Satellite Remote Sensing Imagery Quality and Timeliness: Considerations for Use in Regional Estimation of Crop Production
Most popular crop reports from NASS

**Annually**

Corn Planted Acreage Up Slightly from 2012
Soybean Acreage Up 1 Percent
All Wheat Acreage Up 1 Percent
All Cotton Acreage Down 17 Percent

Corn planted area for all purposes in 2013 is estimated at 97.4 million acres, up slightly from the highest planted acreage in the United States since 1936 when an estimated 100 million acres were planted. All other classes of corn planted are expected to harvest 10.1 million acres for grain, up 1 percent from last year.

Soybean planted area for 2013 is estimated at 77.7 million acres, up 1 percent from 2012 and 2 percent above the 76.9 million acres planted in 2011. It is estimated in New York, Pennsylvania, and South Dakota.

All wheat planted area for 2013 is estimated at 56.5 million acres, up 1 percent from 2012. All wheat planted area, at 48.7 million acres, is up 1 percent above last year and up 2 percent from the previous year. High levels of expected 29.9 million acres are Hard Red Winter, 9.4 million acres are Soft Red Winter, and 1.2 million acres are Soft White Winter. Acre planted to other spring wheat for 2013 is estimated at 12.2 million acres, up 1 percent from last year. The estimated Durum wheat planted area at 1.54 million acres, down 1 percent from the previous year.

All cotton planted area for 2013 is estimated at 10.3 million acres, 17 percent below last year, 10.0 million acres, down 17 percent from 2012. American Pima cotton area is estimated at 226,000 acres.

**Monthly**

Winter Wheat Production Down 9 Percent from 2013
Soybean Production Up Slightly from April Forecast

Winter wheat production is forecast at 1.30 billion bushels, down 9 percent from 2013. As of April 1, 2013, it is forecast at 1.35 billion bushels, down 9 percent from last year.

Hard Red Winter production, at 746 million bushels, is up slightly from a year ago. Soft Red Winter, at 389 million bushels, is down 11 percent from 2012. White Winter production, at 9.9 million bushels, is up 1 percent from last year.

The United States all orange forecast for the 2013-2014 season is 7.21 million tons, up 8 percent from the 2012-2013 season forecast. The Florida all orange forecast (4.95 million tons) is up slightly from the previous forecast but down 17 percent from last year on early maturing, and Navel varieties in Florida are forecast at 3.3 million tons (240 million tons) of the previous forecast but down 21 percent from last season. The Florida Valencia orange forecast (2.57 million tons) is unchanged from the previous forecast but down 16 percent from last season on California and Texas production forecasts carried forward from April.

Florida frost concentrates orange juice (FCOJ) yield forecast for the 2013-2014 season to 2.0 degrees Brix, down 1 percent from the April forecast and down 1 percent from last season's 2.08 degrees Brix. The early-season forecast was projected at 1.25 million tons, up 1 percent from last season's 1.20 million tons. The Valencia portion is projected at 1.65 million tons, down 1 percent from last season. All projections of yield assume the processing maintenance this season will be similar to previous years.

**Weekly**

Crop Progress

Corn Planted - Selected States
Crop Emerged - Selected States

---

[Details from USDA reports on crop planted, acreage, and crop progress]
Land cover mapping - Cropland Data Layer (CDL)

* 2008 – 2016 publically available
* 2017 in the works
* 2008 and 2009 being reprocessed from 56m to 30m
Celebrating 45 Years of Landsat
1972-2017

Landsat represents the world's longest continuously acquired collection of space-based moderate-resolution land remote sensing data.

Landsat Headlines

November 29, 2017
Delivery changes to Band 4 Solar/Sensor Zenith/Azimuth Angle Bands
A recent software release to the Earth Resources Observation and Science (EROS) Center Science Processing Architecture (ESPA) on-demand Interface changes the delivery to users of the Band 4 Solar/Sensor zenith/azimuth angle bands.

