

## **ON-FARM RESEARCH: Utilization of On-Farm Data on Soybean Production**

### **Summary:**

Nowadays good agronomical practices demand the adoption of new technologies that deliver better resource efficiency. The objective of this study was to identify and work closely with soybean farmers in order to implement Ag precision tools, in this case: satellite imagery. Fields were selected for the 2018 growing season. The study is based on working with the field variation according to normalized difference vegetation index (NDVI) values.

### **Introduction**

Vast information about crop health and development can be obtained via characterization of the temporal and spatial variability in the field, for example with the utilization of satellite imagery. Satellite imagery may provide crucial information that could potentially influence the decision-making process related to all farming inputs such as fertilizer, seeding rate, genotype selection, and pesticide application, among others. The main objectives of this study are to: 1) explore the potential use of satellite imagery to identify productivity zones and evaluate soybean development across the growing season at the on-farm scale, and 2) explore relationships between satellite imagery data and ground-truth based plant traits, yield.

### **Procedure**

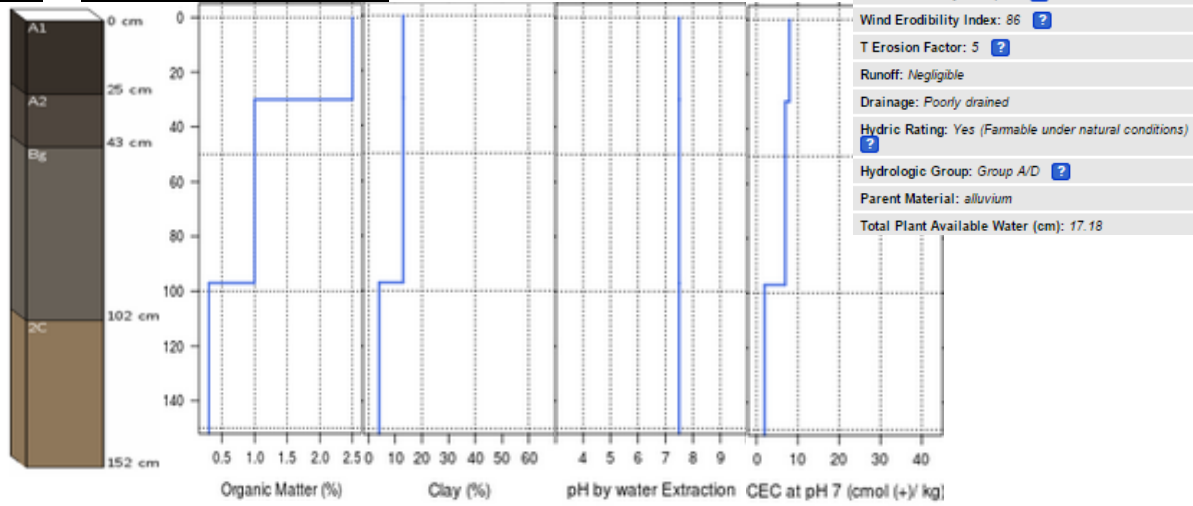
*Sites Description:* All yield data was processed. Below are the examples including all the locations.

### **BURKES DRYLAND**

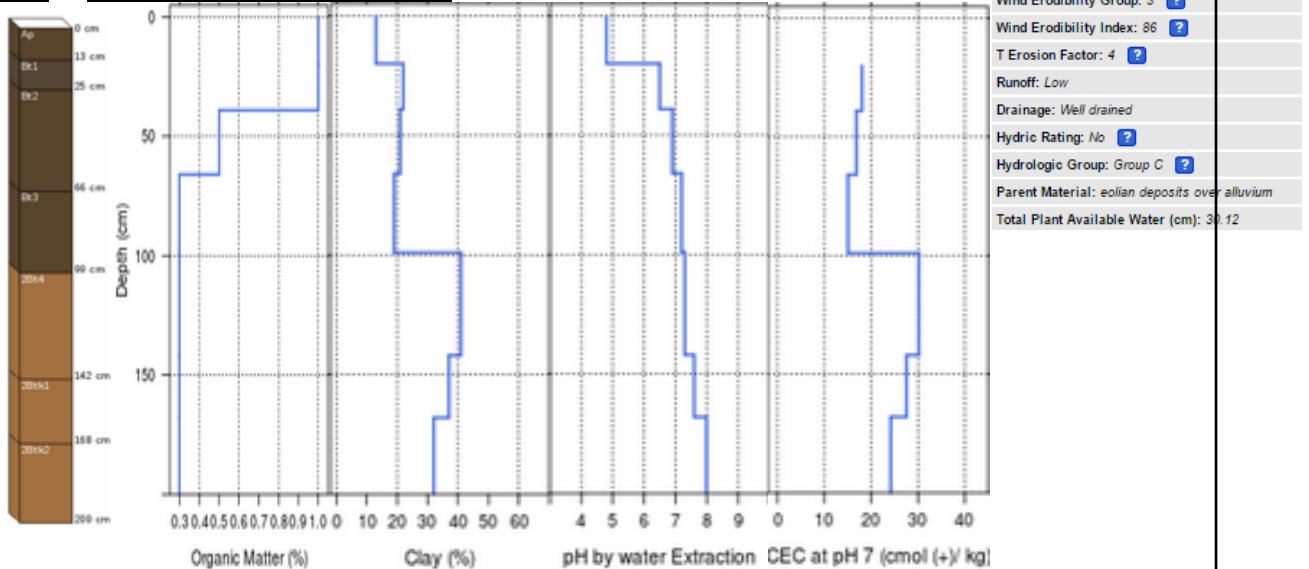
#### **SSURGO**



**5672: *Mollisols Plevna***



**5943: *Mollisols Saltcreek***



5943 covers most of the field area: low pH, OM and medium-low PAW limits production in dry years

## Landscape characterization



Figure 1: Altitude (meters)  
Figure 2: Altitude and SSURGO  
Figure 3: Derived slope (degrees).

## Satellite data

2013-2014-2015-2016

Crop rotation: 2013 Corn- 2014 Soybean- 2016 Soybean

Summer NDVI Soybean 2014-2016

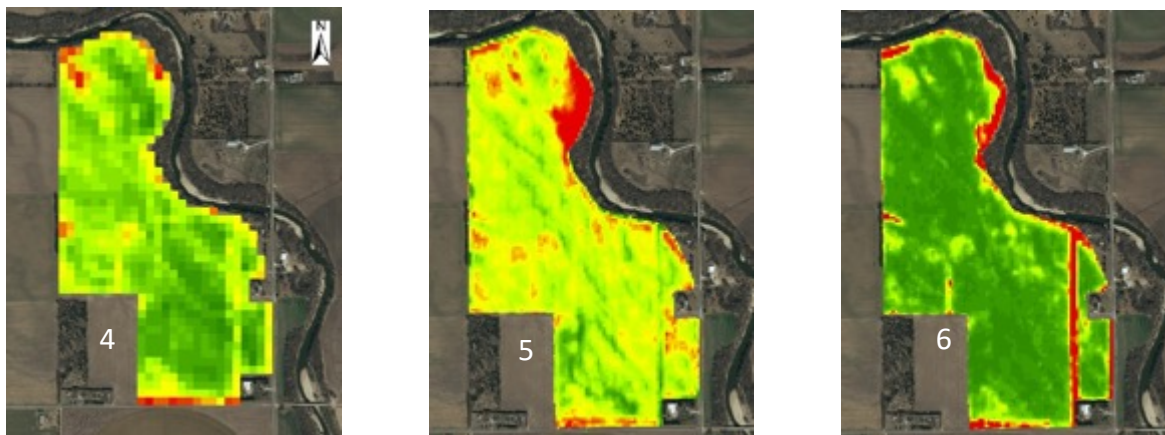


Figure 4: NDVI early August 2014  
Figure 5: NDVI mid-July 2016  
Figure 6: NDVI mid-August 2016

