



# A PHENOLOGICAL ATLAS OF MAJOR CROPS FROM THE UNITED STATES HEARTLAND

David M. Johnson, Geographer  
United States Department of Agriculture  
National Agricultural Statistics Service

# NATIONAL AGRICULTURAL STATISTICS SERVICE

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

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 Land Use Strata for Selected States

**Census of Agriculture**  
 2002 Census Map Gallery  
 2002 Maps: Gallery | Star Tree | List  
 Interact with Data (1997)  
 \*Linked Micromap\* Plots (1997):  
 Corn | Cotton | Hay | Soybeans | Wheat

**Animated Maps**  
 Crop Acreage  
 Vegetation Condition  
 Corn | Cotton | Oats  
 Soybeans | Wheat

**Reports, Papers and Presentations**  
 Research Reports  
 - New! Access archived reports by subject area:  
 GIS | Survey | Yield  
 2004 MEXSAI "Star Trees" Diagram  
 Ron Bosecker, Presenter  
 Last modified: 10/04/07

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### 2001 Wildlife Damage Survey

**7.7 Percent of Crop Value Lost to Deer and Geese**

Maryland farmers lost \$17.2 million of corn, soybeans and wheat to deer or geese during 2001. This translates to Maryland farmers losing 7.7 percent of the crop value to deer and geese. Soybeans accounted for the greatest economic loss, totaling \$9.1 million, 51 percent. Corn losses were \$6.6 million, 3.8 percent and wheat \$1.5 million, 5.6 percent. Deer damage resulted in losses of \$13.6 million, 6.1 percent, while geese losses were \$3.6 million, 1.6 percent.

Production losses totaled 6.0 million bushels. Corn losses were 3.2 million bushels, soybean losses totaled 2.2 million bushels and wheat accounted for 0.6 million bushels. Production losses to deer were 4.7 million bushels and geese 1.3 million bushels.

In terms of yield, losses to deer were most severe in Central and Western Maryland, while geese damage was greater on the Eastern Shore. Corn yield losses of 9.6 bushels per acre and 7.4 bushels per acre were reported in Central and Western Maryland, respectively. The Lower Eastern Shore reported the highest soybean losses of 6.1 bushels per acre.

Sixty-two percent of farms reported deer or geese damage to one or more crops. Damage was reported on 61 percent of farms raising corn, 58 percent of farms growing soybeans and 27 percent of farms with wheat.

Region	Crop	Acres Harvested	Harvested Yield (Bushels)	Average Yield Loss (Bushels)	Production Loss (Bbl)	Economic Loss (\$)
Western Maryland	Corn	6,570	374	7.4	49,710	\$3,438
	Soybeans	300	367	2.3	460	1,317
	Wheat	200	457	2.3	460	1,317
Central Maryland	Corn	14,920	882	5.8	1,204,560	2,478,936
	Soybeans	92,500	342	3.4	360,750	1,479,075

### NEWS RELEASE

**NATIONAL AGRICULTURAL STATISTICS SERVICE**  
 United States Department of Agriculture • Washington, DC 20250  
 Ag Statistics Hotline: (800) 727-9540 • www.nass.usda.gov

Contact: Ellen Dougherty, (202) 690-8122  
 Jeff Geuder, (202) 720-2127

**USDA FORECASTS RECORD-SETTING CORN CROP FOR 2007**

Washington, Aug. 10, 2007 - The National Agricultural Statistics Service (NASS) announced today that the 2007 corn crop is expected to reach a record 13.1 billion bushels, 10.6 percent above the 2006 crop. Based on conditions per acre, up 3.7 bushels from the 2006 crop, the 2007 crop is expected to be behind the 100.4 bushels per acre of corn for the 2006 crop, which was 13.1 million acres of corn for the 2006 crop.

**Wisconsin Milk Production to Recover**

Milk production is expected to increase in Wisconsin during the next five years according to a survey conducted by the Wisconsin Agricultural Statistics Service. The statewide survey of producers asked for 2007. Actual results will depend on future milk prices, input prices, financing availability, crop yields, and other factors.

### 2002 Dairy Producer Opinion Survey

November 2002

Based on the survey, 60 percent of producers expect to keep the same herd size, 20 percent plan to increase herd size, and 20 percent intend to discontinue milking by 2007. Actual results will depend on future milk prices, input prices, financing availability, crop yields, and other factors.

The number of herds projected for 2007 shows that the diversity of small to large herds will continue. The most prevalent herd size will remain at 50 to 99 cows.

### 2002 Census of Agriculture - SVG Interactive Mapping

United States Department of Agriculture  
 National Agricultural Statistics Service 2002 Census of Agriculture

All data items are from Chapter 2 - Table 1. Area Summary Highlights: 2002 Selected crops harvested - Land in orchards (acres)

State: [United States - County Level] Data Item: [Selected crops harvested - Land in orchards (acres)]

United States Total: 5,330,439

State Total:  
 County Total:  
 County Total:

Download data as CSV | XML | PDF

Help | Print | Return to

Legend:  
 Scale: [National] [Zero or Data Withheld] ≤ 20,000  
 20,001 to 40,000  
 40,001 to 60,000  
 60,001 to 80,000  
 80,001 to 100,000  
 100,001 > =

Color: [Green]

Source: USDA-NASS 2002 Census of Agriculture © USDA-NASS 2005-2006

Navigate: Mouse-over a specific state/county to view the state/county level data. Right click to zoom (option-click for MAC users). Hold the alt key and click-drag to pan. For additional assistance with this application, click here to view the support page.

### All Milk Price, Wisconsin Annual Average, 1985 - 2002 1/

1/ For 1985, price is Annual September average.

### Wisconsin Dairy Herds by Herd Size

Milk cow herd size	May 2002 herds	May 2007 herds (projected) 1/	Change 2007/2002
1 - 29	2,600	1,440	-45
30 - 49	4,700	3,440	-27
50 - 99	7,400	9,000	+4
100 - 199	1,900	2,080	+9
200 - 499	700	900	+20
500+	200	440	+20
Total	17,500	13,900	-20

1/ The May 2007 projection is based on farmers' opinions May-June 2002, with the assumption that milk prices for the next five years will be at the same level as the past five years.

### one Dairy Farmer Plans for May 2007 1/ by Herd Size

Herds	Keep same herd size	Increase herd size	Discontinue milking
Number	47	17	38
Percentage	71	9	20
4,700	71	9	20
7,400	85	19	18
1,900	58	37	10
700	83	59	8
200	22	78	0
Total	17,500	60	20

### Percent of Herds by Size Group 2007 Projection

Herd Size Groups:  
 1-29  
 30-49  
 50-99  
 100-199  
 200-499  
 500+

Source: USDA-NASS 2002 Census of Agriculture © USDA-NASS 2005-2006



# WHY CARE ABOUT CROP PHENOLOGY?

- ✘ Help in assessing crop progress
- ✘ Help in assessing crop condition
  
- ✘ Help in choosing suitable imagery dates for cropland classification
- ✘ Help in choosing decision rules for imagery classification

Phenology - the study of periodic plant and animal life cycle events...

# USUAL PLANTING AND HARVEST DATES

United States  
Department of  
Agriculture

National  
Agricultural  
Statistics  
Service



Agricultural  
Handbook  
Number 678



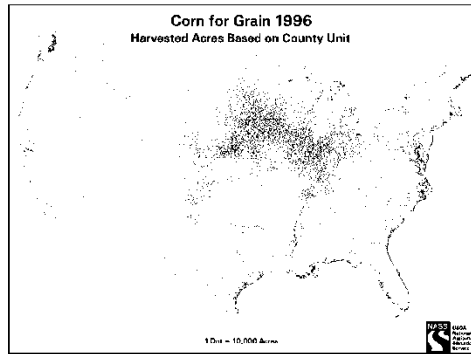
## Usual Planting and Harvesting Dates for U.S. Field Crops

December 1997

### Corn

Corn was the leading U.S. crop in 1996, both in terms of value of production and acreage grown. Over 400 million acres of corn were harvested for grain. The acreage for grain comprised 92% of all corn planted. More of the corn-for-grain acreage lies in the Corn Belt States, with Iowa leading all States and Illinois ranking second. The largest acreage of record, 111 million acres, was harvested in 1917. Acreage decreased from the early 1900s, with the exception of wartime plantings, until the late-1960s. Since then, harvested acreage has generally ranged between 60-75 million acres.

The 1996 National grain yield was 127.1 bushels per acre the third highest yield on record. Yields have increased since the turn of the century, with more rapid increases occurring in more recent years. The high yield on record, 138.6 bushels per acre, occurred in 1994. Corn grain production generally increased through the late-1980s. Irrigate weather caused production to fluctuate significantly in the 1990s. In 1996, 9.3 billion bushels of corn were produced in the Nation, compared with 7.4 billion bushels in 1995 and the record 10.1 billion bushels in 1997.



