Increasing production on sandy soils – narrowing down what to do and where

CASE STUDY 1 | SOUTHERN TRIAL

SNAPSHOT

Farmer name: James Venning
Location: Bute, SA
Farm Size: 4700 ha
Enterprise: Lentils, canola, wheat and some barley
Average annual rainfall: 400 mm, 280 mm GSR

KEY MESSAGES

- All forms of soil disturbance improved grain yields.
- Adding chicken litter marginally improved yields and grain protein, but physical intervention had a bigger impact.
- Ripping needs to be 40 cm or deeper to get a consistent response. Ripping to 60 cm gave the highest yield response, but it was not significantly different from 40 cm.
- The long inclusion plates, long inclusion plates + chicken litter and deep placed chicken litter were consistently high performers across all three trial sites (case studies 1 and 2).
- To date, the largest yield gains in this trial have been observed at the least productive sandy site (this case study). These results show targeting the poorest performing sands will give the greatest benefit.

“Lime is benefiting the crops but takes a long time to see results, said James.”

SANDY SOIL CONSTRAINTS

Compaction | Low fertility | Acidity

Area of land affected (ha): 1000 | Area of land affected (%): 20

Trialled

- Ripping depth (20, 40, 60 cm)
- Chicken litter to boost soil fertility
- Physical intervention (ripping, short inclusion plates, long inclusion plates, spading)

INTRODUCTION

Low production sandy soils make up about 20%, or approximately 1000 ha of James Vennings’ Barunga Grains farm at Bute. On these soils, lentil production is reduced by up to 50% compared to more fertile soils. In a good season, cereal production is 25% lower than better areas.

Soil types on the farm range from sand to loam on a dune-swale landscape. The main sandy soil constraints are compaction, low fertility and acidity. Water repellence is mild to moderate from 0-10 cm.

Since 2018, James has been undertaking a farm-wide pH mapping and liming program, aiming to increase soil pH to 6.0 in the top 30 cm. Table 1 shows soil pH to 30 cm depth.

With lentils as the main crop and cereals as the break crop, managing soil acidity is critical in avoiding decreases in lentil yields. James has also tried spreading chicken litter and biosolids and started deep ripping small areas in 2019.

“Ripping was beneficial straight away on responsive soils, which was the deep sand. The sand over sandy loam soils do not get the same response. Identifying which areas to rip is the biggest issue,” said James.

THE TRIAL

The farm is on a dune-swale system, with soil types varying between the top and bottom of the slopes. Trials were set out at three locations:

1. South mid-slope – least productive soil (this case study)
2. North mid-slope – low productivity soil (see case study 2: Northern trials)
3. North hill top – most productive soil (see case study 2: Northern trials)

This case study reports on the south mid-slope.

Depth	pH South mid-slope
0-5 cm	5.34
5-10 cm	4.90
10-20 cm	5.03
20-30 cm	6.15

Table 1. Soil pH for the southern trial at Bute, SA.

The south mid-slope is a low productivity deep sand that is strongly acidic from 5–20 cm (Table 1), and moderately repellent from 0-10 cm. Organic carbon is low (0.4% from 0-10 cm), and the ECEC is 3.1 cmol+/kg or less in the top 50 cm, indicating very low fertility. The topsoil is moderately water repellent, and the soil is compacted to approximately 40-50 cm depth.

The trials assessed deep ripping (using conventional straight narrow shanks spaced at 500mm) and adding chicken litter and aimed to answer:

- Trial 1:
  - What ripping depth is best? Testing 0, 20, 40 and 60 cm.
- Trial 2
  - Is it better to rip (using short inclusion plates, long inclusion plates), or spade to incorporate lime (to treat acidity) and chicken litter (to improve fertility)?
  - Does incorporating chicken litter, or placing it at depth, give a better response than leaving it on the surface?

