Delving delivers soil and pasture production improvements in the South East

CASE STUDY 3

SNAPSHOT

Farmer name: Jess & James Skeer
Location: Wattle Range, SA
Farm Size: 1200 ha
Enterprise: Dryland and irrigated cropping, dryland pasture for cattle and sheep
Average annual rainfall: 650 mm

KEY MESSAGES

- Delving eliminated water repellence and increased soil fertility. Soil compaction was alleviated to 50cm depth, reducing penetration resistance to < 2,500 kPa.

- Delving increased topsoil pH, however, acidity and nutrient constraints were present after delving. Soil testing is required post amelioration to ensure soil nutrient status is sufficient to match carrying capacity.

- Nitrogen applications after grazing increased recovery of the pasture oat crop (dry matter yield and quality).

SANDY SOIL CONSTRAINTS

Water repellence | Compaction | Low fertility | Acidity

Area of land affected (ha): 540 | **Area of land affected (%): 40**

Trialled

- Delving to alleviate compaction and bring up alkaline clay to treat water repellence and acidity
- Nitrogen to boost pasture recovery after grazing

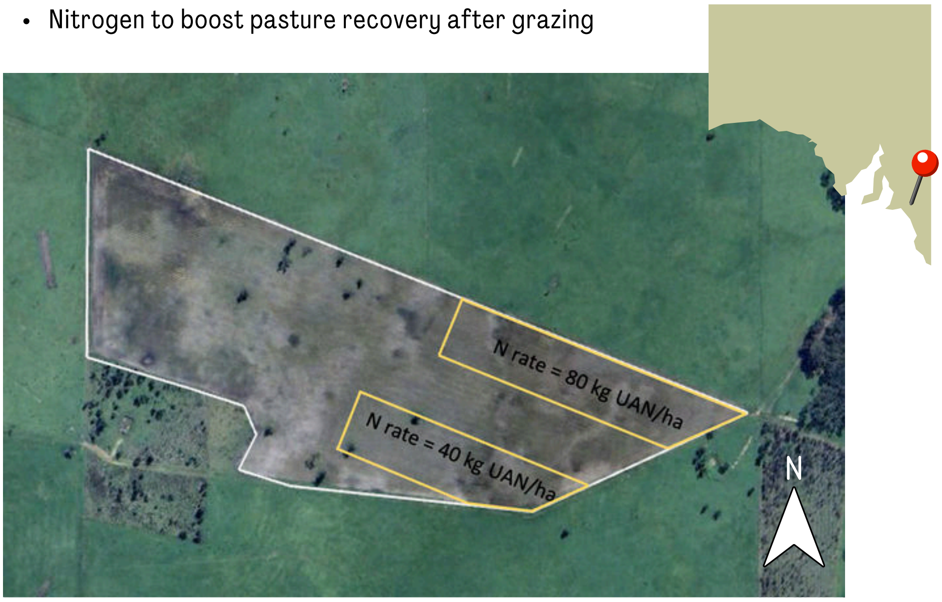

Figure 1. Trial paddock showing the two nitrogen (N) rate applications.

INTRODUCTION

James and Jess Skeer manage their family's 1200 ha grazing property, located 18 km west of Penola in south-east South Australia. The farm hosts a mix of dryland and irrigated cropping, along with dryland pasture production for cattle and sheep grazing.

Low productivity sandy soils cover about 40% of the farm and have a range of issues that affect productivity, including acidity, water repellence, compaction and low fertility. On these sandy soils, there is about a 30% reduction in pasture, and stocking rates are about 60% of better paddocks.

In the past, the Skeer's have tried to improve their pasture establishment but found it challenging due to lack of nutrition, water repellence and acidity. In the early 2000's, they hosted a clay spreading trial using different rates and types of clay, but James says even these sites did not establish well.

"We have attempted to resow some pastures but with all the soil constraints we struggle to get a good pasture going. Two years later and it looks like nothing has changed. It reverts back to acid loving weeds," said James.

