Amelioration options to manage sandy soils with multiple constraints

CASE STUDY 11

SNAPSHOT

Farmer name: Andy & Ben Gosling
Location: Yaapeet, Victorian Mallee
Farm Size: 2400 ha
Enterprise: Cropping, sheep
Average annual rainfall: 300 mm

KEY MESSAGES

- Despite the dry spring, ripping and/or spading to ameliorate soil constraints provided approximately 0.4 t/ha additional yield.
- Spading effectively treated water repellence. Ripping improved water repellence but did not fully remove it.
- Based on trial results, the cost of ripping would have been recovered in the first year.

> "There are about 200 ha that are just losing money."

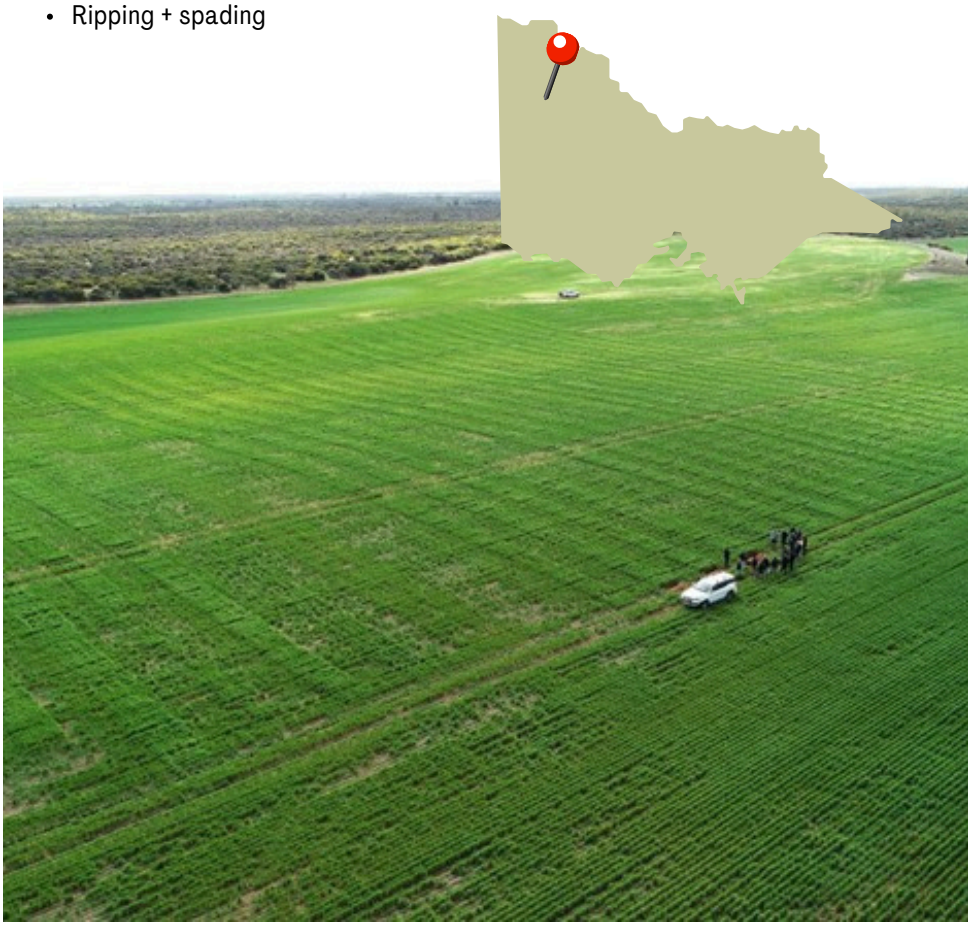
SANDY SOIL CONSTRAINTS

Water repellence | Hardsetting | Low fertility | Acidity (slight)

Area of land affected (ha): 300 | **Area of land affected (%): 20**

Trialled

- Ripping with and without inclusion plates
- Spading
- Ripping + spading



INTRODUCTION

Andy and Ben Gosling farm 2400 ha at Yapeet, in the Victorian mallee region. The family have been on the farm for 120 years and the brothers stepped into the farming management role in 2013.

