Crop sequence and nutrient acquisition: Optimized use of soil resources via complementary root growth?

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Nutrient acquisition from the subsoil

**Topsoil:**
- Low penetration resistance
- High nutrient concentration

**Subsoil:**
- High penetration resistance
- Low nutrient concentration

**Mobilization**
*Nutrient-Hotspot:* 
Drilosphere

**Mineralisation**
Taproots generate biopores: Access paths to the subsoil

**Crop residues**

**Redelivery**
- Root exudates
- Root residues
- Earthworm cast

**Fibrous roots create fine pores in the upper subsoil**
Optimizing the crop sequence for subsoil resource use

1. Influence soil structure via taprooted precrops and anecic earthworms

2. Study root and shoot growth by following crops

Pictures: U. Perkons
Precrop yield and nutrient uptake

Different letters: significant differences (Tukey-Test, α<0.05). Precrops grown 2007-2009, Data from 2009.
Precrop yield and nutrient uptake

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II. Modeling on the field scale with 100 weather scenarios

Model: SIMPLACE coupled with R-SWMS, weather generator LARS-WG

Yield of following crops

<table>
<thead>
<tr>
<th>Precrop</th>
<th>Weather conditions</th>
<th>Main Crop</th>
<th>Cereal grain yield (t ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012: Abundant precipitation</td>
<td>Spring wheat</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>2010: Dry spell in June</td>
<td>Spring wheat</td>
<td>b</td>
</tr>
<tr>
<td></td>
<td>2014: Nov-June dry</td>
<td>Spring barley</td>
<td>a</td>
</tr>
</tbody>
</table>

Different letters: significant differences (Tukey-Test, α<0.05)

Seidel et al. 2019, Soil and Tillage Research; Kautz et al. 2015, GPW
Conclusion

With deeprooting precrops, yield stability and thus static resilience is increased - through structural and microbial changes in the subsoil.

Graph from Döring et al. 2015, Journal of the Science of Food and Agriculture
Different letters: significant differences (Tukey-Test, $\alpha<0.05$). Crops were grown 2018 and 2019, only 2019 data is shown.
Thank you for your attention!