CroplandCROS: A Collaborative USDA Effort to Disseminate U.S. Cropland Data

Rick Mueller & Claire G. Boryan, PhD

U.S. Department of Agriculture (USDA)
National Agricultural Statistics Service (NASS)
USDA National Agricultural Statistics Service (NASS)

- NASS’s mission is to provide **timely, accurate, and useful statistics** in service to U.S. agriculture
  - Using a variety of survey, census, **geospatial, and remote sensing data**

[Images of maps and data layers]

https://www.nass.usda.gov/
Agenda

• Cropland Data Layer (CDL) Introduction
• Introducing CroplandCROS
• CroplandCROS Interface
• How the CDL Is Made
• CDL Applications
What is the Cropland Data Layer?
Cropland Data Layer (CDL)

• Purpose:
  – Combine remotely sensed imagery, Farm Service Agency (FSA) data, and NASS survey data to produce *supplemental and unbiased acreage estimates* for major commodities
  – Produce crop-specific *digital land cover data layers* for dissemination in industry standard formats

Cropland Data Layer Video: [https://youtu.be/vOAuMkprG7k](https://youtu.be/vOAuMkprG7k)
Cropland Data Layer (CDL)

- Annually produced, georeferenced, 30m, crop-specific land cover dataset
- Captures planted acres
- Freely available and open to the public
- Timeframe: National scale since 2008 — 2021 CDL released in February 2022
<table>
<thead>
<tr>
<th>CDL Crop Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Corn</td>
</tr>
<tr>
<td>2. Cotton</td>
</tr>
<tr>
<td>3. Rice</td>
</tr>
<tr>
<td>4. Sorghum</td>
</tr>
<tr>
<td>5. Soybeans</td>
</tr>
<tr>
<td>29. Millet</td>
</tr>
<tr>
<td>34. Rape Seed</td>
</tr>
<tr>
<td>37. Other Hay</td>
</tr>
<tr>
<td>38. Camelina</td>
</tr>
</tbody>
</table>
Introducing CroplandCROS
Introducing CroplandCROS

• USDA Agricultural Research Service and National Agricultural Statistics Service collaborative partnership
• Integrated into the USDA AgCROS platform
  – Agriculture Collaborative Research Outcomes System network
  – Discoverable data collated across space and time
  – Supportive of USDA and external customers needs
• Dissemination of entire NASS Cropland Data Layer archive
• Scalable multi platform app
  – Desktop/smartphone
Introducing CroplandCROS

Newsroom

News Release

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CroplandCROS web app updates existing geospatial data product for agricultural commodities in the United States

WASHINGTON, Oct. 28, 2021 – USDA’s National Agricultural Statistics Service (NASS) and Agricultural Research Service have announced enhancements to the CroSpCape web app, allowing users to more easily conduct area and statistical analysis of planted U.S. commodities.

Now known as CroplandCROS, the geospatial data product hosts the Cropland Data Layer (CDL). The NASS CDL is a 30-meter derived, crop-specific land cover classification that is created annually from satellite imagery.

"CroplandCROS improves the user experience by providing a consolidated, organized, and intuitive interface for conducting area analysis of U.S. cropland commodities," said NASS Director of Research and Development Linda Young. "We’ve made these enhancements while maintaining the analysis integrity of the CropScape application. The app also shows the importance of inter-agency collaboration in building innovative solutions and products."

CroplandCROS is powered by USDA’s Partnerships for Data Innovations (PDI). The app allows users to geolocate farms and map areas of interest. To aid users, the app features a user guide and instructional videos.

The CDL is available equally to everyone – agribusinesses and researchers alike. CDL users can apply the technology to explore yield forecasts, acreage estimates, disaster assessment, wildlife habitat, water use, and more.

The app has undergone enhancements to improve performance that include:

- Faster processing time when running analysis and export tools;
- Options for exporting data and printable maps in various formats;
- Accessibility on mobile devices, including smartphones and tablets;
- New search bar capabilities by address, zip code, and coordinates;
- Tutorials and videos to learn basic to advanced features;
- Embedded ArcGIS tools for advanced mapping and analytics;
- Customizable web apps via REST API; and
- Links and access to additional resources.

