



From Constraints to Solutions: Evaluating Sandy Soil Management with an Interactive Web App

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and Geoff Kuehne.

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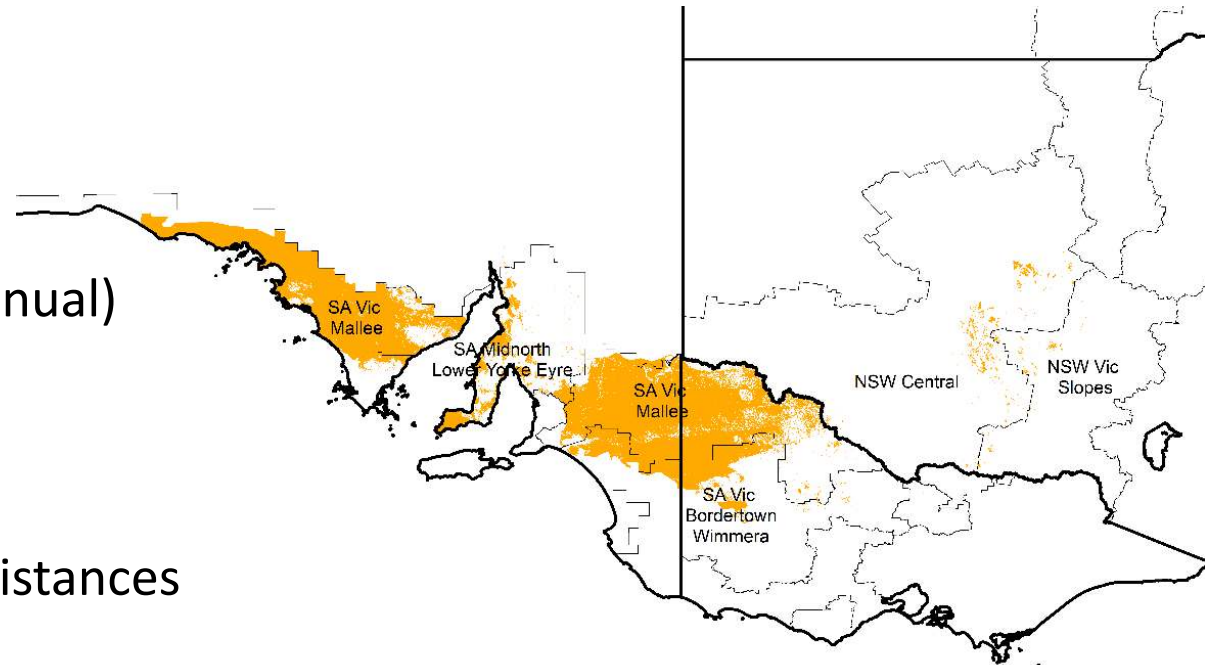




Southern cropping region of south-eastern Australia

Farming in this area is challenging due to:

- Low to medium rainfall (250-450 mm annual)
- Seasonal drought
- Dune-swale systems
- Variable soils which change over short distances



Adapted from Ross Searle

Improved profitability relies on cropping intensification and managing variable soils including less productive sandy soil.