Deep ripping and inclusion treatments were ripped at a speed of 4.5 km/h. Subsoil placement treatments were ripped at a speed of 2.5 km/h. Trial 2 ripping was done at 600 mm depth. Short and long inclusion plates were 250mm mm and 600 mm in length, respectively, 200 mm in height and with their top edge set at 100 mm below the surface. The trials were established in May 2022 with 5 t/ha of lime spread on 9 May. Chicken litter spread and ripping treatments implemented on 10 May, and seeding with Razor CL Plus wheat on 31 May. The site was sown to Commodus CL barley in May 2023.

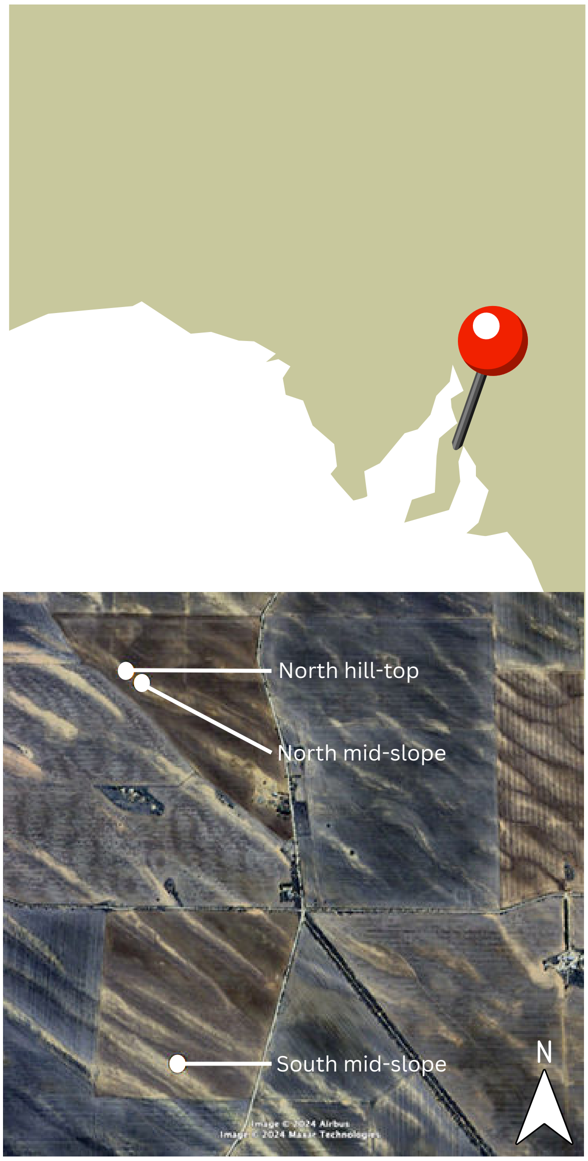

Figure 1. Trial locations at Bute SA. This case study presents results from the South mid-slope site

RESULTS

Deep ripping depth to treat compaction

Results from the deep ripping depth trial were similar in 2022 and 2023. Ripping at 20 cm did not significantly increase grain yields or grain quality (retention and screenings).

Ripping depths of 40 cm and 60 cm produced similar grain yields averaging 2.07 t/ha and 2.13 t/ha respectively in 2023 (Figure 2). Grain quality improved when ripping to 40 cm and 60 cm compared to the Nil and 20 cm.

As observed at the North mid-slope site (see Case Study 2: Northern trials), grain protein was the only quality parameter to be negatively impacted by ripping depth (Figure 2). Protein was reduced in the 40 cm and 60 cm depths and this result relates to yield dilution effects (higher yield = lower protein). However, the protein levels were still within the 9-12% range.

RESULTS cont..

The results suggest the optimal ripping depth at the South mid-slope site is 40 cm as it provides a significant yield benefit. Ripping to 60 cm did not significantly improve the response.

Soil disturbance method – yield and grain quality

All forms of soil disturbance (ripping with and without inclusion plates, spading) gave a yield response (Figure 3).

