Identifying soil constraints using multi-year remote sensing for site-specific management
Multiple soil constraints

Identification is the first step!

Source: National Land and Water Resources Audit 2001
Identification of Soil Constraints

Point scale
Identification of Soil Constraints

Field Scale

Proximal sensing

Classes

- Low
- Medium
- High

Soil depth (m)

- 0.0
- 0.2
- 0.4
- 0.6
- 0.8
- 1.0
- 1.2
- 1.4

Cl (mg/kg)

EMgP (%)

NO₃-N (mg/kg)

VMCLL (cm³/cm³)

ECa (mS/m)

Average wheat yield (t/ha)

Y = 3.95 - 0.02 ECa_LL, r² = 0.97

NS: ECa_UL

Yield mapping with different ECa levels and their relationship with average wheat yield.
Identification of Soil Constraints: Farm scale

Historical yield maps
- 2800-hectare
- 17 paddocks
- 64 wheat crops grown between 2000 and 2009
- 38 of the 64 crops were yield mapped
Grain Yield and Remote Sensing (Landsat)

Predicted yield (t/ha) vs. Farmer-reported yield (t/ha) for the years 2000 to 2009. The scatter plot shows a high correlation with an R² = 0.65 and RMSE = 0.34.

In-crop rainfall (mm) in the range of 0 to 180 mm is shown, with specific years marked by different colors.

Model error (t/ha) with values ranging from -0.8 to 0.8, indicating a significant deviation from the predicted values.

R² = 0.69; P = 0.005
Spatial Variability of Predicted Soil Constraints

- Spatial distribution maps showing areas relatively unconstrained and potentially constrained.
- Graphs illustrating soil depth (m) vs. CI (mg/kg), ESP (%), NO3-N (mg/kg), and VMCLL (cm³/cm³).
Cumulative gross margin for surface applied gypsum $143/ha over 3-4 years
### Matching Nitrogen Fertilizer: Economics

<table>
<thead>
<tr>
<th>Zone</th>
<th>Realistic yield potential (t/ha)</th>
<th>Nitrogen requirement (kg N/ha)</th>
<th>Average available N in the soil (kg N/ha)</th>
<th>Farmer’s rate (kg N/ha)</th>
<th>Actual N required (kg N/ha)</th>
<th>Consequence of uniform N application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1 (20 ha) Low</td>
<td>1.29</td>
<td>59</td>
<td>119</td>
<td>46</td>
<td>0</td>
<td>2.0 t urea waste</td>
</tr>
<tr>
<td>Zone 2 (28 ha) Medium</td>
<td>2.22</td>
<td>100</td>
<td>55</td>
<td>46</td>
<td>45</td>
<td>0.06 t urea waste</td>
</tr>
<tr>
<td>Zone 3 (16 ha) High</td>
<td>3.36</td>
<td>150</td>
<td>36</td>
<td>46</td>
<td>114</td>
<td>3.9 t urea required</td>
</tr>
<tr>
<td>Average (64 ha)</td>
<td>2.21</td>
<td>101</td>
<td>70</td>
<td>46</td>
<td>31</td>
<td>2.0 t urea waste</td>
</tr>
</tbody>
</table>

\[ N \text{ required (kg/ha)} = (\text{RYP} \times \text{protein goal} \times 1.75 \times 2) - \text{Av. NO}_3-N \text{ to 0.9 m} \]
In Summary

• Remote sensing offer opportunity to map spatial variability of soil constraints

• Evaluate sustainable development goals (economic, environmental and social) for site-specific soil and nutrient management