Soil amelioration options to improve the productivity of crops grown on an inherently low productivity sandy soil

CASE STUDY 13

SNAPSHOT

Farmer name: James Stephens
Location: Younghusband, SA
Enterprise: Cropping
Average annual rainfall: 300 mm

KEY MESSAGES

- Higher soil disturbance gave higher yields. Spaded plots gave the highest yield each year.
- Incorporating organic matter generally gave higher yields than surface spreading, though the increase was not always significant.

> **"We can get 75 mm of rain and water still runs off the surface," James said.**

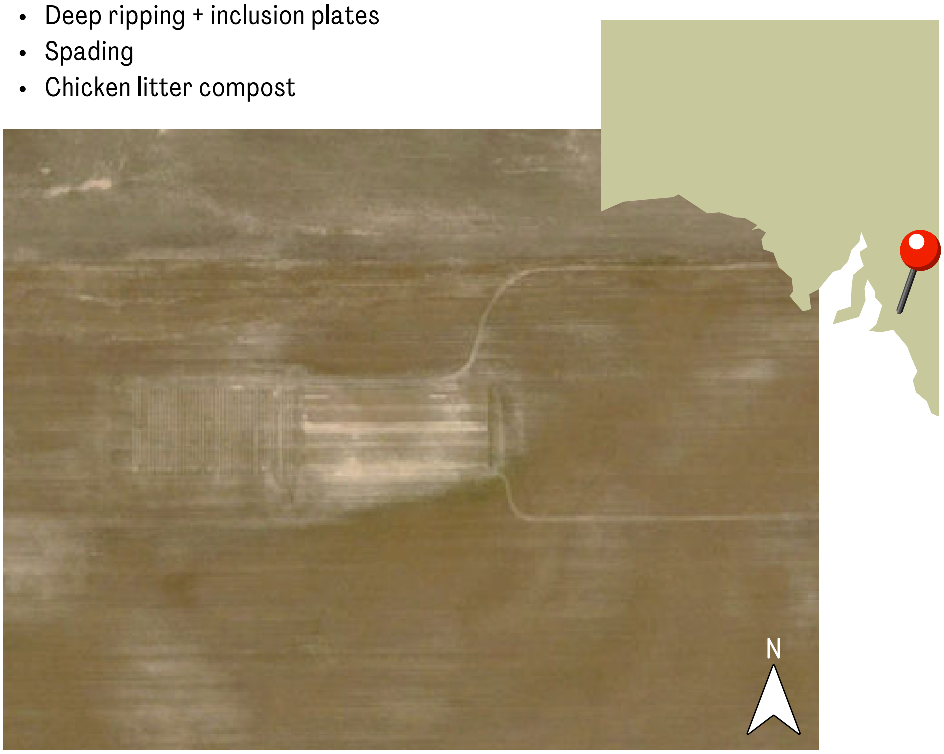
SANDY SOIL CONSTRAINTS

Water repellence | Compaction | Low fertility

Area of land affected (%): 20-25

Trialled

- Deep ripping
- Deep ripping + inclusion plates
- Spading
- Chicken litter compost



INTRODUCTION

On James Stephen's farm near Younghusband, South Australia, sandy soils cover approximately 25% of the farm. The sandy soils are water repellent, compacted and have low fertility. Water repellence is a particular concern, causing problems with crop emergence.

In average to wet years, the sandy soils yield approximately 20% less than the other soils on the farm.

James has previously tried a range of strategies to improve productivity on the sandy soils, including:

- Using wetters at seeding, which helps year to year but does not fix the problem.
- Ripping, which has had variable results.
- Spreading and incorporating chicken manure with inclusion plates. James has seen the benefits of increased nutrition, particularly on cereals, but the process is time consuming.
- Spreading clay from the river flats.

THE TRIAL

The trial explored soil amelioration options to improve the productivity of crops grown on an inherently low productivity sandy soil. The aims of the trial were to:

- Compare soil amelioration techniques with different levels of soil mixing and loosening.
- Determine if adding external organic matter (chicken litter compost) could enhance the benefits of the soil amelioration.

