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Primary Industries and  
Regional Development



Protect  
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# Role of legumes in increasing farming systems profitability and longevity of benefits following soil amelioration

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Soil amelioration = deep tillage



## Strategic deep tillage

### Physicochemical constraints

- Water repellence
- Subsoil compaction
- Subsoil acidity

## Crop rotation

### Nutrition

- Nitrogen

### Biological constraints

- weeds
- Soilborne pests and pathogens

# Deep tillage vs weeds

| Treatment      | Weed density (pl/m <sup>2</sup> ) |                  |                 |                  |
|----------------|-----------------------------------|------------------|-----------------|------------------|
|                | Yerecoin                          |                  | Darkan          |                  |
|                | 2019<br>(wheat)                   | 2020<br>(barley) | 2019<br>(wheat) | 2020<br>(barley) |
| No-Till        | 54 <sup>c</sup>                   | 27 <sup>b</sup>  | 4 <sup>b</sup>  | 5 <sup>b</sup>   |
| Deep Ripping   | 86 <sup>d</sup>                   | 41 <sup>b</sup>  | 5 <sup>b</sup>  | 4 <sup>b</sup>   |
| Soil Mixing    | 27 <sup>b</sup>                   | 15 <sup>b</sup>  | 6 <sup>b</sup>  | 7 <sup>b</sup>   |
| Soil Inversion | 0 <sup>a</sup>                    | 0 <sup>a</sup>   | 0 <sup>a</sup>  | 0 <sup>a</sup>   |