November 21, 2017
Landsat Analysis Ready Data for Alaska and Hawaii Available
USGS Landsat Analysis Ready Data (ARD) for Alaska and Hawaii are now available for download from EarthExplorer. This completes the release of U.S. Landsat ARD for all 50 states. (Read More)

November 8, 2017
New Video Introduces Landsat Analysis Ready Data
A new video introducing Landsat Analysis Ready Data (ARD) has been added to the Landsat ARD webpage, as well as the Landsat Media Library. (Read More)

November 1, 2017
Upcoming Infrastructure Maintenance
On Tuesday, November 7, 2017, the USGS EROS Center in Sioux Falls, South Dakota will temporarily halt Landsat data processing at 11:00 am CST, and all data distribution from EarthExplorer, GloVis, the LandsatLook Viewer, and ESPA at 3:00 pm CST due to planned required infrastructure maintenance. (Read More)

October 30, 2017
Landsat Analysis Ready Data Available
USGS Landsat Analysts Ready Data (ARD) for the contiguous United States are now available for download from EarthExplorer. (Read More)
2017: June 16 – 22

Agricultural areas

Landsat 8

Sentinel 2a

DMC Deimos

DMC UK2

Resourcesat-2 LISS3
Available satellite imagery 2017: June 16 – 22
Classification

False Color IR Imagery

FSA Ground Truth

Land Cover Categories
- Agriculture
  - Pasture/Grass
  - Alfalfa
  - Fallow/idle Cropland
  - Winter Wheat
  - Barley
  - Cotton
  - Almonds
  - Corn
  - Durum Wheat

August with some FSA data overlaid

Final Classification

Land Cover Categories
- Agriculture
  - Pasture/Grass
  - Alfalfa
  - Fallow/idle Cropland
  - Winter Wheat
  - Barley
  - Cotton
  - Almonds
  - Corn
  - Durum Wheat

Final CDL
**Accuracy Assessments**

USDA, National Agricultural Statistics Service, 2014 Colorado Cropland Data Layer

STATEWIDE AGRICULTURAL ACCURACY REPORT

Crop-specific covers only | Correct | Accuracy | Error | Kappa
-------------------------|--------|---------|-------|------
OVERALL ACCURACY**       | 2,630,488 | 85.5%   | 14.5% | 0.812