Usual Planting and Harvesting Dates  
December 1997

Agricultural Statistics Board  
NASS, USDA

Corn for Grain: Usual Planting and Harvesting Dates, by State

State	1996 Harvested Acres (000)	Usual Planting Dates			Usual Harvesting Dates		
		Began	Most Active	End	Began	Most Active	End
AL	260	Mar 5	Mar 25 - Apr 25	May 18	Jul 21	Aug 11 - Sep 20	Nov 2
AZ	40	Mar 5	Apr 1 - May 15	Jun 1	Sep 1	Oct 1 - Nov 1	Dec 1
AR	230	Apr 3	Apr 10 - May 18	May 25	Aug 16	Aug 27 - Sep 18	Oct 1
CA	220	Mar 5	Apr 1 - Jul 1	Jul 15	Sep 1	Oct 1 - Nov 15	Dec 1
CO	940	Apr 15	May 1 - May 15	Jun 1	Oct 1	Oct 15 - Nov 10	Dec 1
DE	150	Apr 19	Apr 30 - May 16	May 28	Sep 10	Sep 20 - Oct 15	Nov 5
FL	112	Mar 1	Mar 15 - Apr 15	Apr 25	Jul 15	Aug 1 - Sep 10	Oct 1
GA	525	Mar 1	Mar 20 - Apr 15	May 5	Jul 25	Aug 15 - Sep 5	Oct 10
ID	40	Apr 21	May 5 - May 26	Jun 9	Sep 29	Oct 20 - Nov 10	Nov 24
IL	10,800	Apr 22	Apr 30 - May 18	May 28	Sep 24	Oct 9 - Nov 3	Nov 9
IN	5,450	Apr 25	May 5 - May 20	Jun 10	Sep 20	Oct 10 - Nov 25	Dec 10
IA	12,450	Apr 22	May 2 - May 16	Jun 3	Sep 17	Oct 7 - Oct 21	Nov 7
KS	2,450	Apr 10	Apr 25 - May 15	May 25	Sep 5	Sep 20 - Oct 20	Nov 10
KY	1,200	Apr 12	Apr 21 - May 18	Jun 8	Sep 8	Sep 22 - Oct 20	Nov 5
LA	523	Mar 10	Mar 19 - Apr 4	Apr 28	Jul 29	Aug 13 - Sep 1	Sep 16
MD	465	Apr 20	Apr 30 - May 20	Jun 7	Sep 9	Sep 22 - Oct 22	Nov 7
MI	2,500	May 1	May 10 - May 21	May 31	Oct 3	Oct 21 - Nov 17	Dec 3
MN	6,950	Apr 24	May 3 - May 22	Jun 8	Sep 20	Oct 15 - Nov 12	Nov 28
MS	605	Mar 27	Mar 31 - Apr 28	Jun 1	Aug 12	Sep 1 - Oct 6	Oct 22
MO	2,650	Apr 5	Apr 20 - May 25	Jun 10	Sep 1	Sep 20 - Oct 30	Dec 1
MT	15	Apr 19	May - May 25	Jun 8	Sep 15	Sep 20 - Oct 5	Oct 15
NE	8,500	Apr 21	Apr 5 - May 19	Jun 1	Sep 21	Oct 1 - Nov 8	Dec 1
NJ	94	May 7	May 28 - Jun 20	Jun 28	Oct 1	Oct 30 - Nov 10	Nov 29
NM	84	Apr 15	Apr 20 - May 10	May 20	Sep 25	Oct 1 - Oct 30	Nov 20
NY	630	Apr 25	May 5 - May 25	Jun 5	Oct 10	Oct 20 - Nov 20	Dec 1
NC	900	Apr 1	Apr 10 - Apr 25	May 20	Aug 20	Sep 0 - Oct 7	Nov 7
ND	720	May 3	May 15 - May 26	Jun 5	Sep 29	Oct 10 - Oct 27	Nov 9
OH	2,750	Apr 22	May 1 - May 20	Jun 12	Sep 25	Oct 15 - Nov 14	Nov 25
OK	170	Mar 25	Apr 18 - May 4	May 15	Aug 25	Sep 8 - Oct 1	Oct 20
OR	33	Apr 20	May 20 - Jun 1	Jun 15	Oct 10	Nov - Nov 20	Dec 15
PA	1070	Apr 30	May 10 - May 25	Jun 15	Sep 25	Oct 15 - Nov 20	Dec 10
SC	380	Mar 10	Mar 20 - Apr 20	May 15	Jul 25	Aug 20 - Sep 25	Oct 10
SD	3,700	May 1	May 9 - May 25	Jun 11	Sep 24	Oct 10 - Nov 6	Nov 20
TN	680	Apr 5	Apr 15 - May 1	Jun 1	Sep 1	Sep 20 - Oct 15	Nov 10
TX	1,800	Feb 28	Mar 20 - Apr 29	May 15	Jul 16	Aug 6 - Sep 24	Nov 1
UT	2	Apr 15	Apr 30 - May 20	Jun 5	Sep 25	Oct 10 - Oct 30	Dec 10
VA	310	Apr 5	Apr 20 - May 20	Jun 5	Aug 25	Sep 5 - Oct 25	Nov 20
WA	120	Apr 15	May 1 - May 20	Jun 5	Oct 5	Oct 20 - Nov 20	Dec 1
WV	40	Apr 25	May 1 - Jun 1	Jun 15	Sep 10	Sep 20 - Oct 25	Nov 25
WI	3,000	Apr 25	May 1 - Jun 5	Jun 10	Oct 1	Oct 15 - Nov 15	Nov 30
WY	50	Apr 22	May 3 - May 21	Jun 10	Sep 24	Oct 11 - Nov 9	Dec 5

Usual Planting and Harvesting Dates  
December 1997

Agricultural Statistics Board  
NASS, USDA

[www.nass.usda.gov/Publications/Usual\\_Planting\\_and\\_Harvesting\\_Dates/uph97.pdf](http://www.nass.usda.gov/Publications/Usual_Planting_and_Harvesting_Dates/uph97.pdf)



# NASS CROP PROGRESS



## Crop Progress

Released November 24, 2008, by the National Agricultural Statistics Service (NASS), Agricultural Statistics Board, U.S. Department of Agriculture. For information on *Crop Progress* call Dawn Keen at (202) 720-7621, office hours 7:30 a.m. to 4:00 p.m. ET.

Note: These data are preliminary and will be released after 4:00 p.m. each Monday, except for holidays. See tomorrow's Weekly Weather and Crop Bulletin for final progress and condition estimates.

Corn: Percent Harvested, Selected States<sup>1</sup>

State	Week Ending			2003-2007 Avg.
	Nov 23, 2008	Nov 16, 2008	Nov 23, 2007	
CO	94	90	99	95
IL	95	88	100	99
IN	97	93	99	96
IA	86	70	98	98
KS	93	87	100	99
KY	100	99	100	100
MI	89	83	95	87
MN	92	80	100	97
MO	88	80	99	98
NE	82	67	99	96
NC	100	100	100	100
ND	53	33	99	93
OH	94	88	99	92
PA	87	81	87	88
SD	75	59	98	97
TN	100	100	100	100
TX	99	97	100	100
WI	83	69	97	90
18 Sts	89	78	99	97

<sup>1</sup> These 18 States harvested 93% of last year's corn acreage.

Winter Wheat: Percent Emerged, Selected States<sup>1</sup>

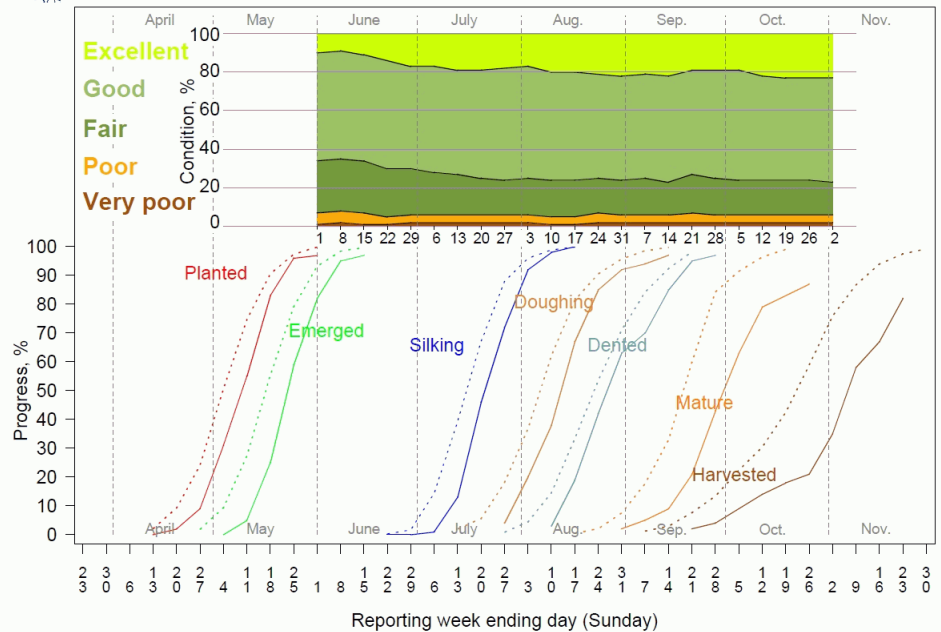
State	Week Ending			2003-2007 Avg.
	Nov 23, 2008	Nov 16, 2008	Nov 23, 2007	
AR	82	74	76	79
CA	30	20	28	31
CO	99	99	100	100
ID	97	94	95	95
IL	99	92	99	97
IN	97	94	100	95
KS	95	91	95	96
MI	100	98	100	94
MO	76	64	89	85
MT	99	97	99	96
NE	100	100	100	100
NC	41	31	44	53
OH	100	100	100	97
OK	96	92	82	92
OR	69	55	90	87
SD	100	100	100	100
TX	85	83	69	80
WA	85	81	96	97
18 Sts	92	88	88	91

<sup>1</sup> These 18 States planted 90% of last year's winter wheat acreage.

We 1 (11-08)



Crop Progress: Corn in Nebraska, 2008  
 \_\_\_\_\_ 2008, - - - - - 2003-2007 Average

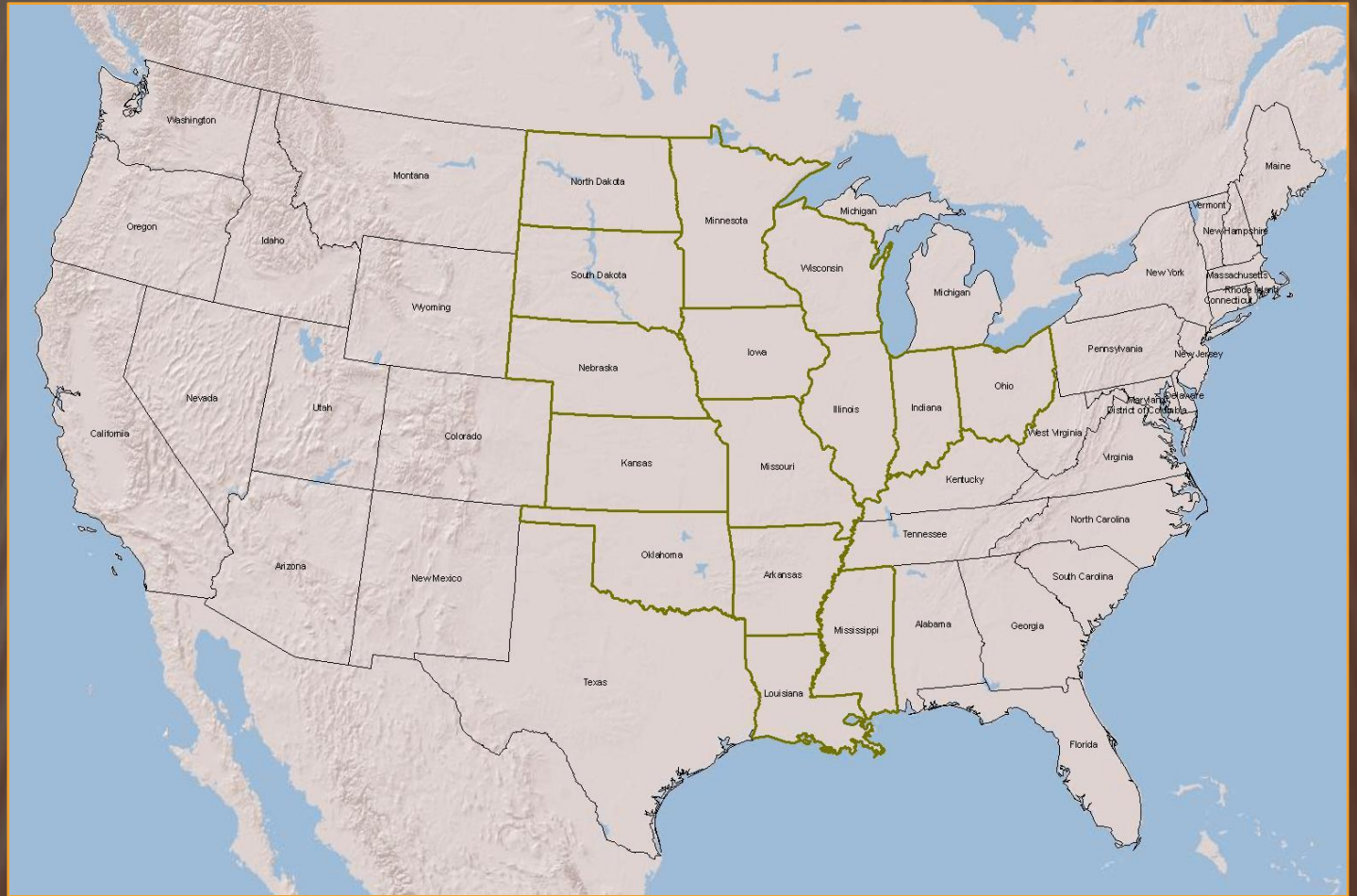


[www.nass.usda.gov/Charts\\_and\\_Maps/Crop\\_Progress\\_&\\_Condition](http://www.nass.usda.gov/Charts_and_Maps/Crop_Progress_&_Condition)



