

Identifying Corn and Soybeans based on Phenological Profiles

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Rational of This Research

- The assessment of crop progress and condition requires early season identification of crop types.
- This technique of deriving ground truth with crop phenological profiles is useful at times when the Cropland Data Layer(CDL) and the Farm Service Agency (FSA) Common Land Unit (CLU) Data are not available.
- The challenge is the identification of crop types during the earliest stages of the growing season without ground truth information.
- Further, this research can be applied to remote sensing applications in which ground truth are not available

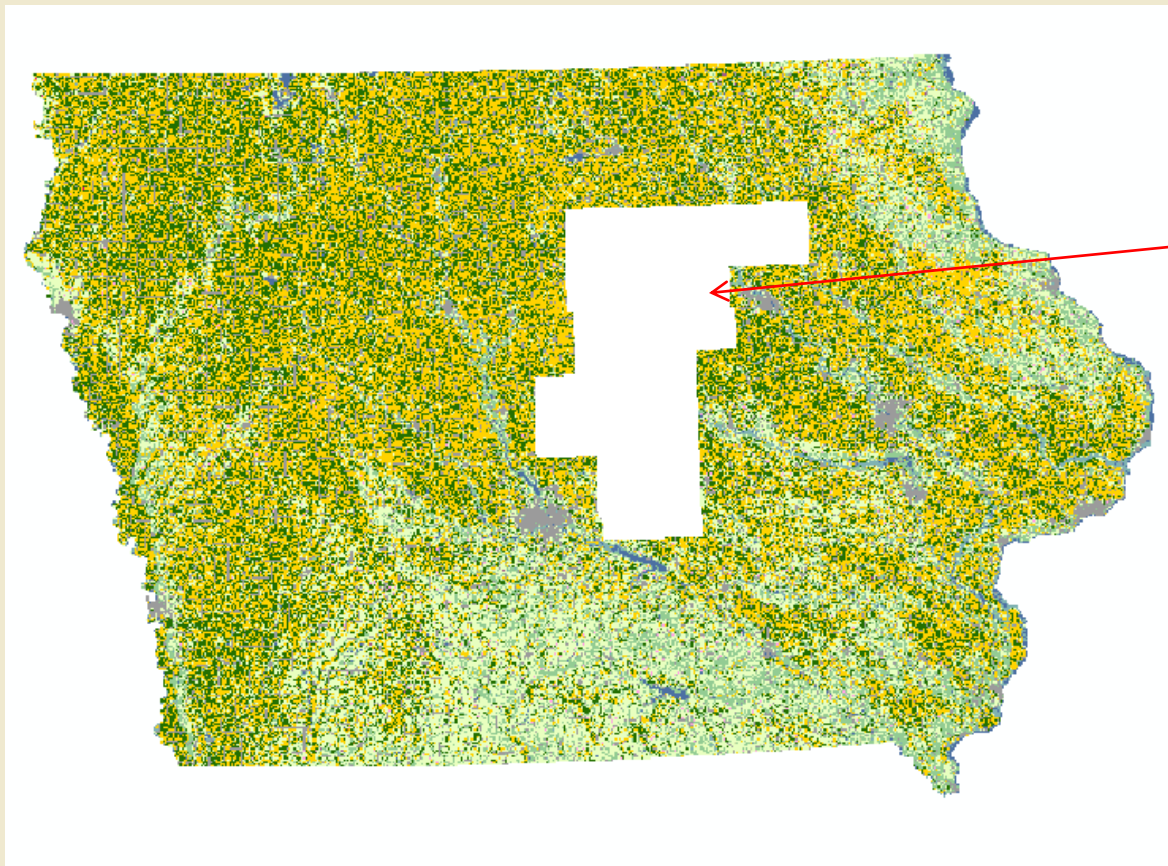


Methodology

- Study site selected in Iowa, 2008 based on availability of cloud free images acquired early in the crop season.
- Utilized Five Advanced Wide Field Sensor (AWiFS) images – 6/5, 6/15, 6/30, 7/5, 7/14
- Run unsupervised (no ground truth) classifications to derive land cover clusters for assessing phenological profiles
- Run NDVI calculations for all images
- Select sample locations for deriving phenological profiles

