David M. Johnson
Geographer

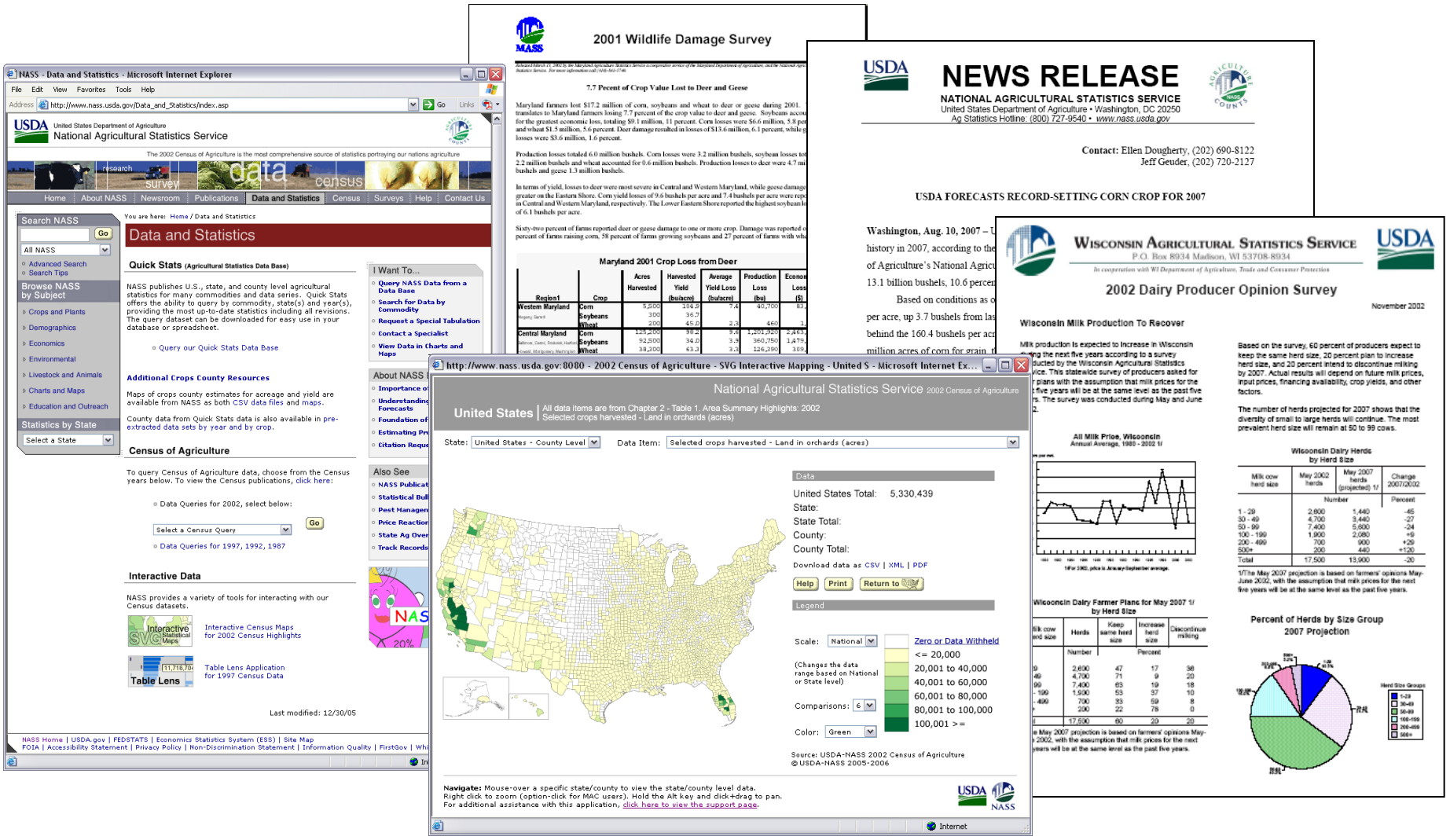
United States Department of Agriculture
National Agricultural Statistics Service
Research and Development Division
Spatial Analysis Research Section

An Overview of USA Crop Production Monitoring and the Role of Satellite Remote Sensing

International Meeting on Food Security, Earth Observations and Agricultural Monitoring
November 21, 2013, Secure World Foundation, Brussels, Belgium

National Agricultural Statistics Service (NASS)

Provider of timely, accurate, and useful statistics in service to U.S. agriculture



www.nass.usda.gov

Continuous Agricultural Statistics Programs

Crops:

grains
hay
oilseeds
cotton
tobacco
potatoes
sugar
other field crops
citrus fruit
non-citrus fruit
nuts
vegetables
floriculture

crop progress

acreage
- prospective plantings
- planted
- harvested

yield & production
- forecasts
- final
- by utilization

stocks
disposition

processing

prices received by farmers

agricultural chemical use

Livestock:

cattle
hogs
sheep
goats
equine
poultry
milk & dairy products
aquaculture
bees & honey
mink

inventory
- total
- by class
- births
- deaths
- predator losses

marketings
slaughter

production/disposition
- meat
- other products (milk, dairy products, wool, mohair, eggs, honey, etc.)

prices received by farmers
inventory/production values

Other:

number of farms
land in farms

land values
cash rents

agricultural labor
- number of workers
- hours worked
- wages paid

cold storage
- holdings
- capacity

cash receipts

production expenditures

weekly ~ monthly ~ quarterly ~ annually

Agricultural Census

total area & land use
irrigation
land in government programs
field & forage crops
fruits, nuts & berries
vegetables & melons
horticultural specialties

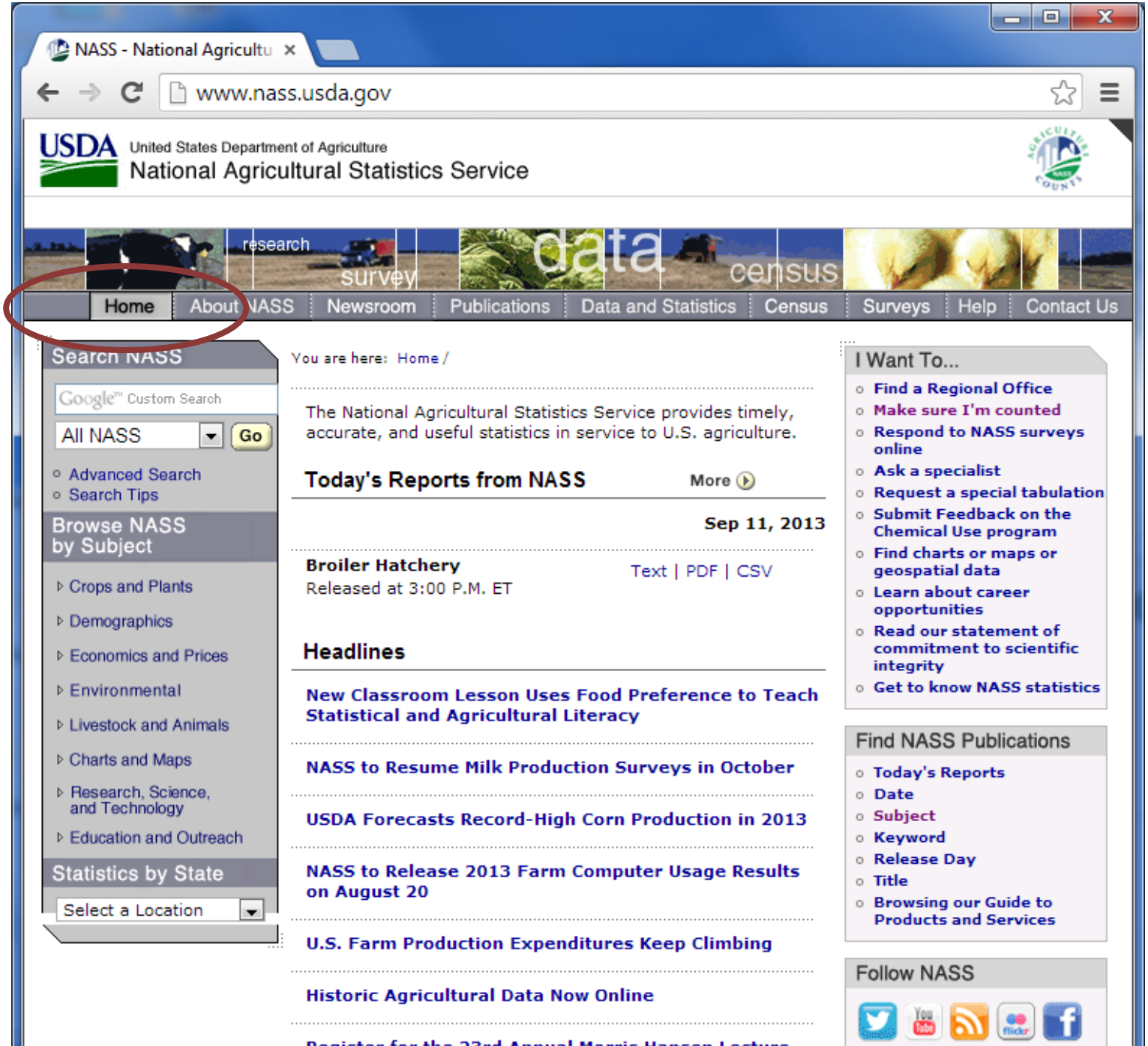
livestock & poultry
animal specialties
aquaculture
production contracts
gross value of sales
direct sales to consumers

government loans
government program payments
farm-related income
grain storage capacity
operator characteristics
farm organization

fertilizer & chemical use
farm production expenses
inventory & value of machinery & equipment
market value of land & buildings
farm labor

~ years ending in “2” & “7” ~

inventories as of December 31 ~ production, sales & other information for calendar year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Today's Reports from NASS
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Sep 11, 2013
Broiler Hatchery
Released at 3:00 P.M. ET
Text | PDF | CSV
Headlines
New Classroom Lesson Uses Food Preference to Teach Statistical and Agricultural Literacy
NASS to Resume Milk Production Surveys in October
USDA Forecasts Record-High Corn Production in 2013
NASS to Release 2013 Farm Computer Usage Results on August 20
U.S. Farm Production Expenditures Keep Climbing
Historic Agricultural Data Now Online
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Make sure I'm counted
Respond to NASS surveys online
Ask a specialist
Request a special tabulation
Submit Feedback on the Chemical Use program
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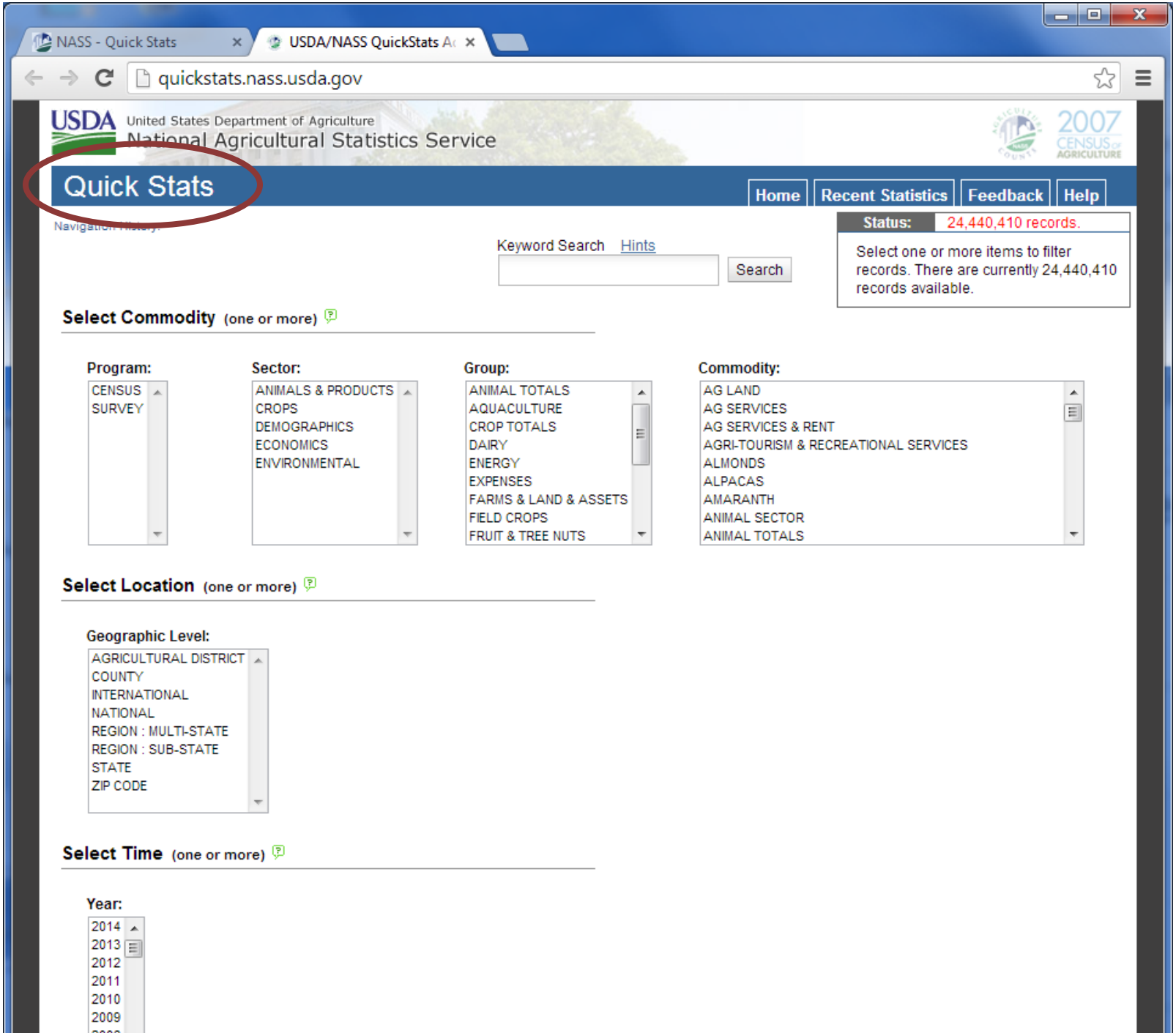
NASS - Quick Stats
USDA/NASS QuickStats A
quickstats.nass.usda.gov
USDA United States Department of Agriculture
National Agricultural Statistics Service
2007 CENSUS of AGRICULTURE
Quick Stats
Home
Recent Statistics
Feedback
Help
Navigation History
Keyword Search Hints
Search
Status: 24,440,410 records.
Select one or more items to filter records. There are currently 24,440,410 records available.
Select Commodity (one or more)
Program:
CENSUS
SURVEY
Sector:
ANIMALS & PRODUCTS
CROPS
DEMOGRAPHICS
ECONOMICS
ENVIRONMENTAL
Group:
ANIMAL TOTALS
AQUACULTURE
CROP TOTALS
DAIRY
ENERGY
EXPENSES
FARMS & LAND & ASSETS
FIELD CROPS
FRUIT & TREE NUTS
Commodity:
AG LAND
AG SERVICES
AG SERVICES & RENT
AGRI-TOURISM & RECREATIONAL SERVICES
ALMONDS
ALPACAS
AMARANTH
ANIMAL SECTOR
ANIMAL TOTALS
Select Location (one or more)
Geographic Level:
AGRICULTURAL DISTRICT
COUNTY
INTERNATIONAL
NATIONAL
REGION : MULTI-STATE
REGION : SUB-STATE
STATE
ZIP CODE
Select Time (one or more)
Year:
2014
2013
2012
2011
2010
2009