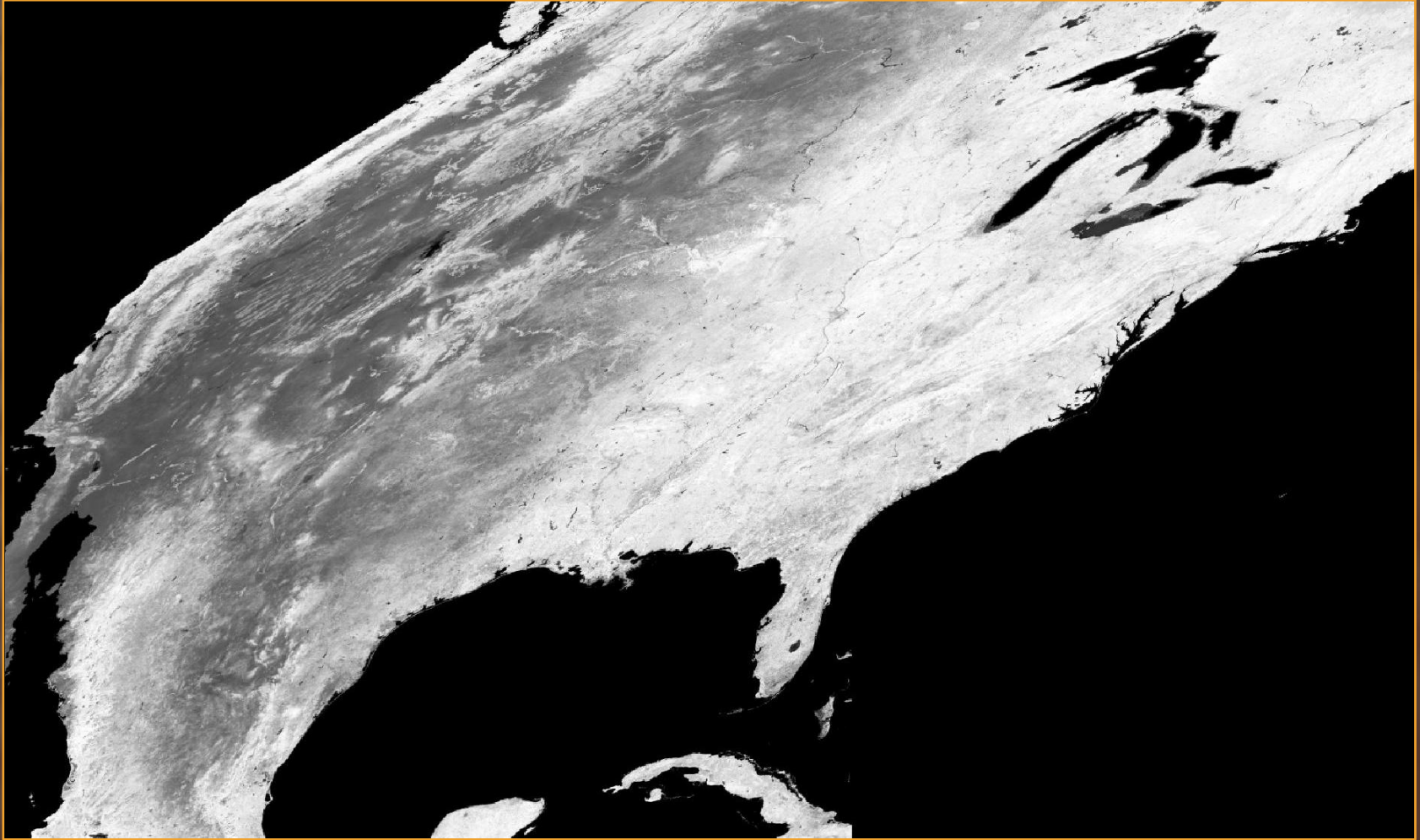
# MAJOR CROPS ACROSS THE CENTRAL USA

- ✘ Corn
- ✘ Soybeans
- ✘ Wheat
  - + Winter
  - + Spring
  - + Durum
- ✘ Cotton
- ✘ Rice
- ✘ Sorghum
- ✘ Barley
- ✘ Oats
- ✘ Alfalfa



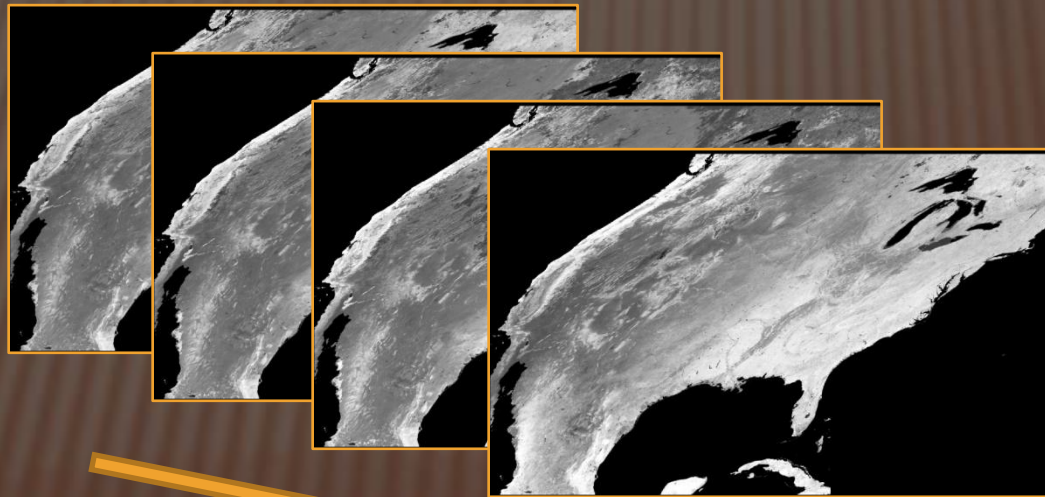
15 states analyzed in “Heartland” region

# TERRA MODIS MOD13Q1.5 NDVI IMAGERY



# 16-DAY COMPOSITE TIME SERIES DATA

- ✘ NDVI images used from 2006, 2007, 2008
- ✘ 3/21 – 11/17 time window for each year
- ✘ 16 composites per year used

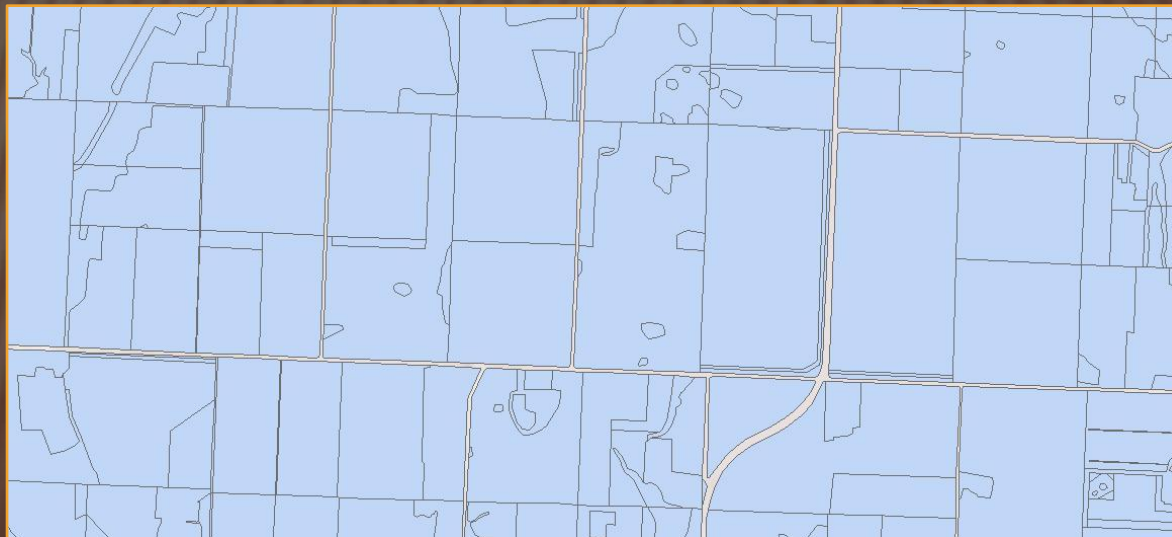




# GROUND TRUTH AVAILABILITY

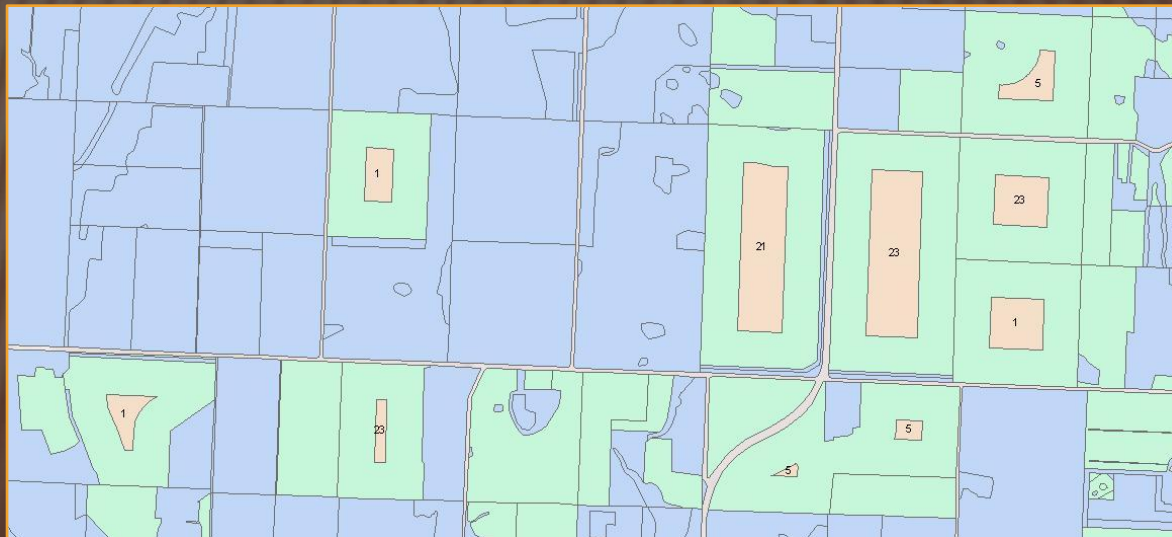
## ✘ Farm Service Agency

- + Common Land Unit (CLU) polygons joined with “578” farmer reported tabular data
- + Data available to NASS because of an interagency agreement
- + NASS has data for ‘06, ‘07, ‘08 for all central US states



