

MODIS Derived Vegetation Phenologies from the United States Heartland

David M. Johnson

United States Department of Agriculture, National Agricultural Statistics Service

Introduction

The following time-series charts describe the phenology, or seasonal life cycle, in terms of satellite observed Normalized Difference Vegetation Index (NDVI) for primary crops across 15 intensively cultivated states of the interior United States for 2008. They were derived by intersecting known field location and crop type information from the Farm Service Agency (FSA) against remotely sensed imagery from the National Aeronautics and Space Administration's (NASA) Terra polar orbiting Earth observing satellite. These charts help objectively portray the growth and senescence of crops and may also be useful for analysis against crop progress, condition, or yield information. Crops analyzed are alfalfa, barley, corn, cotton, oats, rice, sorghum, soybeans, and wheat (durum, spring, winter).

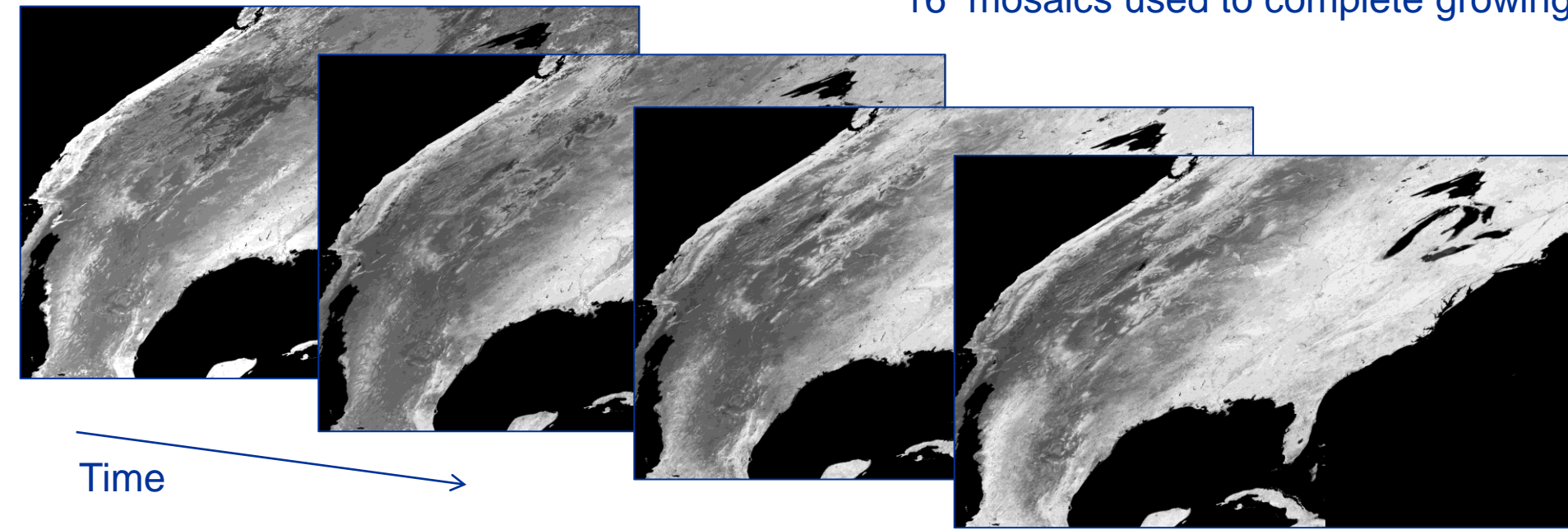
Background

NDVI is a biophysical measurement of the amount of biomass and vigor of vegetation and calculated from multispectral imagery channels as

$$NDVI = (\text{Near-infrared} - \text{Red}) / (\text{Near-infrared} + \text{Red})$$

Theoretical values range from -1.0 to 1.0 but more practically 0.1 is typically close to the minimum (correlated with bare soil) while 0.9 is near the maximum (representing dense, fully leafed-out vegetation). Because NDVI is normalized it allows for consistent comparison of vegetation conditions across differing imagery dates and thus ideal for time-series analysis. The imagery data utilized was collected by the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard the NASA Terra satellite. Specifically analyzed was the derived 16-day composited, 250 meter resolution, NDVI layer from the freely available "MOD13Q1" science product.

