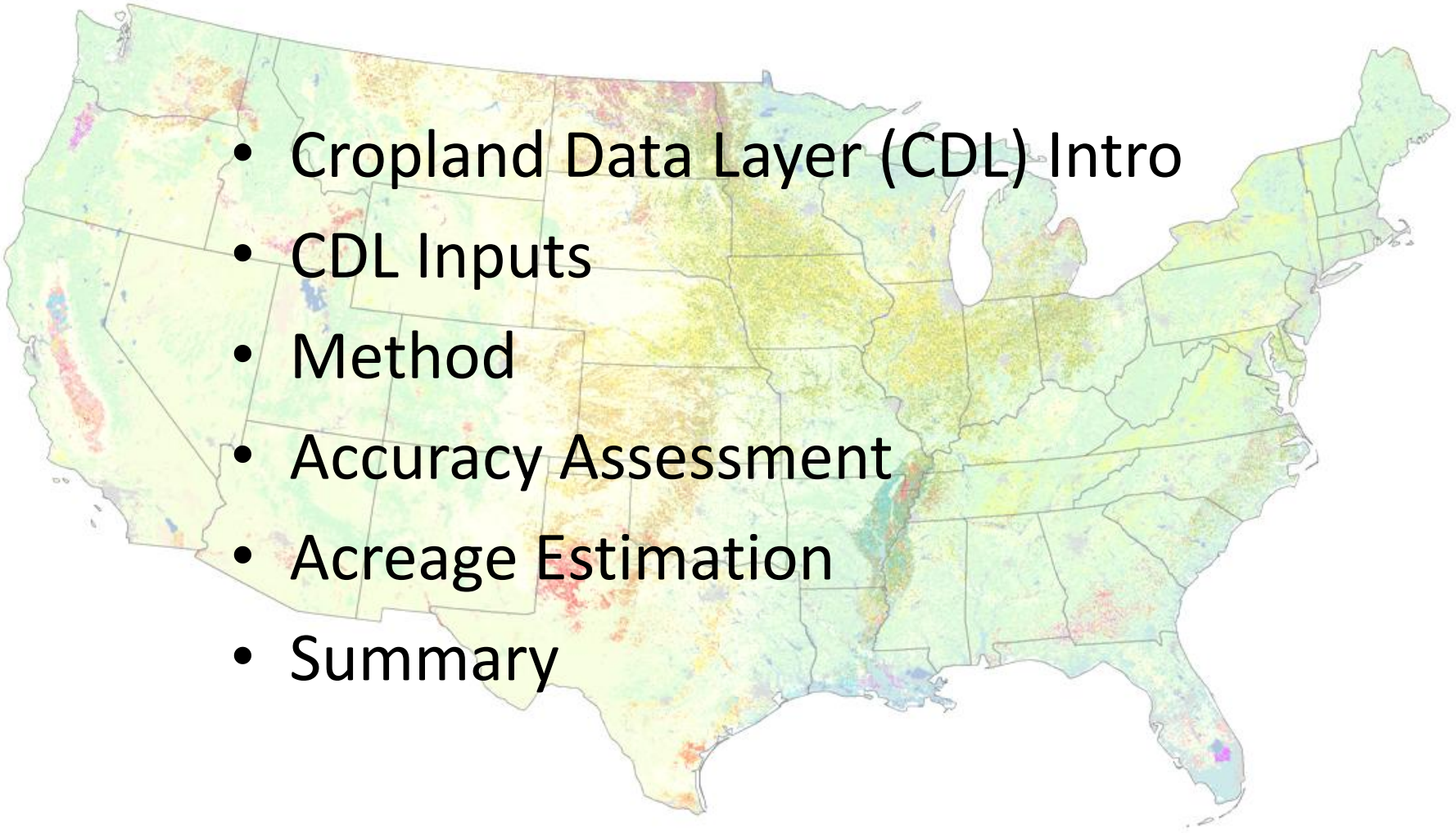
U.S. National Agricultural Land Cover Monitoring

Rick Mueller

USDA/National Agricultural Statistics Service

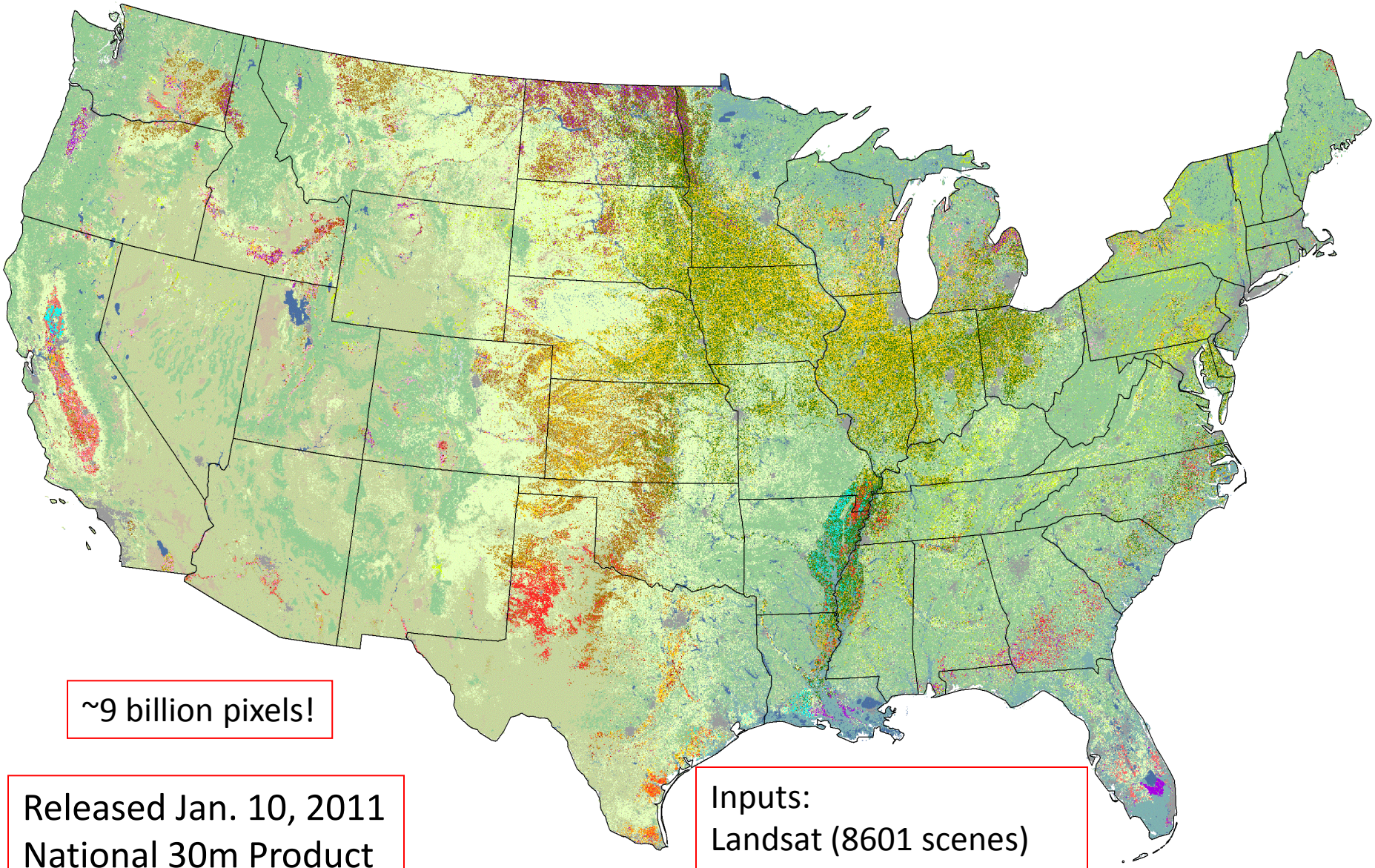
IEEE IGARSS July 28, 2011

Agenda



- Cropland Data Layer (CDL) Intro
- CDL Inputs
- Method
- Accuracy Assessment
- Acreage Estimation
- Summary

