Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

Protect
Grow
Innovate

Realizing the potential of sands in agricultural systems

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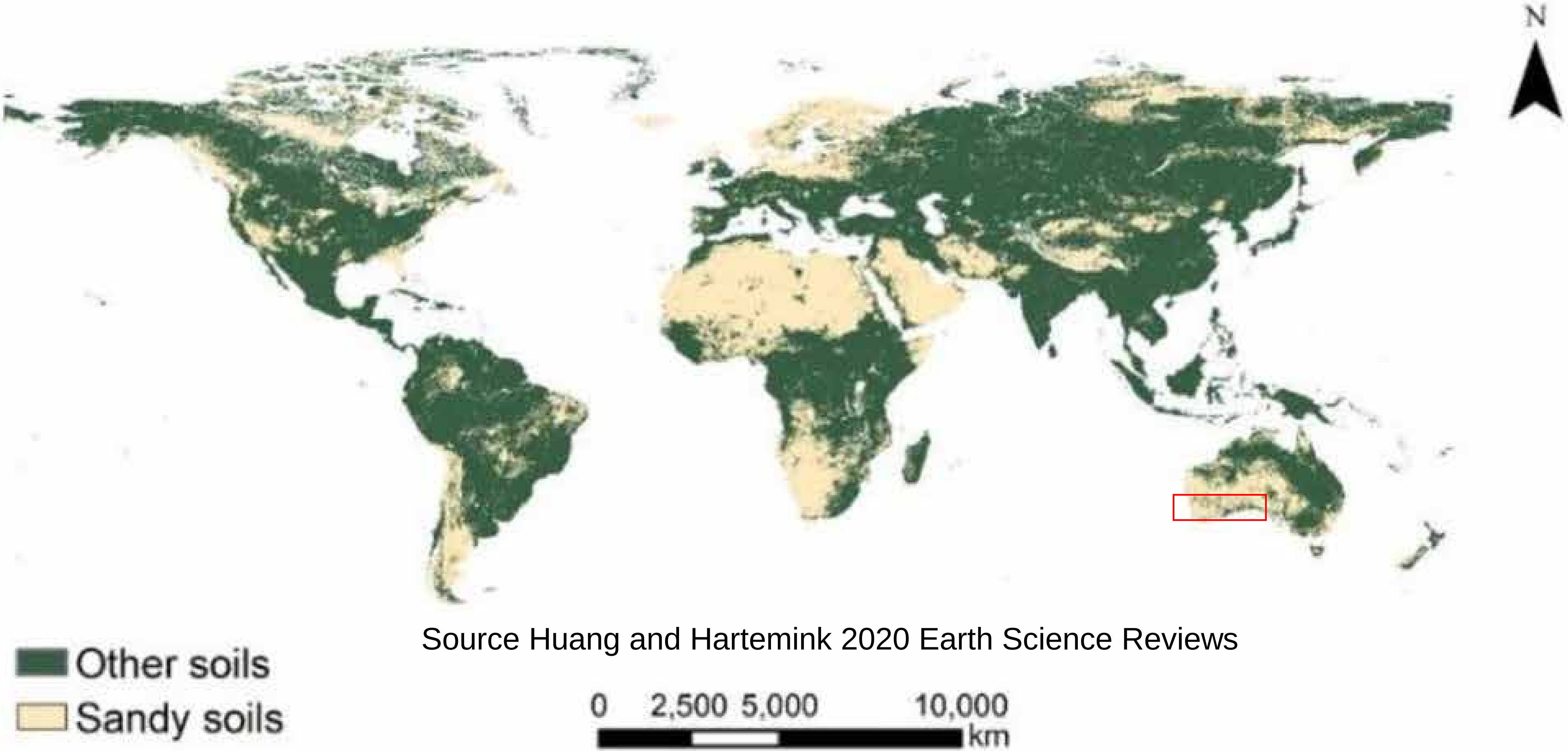
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Global Sandy Soils Conference
23rd July 2025

Distribution of Sandy Soils



Source Huang and Hartemink 2020 Earth Science Reviews

"Everywhere we found the soil sandy and very poor … The general bright green colour, when viewed from a distance, seems to bespeak fertility, a single walk will dispel such an illusion and if he thinks like me will never wish to walk again in so uninviting country."

Charles Darwin, 1836, Albany Western Australia.