<table>
<thead>
<tr>
<th>Cover</th>
<th>Attribute Type</th>
<th>Code</th>
<th>Pixels</th>
<th>*Correct</th>
<th>Producer's Accuracy</th>
<th>Error</th>
<th>Kappa</th>
<th>User's Accuracy</th>
<th>Commission</th>
<th>Cond'l Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td></td>
<td>1</td>
<td>419737</td>
<td>90.76%</td>
<td>9.24%</td>
<td>0.895</td>
<td></td>
<td>90.22%</td>
<td>9.78%</td>
<td>0.889</td>
</tr>
<tr>
<td>Sorghum</td>
<td></td>
<td>4</td>
<td>83214</td>
<td>62.32%</td>
<td>37.68%</td>
<td>0.611</td>
<td></td>
<td>64.72%</td>
<td>35.28%</td>
<td>0.635</td>
</tr>
<tr>
<td>Soybeans</td>
<td></td>
<td>5</td>
<td>1058</td>
<td>43.25%</td>
<td>56.75%</td>
<td>0.432</td>
<td></td>
<td>72.47%</td>
<td>27.53%</td>
<td>0.724</td>
</tr>
<tr>
<td>Sunflower</td>
<td></td>
<td>6</td>
<td>5760</td>
<td>39.64%</td>
<td>60.36%</td>
<td>0.395</td>
<td></td>
<td>70.61%</td>
<td>29.39%</td>
<td>0.705</td>
</tr>
<tr>
<td>Barley</td>
<td></td>
<td>21</td>
<td>7176</td>
<td>71.52%</td>
<td>28.48%</td>
<td>0.715</td>
<td></td>
<td>81.00%</td>
<td>19.00%</td>
<td>0.810</td>
</tr>
<tr>
<td>Winter Wheat</td>
<td></td>
<td>24</td>
<td>1100020</td>
<td>93.26%</td>
<td>6.74%</td>
<td>0.905</td>
<td></td>
<td>94.21%</td>
<td>5.79%</td>
<td>0.918</td>
</tr>
<tr>
<td>Millet</td>
<td></td>
<td>29</td>
<td>75109</td>
<td>67.86%</td>
<td>32.14%</td>
<td>0.671</td>
<td></td>
<td>76.85%</td>
<td>23.15%</td>
<td>0.762</td>
</tr>
<tr>
<td>Alfalfa</td>
<td></td>
<td>36</td>
<td>196153</td>
<td>89.75%</td>
<td>10.25%</td>
<td>0.891</td>
<td></td>
<td>85.60%</td>
<td>14.40%</td>
<td>0.848</td>
</tr>
<tr>
<td>Other Hay/Non Alfalfa</td>
<td></td>
<td>37</td>
<td>84626</td>
<td>63.33%</td>
<td>36.67%</td>
<td>0.624</td>
<td></td>
<td>85.92%</td>
<td>14.08%</td>
<td>0.854</td>
</tr>
<tr>
<td>Sugarbeets</td>
<td></td>
<td>41</td>
<td>4679</td>
<td>63.13%</td>
<td>36.87%</td>
<td>0.631</td>
<td></td>
<td>90.28%</td>
<td>9.72%</td>
<td>0.903</td>
</tr>
<tr>
<td>Dry Beans</td>
<td></td>
<td>42</td>
<td>9406</td>
<td>62.72%</td>
<td>37.28%</td>
<td>0.626</td>
<td></td>
<td>69.54%</td>
<td>30.46%</td>
<td>0.694</td>
</tr>
<tr>
<td>Potatoes</td>
<td></td>
<td>43</td>
<td>6104</td>
<td>89.74%</td>
<td>10.26%</td>
<td>0.897</td>
<td></td>
<td>93.79%</td>
<td>6.21%</td>
<td>0.938</td>
</tr>
<tr>
<td>Fallow/Idle Cropland</td>
<td></td>
<td>61</td>
<td>625989</td>
<td>88.08%</td>
<td>11.92%</td>
<td>0.855</td>
<td></td>
<td>89.23%</td>
<td>10.77%</td>
<td>0.869</td>
</tr>
<tr>
<td>Cover Type</td>
<td>Classified Acres</td>
<td>Enumerated Acres</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>------------------</td>
<td>------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>637.0</td>
<td>640.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean</td>
<td>1.0</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Ag.</td>
<td>2.0</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
At three sites

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Classified Acres</td>
<td>Enumerated Acres</td>
</tr>
<tr>
<td>Corn</td>
<td>34.0</td>
<td>21.0</td>
</tr>
<tr>
<td>Soybean</td>
<td>177.0</td>
<td>155.0</td>
</tr>
<tr>
<td>Wheat</td>
<td>4.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>2.5</td>
<td>0.0</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Non-Ag.</td>
<td>422.0</td>
<td>464.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Classified Acres</td>
<td>Enumerated Acres</td>
</tr>
<tr>
<td>Corn</td>
<td>176.0</td>
<td>190.0</td>
</tr>
<tr>
<td>Soybean</td>
<td>302.0</td>
<td>290.0</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>3.5</td>
<td>0.0</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Non-Ag.</td>
<td>158.5</td>
<td>160.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Classified Acres</td>
<td>Enumerated Acres</td>
</tr>
<tr>
<td>Corn</td>
<td>637.0</td>
<td>640.0</td>
</tr>
<tr>
<td>Soybean</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Non-Ag.</td>
<td>2.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
10 sites and so forth....
Acreage Regression Estimation

We don’t just “pixel count” from CDL to estimate acreage.
SAS-based Regression Estimate system

à la Bob Seffrin
County Estimates

- Use Batteese-Fuller estimator with nested design
- Apply state-strata level regression parameters
- Adjust intercept based on segments in county
- Ag Statistics Districts Est = Sum of County Estimates
Classification comparison #1

30m Sentinel-2a

30m Landsat 8
Classification comparison #2

10m Sentinel-2a

15m Sentinel-2a
60m vs 15m regression analysis - corn

\[
\text{Reported} = -8.2 + 1.04 \cdot \text{Classified} \\
r^2 = 0.910
\]

\[
\text{Reported} = -6.1 + 1.05 \cdot \text{Classified} \\
r^2 = 0.915
\]
A weather system that brought rain to Tehran and Iran’s Caspian Sea coastline and Alborz mountains helped raise dust inland in late November, 2017...

