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

CASE STUDY 2 | NORTHERN TRIAL

SNAPSHOT

Farmer name: James Venning
Location: Bute, SA
Farm Size: 4700 ha
Enterprise: Lentils, canola, wheat and some barley
Rainfall: 362 mm annual in 2023, 225 mm GSR

KEY MESSAGES

- All forms of soil disturbance improved grain yields. Higher disturbance led to higher yields.
- Ripping depth is important and needs to work towards the bottom of the compacted layer.
- On this site, ripping needs to be 40 cm or deeper to get a consistent response (compaction from 30-45 cm).
- Long inclusion plate ripping may provide a useful alternative to spading with reduced erosion risk and a more seeder-ready finish.
- Adding chicken litter marginally improved yields and grain protein, but physical intervention had a bigger impact.
- 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).

SANDY SOIL CONSTRAINTS


Compaction


Low fertility

Acidity

Area of land affected: 1000 ha | **Percentage of land affected: 20%**

Trialled

- Ripping depth (0, 20, 40, 60 cm)
- Chicken litter to boost fertility
- Physical intervention (ripping, short inclusion plates, long inclusion plates, spading)

INTRODUCTION

Low production sandy soils comprise approximately 20% of Barunga Grains farm, or over 1000 ha. On these soils, lentil production is reduced by up to 50% in comparison to more fertile soils. In a good season, cereal production is 25% lower than in reliable soils.

The main soil issues are compaction, low fertility and acidity. Water repellence is not an issue on the two trial sites in this case study but is a problem on the southern trial site (see Case Study 1: Southern trial).

Since 2018, farmer James Venning has been undertaking a farm-wide pH mapping and liming program, aiming to increase soil pH to 6.0. Table 1 shows soil pH to 30 cm depth. With lentils as the primary crop and cereals as the break crop, managing soil acidity is critical in avoiding decreased lentil yields. “Lime is benefiting the crops but takes a long time to see results,” said James.

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 (see Case Study 1: Southern trial). The sand over sandy loam soils do not get the same response. Identifying which areas to rip is the biggest issue.”

THE TRIAL

The farm is on a dune-swale system, with soil types varying between the top and bottom of the slopes. Two trial sites were established:

- Hill-top: most productive, duplex sand (0-10 cm) over loamy sand to depth. Strongly acidic band from 5-10 cm (Table 1). Fertility is low in the topsoil (organic carbon 0.6%; ECEC 3.9 cmol+/kg) but increases with depth.
- Mid-slope: less productive, loamy sand transitioning to a deep sand at 50 cm depth (Figure 1). Strongly acidic from 5-20 cm depth (Table 1). Low fertility throughout (organic carbon 0.4%; ECEC <5 cmol+/kg to 100 cm depth).

The trials assessed deep ripping (using conventional straight narrow shanks spaced at 500 mm) 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, use 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 500 mm depth. Short and long inclusion plates were 250 mm and 600 mm in length, respectively, 200 mm in height and with their top edge set at 100 mm below the surface.

The trial was set up in May 2022, with 5 t/ha of lime spread on May 9, chicken litter spread and ripping treatments implemented on May 10, and seeding with Razor CL Plus wheat on May 31. The site was sown to Commodus CL barley in May 2023.

Depth	Hill-top	Mid-slope
0-5 cm	5.22	5.27
5-10 cm	4.71	4.53
10-20 cm	5.61	4.82
20-30 cm	7.62	5.36

