Drivers of Land Use Change in the United States and South America: *Update*

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Resigned from her position in CARD in August to move to Kansas City
Overview of Activities

• Determine the extent to which CARB’s assumptions about land use change agree with actual U.S. and Brazilian experience.
• Made recommendations to CARB’s expert workgroup on indirect land use
• Reviewed existing literature on drivers of land use change
Key CARB Assumption

• “…all of the land that is well-suited to crop production has already been converted to agricultural uses, yields on newly converted lands are almost always lower than corresponding yields on existing cropland.”
Ratio of yield on new land to yield on existing land

Lower yields on new land means more land needs to be brought into production to meet a given supply

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**GTAP Modeling Results for Corn Ethanol Land Use Change**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economic Inputs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elasticity of crop yields wrt area expansion</td>
<td>0.5</td>
<td>0.75</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.66</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>Crop yield elasticity</td>
<td>0.4</td>
<td>0.4</td>
<td>0.2</td>
<td>0.4</td>
<td>0.4</td>
<td>0.25</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Elasticity of land transformation</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.3</td>
<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Elasticity of harvested acreage response</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
</tbody>
</table>
Previous Work funded by National Biodiesel Board

• Null hypothesis:
  – Brazilian soybean yields on land brought into production since 1996 have the same yield as existing land
If anything, Brazilian soybean yield on new land is higher than yield on old land.
New Estimates for the U.S.

Index of Prices Received in the U.S.

- Wheat
- Corn
- Soybeans
U.S. Crop Acreage is Inelastic

• A 50% increase in expected farmer returns from growing principal crops led to a 1.7% increase in acreage from 2006 to 2009 (about 4 million acres)

• Elasticity of U.S. crop acreage equals 0.033.
U.S. Corn Ethanol Production Expressed in Acres

Million acres

2003 2004 2005 2006 2007 2008 2009
Where did Land Use Change?
Method Used

- Use county level data to estimate where cropland expanded (15 top U.S. crops)
- Use county trend yields to approximate the yield in each county for each crop
- Compare the average yield in counties that expanded to average yields in the base period (2006)
<table>
<thead>
<tr>
<th>Commodity</th>
<th>No Expansion Yield</th>
<th>Yield in Expansion Counties</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat (bu)</td>
<td>40.5</td>
<td>49.8</td>
<td>1.23</td>
</tr>
<tr>
<td>Potatoes (cwt)</td>
<td>426.9</td>
<td>519.8</td>
<td>1.22</td>
</tr>
<tr>
<td>Peanuts (lbs)</td>
<td>3244.8</td>
<td>3622.6</td>
<td>1.12</td>
</tr>
<tr>
<td>Barley (bu)</td>
<td>60.3</td>
<td>63.4</td>
<td>1.05</td>
</tr>
<tr>
<td>Canola (lbs)</td>
<td>1537.3</td>
<td>1567.3</td>
<td>1.02</td>
</tr>
<tr>
<td>Rice (pounds)</td>
<td>7141.3</td>
<td>7014.0</td>
<td>0.98</td>
</tr>
<tr>
<td>Cotton (lbs)</td>
<td>914.3</td>
<td>886.4</td>
<td>0.97</td>
</tr>
<tr>
<td>Corn (bu)</td>
<td>158.7</td>
<td>151.4</td>
<td>0.95</td>
</tr>
<tr>
<td>Rye (bu)</td>
<td>19.3</td>
<td>18.0</td>
<td>0.93</td>
</tr>
<tr>
<td>Beans (lbs)</td>
<td>1726.7</td>
<td>1584.4</td>
<td>0.92</td>
</tr>
<tr>
<td>Sugarbeets (tons)</td>
<td>26.8</td>
<td>24.0</td>
<td>0.90</td>
</tr>
<tr>
<td>Sorghum (bu)</td>
<td>70.8</td>
<td>60.8</td>
<td>0.86</td>
</tr>
<tr>
<td>Oats (bu)</td>
<td>62.3</td>
<td>52.6</td>
<td>0.84</td>
</tr>
<tr>
<td>Soybeans (bu)</td>
<td>43.5</td>
<td>35.7</td>
<td>0.82</td>
</tr>
</tbody>
</table>
Findings

• Shifting of crops is much more important than expansion of crop land in the U.S.
• No evidence of large yield changes due to cropland expansion
• No strong evidence supporting significantly lower crop yields on new land
My Subgroup’s Recommendation to CARB

Elasticity with respect to area expansion

Adopt the value of this parameter by region as documented in Tyner et al (2010).

Tyner et al analysis has ratios between 0.9 and 1.0 for U.S. and Brazil
Impact of Change

• For biodiesel, increase in ration from 0.5 to 0.75 decreased GTAP land conversion by one-third.

• Increasing ratio from 0.666 to 0.9 or 1.0 should decrease average land conversion by between 30 and 40%.
Recommendation 2

Yield elasticity with respect to price

Keep the yield elasticity with respect to price at 0.25.

Despite a lack of data, this value accounts for double cropping and accords well with economic theory.
Recommendation 3

Parameterization of GTAP’s CET Function.

Develop a better method to increase flexibility in the function that determines own and cross price substitution elasticities across land cover types.
Time Permitting: What Has Happened to the Corn Market?
USDA Corn Production Estimates Since August

- August: Down 1.4%
- Sept: Down 3.4%
USDA Corn Beginning Stocks Estimates Since August

Up 300 million bushels
USDA Corn Supply Estimates Since August

- August: Down 1.66%
- Sept: Down 1.2%
- Oct:
USDA Corn Demand Estimates Since August

- Aug: 14.8 billion bu.
- Sept: 14.1 billion bu.

- Graph shows the demand estimates for corn in billion bushels, with a price range of $3.00 to $6.50 per bushel.
USDA Corn Demand Estimates Since August

Aug Supply Estimate

$4.45/bu

$3.80/bu
USDA Supply and Demand Estimates Since August

- **Aug Supply Estimate**
  - $5.00/bu
- **Oct Supply Estimate**
  - $4.45/bu
- **$3.80/bu**

Graph showing the supply estimates for August and October with corresponding price points.
What Caused Price to Move?

- Estimated supply reductions since August account for about half the price increase
- Projected demand increases account for the other half
  - Stronger feed demand
  - Stronger export demand
    - Russian wheat failure
    - China entering market
- If ethanol price drops, then RIN values will increase dramatically and could borrow 2011 RINS
- Without borrowing, almost all the rationing of corn demand will come from livestock industry