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> State and County Profiles
> 2007 Desktop Data Query Tool
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Email updates: National | State | News
THERE ARE MORE THAN 3 Million FARMERS
0:00 / 0:29
Watch the video, "Strength in Numbers"
Have fun learning about agriculture today and the benefits of responding to NASS surveys.
1/2
Headlines
Latest Tweets
• Final Call for the Agriculture Census
• BLOG: Surveying America's Farmers Online – An Innovation in Collecting Ag Stats
• Grow Your Farm Future with the 2012 Census of Agriculture
• USDA Extends Census Deadline, Reminds Producers It's Not too Late
• Two Weeks Remaining to Respond to 2012 Census of Agriculture
• BLOG: Ag Census Demonstrates Value of Agriculture, Data Critical for Programs and Policies
>>> More...
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MARK YOUR CALENDARS!
Census Data Release in February 2014
Respond Online to the Census
On-Farm Energy Production Survey
Census of Horticultural Specialties
Farm and Ranch Irrigation Survey
Organic Production Survey
Quick Stats
Ag Atlas Maps
Recent Census Years

USDA

Crop Progress

ISSN: 1948-3007

Released September 9, 2013, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

Special Note

NASS's annual September surveys on crops and livestock. In the first two weeks of September, NASS will survey U.S. small grains growers for final production. We will also ask hog producers about their summer pig crop, current inventory, and farrowing intentions for the next six months. The responses will provide the foundation for 2013 production estimates. **Farmers should watch for their survey and be sure to respond. Your information matters!**

Corn Dough – Selected States

[These 18 States planted 92% of the 2012 corn acreage]

State	Week ending			2008-2012 Average
	September 8, 2012	September 1, 2013	September 8, 2013	
	(percent)	(percent)	(percent)	(percent)
Colorado	98	87	96	93
Illinois	100	93	95	96
Indiana	100	91	95	96
Iowa	100	73	86	93
Kansas	100	94	97	99
Kentucky	100	85	92	97
Michigan	93	79	89	89
Minnesota	100	68	85	94
Missouri	100	94	97	97
Nebraska	100	93	98	98
North Carolina	100	100	100	100
North Dakota	100	71	90	88
Ohio	99	91	95	94
Pennsylvania	94	89	93	87
South Dakota	97	90	98	94
Tennessee	100	97	100	100
Texas	97	91	93	97
Wisconsin	94	61	76	86
18 States	99	84	92	94

Acreage

ISSN: 1949-1522

Released June 28, 2013, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

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 slig
the highest planted acreage in the United States since 1936 when an estimated 102 n
expect to harvest 89.1 million acres for grain, up 2 percent from last year.

Soybean planted area for 2013 is estimated at a record high 77.7 million acres, up 1
harvest, at 76.9 million acres, is up 1 percent from 2012 and will be a record high, if
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
planted area, at 42.7 million acres, is 3 percent above last year and up 2 percent fron
about 29.4 million acres are Hard Red Winter, 9.96 million acres are Soft Red Winte
Winter. Area planted to other spring wheat for 2013 is estimated at 12.3 million acre
about 11.7 million acres are Hard Red Spring wheat. The estimated Durum wheat pl
1.54 million acres, down 28 percent from the previous year.

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

Crop Production

ISSN: 1936-3737

Released August 12, 2013, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, United States Department of Agriculture (USDA).

Special Note

USDA's National Agricultural Statistics Service is suspending a number of statistical surveys and reports for the remainder of the fiscal year resulting from reduced funding. Suspended commodity programs impacting the *August Crop Production* report are hops, commercial apples, peaches, pears, and grapes. Check the NASS website at www.nass.usda.gov for any future updates to these programs.

Planted Acreage Update

Survey respondents who reported soybean acreage as not yet planted in Arkansas, Illinois, Iowa, Kansas, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, North Carolina, North Dakota, South Dakota, Tennessee, and Wisconsin during the survey conducted in preparation for the *Acreage* report, released June 28, 2013 were re-contacted in July to determine how many of those acres were planted or still intended to be planted. Acreage estimates in this report reflect this updated information.

Corn Production Up 28 Percent from 2012
Soybean Production Up 8 Percent from 2012
Cotton Production Down 25 Percent from 2012
Winter Wheat Production Down Slightly from July Forecast

Corn production is forecast at 13.8 billion bushels, up 28 percent from 2012. If realized, this will be a new record production for the United States. Based on conditions as of August 1, yields are expected to average 154.4 bushels per acre, up 31.0 bushels from 2012. If realized, this will be the highest average yield since 2009. Area harvested for grain is forecast at 89.1 million acres, unchanged from the June forecast but up 2 percent from 2012.

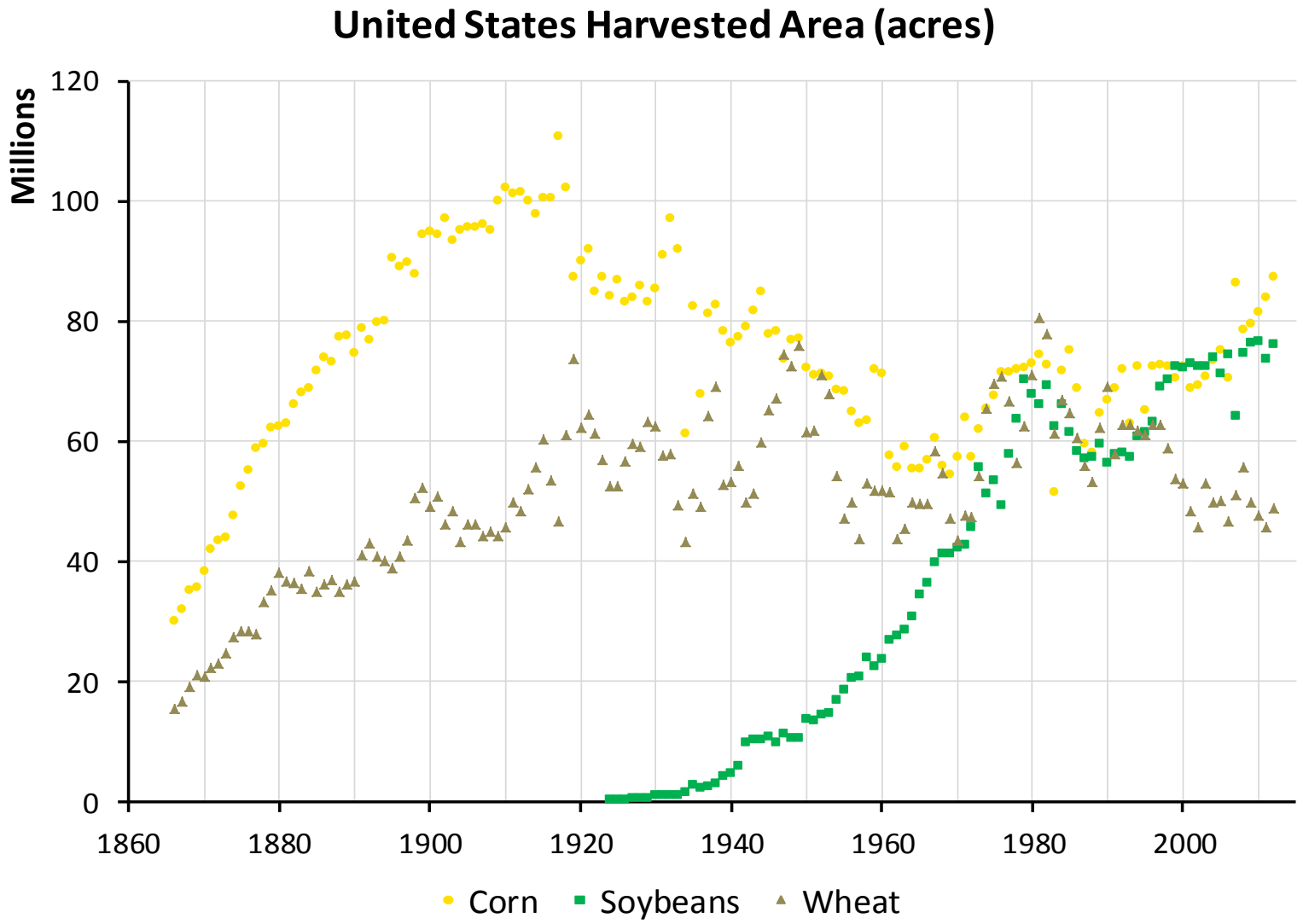
Soybean production is forecast at 3.26 billion bushels, up 8 percent from last year. If realized, production will be the third largest on record. Based on August 1 conditions, yields are expected to average 42.6 bushels per acre, up 3 bushels from last year. If realized, the average yield will be the fifth highest on record. Area for harvest is forecast at 76.4 million acres, down less than 1 percent from June but up slightly from 2012. Planted area for the Nation is estimated at 77.2 million acres, down less than 1 percent from June.

US crop area ranked statistics

Largest crops by area	mil. ha. (2012)
Corn	35.4
Soybeans	30.8
Wheat	19.8
(Winter, spring, durum)	(14.1, 4.9, 0.9)
Hay	22.8
(alfalfa, all other)	(7.0, 15.8)
Cotton	3.8
Sorghum	2.0
Barley	1.3
Rice	1.1

Figures established by a large "area frame" based survey conducted early each June

Area trends of the top US 3 crops



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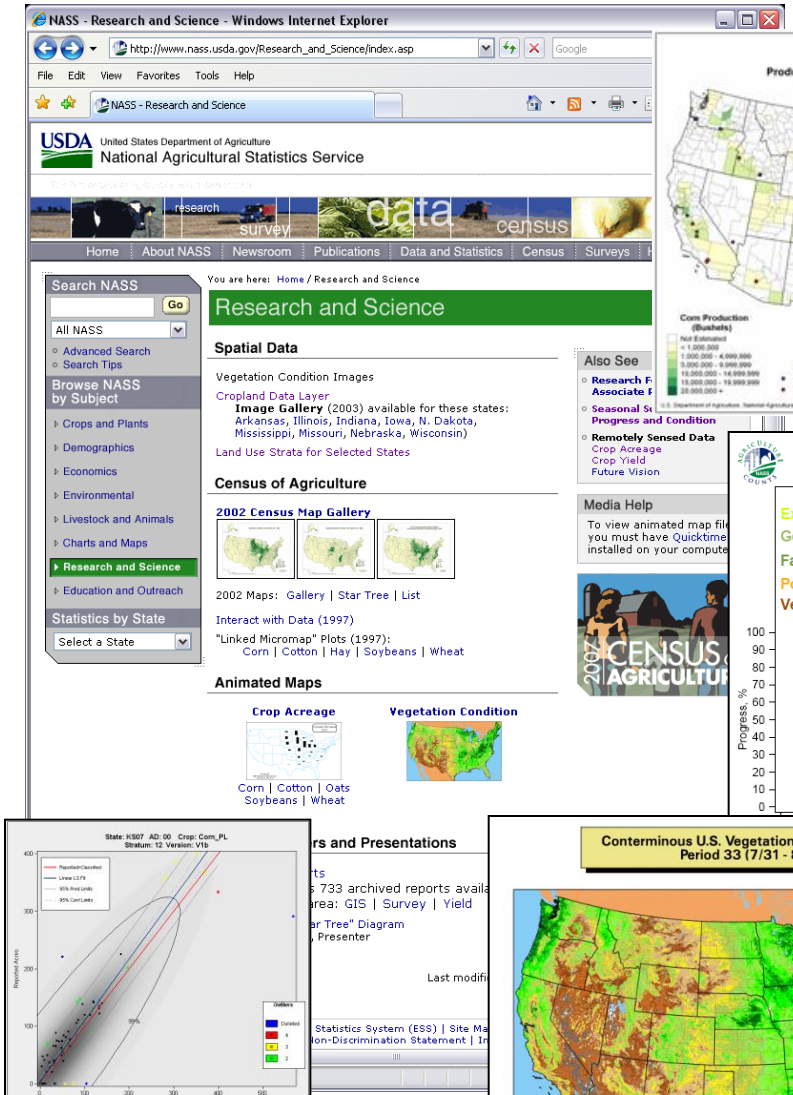
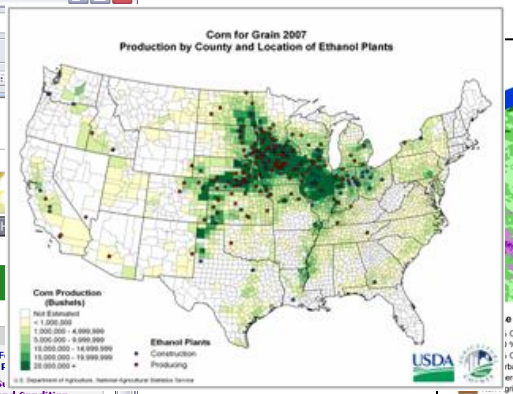
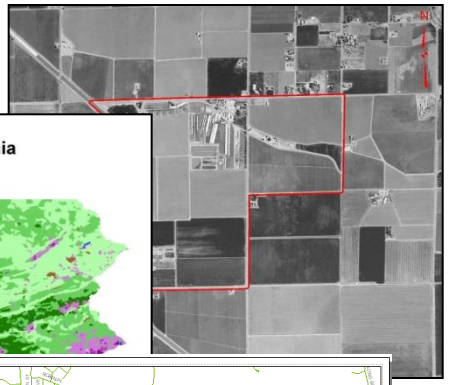
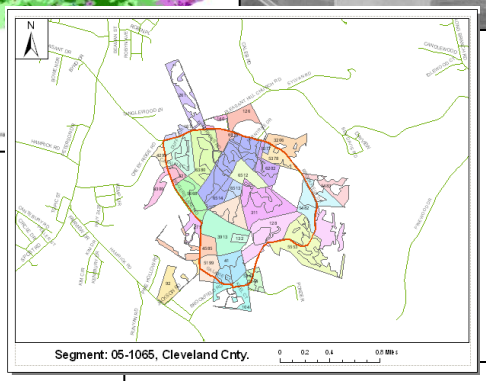
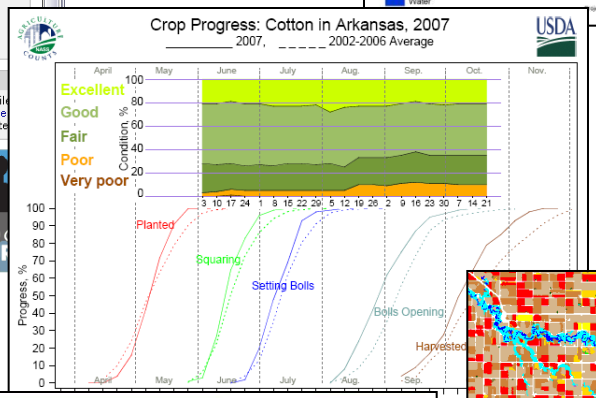
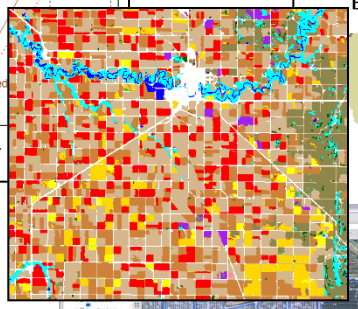