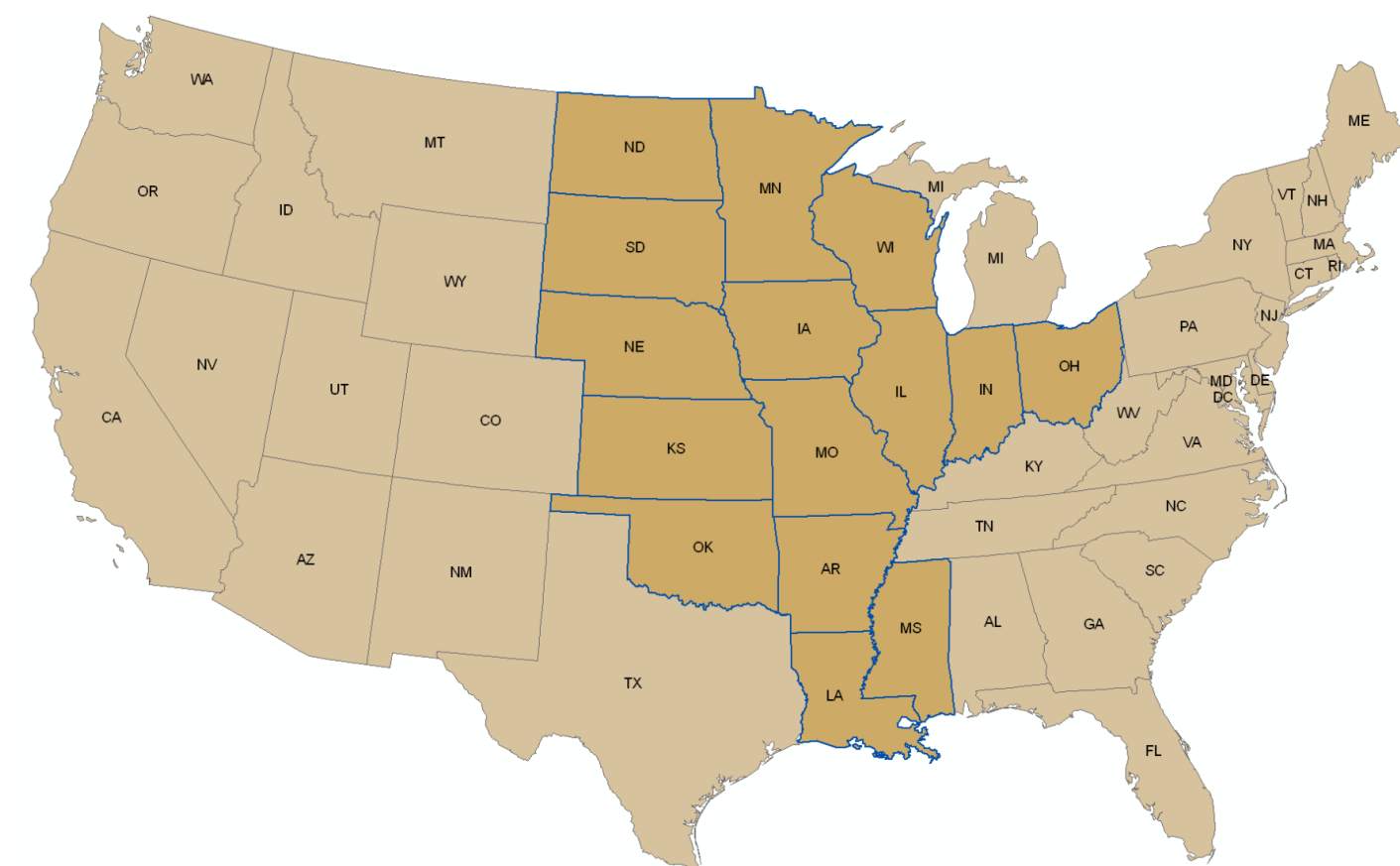
16 mosaics used to complete growing season



