Benefits and Implications of Agricultural Drainage in Southeast Saskatchewan

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The Issue

- precipitation
- Flooding
- Waterlogged soils

(GIWS, 2013)
The Solution

- Agricultural drainage
- Increase land
- Reduces cost
- Extends growing season
- Greater nutrient availability

(GIWS, 2013)
Concerns

- Minimal research on how drainage affects the soil
- Water quality issues

Questions

1. How does drainage change soil properties?
   - Field Study

2. Could nutrient losses vary across soils drained for different durations of time?
   - Greenhouse Experiment
Study Area

Soil Zones of Saskatchewan

- RM of Churchbridge
- Smith Creek Watershed
- Oxbow and Yorkton soils
Methods: Field Study

Source of data: Saskatchewan Geospatial Imagery Collaborative and Ducks Unlimited
Methods: Field Study

- Field descriptions
- pH, EC and texture
- Bulk density
- Structure
  - Wet aggregate stability
- Carbon
  - TC, IC, OC
  - WEOC
  - LF/HF
- Available N, P, K
- Net mineralization
- Potential Nitrification
- P sorption/desorption
Methods: Greenhouse Experiment

- 5 x 3 x 2 (drainage x moisture x fertilizer)
  - Drained for: 0, 14, 20, 42 yr
  - Moisture: Below, normal, above
  - Fertilizer: 300 kg N ha\(^{-1}\), 20 kg P ha\(^{-1}\)
- 3 reps
- Leachate 1/week
- 6 wk. duration

- Analyzed N and P
  - Wheat
  - Soil
  - Leachate
Results: Field Study
Nutrient Availability and SOC

Nutrients and OC remain consistent in RD and MD but in LD and MS
## Nutrient Availability

<table>
<thead>
<tr>
<th>Drainage Category †‡</th>
<th>n</th>
<th>Net Mineralized N (mg kg(^{-1})d(^{-1}))</th>
<th>Potential Nitrification (mg kg(^{-1})d(^{-1}))</th>
<th>P Sorption (mg PO(_4)-P kg(^{-1}))</th>
<th>P Desorption (mg PO(_4)-P kg(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>UD</td>
<td>10</td>
<td>0.25(^{ab})‡</td>
<td>35.0(^{c})</td>
<td>597.1(^{a})</td>
<td>44.1(^{c})</td>
</tr>
<tr>
<td>RD</td>
<td>11</td>
<td>0.18(^{ab})</td>
<td>46.7(^{bc})</td>
<td>586.9(^{ab})</td>
<td>55.7(^{ab})</td>
</tr>
<tr>
<td>MD</td>
<td>10</td>
<td>0.38(^{a})</td>
<td>74.4(^{a})</td>
<td>571.4(^{b})</td>
<td>61.1(^{a})</td>
</tr>
<tr>
<td>LD</td>
<td>11</td>
<td>0.24(^{ab})</td>
<td>54.7(^{ab})</td>
<td>573.6(^{b})</td>
<td>46.0(^{bc})</td>
</tr>
<tr>
<td>MS</td>
<td>42</td>
<td>0.11(^{b})</td>
<td>38.9(^{c})</td>
<td>569.8(^{b})</td>
<td>45.0(^{c})</td>
</tr>
</tbody>
</table>

P value: 0.0277 <0.0001 0.0181 <0.0001

†UD=undrained, RD=recently drained, MD=medium drained, LD=longest drained, MS=midslope.
‡ANOVA used to test differences. Means with same letter in same row are not significantly different according to Tukey Kramer test (P>0.10).
Results:

Greenhouse Experiment
<table>
<thead>
<tr>
<th>Drainage Category†</th>
<th>Mass (g pot⁻¹) ‡</th>
<th>P Uptake (mg pot⁻¹)</th>
<th>N Uptake (mg pot⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UD</td>
<td>15.99b§</td>
<td>26.69c</td>
<td>226.85d</td>
</tr>
<tr>
<td>RD</td>
<td>16.75b</td>
<td>35.65b</td>
<td>289.18b</td>
</tr>
<tr>
<td>MD</td>
<td>20.63a</td>
<td>43.23a</td>
<td>329.44a</td>
</tr>
<tr>
<td>LD</td>
<td>18.59ab</td>
<td>35.21b</td>
<td>307.43ab</td>
</tr>
<tr>
<td>MS</td>
<td>17.67ab</td>
<td>21.62d</td>
<td>257.55c</td>
</tr>
</tbody>
</table>

P value: 0.0017 <0.0001 <0.0001

†UD=undrained, RD=recently drained, MD=medium drained, LD=longest drained, MS=midslope.
‡Averaged across all moisture treatments.
§ ANOVA used to test differences. Means with same letter in same row are not significantly different according to Tukey HSD test (P>0.05).
**Nutrient Loss to Water**

- Greater nutrient availability = greater nutrient losses
  - $\text{PO}_4^{3-}$
  - $\text{NH}_4^+$

<table>
<thead>
<tr>
<th>Drainage category†</th>
<th>$\text{NH}_4^+$ in leachate (mg pot$^{-1}$) ‡</th>
<th>$\text{NO}_3^-$ in leachate (mg pot$^{-1}$)</th>
<th>$\text{PO}_4^{3-}$ in leachate (mg pot$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UD</td>
<td>0.27$^{a}$</td>
<td>20.12</td>
<td>0.10$^{a}$</td>
</tr>
<tr>
<td>RD</td>
<td>0.15$^{b}$</td>
<td>21.94</td>
<td>0.13$^a$</td>
</tr>
<tr>
<td>MD</td>
<td>0.08$^{b}$</td>
<td>27.05</td>
<td>0.09$^{ab}$</td>
</tr>
<tr>
<td>LD</td>
<td>0.08$^{b}$</td>
<td>16.92</td>
<td>0.06$^{bc}$</td>
</tr>
<tr>
<td>MS</td>
<td>0.09$^{b}$</td>
<td>28.96</td>
<td>0.02$^c$</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;0.0001</td>
<td>0.4286</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

†UD=undrained, RD=recently drained, MD=medium drained, LD=longest drained, MS=midslope.
‡Averaged across all moisture treatments.
§ ANOVA used to test differences. Means with same letter in same row are not significantly different according to Tukey HSD test (P>0.05).
Conclusions

1. Drainage ↑/maintain OC, NO$_3$, PO$_4$, K, mineralization, and nitrification initially
   - Benefits appear to decrease after 50 yr

2. Not all soils contribute equally to nutrient losses
   - Most improved soils have greatest nutrient loss potential
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Thank you!

Questions?


Ducks Unlimited. Smith Creek Watershed. Available at http://www.ducks.ca/what-we-do/gis/