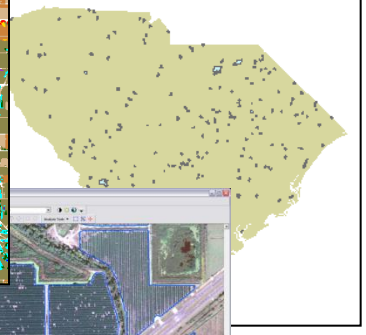


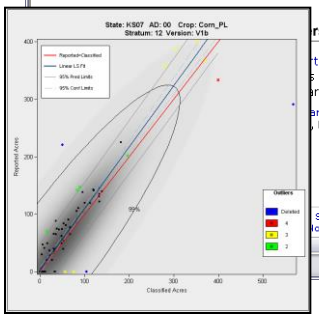


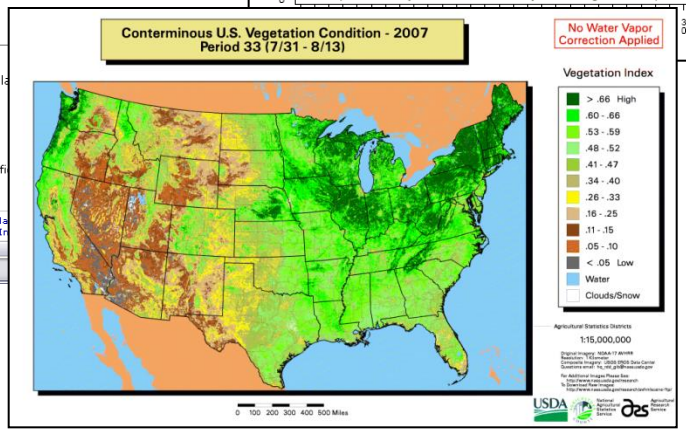




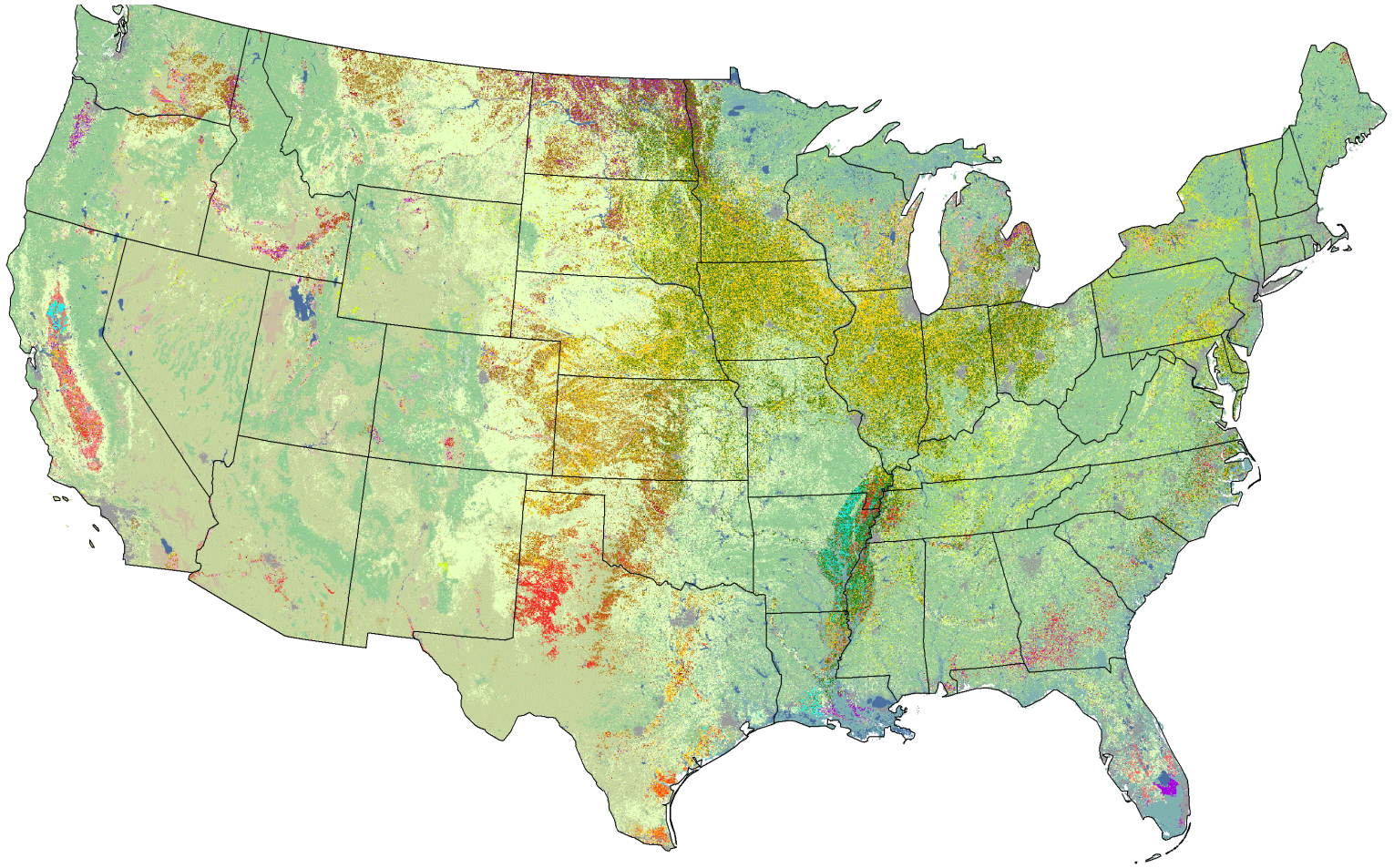








Annually derived Cropland Data Layer (CDL)



Major Land Cover Categories

Agriculture

- Pasture/Grass
- Corn
- Soybeans
- All Wheat
- Other Hay
- Fallow/Idle Cropland
- Alfalfa
- Cotton
- Other Crops
- Vegetables/Fruits/Nuts
- Sorghum
- Other Small Grains
- Rice

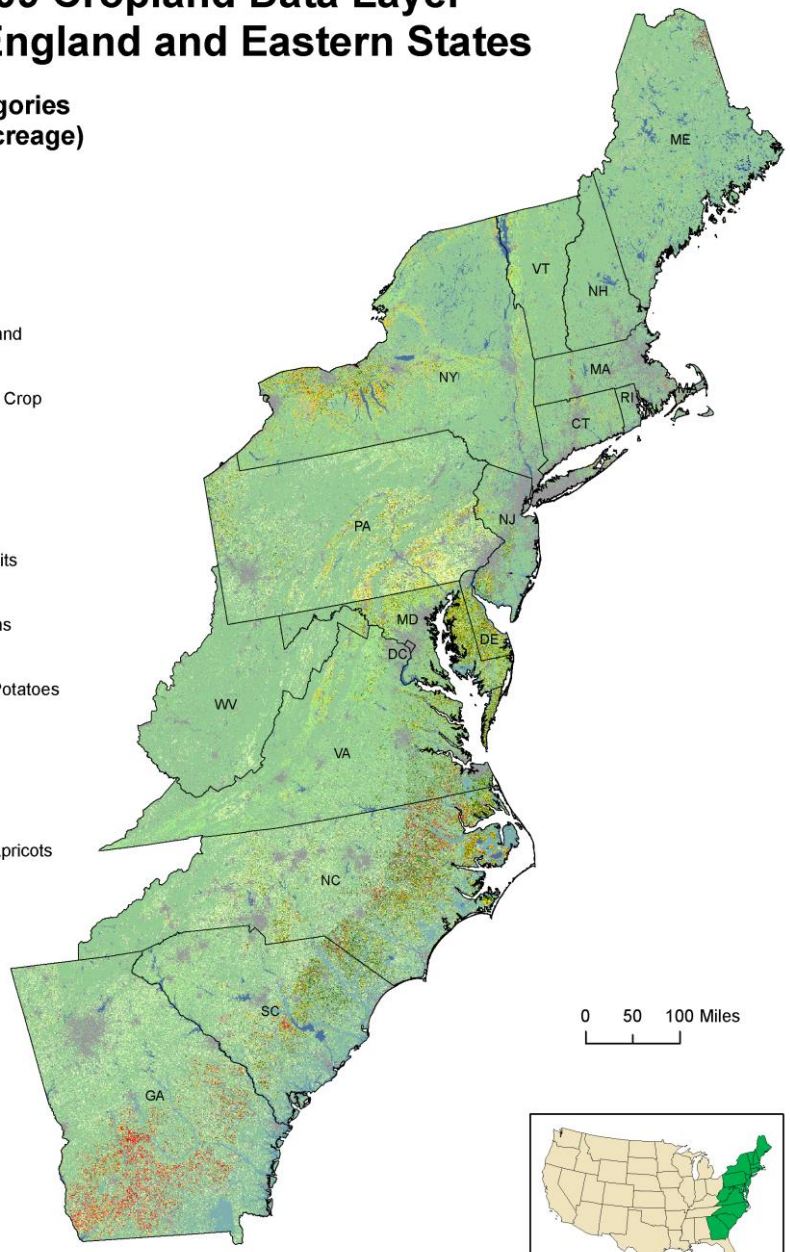
Non-Agriculture

- Woodland
- Shrubland
- Urban/Developed
- Wetlands
- Water
- Barren
- Perennial Ice/Snow

Mapped Crop Categories

1	Corn	41	Sugarbeets	73	Other Tree Fruits	227	Lettuce
2	Cotton	42	Dry Beans	74	Pecans	228	Cucumbers
3	Rice	43	Potatoes	75	Almonds	229	Pumpkins
4	Sorghum	44	Other Crops	76	Walnuts	230	Lettuce/Durum Wht
5	Soybeans	45	Sugarcane	77	Pears	231	Lettuce/Cantaloupe
6	Sunflower	46	Sweet Potatoes	80	Other Non-Tree Fruit	232	Lettuce/Upland Cotton
10	Peanuts	47	Misc. Vegs. & Fruits	92	Aquaculture	233	Lettuce/Barley
11	Tobacco	48	Watermelons	204	Pistachios	234	Durum Wht/Sorghum
12	Sweet Corn	49	Onions	205	Triticale	235	Barley/Sorghum
13	Pop. or Orn. Corn	50	Pickles	206	Carrots	236	WinWht/Sorghum
14	Mint	51	Chick Peas	207	Asparagus	237	Barley/Corn
21	Barley	52	Lentils	208	Garlic	238	WinWht/Cotton
22	Durum Wheat	53	Peas	209	Cantaloupes	239	Soybeans/Cotton
23	Spring Wheat	54	Tomatoes	210	Prunes	240	Soybeans/Oats
24	Winter Wheat	55	Caneberries	211	Olives	241	Corn/Soybeans
25	Other Small Grains	56	Hops	212	Oranges	242	Blueberries
26	Dbl. Crop WinWht/Soy	57	Herbs	213	Honeydew Melons	243	Cabbage
27	Rye	58	Clover/Wildflowers	214	Broccoli	244	Cauliflower
28	Oats	59	Sod/Grass Seed	216	Peppers	245	Celery
29	Millet	60	Switchgrass	217	Pomegranates	246	Radishes
30	Speltz	61	Fallow/Idle Cropland	218	Nectarines	247	Turnips
31	Canola	62	Pasture/Grass	219	Greens	248	Eggplants
32	Flaxseed	66	Cherries	220	Plums	249	Gourds
33	Safflower	67	Peaches	221	Strawberries	250	Cranberries
34	Rape Seed	68	Apples	222	Squash	251	Corn - Non-Irrigated
35	Mustard	69	Grapes	223	Apricots	252	Soybean - Non-Irrigated
36	Alfalfa	70	Christmas Trees	224	Vetch	253	WinWheat - Non-Irrigated
37	Other Hay	71	Other Tree Nuts	225	WinWht/Corn		
38	Camelina	72	Citrus	226	Oats/Corn		