The data is a "best of" single image mosaic derived through an algorithm which chooses the best acquisitions, from dozens possible, within set 16-day time spans. Effectively created is an image every 16 days with little contamination from atmospheric obstructions (e.g. clouds and haze) or ground cover anomalies (e.g. snow or standing water). The utilized image mosaics ranged from March 22 to December 3, 2008, for a total of 16, and were adequate to document both fall and spring planted crops.

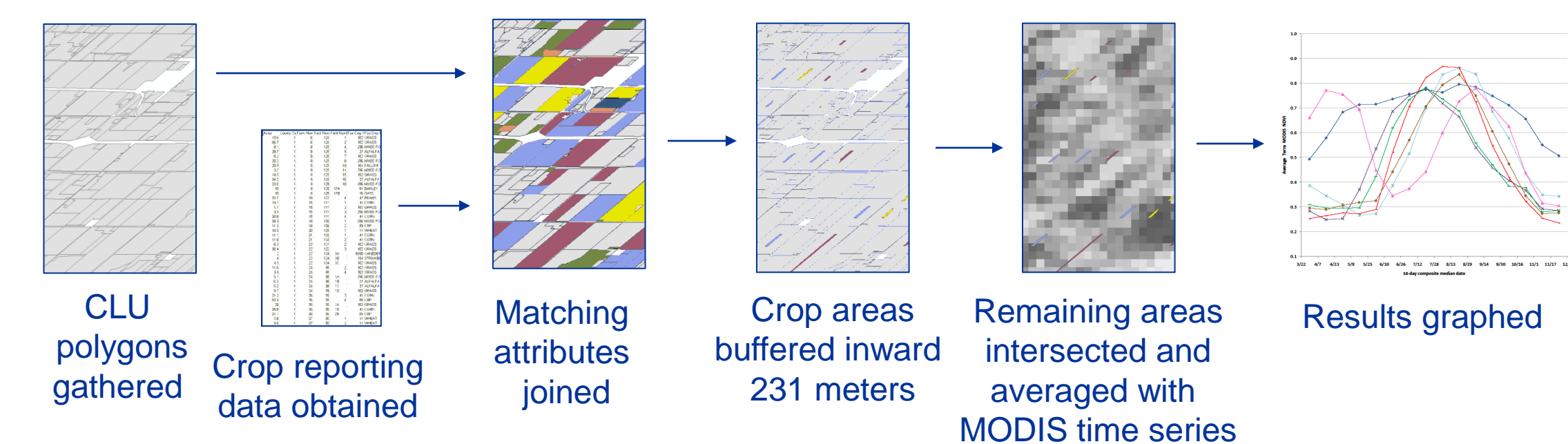
Study area

States included are Arkansas, Illinois, Indiana, Iowa, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, and Wisconsin.