Weed control

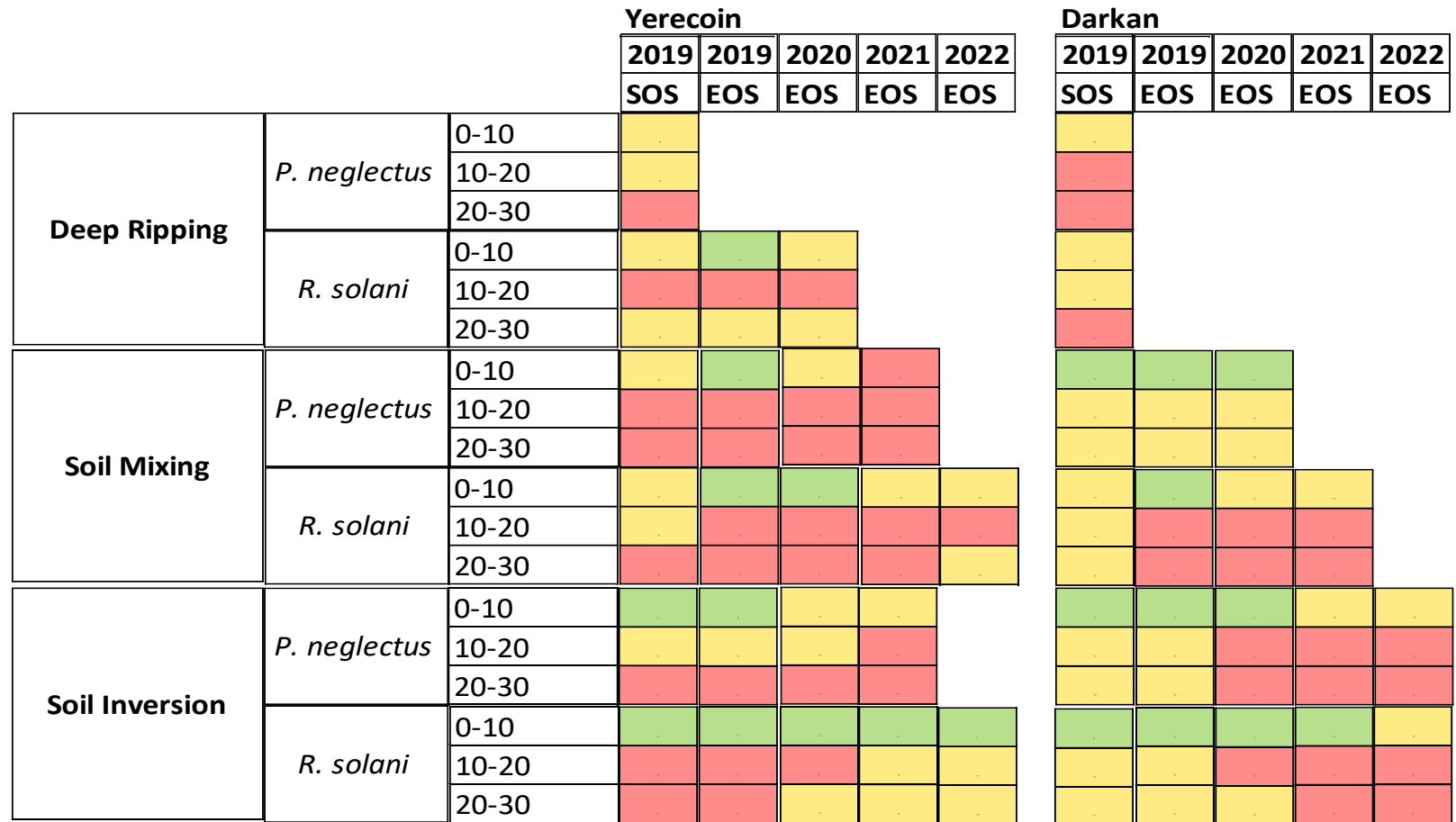


Inconsistent; transient



Consistent; longer lasting

# Deep tillage vs soilborne pests and pathogens



## Longevity of changes

<1 season

<1-2 seasons

2-3 seasons

3-4 seasons

3-4 seasons

>4 seasons

Same as no-till
  Lower than no-till
  Higher than no-till

Source: Wilkinson et al, manuscript in preparation

# Crop sequencing after soil amelioration



Meckering

- Gravelly yellow sandy earth
- Deep ripped (with some mixing) in July 2019
- Rotation trial commenced in 2020



Mingenew

- Deep yellow sand
- Spaded in 2020
- Rotation trial commenced in 2020

# Crop sequences



|      | 1              | 2               | 3    | 4    | 5    | 6    | 7                         | 8                         |
|------|----------------|-----------------|------|------|------|------|---------------------------|---------------------------|
|      | Cont.<br>Wheat | Cont.<br>Cereal | LWLW | CWCW | LWCW | CWLW | LCWW<br>(double<br>break) | CLWW<br>(double<br>break) |
| 2020 | W              | W               | L    | C    | L    | C    | L                         | C                         |
| 2021 | W              | W               | W    | W    | W    | W    | C                         | L                         |
| 2022 | W              | B               | L    | C    | C    | L    | W                         | W                         |
| 2023 | W              | W               | W    | W    | W    | W    | W                         | W                         |