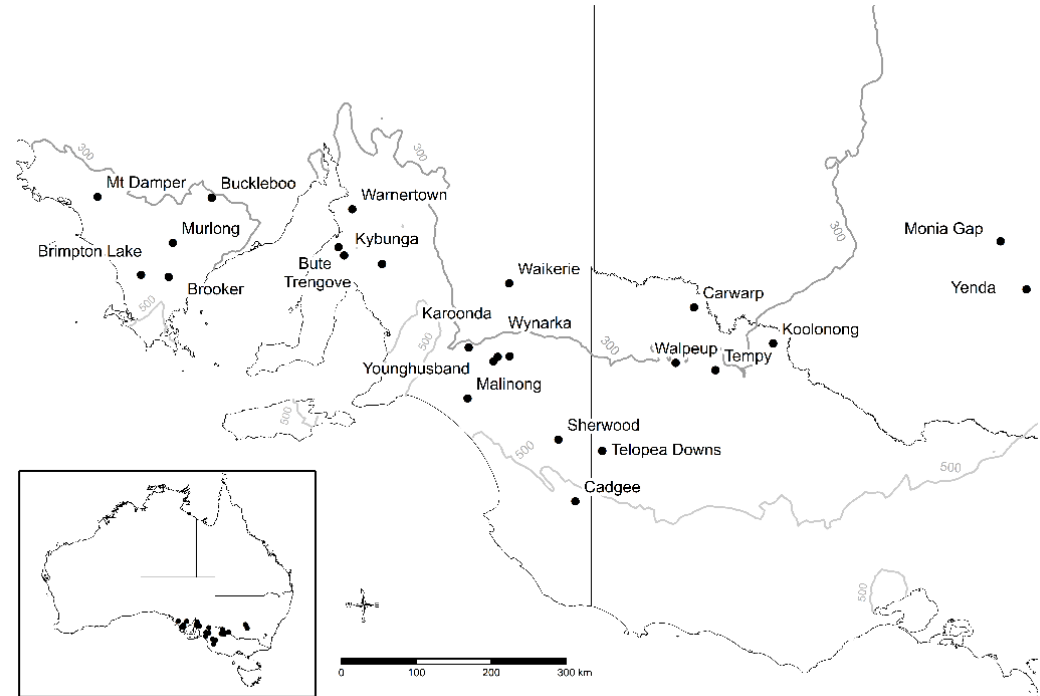
More than five million ha of cropping land is sandy in this area.



Sandy Soil project

Six-year GRDC project set out to:

- Boost yields in underperforming sandy soils.
- Improve diagnosis and management.
- Support growers.
- Develop an interactive Web Tool to support growers managing sandy soils.
- Experiments run 2014 -2022 growing seasons at 26 sites / 138 treatments.





A recent survey of growers and consultants who attended the ‘Sandy Soil Roadshow’ found:

25% used deep-ripping in the last 5 years and is expected to increase to 56% over next 5 years.

Do growers invest in treatments to lift yields? What practices should they adopt?

- Sandy soil constraints
- Management options
- Tool to support the management of sandy soils including Interactive web App
- Demonstration of the ‘Sandbox’ interactive web application.



Sandy Soil Constraints

Not all sandy soils are the same.

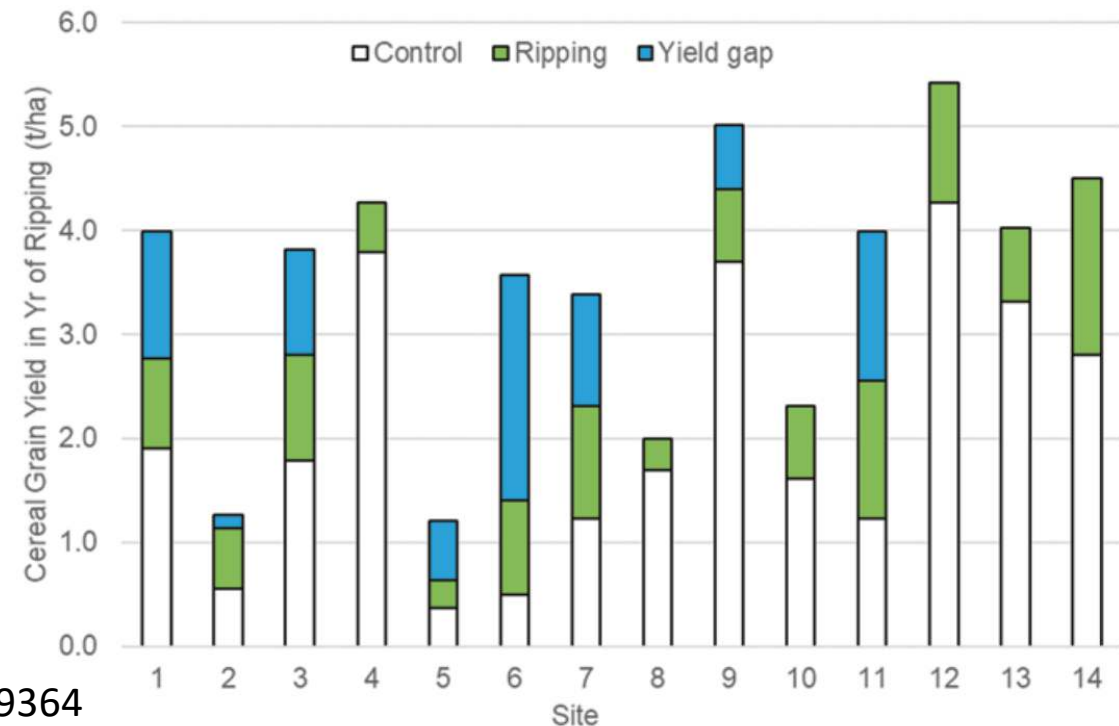
Growers report 'water left behind' after underperforming crops in sandy soils.