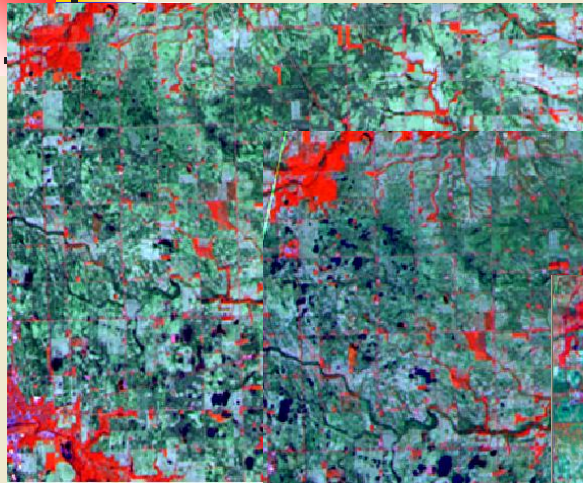


Study Area – Iowa 2008

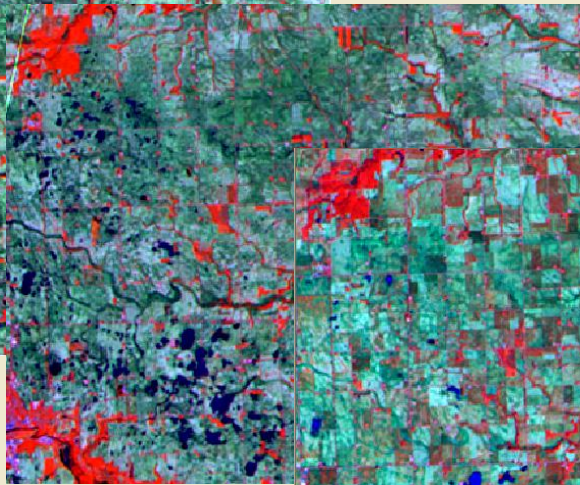


Study Area

AWiFS Image Data



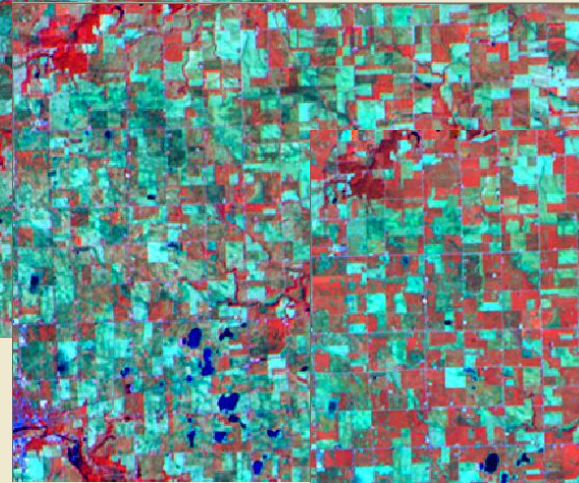
June 1



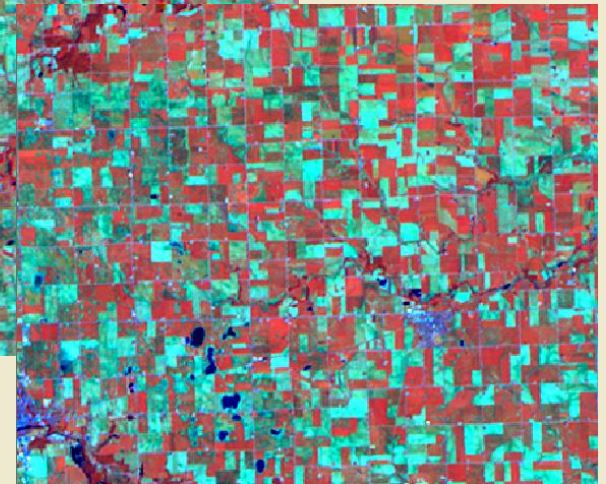
June 16



June 30



July 5



July 14

Zoom of Iowa, 2008
Study site

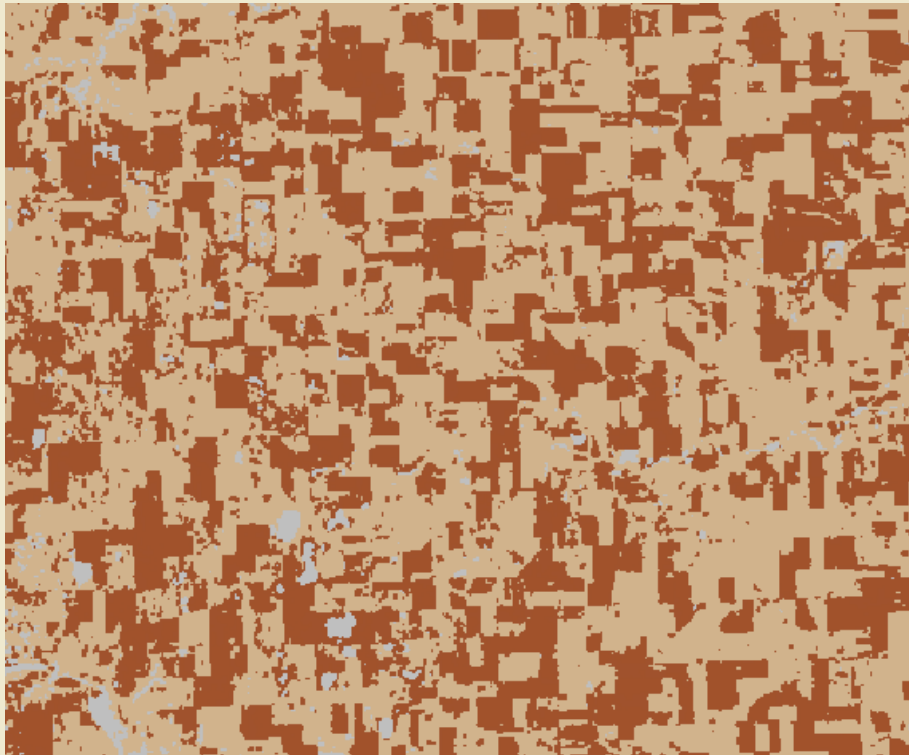


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Unsupervised Classification

(No ground truth/ ISODATA algorithm)



Using 7/15/2008 AWiFS image

An ISODATA algorithm was used to perform the unsupervised classification of the study site