SOIL CONSTRAINTS

Soils on this farm (Figure 2) typically have:

- Moderate to severe water repellence in the top 10 cm
- Severe acidity (pH 4.03–4.58) from 10–60 cm
- Very low organic carbon and cation exchange capacity in the A2 horizon, with very low water holding capacity
- Severe deficiencies in phosphorus and potassium
- Severe soil strength below 15 cm (penetration resistance >2500 kPa)

Low pasture productivity and quality is common, owing to severe constraints below the top 10cm, as evidenced by the very high concentration of roots in the surface layer (Figure 2).

Figure 2. Soil profile showing 70 cm of well drained sand, overlying 30 cm of saturated sand, overlying clay at 100 cm; water and sand oozed from this layer when the pit was dug.

THE TRIAL

The trial aimed to:

1. Overcome water repellence, acidity and compaction by clay delving; and,
2. Demonstrate that pastures are responsive to nitrogen application after grazing, boosting feed volume and value.

Delving and incorporating clay aimed to serve multiple purposes:

- neutralising some of the soil acidity with the alkaline clay
- breaking up compaction
- reducing water repellence by increasing topsoil clay content
- boosting soil fertility by increasing topsoil clay content.

Figure 3: Ribbons of clay were delved to the surface in December 2022 and allowed to dry before being cross-worked and incorporated in January and February 2023.

The 40 ha paddock was delved to 50 cm in December 2022. The aim was to bring up as much alkaline clay as possible. James said that the operator was lifting and dropping the delver as he went, but most of the clay was within 50 cm of the surface.

The clay ribbons were left to dry on the surface (Figure 3). In January 2023, the clay ribbons were broken up with railway irons and incorporated with offset discs. A final pass with a spader was planned for April, but early season autumn rain saturated the soil profile and made spading impossible. In May 2023, the paddock was sown to oats for grazing. Nitrogen at 40 and 80 L/ha UAN was then applied in September 2023, after a grazing event to boost recovery.

RESULTS

Soil properties in the paddock were compared to soil from an adjacent, untreated paddock.

Soil constraints

Delving and clay incorporation reduced compaction to 50 cm depth, reducing the penetration resistance (PR) to <2,500 kPa (Figure 4). Root growth is severely restricted above 2,500 kPa. The most noticeable difference in PR was from 20-50 cm depth. Soil strength is still high and the soil will benefit from better mixing and decompaction, as was planned with the spader.

RESULTS cont...

Delving and incorporation changed the soil texture from a sand to a sandy loam, increasing clay content in the top 15 cm to over 10%. This eliminated water repellence and improved soil fertility by raising the cation exchange capacity to >6 cmol+/kg.

Organic carbon content decreased, but a large bank of nitrogen was detected, suggesting substantial mineralisation over the warm and wet summer period. Potassium deficiency was rectified. Phosphorus also showed positive increases, demonstrating the benefit of banding P fertiliser at sowing with annual crops/pastures.

Acidity was not fully treated, with pH remaining acidic below 5 cm depth (4.8 from 5-15 cm and 4.4 from 15-25 cm). The pH of the clay material was only 6.3; it contained no liming material to offer substantial improvements in pH. Exchangeable aluminium is still elevated below 15 cm. Liming is recommended to correct this constraint.