2009 Cropland Data Layer
New England and Eastern States



2009 Ohio Cropland Data Layer

0 10 20 30 40 50 Miles

Land Cover Categories (by decreasing acreage)

AGRICULTURE

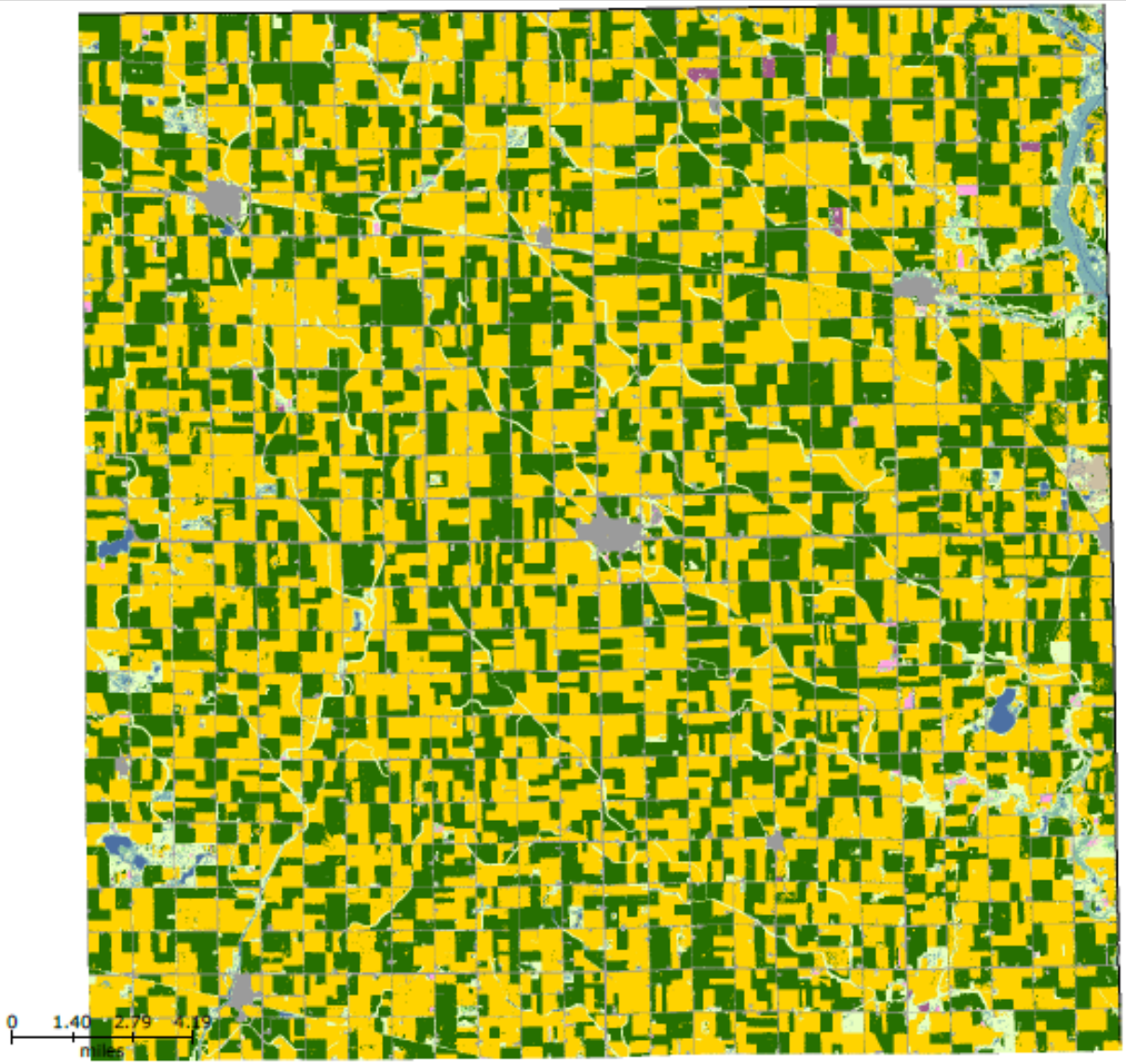
- Pasture/Grass
- Soybeans
- Corn
- Winter Wheat
- Other Hays
- Alfalfa
- W. Wht./Soy. Dbl. Crop
- Fallow/Idle Cropland
- Misc. Vegs. & Fruits
- Clover/Wildflowers
- Other Crops
- Oats

NON-AGRICULTURE

- Woodland
- Urban/Developed
- Water
- Wetlands
- Barren
- Shrubland

N

2011 CDL, Pocahontas, Iowa



Land Cover Categories

(by decreasing acreage)

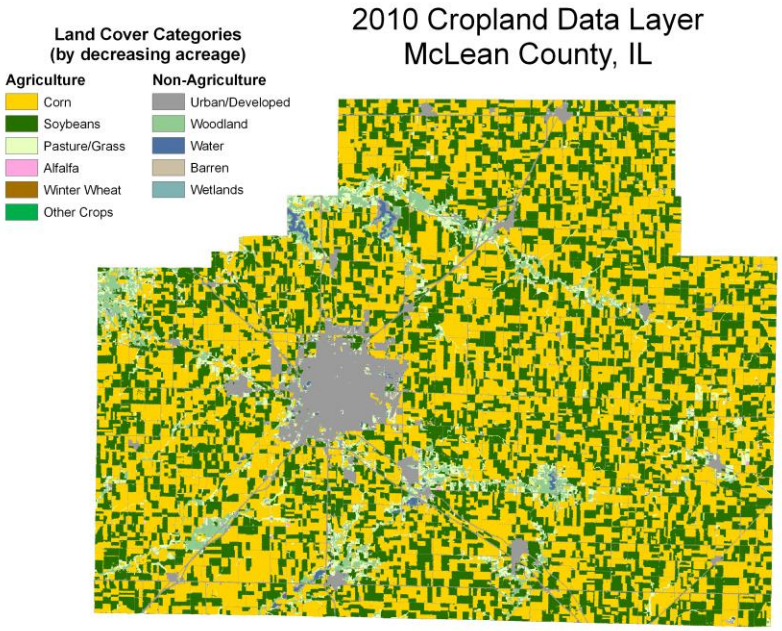
AGRICULTURE

- Corn
- Soybeans
- Grassland Herbaceous
- Alfalfa
- Oats
- Other Hay/Non Alfalfa
- Pop or Orn Corn
- Winter Wheat
- Fallow/Idle Cropland

NON-AGRICULTURE*

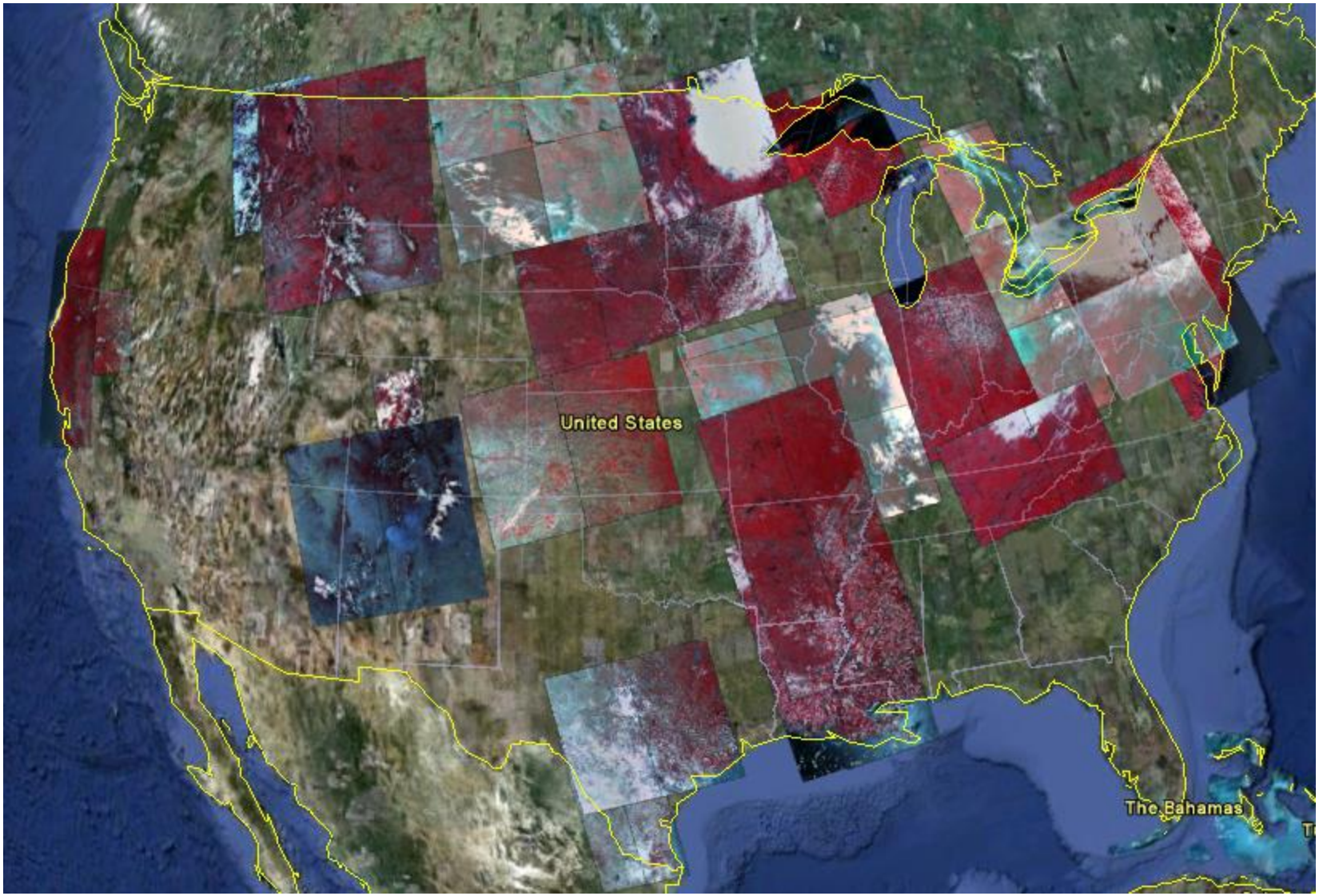
- Developed/Open Space
- Herbaceous Wetlands
- Developed/Low Intensity
- Woody Wetlands
- Open Water
- Deciduous Forest

CDL generalities

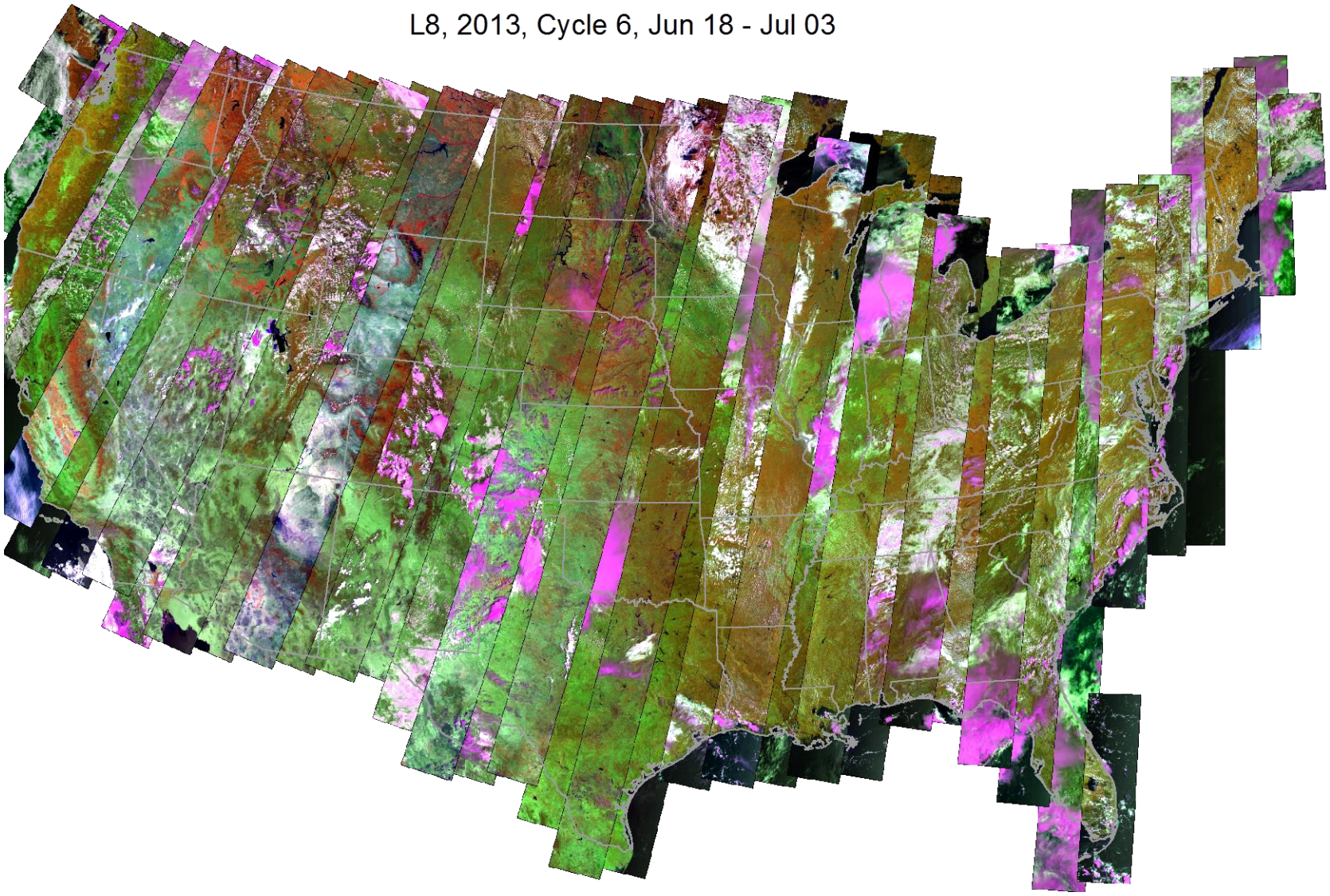


- Annual land cover classification targeted to identifying *circa* summer cultivated crops
- Encompasses all of conterminous USA (since 2008, some states prior)
- 56m or 30m resolution
  - Depending on year but now all 30m
- Built with a supervised boosted classification tree methodology
  - Implemented with See 5.0
- Utilizes ground/training data from USDA Farm Service data and ancillary data from National Land Cover Database
- Highly robust for dominant crop types
  - corn, soybeans, wheat, rice, cotton, etc.
- Used internally by NASS to refine planted acreage estimates
- Derived primarily from
  - Resourcesat-1 AWiFS
  - Landsat-5 TM
  - DMC Deimos-1 and UK-2
  - Landsat-8 OLI and TIRS