Low productivity sandy soils cover 500 ha or approximately 20% of the property.

INTRODUCTION cont...

Water repellence is the major issue on the farm, though there is also hardsetting soil and acidity. In the past, the Gosling's have tried multiple techniques to improve establishment in water repellent soil including:

- Sowing deeper below the water repellent soil, up to 10 cm deep for barley and shallower for wheat.
- Installing a liquid system on the airseeder to apply soil wetters at seeding.
- Since 2018, have been delaying seeding until the soil wets up before sowing, which has improved emergence and crop yield.
- Fencing off paddocks by soil type, to sow predominantly barley on sands and wheat on heavier soils.

Compared to other soil types, the sandy soils generally have a yield reduction of 25–30%, with up to 50% on the worst areas. The difference in yield is more noticeable in wet years. In 2023, the yield difference was nearly 100% between the sandy soils and other soils.

Some of the deep sands also set very hard and have a very low water holding capacity, creating problems for water access throughout the season. Soil tests in 2023 found that at saturation, the sandy soils only held 3% or 30 mm/m of moisture.

> This year [2023] was an absolute horror for sand. It just dried out and the crop nearly died before the last bit of rain, said Andy.

Andy hoped that breaking up the hardpan at depth would help the crop access deeper moisture.

THE TRIAL

The trial site's soil was a deep sand over one metre deep. The pH was neutral to slightly alkaline. Soil fertility was generally low with surface soil organic carbon at 0.5%. The key issues were moderate water repellence and high soil strength (Figure 1). Soil strength exceeded 2000 kPa from 22 cm depth and peaked nearly 4000 kPa at 35–45 cm depth.

To tackle water repellence and hardsetting soil, a combination of ripping and spading treatments were set out in large 2 m x 150 m strips with a 5 m spacing between each treatment.

The aim was to loosen the soil while mixing wettable soil in with the repellent topsoil. Treatments included:

- Deep ripping to 600 mm.
- Deep ripping (to 600 mm) with shallow (200 mm tall) inclusion plates.
- Deep ripping (to 600 mm) with deep (400 mm tall) inclusion plates.
- Rotary spading (350 mm).
- Deep ripping + Rotary spading.

An untreated control (Nil) strip was included between each soil amelioration treatment. Each treatment had four replicates.

The various treatments were implemented on 4 April 2023 and the site was sown to Sheriff$^{(D)}$ wheat on 8 May 2023.

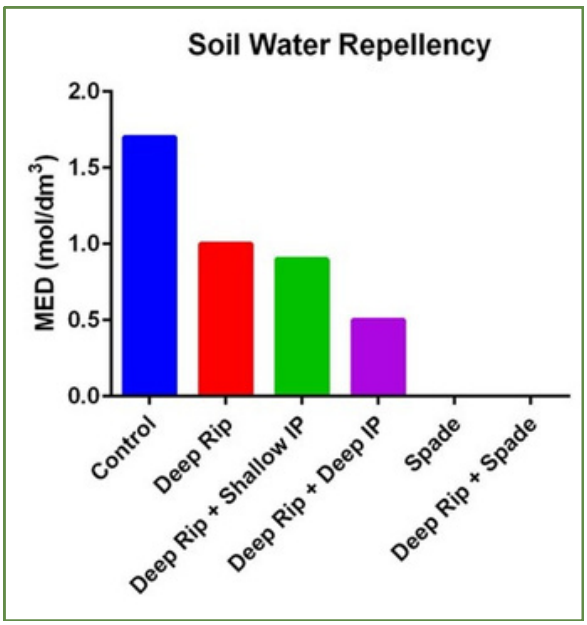


Figure 1. Water repellence readings after treatment using the Molarity of Ethanol Drop (MED) test

RESULTS

Soil properties

Spading effectively treated the water repellence. After deep ripping, the soil was still mildly repellent (MED 1.0). Inclusion plates during deep ripping showed some improvement (MED 0.9 with shallow inclusion plates and 0.5 with deep inclusion plates) but not as significantly as spading (Figure 2).