Native vegetation on a deep sand. Western Australia

Production Limitations:

- Susceptible to wind erosion
- Poor water and nutrient retention
- Nutrient deficiencies
- Water repellent surface
- High strength subsoils
- Acidic with low buffering capacity

Management Options : Australia vs Elsewhere

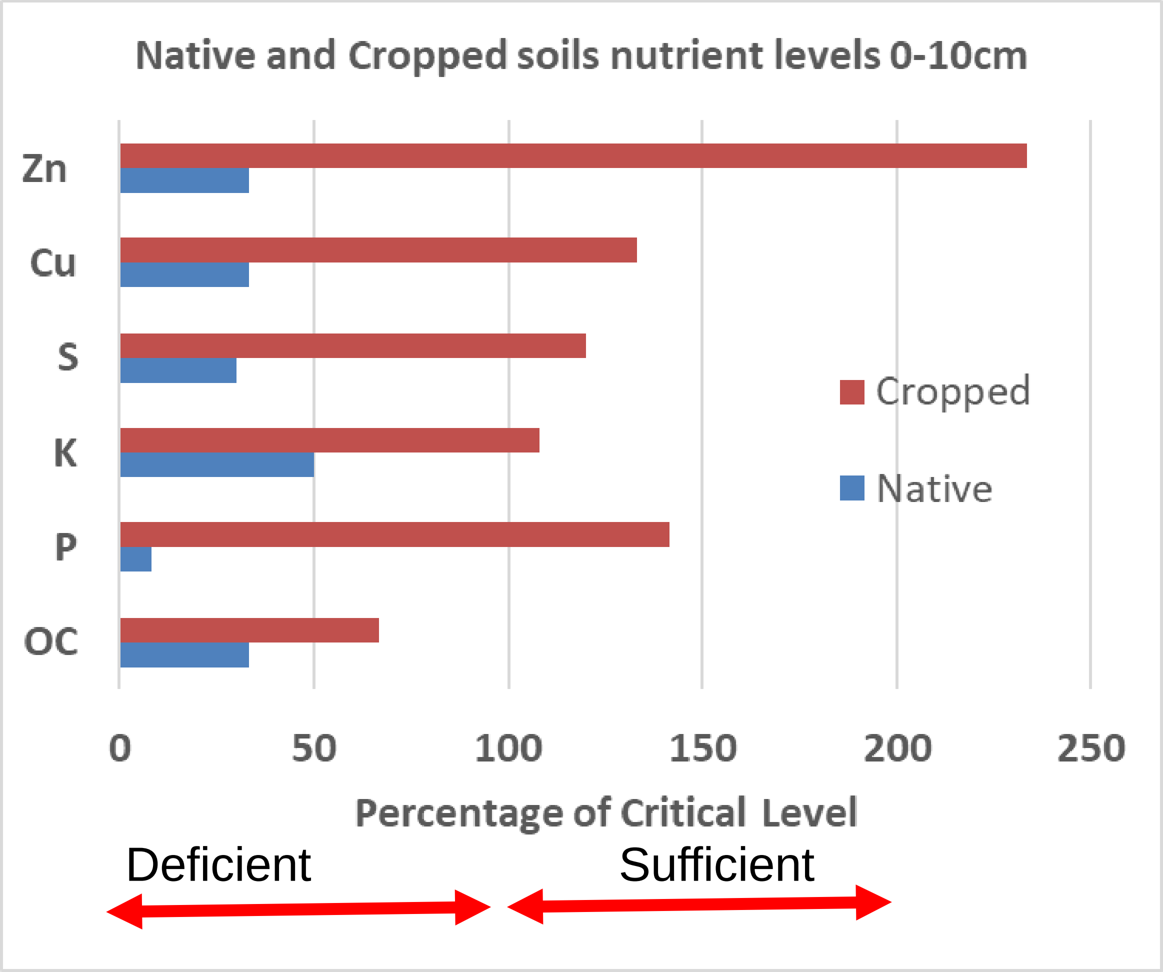
Constraint	Southern Australia	Nth Europe Americas South Africa
Wind erosion	No-till + stubble retention	Min/No-till + stubble retention Cover Crops, Windbreaks
Nutrient deficiencies	Mineral Fertilizers	Mineral+Organic Fertilizers
Compaction	Controlled traffic Deep Strategic Subsoiling	Controlled traffic Subsoiling
Water repellence	Wetting agents Furrow seeding Claying On row seeding Inversion tillage	Wetting agents
Acidity	Incorporated Lime	Incorporated Lime + Gypsum

Wind erosion management


Wind erosion: Esperance 1990s

- Mitigated by rapid adoption of No-tillage with stubble retention *D'Emden et al. 2006*
- Windbreaks and cover crops have not been adopted in southern Australia.
  - Windbreaks : 3 - 5% reduction in yields and profits due to tree-crop competition ***Sudmeyer et al 2002***
  - Summer Cover crops : 20 mm less water available for subsequent winter crops = yield reduction of 200 - 400 kg/ha
  - ***Robertson et al 2005***