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CroplandCROS Interface
CroplandCROS

- Web service-based tool to provide online analysis, visualization, and data dissemination of the current and historical CDLs
- Platform agnostic
- Free and available to the public

CroplandCROS: [https://cropcros.azurewebsites.net/](https://cropcros.azurewebsites.net/)
CroplandCROS Major Functions (Select Year, Select Area)

Area selection – state/county and year of interest
CroplandCROS Major Functions (Filter Crops, Change Basemap)

Select crop(s) of interest and choose basemaps overlay
CroplandCROS Major Functions (Add Derivative Products)

Select alternative CDL products for display and query
CroplandCROS Major Functions (Define Area of Interest)

Area selection – define shape or import shapefile
CroplandCROS Major Functions (Analysis)

View selected area statistics and charting features
Input address or place for geographic lookup
CroplandCROS Major Functions (Map Overlays)

Toggle on CDL products or toggle other high-resolution overlays
Export selected area into GeoTIFF image – not a “shapefile”
CroplandCROS Major Functions (Export/Map Production)
CroplandCROS Major Functions (Help)

Purpose

The User Guide page is meant to provide users with guidance on how to use the CroplandCROS application, including the widgets, analysis buttons and export features. Additionally users may find links to instructional videos discussing how to use the CroplandCROS app, how to navigate the resources pages and how to apply an analysis using CroplandCROS data in ArcGIS Pro.

View Instructional Videos

User Help videos and topics of interest

Table of Contents

Analysis Toolbar
  Buttons
  Map Navigation Widgets
  Keyboard Shortcuts

Examples of Functionality
  Identify Crop by Pixel
  Choose an AOI
  Import Shapefile
  Select Crops
  Perform Analysis
  Export AOI

Add Exported Files into ArcGIS Pro
CroplandCROS Major Functions (Resources Help)

Resource Links

Click on the icon links below to learn how to use the CroplandCROS app, access information about the Cropland Data Layer program and download CDL data for use in other applications.

- Download Data
- Developer Guide
- User Guide
- FAQ
- References
- History of CDL
CroplandCROS Major Functions (Help - Developers)

- Web map services for developers
- Use ESRI application web services
  - Enterprise, Online, Desktop
- Google Earth (KML)
- Web Coverage Service client applications (as OGC WMS)
- Web Mapping Service client applications (as OGC WMS)
- ArcGIS REST APIs
CroplandCROS Feedback
How is the Cropland Data Layer made?
CDL Methodology

Input Imagery, Ancillary Data, & Reference Data

Sampling, Decision Trees, & Classifier

Output Maps & Metadata
Input Imagery

- Optical imagery acquired throughout the growing season
- Imagery resampled to 30m spatial resolution
- Sensors currently used:
  - Landsat 8, Sentinel 2 A & B, LISS 3
Ground Reference Data: Agricultural Data

Agriculture Ground Reference

• Farm Service Agency (FSA)
  – Common Land Unit (CLU)
  – Form 578 Data

• 70% Training Points

• 30% Validation Points
Ground Reference Data: Common Land Unit

Common Land Unit (CLU)

- Digitized field locations
- GIS-ready polygon shapefiles
- Managed by FSA state & county offices
- No crop information
Farm Service Agency (FSA)

578 Data

• Farmer reported data specifying crop type and location
• Linked to CLU data
Ground Reference Data: Agricultural Data

False Color IR Imagery

April

May

June

July

FSA Ground Reference

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
Supplemental Ground Reference Data (Napa Valley, California)

No additional ground reference data or historical ancillary inputs

Additional ground reference data and historical ancillary inputs
Ground Reference Data: Non-Agricultural Data

Non-Agriculture Ground Reference

- US Geological Survey National Land Cover Database (NLCD)
- Updated every 3 years (Latest: 2019)
- Forest, wetlands, water, barren, developed, etc.
Acreage is based on CDL pixel counts and are not official estimates.
### Cropland Data Layer 2020, Fresno County, CA