RESULTS cont...

As the soil is a deep sand, the spading did not mix clay in with the repellent sand. Rather, it diluted the repellent sand with more wettable sand. To fully remove repellence, the clay content in the soil needs to increase above 5% as a minimum. The longevity of the water repellence amelioration is uncertain but trial manager Michael Moodie from Frontier Farming said he expects the effect to last at least 3–5 years.

Spading improved compaction to 350 mm depth, dropping the penetration resistance readings to below 2500 kPa (above which root growth can be severely restricted) to around 400 mm depth (Figure 2). Deep ripping alleviated compaction to 600 mm depth, dropping penetration resistance readings to <2500 kPa at 450 mm depth.

Crop establishment

By 21 June 2023, treatments which included spading had 20% higher crop establishment over the control. Deep ripping with inclusion plates also improved crop establishment, relative to the deep rip only treatment (Figure 3 left). Despite lower plant numbers, all treatments had adequate plant density to achieve yield potential in 2023.

"The spaded treatments had a lot more vigour," said Andy. "The wheat crop grew a bit better over the rip lines (600 mm apart), but in between the crop was just as poor anywhere else."

There was a negative correlation (R^2=0.95) between soil water repellence (MED) and crop establishment which indicated that repellence was primarily responsible for the establishment differences observed between treatments (Figure 3 right).

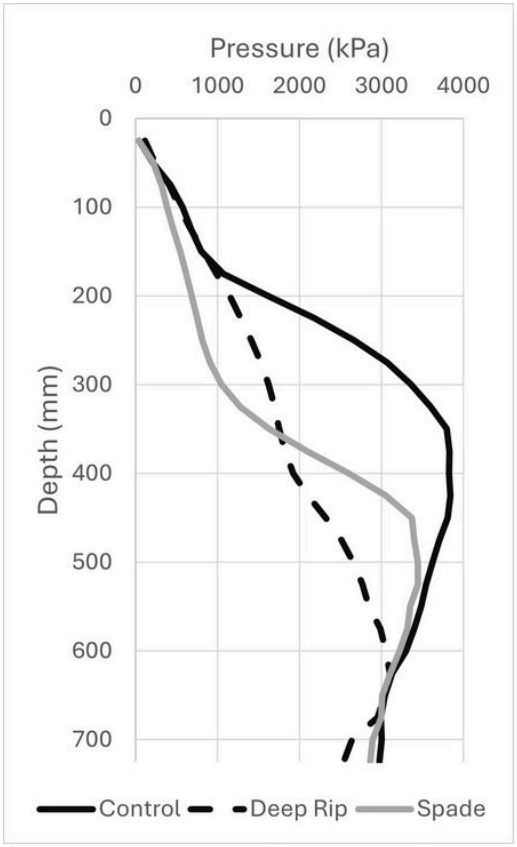


Figure 2. Soil penetration resistance comparing no treatment, spading and deep ripping. The ripping treatments gave similar results; only one data set is presented for ease of reading.

Yield

Early in the season, differences in crop vigour were evident between treatments, however, dry conditions during September led to relatively low grain yields with control plots yielding just 0.7 t/ha. Soil amelioration treatments led to a grain yield benefit approximately 0.4 t/ha.

The highest yielding treatment was the deep ripping with deep inclusion plates (Figure 4). However, the variation between all soil amelioration treatments was only 0.16 t/ha, meaning that all treatments provided a similar benefit.

Andy said, "any strips that were spaded were very thick and came up a lot better at the very start. But towards the end [of the season] ripping with deep inclusion plates looked good, and shallow inclusion plates looked good. Crop growth looked good, but we didn't have the moisture to finish it."

Trial Manager, Michael Moodie noted that the dry year played a role in the outcome. "We would have expected the treatments to provide more of a yield boost than they did, but whether or not there would have been a bigger difference between the amelioration options is less clear."

He also commented that on such a sandy soil with a low water holding capacity, part of the benefit of ripping comes from improved water access, and would expect better results in the future in wetter years.

