Creating America’s Energy Future - Today

Martha Schlicher
Bioenergy Lead
Monsanto Company
Creating a Different Energy Future: What’s Possible Today

• **Diversify our transportation fuel supply - permanently**
  • Displacing >10% of US gasoline demand; 30% by 2030
  • Drive infrastructure changes (10% blends; higher blends, FFVs and blender pumps)

• **Improve the environment**
  • Permanently reduce greenhouse gas emissions, relative to gasoline, by 27% for every gallon used
  • Improve the footprint of production agriculture: drive higher yields and greater environmental stewardship

• **Keep critical acres in production by utilizing excess supply**
  • Create incremental feed and biomass supplies
  • Preserve future land options

• **Pave the way for future opportunities**
  • Develop commercial biomass operations with agricultural residues
  • Develop ~1BGY of commercially viable cellulosic ethanol
  • Produce economically viable higher hydrocarbons
Imported petroleum for transportation dominates US energy use

EIA Energy Outlook 2009

- 50% of OPEC imports today displaced by ethanol
- Allows for NAFTA supplied fuels by 2030
US petroleum demand is significantly impacted by CAFÉ and the RFS

>25% reduction in gasoline use by 2022

Renewables volumes: EPA RFS2; Petroleum estimates: Kevin Lindemer – oil industry consultant; Oxygenate demand: EIA

Infrastructure changes are critical to allow for higher blends
Improved lifecycle-based estimates of GHG emissions indicate corn based ethanol is 27% better than gasoline.

- Accounting methods have changed
- Systems boundaries have expanded
- Production processes have improved
- Models and data continue to improve

GREET 2010
Corn ethanol has provided an outlet for increased yield with otherwise flat demand.

US corn demand: 98-99 to 08-09

Corn demand corrected for DDGS use

ProExporter Nov 08; AgMRC 12.18.09
Corn is the highest yielding renewable fuel

15 BGY of corn ethanol *today* uses 14M net acres

<table>
<thead>
<tr>
<th></th>
<th>Ethanol gal/Net Acre</th>
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<tbody>
<tr>
<td></td>
<td><strong>Today</strong></td>
</tr>
<tr>
<td>Corn</td>
<td>1000</td>
</tr>
<tr>
<td>Switchgrass</td>
<td></td>
</tr>
<tr>
<td>Sugarcane</td>
<td>600</td>
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EPA DDGS, ethanol yields and displacement; 2009 corn/soybean yields
“Virtual” Acres, Created by Increasing Corn Yields and Flat Demand in Food & Feed Sectors, Enabled U.S. Ethanol Production

Acres required to meet all non-fuel demand for corn dropped 20% in a decade

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg. Yield (Bu/Ac)</th>
<th>Acres Harvested</th>
<th>Acres Needed Non-fuel Demands</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>164.7</td>
<td>86.5 M</td>
<td>53.8 M</td>
</tr>
<tr>
<td>1999</td>
<td>133.8</td>
<td>77.4 M</td>
<td>66.9 M</td>
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</tbody>
</table>

15 BGY of corn ethanol requires just 16% of planted acres

Sources: USDA-NASS, USDA-ERS, EIA
## Corn’s Impacts, 1987-2007

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Soil Loss</th>
<th>Irrigation</th>
<th>Energy</th>
<th>Climate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of land to produce one bushel of corn</td>
<td>Soil loss per bushel, above a tolerable level</td>
<td>Irrigation water use per bushel</td>
<td>Energy used to produce one bushel</td>
<td>Emissions per bushel</td>
</tr>
</tbody>
</table>

| 37% | 69% | 27% | 37% | 30% |
Yield projections suggest surpluses will remain available
What is the alternative?

- Pasture
- Conservation Reserve Program
- Soybeans
- Native Prairie
- Suburban Development
- Energy Crops
What Would Growers Need to be Paid to Convert Land to Corn Alternatives?

By 2022, growers could expect to receive $205 per acre in rent.

Can the alternatives provide similar revenue?

Sources: 2022 land rent estimate - IHS Global Insights Ag Division; current land rents – USDA ERS and NASS; CRP payment – USDA Farm Service Agency
The Most Significant Land Use Change in This Century has Nothing to do with Food or Fuels

With the majority of the land coming out of crop production

Source: USDA National Resources Conservation Services
Other renewables are going to take time

1. Grasses have field production reliability challenges

Miscanthus grass was shredded by a 10 minute hail storm

Miscanthus is fairly easy to grow, but no production system in place.

2. Logistical challenges with wheat straw

This would be a one day supply needs 2000 tons/day

This is a one day supply needs 50K BU/day

3. Capital costs for cellulosic ethanol facility

Abengoa Bioenergy: $500M for 15 BGY/100MW refinery
$13/gallon versus <$2/gallon for corn

4. Processing costs for cellulosic ethanol

Fermentation
Current enzyme costs $0.50/gal vs $0.03/gal for corn grain
What’s Left in the Field is Yet Unrealized Potential

Harvest index vs. grain yield

Grain makes up about 58% of the biomass in a field at harvest
Stover (stalks, cobs, leaves) makes up about 42% of the biomass

2008 trials—13 locations, 14 unique hybrids (101 to 111RM)

200 bu/ac field
4.8 dry tons/ac

Planting 2nd yr corn in Nebraska

200 bu/ac field
3.4 dry tons/ac
Increased yields creates additional food, environmental and energy benefits

The best GHG reduction from stover is to displace coal

- Seed, chemical, fertilizer production
- Corn production
- Ethanol production
- Animal feed production
- Stover
- Fuel use
- Animal feed production

Offsets additional corn production

Displace coal

90% GHG reduction per BTU

Offsets energy crop production

CO₂ Credit

Cellulosic ethanol

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Cellulosic ethanol is available today from corn kernel fiber

**Forty percent of the dry grind industry is extracting backend oil for biodiesel today:**

- 56 lbs corn
- 2.8 gallons ethanol
- 16.5 lbs distillers grains
- 0.5 lbs corn oil for biodiesel
- 16 lbs distillers grains

**Fractionation providers are focused on adding equipment to separate just the fiber on the front end**

- 2 lbs celluose fiber
- 2.8 gallons ethanol
- 14 lbs distillers grains
- 0.5 lbs corn oil for biodiesel

**Cellulosic startups are focused on “one pot” enzyme/yeast combinations to convert the cellulose in situ**

- +$0.03/gal
- 16K BTU
- 0.1 gallon cellulosic ethanol
An acre of corn: meeting food, fuel and fiber needs

15 BGY of corn ethanol **today** uses 14M net acres and offsets the need for 3M acres of an energy crop

**Energy balance:** 2.3MM BTU output for 1MM BTU input
**GHG profile:** 27% less than gasoline without stover credit
**Protein balance:** 100% available for feed and food
**Fat balance:** 100% available for feed or diesel use
**Fiber balance:** 100% available for feed, solid or liquid fuel use