Deep roots in Controlled traffic farming and intercropping – but not no-tillage systems – increased system’s resilience and nitrogen recycling

Any general conclusions to draw on deep roots from the complex effects of cropping systems?

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Thanks to funders

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In situ methods to 3 m depth
Dept. Food Science, Aarhus University

Mini video camera for filming

Non-destructive root registration in minirhizotrons

Roots of fodder radish in 2 m depth

15N injection and soil sampling

Photos AU FOOD
Controlled Traffic Farming - roots

- ↑ Root growth
- ↑ Yields and crop residues
- ↑ Mineralisation
- ↑ N uptake
- No effect on NO$_3^-$ leaching

Hefner et al. (2019) Soil & Tillage Research 191: 117-130
Controlled Traffic Farming – increase of system’s resilience

Hefner et al. (2019) Soil & Tillage Research 191: 117-130
Intercropping – more roots at harvest

Xie & Kristensen (2017)
European Journal of Agronomy 82: 21-32
Intercropping – decrease of soil $N_{\text{min}}$

Xie & Kristensen (2017)
European Journal of Agronomy 82: 21-32
# More deep roots – system’s sustainability?

<table>
<thead>
<tr>
<th>System/Management</th>
<th>Soil type</th>
<th>Crop</th>
<th>Yields</th>
<th>Deep roots</th>
<th>N exploitation</th>
<th>Cause</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled Traffic Farming vs Random TF</td>
<td>Sandy loam</td>
<td>Many vegetables</td>
<td>+</td>
<td>+</td>
<td>(+)</td>
<td></td>
<td>Hefner et al. 2019 Soil &amp; Tillage Research</td>
</tr>
<tr>
<td>CTF vs RTF</td>
<td>Sand</td>
<td>Beetroot</td>
<td>+</td>
<td>+</td>
<td>(+)</td>
<td></td>
<td></td>
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<tr>
<td>Intercropping vs sole cropping</td>
<td>Sandy loam</td>
<td>Leek Dyer’s woad</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>Xie &amp; Kristensen 2017</td>
</tr>
<tr>
<td>Winter legumes vs legume-rye mix</td>
<td>Sandy loam</td>
<td>Cabbage</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>N limited</td>
<td>Hefner et al. Accepted. Agriculture, Ecosystems &amp; Environment</td>
</tr>
<tr>
<td>No-tillage vs full incorporation</td>
<td>Sandy loam</td>
<td>Cabbage</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>N limited</td>
<td></td>
</tr>
<tr>
<td>High sowing density vs low</td>
<td>Coarse sand</td>
<td>Rucola</td>
<td>+</td>
<td>+</td>
<td>(+)</td>
<td></td>
<td>Kristensen &amp; Stavridou 2017. Soil Use &amp; Management</td>
</tr>
<tr>
<td>Low late season N fertilisation vs high</td>
<td>Coarse sand</td>
<td>Rucola</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>N saturated</td>
<td></td>
</tr>
<tr>
<td>Low top soil N vs high</td>
<td>Sandy loam</td>
<td>Fodder radish</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>Xie et al. Submitted</td>
</tr>
<tr>
<td>Farmyard manure vs plant-based fertiliser</td>
<td>Sandy loam</td>
<td>Beetroot</td>
<td>+</td>
<td>+</td>
<td>(+)</td>
<td></td>
<td>Shanmugam et al. In prep.</td>
</tr>
</tbody>
</table>
Key message for discussion

Session 3: Enhancing resource use through deep rooting – What is the potential for water and nutrient uptake by deep rooted crops?

Yes – more deep roots increase system’s sustainability
Unless crop N status interferes

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