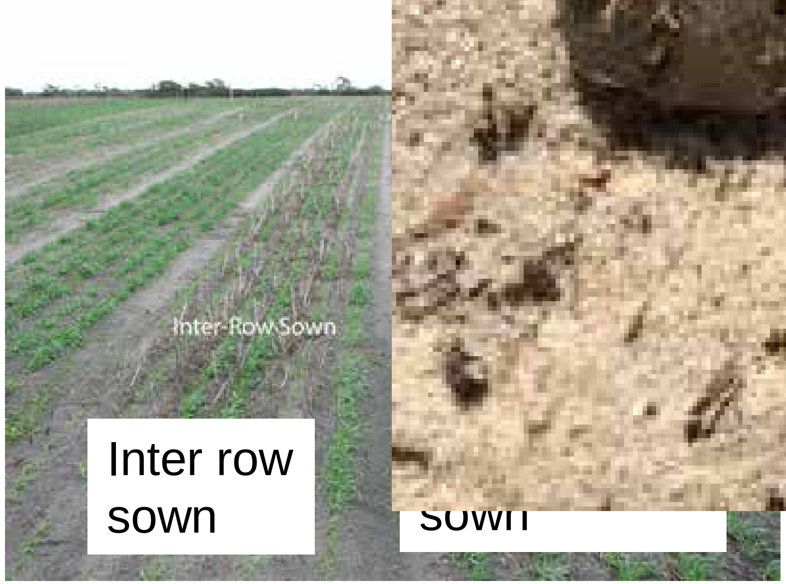
Inorganic and organic amendments



- High adoption and effectiveness of mineral fertilizers.

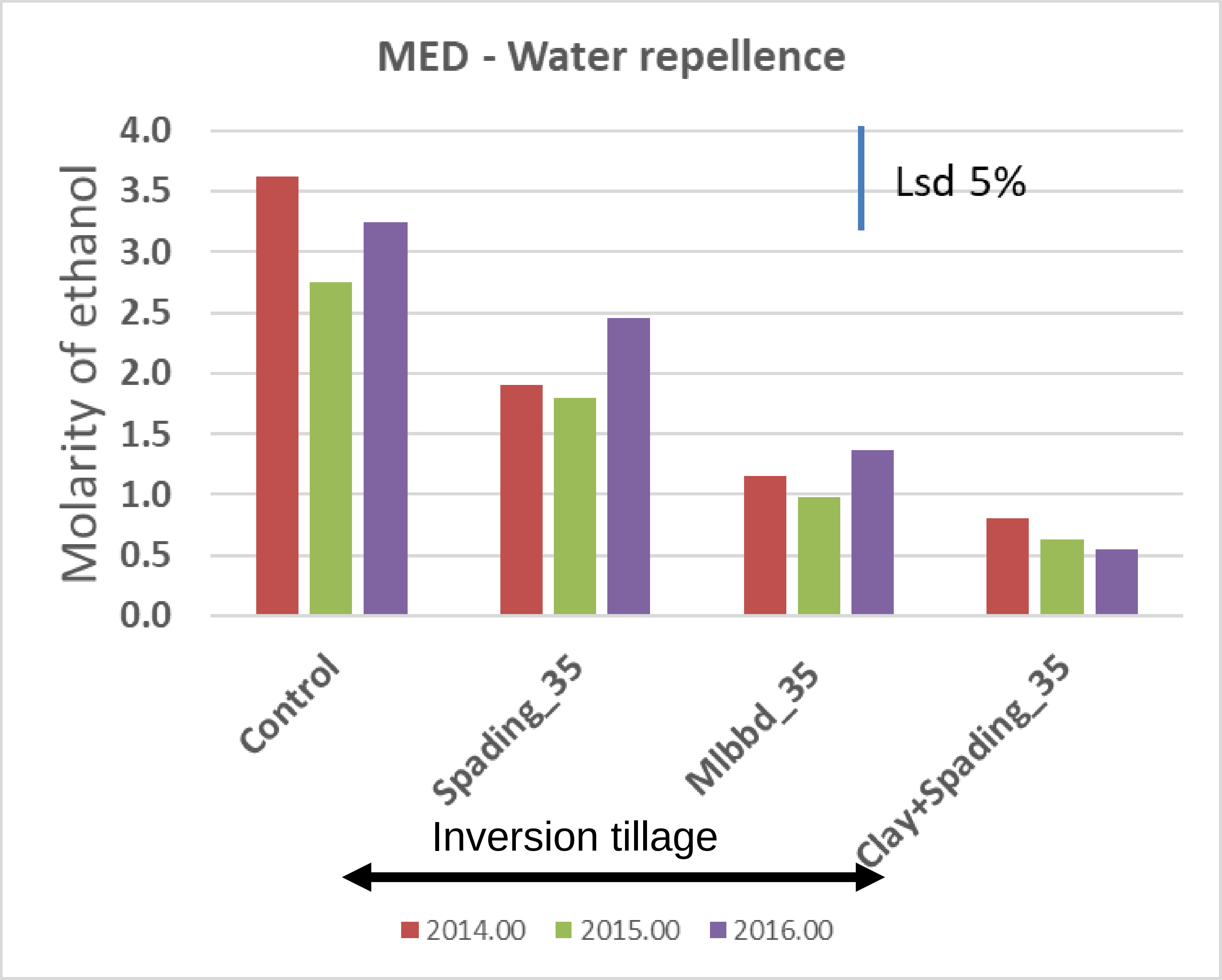
- Low adoption of organic fertilizers and amendments in Australia
  - Biochars 11% yield increase **Blackwell 2010**
  - Composts (10, 20 t/ha) + trenching increased yield by 30 % mainly due to nutrition. ***Hall and Edwards 2025***
  - Limited product and profitability
  - No clear benefit over mineral fertilizers.