2010 Cropland Data Layers

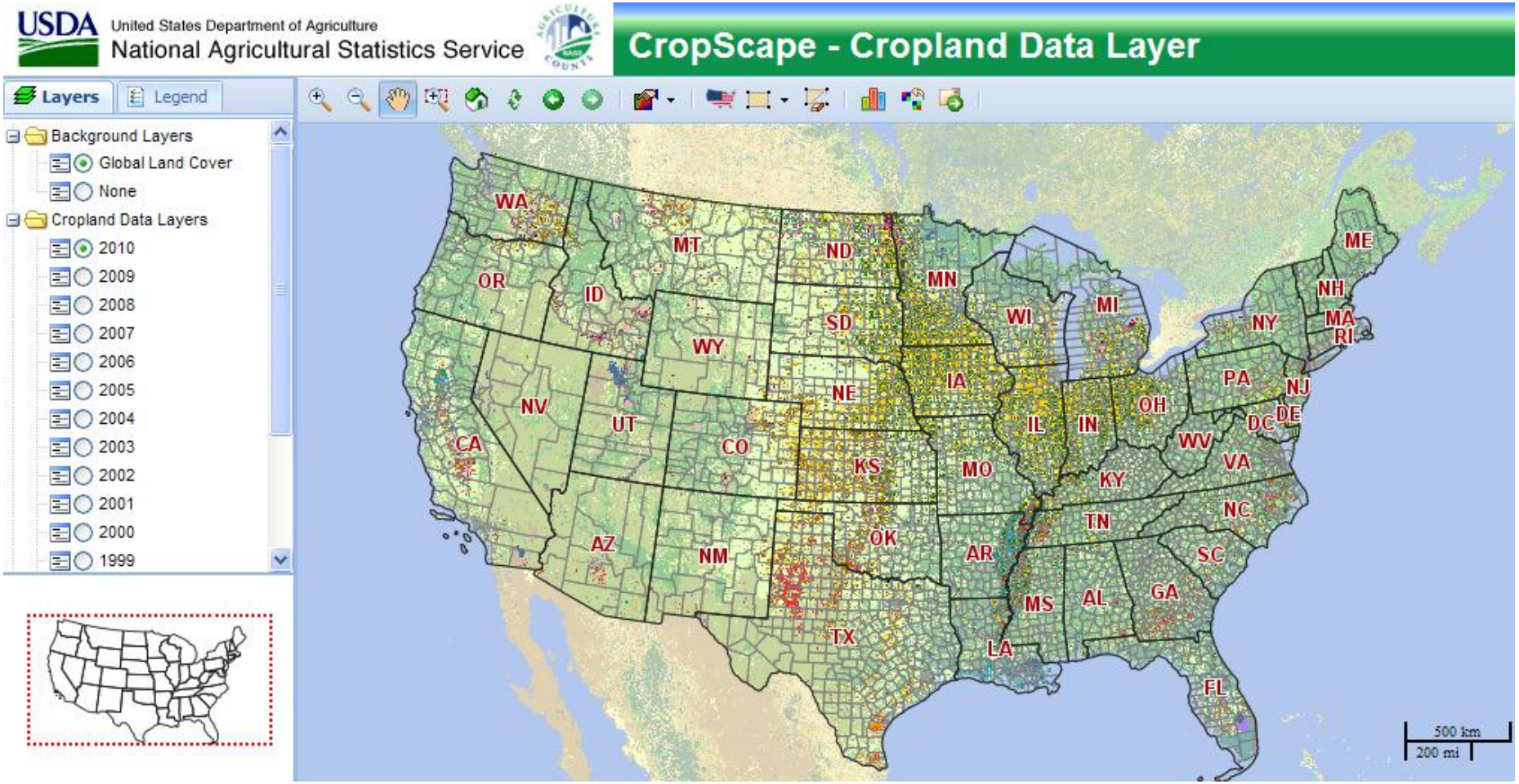


~9 billion pixels!

Released Jan. 10, 2011
National 30m Product

Inputs:
Landsat (8601 scenes)
AWiFS (1194 scenes)

http://nassdata.gmu.edu/CropScape



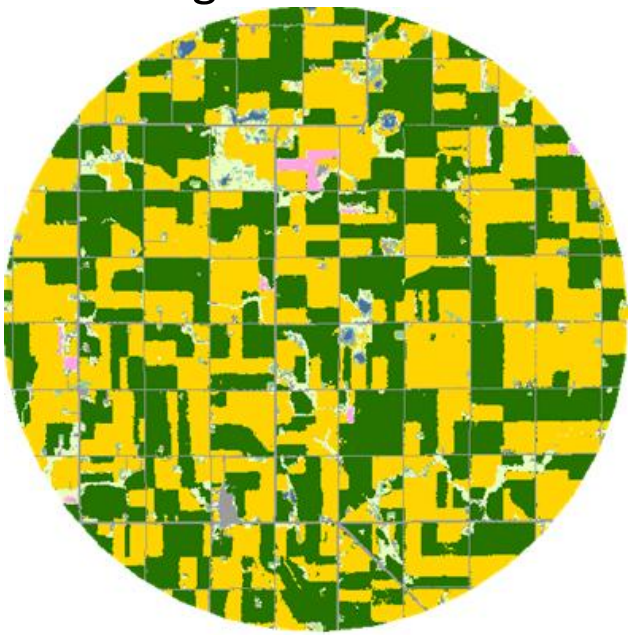
Harmonize ALL historical CDL products to standards:
color scheme, categories, projection, metadata

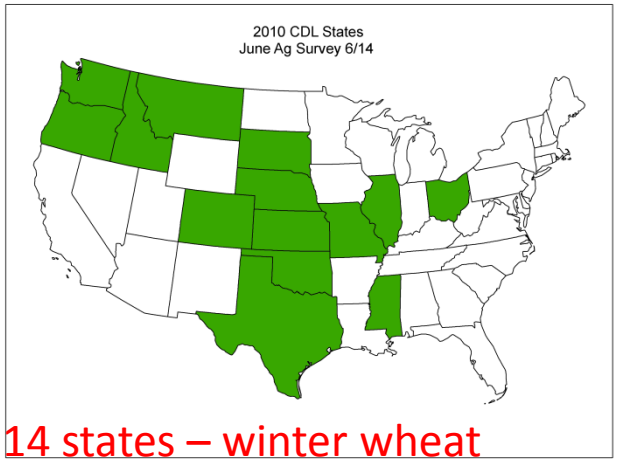
Cropland Data Layer (CDL) Objectives

- *Annually* cover major crops for conterminous United States
- Potential adjusted Ag Census @ .22 acre/pixel scale

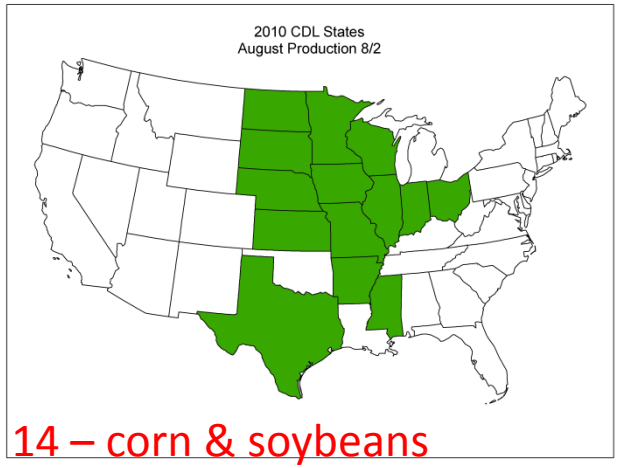
- Deliver in-season remote sensing acreage estimates
  - For June, August, September, and October Official Reports
  - Update planted area/survey variance reduction
  - Reduce respondent burden
  - Basis for crop progress/condition/yield program monitoring

- Provide timely, accurate, useful estimates
  - Measurable error
  - Unbiased/independent estimator
  - State, District, County