Table 1. Soil pH for the two northern trials at Bute, SA

Figure 1. Mid-slope loamy sand transitioning to a deep sand

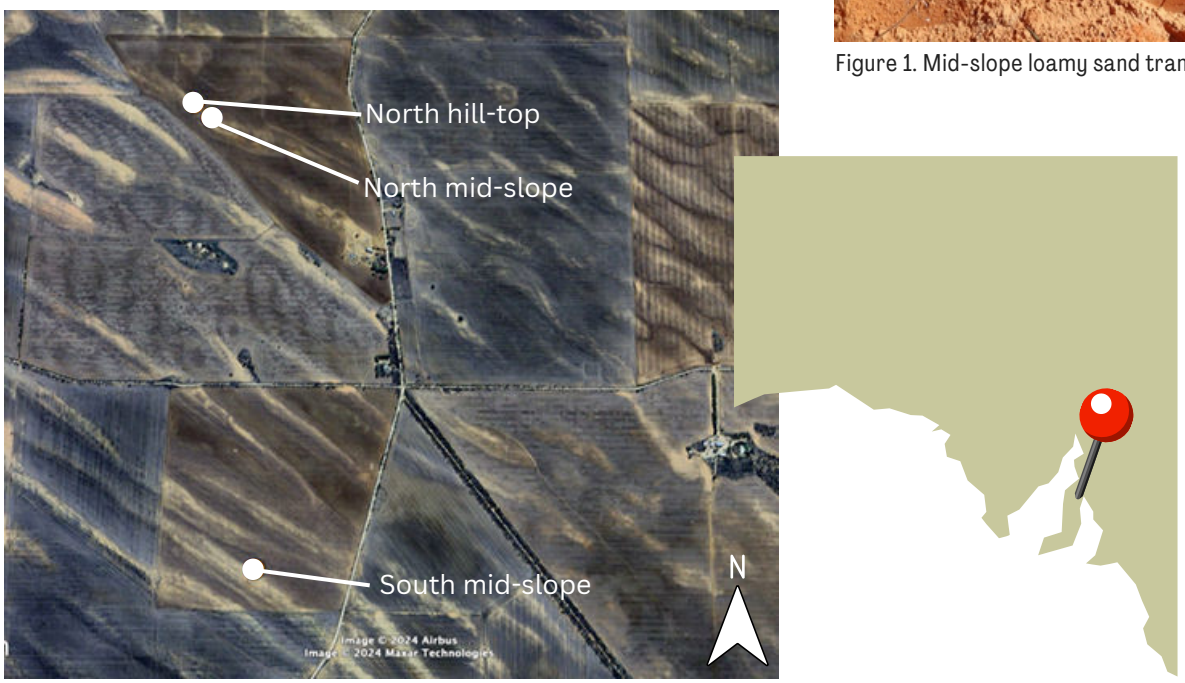

Figure 2. Trial locations at Bute SA. This case study presents results from the hill-top and mid-slope sites

RESULTS

Ripping depth to treat compaction

Grain responses to ripping depth were similar in 2022 and 2023. Ripping to 20 cm depth did not increase grain yields or grain quality (retention and screenings) at either site.

Hill-top site

Ripping depths of 40 cm and 60 cm produced similar grain yields averaging 4.62 t/ha, 17% higher than the Nil. Ripping depth did not impact any of the barley grain quality parameters measured in 2023.

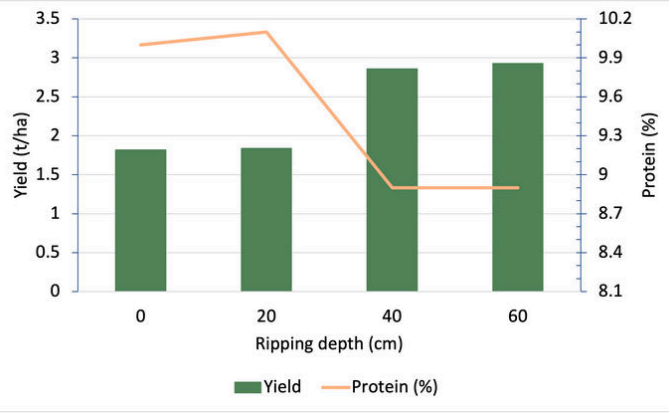

Figure 3. Grain yield and protein in 2023 on the mid-slope site.

Mid-slope site

Ripping to 60 cm gave a better response in the first year, but in 2023 ripping depths of 40 cm and 60 cm produced similar grain yields averaging 2.9 t/ha (59% higher than the Nil, Figure 3). Grain protein was the only quality parameter to be negatively impacted by ripping depth. Protein was reduced in the 40 cm and 60 cm depths (8.9%) and this result relates to yield dilution effects (higher yield = lower protein).

The results suggest the optimal ripping depth for these soils is at least 40 cm as it provides a significant yield benefit. Ripping to 60 cm does not significantly improve the response. Ripping to 40 cm is working towards the bottom of the compacted layer, which is ideal to break up compaction.

Soil disturbance method – yield and grain quality

The benefit of inclusion plates was not clear based on first year grain yield response in 2022. Neither short nor long inclusion plates gave any yield benefit compared to deep ripping with no inclusion plates in 2022, despite observations from soil pits showing better topsoil inclusion deeper into the profile.

James said, "One thing that came out last year (2022) which was disappointing, was deep ripping with long inclusion plates. The research suggested deep ripping gives a certain response, and adding inclusion plates gives more, but the first-year results showed there was no added benefit of having the inclusion plates. There was in fact a negative opportunity cost of running them because they consume more horsepower and you can't deep rip as deep," said James.

Despite this, James kept ripping with the inclusion plates throughout 2023, to help get lime deeper and treat subsoil acidity. He was hoping for a response in year two and by September 2023, the inclusion plate strips looked visually better than those without plates. Long inclusion plates ended up producing higher yields than short inclusion plates.

Hill-top site

At the end of 2023, the highest disturbance treatments (spading, long inclusion plates) produced the highest grain yields (Figure 6). Long inclusion plates produced better yields (5.20 t/ha) than short inclusion plates (4.58 t/ha).