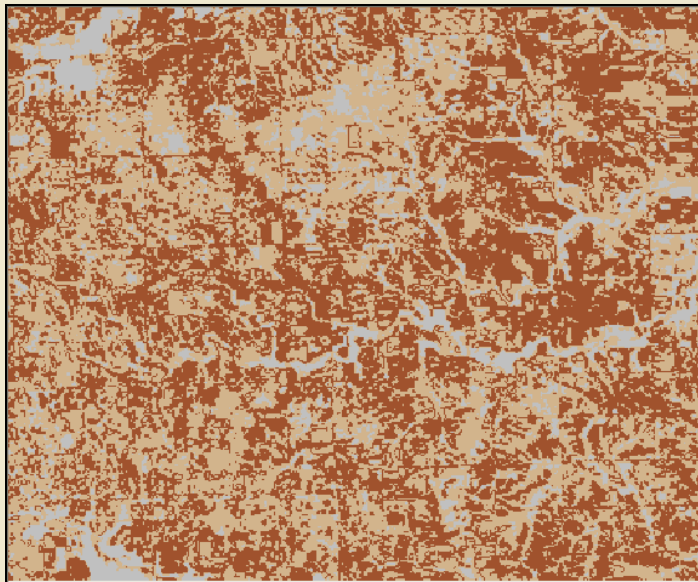
The ISODATA clustering method uses the minimum spectral distance formula to form clusters.

Clusters are used to identify locations for selection of profiling sample points.

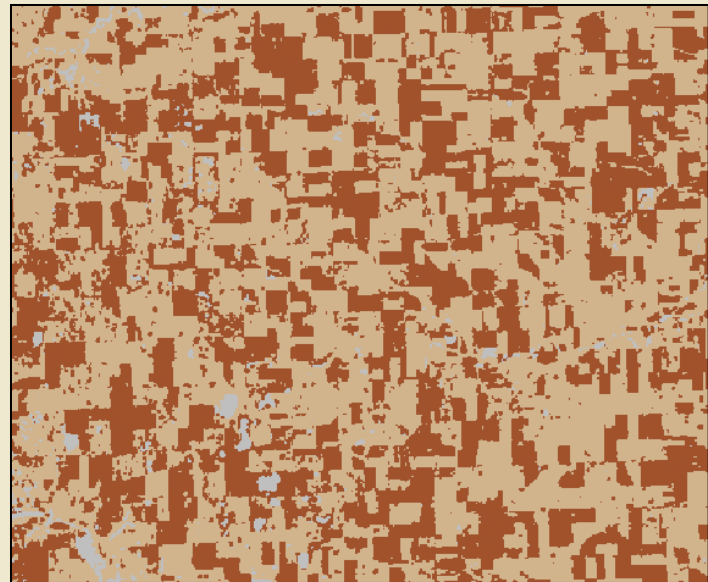


Unsupervised Classification

To determine locations for selection of phenological profile points



Using 5 scene layer stack



Using 7/15/2008 AWiFS acquisition



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Normalized Difference Vegetative Index (NDVI)

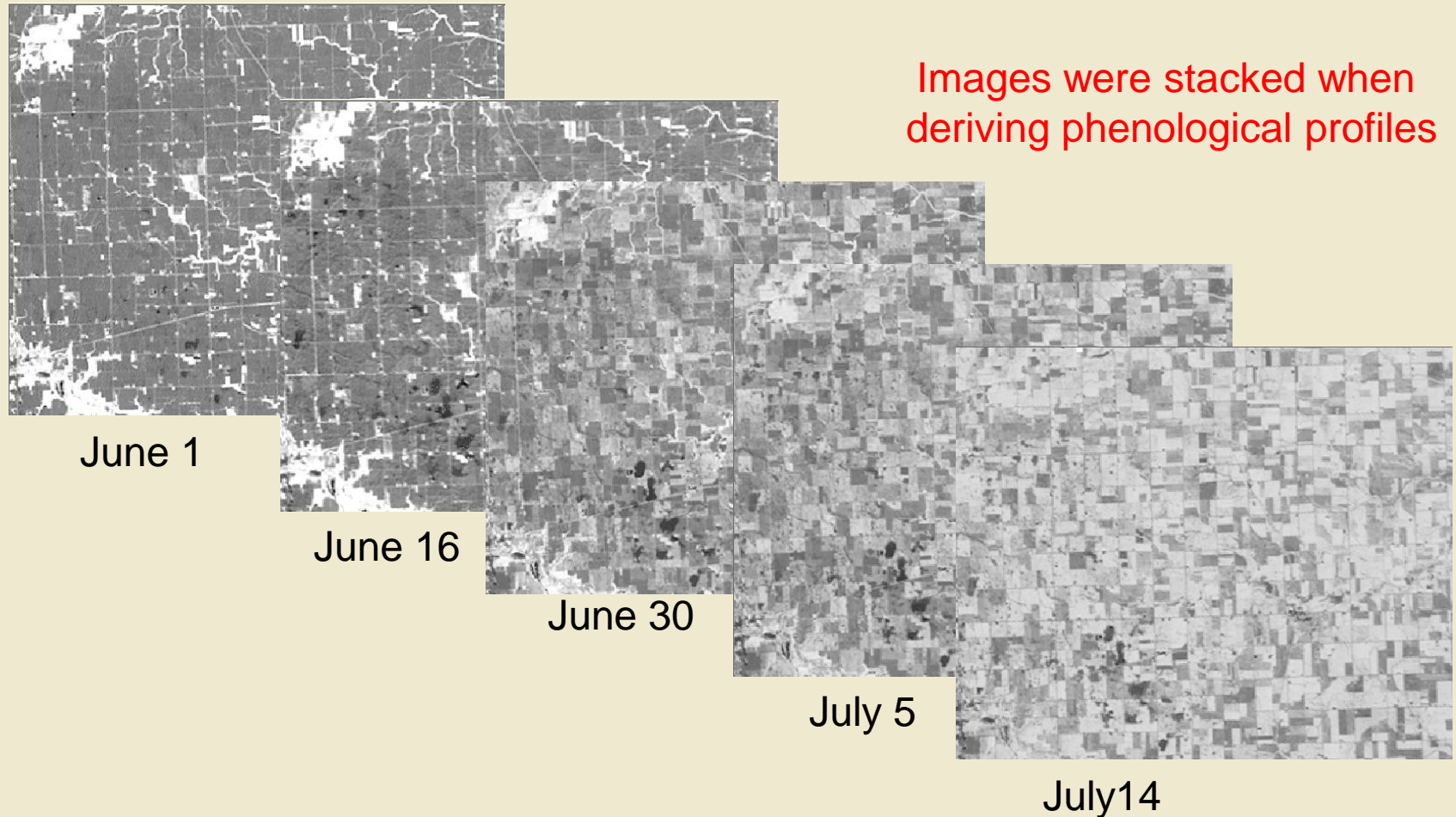
$$\text{NDVI} = (\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red})$$