**NDVI SATELLITE IMAGERY:**

Summer NDVI Soybean 2014-2016

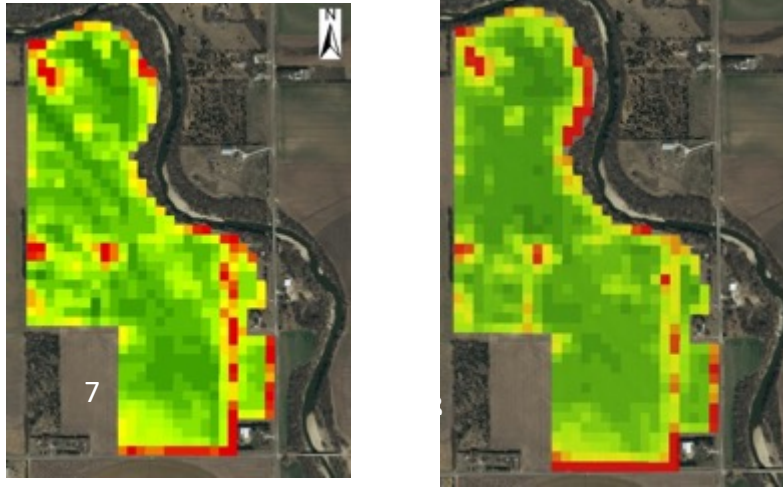
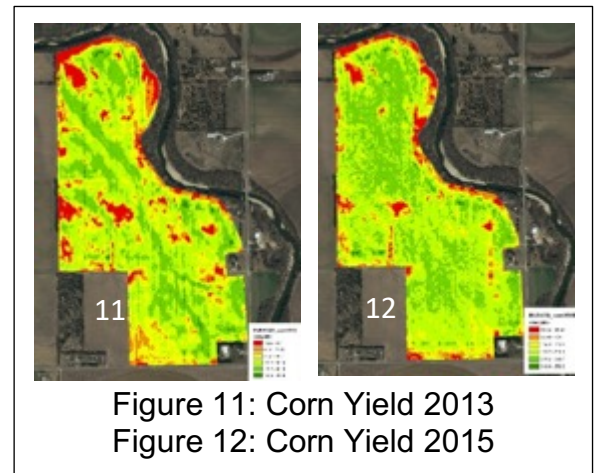
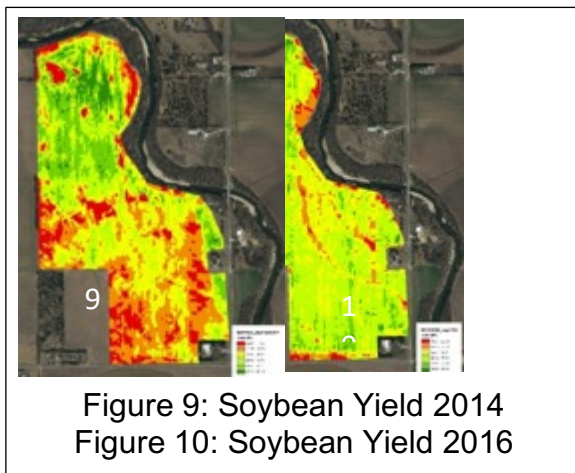


Figure 7: NDVI 2013 mid-July  
Figure 8: NDVI 2015 mid-July

**YIELD**





## Season 2017

### NDVI SATELLITE IMAGERY:

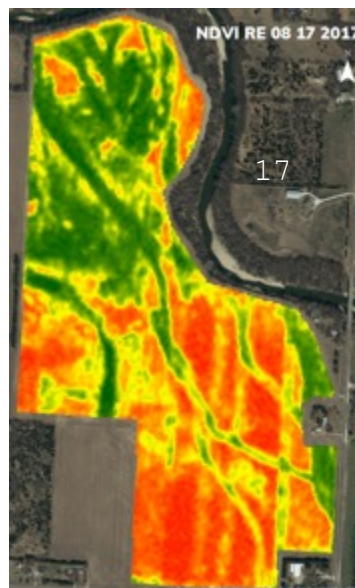
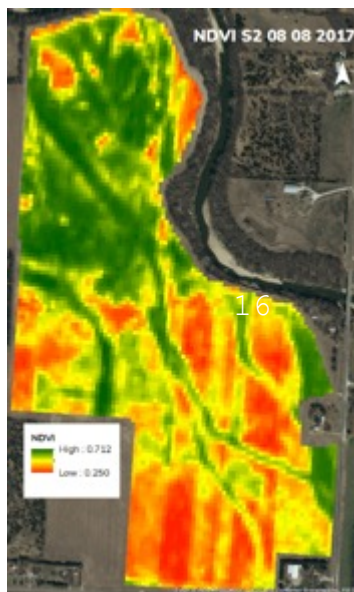
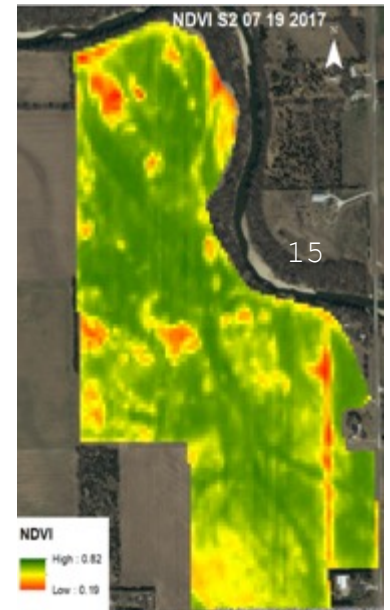
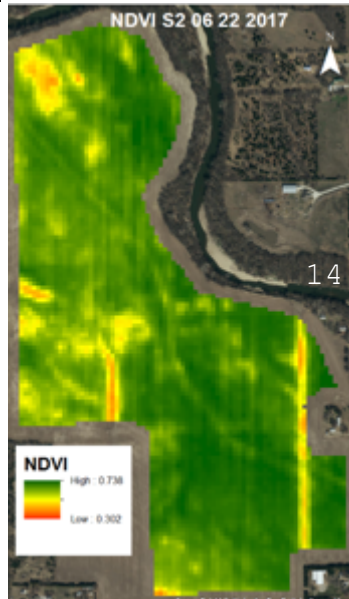
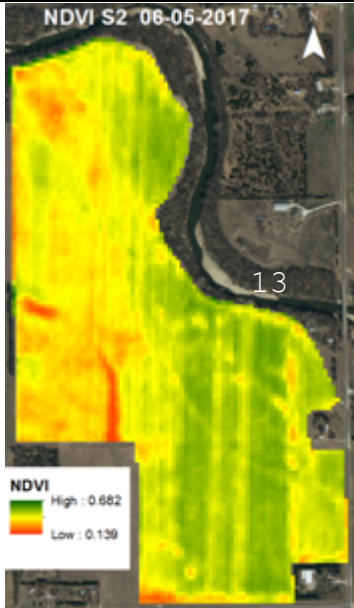


Figure 13: NDVI S2  
June

Figure 14: NDVI S2  
June 22<sup>th</sup>

Figure 15: NDVI S2  
July 19<sup>th</sup>

Figure 16: NDVI S2  
August 8<sup>th</sup>

Figure 17: NDVI  
Rapid Eye August

Volumetric Water Content:

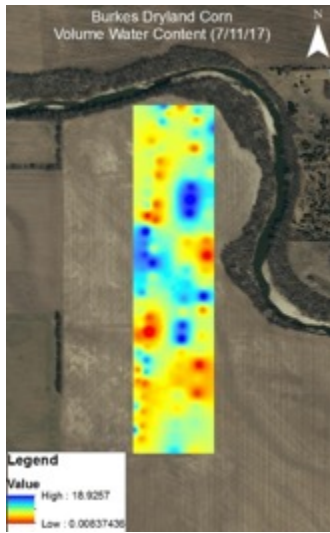
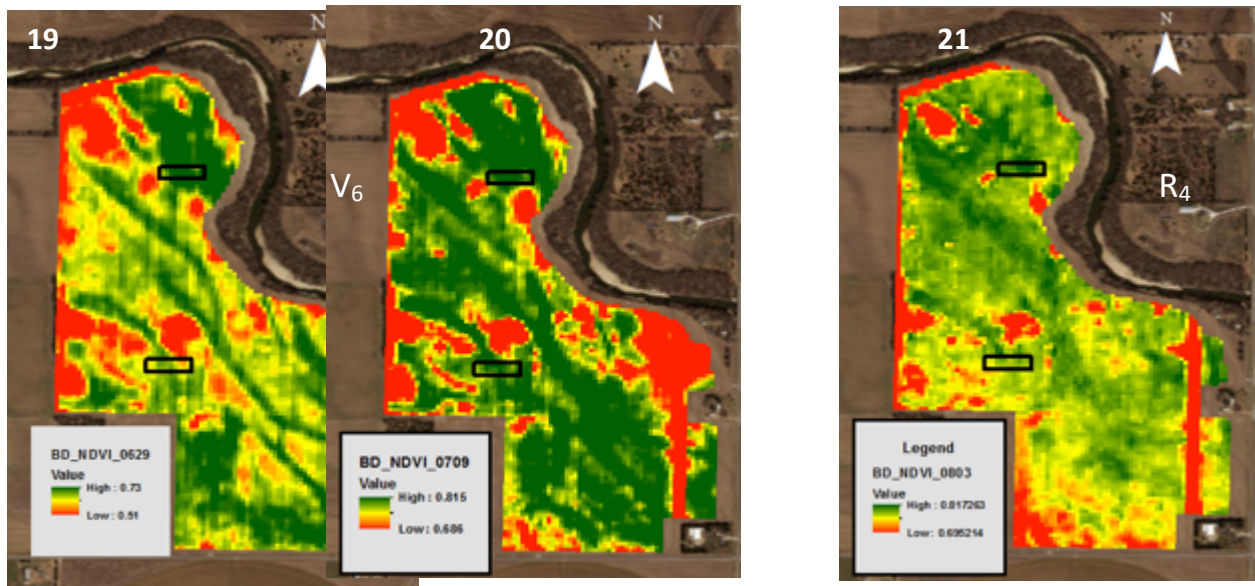


Figure 16: VWC Values July

Season 2018

NDVI SATELLITE IMAGERY:



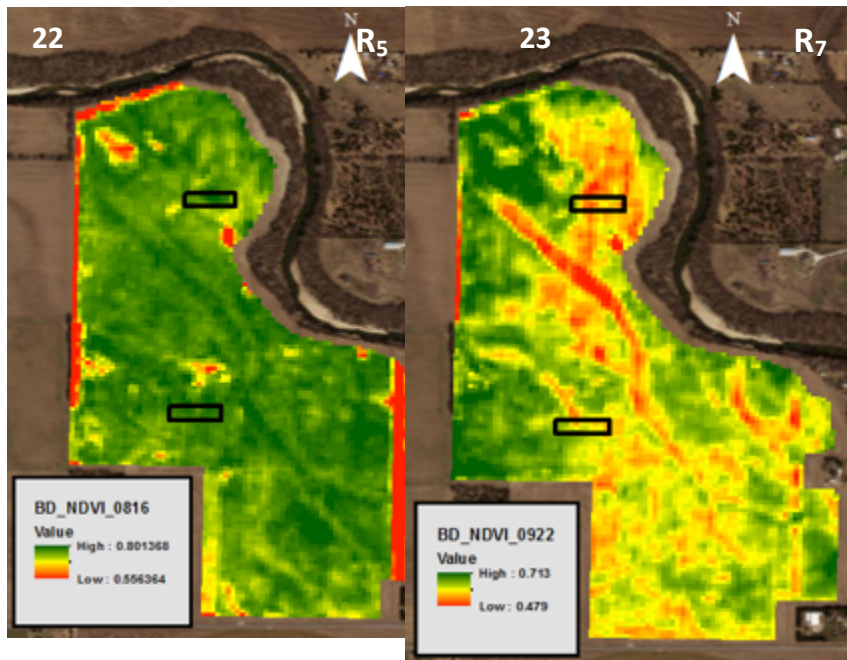
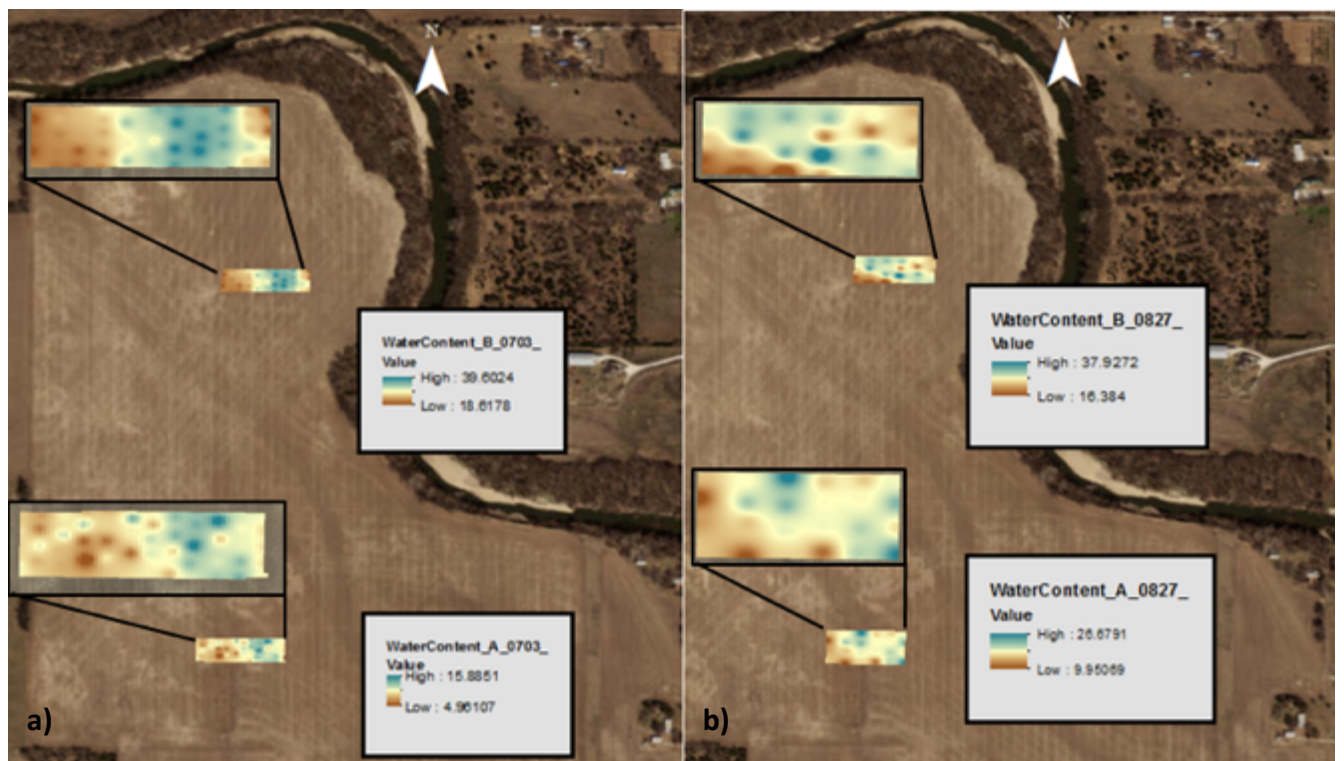


Figure 22: NDVI S2 June 29<sup>th</sup> - Phenology (**V<sub>5-6</sub>**)  
 Figure 23: NDVI S2 July 9<sup>th</sup> - Phenology (**R<sub>1</sub>**)  
 Figure 24: NDVI S2 August 3<sup>th</sup> - Phenology (**R<sub>4</sub>**)  
 Figure 25: NDVI S2 August 16<sup>th</sup> - Phenology (**R<sub>5</sub>**)  
 Figure 26: NDVI S2 September 22<sup>th</sup> - Phenology (**R<sub>7</sub>**)