This poor crop water use is due to constraints that limit production.

- Physical constraints (i.e. high soil strength)
- Water repellence
- Acidity
- Lack of nutrients

Yield gap analysis demonstrates that managing these soils can close the gap.

<https://www.springerprofessional.de/en/sandy-soils/26689364>





Management Options

“The sand was always deemed the shit soil on the farm, and then all of a sudden, it became better than the red ground in some ways. There is an element of excitement in trying to fix these soils and then manage them.” (Participant from impact and adoption survey)

Mitigation options

Improving crop establishment
Polymers/wetters
Residue management
Sowing on or near the previous crop row

Amelioration options

Soil inversion
Soil mixing
Soil shattering
All with or without amendments

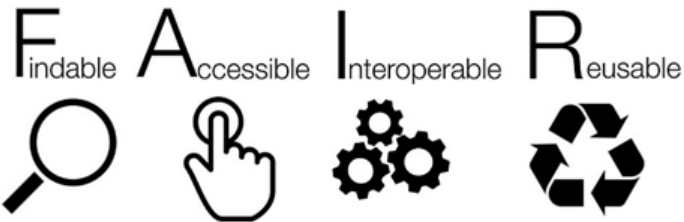
The key to success is the diagnosis and management of constraints



Data Sharing

Sharing project data is now expected practice.

- Data Access Portal <https://data.csiro.au/>



- R Shiny app
'Sandy soil App – Sandbox'

<https://shiny.csiro.au/soil-sandbox/>

'Sandbox' interactive web application.

Helps users to better understand sandy soil constraints, diagnosing constraints and exploring management options with possible yield responses.

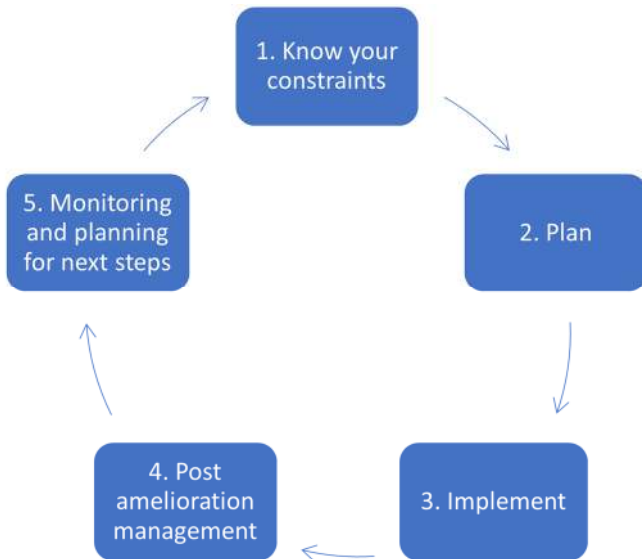
- Connect growers and advisers to soil mitigation and amelioration research outputs
- Includes factsheets, decision matrices and a database of experiment results



'Sandbox' interactive web application

The app is made up of multiple pages:

Introduction, What is my constraint, Trial results, Management Options



<https://shiny.csiro.au/soil-sandbox/>

Introduction | What is my constraint | Trial results | Management Options

Welcome to Sandy soil App - Sandbox

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About the app:
This interactive web application allows the users to interrogate and visualise sandy soil project trial yield results alongside site climate and soil constraint information. It is aimed at helping grain growers evaluate amelioration options in the context of their own soils and climate. The app also houses a series of fact sheets relating to soil constraint identification and machinery selection to support the user to view the most useful results and to identify the most suitable management options.

