Maximizing ArcGIS Pro
for The Crop Sequence Boundaries (CSB) Project

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Session: Optimize Crop Zoning and Land Planning Boundaries
Date & Time: Thursday, July 13, 2023, at 10:00 am PST
Room: 28B

Disclaimer: The findings and conclusions in this report are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy.
1. What are Crop Sequence Boundaries (CSB)?
2. Motivation for CSB
3. Study area
4. Methodology
5. Results
6. Conclusion
7. CSB public release information
What are Crop Sequence Boundaries (CSB)?

CSB represent **field-level boundaries** over a **set time frame** in a **homogenously** cropped area.

1. Automatically delineated fields
2. Homogenously cropped areas over a set time frame
3. Physical boundaries and boundaries between different crop types
4. Coverage is complete for the contiguous US
Motivation for CSB

Many automatically delineated field polygons exist

- Almost all are **small area pilot studies**

Need for a contiguous US product that is derived from the NASS Cropland Data Layer (CDL)

- Can be used as a **standard foundation for crop field level** geospatial analysis
- That is **publicly available** for download

2013-2020 CSB layer (red outline) in McLean County, IL, overlaid onto CDL
• The CSB project began in 2020
• Piloted for Illinois, US and expanded to the contiguous US
• CSBs are created for all years between 2008 to 2022 using 8-year time frames (i.e., 2015-2022)
• CSB areas compared to estimated corn and soybean planted acres
Basic geospatial-processing steps for creating polygons from the CDL:

- **Filter/clean**
- **Stack years**
- **Process polygon**

**Methodology overview**

- **Google Earth Engine**
- **Esri ArcGIS Pro**

High performance cloud computing
Methodology

CDL Processing

- Resample CDL to 10m
- Reclassify CDL to Simple Classes
- Filter Multiple Times (focal-mode)
- Re-impose Road / Rail Network
- Export Desired Years and Extent

CDL Processing in Google Earth Engine

- Split Raster by Sub-Regions
- Stack Years into Unique Raster
- Remove Non-Cropland (n-n, n-1)

Vector Processing

- Convert Raster to Polygons
- Project to Albers Conical
- Eliminate under 1 ha into Neighbor
- Export Polygons Over 1 Hectare

Post-Processing

- Merge to State or contiguous US
- Create Unique Identifying Code
- Populate Attribute Table
- Package for Distribution

ArcGIS Pro

- Raster Prep
- In Cloud

ArcGIS Pro

- Post-Processing
- In Cloud

United States Department of Agriculture
National Agricultural Statistics Service
Tuning methods:
• Using too many years - split fields too much
• Using too few years - does not divide fields enough
• Filtering too much – soften edges
• Filtering too little – leaves islands
• Many choices for fixing edge noise

Contiguous US has about 19.5 million unique polygons
### National results for corn and soybean

<table>
<thead>
<tr>
<th>Year</th>
<th>Published* (planted acres)</th>
<th>CSB (acres)</th>
<th>Error (%)</th>
<th>Published* (planted acres)</th>
<th>CSB (acres)</th>
<th>Error (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>88,019,000</td>
<td>89,888,422</td>
<td>2.1%</td>
<td>82,660,000</td>
<td>87,120,721</td>
<td>5.4%</td>
</tr>
<tr>
<td>2016</td>
<td>94,004,000</td>
<td>96,665,222</td>
<td>2.8%</td>
<td>83,453,000</td>
<td>87,644,495</td>
<td>5.0%</td>
</tr>
<tr>
<td>2017</td>
<td>90,167,000</td>
<td>93,440,276</td>
<td>3.6%</td>
<td>90,162,000</td>
<td>96,119,359</td>
<td>6.6%</td>
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<tr>
<td>2018</td>
<td>88,871,000</td>
<td>92,904,634</td>
<td>4.5%</td>
<td>89,167,000</td>
<td>95,515,323</td>
<td>7.1%</td>
</tr>
<tr>
<td>2019</td>
<td>89,745,000</td>
<td>93,459,732</td>
<td>4.1%</td>
<td>76,100,000</td>
<td>80,548,849</td>
<td>5.8%</td>
</tr>
<tr>
<td>2020</td>
<td>90,652,000</td>
<td>95,060,605</td>
<td>4.9%</td>
<td>83,354,000</td>
<td>88,401,544</td>
<td>6.1%</td>
</tr>
<tr>
<td>2021</td>
<td>93,252,000</td>
<td>97,139,581</td>
<td>4.2%</td>
<td>87,195,000</td>
<td>93,138,351</td>
<td>6.8%</td>
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<tr>
<td>2022</td>
<td>88,579,000</td>
<td>93,071,290</td>
<td>5.1%</td>
<td>87,450,000</td>
<td>94,088,968</td>
<td>7.6%</td>
</tr>
</tbody>
</table>

*Official estimates published by USDA-NASS
https://quickstats.nass.usda.gov/

\[
PE_{crop} = \frac{A_{crop} - T_{crop}}{A_{crop}} \times 100
\]

*PE is the percent error, \( A_{crop} \) is the CSB acres, and \( T_{crop} \) is the Quick Stats planted acres*
State results for corn

- 2015: $R^2$ is 0.952, $y = 0.888x + 1.46$
- 2016: $R^2$ is 0.998, $y = 1.01x + 0.143$
- 2017: $R^2$ is 0.995, $y = 1.03x - 0.488$
- 2018: $R^2$ is 0.989, $y = 1.01x - 0.2$
- 2019: $R^2$ is 0.997, $y = 1.01x - 0.232$
- 2020: $R^2$ is 0.997, $y = 1.01x - 0.175$
- 2021: $R^2$ is 0.996, $y = 1.01x - 0.293$
- 2022: $R^2$ is 0.996, $y = 1.02x - 0.311$
State results for soybean

R² is 0.991
y = 0.989x+0.0727

R² is 0.998
y = 0.998x+0.0464

R² is 0.99
y = 0.98x+0.185

R² is 0.991
y = 0.986x+0.0946

R² is 0.997
y = 1x+-0.226

R² is 0.988
y = 1x+-0.131

R² is 0.989
y = 1.01x+-0.183

R² is 0.992
y = 1.04x+-0.736
Conclusions

• A repeatable automated process for building crop field polygons
• Now producing large area products because of advancements in cloud computing
• Prioritizing a uniform spatial and temporal methodology which produces a streamlined product but likely at the cost of accuracy
• Future versions need to account for local variability and may have to incorporate new considerations and advancements in the research
• Extremely useful applications including aggregating gridded data, improving satellite-based estimates of tillage, cover crops and other practices, predicting preseason planted acreage and providing a standard for field-level research
CSB public release information

Link - https://www.nass.usda.gov/Research_and_Science/Crop-Sequence-Boundaries/

- Interactive map to explore data
- GDB datasets are available for download
- On GitHub algorithm is available

Released this July!

Example of CSB interactive map
Thank you

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