Volumetric Water

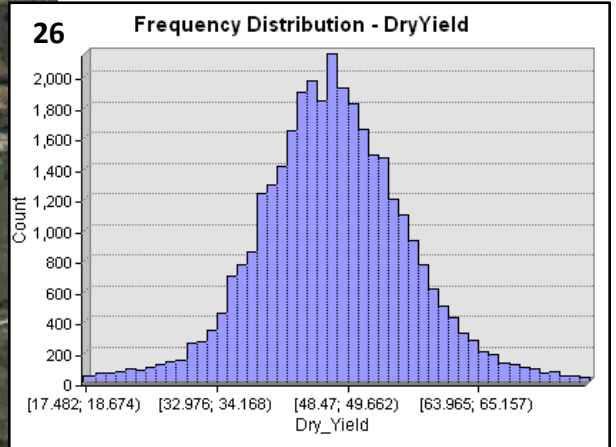
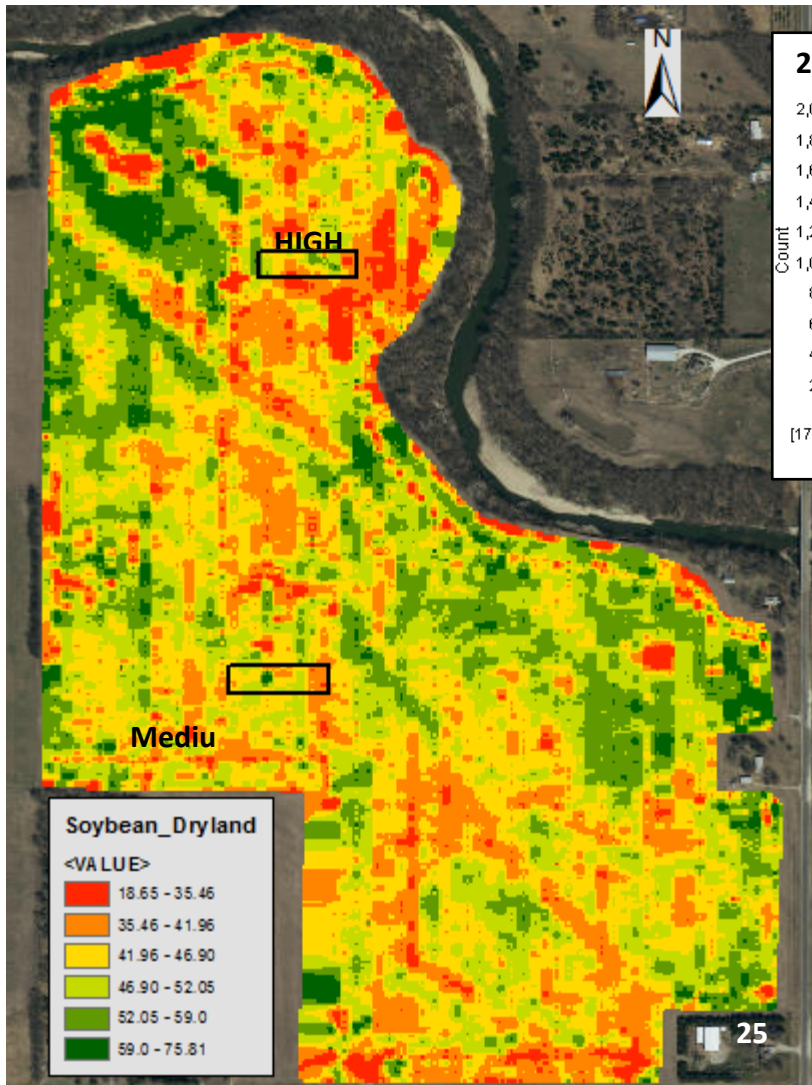
Content:



**Figure 24.** Volumetric water content in **a)** July 2018 (beginning of flowering), and **b)** August 2018 (beginning of grain filling), for two potential yield environments **A** (medium) and **B** (high) chosen for the study of seeding rates in soybean.



Yield Data: Soybean 2018



**Figure 26.** Frequency distribution of dry yield of soybean for the **entire field**.

Environment	Yield (mean)	Standard Deviation
al Field	46.65	7.21

**Table 1.** Summary of the average dry yield for the **entire field** and its standard deviation.

**Figure 25.** Final dry yield map of Soybean.

And location of the two environments (**Medium** and **High**) selected for seeding rates studies, based on historical NDVI imagery and yield maps. And also support information such as soils (SSURGO) and altitude (LIDAR) of the field.