Water repellence management



Source: T Blacker/ M Roper

Water repellence solutions



Hall et al 2020

Clay spreading : Condingup 2024

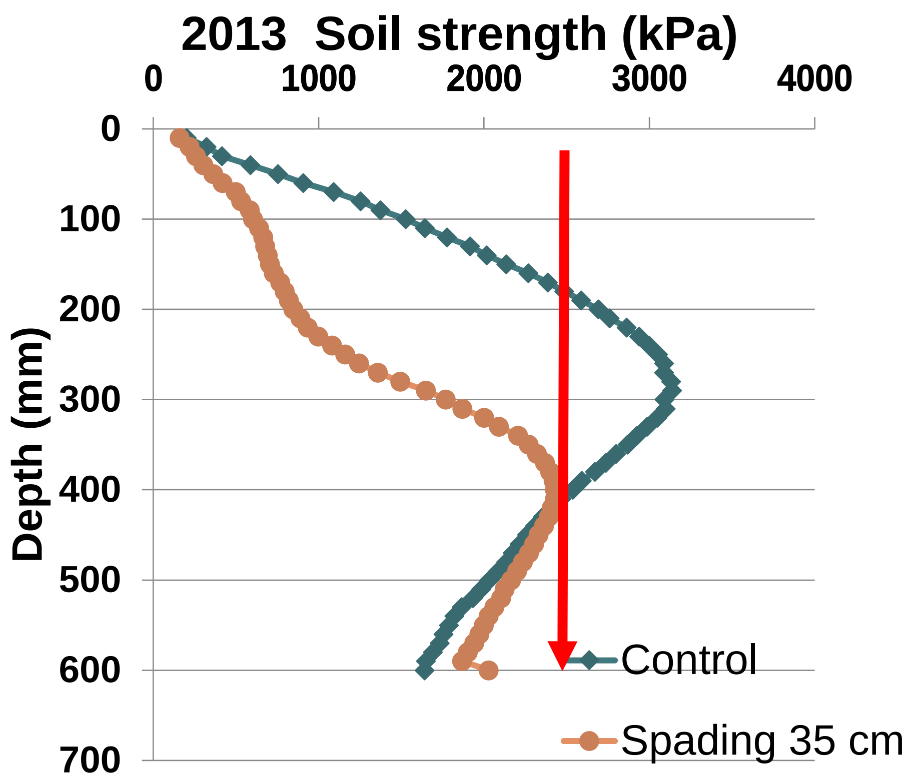
Claying and nutrition (0 -10 cm) after 15 years