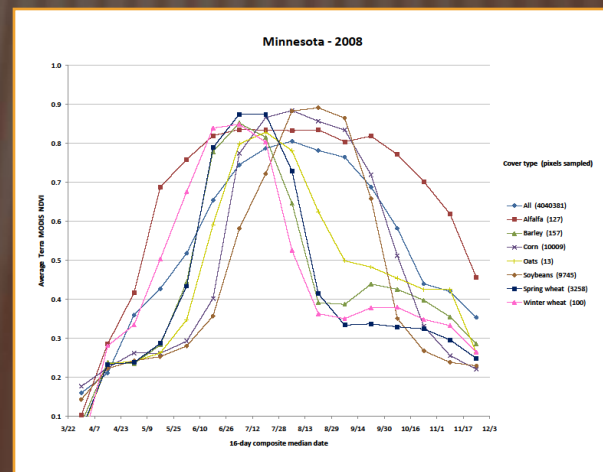
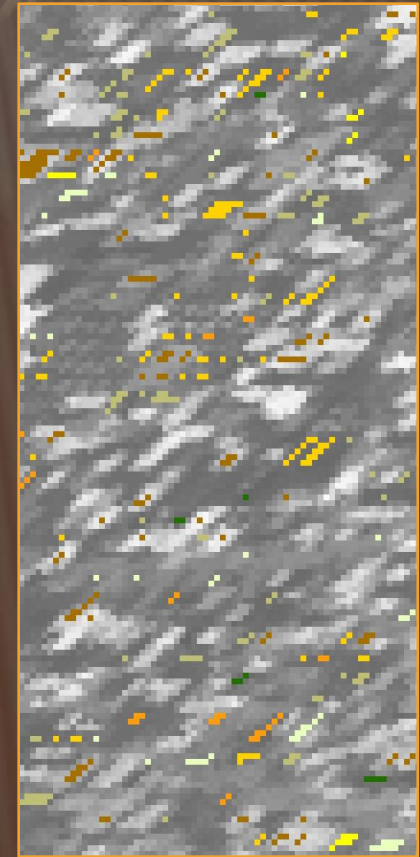
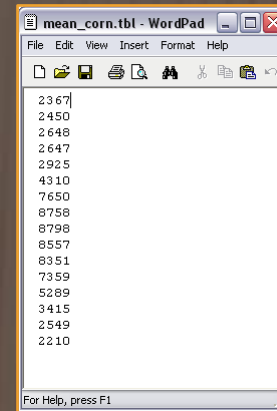
# GROUND TRUTH METHODOLOGY

- ✘ Joined CLU polygons to “578” attributes when records matched
  - + Performed state by state, year by year
- ✘ Selected only relevant polygons
- ✘ Buffered inward polygons by 232 meters (about a MODIS pixel size)
  - + to rid potentially spectrally mixed edge pixels
- ✘ Reprojected polygons to MODIS sinusoidal projection
- ✘ Rasterized polygons to MODIS pixel scale

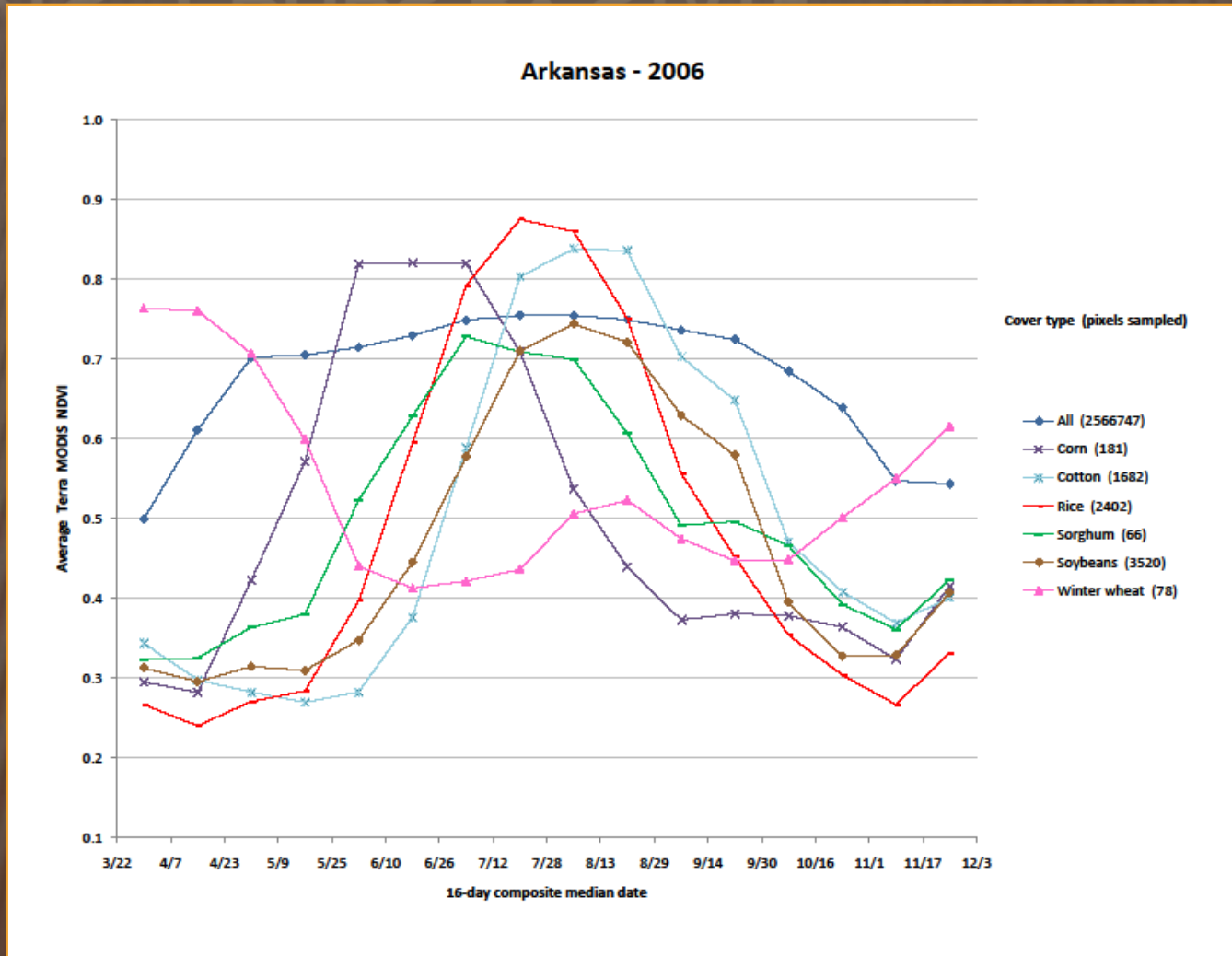


# IMAGERY STATISTICS EXTRACTION

- ✘ “Stacked” MODIS time series data by year
  - + 16 composites (spring through fall) each year
- ✘ Overlaid rasterized ground truth
- ✘ Extracted and averaged, by crop type, the MODIS pixels on a state by state basis
- ✘ Developed time series charts