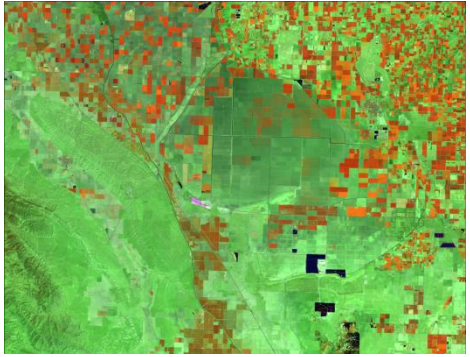
DMC Deimos-1/UK2 Collections



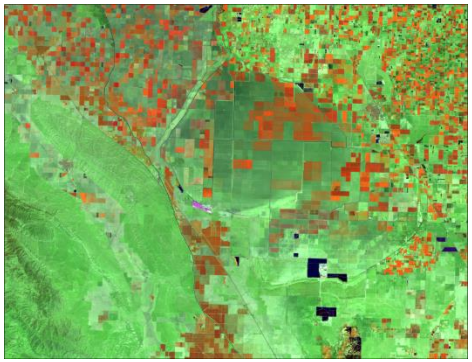
Landsat 8 Collections



April



May



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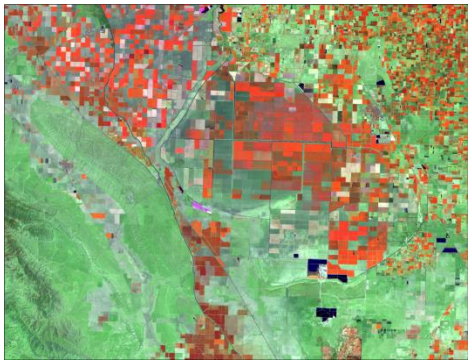
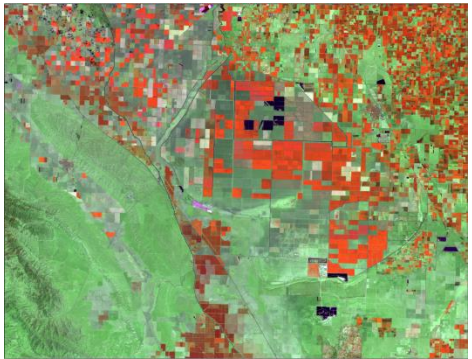
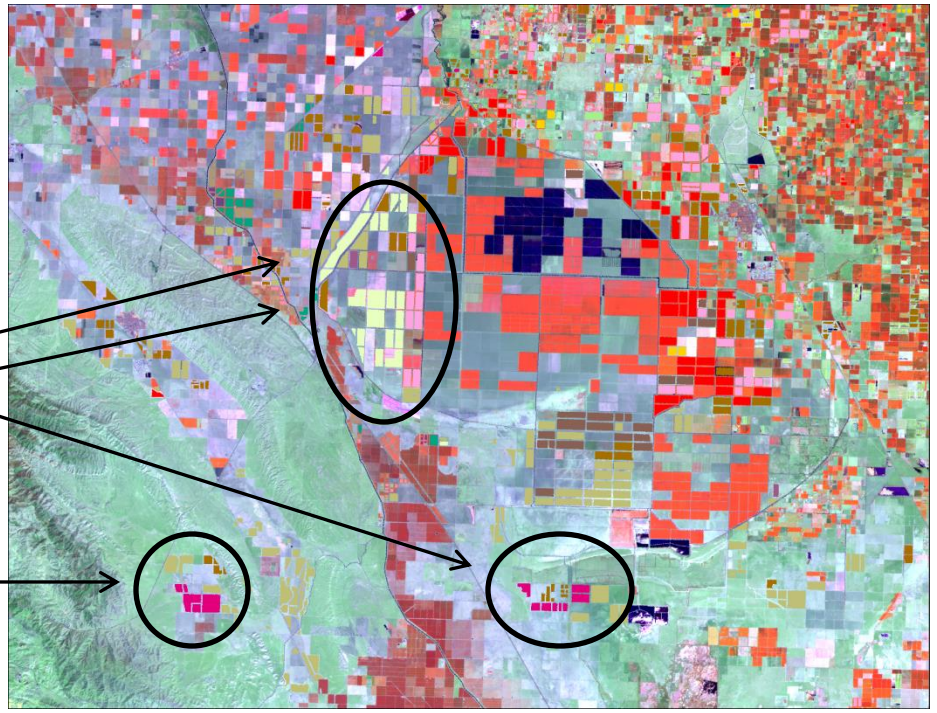


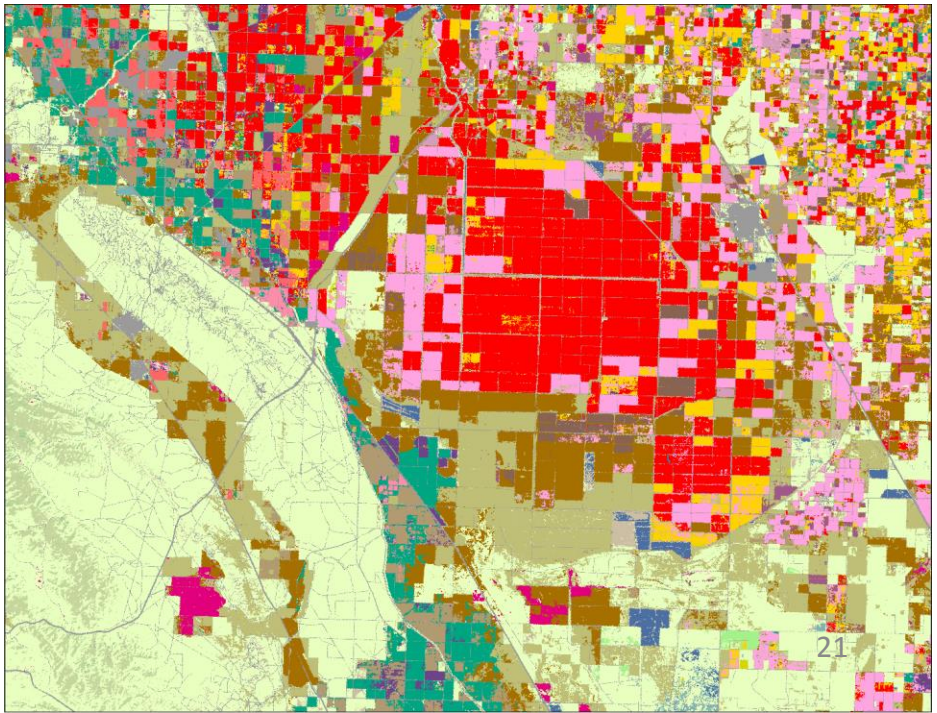
July



August
with farm
data

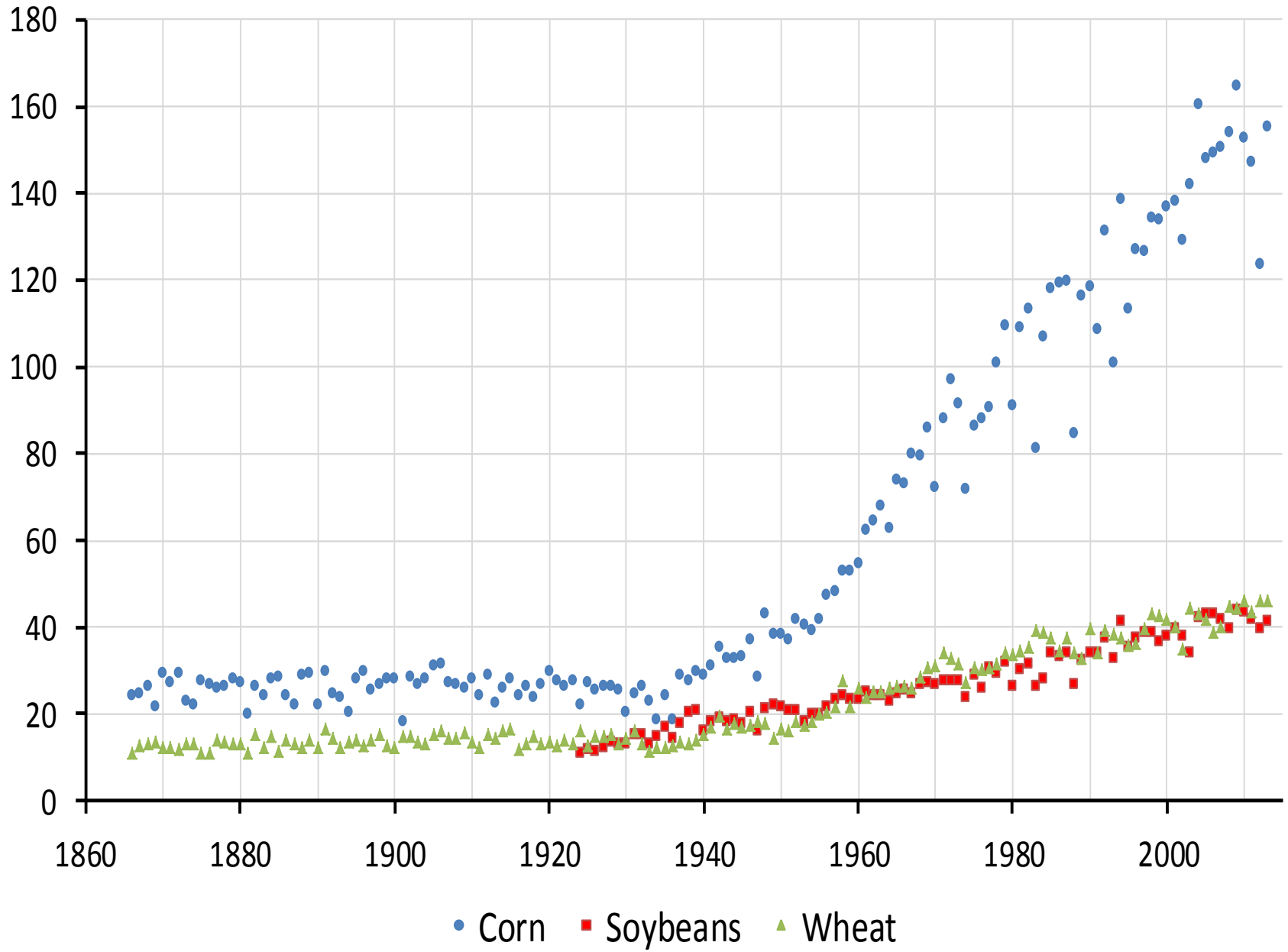


Final
CDL



Crop area mapping lessons learned

- Heavy volumes of time-series imagery important
  - Agriculture is a dynamic land cover
- Fine spatial resolution is somewhat important
  - Particularly if field sizes are relatively large
- Multi-spectral resolution least important
  - The time component reigns supreme
- Crop area estimation by “pixel counting” alone is not sufficient
  - A bias measurement of the classification is needed
  - “regression estimator”
- Some sort of reasonably accurate “ground truth” needed to drive the classifier
  - ~ 1% of land cover might be sufficient


United States Yield (bushel/acre)
180
160
140
120
100
80
60
40
20
0
1860
1880
1900
1920
1940
1960
1980
2000
Corn
Soybeans
Wheat

Yields results primarily derived from two surveys

Agricultural Yield

- Farmer reported survey data of expected crop yields.
- Data obtained throughout the growing season.
- Conducted in all states except Alaska and Hawaii.
- Sample size in the 1000s per state.
- Farm operator contacts are selected from the March Crops/Stocks survey (small grains) and the June Crops/Stocks survey (late season crops and tobacco).
- Primarily telephone based.