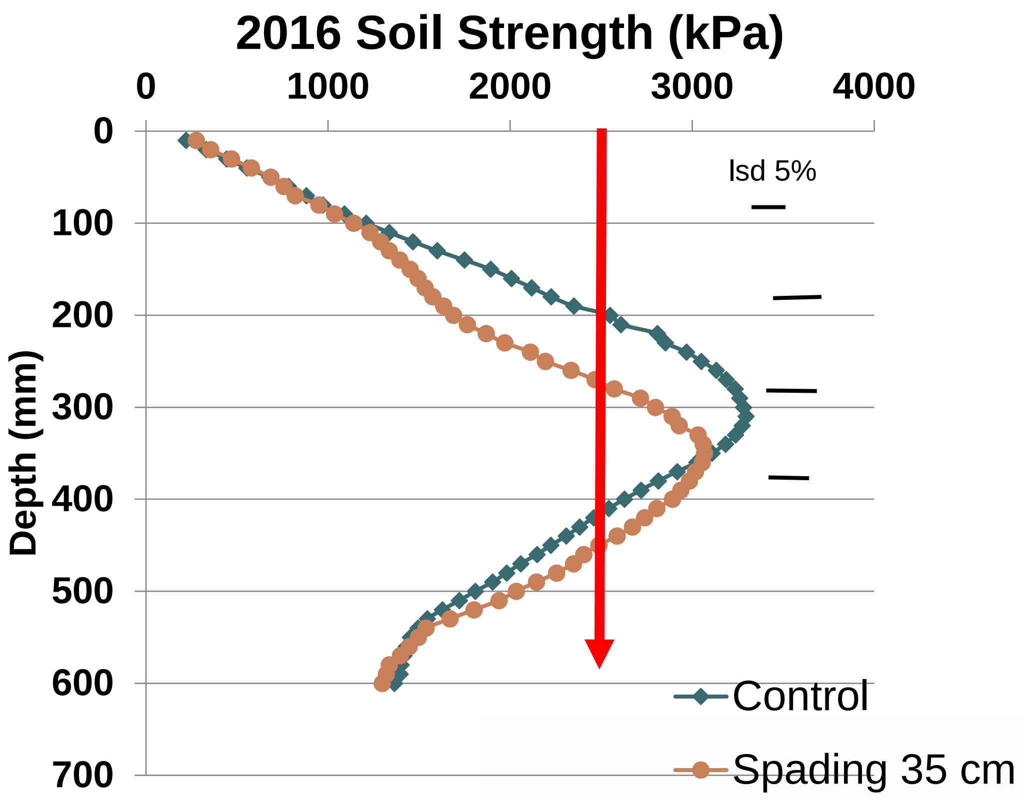
Clay rate t/ha	Clay%	MED	pHca	P mg/kg	K mg/kg	S mg/kg	OrgC %	CEC cmol+/kg
Applied Clay	41	0	7	2	352	72	0.2	9
0 Control	0.8	2.2	5.0	9.7	17.2	9.3	0.9	2.7
50	0.9	**1.0**	5.0	8.8	21.8	10.5	1.0	2.9
100	1.0	**0.8**	5.0	10.5	23.3	9.8	1.0	2.9
200	**3.1**	**0.1**	**5.3**	**14.3**	**37.7**	**11.5**	**1.1**	**3.6**
300	**6.6**	**0.0**	**5.6**	**22.3**	**64.5**	**14.2**	**1.1**	**4.4**