The aim of the Sandy Soils project is to boost crop yields by increasing crop water in underperforming sandy soils by improving the diagnosis and management of constraints. Crop water-use and yields on sandy soils are commonly limited by a range of soil constraints that reduce root growth.

<https://grdc.com.au/resources-and-publications/all-publications/factsheets/2022/physical-soil-constraints-fact-sheet>



'Sandbox' - What is my constraint


1. Better understand and assess their constraints.
2. Select a trial site that has similar constraints to their farm

Introduction
What is my constraint
Trial results
Management Options

Water repellence

Water repellence forms when waxes from decayed organic material (e.g. stubbles) coat grains of soil, making them repel water, which inhibits water entry into the soil profile.

This leads to patchy crop establishment and a staggered germination of weeds, reducing yield potential at the start of the season.

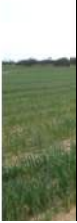


Nutrition

Sandy soils are often nutrient deficient or infertile because they are highly weathered soil with a low ability to retain and cycle nutrients.

The realisation of the potential of sands relies on adequate nutrient inputs.

There are some key constraints...



What are your constraints?

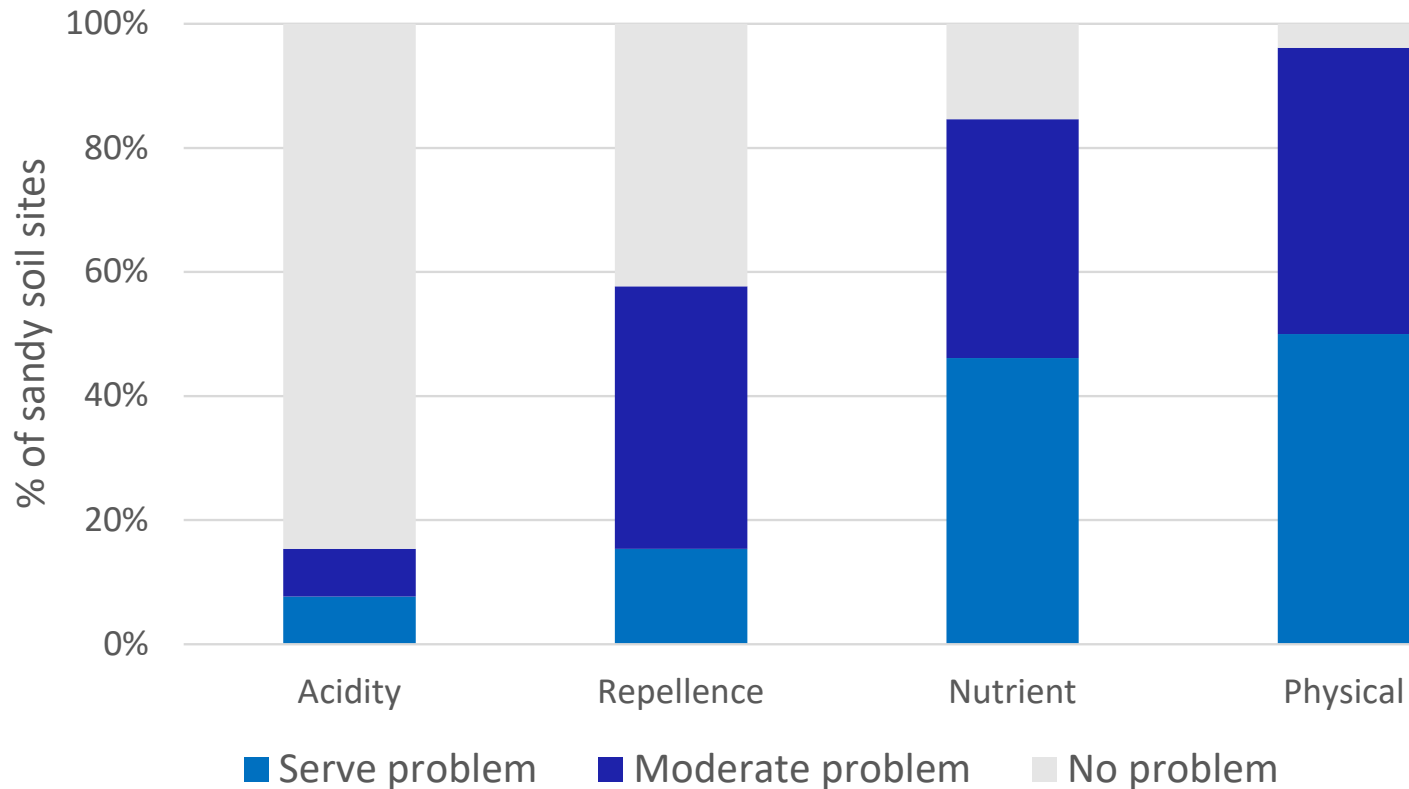
Use the filter feature in the below table
To select sites with similar constraints