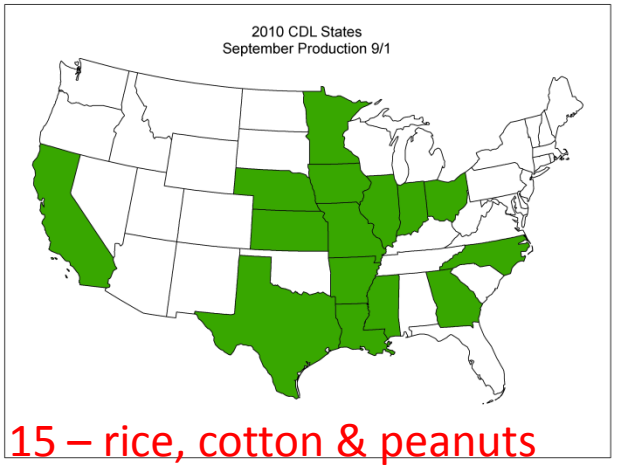




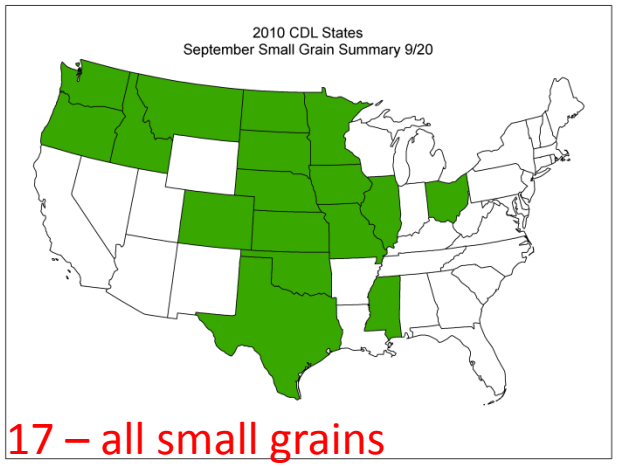
14 states – winter wheat



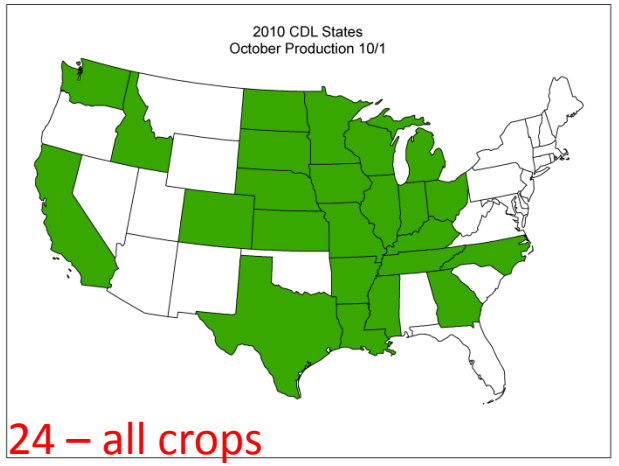
14 – corn & soybeans



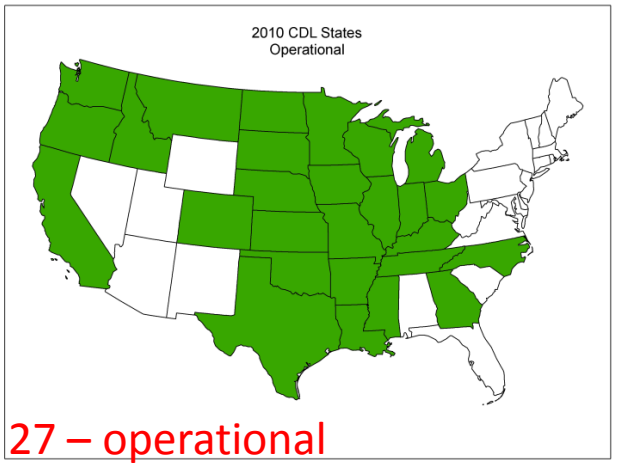
15 – rice, cotton & peanuts



17 – all small grains

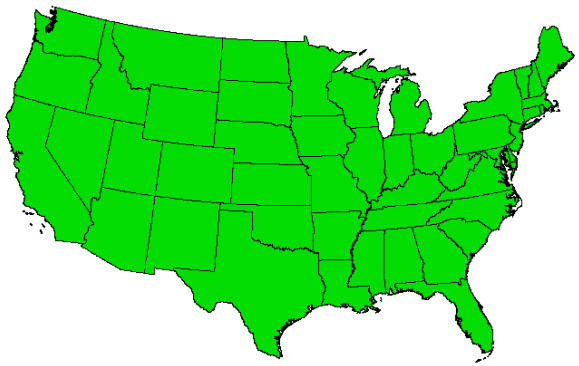


24 – all crops



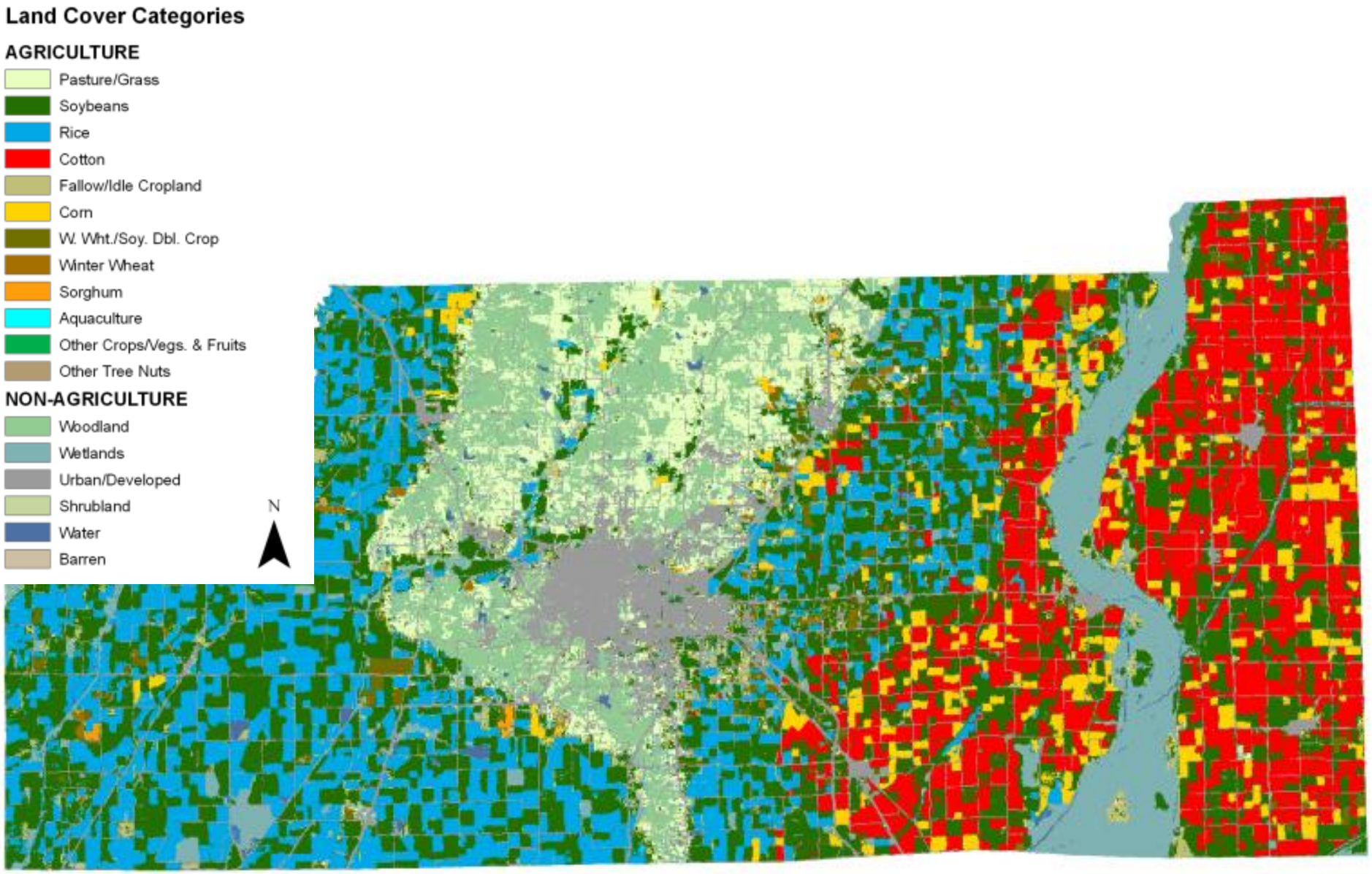
27 – operational