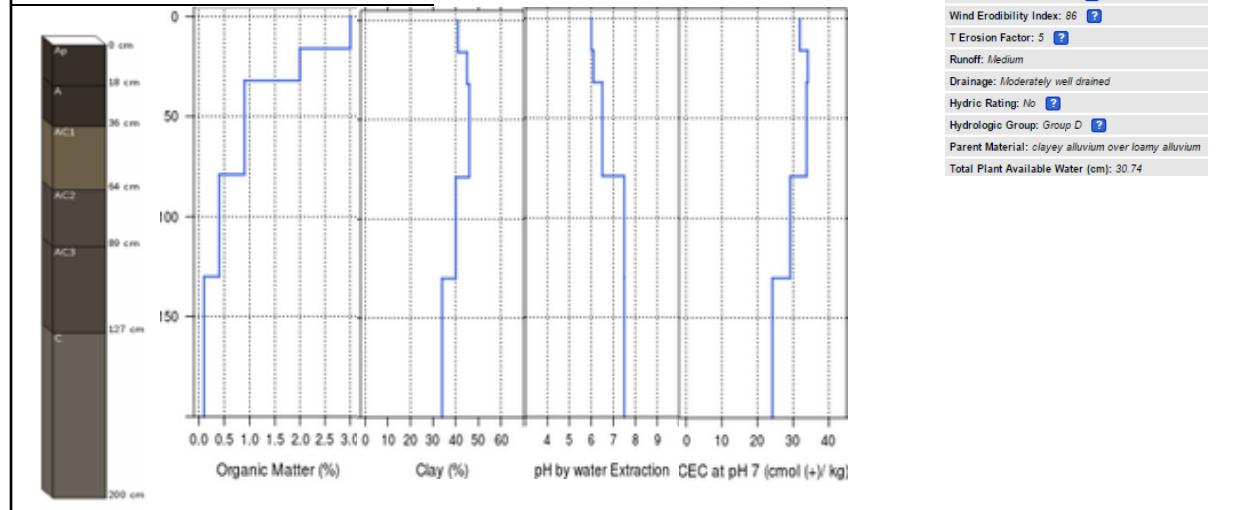
# BURKES

Irrigated, 160 acres

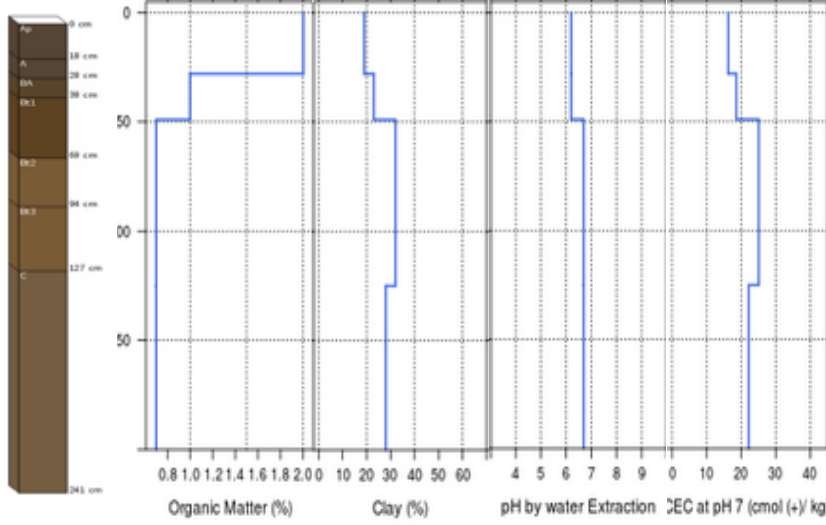
## SSURGO



### 3857: *Vertisol Goessel*

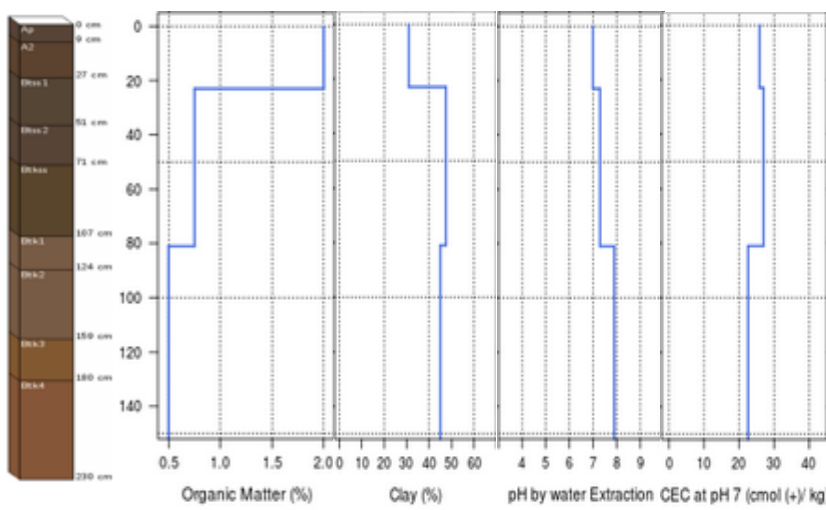


5976: *Mollisols Vanoss*



- Wind Erodibility Group: 5 ?
- Wind Erodibility Index: 56 ?
- T Erosion Factor: 5 ?
- Runoff: Low
- Drainage: Well drained
- Hydric Rating: No ?
- Hydrologic Group: Group B ?
- Parent Material: alluvium
- Total Plant Available Water (cm): 40

5967: *Mollisols Tabler*



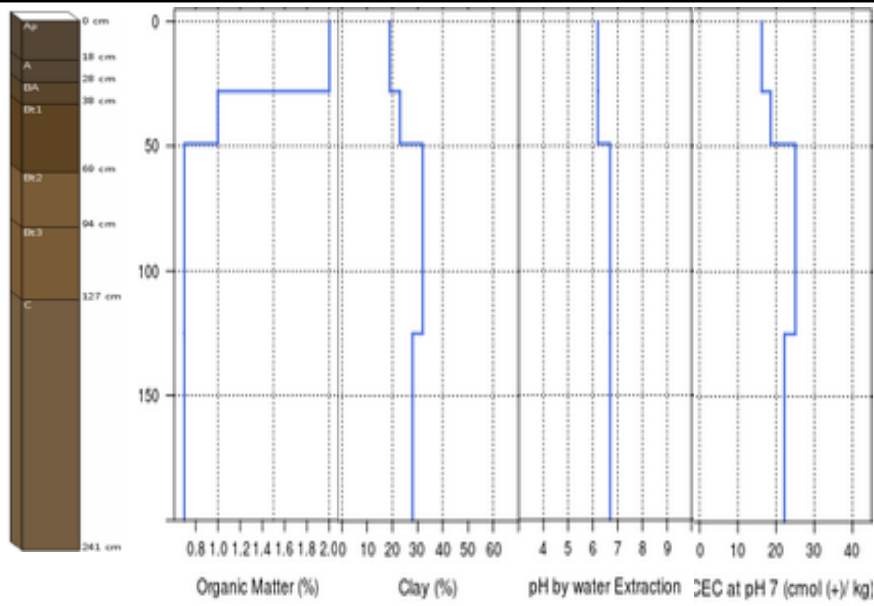
- Wind Erodibility Group: 6 ?
- Wind Erodibility Index: 48 ?
- T Erosion Factor: 5 ?
- Runoff: Very low
- Drainage: Moderately well drained
- Hydric Rating: No ?
- Hydrologic Group: Group D ?
- Parent Material: clayey alluvium
- Total Plant Available Water (cm): 25.14

6370: *Mollisols Milan*



Wind Erodibility Group: 6	<a href="#">?</a>
Wind Erodibility Index: 48	<a href="#">?</a>
T Erosion Factor: 5	<a href="#">?</a>
Runoff: <i>Medium</i>	
Drainage: <i>Well drained</i>	
Hydric Rating: <i>No</i>	<a href="#">?</a>
Hydrologic Group: <i>Group C</i>	<a href="#">?</a>
Parent Material: <i>alluvium</i>	
Total Plant Available Water (cm): 28.2	

3977: *Mollisols Vanoss*



Wind Erodibility Group: 5	<a href="#">?</a>
Wind Erodibility Index: 56	<a href="#">?</a>
T Erosion Factor: 5	<a href="#">?</a>
Runoff: <i>Low</i>	
Drainage: <i>Well drained</i>	
Hydric Rating: <i>No</i>	<a href="#">?</a>
Hydrologic Group: <i>Group B</i>	<a href="#">?</a>
Parent Material: <i>alluvium</i>	
Total Plant Available Water (cm): 40	

## Landscape characterization

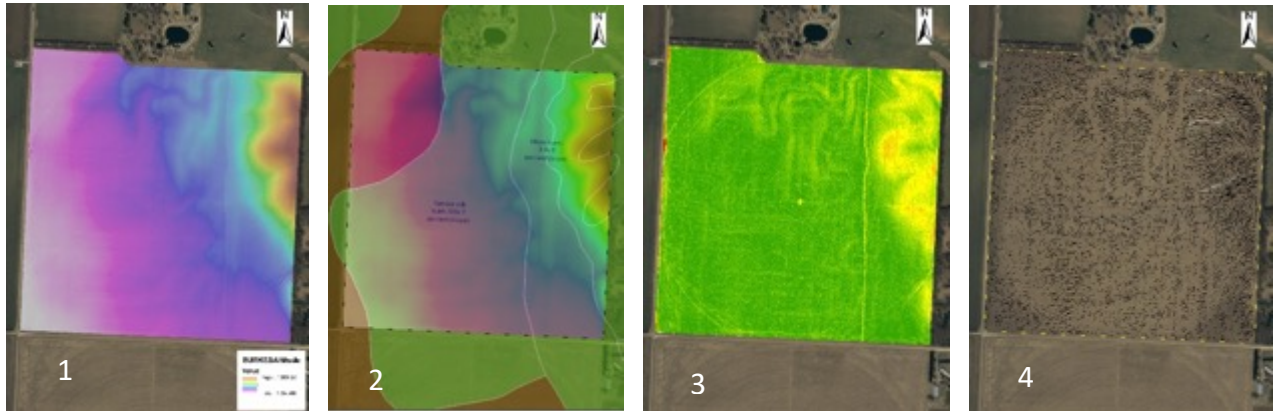


Figure 1: Altitude (meters)  
Figure 2: Altitude and SSURGO  
Figure 3: derived slope (degrees)  
Figure 4: flow accumulation