The soil was sandy throughout the profile, slightly acidic to 40 cm depth, and severely water repellent. The soil was compacted, with penetration resistance exceeding 2000 kPa from 20 cm below the surface, with the most severe resistance levels at a depth of 35-40 cm (Figure 1).

Treatments were chosen to address water repellence, low fertility and compaction. The trial compared soil amelioration practices with and without the addition of organic matter (chicken litter compost). Treatments were implemented in April 2021 and included:

- No amelioration (Untreated Control (UTC))
- Deep Ripping to 50 cm
- Deep Ripping + Inclusion Plates (IP)
- Spading to 30 cm

Chicken litter compost was spread on the soil surface at a rate of 5 t/ha before soil amelioration. Chicken litter was also directly injected into the void created by the inclusion plates during the ripping process.

The site was sown to barley in 2021, split to lupins and lentils in 2022, and wheat in 2023.

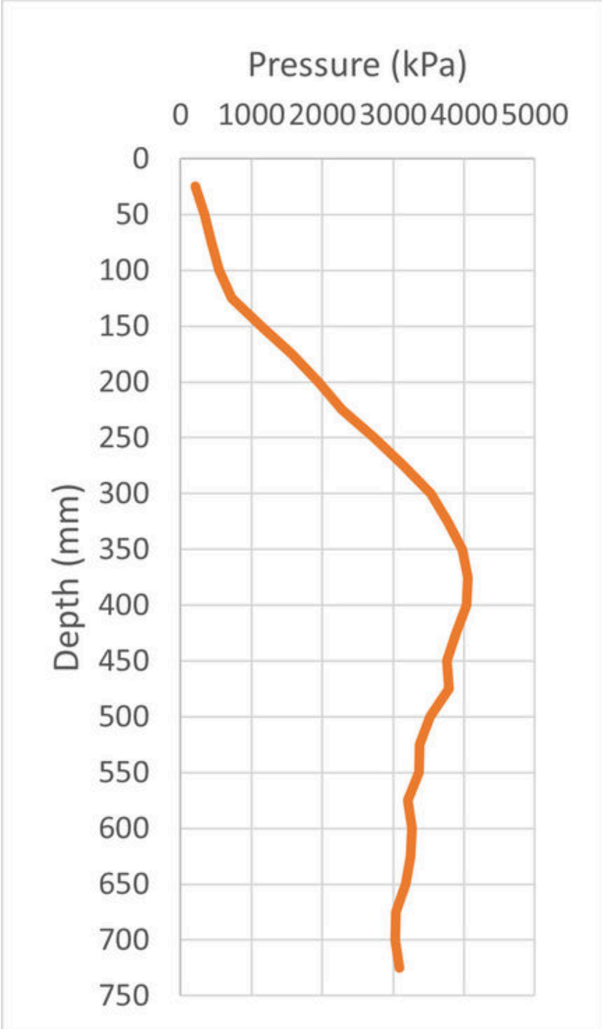


Figure 1. Penetration resistance measured down the soil profile using RIMIK CP402 cone penetrometer.

RESULTS

Crop establishment

In 2021, barley established best on spaded plots (Figure 2). Deep ripping had only a minor impact on crop establishment, however, deep ripping with inclusion plates led to reduced barley emergence. The inclusion plates increased the disturbance of the topsoil and resulted in excessive soil throw during the seeding operation which negatively affected crop emergence in some rows.

While spading also caused high soil disturbance, it ameliorated water repellence in 2021 which improved crop establishment. It was also easier to get a more uniform seeding depth on the spaded plots than the ripping + inclusion plates plots.

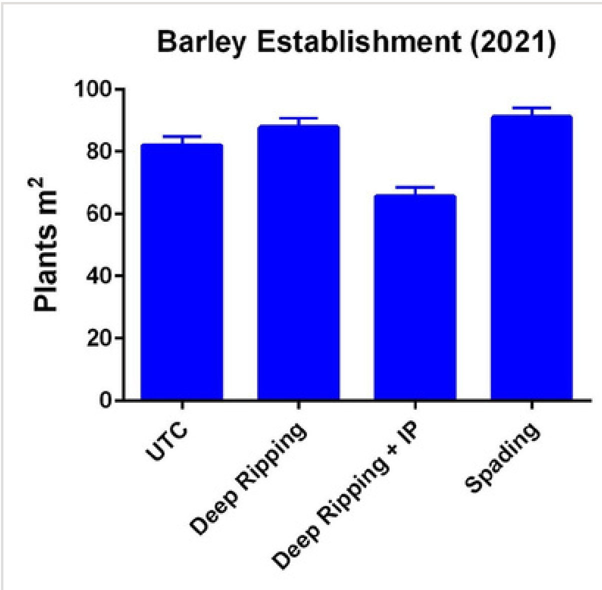


Figure 2. Barley established best on spaded plots in 2021, followed by deep ripping without inclusion plates.