Grain quality results showed high retention values (81.2-94.0%) and low screenings (all samples <5.2%) across the trial.

Seed placement was an issue following spading in year one, and 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. As deep ripping with long inclusion plates gave similar yields to spading, long inclusion plate ripping may provide a useful alternative to spading with reduced erosion risk and a more seeder-ready finish. Seeding and spading in one pass is another method to help manage seed placement issues.

Mid-slope site

Similar to the hill-top site, the highest disturbance treatments (spading, long inclusion plates) produced the highest grain yields (Figure 6). Again, ripping with long inclusion plates gave a higher yield (3.08 t/ha) than short inclusion plates (2.68 t/ha).

Grain quality was generally high across the incorporation methods. Grain protein was lower (8.3-8.5%) in treatments with physical incorporation and no chicken litter (except spading). Spading was the only incorporation method to have higher screenings compared to the other methods.

RESULTS cont...

Soil disturbance method – soil compaction

Hill-top site

The ripping treatments had a similar effect on lowering penetration resistance to about 550 mm depth (Figure 4). Spading alleviated compaction to 350 mm depth.

Mid-slope site

Treatments improved compaction but to less of a degree than on the hill-top. There was also more of a difference in penetration resistance between treatments (Figure 5). Spading and deep ripping with long-inclusion plates were the most effective to 400 mm depth.

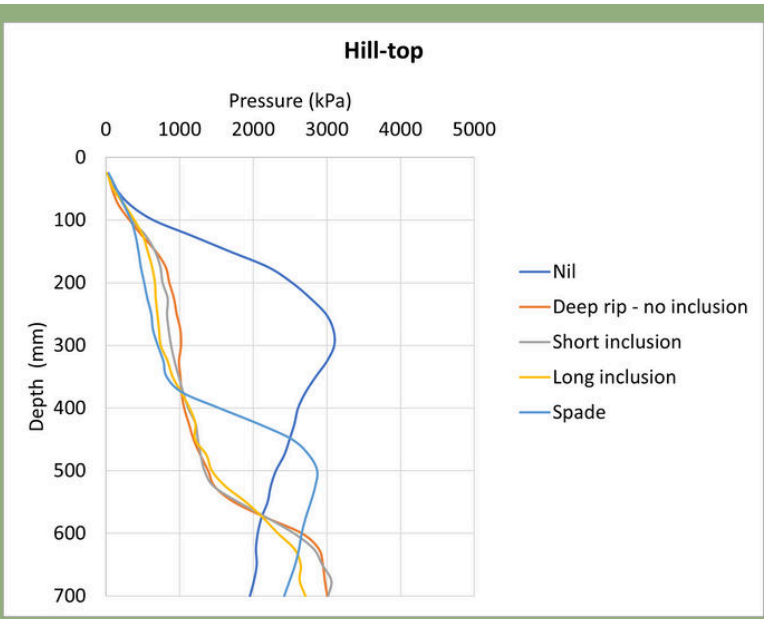

Figure 4: Penetrometer resistance at the hill-top site, measured August 2022, 3 months after treatment.

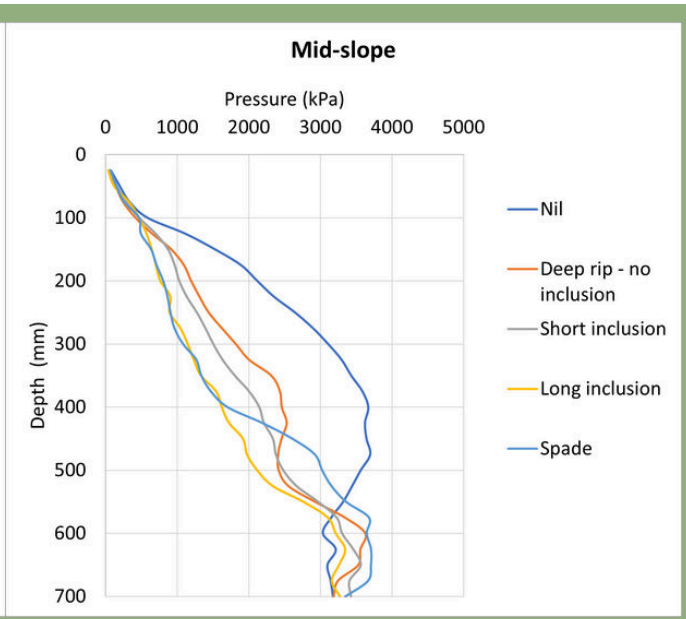

Figure 5: Penetrometer resistance on the mid-slope, measured August 2022, 3 months after treatment.

Chicken litter

Adding chicken litter generally improved yields and grain protein, however the impact was marginal and secondary compared to the soil disturbance treatments. In the absence of chicken litter, protein levels are lower, particularly where ripping has occurred with several treatments (<9%), indicating that with an increased yield potential the standard fertiliser regime is barely supplying enough to meet potential. While chicken litter improves nutrient supply, in these examples it is not driving a big yield response.