## Satellite data Analysis:

Summer crops 2014 Soybean/2015 Corn/2016 Soybean - NDVI

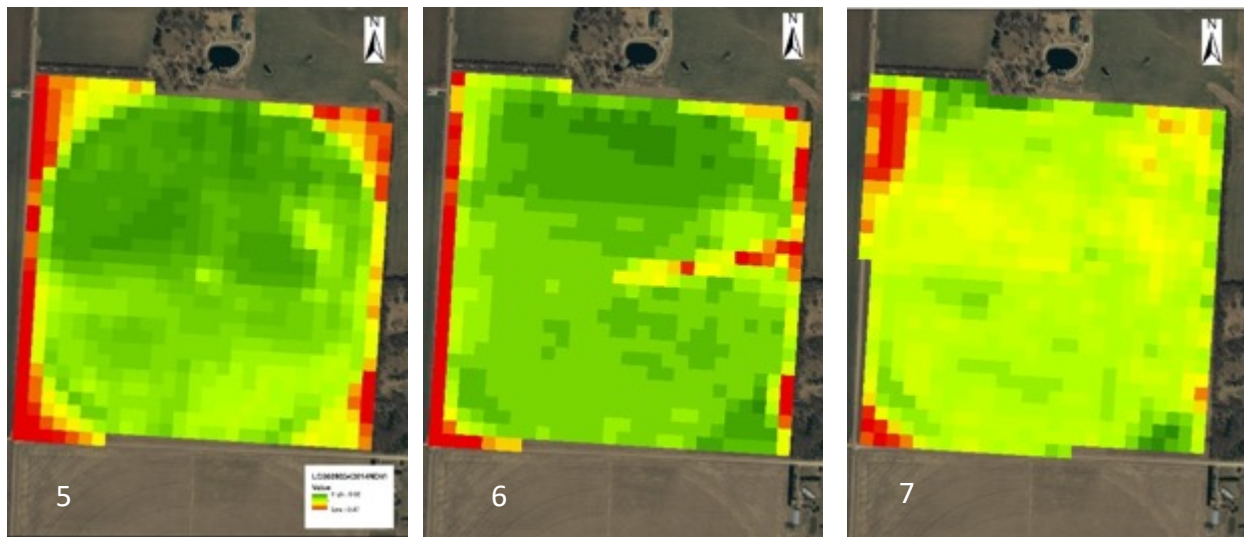


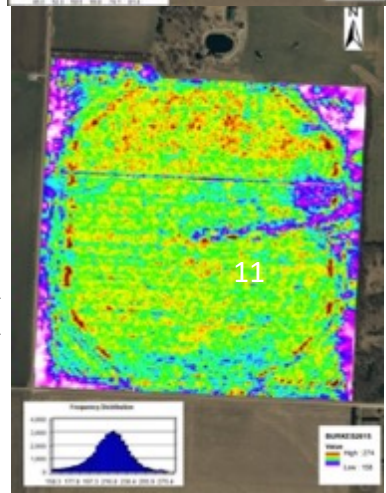
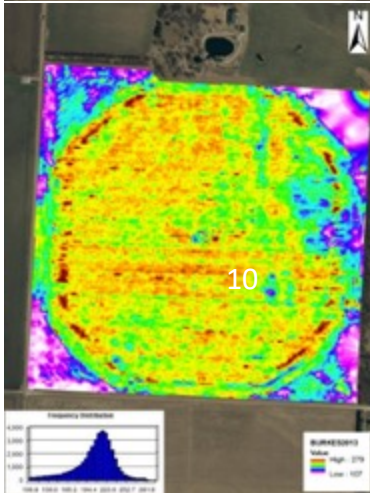
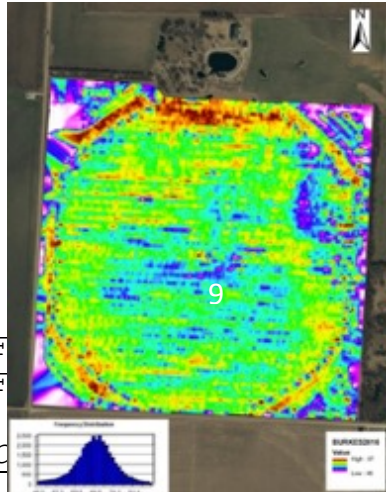
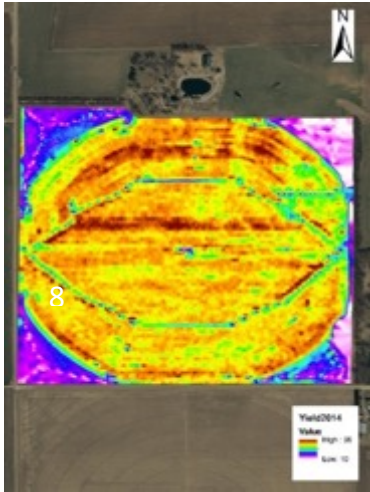
Figure 5: NDVI July 2014 Soybean  
Figure 6: NDVI July 2015 Corn  
Figure 7: NDVI July 2016 Soybean  
*Irrigation system mask soil zoning effect.*

## Yield data:

Soybean 2014 2016:

*It confirms the irrigation masking effect, there's a slight high yielding in the north region of the field, it needs more insights that doesn't evidence any correlation with SSURGO*





F  
 F  
 C  
 an 2014  
 an 2016

n  
 n

**ISO Clustering Data**



Season 2017

NDVI SATELLITE IMAGERY:

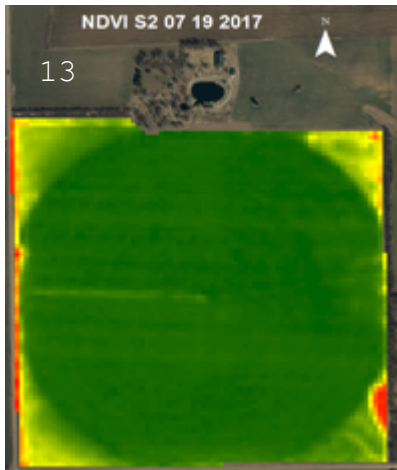
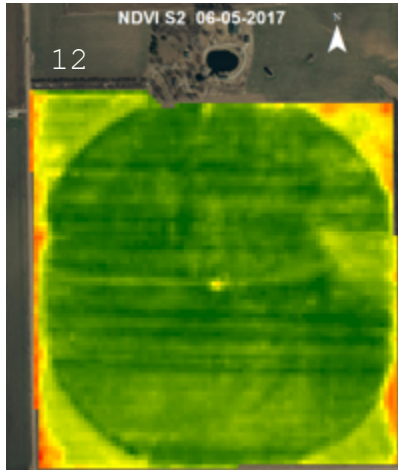
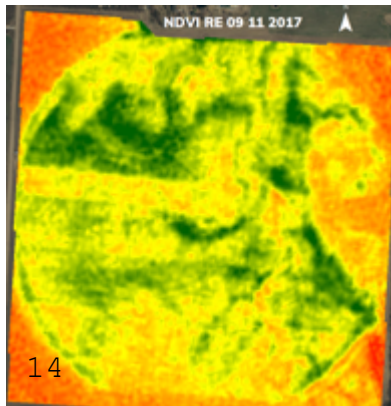


Figure 12: NDVI S2  
June 2<sup>sd</sup>

Figure 13: NDVI July  
19<sup>th</sup>

Figure 14: NDVI  
September 11<sup>th</sup>



Season 2018

NDVI SATELLITE IMAGERY:

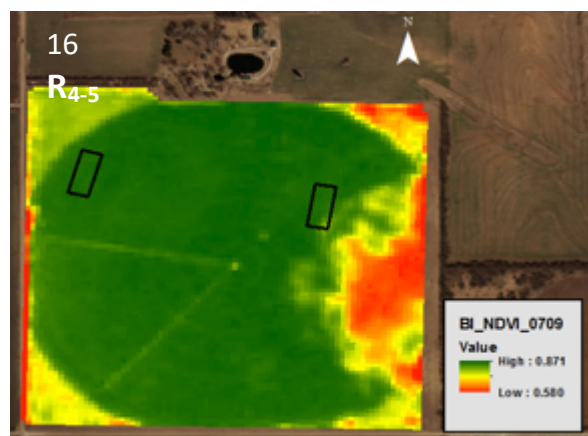
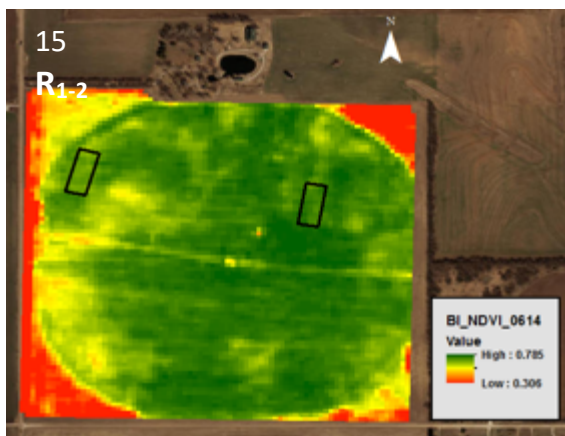
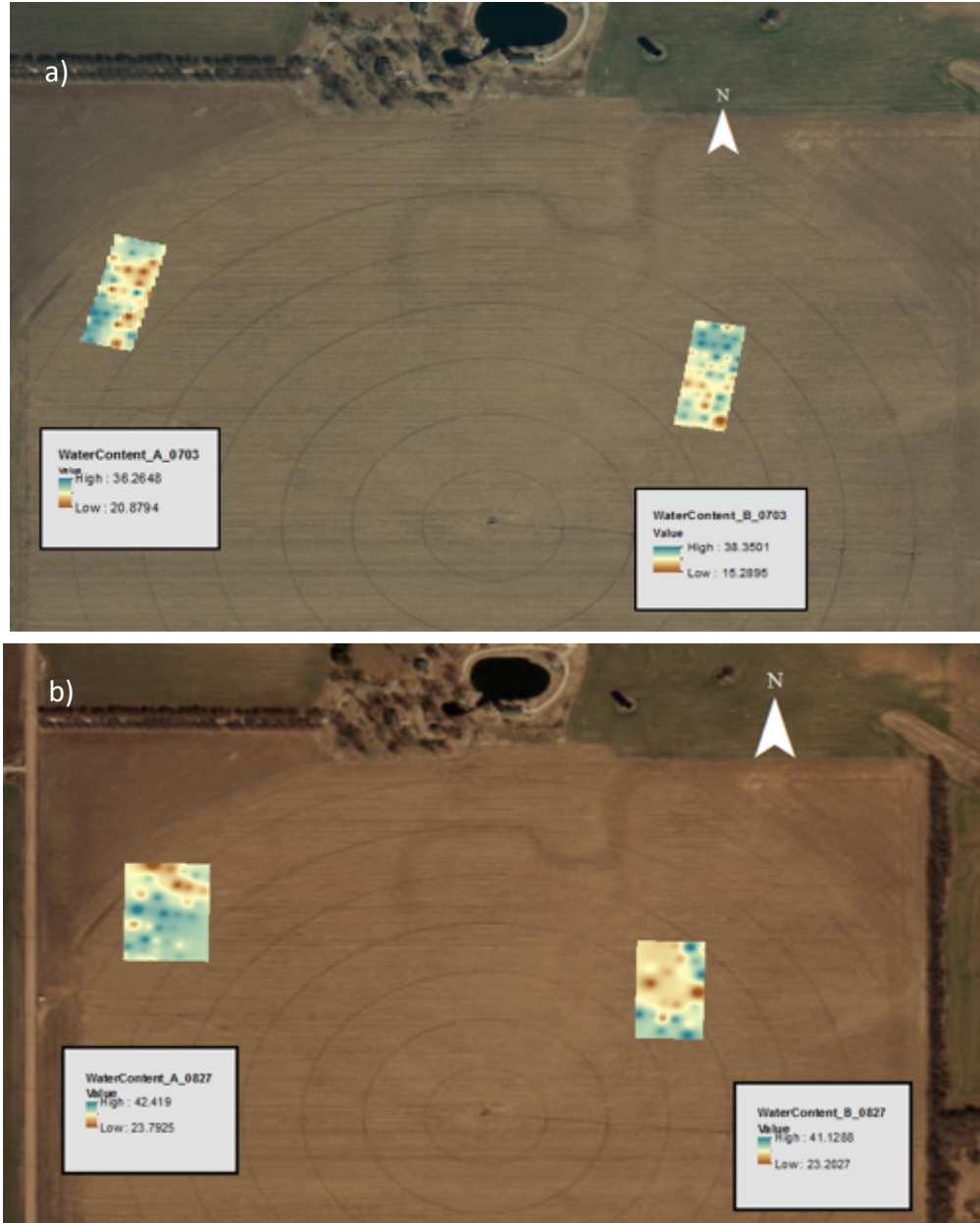


Figure 15: NDVI S2 June 14<sup>th</sup> -  
Phenology (**R<sub>1-2</sub>**)

Figure 16: NDVI S2 July 9<sup>th</sup> - Phenology (**R<sub>4-5</sub>**)

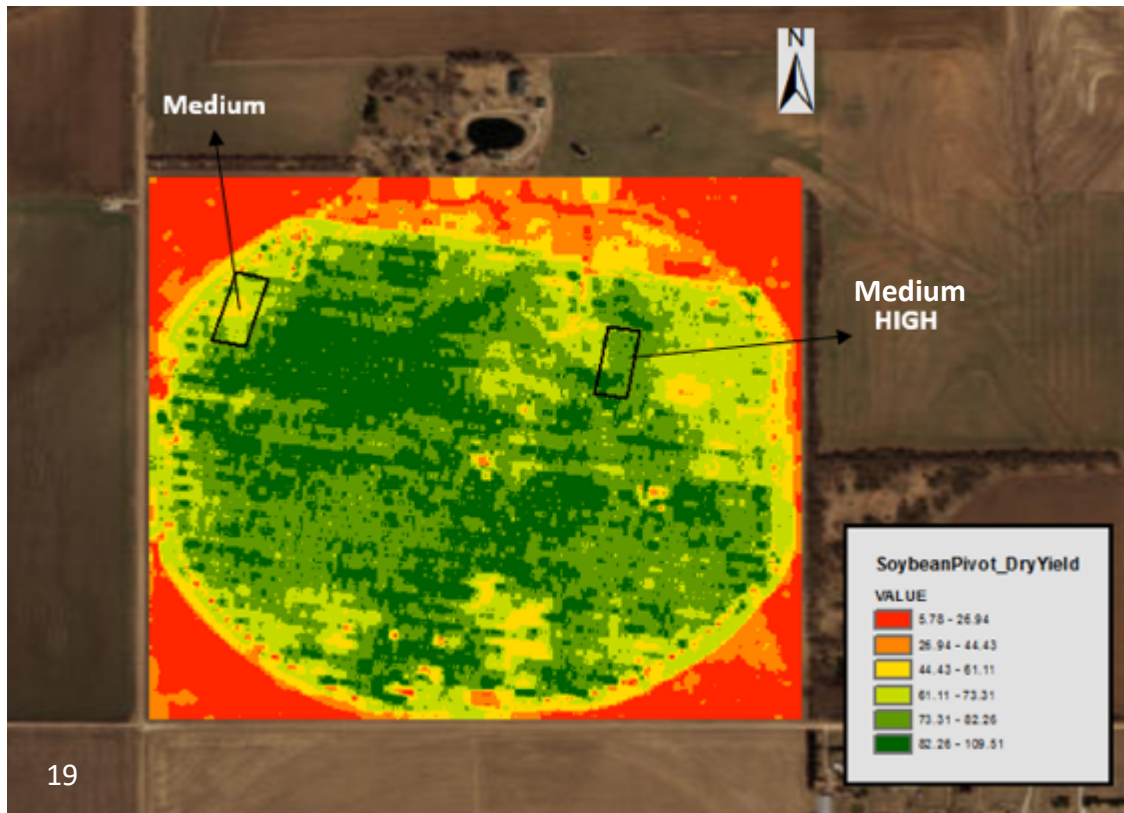
Volumetric Water Content:



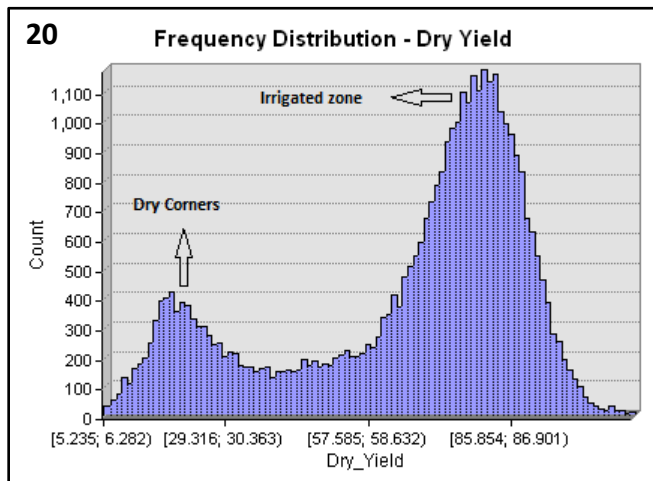
**Figure 17.** Volumetric water content in **a)** July 2018 (beginning of grain filling), and **b)** August 2018 (close to physiological maturity), for two environments (**A** and **B**) chosen in the study of seeding rates in soybean.