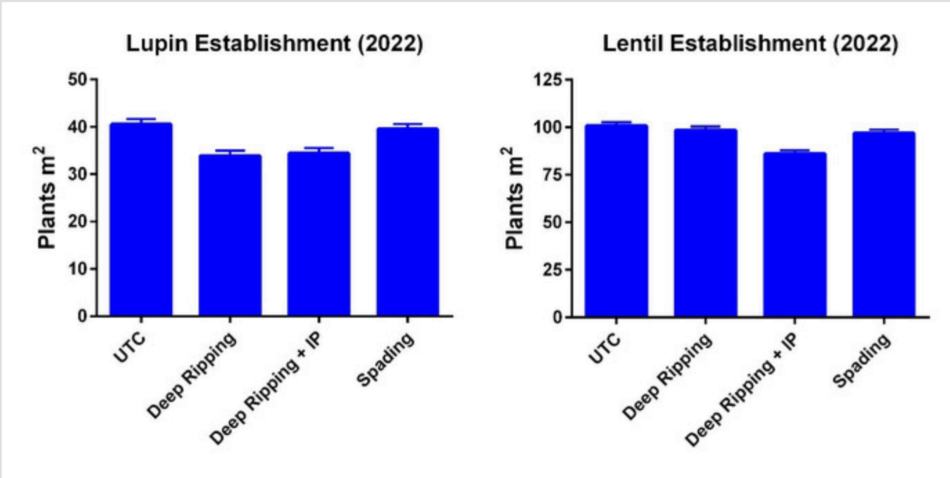


Figure 3. The effect of deep ripping and spading treatments on the establishment of lupins and lentils in 2022, compared to the untreated control (UTC)

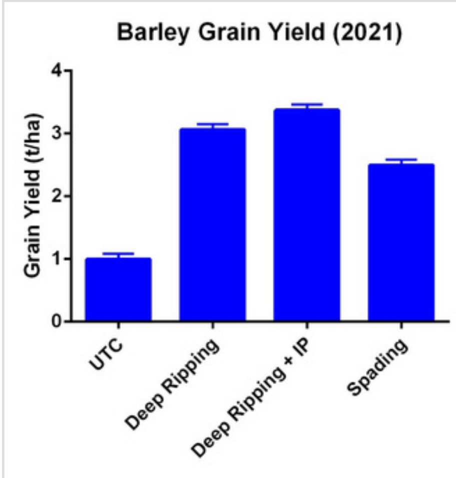


Figure 4. The effect of deep ripping and spading treatments on the grain yield of barley in 2021, compared to the untreated control (UTC)

In 2022, deep ripping either with or without inclusion plates reduced lupin establishment by 15% (Figure 3 left). There was also a 15% reduction in lentil establishment where the soil had been deep ripped with inclusion plates (Figure 3 right). Again, the reduction of crop establishment in lupins and lentils was attributed to difficulties with seeding and excessive soil throw in soft soil.

In 2023, a wetting agent was applied to remove water repellence as a factor in the trial and focus on the effect of the physical treatments. Crop establishment was not monitored in the 2023 wheat crop.

Yield

In 2021 (barley), all soil amelioration treatments provided a 1.5–2 t/ha benefit over the untreated control. Deep ripping with inclusion plates improved grain yield over deep ripping alone, while both deep ripping treatments produced a higher grain yield than spading (Figure 4).

Across all soil amelioration treatments, surface applied chicken litter compost increased barley yield by 0.6 t/ha. Injecting organic matter increased barley yield further, with an additional 1 t/ha on the deep ripping + inclusion plates plot.

