Oilseed rape establishment systems: impact on crop, GHG emissions and soil.

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Background: Why these studies

- Limited rotation, few break crops
- CROPQUEST: focus now on beans and OSR
- Crop establishment: Scope for savings?

Plough-based establishment systems
- Expensive and slow; prone to moisture loss in dry autumn
- May be less sustainable from C and soil perspective.

Non-inversion systems
- Min-till; Strip-till: commercial but little research in our climate.
- Low cost and fast but how will their use impact on:
  - Crop performance;
  - Sustainability of crop production.
Aims

To evaluate alternative crop establishment systems

- Plough-based
- Min-till
- Strip-till.

Determine their impact on:

- Crop growth, development and yield.
  - The need for different crop management
- Greenhouse gas emissions
- Microbiome: microbial populations in soil and adjacent root and shoot areas.
Strip Till
200mm depth
600mm row

Min-till
Stubble Cultivator
75mm deep
Cultivator drill
125mm+600mm

Plough
200mm deep
One-Pass
125mm+600mm
The trials:

Row width, Seed rate and Variety type
- 125mm, 250mm, 500mm and 750mm rows
- 10 seeds/m², 15 seeds/m², 30 seeds/m², 60 seeds/m²
- Standard and Low biomass variety types

Systems and management
- Plough-based at 125mm
- Strip-till at 600mm
- Min-till at 125mm and 600mm
- Plough at 600mm

N response
- Plough 125mm vs Strip-till 600mm

3 years
What was measured?

Crop performance
- All trials
- Establishment, Growth, Yield.

GHG emissions
- Using some trials
- CO$_2$ and N$_2$O
- Ecosystem C exchange

Microbiome
- Using some trials
- DNA analysis of soil and plant samples (one trial)
- DNA analysis to check for rotation benefits from OSR
Results: Crop Performance (Roisin Byrne)
Results: Row widths and crop

- No difference from 125mm to 500mm.
- One site: significant yield drop at 750mm.
- Some differences in establishment and GAI.
- Little interaction with variety.
- OSR can overcome wide plant spacing.
- Widths of 500 and 600mm give good results.
The results: Seed rates and row widths

Seedrate

- Site with spring GAI > 0.5: **no** impact on yield
- Site with spring GAI < 0.25: **yield impact**
- Lower yield associated with less GAI.
- Avoid very low seed rates if establishment /grazing risks.
- Little interaction between SR and RW or variety type
The results: Establishment Systems

- No significant difference in yield.
- Plough 125mm had best establishment (up to 80% higher than poorest).
- The response to N management (fixed or canopy management) was not affected by system.
System

- Compared in six separate trials (sites/years).
- Compared across different N levels in three.
- No difference on 4 sites
- Plough was significantly better in two trials.
The results: N requirement

Evaluated
- 0 and 30kg N autumn
- 0, 80, 160, 240, 320kg N.

Results
- Autumn N resulted in more autumn growth but did not impact on yield
- Little difference in N response between cultivation systems.
- On two sites, economic optimum was close to 160kg N/ha
Results: GHG Emissions

(Macdara O’Neill)
Results: Soil CO$_2$ loss- at sowing

Response to tillage

- ‘De-gassing’ of CO$_2$
- More disturbance – more loss.
- But very short term

Soil CO$_2$ flux (mg C m$^{-2}$ hr$^{-1}$)

<table>
<thead>
<tr>
<th>Tillage</th>
<th>Soil CO$_2$ flux (mg C m$^{-2}$ hr$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plough</td>
<td>300</td>
</tr>
<tr>
<td>Strip Till</td>
<td>150</td>
</tr>
<tr>
<td>Min-till</td>
<td>50</td>
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</tbody>
</table>

Graph showing soil CO$_2$ flux for different tillage methods.
Results: Soil CO$_2$ loss over 2 weeks
Results: Ecosystem C

Measured

- Field level measurements NEE
- Net inflow and outflow of C at field level.
- Plant photosynthesis and respiration.

Results

- Over 6 months (Feb to July):
  - 5.3t of C/ha net uptake. (vs 2.84t all crops)
- At harvest:
  - 2.46t of C exported
  - 2.84t of C residue remains in field.
The results: $\text{N}_2\text{O}$ emissions

Peaks align with times and treatments with higher levels of water filled pore space (less disturbance).
The results: N$_2$O emission factors

Emission Factors
- The proportion of N inputs lost as N$_2$O
- IPCC default is 1%.

Results
- Lots of variation
- Plough-based less than Strip-till and IPCC default value.
- But levels are low overall
Results: Microbiome (Ridhdhi Rathore)
Results: Microbiome and cultivations

Measured

- Soil and Plant samples from Plough and Strip Till established crops at three growth stages.
- DNA of the microbial population extracted and sequenced

Results

- Root, shoot and soil microbiome evolves over the season
- Tillage system impacts on the microbial communities
  - Particularly on root and shoot colonies; less on rhizosphere
  - Has the potential to impact on relationship between the microbiome and the OSR plants
Results: Microbiome and take-all

Measured

- Soils from wheat after wheat, wheat after OSR, and from OSR were taken from Ploughed and Strip-Tilled plots.
- Quantitative PCR was used to determine the presence of the pseudomonas spp which produce 2,4-DAPG (active against take-all)

Results

- Crop rotation (in combination with Strip-tillage) increased the population of pseudomonas species that produce 2,4- DAPG.
Conclusions

- Winter OSR can be successfully produced with non-plough systems
  - Row widths up to 600mm
  - Different cultivation methods

- Establishment and growth differences may not impact on yield.
- Non-inversion cultivation can be used across rotations
- **Scope to save costs and time when establishing OSR**

- OSR production captures and retains significant amounts of C
- Less tillage can:
  - reduce soil C loss but differences are small
  - increase N$_2$O emissions, but emission factors are still quite low.
- Soil microbiome studies have the potential to reveal the mechanisms through which management can impact on production.
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Kevin Murphy
Frank Ryan

Everyone else!

QUESTIONS?