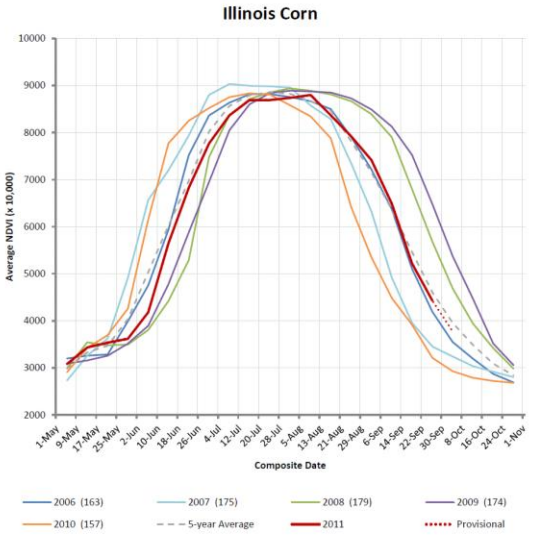
Objective yield

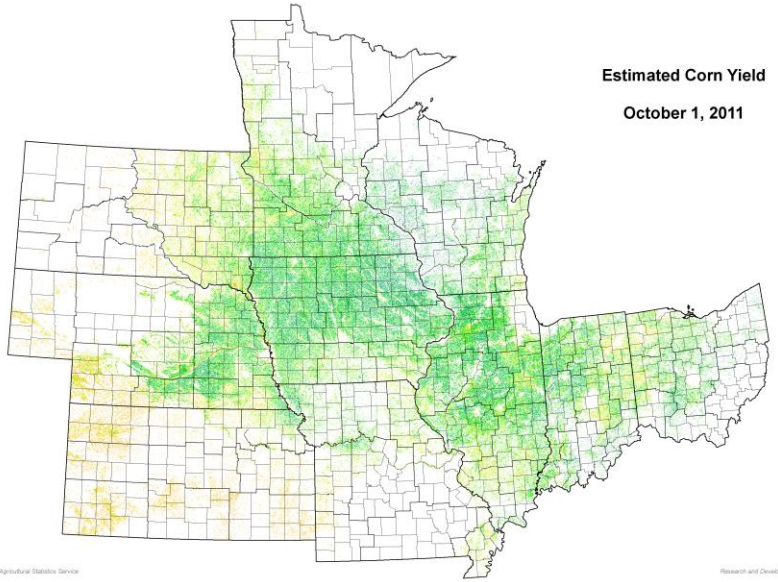
- Corn, Cotton, Soybeans, Wheat, Potatoes.
- Only done in states where the commodities are primarily found.
- Samples selected from areas found in June Area Survey (“Acreage”).
- Performed at 100s of sample sites per state.
- Biophysical plant/seed measurements obtained.
- Each plot revisited a few times per season.

Remote Sensing Yield

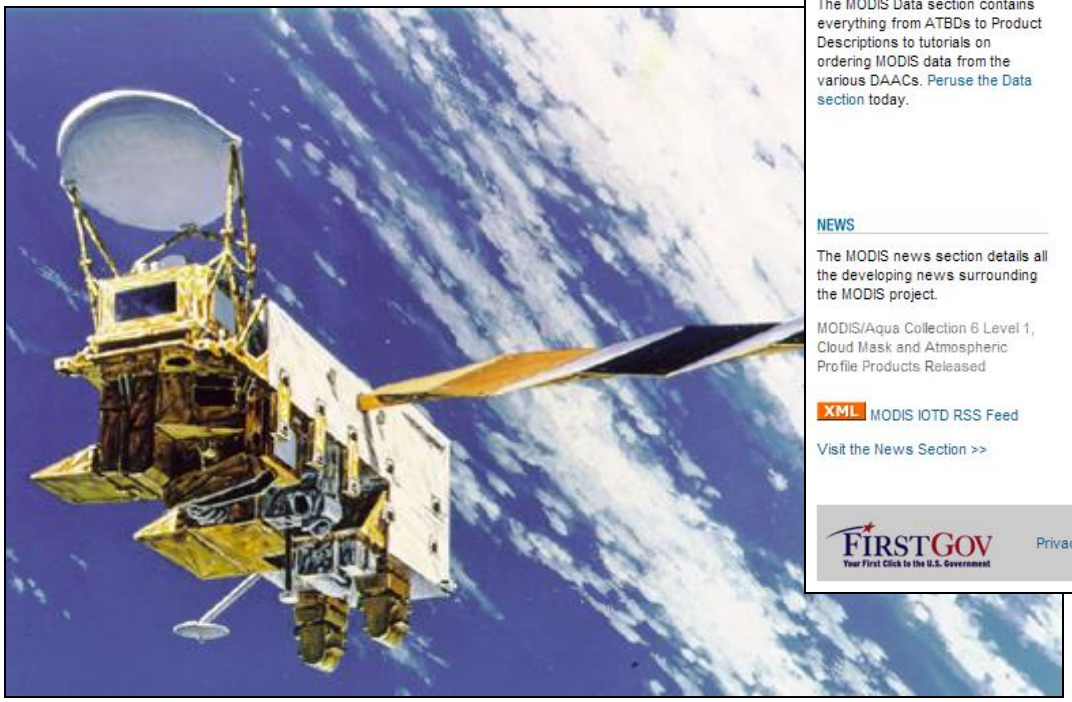
Third method for yield estimates

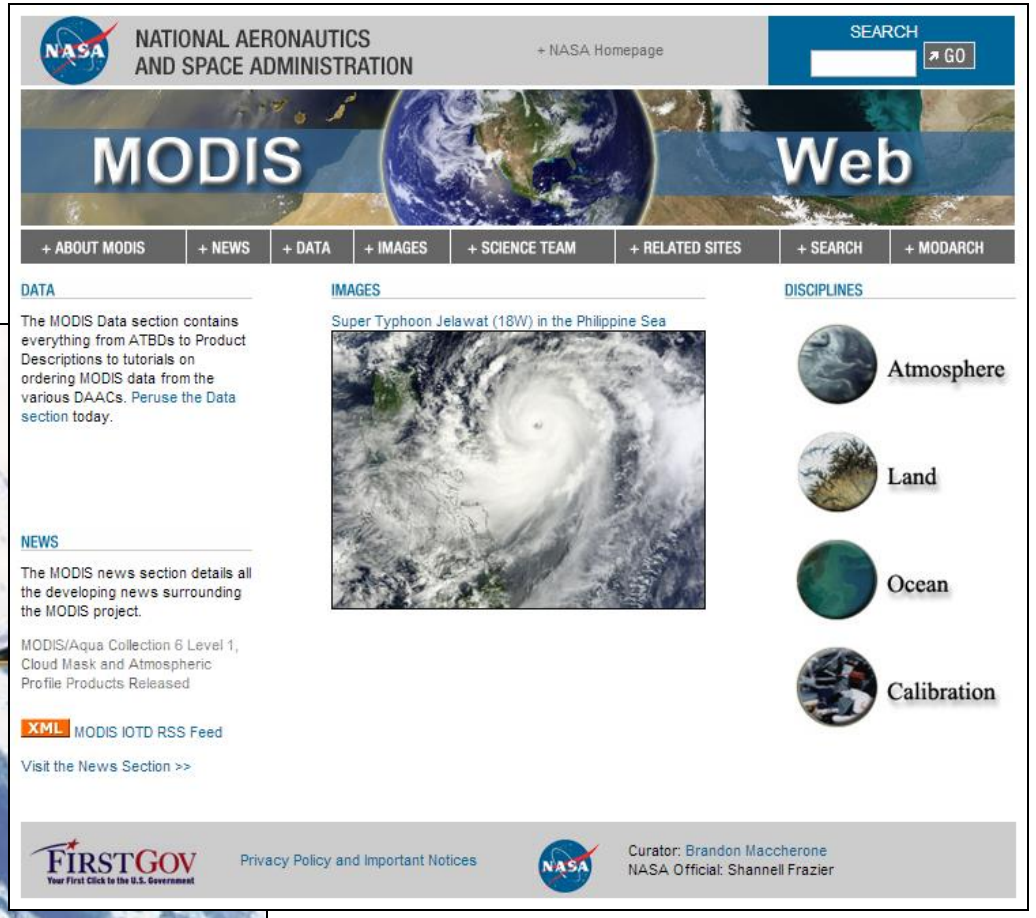
- Premise
  - There is a Relationship between crop
    - Biomass, vigor, “greenness”, NDVI
      - and
    - Land surface temperature
  - And the resulting crop yield
- Utilize MODIS data to obtain biomass and temperature variables
- National, State, ASD, and County
  - Corn and Soybeans only
  - “Speculative” region only
    - i.e. Corn Belt

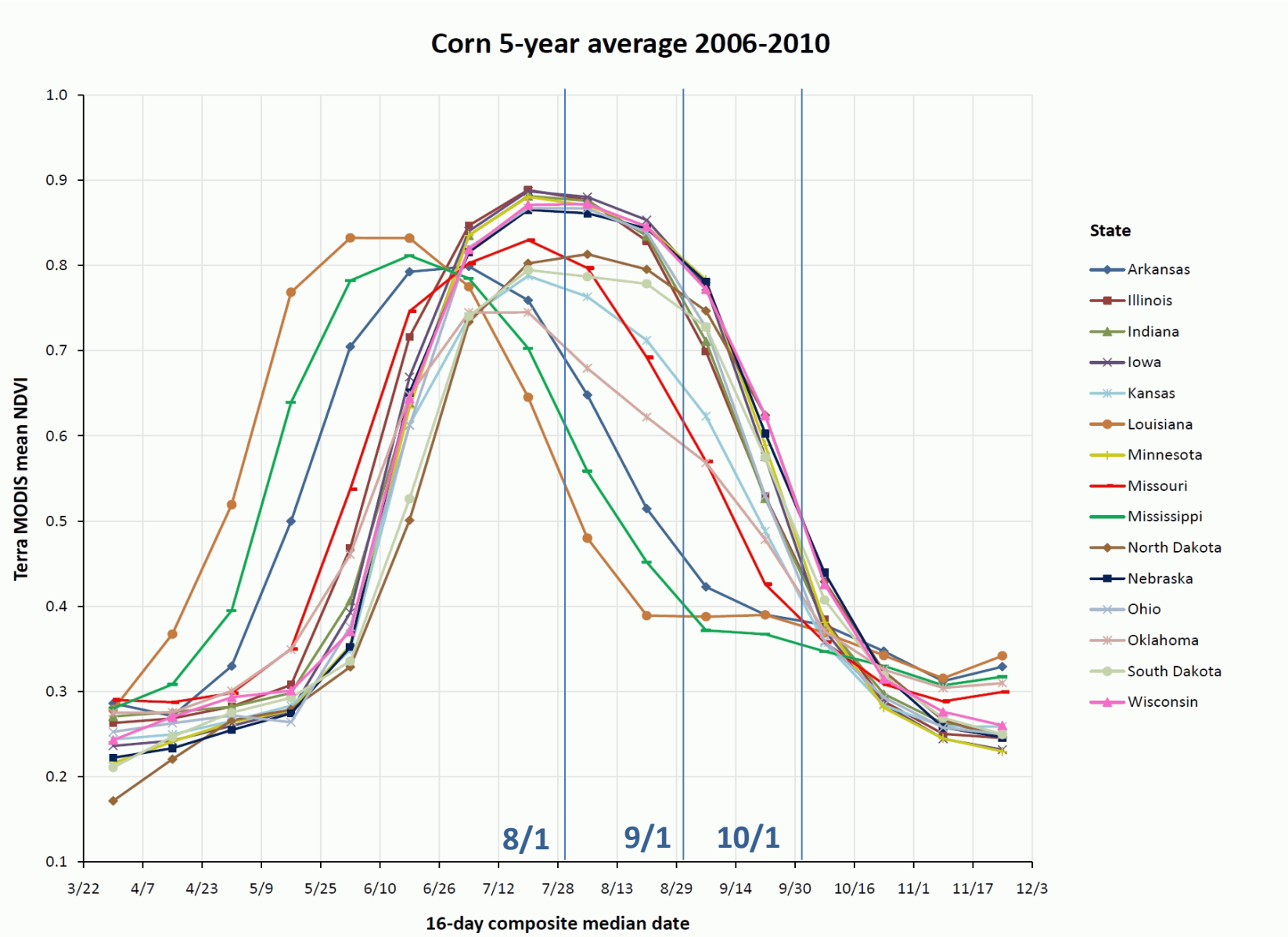




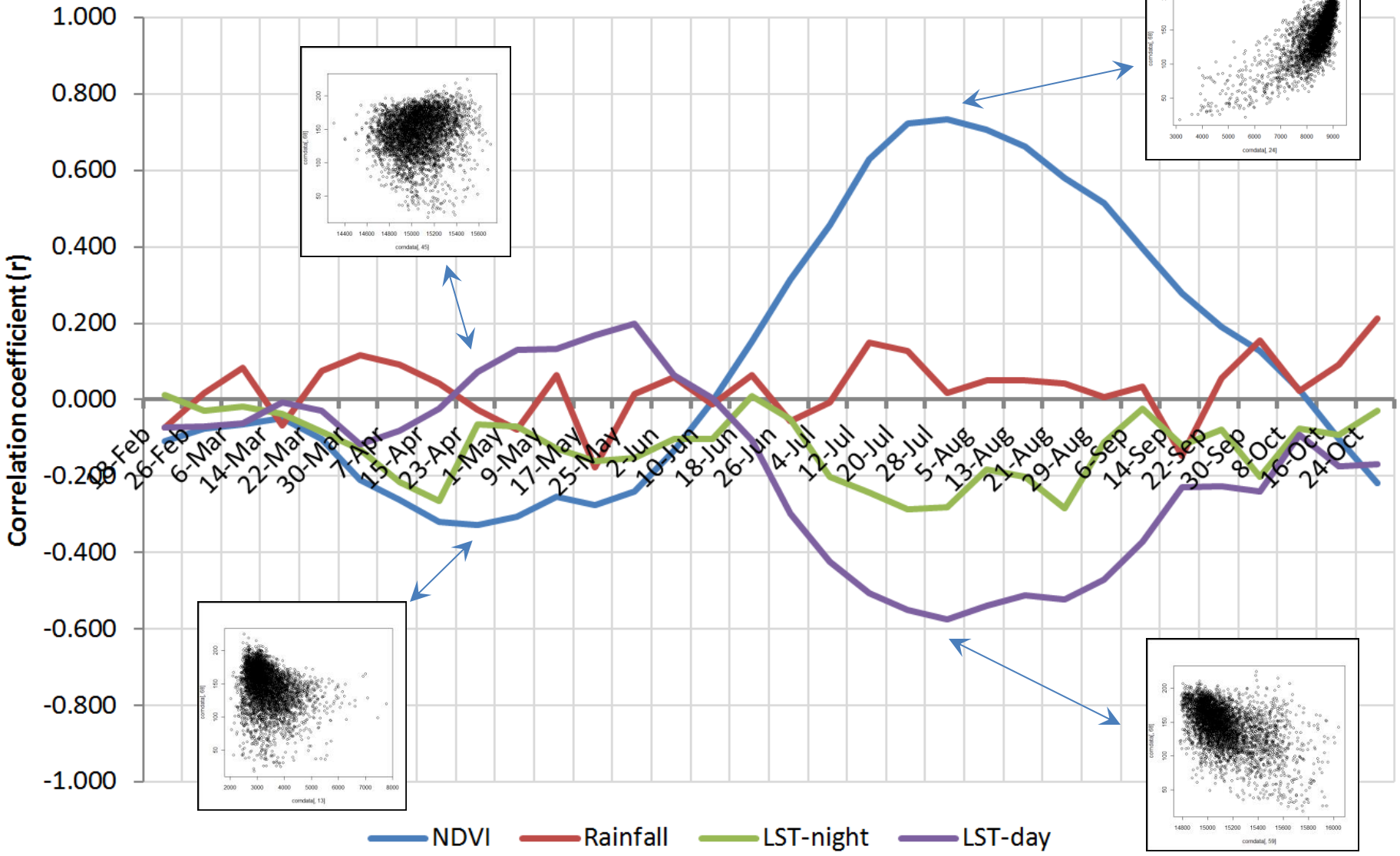
Moderate Resolution Imaging Spectroradiometer (MODIS)