Continue Reading

**Data**

The MODIS Data section contains everything from ATBDs to Product Descriptions to Product ordering information, including from Direct Broadcast data providers. Visit the Data section for more information.

Learn More About MODIS Data

**News**

LP DAAC Announces Release of MODIS Version 6 Net Evapotranspiration Products

Release of NASA MEaSUREs CAMEL 5 km Products Announced By LP DAAC

View More MODIS News

**Tools**

The MODIS Tools section has a complete listing of web-based tools that can be used to access a wide variety of MODIS Data, along with an array of links and a summary of each tool.

Learn More About MODIS Tools >>
Hail example
MODIS Imagery - Snow event
Calculation and use of NDVI

Normalized Difference Vegetation Index

From Wikipedia, the free encyclopedia

This article reads more like a story than an encyclopedia entry. To meet Wikipedia’s quality standards and conform to the neutral point of view policy, please help to introduce a more formal style and remove any personally invested tone. [July 2017]

The Normalized Difference Vegetation Index (NDVI) is a simple graphical indicator that can be used to analyze remote sensing measurements, typically but not necessarily from a space platform, and assess whether the target being observed contains live green vegetation or not.

**Contents**

1. Brief history
2. Rational
3. Performance and limitations
4. See also
5. References
6. External links

**Brief history**

The exploration of outer space started in earnest with the launch of Sputnik 1 by the Soviet Union on 4 October 1957. This was the first man-made satellite orbiting the Earth. Subsequent successful launches, both in the Soviet Union (e.g., the Sputnik and Cosmos programs), and in the U.S. (e.g., the Explorer program), quickly led to the design and operation of dedicated meteorological satellites. These are orbiting platforms embarked instruments specially designed to observe the Earth’s atmosphere and surface with a view to improve weather forecasting. Starting in 1960, the TIROS series of satellites embarked television cameras and radiometers. This was later (from 1964 onwards) followed by the Nimbus satellites and the family of Advanced Very High Resolution Radiometer instruments onboard the National Oceanic and Atmospheric Administration (NOAA) platforms. The latter measures the reflectance of the planet in red and near-infrared bands, as well as in the thermal infrared. In parallel, NASA developed the Earth Resources Technology Satellite (ERTS), which became the precursor to the Landsat program. These early sensors had minimal spectral resolution, but tended to include bands

\[
NDVI = \frac{(\text{NIR} - \text{VIS})}{(\text{NIR} + \text{VIS})}
\]

**Ranges from -1.0 to 1.0**

NDVI is a related to:

- Plant health
- Chlorophyll content
- “Greenness”
- Amount of Biomass
- Vegetation vigor
- Yield!
MODIS NDVI 8-day composite imagery example

Lighter shades, greater NDVI
Average NDVI phenologies over United States

Signals isolated using crop specific masks
Real-time tracking of NDVI
NASS recent efforts on remote sensing of crop yields

Premise
– Positive relationship between crop yield and biomass – plant vigor - “greenness” - NDVI
– Negative relationship between crop yield and land surface temperature

Utilize time-series MODIS satellite data to obtain biomass and temperature estimates throughout the growing season
– Use Cropland Data Layer to isolate known crop areas
– Then use them in an empirically-based prediction model based on historical imagery and NASS county-level yield statistics

Run model at National, State, and County levels
– Integrating over season approach
– Using decision trees (Rulequest Cubist)
– Corn and Soybeans operational currently

Perform within crop season at monthly intervals

Must be timely, accurate, and useful
Intersecting of crop “mask” with time-series of MODIS data

CDL

Isolate crop of interest

Intersect crop mask with MODIS time series and then spatially average those pixels
County-level time-series database has been built 2006 -> present