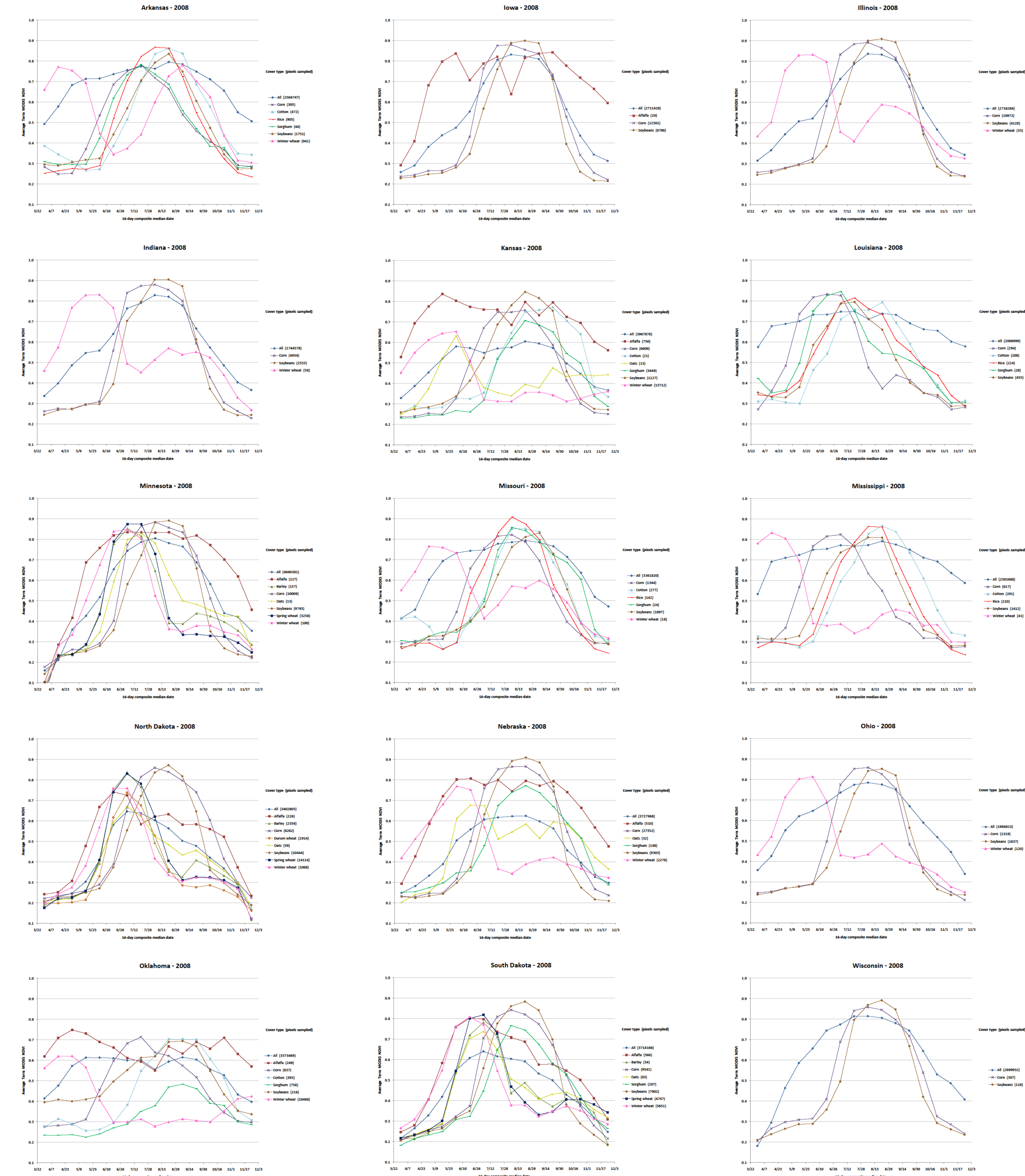


Methodology

Ground information needed to ascertain which portions of the images pertained to what crops was gathered from the FSA. FSA's "form 578" farmer crop reporting data was matched with FSA's Common Land Unit (CLU) polygon based geographic information system (GIS) data. Next, the matching GIS records were spatially "buffered" inward by 231 meters, or a true MODIS pixel size, to assure that no field edge pixels, which likely contain mixed cover types, were included. The remaining buffered FSA areas were then intersected with the MODIS time series and averaged for each crop by state to provide the representative phenological curve. All analysis was done in the MODIS sinusoidal projection. Crops found in abundance have more samples going into the mean (the number of pixels used are displayed in the legend's parentheses) and are thought to be more accurate. Any crop that did not contain at least 10 samples within a state was excluded. The average time-series profile for all pixels within the state, regardless if cropland or not, was also included for reference.