Site	Replence	Nutrition	Acid	Strength
<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>
Younghusband	Severe issue	Severe issue	No issue	Severe issue
Kooloonong	No issue	Moderate issue	No issue	Moderate issue
Tempy	Moderate issue	Moderate issue	No issue	Moderate issue
				Moderate issue
				Moderate issue
Malinong	Moderate issue	No issue	Moderate issue	Moderate issue

<https://grdc.com.au/resources-and-publications/all-publications/factsheets/2022/physical-soil-constraints-fact-sheet>



Constraint at sandy soil trial sites



Physical constraint was the most common constraint.

Acidity was less common with only 15% of sites rating this as moderate or severe.

Many sites had multiple soil constraints.

Percentage of trial sites with multiple constraints - ranked as moderate or severe

2 Constraints
42%

3 Constraints
50%

4 Constraints
4%



Supporting decisions – identify similar sites



<https://grdc.com.au/resources-and-publications/all-publications/factsheets/2022/physical-soil-constraints-fact-sheet>

Hypothetical farm near Karoonda

<u>Repellence</u>	<u>Nutrition</u>	<u>Acid</u>	<u>Strength</u>
Moderate issue	Severe issue	No issue	Severe issue

Site	Replence	Nutrition	Acid	Strength
All	moderate <input checked="" type="checkbox"/>	severe <input checked="" type="checkbox"/>	no issue <input checked="" type="checkbox"/>	severe <input checked="" type="checkbox"/>
Bute	Moderate issue	Severe issue	No issue	Severe issue
Lowaldie	Moderate issue	Severe issue	No issue	Severe issue



Supporting decisions – review the options

Hypothetical farm near Karoonda

Repellence
Moderate issue

Nutrition
Severe issue

Acid
No issue

Strength
Severe issue

<https://grdc.com.au/resources-and-publications/all-publications/factsheets/2022/ripping-technology-national-fact-sheet>

Constraint	Seeder Strategies		Amelioration Options			
	Furrow inputs	Paddock practices and Seeder upgrades	Amendments	Strategic deep tillage options		
				Ripping	Mixing	Inversion
Water repellence	✓	✓	Clay	*/✓	✓	✓
Acidity	×	×	Lime Alkaline clay	With inclusion plates (IP)	✓	✓
Soil Strength	×	×	Gypsum Organic amendment	✓	✓	✓
Low nutrient fertility	×	✓	Fertiliser package Organic amendment Clay	IP	✓	×