Cropland Data Layer 2010 in-season production @ 56m



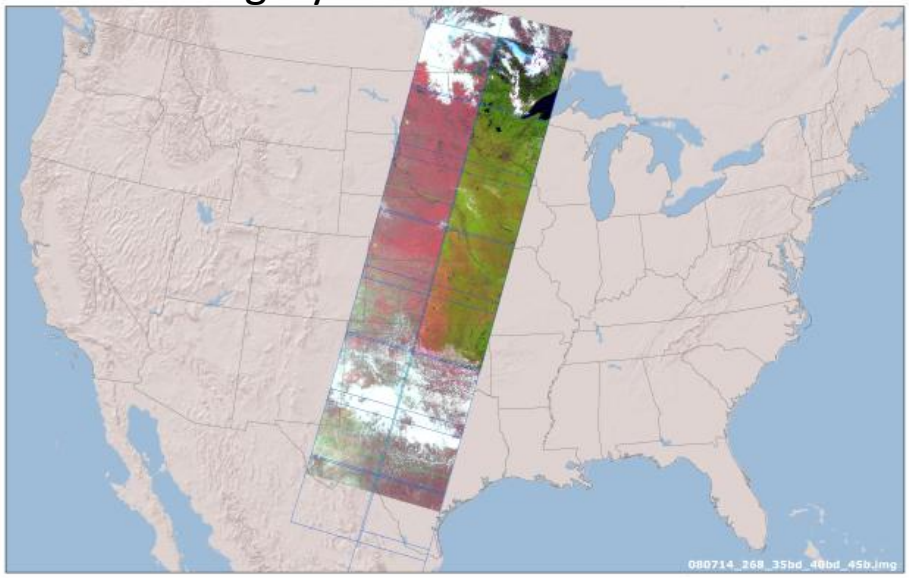
48 states
post season
@ 30m

2010 Craighead County Arkansas

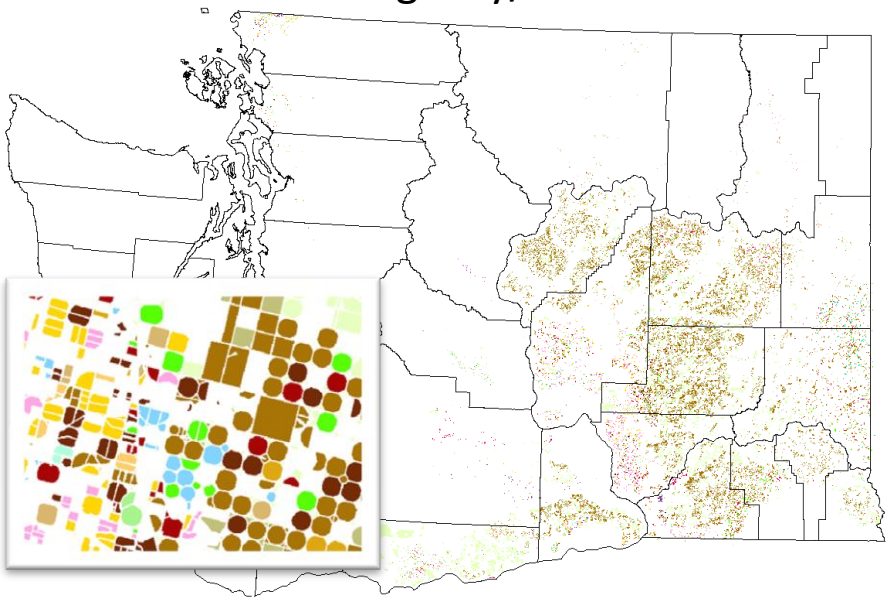


2010 Cropland Data Layer Inputs

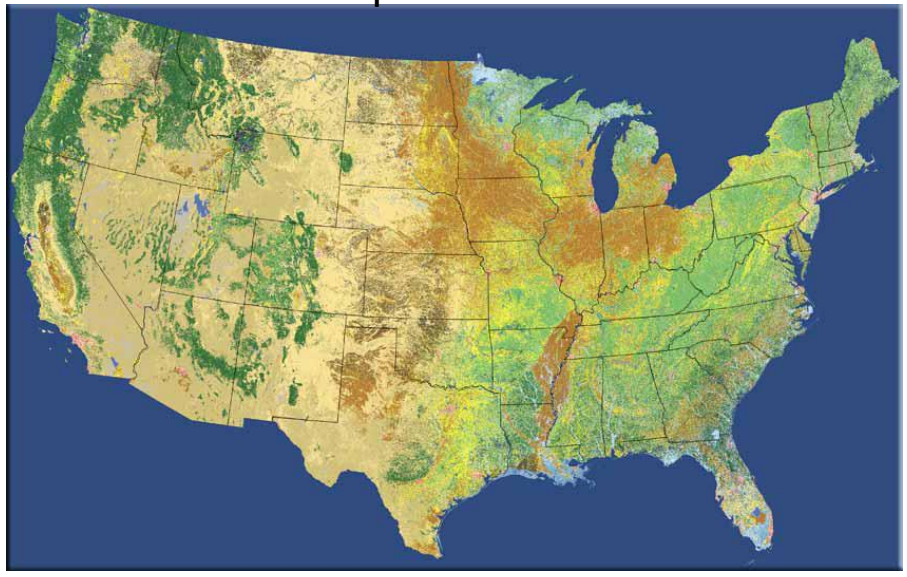
Satellite Imagery - AWiFS & Landsat TM



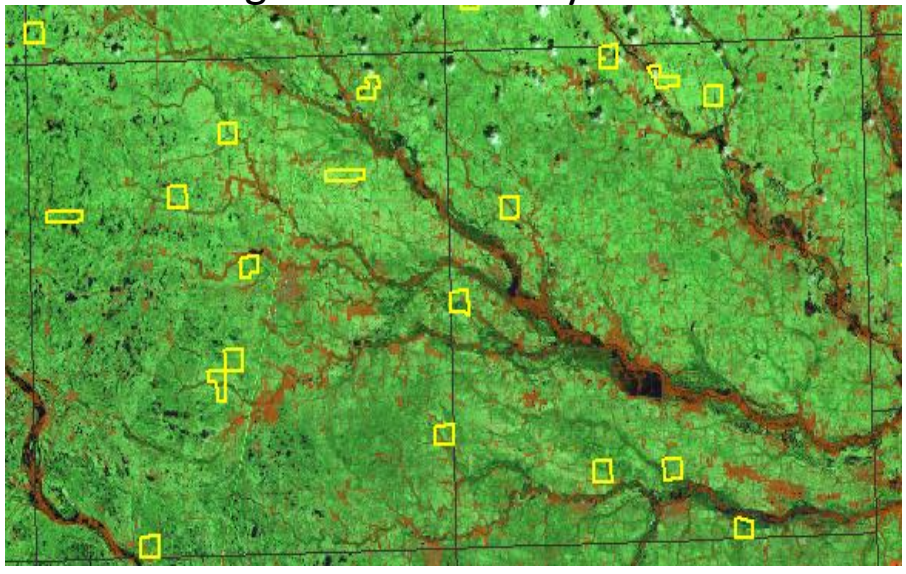
USDA Farm Service Agency/Common Land Unit



