Challenges to mapping yields and modeling production of woody crops

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October 19, 2010

8th Biennial Short Rotation Woody Crops Operations Working Group Conference, 17-19 October, 2010, Syracuse, NY
Outline of presentation

- Determining, mapping yields
- POLYSYS baseline yields
- Analysis of baseline scenarios (years 2012-2030)
- Energy crops land competition
- Conclusion and next steps
Determining tree yields

- Yield figures arrive in many forms
- Yield = fn(specie, genetics, harvest timing, existing site conditions, silviculture, irrigation/precipitation, rotation length, tree rooting, degree days, stand density)
Current POLYSYS Herbaceous Crops Yields

Current POLYSYS Woody Crops Yields

Yield (ODT ac\(^{-1}\)year\(^{-1}\))

- 0.0
- 3.5
- 4.0
- 4.5
- 5.0
- 5.1
- 5.5
- 6.0
Policy Analysis System (POLYSYS)

- Models entire U.S. agricultural sector (including exports)
- Optimizes land use across traditional and energy crops, after USDA baseline projections are met (food, feed, fiber, fuel)
- Land owners offered constant nominal biomass price across time sequence
Policy Analysis System (POLYSYS)

- Energy crops compete for cropland, cropland used as pasture, and permanent pasture

- Woody crops production budgets include
  1. Costs (planting, maintenance, harvest)
  2. Yield (MAI, Location, specie)
  3. Rotation length

- Published sources, expert opinion

- All costs are estimated to the farmgate
Productivity Assumptions in Basecase

- **Energy crop productivity (ODT/acre/year)** increases with time
  - Herbaceous crop yields
    - 2010 yield = 3-9.9;
    - 2030 yield = 3.6 – 12.0 (baseline scenario)
  - Woody crop yields
    - 2010 yield = 3.5 – 6;
    - 2030 yield = 4.2 – 7.2 (baseline scenario)
Cropping budgets at USDA FPR level

Crop Production Regions

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BASECASE RESULTS
Modeling: Basecase $40/dry ton (farmgate)
Modeling: Basecase $50/dry ton (farmgate)
Modeling: Basecase $60/dry ton (farmgate)
Modeling: Baseline results

- At all feedstock prices in the baseline, planted acres of herbaceous crops exceed planted acres of woody crops at the national level.

- The same conclusion results from increasing yield growth assumptions.
Modeling: Baseline results at different yield assumptions

Proportions of energy crops production with different yield growth assumptions

2030, $50/dt (farmgate)
BASELINE RESULTS VARY BY LAND CLASSIFICATIONS
Modeling: Baseline results for cropland

Proportion of planted acres of energy crops on cropland for 3 selected years at various prices

% Woody Crops / % Herbaceous Crops

<table>
<thead>
<tr>
<th>Year</th>
<th>$40</th>
<th>$50</th>
<th>$60</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>100</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>2022</td>
<td>70</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>2030</td>
<td>80</td>
<td>70</td>
<td>60</td>
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Modeling: Baseline results for cropland pasture

Proportion of planted acres of energy crops on cropland pasture for 3 selected years at various prices

<table>
<thead>
<tr>
<th>Year</th>
<th>Woody Crops</th>
<th>Herbaceous Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>90%</td>
<td>10%</td>
</tr>
<tr>
<td>2022</td>
<td>90%</td>
<td>10%</td>
</tr>
<tr>
<td>2030</td>
<td>90%</td>
<td>10%</td>
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</tbody>
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Modeling: Baseline results on permanent pasture

Proportion of planted acres of energy crops on permanent pasture for 3 years and various prices
CHIPS VS. BALES
Supply chain cost advantage of woody crops

- Less complex storage and transportation process
  - Storage “on the stump” and just-in-time delivery to depot or processing facility
- Assuming the same offered price per dry ton, $10/dt storage fee, and 5’ x 6’ round bale or 3’ x 6’ x 8’ rectangular bale
INCORPORATING SUPPLY CHAIN CREDIT TO WOODY CROPS
Modeling: National results at $50/dry ton

With no credit for woody crops

Herbaceous Crops Baseline

Woody Crops Baseline

Managed by UT-Battelle for the Department of Energy
Modeling: National results at $50/dry

With +$5/dry ton credit for woody crops

Herbaceous Crops ($5/dry ton credit)

Woody Crops ($5/dry ton credit)
Modeling: National results at $50/dry

With $10/dry ton credit for woody crops

- Herbaceous Crops ($10/dry ton credit)
- Woody Crops ($10/dry ton credit)
Baseline production results with supply chain credit to woody crops

Baseline $50/dry ton +$5/dry ton +10/dry ton

Herbaceous crops
Woody crops
Conclusions

- In all baseline price and yield scenarios to 2030, modeling predicts herbaceous crops outperform woody crops (in total acres planted and production) at a national level.

- In the $10/dry ton woody crops credit scenario, woody acres exceed herbaceous acres in 2018, production in 2020.

- Farmgate credits can increase deployment of woody crops, but acres planted still trail herbaceous crops plantings.
Future Analysis

- Improve yield estimates
- Identify regional competition parameters (land types, with/without woody crops credits)
- Cost comparisons of energy crops publication
Thank you for your attention!

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Questions?
Additional Slides
Potential range of various cellulosic crops

Source: Wright, 2009. ORNL TM.
Modeling: Baseline results

Woody crops at $55/ODT outcompete Herbaceous crops at $40/ODT (~+$15), and at $60 outcompete Herbaceous crops at $45 and $50/ODT after 2019, 2023 (~+$15, +$10) at the farmgate