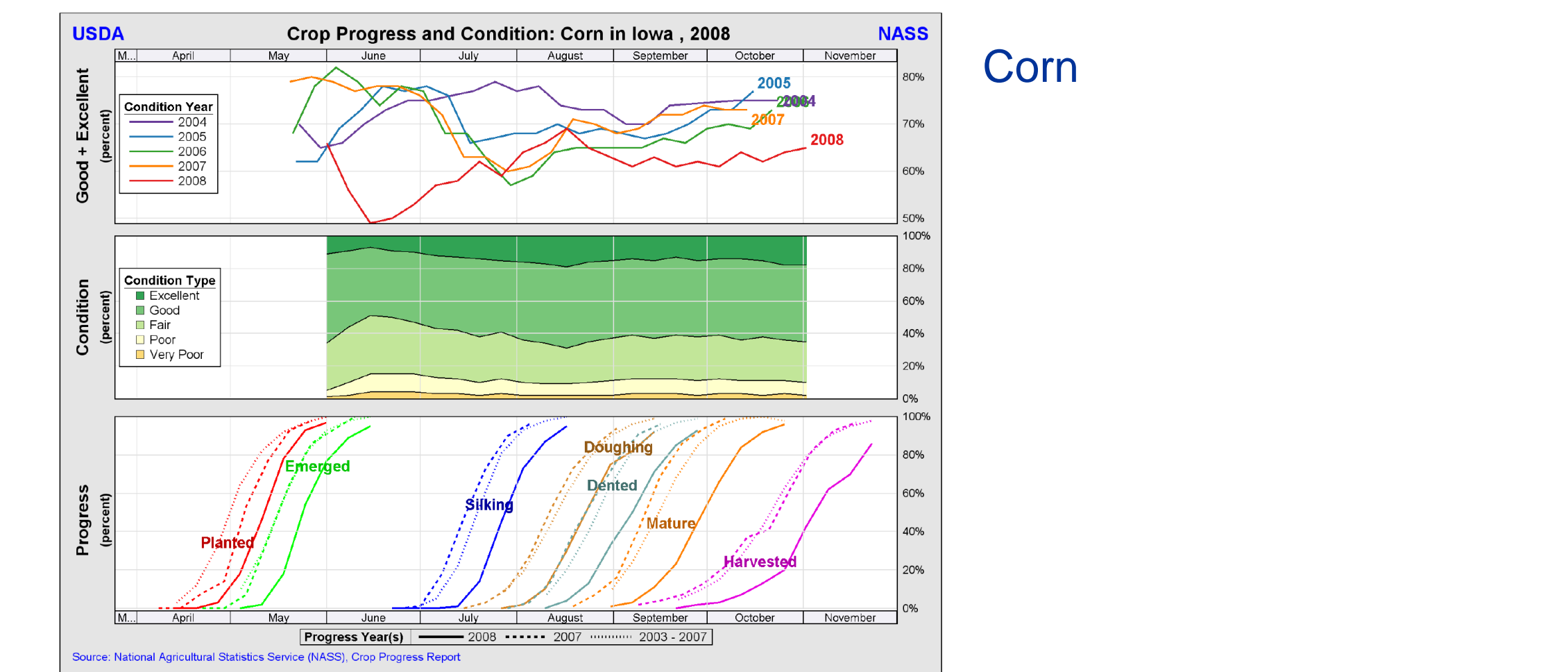


State-level 2008 results



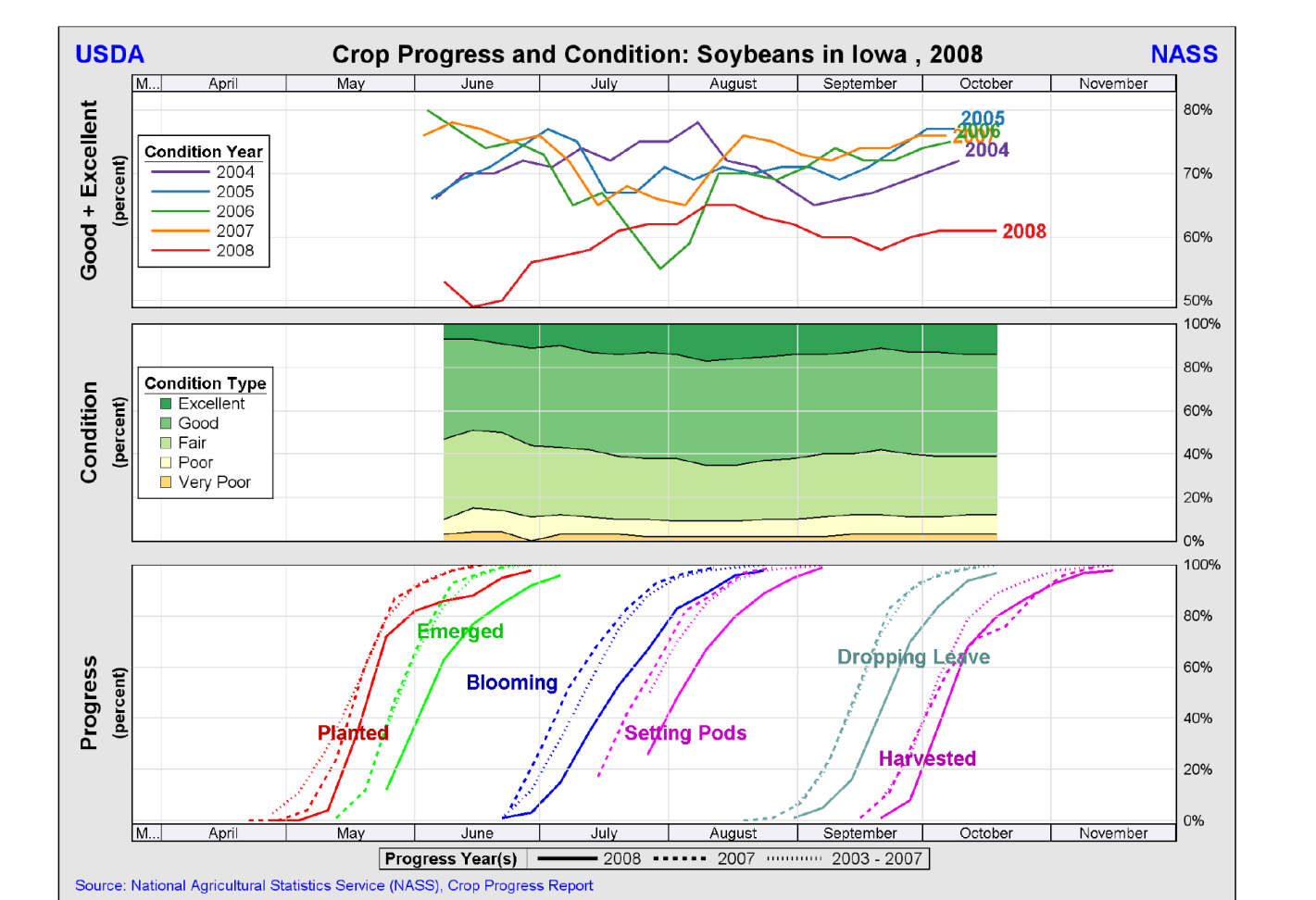
Relation to crop progress reports

During the growing season NASS subjectively reports on the progression and condition of crops at a state-wide basis. Graphical representations for Iowa corn and soybeans are shown for example. These could be used for intercomparison.