- NDVI is an index used to measure vegetation condition and ranges between -1.0 and +1.0
- Red and NIR refer to the reflectance measurements acquired in the red and near infrared (NIR) bands of the spectrum.

Normalized Difference Vegetative Index (NDVI) images derived from AWiFS Images

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

Images were stacked when
deriving phenological profiles

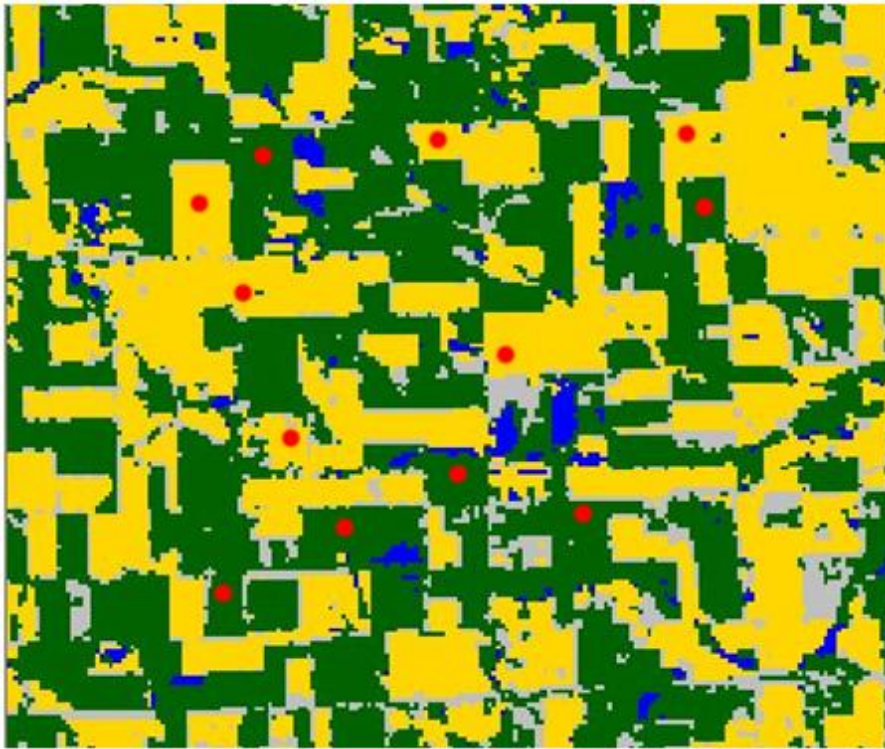