Adapted from Hall et al 2010

Compaction in sandy soils

- Sandy soils most responsive to deep tillage Jarvis 2000, Kirkegaard 2009,





Hall et al 2020

Sand Strength and Compaction Management

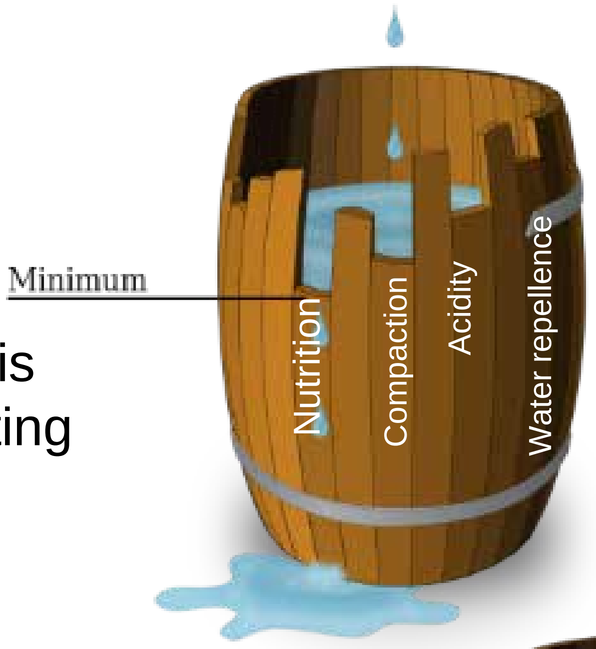
Controlled traffic

Photo: DPIRD

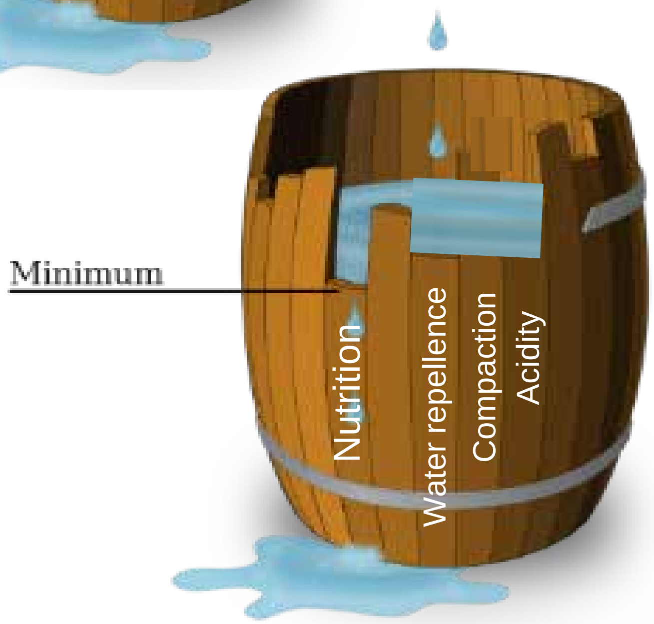
Deep tillage

Tactical strategies

Managing multiple constraints



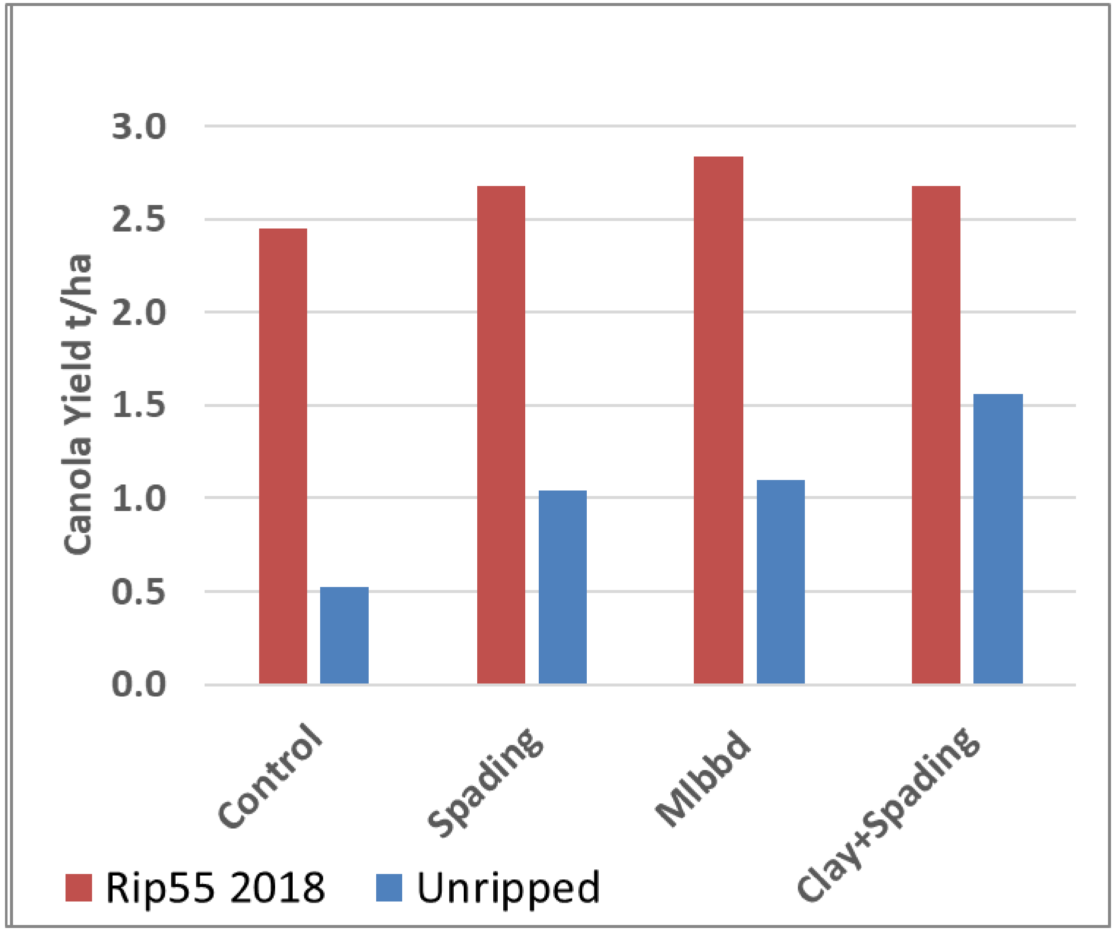
Liebig's law: Achieving yield potential is dependent on eliminating the most limiting constraint(s).