#### Land Cover Categories
(by decreasing acreage)

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Planted Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almonds</td>
<td>324999.1</td>
</tr>
<tr>
<td>Grapes</td>
<td>200849.7</td>
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<tr>
<td>Fallow/Idle Cropland</td>
<td>177802.7</td>
</tr>
<tr>
<td>Barren</td>
<td>167128.2</td>
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<tr>
<td>Pistachios</td>
<td>141411</td>
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<td>Winter Wheat</td>
<td>94663.4</td>
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<tr>
<td>Tomatoes</td>
<td>93247</td>
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<tr>
<td>Alfalfa</td>
<td>44565.7</td>
</tr>
<tr>
<td>Cotton</td>
<td>43590.9</td>
</tr>
<tr>
<td>Citrus</td>
<td>42539.2</td>
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<tr>
<td>Walnuts</td>
<td>16086.7</td>
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<tr>
<td>Other Tree Crops</td>
<td>12694.7</td>
</tr>
<tr>
<td>Garlic</td>
<td>11019.4</td>
</tr>
<tr>
<td>Herbaceous Wetlands</td>
<td>10745</td>
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<tr>
<td>Barley</td>
<td>10304.7</td>
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<tr>
<td>Dbl Crop WinWht/Corn</td>
<td>8718.5</td>
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<tr>
<td>Corn</td>
<td>7908.1</td>
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<tr>
<td>Onions</td>
<td>7620.6</td>
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<tr>
<td>Triticale</td>
<td>7023.9</td>
</tr>
<tr>
<td>Pomegranates</td>
<td>6306.2</td>
</tr>
<tr>
<td>Chickpeas</td>
<td>5652.8</td>
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<tr>
<td>Dbl Crop Triticale/Corn</td>
<td>5426.9</td>
</tr>
<tr>
<td>Cherries</td>
<td>5005.4</td>
</tr>
</tbody>
</table>

**Includes crops with more than 5000 acres**

Acreage is based on CDL pixel counts and are not official estimates.
Metadata

CLASSIFICATION INPUTS:
- DATE 20150101 PATH/ROW BPC
- DATE 20150107 PATH/ROW AC7
- DATE 20150106 PATH/ROW BDF
- DATE 20150101 PATH/ROW CS0
- DATE 20150107 PATH/ROW D5D
- DATE 20150303 PATH/ROW F0G
- DATE 20150304 PATH/ROW F68

LANDSAT 8 OLI/TIRS DATE 20150423 PATH 021 ROW 029 28-40
LANDSAT 8 OLI/TIRS DATE 20150423 PATH 029 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150430 PATH 029 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150521 PATH 021 ROW 029 28-40
LANDSAT 8 OLI/TIRS DATE 20150523 PATH 021 ROW 029 28-40
LANDSAT 8 OLI/TIRS DATE 20150617 PATH 020 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150710 PATH 021 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150712 PATH 019 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150712 PATH 019 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150712 PATH 019 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150720 PATH 021 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150722 PATH 021 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150728 PATH 019 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150804 PATH 029 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150813 PATH 020 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150813 PATH 020 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150813 PATH 020 ROW 029 39-59
LANDSAT 8 OLI/TIRS DATE 20150819 PATH 021 ROW 029 39-59

WES, NATIONAL ELEVATION DATASET
WLS01, NATIONAL LAND COVER DATASET 2011 IMPERVIOUSNESS
WLS02, NATIONAL LAND COVER DATASET 2011 TREES CANOPY
WLS03, BNPS AS DATA BASED ON 2010-2014 COGS (INTERNAL USE DATA LAYER)
- DATE 20150423 PATH/ROW BPC
- DATE 20150430 PATH/ROW AC7
- DATE 20150521 PATH/ROW BDF
- DATE 20150523 PATH/ROW CS0
- DATE 20150617 PATH/ROW D5D
- DATE 20150710 PATH/ROW F0G
- DATE 20150712 PATH/ROW F68

TRAINING AND VALIDATION:
- USDA, FARM SERVICE AGENCY 2015 COMMON LAND UNIT DATA
- WLS02, NATIONAL LAND COVER DATASET 2011