- Only four of eight rotations presented today

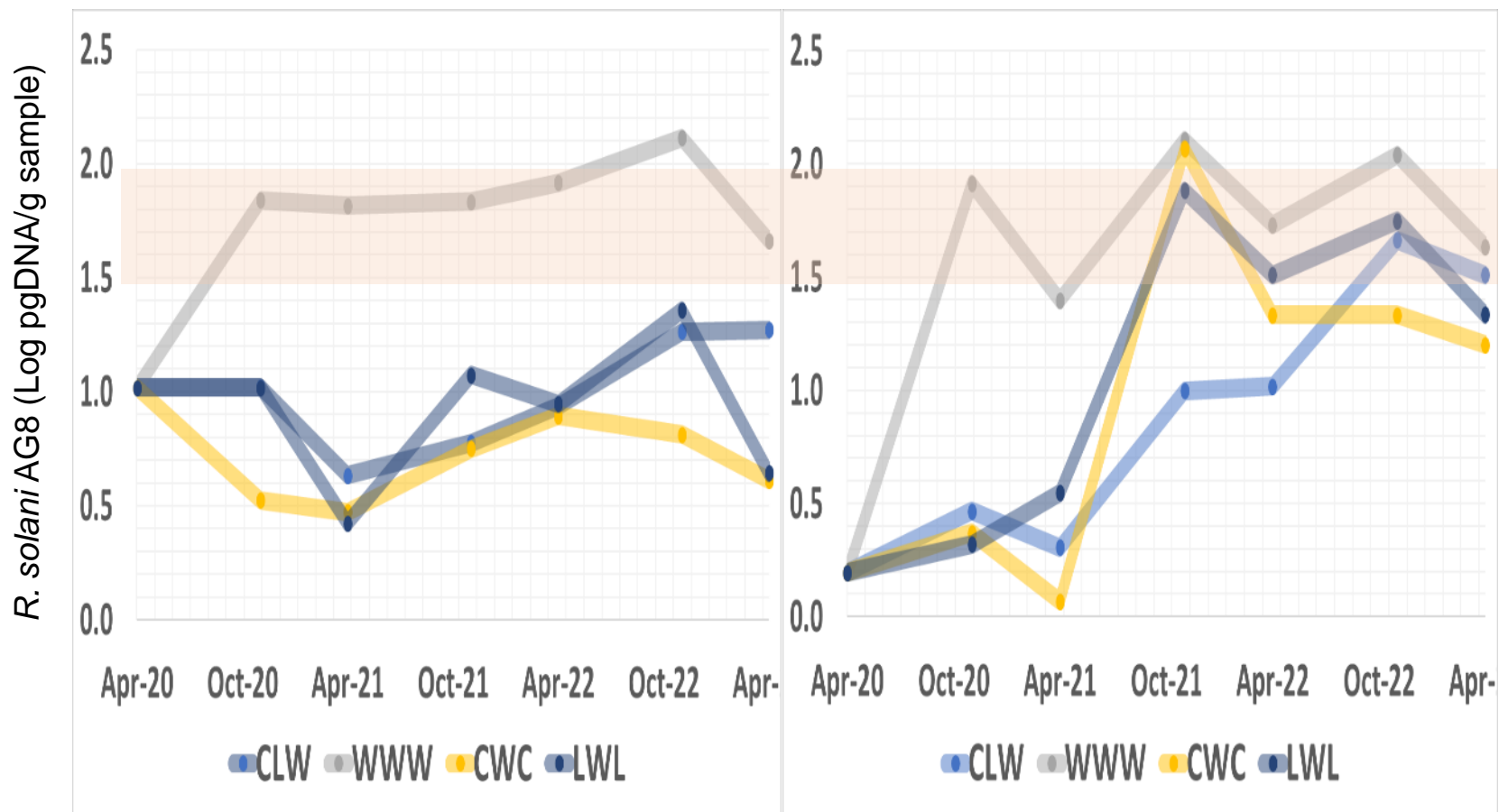


# Weeds

| Rotation    | Annual ryegrass density (pl/m <sup>2</sup> ) |                   |                   |                  |                   |      |                  |                   |
|-------------|--|-------------------|-------------------|------------------|-------------------|------|------------------|-------------------|
|             | Meckering                                    |                   |                   |                  | Mingenew          |      |                  |                   |
|             | 2020   | 2021              | 2022              | 2023             | 2020              | 2021 | 2022             | 2023              |
| <b>WWWW</b> | 0.5 <sup>a</sup>                             | 0.2 <sup>a</sup>  | 0.9 <sup>a</sup>  | 0.0 <sup>a</sup> | 5.1 <sup>a</sup>  | -    | 2.2 <sup>a</sup> | 2.7 <sup>a</sup>  |
| <b>LWLW</b> | 2.3 <sup>ab</sup>                            | 12.1 <sup>b</sup> | 14.7 <sup>b</sup> | 7.7 <sup>b</sup> | 3.1 <sup>a</sup>  | -    | 6.8 <sup>b</sup> | 14.1 <sup>b</sup> |
| <b>CWCW</b> | 3.6 <sup>b</sup>                             | 1.1 <sup>a</sup>  | 1.5 <sup>a</sup>  | 0.8 <sup>a</sup> | 29.3 <sup>b</sup> | -    | 1.0 <sup>a</sup> | 9.1 <sup>b</sup>  |
| <b>CLWW</b> | 2.6 <sup>b</sup>                             | 4.4 <sup>a</sup>  | 1.4 <sup>a</sup>  | 2.1 <sup>a</sup> | 24.9 <sup>b</sup> | -    | 4.2 <sup>b</sup> | 13.0 <sup>b</sup> |

