water repellence | Acidity

Area of land affected (ha): 300 | Area of land affected (%): 50% of the Conkar Park block

Trialled

- Lime rates at 3 and 5 t/ha
- Spading and ripping to incorporate lime (to treat acidity), break up compaction and bring up clay (to treat water repellence)

INTRODUCTION

Conkar Park is a 600 ha grazing property located 25 km north east of Naracoorte, in south east South Australia. The property is divided into a "wagon wheel" rotational grazing system, with cells averaging 20ha in size (Figure 1). Conkar Park is just one of the farm's blocks, which totals 1,000ha.

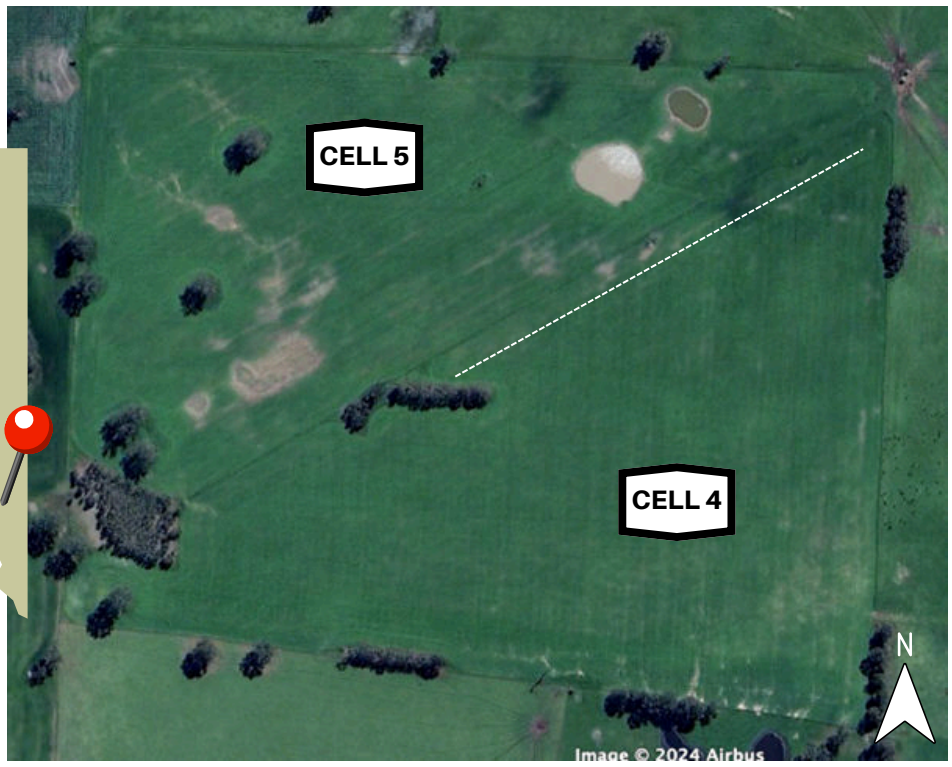


Figure 1. Conkar Park farm map with trials in cells 4 and 5. Both of these cells were ameliorated – 40 ha in total, other than two strips, 4 m wide, that were left un-spaded (white dashed line in cell 4).

Depth (cm)	Repellence	Acidity	Compaction
0-5	Moderate		
5-10	Mild	Moderate (pH 4.98 - 5.17)	
10-15			Severe (>2500 kPa)
15-20		Severe (pH 4.55 - 4.83)	Moderate (>1500 kPa)
20-25			
25-30			
Clay	Sodic (ESP>10)		

Figure 2. Soil in Cell 4. Photo credit: Stacey Solomon – Frontier Farming Systems.

Justin Hurrell commenced as Farm Manager of Conkar Park in 2021. He noticed poor pasture growth and quality in some paddocks, and previous attempts to sow new pasture (Phalaris, cocksfoot and subclover) was largely unsuccessful.

"The pasture was deteriorating and going from clover to barley grass, silver grass and capeweed," he said. "Clover doesn't hang on well, and the perennial grasses aren't doing well."

Being early days in the role, Justin is still getting to know the constraints on the block and exploring the best way to ameliorate them. A liming program using dolomite and magnesite had commenced, using a low liming rate (2 t/ha) and incorporating using a speed tiller, aimed at mitigating both grass tetany and soil acidity.

THE TRIAL

The trial aimed to overcome acidity, water repellence and compaction through a combination of lime, soil mixing and deep ripping. Based on soil test results, lime was applied at 3 t/ha in Cell 4 and 5 t/ha in Cell 5, aiming to keep the pH above 5.5 in the top 10 cm and above 4.8 in the subsurface.

The B horizon clay was severely sodic, but given the soil was acidic to 30 cm depth, lime was the ameliorant of choice (rather than gypsum), supplying both carbonate to neutralise the acidity and calcium to displace sodium.

Lime was incorporated with an Imants spader with deep ripping tynes in the front. The ripping tynes were set at 600 mm depth, with the tynes ripping into the subsoil clay and the spader (working at 400 mm) following behind to incorporate both the clay and the lime. The spader covered 0.9 ha/hr. The spading operator was careful to not bring up too much clay, and while there was some dispersion early on (high June rainfall), it did not impact pasture establishment or cause crusting.

Figure 3. Single pass with the spader, showing lumps of clay that have been brought to the surface.

RESULTS

Soil properties

Ripping + spading, ameliorated or improved all of the tested soil constraints. Compaction was alleviated to just over 30 cm depth. This is demonstrated in Figure 4 as the grey line (control) compared with the black line (ripping + spading).