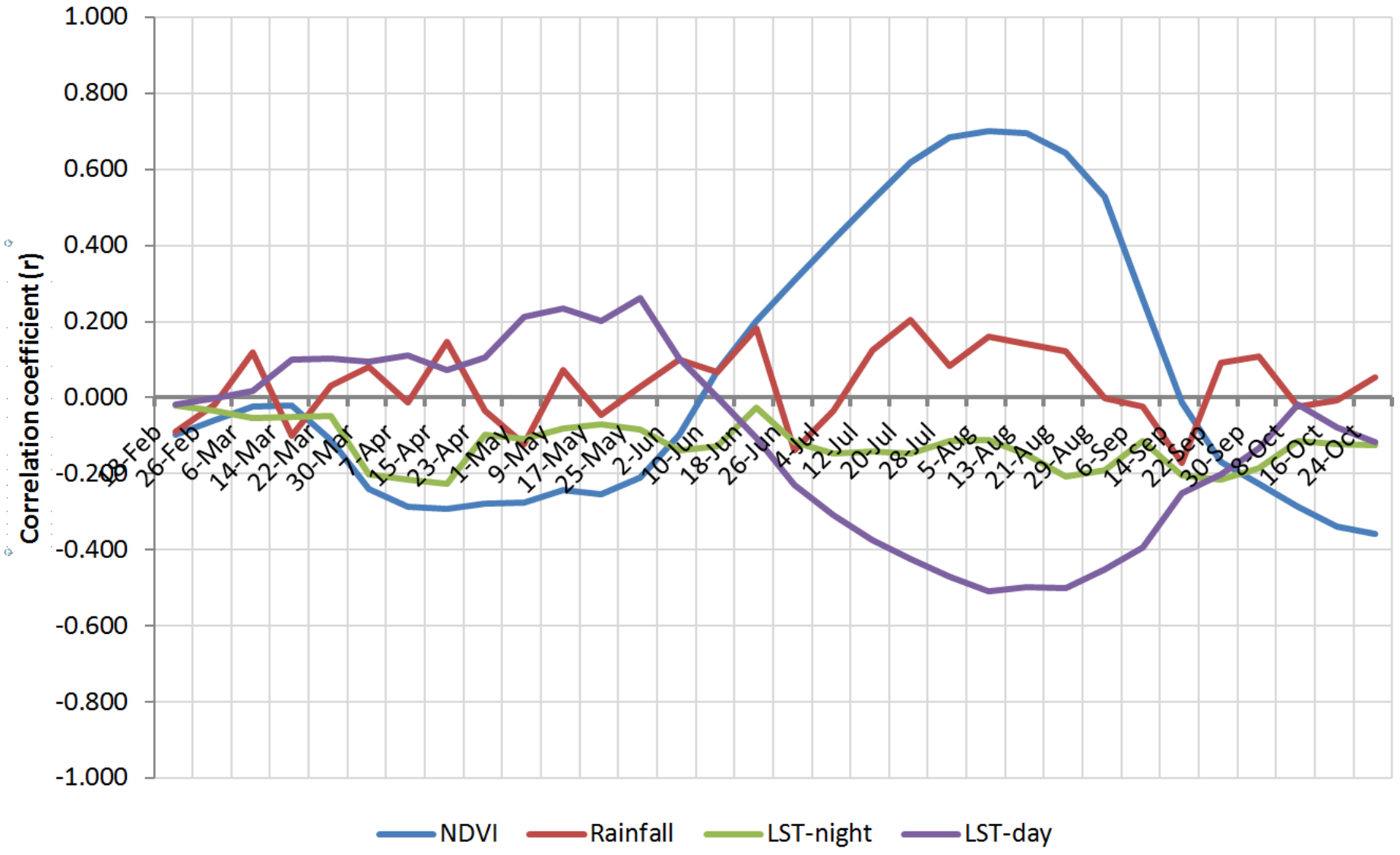



Corn 5-year average 2006-2010
Terra MODIS mean NDVI
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
3/22
4/7
4/23
5/9
5/25
6/10
6/26
7/12
7/28
8/13
8/29
9/14
9/30
10/16
11/1
11/17
12/3
16-day composite median date
8/1
9/1
10/1
State
Arkansas
Illinois
Indiana
Iowa
Kansas
Louisiana
Minnesota
Missouri
Mississippi
North Dakota
Nebraska
Ohio
Oklahoma
South Dakota
Wisconsin

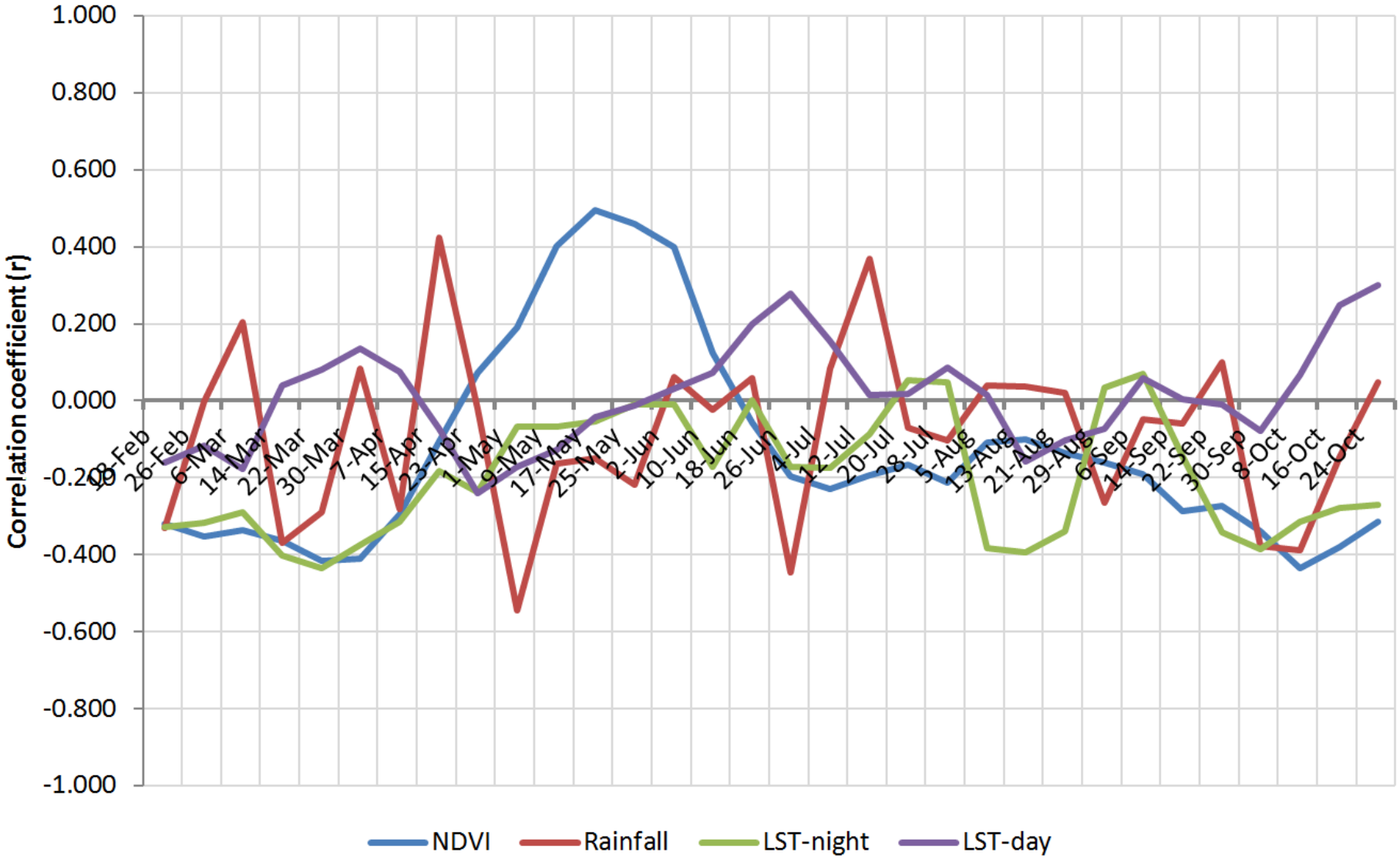
Corn yield dependence at county level speculative region, 2006-2011



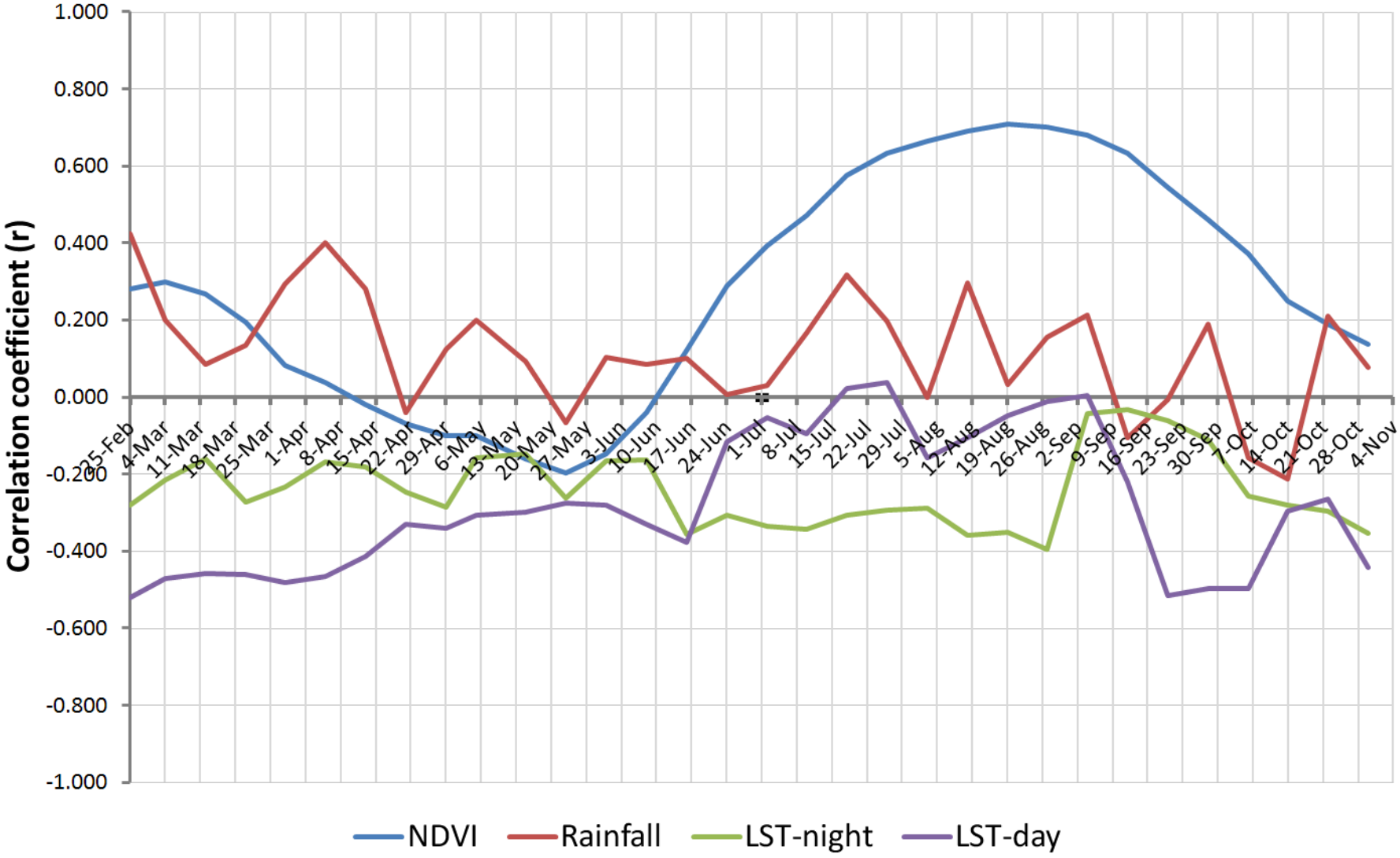
Soybean yield dependence at county level speculative region, 2006-2011