Without chicken litter, ripping with either long or short inclusion plates did not significantly improve yields compared to ripping without inclusion plates. Spading and ripping with long inclusion plates gave a similar yield response.

As expected, grain protein decreased as yield increased. The spading treatments had poorer grain quality in terms of lower test weight, lower retention and high screenings. Similar to the North mid-slope site (Case Study 2), this suggests the spading depth of 30 cm has not allowed deeper root exploration to fulfil its yield potential.

Seed placement was an issue following spading in year one. The wheat crop struggled to emerge and impacted crop performance. However, this was not observed in year two, with high crop emergence across all three sandy trial sites.

Soil disturbance method – soil compaction

The ripping treatments had a similar effect on lowering penetration resistance (Figure 4). Spading alleviated compaction to <2500 kPa to 350 mm depth.

Chicken litter

The benefit of chicken litter on yield was negligible at this site. However in 2023, chicken litter increased protein in comparative treatments by 0.7-1.7%, indicating it played a role in N supply.

While responses to chicken litter were not significant on this low productivity sandy soil, chicken litter should make the soil more resilient over time by acting as a source of slow-release nutrients until the supply is exhausted.

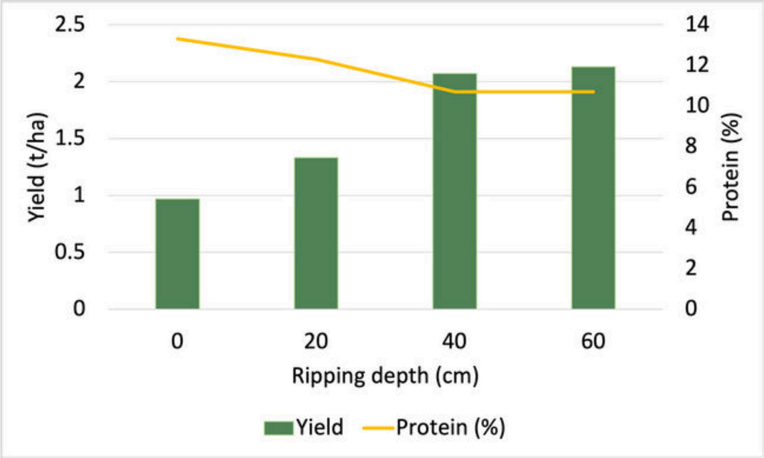

Figure 2. 2023 barley yield vs grain protein.

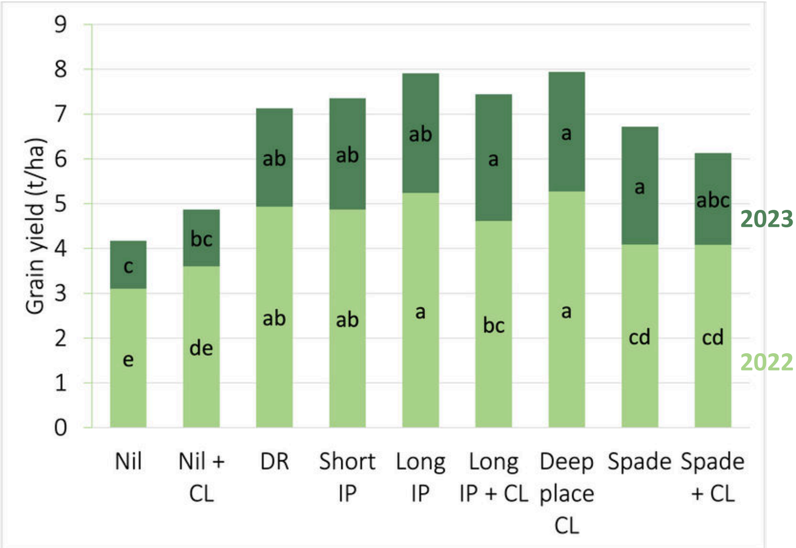

Figure 3. Grain yield responses in 2022 (wheat) and 2023 (barley).