Crop-specific covers only: *Correct Accuracy Error Kappa

<table>
<thead>
<tr>
<th>Cover</th>
<th>Attribute</th>
<th>Type</th>
<th>Code</th>
<th>*Correct</th>
<th>Pixels</th>
<th>Accuracy</th>
<th>Error</th>
<th>Kappa</th>
<th>Producer’s Commission</th>
<th>User’s Commission</th>
<th>Cond’t</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td></td>
<td></td>
<td>1</td>
<td>5153</td>
<td>92.98%</td>
<td>7.02%</td>
<td>0.924</td>
<td>91.04%</td>
<td>6.16%</td>
<td>0.913</td>
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<tr>
<td>Cotton</td>
<td></td>
<td></td>
<td>2</td>
<td>69923</td>
<td>97.34%</td>
<td>2.66%</td>
<td>0.866</td>
<td>88.31%</td>
<td>14.65%</td>
<td>0.841</td>
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<tr>
<td>Sorghum</td>
<td></td>
<td></td>
<td>3</td>
<td>2672</td>
<td>94.15%</td>
<td>5.85%</td>
<td>0.900</td>
<td>79.24%</td>
<td>21.10%</td>
<td>0.707</td>
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</tr>
<tr>
<td>Soybeans</td>
<td></td>
<td></td>
<td>4</td>
<td>88460</td>
<td>86.76%</td>
<td>13.24%</td>
<td>0.853</td>
<td>86.82%</td>
<td>13.15%</td>
<td>0.854</td>
<td></td>
</tr>
<tr>
<td>Sunflower</td>
<td></td>
<td></td>
<td>5</td>
<td>28</td>
<td>29.18%</td>
<td>70.82%</td>
<td>0.392</td>
<td>90.96%</td>
<td>9.04%</td>
<td>0.905</td>
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</tr>
<tr>
<td>Peanuts</td>
<td></td>
<td></td>
<td>6</td>
<td>30979</td>
<td>85.50%</td>
<td>14.50%</td>
<td>0.945</td>
<td>84.87%</td>
<td>15.13%</td>
<td>0.862</td>
<td></td>
</tr>
<tr>
<td>Sweet Corn</td>
<td></td>
<td></td>
<td>7</td>
<td>19</td>
<td>43.80%</td>
<td>56.20%</td>
<td>0.393</td>
<td>66.67%</td>
<td>33.33%</td>
<td>0.467</td>
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</tr>
<tr>
<td>Spring Wheat</td>
<td></td>
<td></td>
<td>8</td>
<td>0</td>
<td>0.00%</td>
<td>100.00%</td>
<td>0.000</td>
<td>0.000</td>
<td>100.00%</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Winter wheat</td>
<td></td>
<td></td>
<td>9</td>
<td>1228</td>
<td>32.80%</td>
<td>67.20%</td>
<td>0.319</td>
<td>57.62%</td>
<td>42.38%</td>
<td>0.577</td>
<td></td>
</tr>
<tr>
<td>Hill Crop Wind/h Soybeans</td>
<td></td>
<td></td>
<td>10</td>
<td>25581</td>
<td>67.24%</td>
<td>32.76%</td>
<td>0.669</td>
<td>65.65%</td>
<td>14.44%</td>
<td>0.651</td>
<td></td>
</tr>
<tr>
<td>Rye</td>
<td></td>
<td></td>
<td>11</td>
<td>1378</td>
<td>38.64%</td>
<td>61.36%</td>
<td>0.384</td>
<td>44.97%</td>
<td>55.03%</td>
<td>0.646</td>
<td></td>
</tr>
<tr>
<td>oats</td>
<td></td>
<td></td>
<td>12</td>
<td>1585</td>
<td>40.94%</td>
<td>59.06%</td>
<td>0.460</td>
<td>59.24%</td>
<td>40.76%</td>
<td>0.591</td>
<td></td>
</tr>
<tr>
<td>Millet</td>
<td></td>
<td></td>
<td>13</td>
<td>980</td>
<td>38.24%</td>
<td>61.76%</td>
<td>0.351</td>
<td>60.12%</td>
<td>39.88%</td>
<td>0.600</td>
<td></td>
</tr>
<tr>
<td>Canola</td>
<td></td>
<td></td>
<td>14</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>100.00%</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td></td>
<td></td>
<td>15</td>
<td>37</td>
<td>50.75%</td>
<td>49.25%</td>
<td>0.355</td>
<td>81.82%</td>
<td>18.18%</td>
<td>0.816</td>
<td></td>
</tr>
<tr>
<td>Other Hay/Non-Alttae</td>
<td></td>
<td></td>
<td>16</td>
<td>32515</td>
<td>76.25%</td>
<td>23.75%</td>
<td>0.746</td>
<td>62.47%</td>
<td>37.53%</td>
<td>0.815</td>
<td></td>
</tr>
</tbody>
</table>