Supporting decisions – review the results

Bute

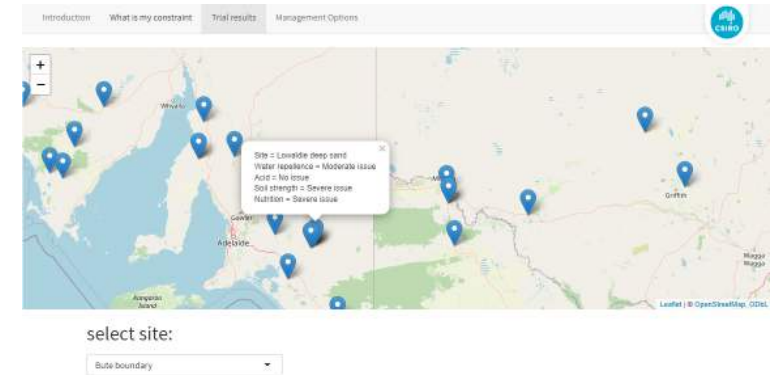
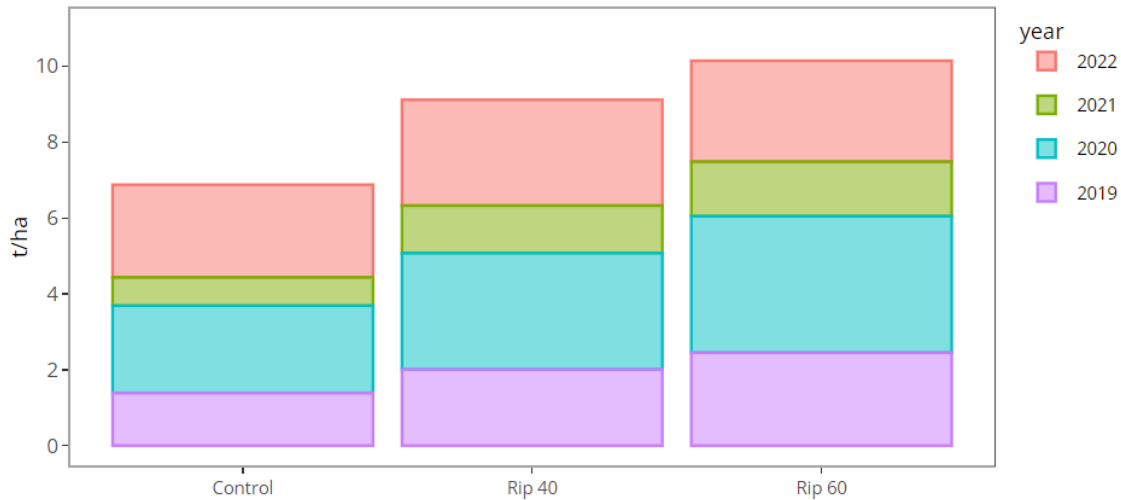
Chicken litter at surface
Ripping +/- Chicken litter

Lowaldie x2 paddocks

Rip no amendments

Cumulative Yields

Lowaldie



ANOVA Results of Cumulative Yields

Show 10 entries

Search:

Treatment	Detailed Treatment Name	Yield	Significance of ANOVA	Groups
Control	Control	6.88	*	b
Rip.40	Ripping to 40cm with no amendments	9.13	*	ab
Rip.60	Ripping to 60cm with no amendments	10.14	*	a