NLCD & Derivative products



NASS June Agricultural Survey



Ground Truth – Land Cover

Agriculture Ground Truth

Provided by Farm Service Agency

- Identifies known fields and crops

Divide known fields into 2 sets

- 70% used for training software
- 30% used for validating results

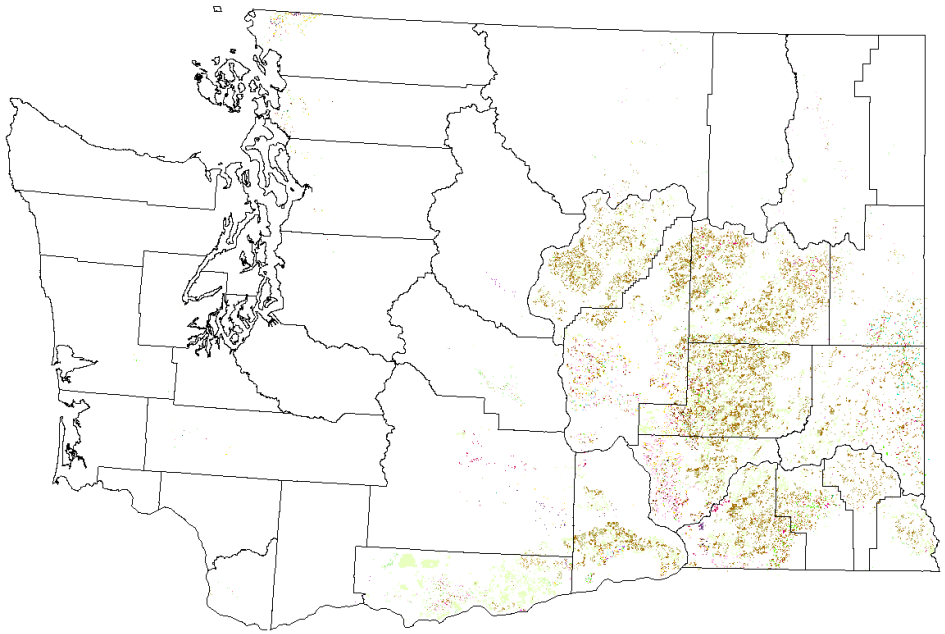
Non-Agriculture Ground Truth

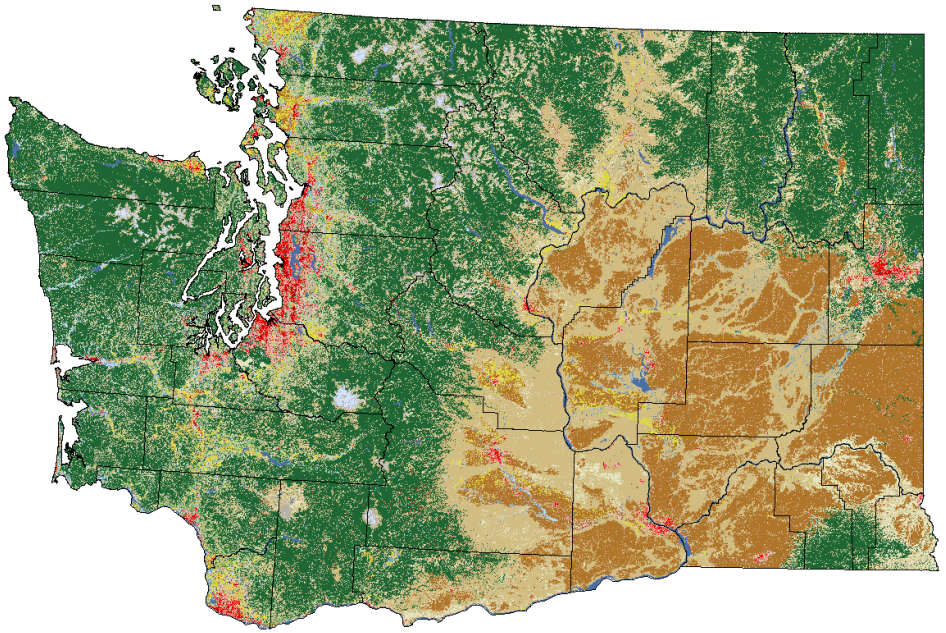
U.S. Geological Survey

- National Land Cover Dataset

Identifies urban infrastructure and non-agriculture land cover

- Forest, grass, water, cities



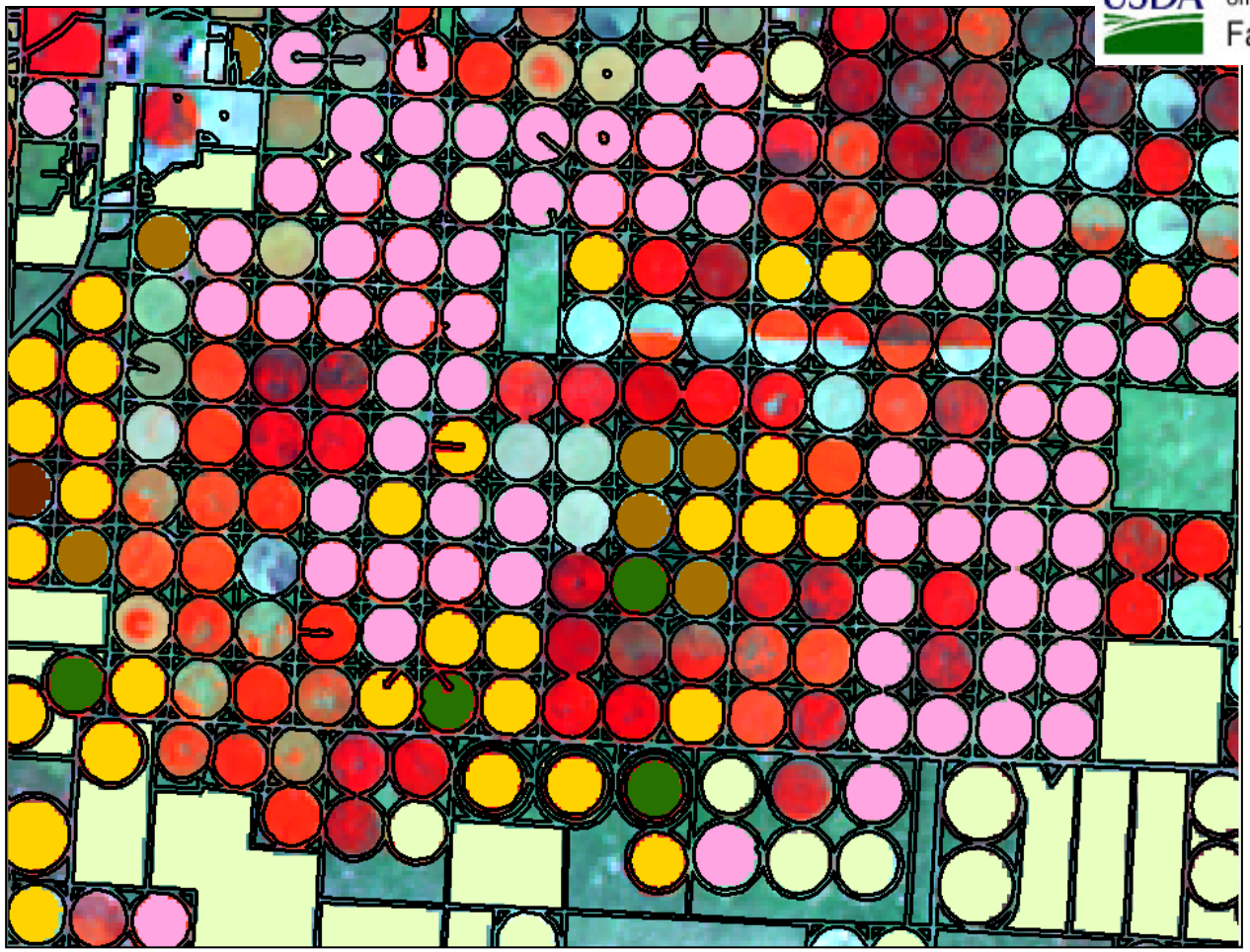


Satellite Data with Farm Service Agency Common Land Unit (CLU) Polygons

USDA United States Department of Agriculture
Farm Service Agency

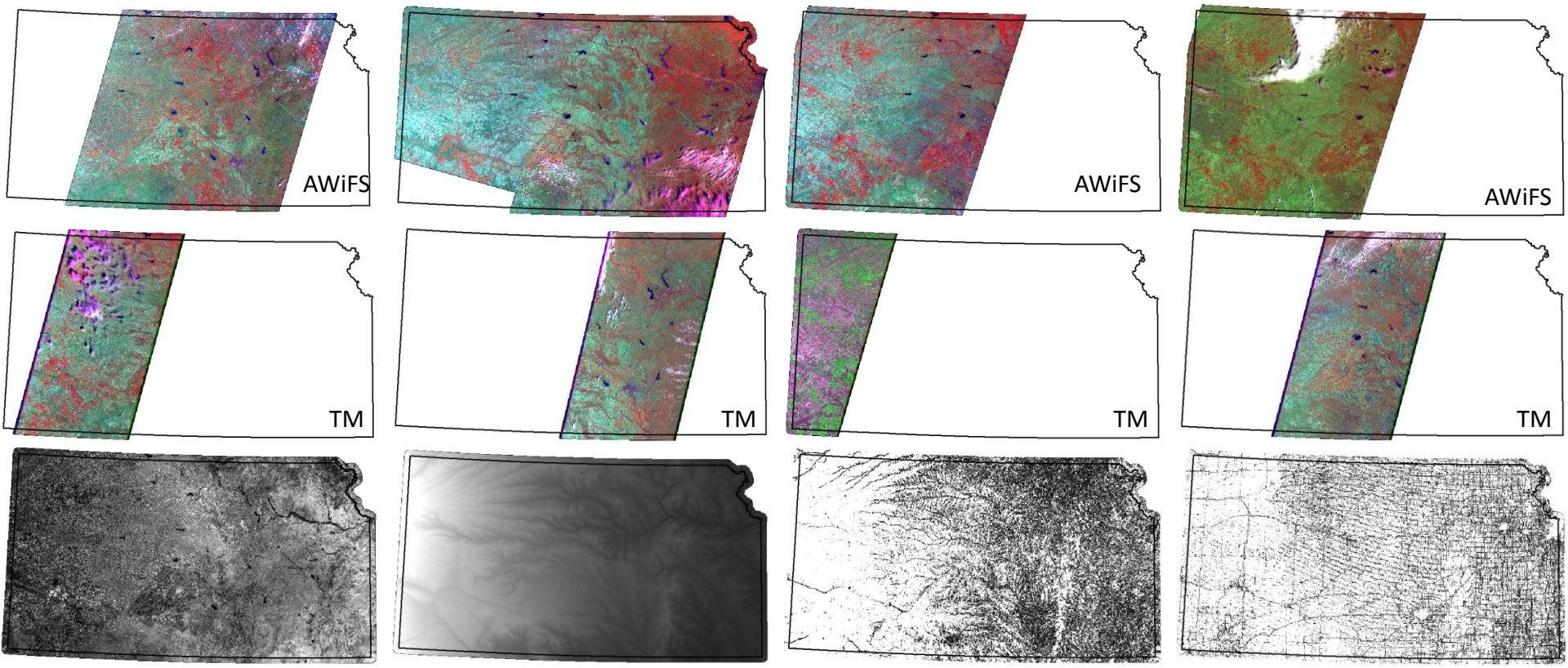
Satellite Data with Farm Service Agency CLUs Overlay

