Innovations in agricultural drainage management

Workshop on Nutrient Management Challenges & Solutions
Drainage is required in 40 to 50% of Indiana’s cropland to provide:

- aeration needed for crop growth
- and trafficable conditions for field operations

Photos courtesy Wayne Skaggs
Once drained, Indiana’s wet soils are among the most productive in the world.
Intended effects of tile drainage

- Increased crop yields

Photo from Dan Jaynes
Unintended effects of tile drainage

- Greatly increases loss of nitrate to streams
Nitrogen delivered to the Gulf of Mexico (USGS SPARROW estimate)

- Image from: Robertson et al., 2009 (http://www3.interscience.wiley.com/journal/122278544/issue)
Innovation:

Drainage Water Management

- **Goal**: drain only what is needed for crop production
- Drainage needed varies through the year.
  - **In winter**, drainage is not needed.
  - **In spring**, maximum drainage is needed to get into the field.
  - Holding back water in **the summer** can help the crop.
Drainage Water Management

Conventional Drainage Mode

- Tile drain
- Water control structure
- Saturated soil
- Drainage to ditch
Drainage Water Management

Winter Conservation Mode

Drainage outlet is raised

Water table rises, when drainage is not needed
Drainage Water Management

Lowered before planting
Drainage Water Management

Summer Conservation Mode
Drainage water management research on a Purdue University farm
40-acre field divided into 4 quadrants: 2 managed, 2 free drainage

- Yield map for one year
Each site is instrumented to measure flow and water quality continuously.
Reductions in nitrate loss due to drainage water management on Indiana farms

<table>
<thead>
<tr>
<th></th>
<th>Predicted if no DWM (kg/ha)</th>
<th>Observed (kg/ha)</th>
<th>Reduction (kg/ha)</th>
<th>Reduction</th>
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<tbody>
<tr>
<td>2008</td>
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<tr>
<td>Site A</td>
<td>76.5</td>
<td>62.1</td>
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<tr>
<td>Site B</td>
<td>52.4</td>
<td>44.4</td>
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<td>2009</td>
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<tr>
<td>Site A</td>
<td>35.9</td>
<td>24.8</td>
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<tr>
<td>Site B</td>
<td>26.9</td>
<td>20.7</td>
<td>6.2</td>
<td>23.0%</td>
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</table>
Innovation:

Woodchip Denitrifying Bioreactor

- Subsurface trench filled with a carbon source, mainly wood chips
- Tile drain water flows through the trench before entering the ditch
Bioreactor research on a Purdue University farm

- Installed at Throckmorton Purdue Agricultural Center in September 2012.

- Research on
  - nitrate reduction (flow, nitrate concentration)
  - water level and temperature across the bioreactor
  - woodchip decomposition
Bioreactors use bacteria to treat nitrate

- The carbon source (woodchips) in the trench serves as a substrate for bacteria
- Bacteria break down the nitrate through **denitrification** or other biochemical processes
- Bioreactors treat nitrate very effectively if residence time is long enough for denitrification to occur
Purdue researchers are developing and testing other agricultural innovations for drained land

- Cover crops (*Focus of the Conservation Partnership’s Soil Health Initiative*)
- Improved nitrogen application recommendations (*Based on results from cooperating farmers who are willing to apply reduced amounts – now more than 200 plot years*)
- Other ways that drainage can flow through wet areas, such as 2-stage ditches
Bringing agricultural drainage management innovations to people who can use them