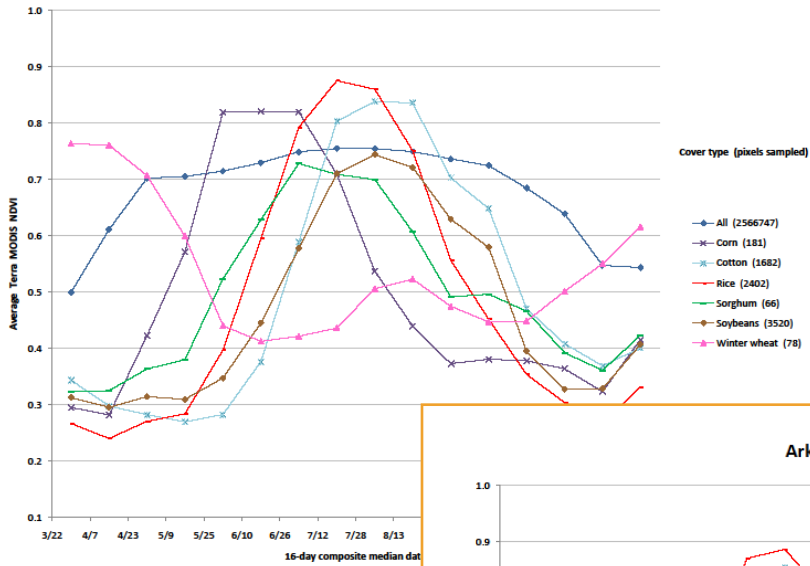


# CHARTS - CROPS BY STATE

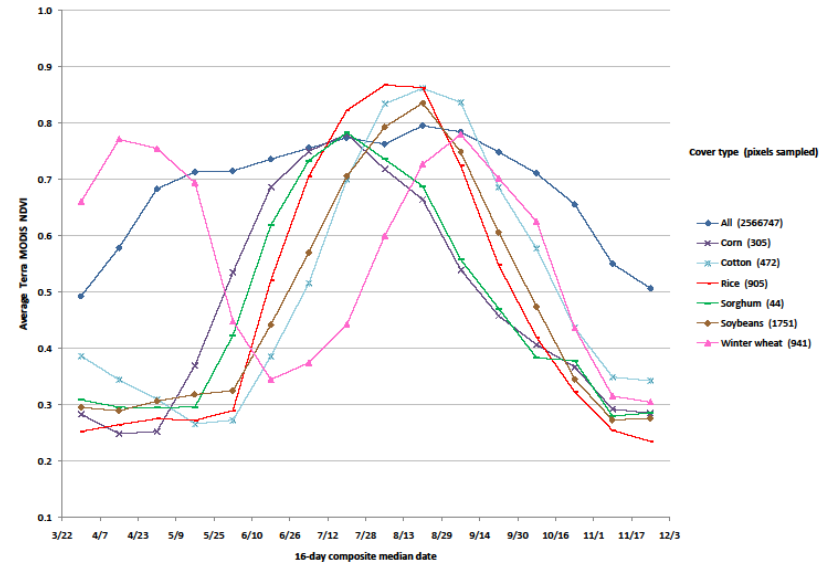


# ARKANSAS CROPS, 3 YEARS

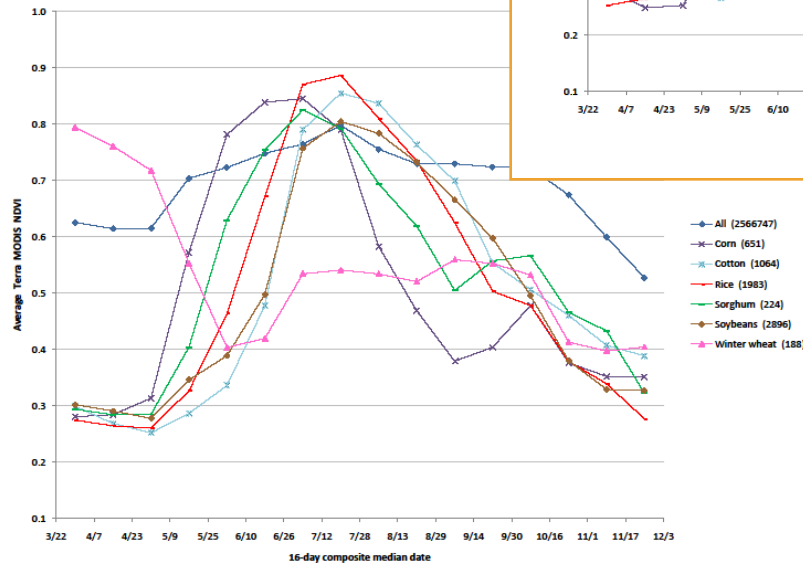
Arkansas - 2006



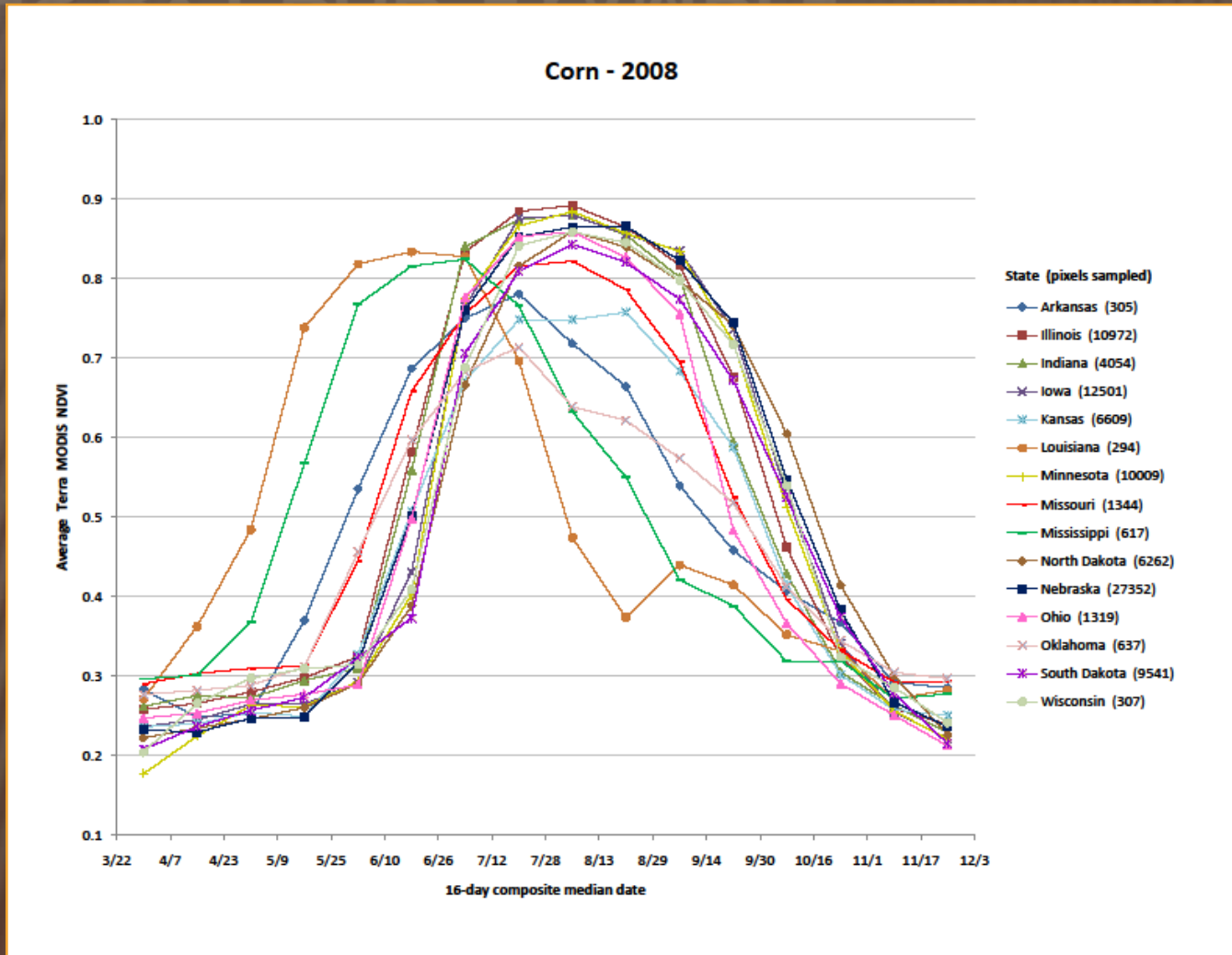
Arkansas - 2008



Arkansas - 2007

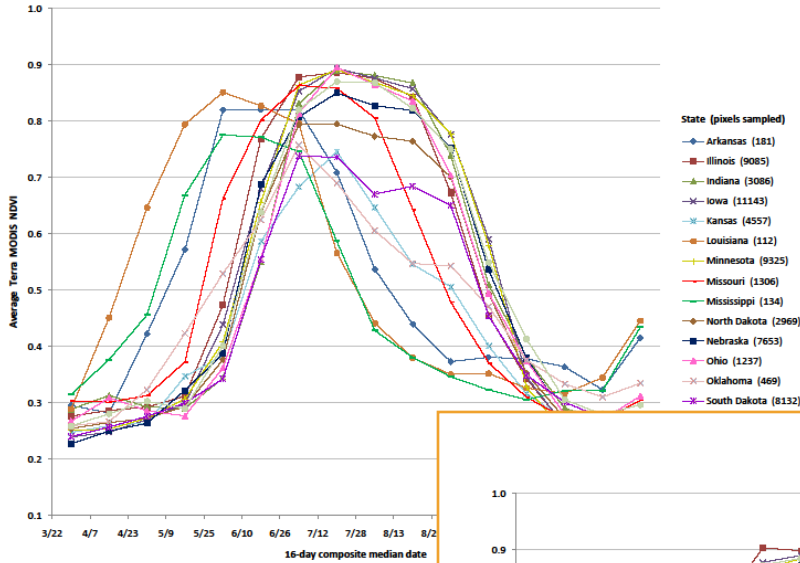


# STATES BY CROP, EXAMPLE

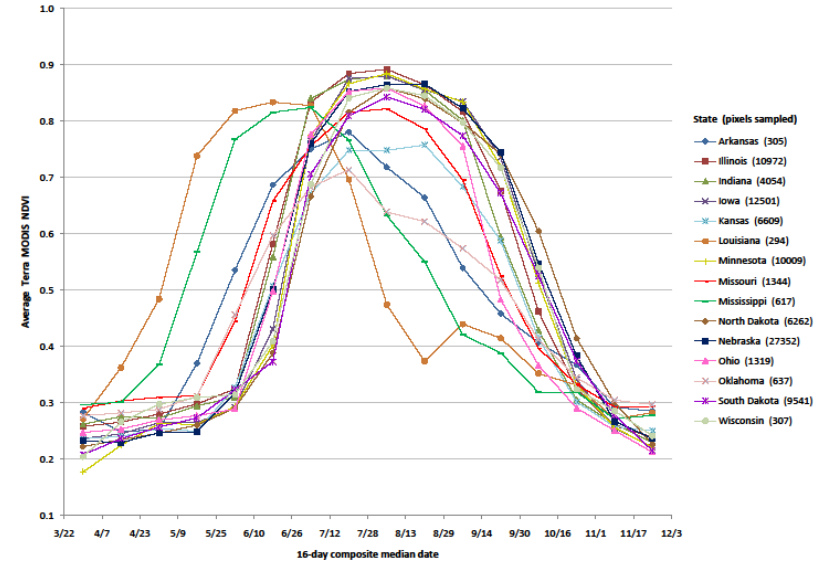


# CORN BY STATE, 3 YEARS

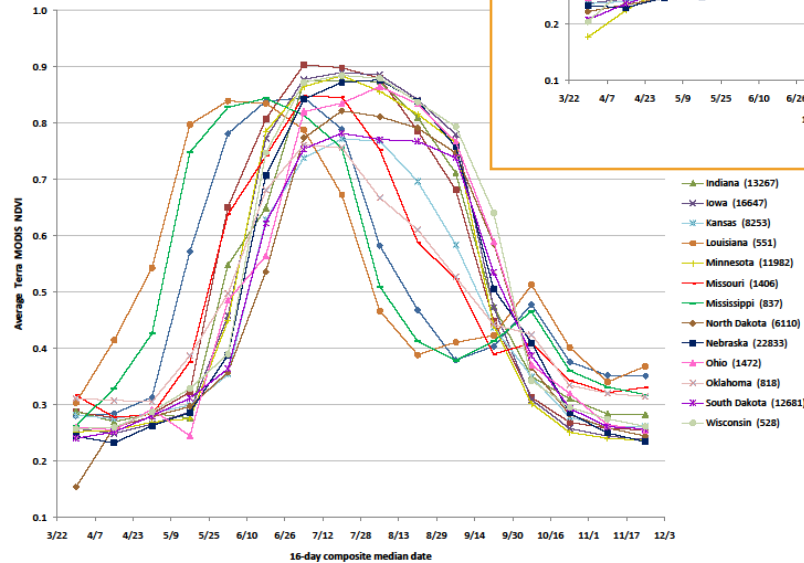
Corn - 2006



Corn - 2008

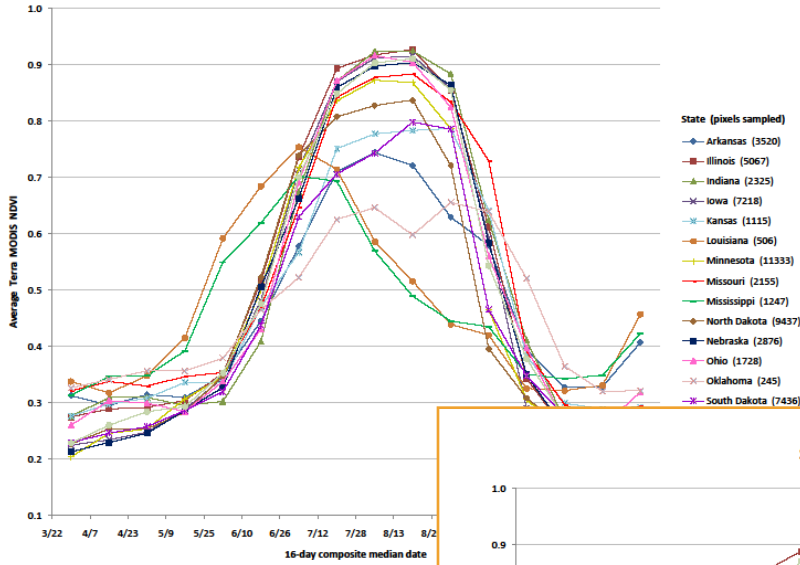


Corn - 2007

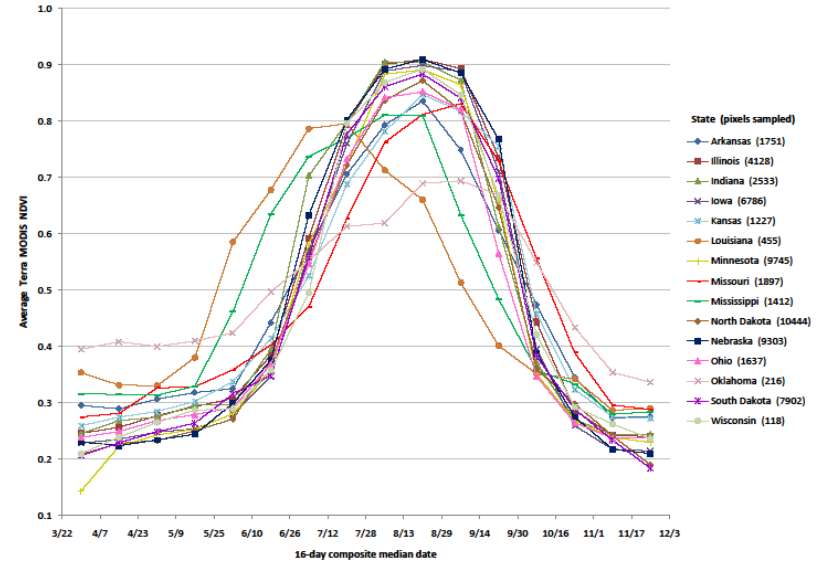


