Some Water Quality Impacts of Alternative Energy Crops

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Biomass Energy Crops and the Environment

• Consider two sources of biomass:
  – Corn stover
  – Switchgrass

• Conventional wisdom
  – Reliance on stover increases environmental damage
  – Reliance on switchgrass will lower it
Investigate effects of these crops on water quality

- Three very stylized scenarios
- Single watershed in Iowa
- Much is unknown about how these crops would actually be grown and harvested
- Thus, findings reported here should be considered suggestive and preliminary
Maquoketa River Watershed

• Major contributor of sediments and nutrients to Mississippi River
• Dominant land uses
  – Cropland (corn and soybeans) 55%
  – Grassland (pasture) 32%
  – Forest 10%
  – Urban 3%
Model/Data

SWAT - Soil and Water Assessment Tool

– Predicts effect of land management practices on hydrology and water quality
– Watershed based
– Extensively used, over 250 peer reviewed publications
Model/Data

Key Data

- U.S. Geological Survey, Iowa Geological Survey Bureau: Flow, water quality data,
- National Resource Inventory: land use, cropping history, slope, etc.
- Weather, soils, etc.
- Model calibrated using flow, sediment, and nitrates
Scenarios

• Meant to illustrate extremes

• Three land use scenarios
  – Switchgrass: convert all potential cropland to switchgrass
  – Corn: convert all potential crop land to continuous corn, remove 50% biomass
  – Mixed strategy: switchgrass on HEL, continuous corn elsewhere
Scenarios

• Compare each to Baseline
  – Baseline is current land use
  – Compare streamflow, sediment, nitrate, total N, and total P
1. Switchgrass

- All potential cropland becomes switchgrass, includes current CRP
- No tillage of soil undertaken
- Spring fertilization: 110 lb/ac of nitrogen fertilizer, 60 lb/ac of phosphorous
- No fall fertilization
2. Corn

- All potential cropland becomes continuous corn
- Remove 50% biomass
- Mulch tillage operation
- Fertilization rates: 182 lb/ac of nitrogen, 54 lb/ac of phosphorus
3. Corn and Switchgrass

- Switchgrass on HEL, continuous corn elsewhere
- Highly Erodible Land = Erosion Index ≥ 8
- Switchgrass on HEL land, 53% of watershed
- Corn elsewhere, 47% of watershed
## Summary Findings

<table>
<thead>
<tr>
<th>Description</th>
<th>Stream Flow (mm)</th>
<th>Sediment Yield (Tons)</th>
<th>Nitrate (Tons)</th>
<th>Total N (Tons)</th>
<th>Total P (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>250</td>
<td>146,652</td>
<td>8,380</td>
<td>10,030</td>
<td>360</td>
</tr>
<tr>
<td>1. All Switch Grass</td>
<td>255</td>
<td>22,780</td>
<td>4,673</td>
<td>4,697</td>
<td>65</td>
</tr>
<tr>
<td>2. All Corn (remove 50% biomass)</td>
<td>257</td>
<td>180,054</td>
<td>20,738</td>
<td>25,067</td>
<td>857</td>
</tr>
<tr>
<td>3. Mixed (corn HEL&lt;8)</td>
<td>254</td>
<td>119,135</td>
<td>12,382</td>
<td>13,201</td>
<td>206</td>
</tr>
</tbody>
</table>
Summary Thoughts

• Significant move towards continuous corn and biomass removal likely to worsen water quality

• Switchgrass relatively water quality friendly

• Targeting switchgrass to highly erodible land can dampen water quality problems from continuous corn, but may still be problematic, particularly with respect to N

• Much better understanding of these systems needed