Profiting from Rotations

Jim Orson
UK competitiveness based on technology

Average wheat yields (t/ha)

- Effective herbicides
- Effective fungicides
- Increase in N
- Semi-dwarf varieties

Graph showing trends over the years.

USA vs UK comparison.
## Soil management throughout a revised rotation

<table>
<thead>
<tr>
<th></th>
<th>Crop 1</th>
<th>Crop 2</th>
<th>Crop 3</th>
<th>Crop 4</th>
<th>Crop 5</th>
<th>Crop 6</th>
<th>Crop 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime &amp; Organic manure</td>
<td>Lime 70 &amp; Turkey manure</td>
<td>Turkey manure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cover crop</td>
<td></td>
<td>Opus/ Bio-Drill 50 mm points</td>
<td>Opus/ Bio-Drill 50 mm points</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cover crop control</td>
<td>Carrier Straw harrow</td>
<td>Carrier CrossCutter</td>
<td>Carrier CrossCutter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First preparation</td>
<td>Carrier 50 mm points</td>
<td>Opus 50 mm points</td>
<td>Opus 50 mm points</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weed control</td>
<td>Glyphosate</td>
<td>Glyphosate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second preparation</td>
<td>Opus 50 mm points</td>
<td>Opus 50 mm points</td>
<td>Opus 50 mm points</td>
<td>Opus 50 mm points</td>
<td>Opus 50 mm points</td>
<td>Opus 50 mm points</td>
<td>Opus 50 mm points</td>
</tr>
<tr>
<td>Drilling</td>
<td>Rapid</td>
<td>Opus/ Bio-drill 50 mm points</td>
<td>Rapid</td>
<td>Compactor /Precision drill</td>
<td>Rapid</td>
<td>Rapid</td>
<td>Rapid</td>
</tr>
<tr>
<td>Planted crop</td>
<td>Winter barley</td>
<td>W. oilseed rape</td>
<td>Winter wheat</td>
<td>Sugar beet</td>
<td>W. Wheat or Spring barley</td>
<td>Spring beans</td>
<td>Winter wheat</td>
</tr>
</tbody>
</table>
Winter wheat, 1995-2016

- Salle Farms
- England
- Eastern Region
Spring barley, 2000-2016

- Salle Farms
- England
- Eastern Region

Yield t ha⁻¹

Winter oilseed rape, 2001-2016
Sugar beet, 2003-2016

Adjusted yield t ha⁻¹

- Salle Farms
- Cantley
- UK Average
Plant-soil feedbacks

Cortois et al., J. of Ecology, Volume 104, Issue 6
November 2016
Pages 1608–1617
The fundamental principle of crop rotation is to exert a control function that prevents particular Arbuscular Micorrhizal Fungi (AMF) from dominating the soil matrix:

- Continuous wheat favours the selection and proliferation of less co-operative and more aggressive fungal symbionts. These are likely to enact similar behaviour to parasitism.
- This can be toned down by ‘break crops’, such as Brassicae or legumes:
  - Brassicae are non-mycorrhizal crops that act as inhibitors of the dominant AMF species proliferation
  - Legumes are AMF dependent crops that favour the overall propagation of AMF communities
The impact of rotational intensity on the yield of oilseed rape within HGCA project 2922. Data are presented as mean yields from years 3 – 7 (2006 – 2010).
Impact on vigour

1\textsuperscript{st} OSR after wheat

5\textsuperscript{th} OSR - Continuous
OIlseed Rape
2016/7 Crop

No Neonicotinoids
No Slug Pellets
Changes in topsoil total organic carbon (TOC) with total carbon (C) inputs (manures & crop residues)

\[ y = 0.32x \]

40t of OC represents at least 10 years of max applications

Chambers and Nicholson 2003
Building fertility: Straw residues

Morley long-term straw incorporation study

- Grain yields at Morley
  - ranged from 2 (no N) - 10 t/ha (highest N).
  - incorporation of 3-7 t/ha crop residue dry matter pa (ca. 2-5 t OM/ha)

- The incorporation has
  - increase in OM by ca.10% (highest N rate)
  - from 1.57% to 1.74% SOM

- Other changes
  - Microbial biomass increased by ca.35% (at highest N rate)
  - Potentially mineralisable N increased by ca.60%
  - The ability of the soil to supply N from the decomposition of OM
  - a 10% decrease in penetration resistance
  - indicating that higher N rates make the soil easier to cultivate.
Influence of green manure and cultivation on microbial populations

Figure 5. Carbon dioxide release from incubated soil over six weeks. Cirencester 2006

Figure 6. Carbon dioxide release from incubated soil over six weeks. Andover 2006

HGCA project 414
# Spring barley following cover crops

Mean data from studies over 5 seasons:
(assumes N at £0.67/kg and barley at £120/t)

<table>
<thead>
<tr>
<th></th>
<th>No cover crop</th>
<th>Following cover crop</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yield (t/ha)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 kg/ha N</td>
<td>3.64</td>
<td>4.60</td>
</tr>
<tr>
<td>150 kg/ha N</td>
<td>5.56</td>
<td>5.92</td>
</tr>
<tr>
<td><strong>Margin over N (£/ha)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 kg/ha N</td>
<td>437</td>
<td>552</td>
</tr>
<tr>
<td>150 kg/ha N</td>
<td>567</td>
<td>610</td>
</tr>
</tbody>
</table>

Margin at 150 kg/ha with cover crop gave a mean response over 5 seasons of £43/ha
New Farming Systems research using cover crops for bio-cultivation (winter wheat, 2015)

- Increases in margin over input costs in cover crop comparisons
- £47/ha (comparing shallow tillage ± radish)
- £38/ha (comparing ‘plough - cover crop’ to ‘shallow tillage + cover crop’).
- Does not include cover crops costs.

<table>
<thead>
<tr>
<th></th>
<th>Cover crop (CC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- CC £ ha⁻¹</td>
</tr>
<tr>
<td>Plough</td>
<td>741</td>
</tr>
<tr>
<td>Shallow non-inv</td>
<td>732</td>
</tr>
</tbody>
</table>

Costs based on 2012 spot prices for the year of production: wheat (£120/t), diesel (£0.64/L) and liquid fert (£0.67/kg N).
The impact of cultivation and cover crop on OSR yield (t/ha) 2014

Mean yield loss ca. 6%

LSD (all): 0.48 t/ha
CV: 8.3%
SIP: Field scale cover crops at Morley

- Recent field strip highlights:
  - Increases in N retention and earthworm biomass
  - Sugar beet shown 11% population increase and GAI from 1.2 to 1.9
  - Yield responses of 7 t/ha
  - Little difference in sugar or amino-N

Soil moisture @ 10cm depth (+ or - cover crop) – in sugar beet
A few comments

• Consider the whole rotation:
  – each crop type should not be assessed individually but as a contribution to the whole rotation
  – the rotational plan should also involve a soil management plan – cultivation type and depth, organic amendments, cover crops
  – need to reduce reliance on glyphosate?

• Advances in the identification and assessment of soil microbial biomass may result in improved guidance for rotational planning

• Nitrogen and cover crops – the role of legacy N?