# SOYBEANS BY STATE, 3 YEARS

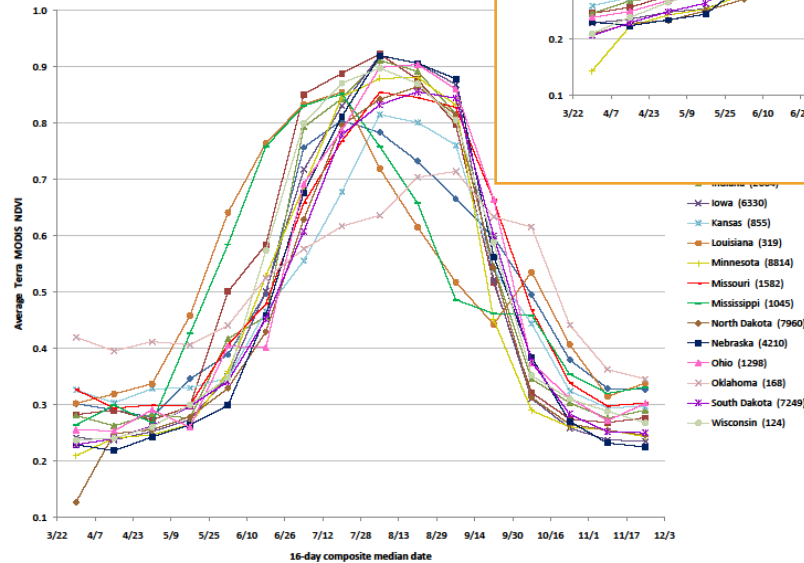
Soybeans - 2006



Soybeans - 2008



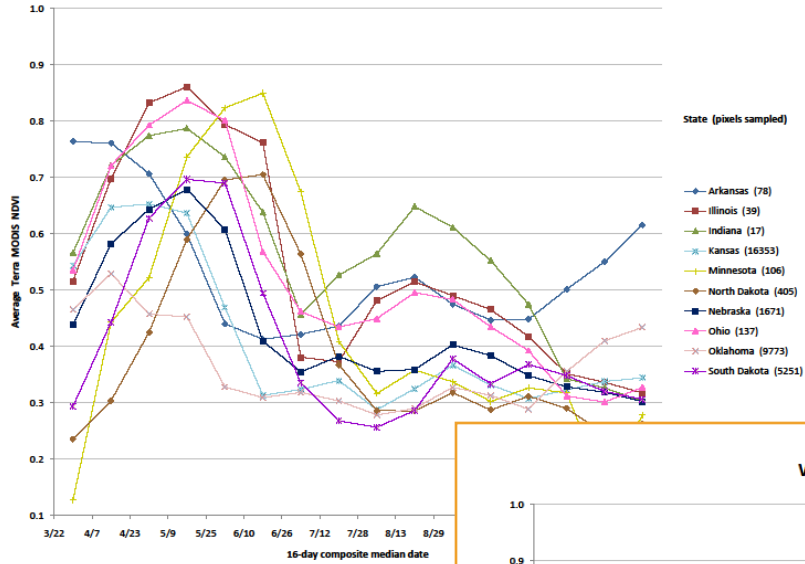
Soybeans - 2007



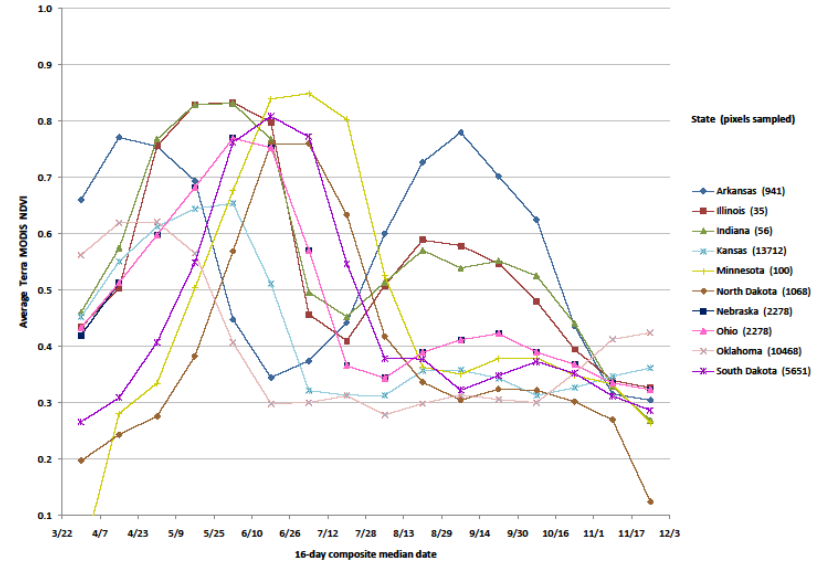


# WINTER WHEAT BY STATE, 3 YEARS

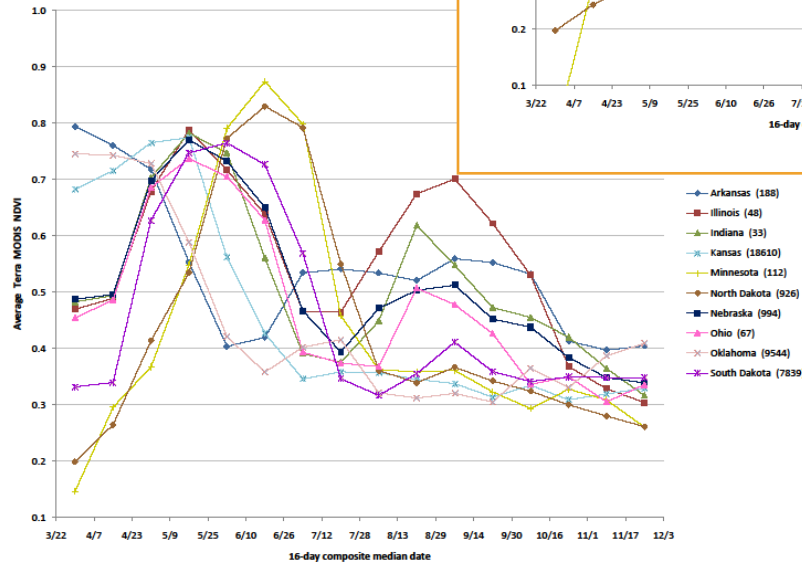
Winter Wheat - 2006



Winter Wheat - 2008

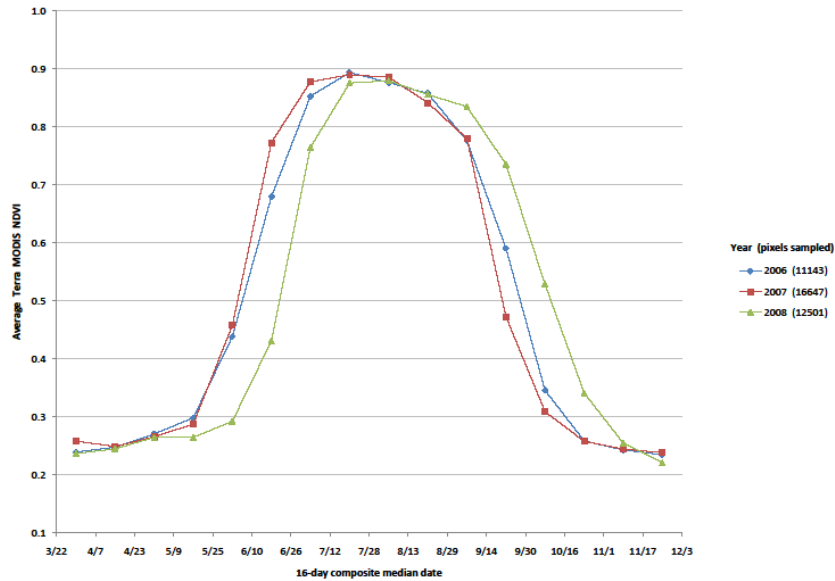


Winter Wheat - 2007

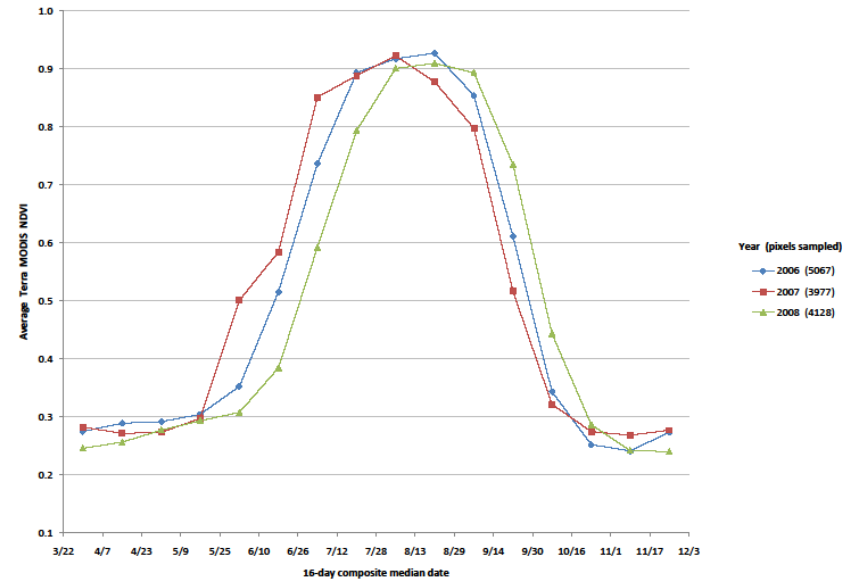


# CROPS BY STATE AND YEAR, EXAMPLES

Iowa - Corn

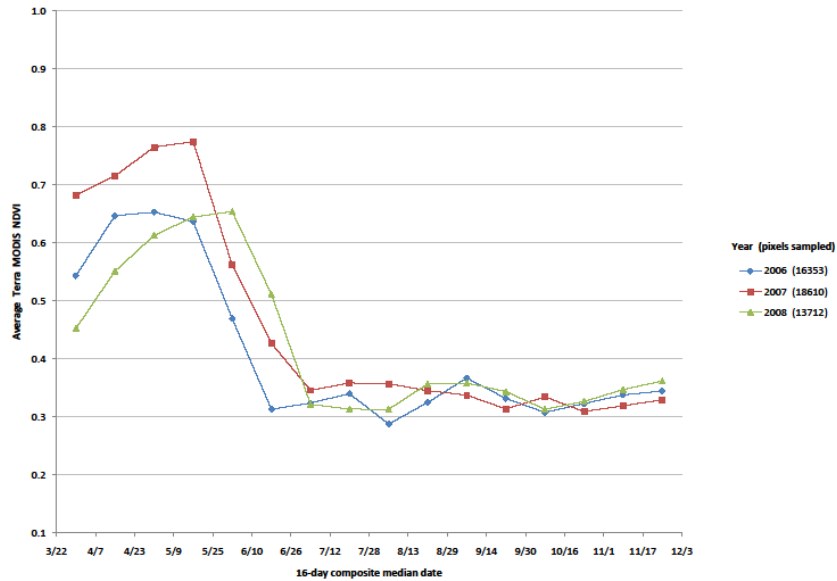


Illinois - Soybeans

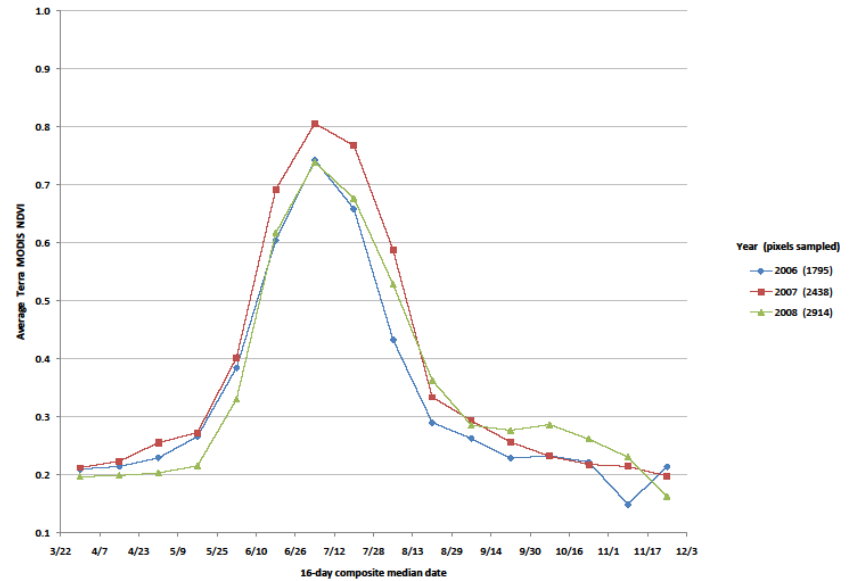