Corn

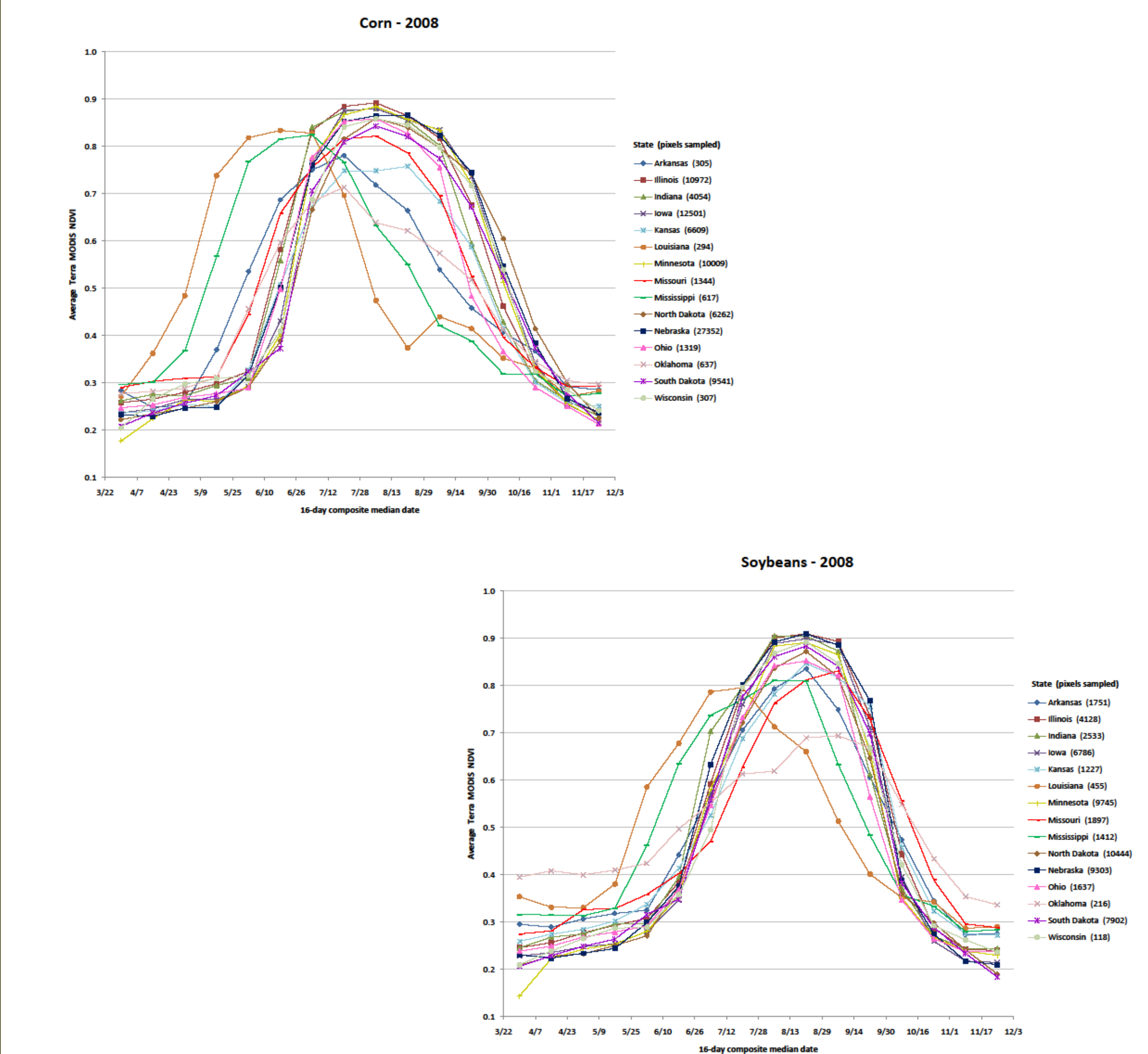
Soybeans



Current and historical charts can be obtained at: www.nass.usda.gov/Charts_and_Maps/Crop_Progress_&_Condition/index.asp

Regional comparisons

To better describe the differences in phenology based on geographic region, examples of corn and soybeans plotted by state are shown.



These charts, and those for 2006 and 2007, can be obtained at: www.nass.usda.gov/research/sarsblog/

Correspondence

Email: dave_johnson@nass.usda.gov
Phone: 703-877-8000 x169
Web: www.nass.usda.gov/research