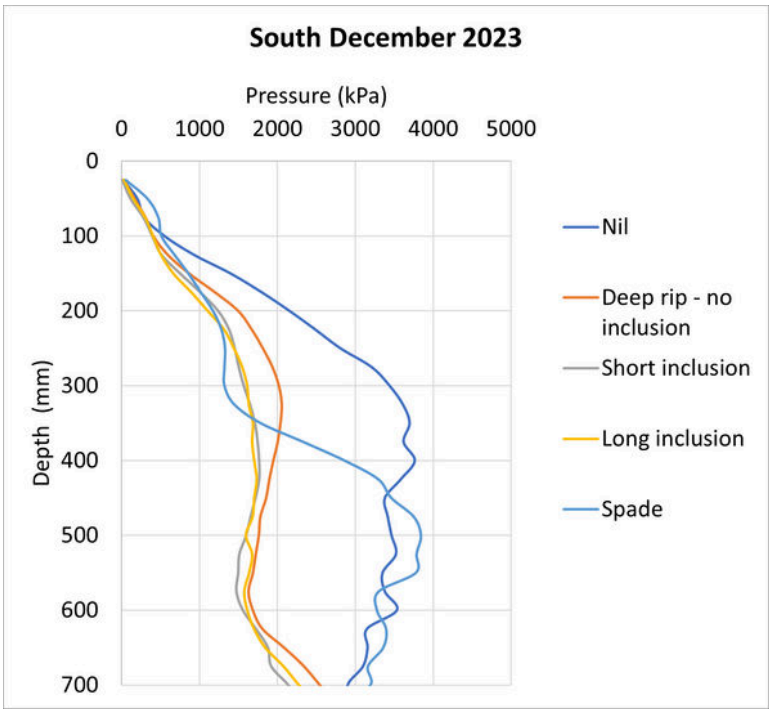

Figure 4: Penetrometer resistance measured December 2023, 19 months after treatment implementation.

NEXT STEPS

The longevity of treatments in these trials will be assessed in 2024 where the sites will be sown to lentils.

James plans to keep ripping across the farm, using long inclusion plates to break compaction and drop some lime into acidic layers. He will treat the worst performing soils like the deep sandy soils in this trial.

“In the short term we’re targeting the very poor performing soils because there’s not much to lose. There is a benefit to starting with the low productivity sands, learning as I go, and not risking doing a poor amelioration job on the high productivity sands,” James said.

The lowest productivity deep sands are a good starting point as amelioration sometimes uncovers other problems, such as herbicide toxicity, or causes wind erosion. Pre-emergent herbicides bind less to soil with lower organic matter and can cause more crop damage. Lime application also increases herbicide solubility.

Finding the balance is a challenge, with James experiencing both ‘dirty’ crops when not using enough herbicide, or crop damage using higher rates. James says, “When you ameliorate, you stimulate every single weed seed so you get 5-10 times more weeds the next year. On top of this the crop is super sensitive to herbicide, so you want to use safer/weaker herbicides, but can’t afford to do that because so many need treating. You’re on a knife edge using safe chemistry for your crop but need to kill so many more weeds.”

James has been using a 6 m Hanton and Sharrad ripper with 550 mm tyne spacing, pulling 11 shanks. Based on the results from the trial and the post-amelioration challenges, James is considering changing to 1.1 m tyne spacing and doing the operation over two years rather than one.

This is so the soil stays more firm and seed placement is more consistent. James says it’s about spreading the risk without harming productivity. “It’s going to look ugly, but it’s about returns,” he said.

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RESOURCES

AgriKnow: https://www.agriknow.com.au/trial/29

PROJECT INFORMATION

Trials run by Sam Trengove, Trengove Consulting.
Many thanks to James Venning for hosting the trials.

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