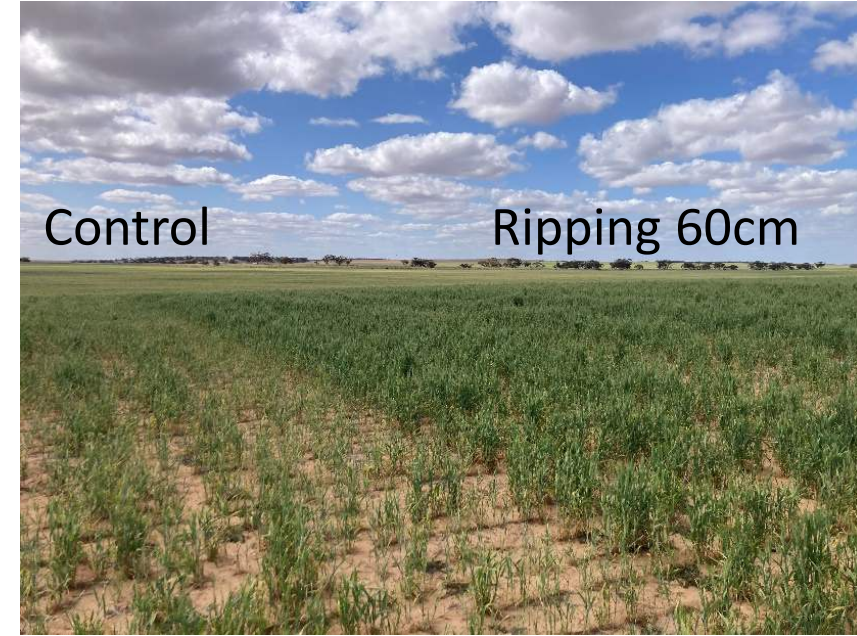
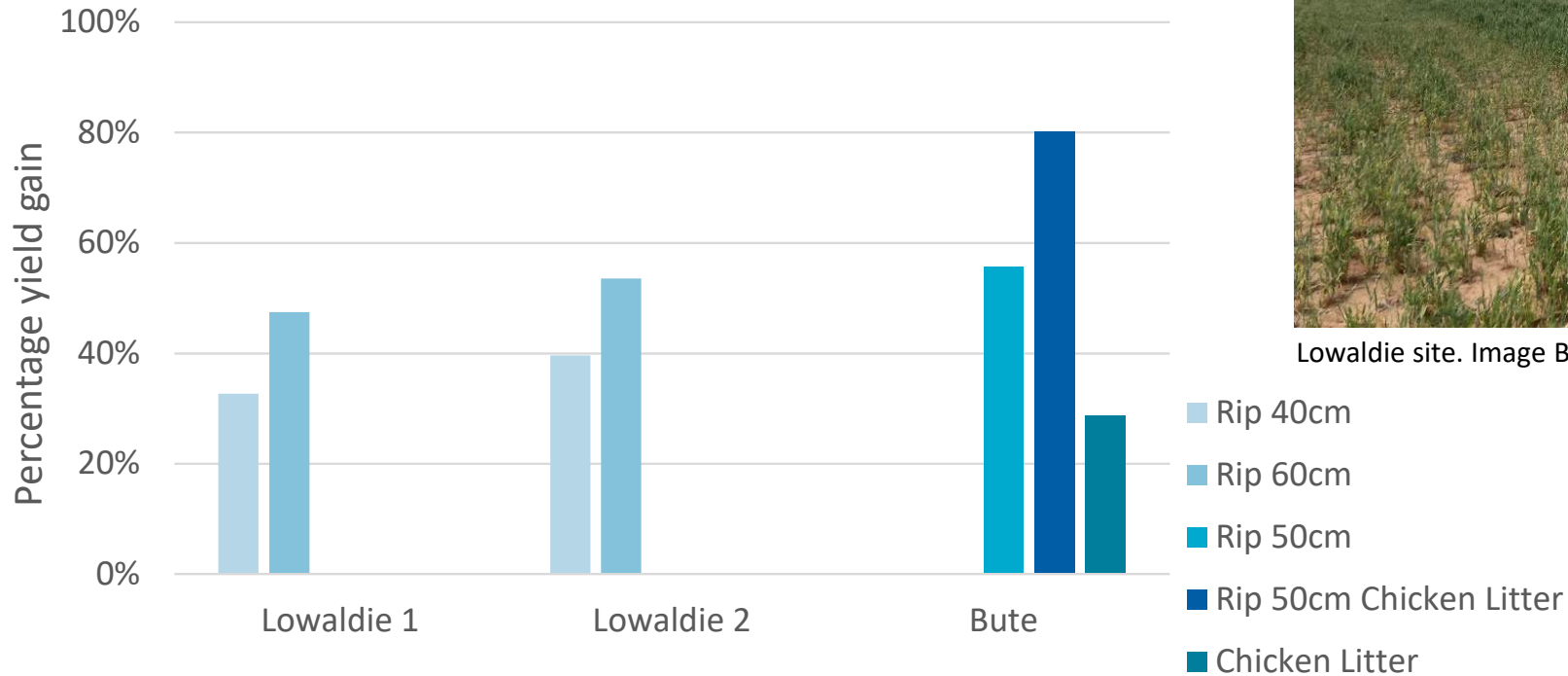
Compare results