Every eight day “window” through the growing season

- Observed average value of NDVI
- Observed average value of LST

For every county we also know

- NASS published yield

<table>
<thead>
<tr>
<th>state</th>
<th>county</th>
<th>year</th>
<th>yield</th>
<th>NDVI</th>
<th>LST</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>99</td>
<td>2010</td>
<td>160.6</td>
<td>2980.679</td>
<td>3264.547</td>
</tr>
<tr>
<td>17</td>
<td>95</td>
<td>2010</td>
<td>159.9</td>
<td>2952.395</td>
<td>3277.046</td>
</tr>
<tr>
<td>17</td>
<td>97</td>
<td>2010</td>
<td>162.9</td>
<td>2844.2</td>
<td>3571.099</td>
</tr>
<tr>
<td>17</td>
<td>101</td>
<td>2010</td>
<td>156.9</td>
<td>3674.741</td>
<td>3989.952</td>
</tr>
<tr>
<td>17</td>
<td>103</td>
<td>2010</td>
<td>173.6</td>
<td>2702.144</td>
<td>3005.154</td>
</tr>
<tr>
<td>17</td>
<td>105</td>
<td>2010</td>
<td>166.6</td>
<td>2816.087</td>
<td>3007.861</td>
</tr>
<tr>
<td>17</td>
<td>107</td>
<td>2010</td>
<td>155.7</td>
<td>2706.579</td>
<td>2846.325</td>
</tr>
<tr>
<td>17</td>
<td>109</td>
<td>2010</td>
<td>141.8</td>
<td>3104.659</td>
<td>3140.878</td>
</tr>
<tr>
<td>17</td>
<td>111</td>
<td>2010</td>
<td>166.2</td>
<td>3079.982</td>
<td>3283.637</td>
</tr>
<tr>
<td>17</td>
<td>113</td>
<td>2010</td>
<td>169.5</td>
<td>2727.7</td>
<td>2899.42</td>
</tr>
<tr>
<td>17</td>
<td>115</td>
<td>2010</td>
<td>166.8</td>
<td>2751.229</td>
<td>2943.958</td>
</tr>
<tr>
<td>17</td>
<td>117</td>
<td>2010</td>
<td>146.9</td>
<td>3213.265</td>
<td>3342.063</td>
</tr>
<tr>
<td>17</td>
<td>119</td>
<td>2010</td>
<td>186.3</td>
<td>3282.815</td>
<td>3405.388</td>
</tr>
<tr>
<td>17</td>
<td>121</td>
<td>2010</td>
<td>149.7</td>
<td>3524.353</td>
<td>3534.901</td>
</tr>
<tr>
<td>17</td>
<td>123</td>
<td>2010</td>
<td>168.8</td>
<td>3524.353</td>
<td>3534.901</td>
</tr>
</tbody>
</table>
Map Output

CORN
Field-level Yields
Remote Sensing Modeled
November 1, 2014

Normal year
Map Output

Estimated Corn Yield
December 1, 2012

Drought year

Johnson, 2014
Localized example of yield map variability

Scene of a large hailstorm

Landsat image

Modeled yields from MODIS
Highly already customized tool for time series analysis and display
Also, shifting to a simpler model construction

Integrate NDVI chart

<table>
<thead>
<tr>
<th>Year</th>
<th>Yield</th>
<th>vi</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>129.3</td>
<td>1.749</td>
</tr>
<tr>
<td>2003</td>
<td>142.2</td>
<td>1.765</td>
</tr>
<tr>
<td>2004</td>
<td>160.3</td>
<td>2.106</td>
</tr>
<tr>
<td>2005</td>
<td>147.9</td>
<td>2.024</td>
</tr>
<tr>
<td>2006</td>
<td>149.1</td>
<td>2.104</td>
</tr>
<tr>
<td>2007</td>
<td>150.7</td>
<td>2.08</td>
</tr>
<tr>
<td>2008</td>
<td>153.3</td>
<td>2.07</td>
</tr>
<tr>
<td>2009</td>
<td>164.4</td>
<td>2.324</td>
</tr>
<tr>
<td>2010</td>
<td>152.6</td>
<td>2.082</td>
</tr>
<tr>
<td>2011</td>
<td>146.8</td>
<td>2.105</td>
</tr>
<tr>
<td>2012</td>
<td>123.1</td>
<td>1.637</td>
</tr>
<tr>
<td>2013</td>
<td>158.1</td>
<td>2.179</td>
</tr>
<tr>
<td>2014</td>
<td>171</td>
<td>2.44</td>
</tr>
<tr>
<td>2015</td>
<td>168.4</td>
<td>2.382</td>
</tr>
<tr>
<td>2016</td>
<td>174.6</td>
<td>2.477</td>
</tr>
</tbody>
</table>