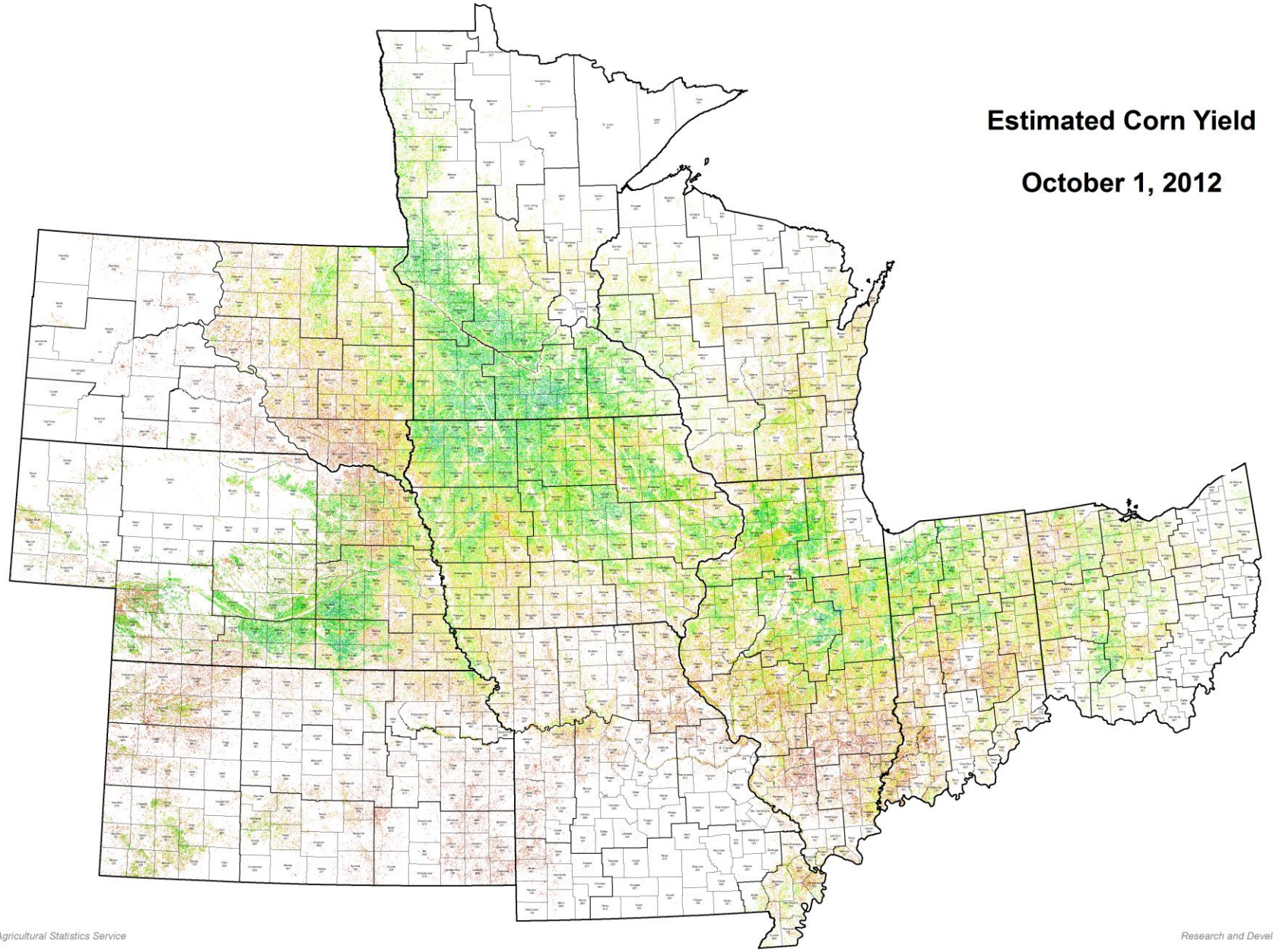


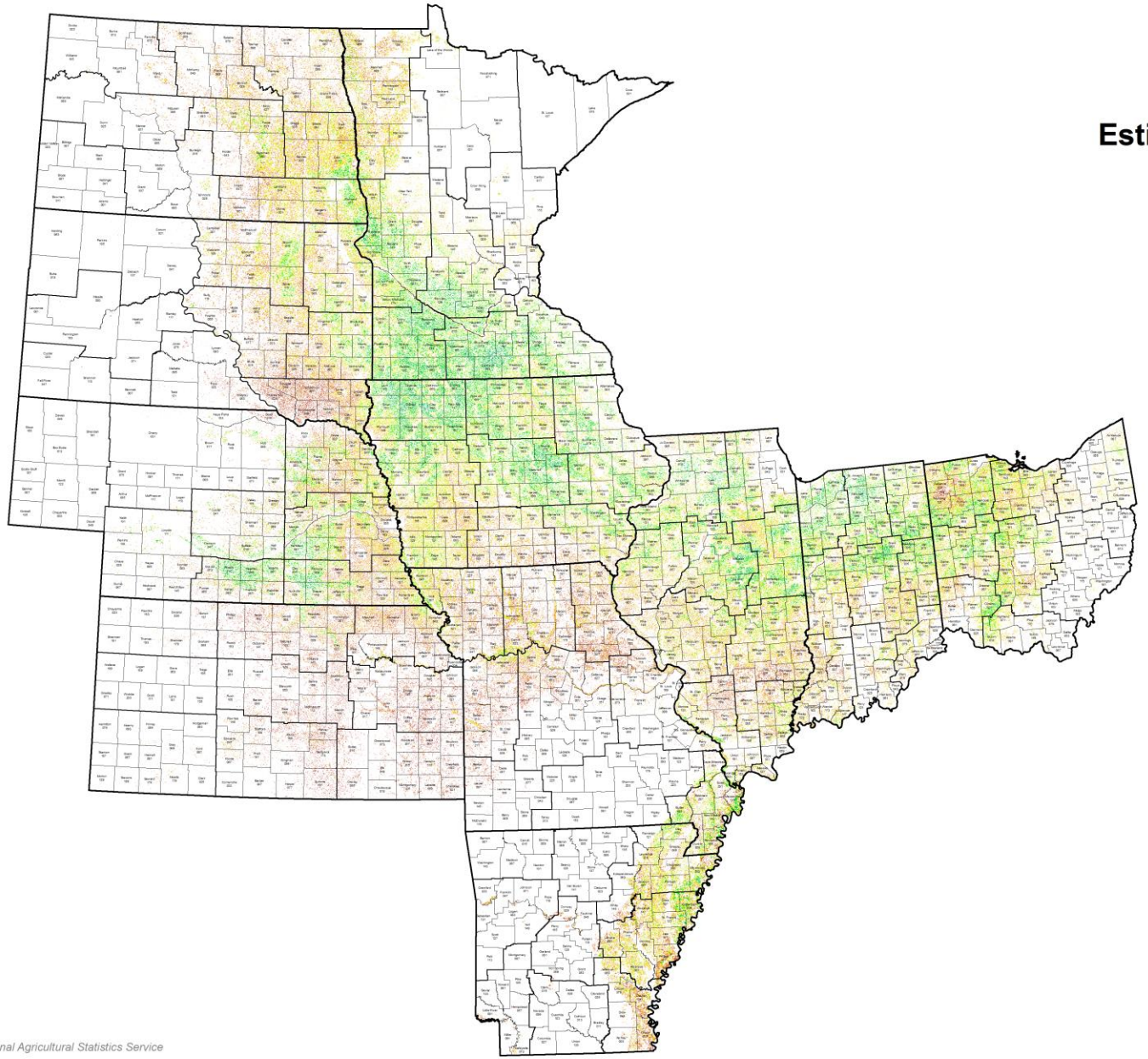
Winter wheat yield dependence at county level
Kansas, 2006-2011



Cotton yield dependence at county level
TX & AR, 2005-2011



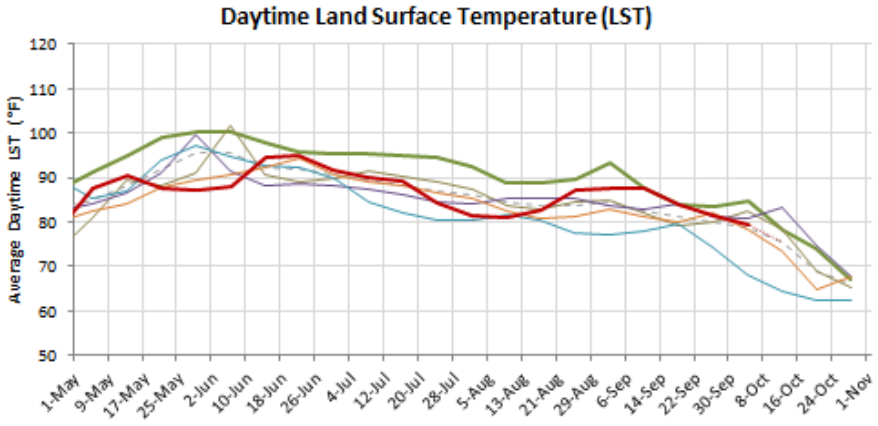

Estimated Corn Yield
October 1, 2012
USDA/National Agricultural Statistics Service
Research and Development Division

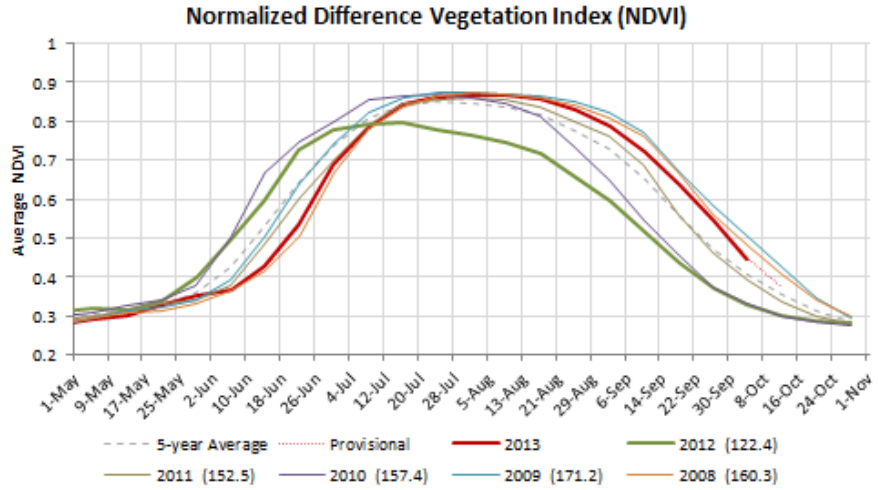


Estimated Soybean Yield

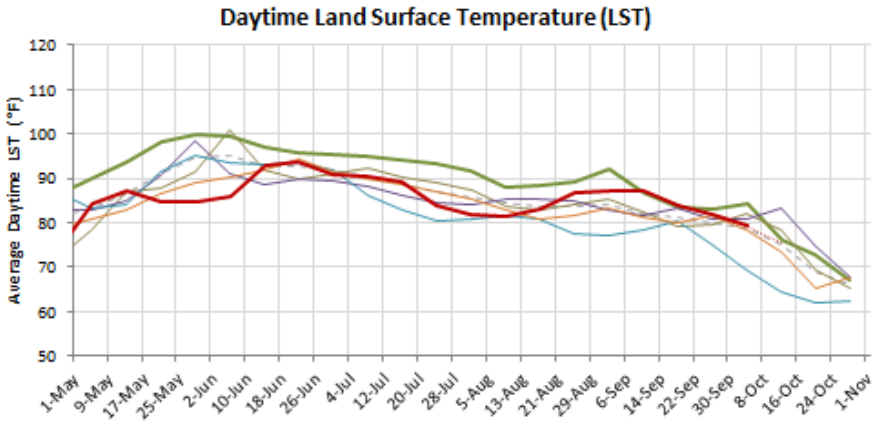
October 1, 2012

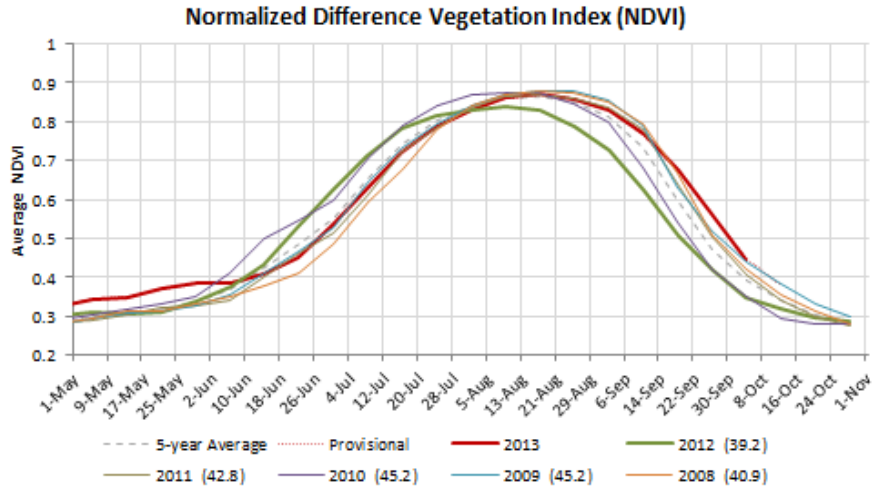
MODIS-derived crop dynamics based on CDL areas





Corn





Soybeans

This winter: Try to understand all common MODIS derived variables and how they relate to various crops' yields

- Explore fully beyond only corn and soybeans
  - Wheat
  - Rice
  - Potatoes
  - Cotton
- Compare the full suite of common MODIS variables
  - NDVI
  - EVI
  - LAI
  - FPAR
  - LST (daytime and nighttime)
- Test Both Terra and Aqua platforms
  - Truly assess the AM vs PM overpass time
- Look at pixel scale issues
  - 250 m vs. 500 m vs. 1000 m (particularly for NDVI)

Final thoughts about crop production monitoring using earth observation satellites

- A wealth of satellite data already exists
  - Free and with significant history
    - Terra and Aqua MODIS
    - Landsat 7 and 8
  - Others are out there too to supplement
    - DMC, Rapideye, Digital Globe, SPOT, IRS, etc…
    - Plus those coming online like VIIRS, Sentinel II,
- Computing infrastructure can handle it
- …..and the research is there to guide best practices

Thank You

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http://nassgeodata.gmu.edu/CropScape