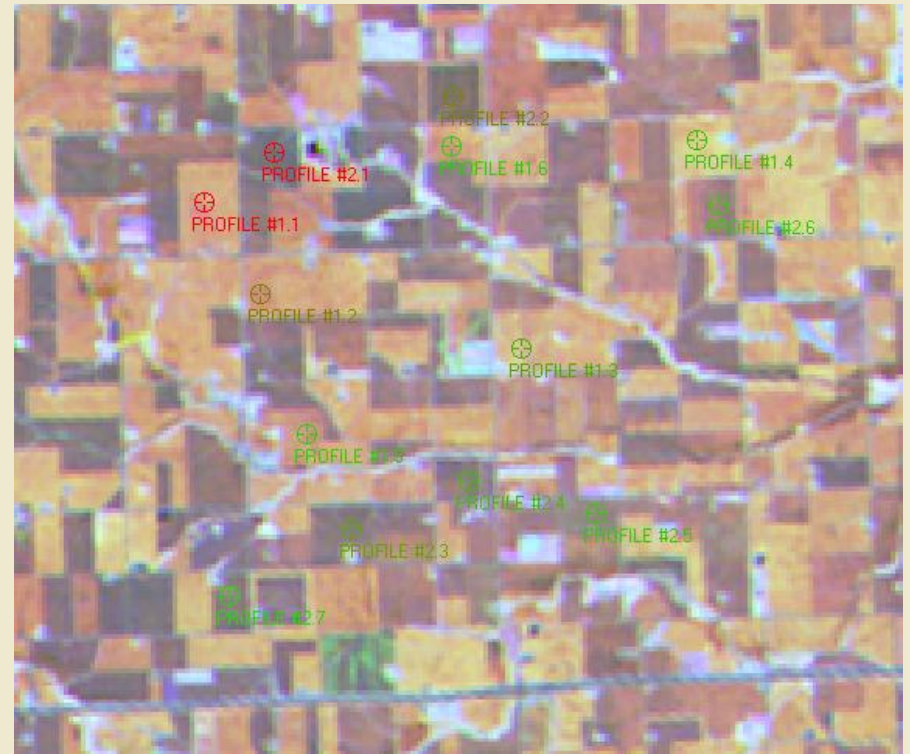
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- **Select sample locations for deriving phenological profiles**

Select Sample Pixels for Crop Phenology Profiling



Determine locations based on clusters for selection of phenology profiling sample pixels



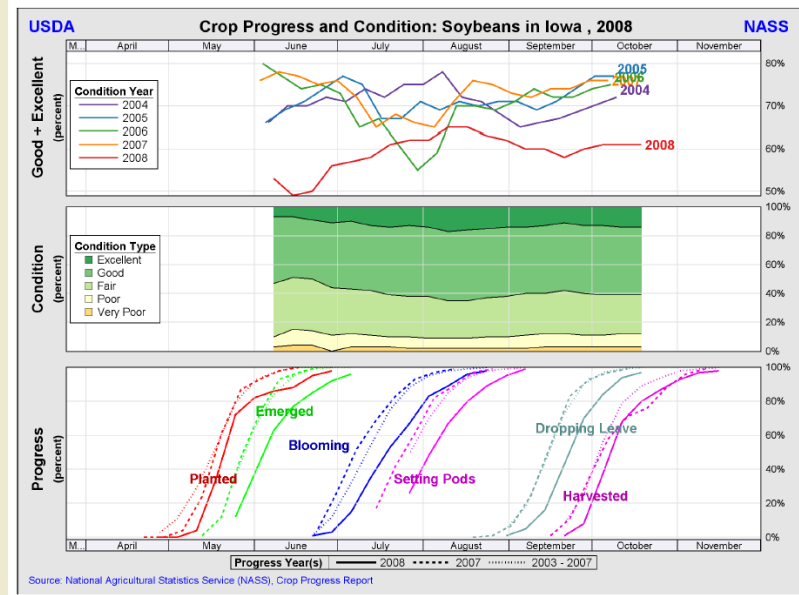
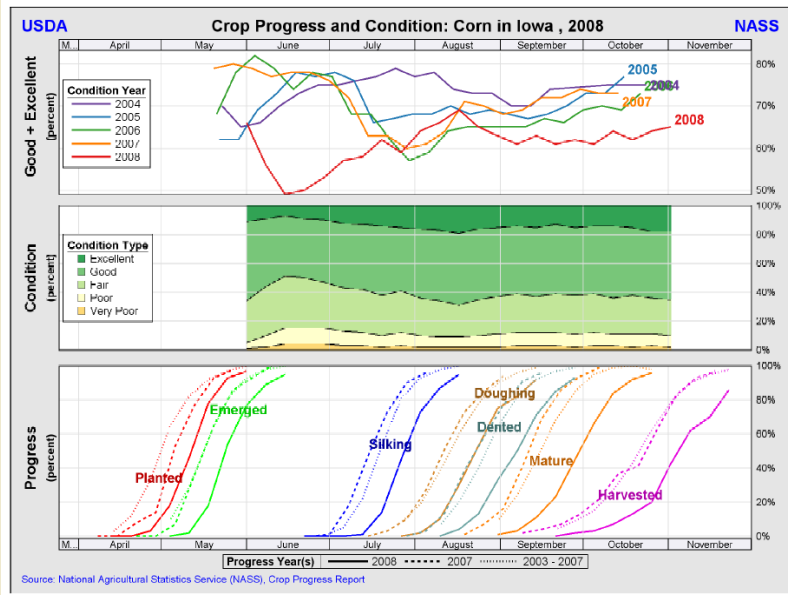
Stacked NDVI images with phenology profiling pixels selected.