Find Optimal Threshold Value

Calculate area under the curve, over a threshold and relate to past years.
USA national-level simplistic corn yield model

Trend

$y = 1.7218x - 3306.3$

$R^2 = 0.2868$

Integrate

$y = 56.149x + 34.785$

$R^2 = 0.927$

Max

$y = 690.44x - 417.1$

$R^2 = 0.8414$

Standard Error 12.5996

Standard Error 4.0309

Standard Error 5.9422
State-level simplistic yield modeling

**Minnesota**
- $R^2 = 0.8162$
- Standard Error: 6.1590

**South Dakota**
- $R^2 = 0.8167$
- Standard Error: 9.4601

**Nebraska**
- $R^2 = 0.9058$
- Standard Error: 4.9836
County-level simplistic yield modeling

Sioux, Iowa

Minnehaha, South Dakota

Madison, Nebraska

Standard Error 10.41041

Standard Error 6.31143

Standard Error 9.377654
Map output still possible

2016
Corn

NASA Terra MODIS Modeled

Bushels per Acre

100
200
300
50
150
250

David M. Johnson, Economics & Development Division

dave.johnson@state.mn.us, 612-653-2860, 360-pub
And easy to create time series...
Summary of Remote Sensing for Crop Production Estimation

• **Strengths**
  – Good areal coverage
  – Solid temporal coverage
  – Many free data sources
  – Better sensors on the way
  – Little data latency
  – Fine spatial detail
  – Simple statistical models seem to be as good as complicated ones
  – Cheap computing and analytics has been a boon

• **Weaknesses**
  – Computationally intensive
  – Integrative skill set required
  – Calibration of datasets always ongoing
  – Measurement uncertainties difficult to quantify
  – A variety of noise sources are present
  – No long-term history
  – *In situ* validation lacking
  – Past utility was oversold
Sentinel-2 vs Landsat 7 & 8 spectral bands
Acreage estimate for a crop in stratum $h$

$$\hat{y}_h = N_h [\bar{y}_h + b_h (\bar{X}_h - \bar{x}_h)]$$

$N_h = \text{Number of frame units (segments in frame)}$

$\bar{y}_h = \text{sample mean per segment of reported acres of crop cover}$

$b_h = \text{Slope of the regression of acres in segment on pixel (acres)}$

$\bar{X}_h = \text{population mean pixels (acres) in segment}$

$\bar{x}_h = \text{sample mean pixels (acres) in segment}$
Estimate of county total for a crop, stratum

\[
\hat{T}_{(BF)hc.} = N_{hc} \left[ \hat{\beta}_{0h} + \hat{\beta}_{1h} \bar{x}_{hc} + \delta_{hc} \bar{u}_{hc.} \right]
\]

\[
\bar{u}_{hc.} = \bar{y}_{hc.} - \hat{\beta}_{0h} - \hat{\beta}_{1h} \bar{x}_{hc}.
\]

1) if \( \sigma^2_{\text{within}} = 0 \), use \( \delta = 1 \),
2) if \( \sigma^2_{\text{between}} = 0 \), use \( \delta = 0 \),
3) if < 2 segments use \( \delta = 0 \),
4) if \( \sigma^2_{\text{within}} = 1.0 \), use \( \delta = 0 \),
5) otherwise use \( \delta = \gamma \).