Categorisation Code: Land Cover
- "1": Corn
- "2": Cotton
- "3": Rye
- "4": Sorghum
- "5": Soybeans
- "6": Sunflower
- "7": Peanuts
- "8": Tobacco
- "9": Sweet Corn
- "10": Pop or Orn Corn
- "11": Rye

OVERALL ACCURACY* 334,711 75.9% 20.1% 0.766
CDL Applications
CDL Independent Acreage Estimates

### Soybeans - October

- **Reported** = -.15 + 1.01*Classified
- \( r^2 = 0.950 \)

### Dependent (Y) vs. Independent (X)

<table>
<thead>
<tr>
<th>Soybeans</th>
<th>Enumerated JAS Segments</th>
<th>CDL Classified Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>227</td>
<td>273</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wheat</th>
<th>Enumerated JAS Segments</th>
<th>CDL Classified Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>337</td>
<td>541</td>
<td></td>
</tr>
</tbody>
</table>
Cultivated Layer

- Two Categories:
  - Cultivation (planted crops)
  - Non-Cultivation (includes hay, pasture, and rangeland)
- Combine most recent five years of CDL data
- Cultivation is defined as:
  - Any pixel identified as cultivated in two out of the last five years
  - Any pixel identified as cultivated in the most recent year

2020 Cultivated Layer
Based on the 2016-2020 CDLs
Crop Frequency Layers

- Combined CDLs from 2008 to most recent year
- Frequency is defined as:
  - the number of years a pixel was classified as a certain crop in the time range, regardless of consecutive years
- Available for 4 commodities:
  - Corn
  - Cotton
  - Soybeans
  - Wheat
Crop Frequency Layers

Corn & Wheat
Planting Frequency Data Layers 2008 - 2014
Primary Sampling Units (PSUs) percent cultivation calculated from the CDL-based Cultivated Layer

PSUs labeled with a stratum category
June Area Survey (JAS) Imputation

Predicting crop types using rotation patterns
• Estimate crop type and field area for June Area Survey Sample
• Intended to assist for imputation of refusals and inaccessibles
• Incorporate predicted cropland information, in addition to historic CDLs
• Used in the 2021 JAS – June Area Tool
Disaster Monitoring

- Monitor agricultural disasters in near-real time using geospatial and remotely sensed data including:
  - Synthetic Aperture Radar (SAR) data for flooding/inundation detection
  - Wind and fire geospatial data for hurricane wind speed and wildfire analysis
  - Land cover data (CDL, Cultivated Layer, and pasture/hay layer) for land cover analysis

CDL Users
Useful Links

CroplandCROS

CroplandCROS (cropcros.azurewebsites.net)

Instructional Videos

https://pdienterprise.azurecloudgov.us/portal/apps/sites/#/cropcros/pages/instructional-videos

Cropland Data Layer Video

https://youtu.be/vOAuMkprG7k

Remote Sensing Tutorial

https://experience.arcgis.com/experience/bb29798ed04f40eb9801d2563f5383b2/
Thank You

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Claire G. Boryan, PhD
Claire.Boryan@usda.gov

U.S. Department of Agriculture (USDA)
National Agricultural Statistics Service (NASS)