Lowaldie X2 paddocks

Bute

Rip no amendments

Chicken litter at surface
Ripping +/- Chicken litter



Lowaldie site. Image Bill Davoren.



Conclusions

- The app guides users in identifying the soil constraints and choosing management options.
- The treatment results highlight the benefit of improving unproductive sand by ripping .
- The cost of the management choice varies and influences the option chosen.
- Soil-sandbox app is useful in supporting these complex decisions.
- Paddock test strips are the next step in supporting the decision.





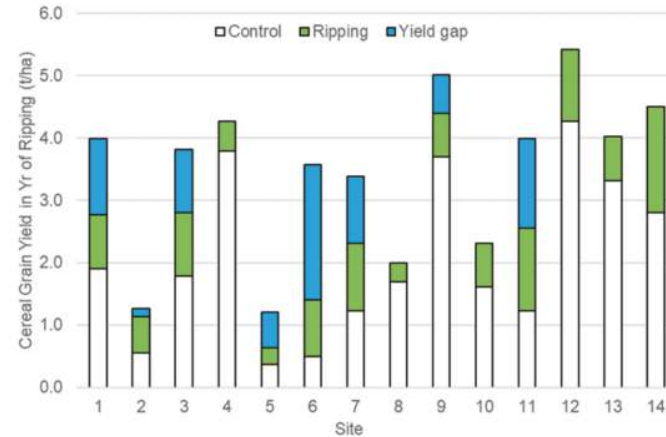
Thank you

Therese McBeath, Lynne Macdonald, Rick Llewellyn, Masood Azeem, Kenton Porker, Bill Davoren, Willie Shoobridge, Rachel Hennesey, Murray Unkovich, Jack Desbiolles, Chris Saunders, Mustafa Ucgul, Andrew Burge, Nigel Wilhelm, Ian Richter, Sjaan Davey, David Davenport, Brett Masters, Melissa Fraser, Michael Moodie, Todd McDonald, Chris Davies, Sam Trengove, Stuart Sherriff, Jordan Bruce, Rachael Whitworth, Barry Haskins, Royce Pitchford, Patrick Redden, Tanja Morgan, Meg Bell, Naomi Scholz, Stefan Schmitt.

<https://shiny.csiro.au/soil-sandbox/>



Yield gap



- The grain yield gap between potential water-limited yield and yield achieved is often used to benchmark a system relative to the water limited potential (Hochman and Horan 2018).
- The potential yield (t/ha) was calculated as $22 \text{ (kg/ha/mm)} \times \text{water use (mm)} - 60 \text{ (mm evaporation)}/1000$ according to the calculation outlined by Sadras and Angus (2006).
- Water use was assumed to be growing season rainfall (mm) plus $0.25 \times \text{fallow rainfall (mm)}$.
- The yield gap was the difference between yield potential and yield attained in the ripped treatment.
- An evaluation of the role of deep tillage for closing the yield gap was completed for 14 sandy soil sites which had a soil PR > 2.5 MPa between 30 and 50 cm depth.
- At six sites the yield gap was closed, and the actual yield exceeded the estimated grain yield potential by 0.1–2.0 t/ha (Fig. 19.2).
- Where a substantive yield gap remained, it was often attributable to a very dry growing season (decile 1–3, worst 10–30% of seasons) (Fig. 19.2).
- Further analysis has revealed that crop rooting depth and efficiency of water utilisation have played a key role in the yield benefits gained by amelioration treatments (Unkovich et al. 2023).