# CROPS BY STATE AND YEAR

Kansas - Winter Wheat

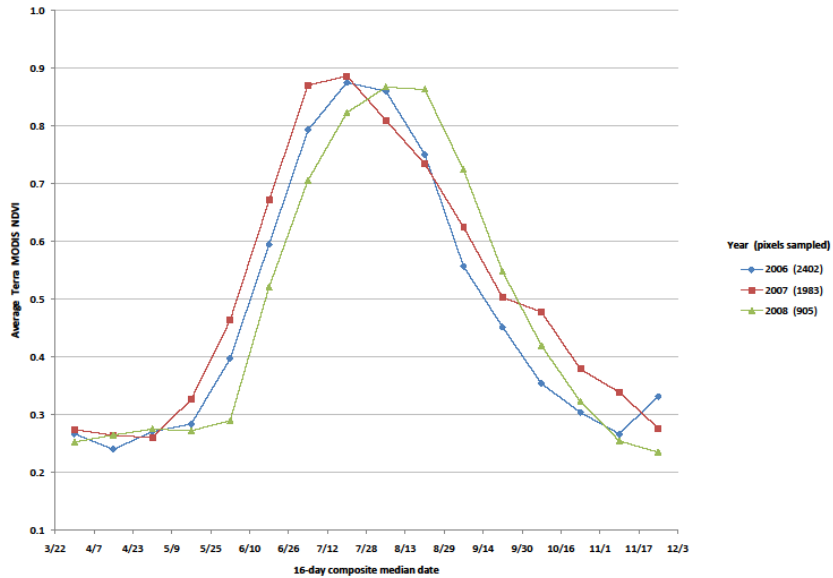


North Dakota - Durum Wheat

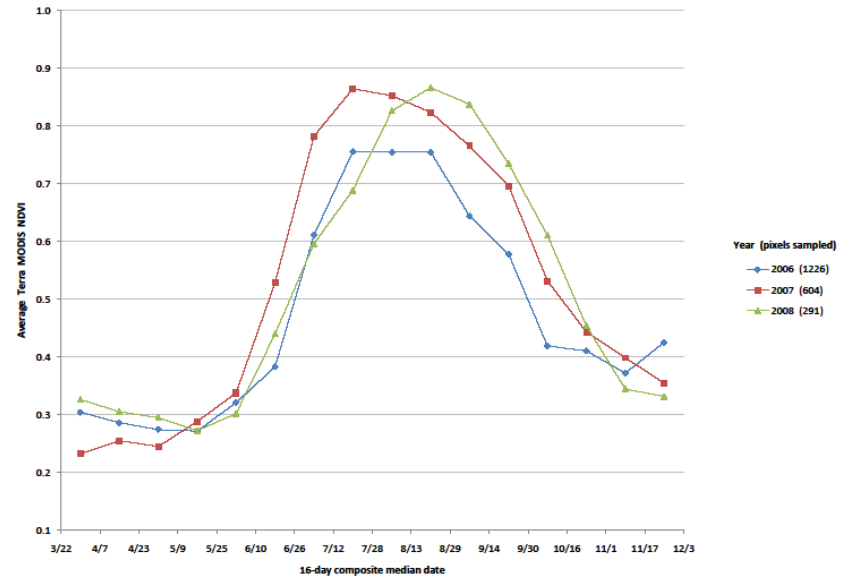


# CROPS BY STATE AND YEAR

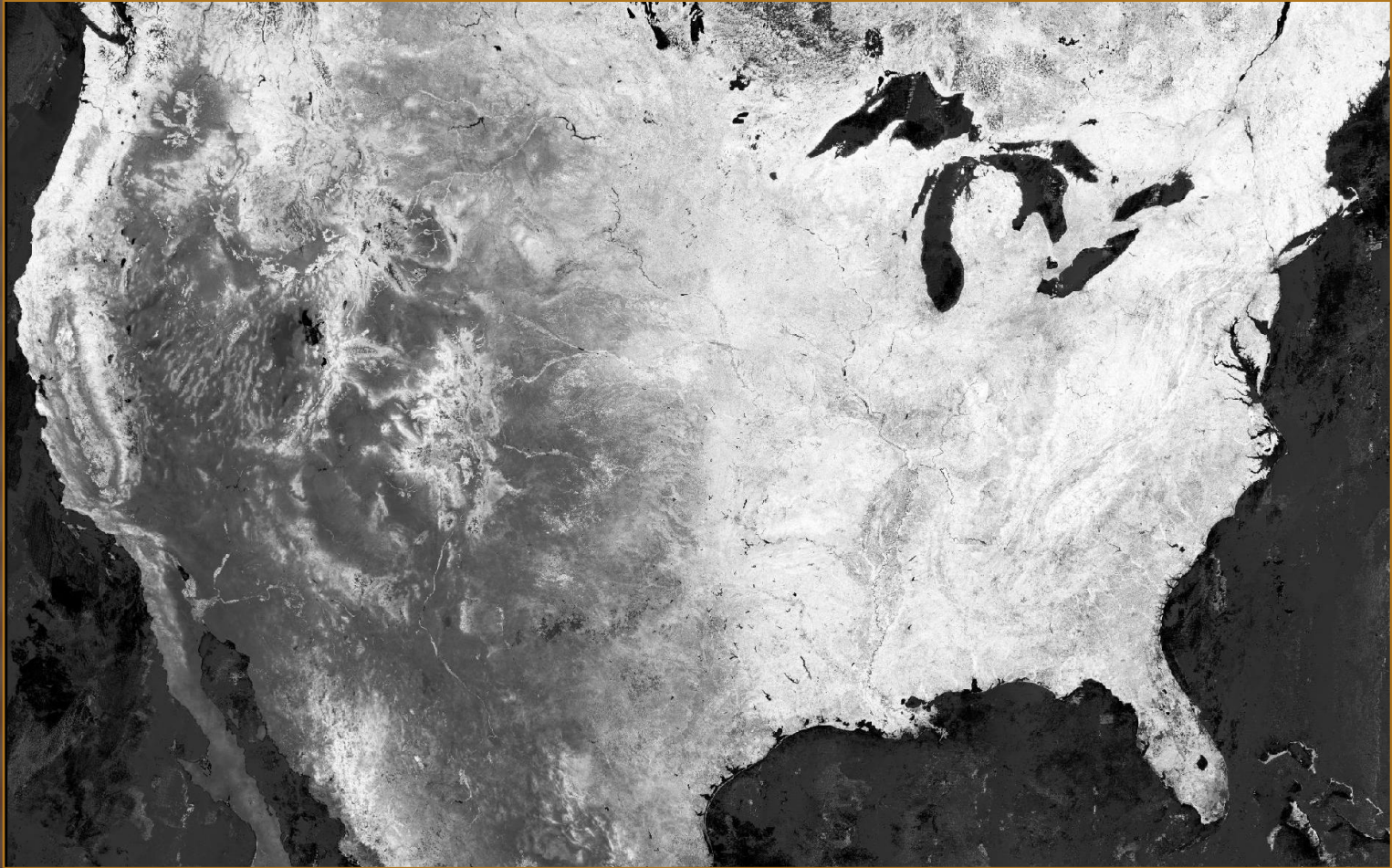
Arkansas - Rice



Mississippi - Cotton

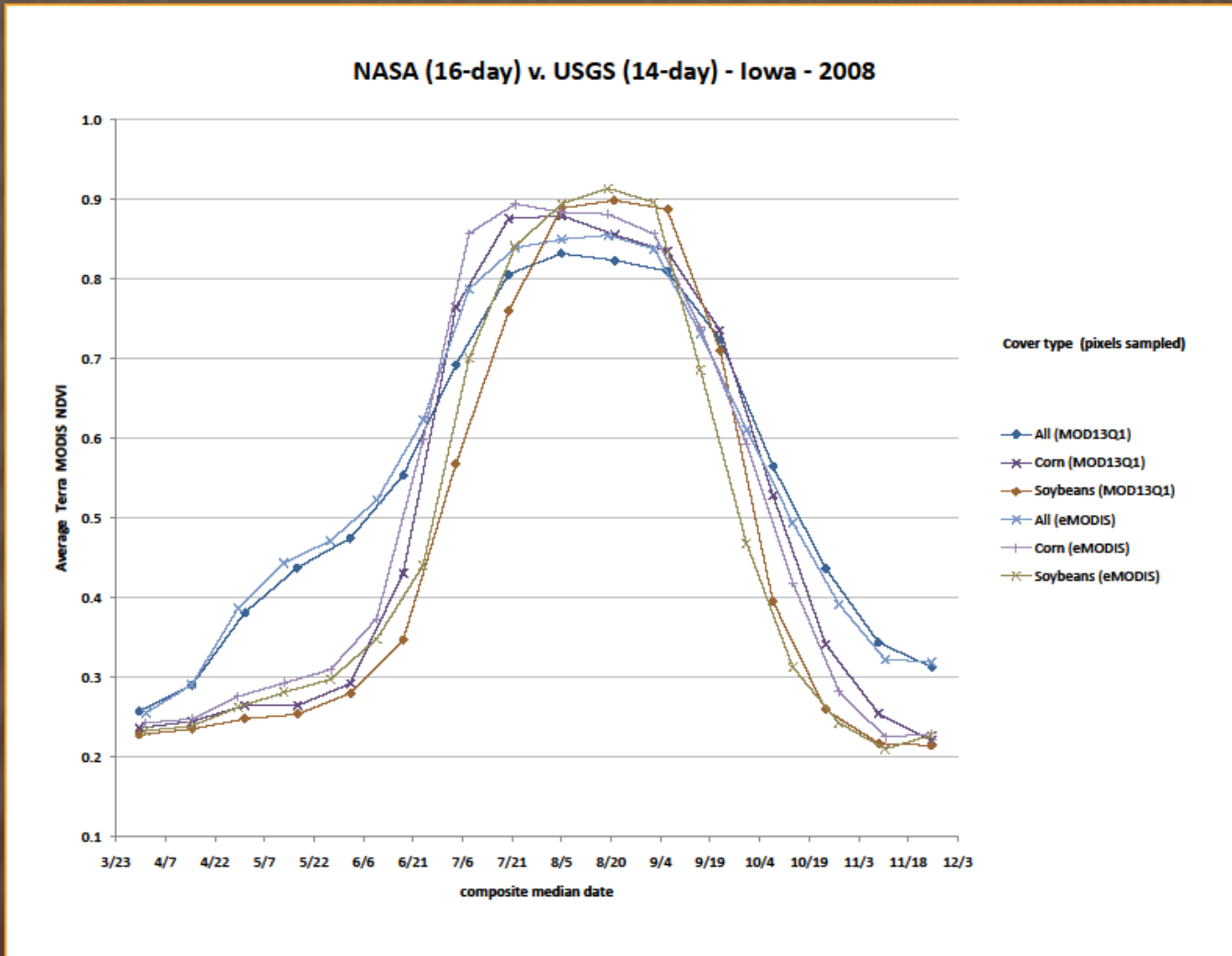


# eMODIS

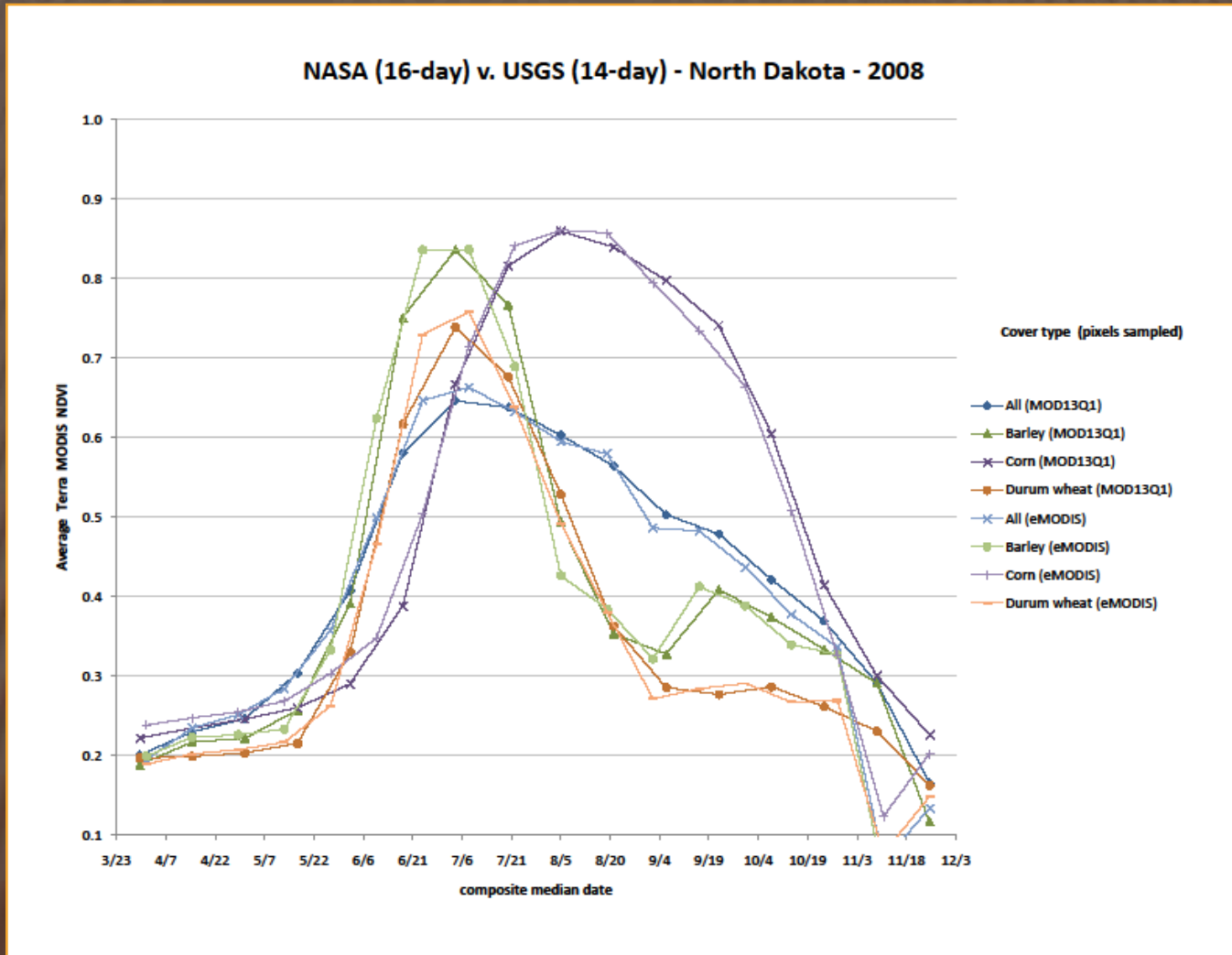


eMODIS 14-day NDVI composite example

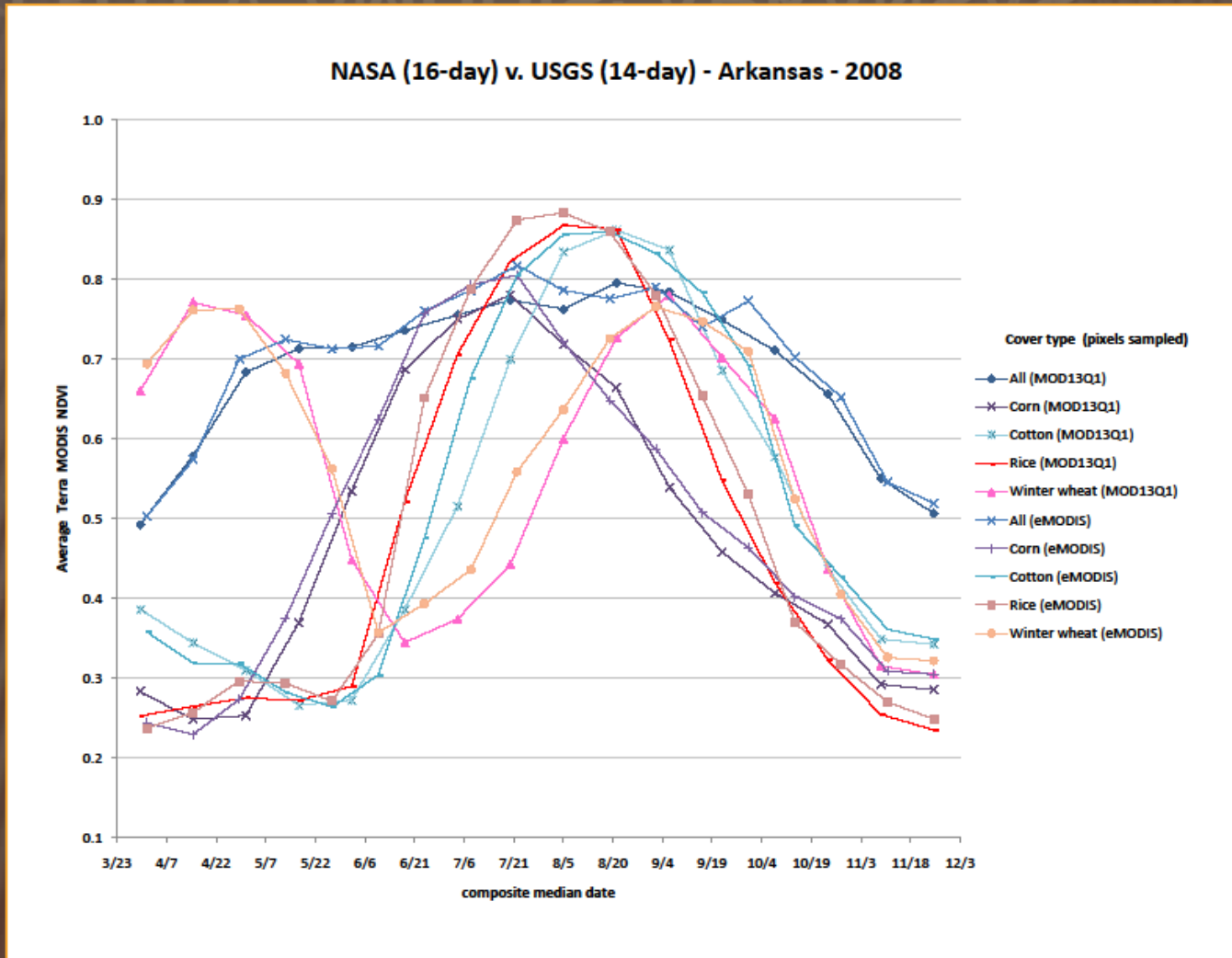
# MOD13Q1 v. eMODIS: IOWA



# MOD13Q1 v. eMODIS: NORTH DAKOTA



# MOD13Q1 v. eMODIS: ARKANSAS





# SUMMARY

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- ✘ A comprehensive and up-to-date overview of the cropping lifecycles in the central US is shown
- ✘ Based on robust ground truth
- ✘ eMODIS looks comparable
- ✘ Could be disaggregated to smaller regions for dominant categories
- ✘ Could include a few other crops
  - + Sunflowers, Canola, Sweet Potatoes, Sugarbeets, Dry beans, Potatoes...
- ✘ Time series profiles could, and should, be analyzed against planting guide, crop progress, climate data, yield information, etc.

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# THANKS

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