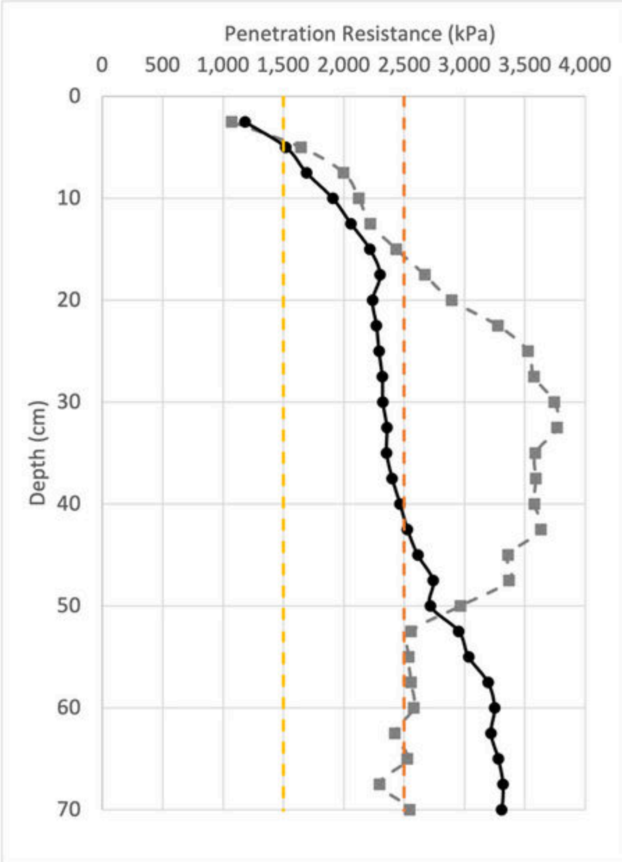

Figure 4. Delving and incorporation reduced compaction in the top 50 cm. Grey line = control, black line = delved soil.

Pasture growth

After grazing, there was 2.4 t/ha dry matter remaining in the paddock in late August 2023.

Pasture recovery was measured with a rising plate meter three weeks after UAN was applied. Pasture growth increased in line with UAN rates:

- 1053 DM kg/ha with no UAN
- 1308 DM kg/ha with 40 L/ha UAN
- 1460 DM kg/ha with 80 L/ha UAN

The impact of this application was visible as both additional biomass, vigour and colour (Figure 5). The UAN 80 treatment had slightly less digestibility and metabolisable energy than the UAN 40 treatment at the time of sampling, but had higher protein.

Nonetheless, a 500 kg cow could consume >190 MJ of energy from this feed (with neutral detergent fibre of 38%), which is well in excess of its daily 149 MJ maintenance energy requirement.

Treatment	DM kg/ha after grazing	DM kg/ha (±se) 3 weeks after UAN application	ME MJ/kg DM	CP %	DMD %
0 N	2,398	3,451±14	12.5	17.1	81.8
UAN 40		3,706±26	12.8	17.1	84.1
UAN 80		3,858±21	12.4	18.2	81.7

Table 1. Oat dry matter (DM), metabolisable energy (ME), crude protein (CP) and dry matter digestibility (DMD) at Nurragi in 2023, three weeks after UAN application.

Figure 5. Recovery in the oats, four weeks after grazing and three weeks after UAN application, showing patchy growth and light green colour in the control, with moderate improvement with an application of 40 L/ha of UAN (left) and substantial improvement in vigour with 80 L/ha of UAN (right).

Economics

The total cost for soil amelioration was $700-800/ha including delving ($500/ha contractor rate) and levelling costs ($200-300/ha farmer machinery). If the spading had been undertaken ($250/ha), costs would have totalled approximately $1000/ha.

Further levelling works will add to the cost, though might not have been necessary if the paddock could have been spaded. “The paddock is quite rough still,” said James, “and this summer when it dries out we need to smooth it out and incorporate the clay. The delver makes a massive disturbance; after that the paddock needs many more passes to make a smoother paddock”.

The fertiliser cost $80/ha for 40L/ha of UAN, and $160/ha for 80L/ha of UAN but only resulted in an extra 260 and 410 kg/ha of DM at the time of sampling. While this cost may seem excessive for the limited return in biomass, applying nitrogen substantially improved recovery in areas where waterlogging was prevalent (Figure 6), indicating nitrogen applications can be used as a strategy to boost recovery and overcome waterlogging in very wet years. Over time, the yield difference would likely increase. Additionally, James noted that at the time urea was hard to get, hence he used the more expensive UAN.

> **James said that while the amelioration cost is substantial, he is hoping to get a return on the work with increased stocking rates.**

NEXT STEPS

Based on results from the trial, James is keen to delve another paddock to bring up clay, then spade to incorporate. He said that delving in general is overcoming the issues, but the challenge is finding paddocks with the right depth to clay and ideally not too uneven.

The high cost of delving and the time needed to spade and level means James will only do small areas at a time.

Figure 6. A patch of waterlogged soil, showing pasture growth and vigour with 80 L/ha UAN applied (left) and no nitrogen applied (right).

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RESOURCES

https://soilhub.com.au/wattle-range-south-australia/
https://www.agriknow.com.au/trial/32

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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