USDA United States Department of Agriculture
Farm Service Agency



Corn - Soybean - Winter Wheat - Alfalfa -

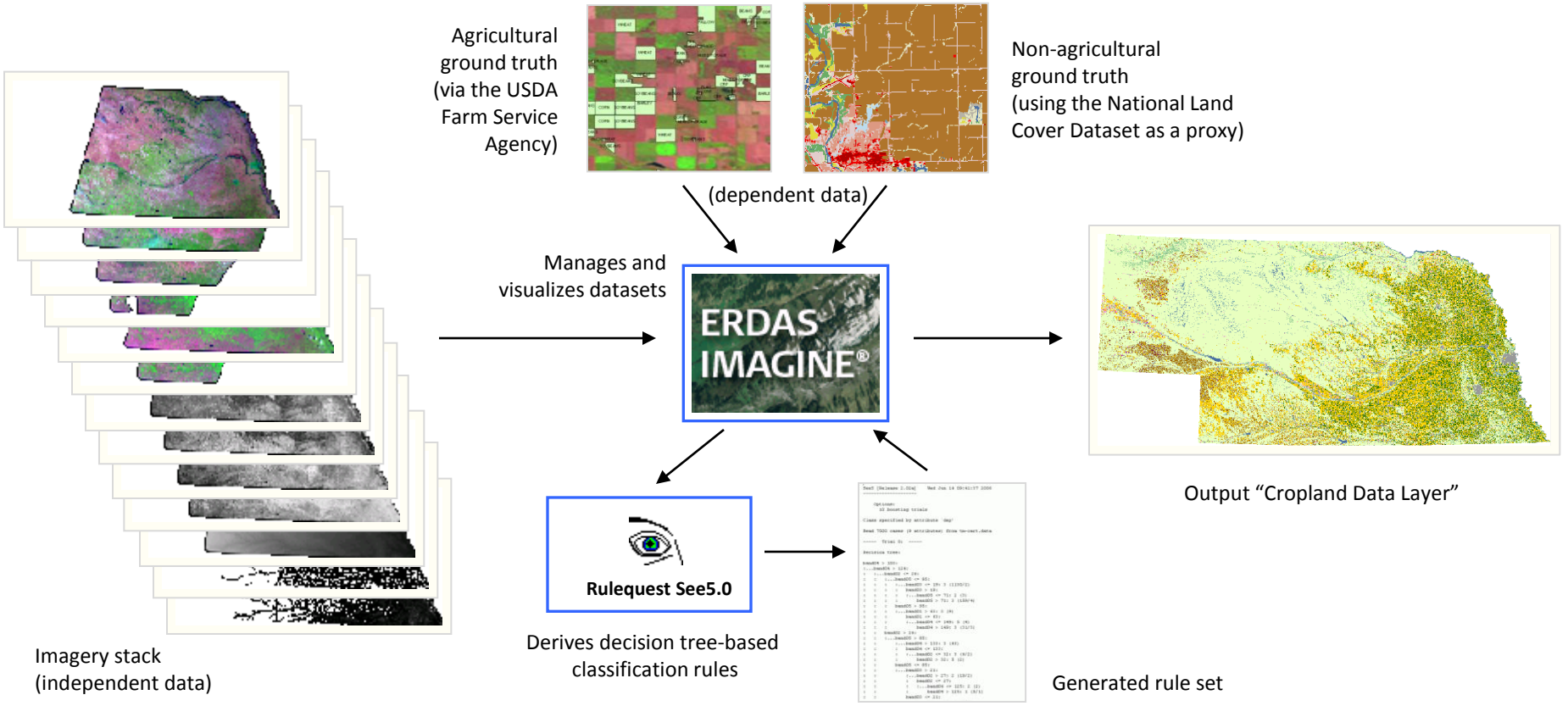
Kansas 2010 CDL Input Layers



Scenes of data actually used: 24 AWiFS, 13 Landsat TM, 2 MODIS NDVI, DEM, Canopy, and Impervious

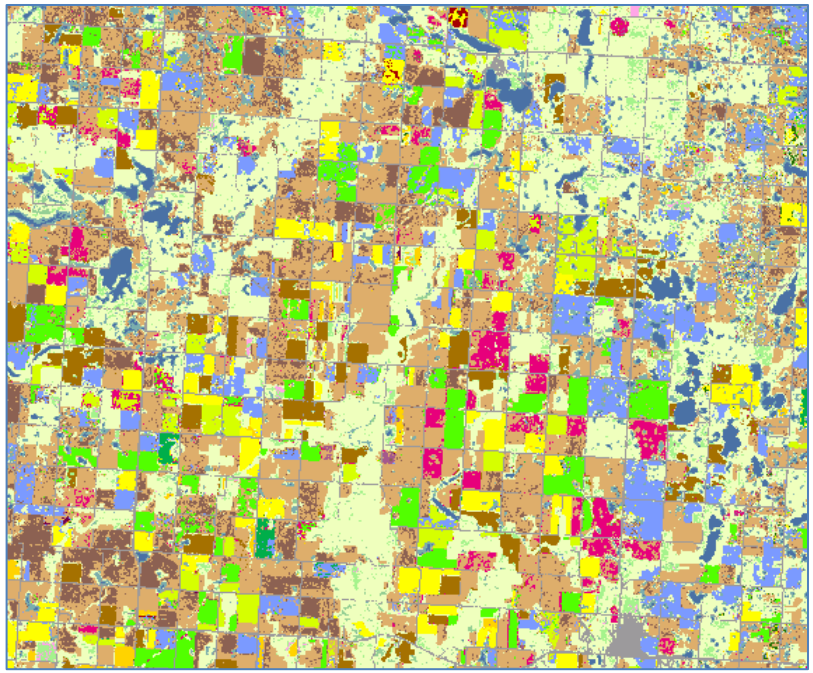
Classification Methodology Overview

1) "Stack" Landsat, Landsat-like data, and ancillary data layers within a raster GIS
2) Sample spatially through stack from known ground truth from FSA (ag. categories) and NLCD (non-ag. categories)
3) "Data-mine" those samples using Boosted Classification Tree Analysis to derive best fitting decision rules
4) Apply derived decision rules back to entire input data stack to create full scene classification

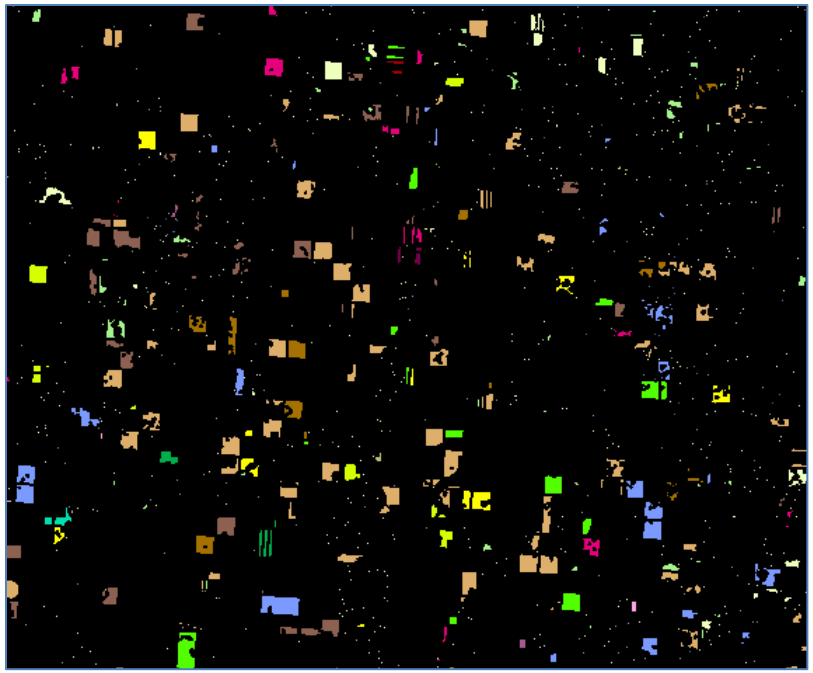


CDL Accuracy Assessment

Each classification tested against independent set of ground truth data to determine overall and within class accuracies



Example classification subset



Example validation subset

Accuracy Statistics

Crop-specific covers only	*Correct	Accuracy	Error	Kappa
OVERALL ACCURACY**	2368649	83.10%	16.90%	0.7891