- Continuous wheat maintained low weed densities
- Increased weeds in the lupin phase

# Rhizoctonia solani AG8

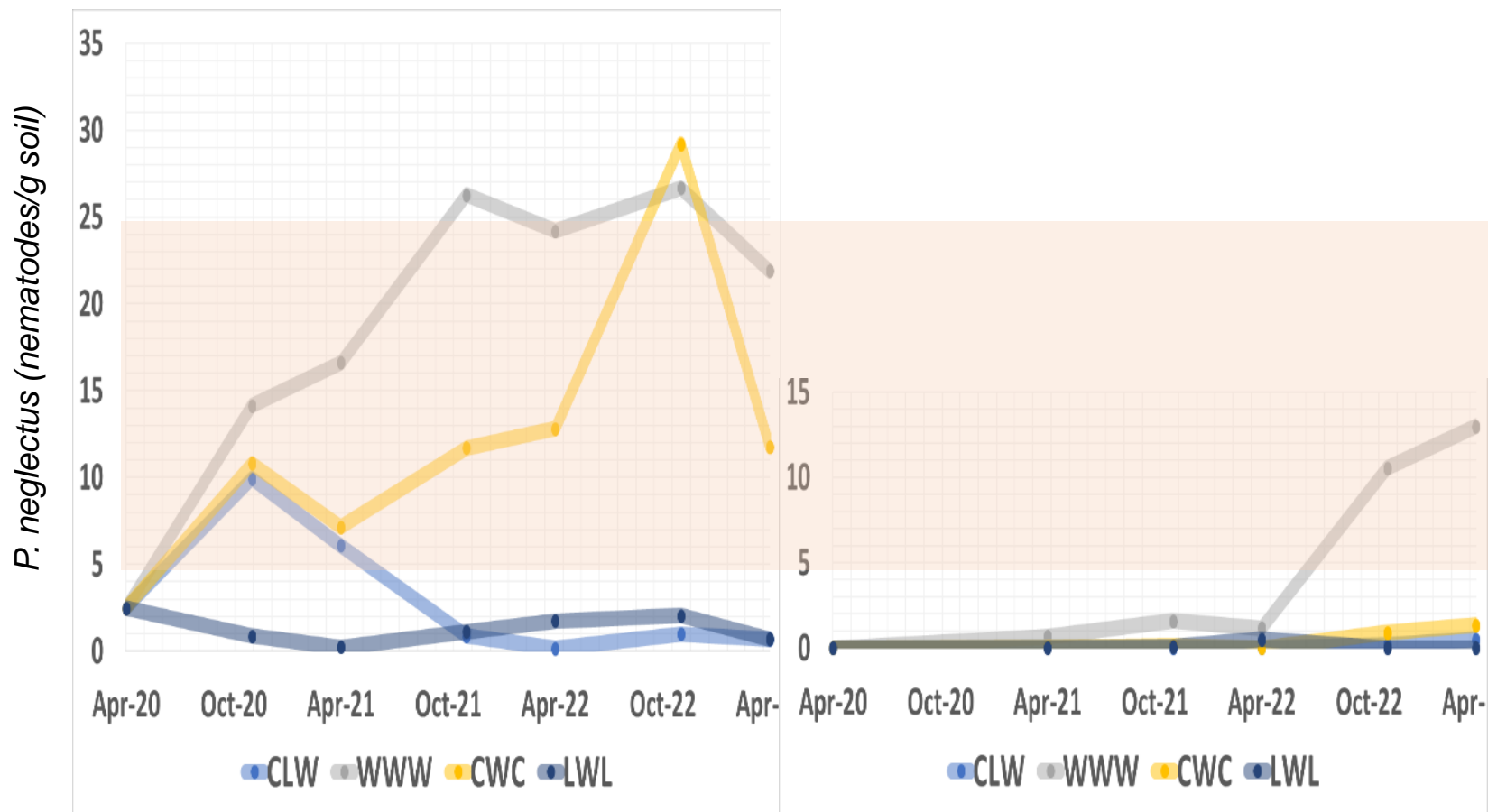


Meckering

Mingeneew

- Continuous wheat – medium to high risk of disease
- Lupin and canola lowered disease risk at Meckering
- Lupin and canola did not have a similar effect at Mingeneew due to grass weeds