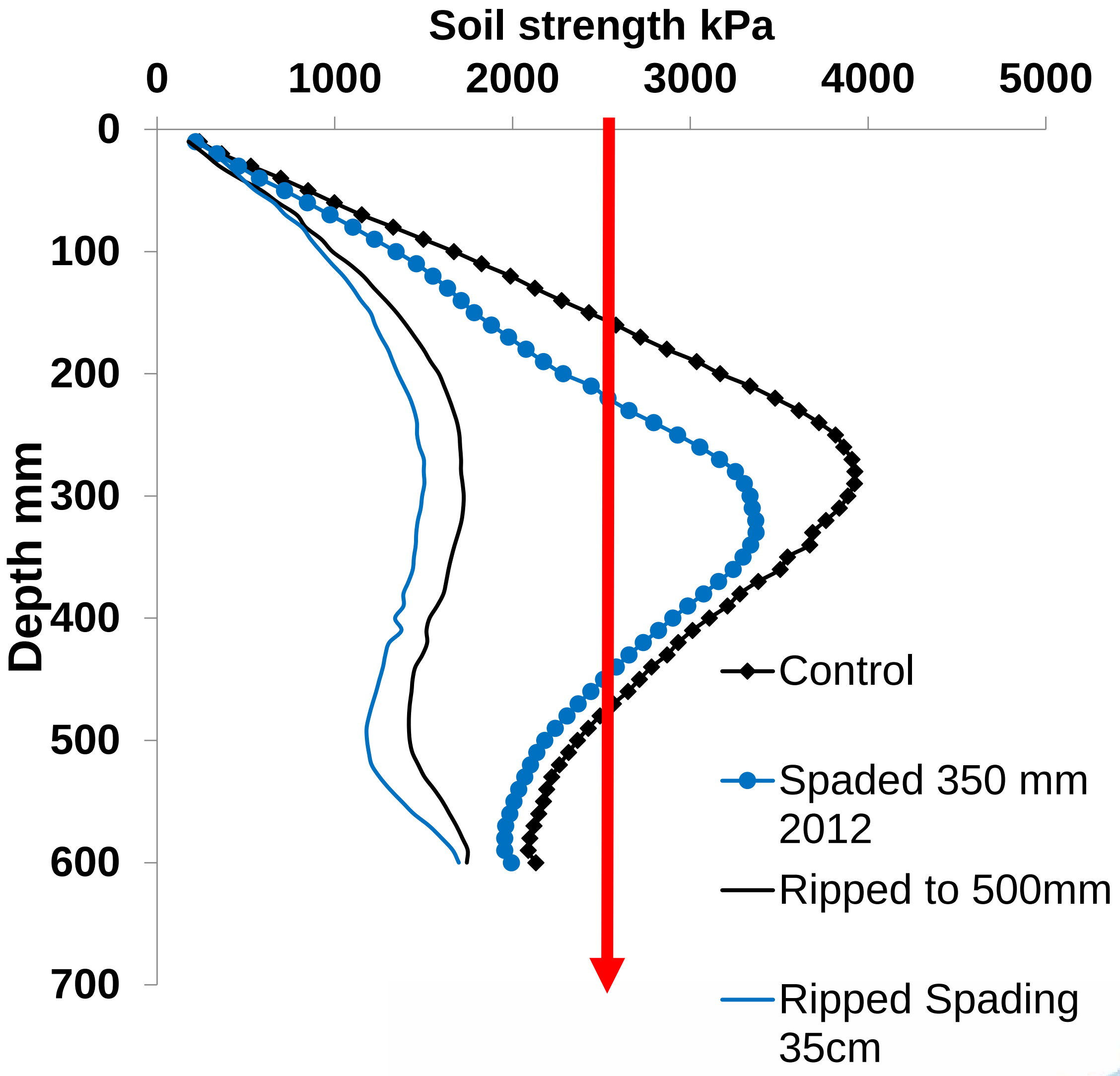


Sandy soils constraints where severity of constraints are equal.

