Development of a Regional Aggregated Crop Yield Index

Timothy S. Griffin, Christian J. Peters, David H. Fleisher, Sherri L. DeFauw and Jonathan P. Resop

Tufts University

Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy
Northeast Region

- Many crops grown but dominated by a few
- Historical data availability uneven
- Models limited in number
Objectives

1. Establish temporal and spatial trends for crops yields and land use in the region that could be incorporated in projections of production capacity under climate change

2. Assess the potential for development of productivity index based on a single crop or multiple crops, to characterize potential productivity under climate change at different scales and for additional crops

$$\text{Output}_{\text{Food Group}} = \left( \frac{Y_i \text{ reference}}{Y_{\text{mean reference}}} \right) \times Y_{\text{food group}} \times \text{area}_i$$

*Reference* could be a single crop or aggregate of multiple crops
Data Sources

• Census of Agriculture and NASS Annual Surveys
  – 1981-2010 (county level)
  – Corn (grain and silage), soy, wheat, potato, hay
  – Yield and acreage

• Cropland Data Layer (CDL) 2008-2012

• Simulation model output (corn, wheat, potato)
Methods

• Temporal yield changes: linear regression
• Yield relationship between crops: correlation
• Yield stability: normalized yields and GIS
• Land use: spatial interdependencies
Framing Questions and Results
Q: How do yields change over time?

**Corn grain**
- $y = 84.967 + 1.4652x$
- $R^2 = 0.46915$

**Potatoes**
- $y = 219.23 + 2.0861x$
- $R^2 = 0.25946$

**Wheat**
- $y = 40.651 + 0.7776x$
- $R^2 = 0.65584$

**Alfalfa hay**
- $y = 2.8382 - 0.0058x$
- $R^2 = 0.08009$
Q: How are yields of major crops related?
(includes all county*yr data points with at least 1000 acres)

<table>
<thead>
<tr>
<th></th>
<th>Corn grain</th>
<th>Corn silage</th>
<th>Wheat</th>
<th>Potatoes</th>
<th>Soybeans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn grain</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn silage</td>
<td>0.7399***</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>0.3181***</td>
<td>0.2331***</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
<td>0.4529***</td>
<td>0.3505***</td>
<td>0.1730*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Soybeans</td>
<td>0.7053***</td>
<td>0.5989***</td>
<td>0.1654***</td>
<td>0.2688***</td>
<td>1</td>
</tr>
</tbody>
</table>

*Significant at the 1% level.
Q: Are high or low yields stable over time? (Uses weighted, normalized yields across the region)
Q: Are high or low yields stable over time?
(Uses weighted, normalized yields across the region)

The “Year Effect” is much greater magnitude than “Location Effect”
Q: What are Multi-Year Crop Production Footprints?
Q: Are target crops being grown on same landbase?

Delaware

Maine
Pulling it together…

• Simulation of climate impacts will be refined by trends identified
  – Yield trajectory
  – Rotation intensity
  – Assigning specific land base to specific crops

• If changes in land use occur, transition between crops will be important (rather than expansion)

• Indexing productivity allows assessment of broader range of crops in the region
Thank You