Methodology

- Use NDVI images to derive phenological profiles for sample pts.
- Using expert knowledge of corn and soybean phenology to determine corn and soybean sample pts.
- Generate ground truth data from NDVI profile points
- Use ground truth data to perform supervised classifications
- Results examined

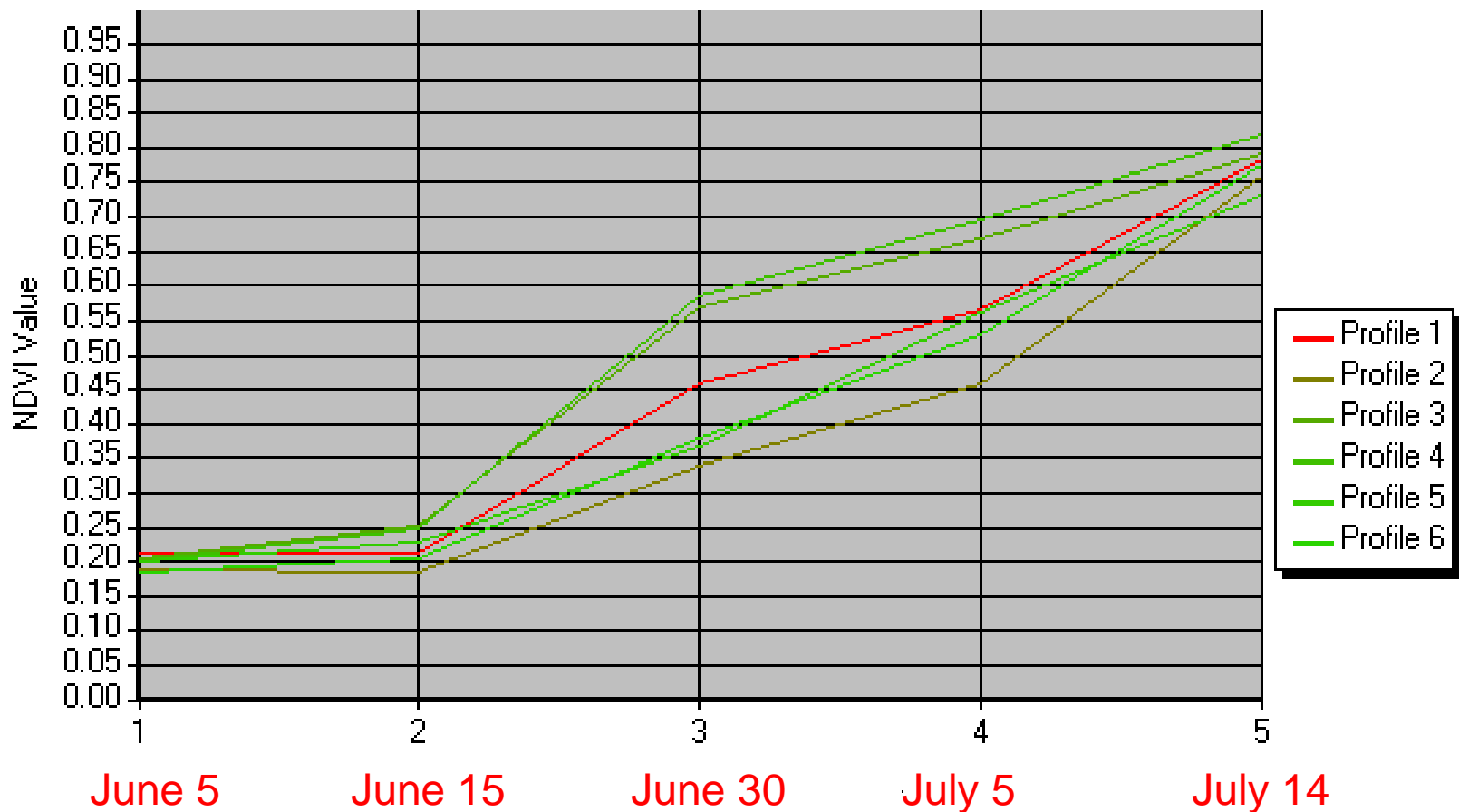
Crop Progress Knowledge



Source: http://www.nass.usda.gov/Charts_and_Maps/Crop_Progress_&_Condition/2008/IA_2008.pdf