# *Pratylenchus neglectus* (RLN)



Meckering

Mingeneau

- Continuous wheat – medium to high risk of yield loss
- Canola slightly lowered disease risk
- Lupin the most effective at suppressing RLN

# Grain yield

| Site      | Rotation | Grain yield (t/ha) |      |      |      |
|-----------|----------|--------------------|------|------|------|
|           |          | 2020               | 2021 | 2022 | 2023 |
| Meckering | CLWW     | 2.4                | 3.6  | 4.9  | 3.7  |
|           | WWWW     | 5.4                | 4.8  | 6.0  | 2.8  |
|           | CWCW     | 2.3                | 6.1  | 1.8  | 3.7  |
|           | LWLW     | 2.3                | 6.9  | 2.8  | 3.9  |
| Mingenew  | CLWW     | 1.7                | 2.8  | 2.6  | 1.2  |
|           | WWWW     | 3.9                | 1.7  | 1.4  | 1.0  |
|           | CWCW     | 1.7                | 2.4  | 0.9  | 1.3  |
|           | LWLW     | 3.5                | 2.9  | 2.5  | 1.5  |

wheat
  canola
  lupin

- Wheat grain yield after canola was 33% higher than after wheat
- Wheat after lupin yielded 52% higher than after wheat
- Wheat after lupin yielded 16% higher than after canola
  - reduced root disease inoculum
  - increased soil N supply from the legume.

# Gross margins

| Site      | Rotation | Gross margin rankings |      |      |      | NPV(\$) |   |
|-----------|----------|-----------------------|------|------|------|---------|---|
|           |          | 2020                  | 2021 | 2022 | 2023 |         |   |
| Meckering | WWWW     | 1                     | 4    | 2    | 4    | 3200    | 2 |
|           | LWLW     | 4                     | 1    | 3    | 1    | 3100    | 3 |
|           | CWCW     | 3                     | 2    | 4    | 3    | 3000    | 4 |
|           | CLWW     | 2                     | 3    | 1    | 2    | 3600    | 1 |
| Mingenew  | WWWW     | 2                     | 4    | 3    | 4    | 1200    | 3 |
|           | LWLW     | 1                     | 2    | 1    | 1    | 2000    | 1 |
|           | CWCW     | 3                     | 3    | 4    | 2    | 1200    | 3 |
|           | CLWW     | 4                     | 1    | 2    | 3    | 1700    | 2 |

wheat
  canola
  lupin

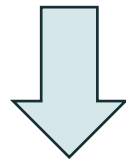
NB: based on 10-year average prices

# Conclusion

## Strategic deep tillage

### Physicochemical constraints

- Water repellence
- Subsoil compaction
- Subsoil acidity



**Profitability**

## Crop rotation


### Nutrition

- Nitrogen

### Biological constraints

- weeds
- Soilborne pests and pathogens

# Acknowledgements

- DPIRD and GRDC for investment into DAW 1901-006RTX - Increasing farming system profitability and longevity of benefits following soil amelioration
  - Host growers – Darren Morrell, Murray Preston, Russell Prowse, Todd Duggan
  - DPIRD staff –Andrew Blake, Ranny Wilkins, Melanie Kupsch, Erin Hampson, Aman Kaur, Deb Barker, Kanch Wickramarachchi, Sarah Collins, Daniel Huberli, Sean Kelly, Mengistu Yadete, Sultan Mia, Andrew Van Burgel, and Northam, Geraldton and Wongan Hills RSU
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# Thank you

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