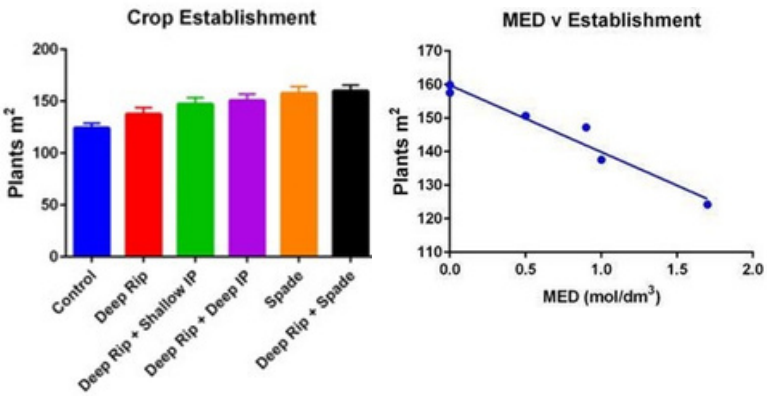


Figure 3. All treatments improved crop establishment compared to the control (left). Correlation between water repellence and crop establishment (right)

ECONOMINCS

While a formal economic analysis was not undertaken for this site, basic calculations indicate that the cost of ripping would have been recovered in the first year. Using a wheat price of $350/t, the 0.4 t/ha yield boost equates to $140/ha, slightly above the expected ripping cost of $120/ha. The benefits from soil amelioration are expected to last 3-5 years, improving future profitability.

NEXT STEPS

Based on the trial, Andy favours ripping with inclusion plates. Although it has a slightly lower yield than spading, it is cheaper and leaves more groundcover. The inevitable soft soil, erosion risk, and lumpy paddock after spading is a concern.

"Spading is good in a trial, but how do you put it into practice on such a large area? Spading leaves the soil very bare and we have some big sand hills. We would prefer to rip if we could," Andy said.

In 2024 they plan on hiring a ripper to do some trafficability trials.

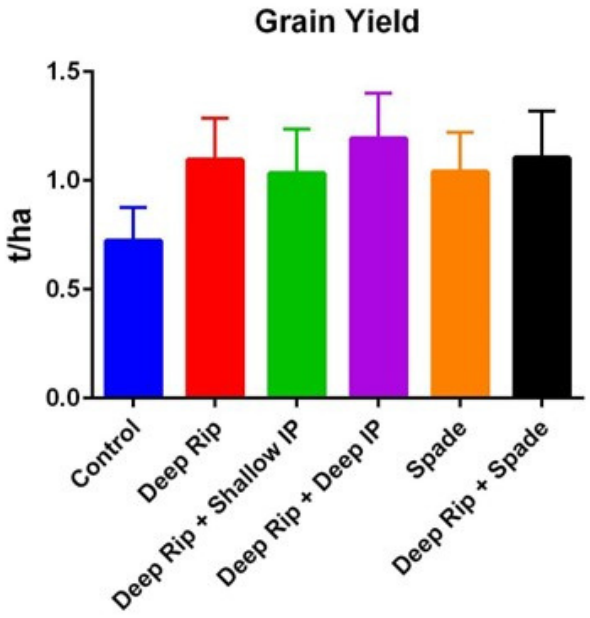


Figure 4. All treatments improved grain yield compared to the control

"We struggle with trafficability on our hills anyway. We need to do trials to see what tractor we need to pull the ripper and if we can actually get up the hills. The ripper with the deep inclusion plates looks like a good balance between spading and ripping alone, in terms of soil shattering. We don't have a tractor that can pull it, but if it still looks really good in a few years, we will look to expand it," Andy said.

Andy hopes that combining the liquid wetter placement with ripping is an option, as it leaves the paddock flatter than spading.

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RESOURCES

Agriknow: https://www.agriknow.com.au/trial/10

PROJECT INFORMATION

Trial run by Michael Moodie, Frontier Farming Systems.
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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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