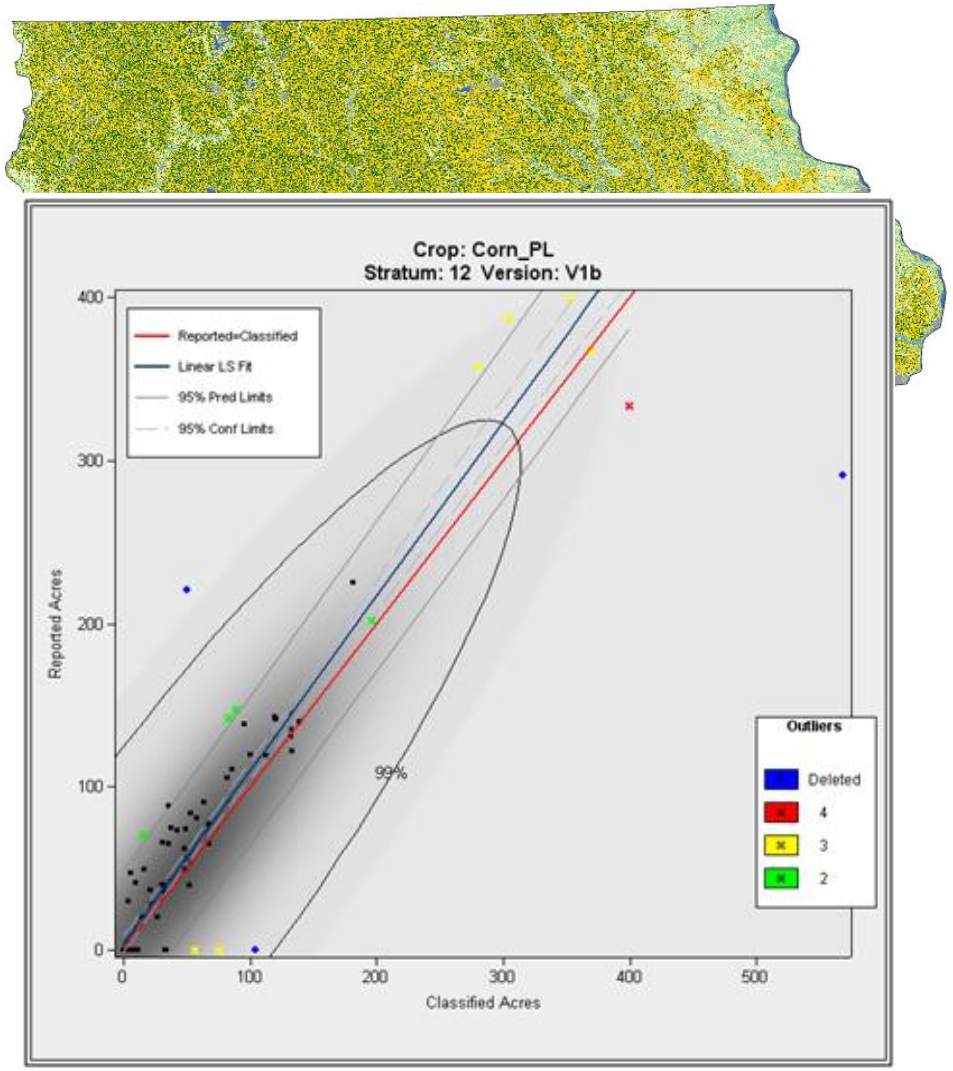
Cover Type	Attribute Code	*Correct Pixels	Producer's Accuracy	Omission Error	Kappa	User's Accuracy	Commission Error	Cond'l Kappa
Corn	1	460221	93.78%	6.22%	0.9272	94.47%	5.53%	0.9351
Sorghum	4	63253	57.82%	42.18%	0.5677	77.37%	22.63%	0.7660
Soybeans	5	1870	48.85%	51.15%	0.4882	94.02%	5.98%	0.9401
Sunflower	6	26389	61.28%	38.72%	0.6087	74.09%	25.91%	0.7375
Sweet Corn	12	905	54.75%	45.25%	0.5474	92.73%	7.27%	0.9272
Barley	21	7877	66.47%	33.53%	0.6636	71.55%	28.45%	0.7145
Durum Wheat	22	0	n/a	n/a	n/a	0.00%	100.00%	0.0000
Spring Wheat	23	2286	48.46%	51.54%	0.4839	49.02%	50.98%	0.4895
Winter Wheat	24	817165	92.79%	7.21%	0.9030	95.50%	4.50%	0.9389
Rye	27	285	14.57%	85.43%	0.1455	31.39%	68.61%	0.3135
Oats	28	4483	33.63%	66.37%	0.3344	47.41%	52.59%	0.4720
Millet	29	70479	79.66%	20.34%	0.7900	66.96%	33.04%	0.6606
Speltz	30	85	85.00%	15.00%	0.8500	49.13%	50.87%	0.4913
Canola	31	0	n/a	n/a	n/a	0.00%	100.00%	0.0000
Flaxseed	32	0	n/a	n/a	n/a	0.00%	100.00%	0.0000
Safflower	33	577	31.26%	68.74%	0.3120	19.97%	80.03%	0.1992
Alfalfa	36	174154	72.85%	27.15%	0.7109	85.82%	14.18%	0.8472
Other Hay	37	54825	39.87%	60.13%	0.3862	80.78%	19.22%	0.7995
Sugarbeets	41	4381	80.64%	19.36%	0.8061	83.04%	16.96%	0.8301
Dry Beans	42	12029	68.64%	31.36%	0.6844	54.83%	45.17%	0.5459
Potatoes	43	12742	85.17%	14.83%	0.8511	91.00%	9.00%	0.9096
Other Crops	44	0	0.00%	100.00%	0.0000	n/a	n/a	n/a
Misc. Vegs. & Fruits	47	0	n/a	n/a	n/a	0.00%	100.00%	0.0000
Watermelons	48	25	6.35%	93.65%	0.0634	39.68%	60.32%	0.3968

Producer's Accuracy: relates to the probability that a ground truth pixel will be correctly mapped and measures errors of omission.
Errors of Omission: occur when a pixel is excluded from the correct category
User's Accuracy: indicates the probability that a pixel from the classification actually matches the ground truth data and measures errors of commission
Errors of Commission: occur when a pixel is included in an incorrect category

Regression-based Acreage Estimator

Acreage not just about counting pixels

Simple Linear Regression



Regression used to relate categorized pixel counts to the ground reference data

- **(X) – Cropland Data Layer (CDL) classified acres**
- **(Y) – June Agricultural Survey (JAS) reported acres**