Economics

James normally budgets $100/ha to deep rip, but recently increased to $120/ha due to fuel price rises.

“Which over multiple years you’re easily going to get, sometimes it’s just about surviving the first year when you’re sensitive to post-amelioration issues, herbicides, weeds, erosion, etc. and get benefits in years 2, 3 and 4,” James said.

NEXT STEPS

James plans to keep ripping across the farm, using long inclusion plates to break compaction and drop some lime into acidic layers. Managing the paddocks post-ripping is the next focus. Trafficability after ripping is the main concern as it makes seed placement more difficult.

“We’re well aware of this issue and have never deep ripped in front of canola. We generally only rip into wheat stubble before going into barley to get good ground cover,” James said.

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 moving to 1.1 m tyne spacing to do the ripping operation over two years rather than one. This is so the soil stays more firm and achieves better seed placement. James says it’s about spreading the risk without harming productivity.

> “It’s going to look ugly, but it’s about returns.” said James

NEXT STEPS cont..

The other concerns are erosion risk after spading and managing pre-emergent herbicides after ripping. Pre-emergent herbicides bind less to soil with lower organic matter which can result in more crop damage. Lime application also increases herbicide solubility.

“Herbicide is a massive problem. 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 said.

Finding the balance is a challenge with James experiencing both ‘dirty’ crops when not using enough herbicide, or crop damage using higher rates.

James will also look more closely at spading, which can give good returns but is slow, expensive, time-sensitive and comes with a higher erosion risk than ripping. He said, “I can only do about 50 ha/yr with a contractor, compared to deep ripping 400 ha/yr, and it needs to happen at a very busy time of year. But spading fixes the non-wetting, lentils love it - maybe because it mixes the lime in well.”

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

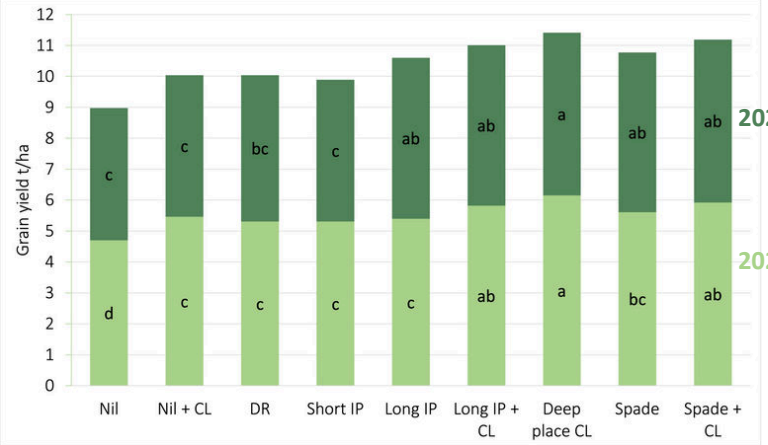

Figure 6. Hill-top yields 2022 and 2023.

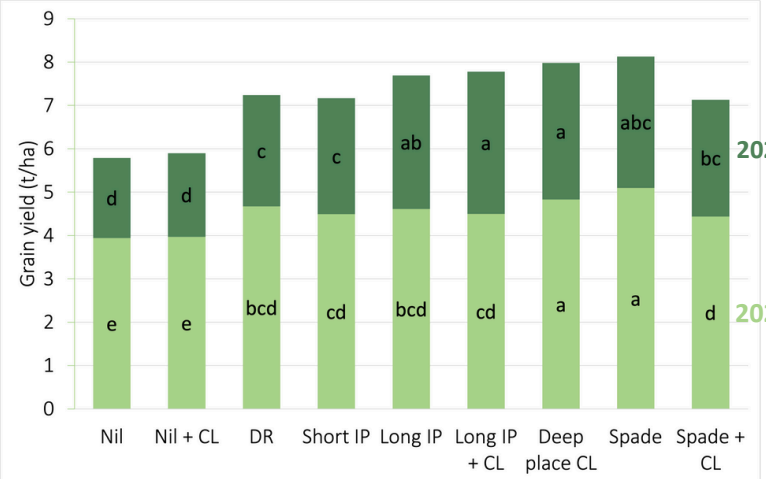

Figure 7. Mid-slope yields 2022 and 2023.

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RESOURCES

Soil Hub: https://soilhub.com.au/front-page/bute/
AgriKnow: https://www.agriknow.com.au/trial/29

PROJECT INFORMATION

Trials run by Sam Trengove (Trengove Consulting).
Thanks to James Venning for hosting the trials.

Building drought resilience by scaling out farming practices that will enhance the productive capacity of sandy soil landscapes.
Activity ID: 4-H6P3CX5

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