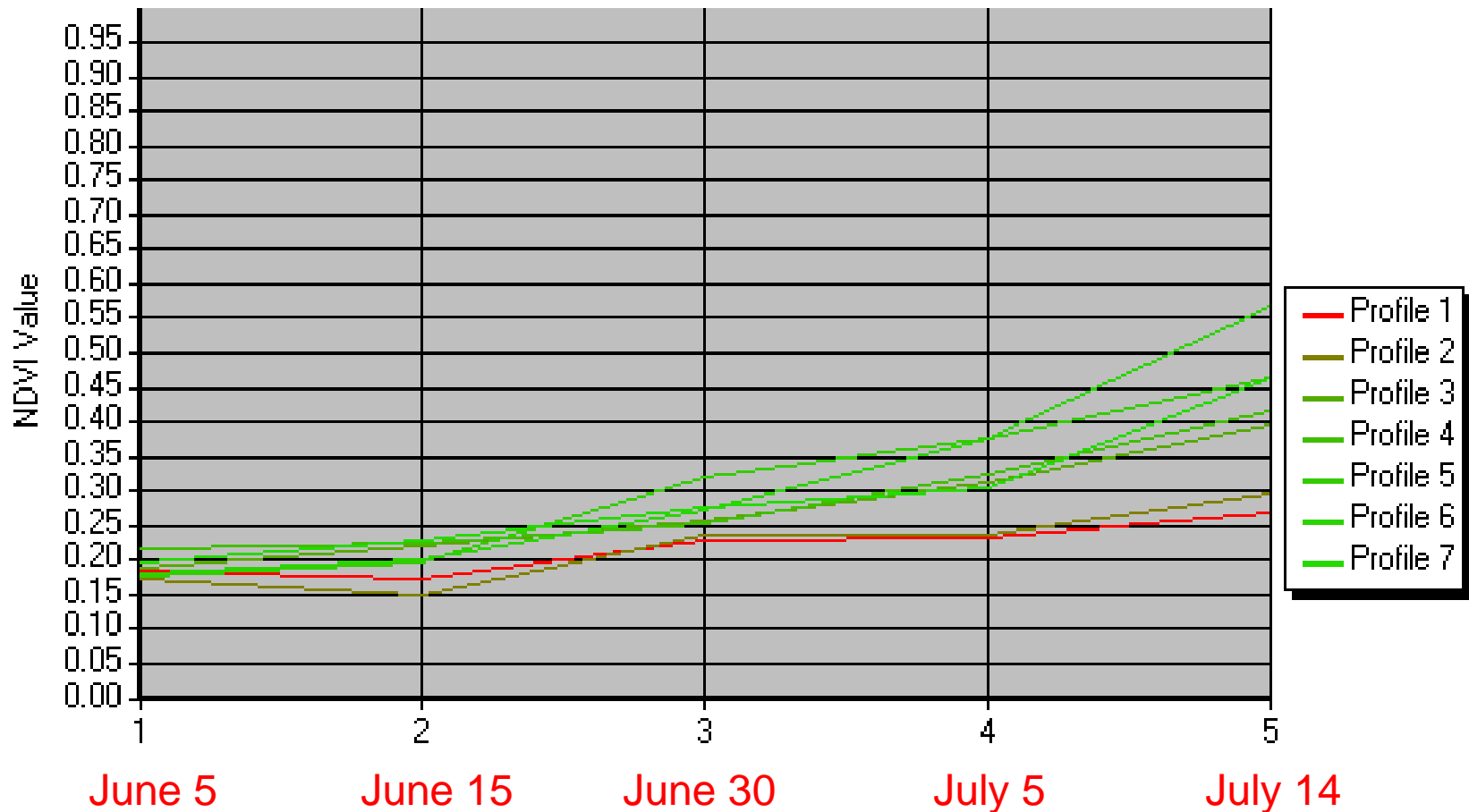
Time Series profile for Corn

NDVI Time Series Profile for Corn



Time Series profile for Soybeans

NDVI Time Series Profile for Soybean





Methodology

- Use NDVI images to derive phenological profiles for sample pts.
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- Define rules to derive ground truth
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Rules to Derive Ground Truth

- Individual rules for the identification of corn and soybeans were derived from the phenological curves as follows:

Corn: if $(0.17 \leq \text{NDVI}_1 < 0.23) \&\&$
 $(0.17 \leq \text{NDVI}_2 < 0.27) \&\& (0.33 \leq \text{NDVI}_3 < 0.62)$
 $\&\& (0.45 \leq \text{NDVI}_4 < 0.72) \&\& (0.7 \leq \text{NDVI}_5 < 0.85)$

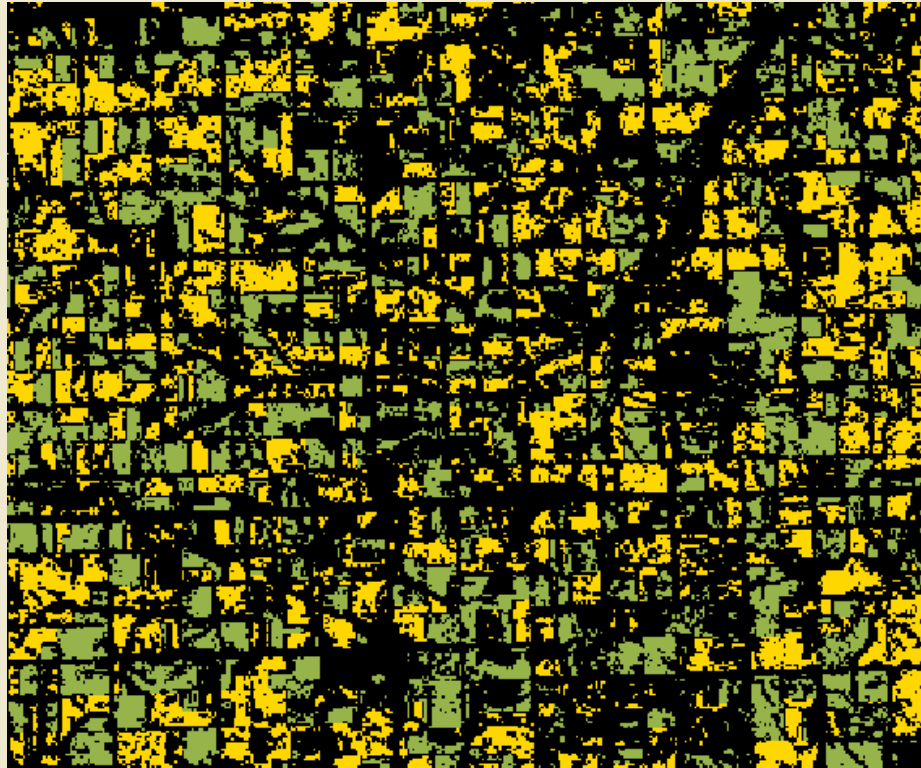
Soybean: if $(0.16 \leq \text{NDVI}_1 < 0.23) \&\&$
 $(0.15 \leq \text{NDVI}_2 < 0.25) \&\& (0.22 \leq \text{NDVI}_3 < 0.33)$
 $\&\& (0.23 \leq \text{NDVI}_4 < 0.4) \&\& (0.25 \leq \text{NDVI}_5 < 0.6)$

Other: for all values not fitting within the specified parameters

where $\text{NDVI}_{i\text{th}}$ represents the NDVI series number i .