We need to know the relative effect of each constraint on production

Knowing the severity of multiple constraints





Source: Tom Edwards

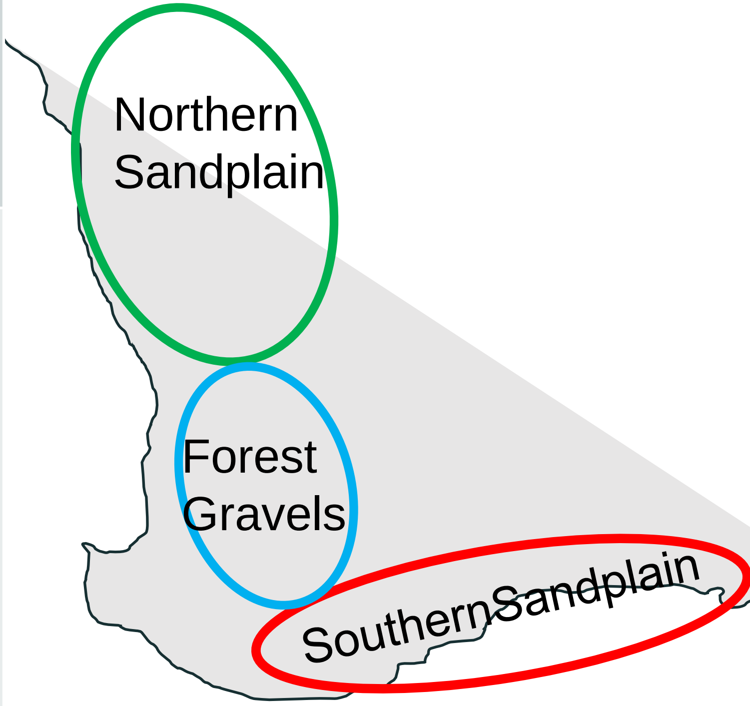
How far can we improve water use efficiencies?

Cereal water use efficiency (Yield/Growing season rainfall)		
Treatment	kg/mm/ha	% of current Potential*
[A]Control	8.9	40
Inversion tillage (40 cm)	10	45
Inversion tillage +Clay	11	50
Ripped to 50 cm	11	50
Ripped + Inversion tillage	13	59
Deep tillage slots+ OM (10t/ha)	15	68
Ripped + Inversion tillage +clay	16	73
[1]Re-Engineering + Lime +OM	30	136

[A]Edwards pers com, [1]Azam et al 2025, *22 mm/kg/ha

Adoption of management systems

Amelioration	Northern Sandplain	Forest Gravels	Southern Sandplain
Main methods	Inversion Tillage +Ripping + Lime	Wetting agents + Near row seeding	Ripping + Claying+ Inversion tillage + Near row seeding +Lime
Reasons	Gradational soils. Clay increases with inversion. Acid sands Poor response to clay application (premature haying off).	Gravels highly responsive to wetting agents. Gravels too abrasive on deep tillage machinery.	Claying benefits: Wind erosion control nutrition (K) Weed management Wind erosion risk from inversion. .



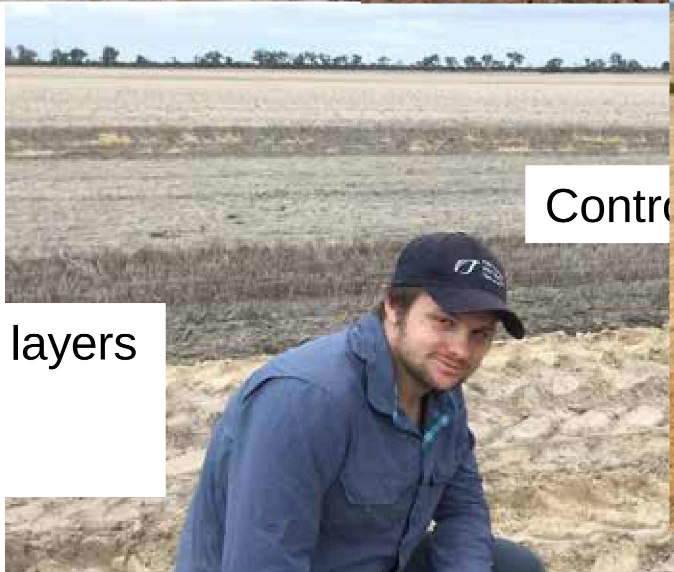
> $200M/yr increase in profitability Davies 2020

Conclusions

- Sands have limitations but they are highly responsive to amelioration.
- Australia has developed its own unique systems for managing sands.
- Effective management of multiple constraints (compaction, repellence, acidity, nutrition) has doubled yields and water use efficiencies leading to greater profits.

Thank you

Strategic inversion tillage: one off pass to improve multiple limitations



Contr

- Mix and dilute water repellent layers
- Incorporate amendments
- De-compact subsoil

Tackling multiple constraints in sands

Site	Repellence	Nutrition	Acidity	Strength
Murlong	Severe Issue	Severe Issue	No Issue	Severe Issue
Brimpton Lake	Moderate Issue	Moderate Issue	Moderate Issue	Severe Issue
Cadgee	Severe Issue	Severe Issue	Severe Issue	No Issue

Source: shiny.csiro.au/soil-sandbox/