Outlier segment detection - removal from regression analysis

Using regression results in estimates reduces error rates over using JAS alone

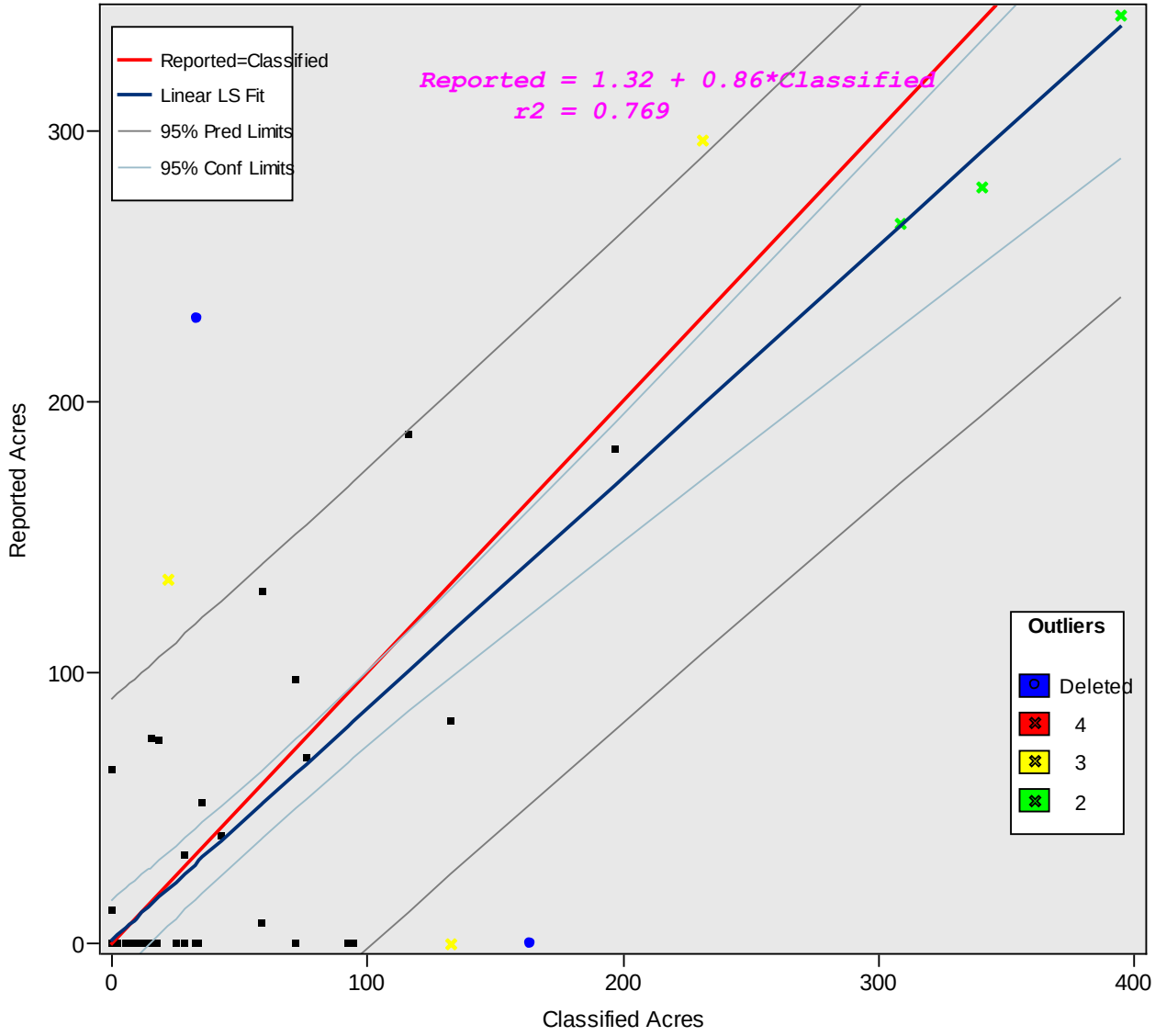
Estimate 17 crops in 39 states

R^2

Jun – 0.769

Washington - June

Winter Wheat – Stratum 11

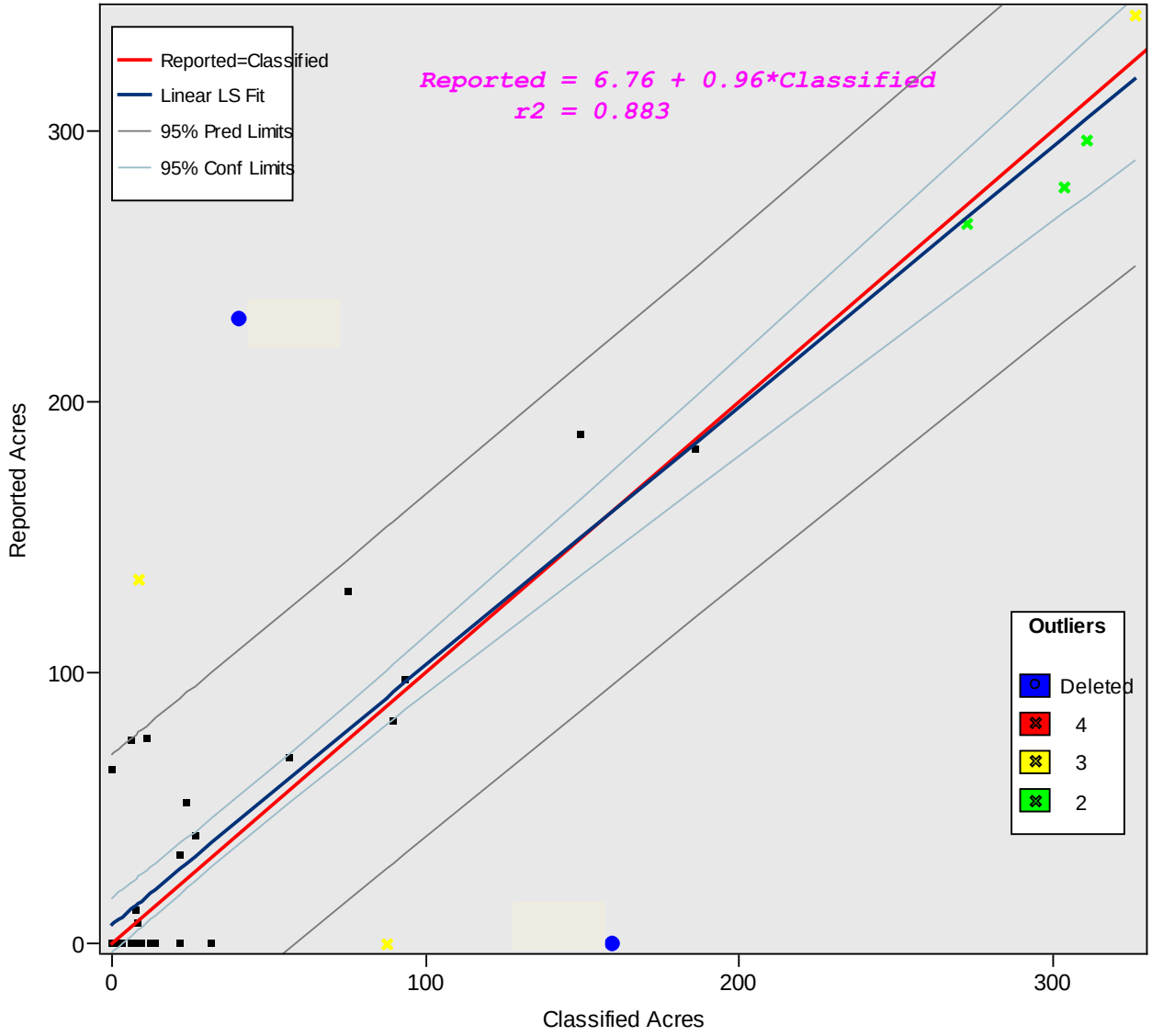


IMG file description: _class_

R^2
Jun – 0.769
Sep – 0.883

Washington - September

Winter Wheat – Stratum 11



IMG file description: _class_

Washington - October

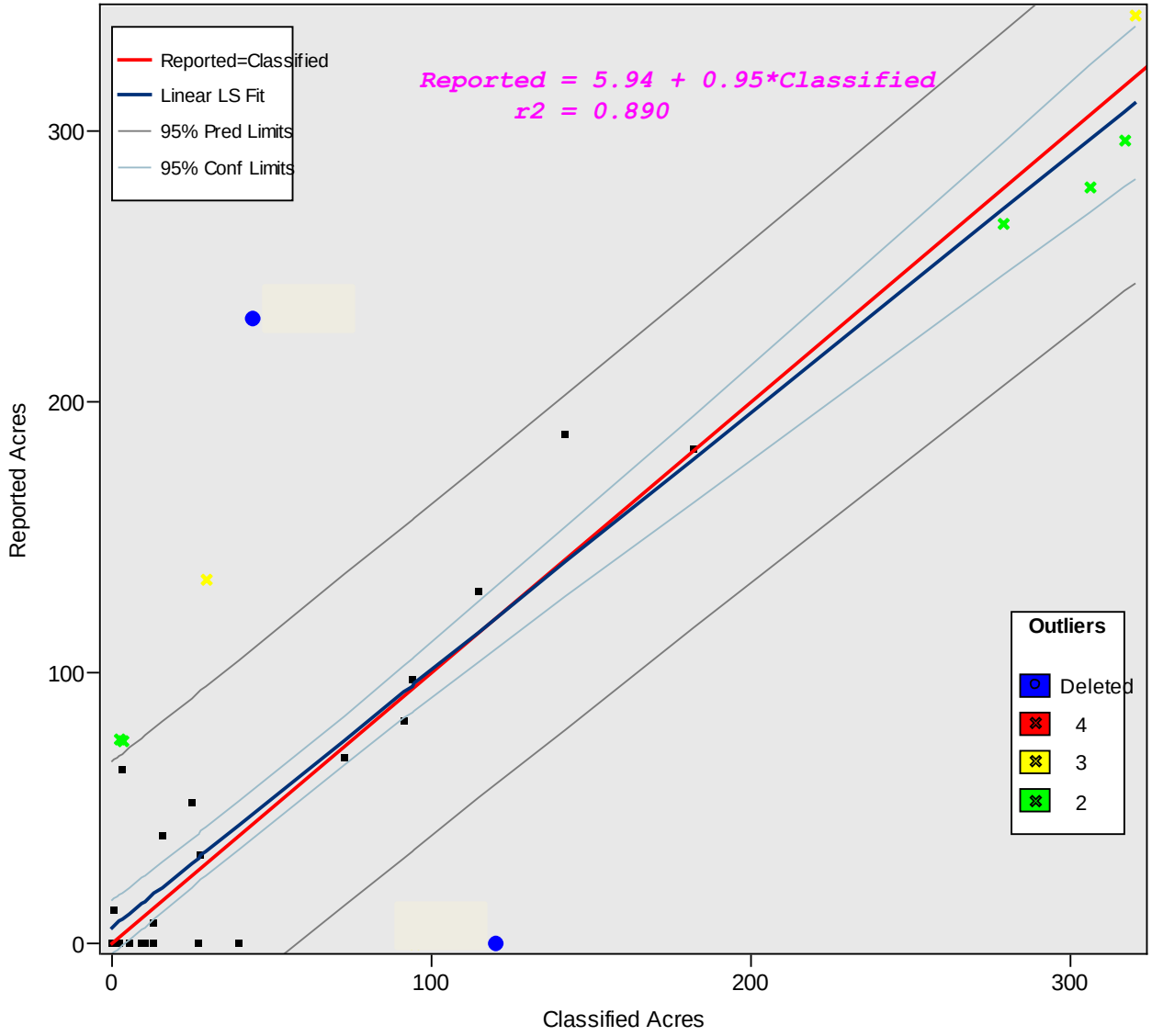
Winter Wheat – Stratum 11

R^2

Jun – 0.769

Sep – 0.883

Oct – 0.890



IMG file description: _wsda_

Cropland Data Layer Summary

- **Operational Program**
  - Timely estimate delivery
  - Measureable statistical error
  - Set national/regional/county acreage estimates
- **Components**
  - AWiFS/Landsat imagery
  - Farm Service Agency/Common Land Unit
  - USGS NLCD/ancillary layers
  - June Agricultural Survey
- **Leverage**
  - CDL program paramount to other NASS geospatial activities
  - Partnerships with cooperating agencies critical for success
  - Heavy reliance on satellites and information technology
- **Distribution**
  - CropScape Portal
  - NRCS Data Gateway

Thank you!

Spatial Analysis Research Section
USDA/NASS R&D Division

nassgeodata.gmu.edu/CropScape