Derived Ground Truth



Generated ground truth to run supervised classifications



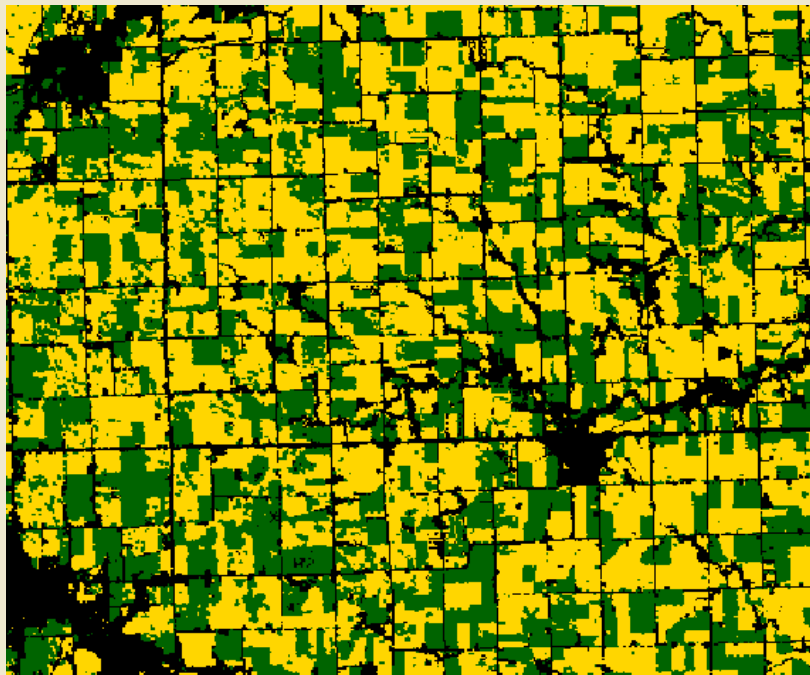
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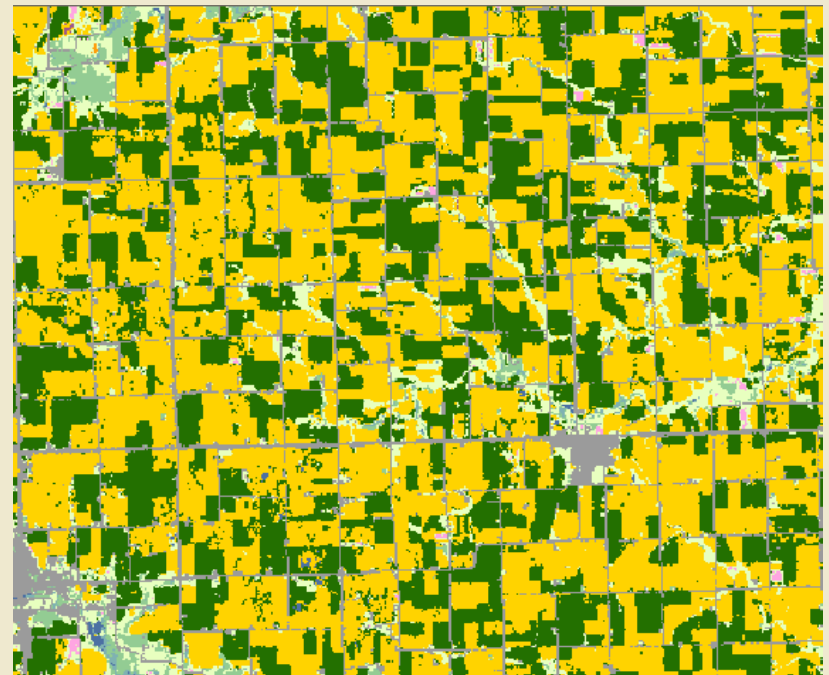


Supervised Classification

Corn and Soybeans only



Iowa 2008 CDL



Classification results using
generated ground truth

Accuracy Assessment

Table 1. Supervised classification results based on crop phenological differences

Accuracy Measures	Corn	Soybeans	Overall
Producer Accuracy	91.95%	72.91%	
Error of Omission	8.05%	27.09%	
Producer Conditional Kappa	0.7702	0.5831	
User Accuracy	82.66%	86.58%	
Error of Commission	17.34%	13.42%	
User Conditional Kappa	0.5831	0.7702	
Total Classification Accuracy			84.04%

Conclusions

- Unsupervised classifications provided land cover clusters for assessing phenological profiles.
- Ground truth data were generated based on rules for NDVI sample points.
- Prior knowledge of corn and soybean phenological differences was required





Conclusions continued

- Generated ground truth was utilized to perform supervised classification using decision tree classification method
- These preliminary classification results are favorable and the method could be useful in situations when ground truth data are unavailable.





Future Work

- Conduct additional research on phenological profiling
- Develop systematic procedure to derive ground truth based on phenological profiles
- Expand to include more crop types in more states/regions.

THANKS!

Questions?