In 2022, spading gave the highest yields in both lentils and lupins. In lupins, the difference between the highest (4.7 t/ha) and lowest (4.28 t/ha) yielding treatments was less than 9% (Figure 5). In lentils, spading led to a 70% grain yield increase. Chicken litter gave a small increase (7%) in lentil grain yield, but did not affect lupin yield. Surface spreading or incorporating the chicken litter did not make a difference.

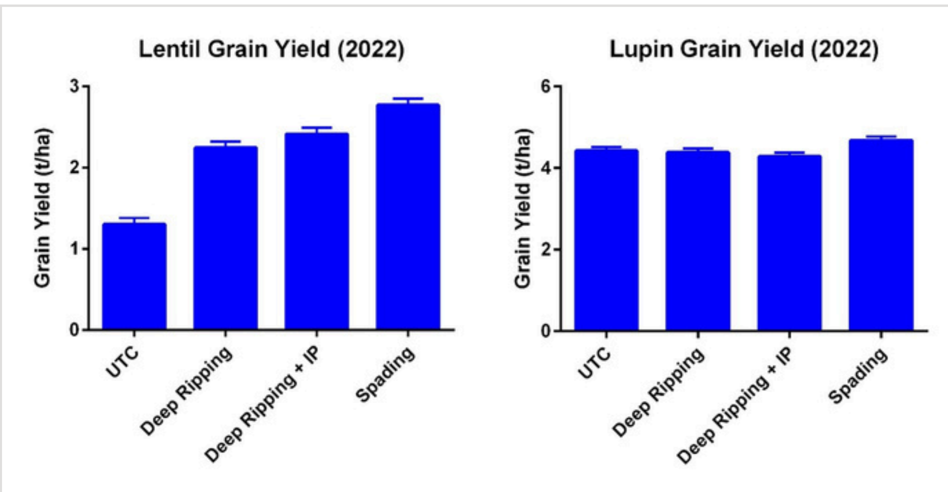


Figure 5. The effect of deep ripping and spading treatments on the grain yield of lupins and lentils in 2021, compared to the untreated control (UTC)

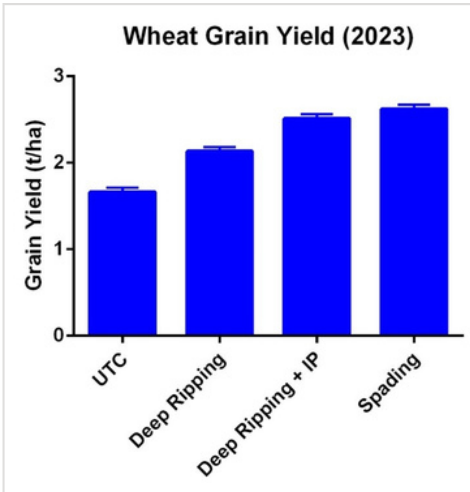


Figure 6. The effect of deep ripping and spading treatments on the grain yield of wheat in 2023, compared to the untreated control (UTC)

RESULTS cont..

In 2023, spading again gave the biggest yield improvement (Figure 6). The spading treatment (2.6 t/ha) produced 1 t/ha more in grain yield than the untreated control. Deep ripping provided a 0.5 t/ha yield benefit over the untreated control, however using inclusion plates during the ripping process increased this benefit by a further 0.4 t/ha.

Surface applied chicken litter provided a small (0.1 t/ha) yield benefit. This benefit was improved to 0.3 t/ha where the organic matter was incorporated in the deep ripping with inclusion plate treatment.

NEXT STEPS

James is keen to understand the longevity of the various treatments and would like to see a yield benefit over a number of seasons, as well as water repellence amelioration, before committing to a specific amelioration option.

Aerial view of plots in 2022, with lupins in the top two rows and lentils in the bottom two rows.

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RESOURCES

AgriKnow: https://www.agriknow.com.au/trial/34

PROJECT INFORMATION

Trial run by Michael Moodie, Frontier Farming Systems.
Many thanks to James Stephens for hosting the trial.
Trial originally set up under SAGIT project 'Deep ripping to enhance production on Mallee Sandy Soils'(MSF219).

Building drought resilience by scaling out farming practices that will enhance the productive capacity of sandy soil landscapes.
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