Water repellence was reduced by spading through a combination of dilution and clay incorporation. While the average clay content was only raised to 4.2% through the top 15 cm, there are still large clods of clay present through the topsoil and subsurface layers.

It is anticipated that these clods will continue to break down and disperse with time and be incorporated further by worms and dung beetles.

Incorporating lime treated acidity and increased soil pH to >5.5 to 25 cm depth. Soil fertility (Table 1) improved with increases in cation exchange capacity, organic carbon, nitrogen, phosphorus and potassium from 5-25 cm depth.

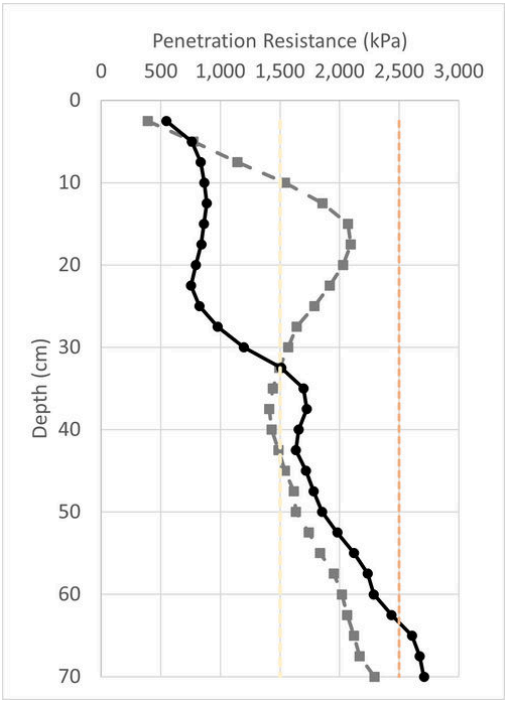


Figure 4. Spading + ripping alleviated compaction in the top 30 cm. Grey line = pre-treatment; black line = post-amelioration.

Table 1. Chemical characteristics of the soil 1 year after amelioration at Conkar Park.

Depth (cm)	Texture/clay (%)	pH (CaCl)	Organic Carbon (%)	Cation exchange capacity (cmol+/kg)	Mineral nitrogen (kg/ha)	Colwell phosphorus (mg/kg)	Exchangeable potassium (mg/kg)
Deep Rip + Spade							
0-5	Sand 3.6	6.4	1.06	3.73	5.7	28	88
5-15	Loamy sand 4.7	6.0	1.12	4.25	4.2	36	35
15-20	Loamy sand 6.1	5.6	1.01	4.08	8.7	31	38
Unmodified control							
0-5	Sand 3.3	6.6	1.4	5.99	2.1	45	85
5-15	Loamy sand 4.1	5.1	1.06	2.25	1.5	22	25
15-25	Loamy sand 3.5	4.6	0.57	0.82	1.5	18	17

Pasture biomass

By removing water repellence, spading + ripping improved pasture establishment by 26 plants/m^2. The treated pasture also showed advanced maturity and vigour (Figure 5), with Justin saying the trial area looked 'magnificent' by November 2023.

While spring dry matter increased by 1.9 t/ha with spading, it had slightly lower metabolisable energy and dry matter digestibility. However, crude protein was higher at 17.9% (Table 2).

Table 2. Pasture establishment, dry matter (DM), metabolisable energy (ME), crude protein (CP) and dry matter digestibility (DMD) at Conkar Park in 2023, following amelioration.

Treatment	Establishment p/m^2	NDVI	DM t/ha (±se)	ME MJ/kg DM	CP %	DMD %
Unmodified Control	97 ±2.4	0.23	2.9 ±0.1	11.3 ±0.2	16.1 ±0.6	75.1 ±0.9
Spade + Rip	123 ±1.2	0.24	4.8 ±0.2	10.5 ±0.6	17.9 ±1.3	70.8 ±0.7

Figure 5. Pasture establishment on the unmodified control (left) and improved establishment, vigour and growth with spading (right).

ECONOMINCS

Liming and spading cost $378/ha. Increases in pasture production resulted in a 3.2 DSE/ha increase in carrying capacity in October, with an estimated value of $472/ha ($189 increase above the control).

125% of the amelioration cost would have been recovered in a single grazing event, demonstrating that amelioration costs can easily be recovered in a grazing system.

However, these costs do not include the extra work required to level the paddock. Trafficability after spading was a problem and the paddock required two passes with a rubber tyre roller and a leveller bar to fill in wheel ruts.

Despite this, Justin says that the process is very economical and worth the investment. “The pasture established really well and persisted into summer even though we didn’t have much rain,” he said.

Historically, delving has been the more common method to ameliorate soil constraints. Delving is more expensive, requiring multiple passes required to level, distribute and incorporate the clay (costing upwards of $1000/ha).

Overall, at $272/ha, a single pass rip + spade is a very cost-effective alternative to delving that has proven to successfully ameliorate the constraints present at this site. The process will be promoted as a viable alternative in grazing systems where B horizon clay can be intercepted within 40 cm of the surface.

NEXT STEPS

“If I do it again next year, I will spade earlier to allow soil to settle,” says Justin. “Ideally I would do it the year before establishing pasture and sow a hay crop. As we would get better weed control.”

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RESOURCES

Soil Hub: https://soilhub.com.au/frances-south-australia/
AgriKnow: https://www.agriknow.com.au/trial/31

PROJECT INFORMATION

Trial run by Dr Melissa Fraser, Soil Function Consulting.
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Building drought resilience by scaling out farming practices that will enhance the productive capacity of sandy soil landscapes.
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