**Yield Data:**



**Figure 19.** Black arrows indicate the location and potential productivity of each environment, where the experimental plots were located, based on historical NDVI imagery and yield maps. And also support information such as soils (SSURGO) and altitude (LIDAR) of the field.



outside the pivot.

**Table 1.** Dry yield summary.

Environment	Yield (mean)	Standard Deviation
Total Field	63.4	24

**Figure 20.** Indicates the frequency of distribution of dry yield of the entire field. Clearly representing the difference between the irrigated area and the area



**Seeding rate study**

	<b>Final Plant Density</b>	<b>Dry Yield</b>
<b>Environment</b>	0.0036	0.0201
<b>Seeding Rate (SR)</b>	0.0005	NS
<b>Environment x SR</b>	<b>NS</b>	<b>NS</b>
<b>CV</b>	6.96	11.17

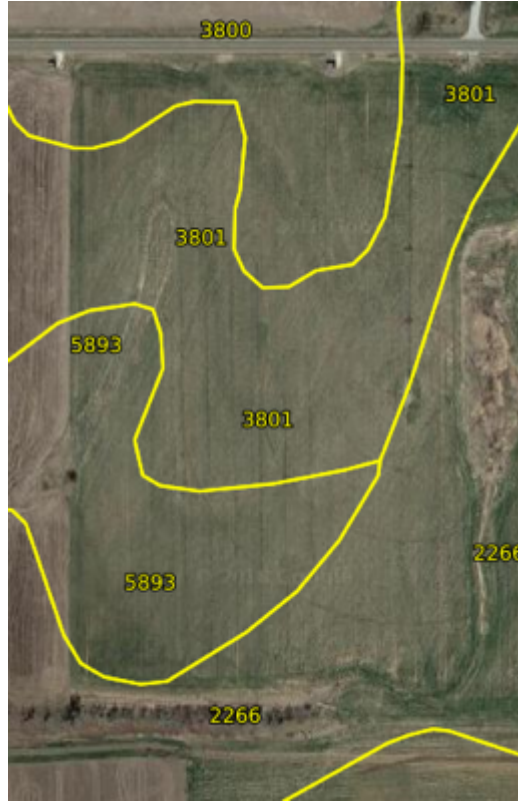
p-value <0.05

<b>Environment</b>	<b>Final Plant Density</b>	<b>Dry Yield</b>
<b>HIGH</b>	<b>121194</b>	<b>73.7</b>
<b>MEDIUM</b>	107642	64.0
LSD (0.05)	8179	7.78

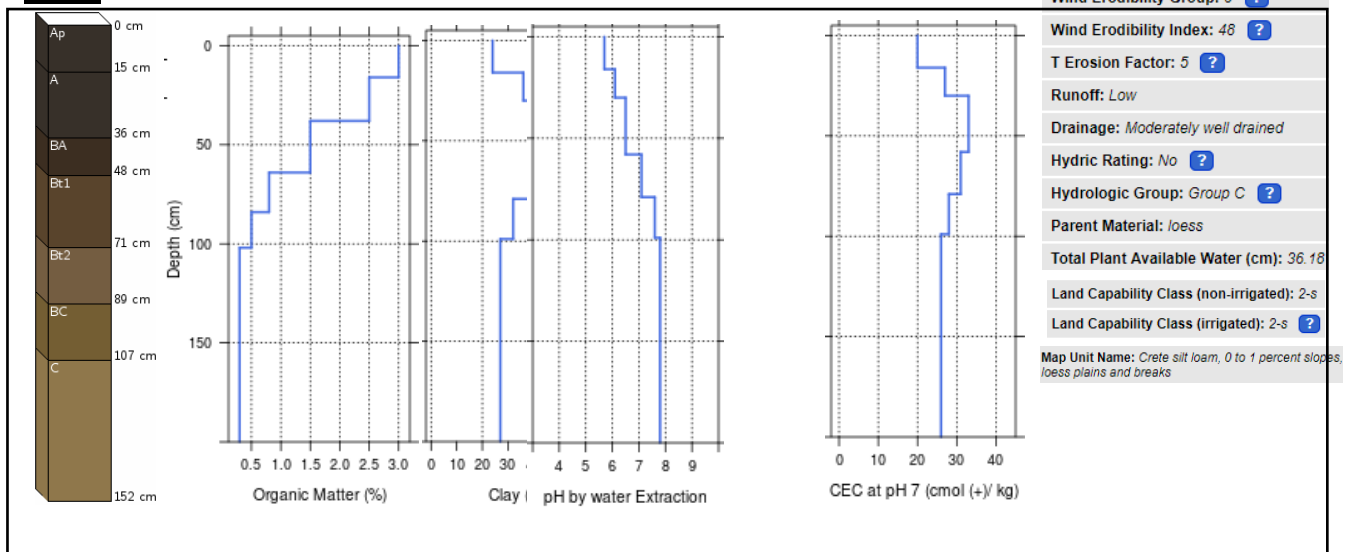
<b>Seeding Rate</b>	<b>Final Plant Density</b>	<b>Dry Yield</b>
<b>130</b>	103383	65.6
<b>160</b>	111514	69.5
<b>190</b>	<b>128357</b>	71.3
LSD (0.05)	<b>10017</b>	NS

# FLICKNER SDI Season 2018

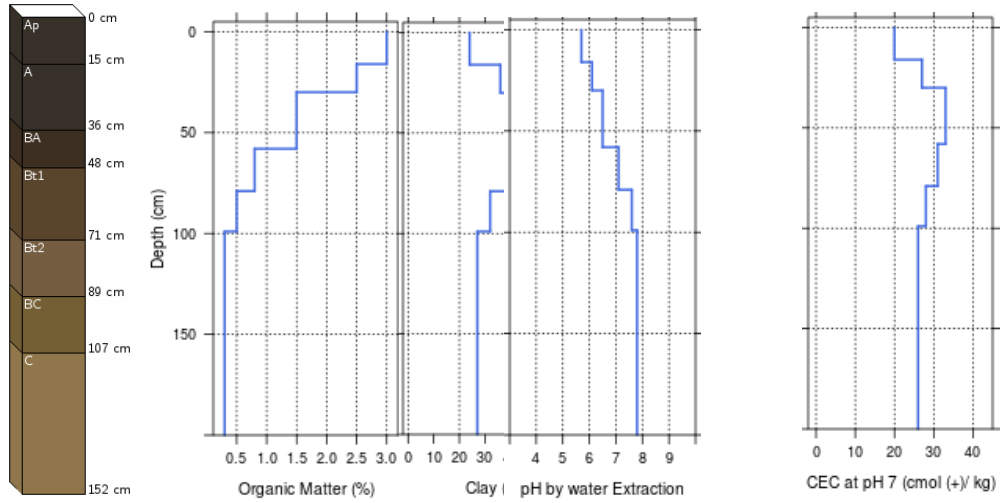
## SSURGO



### 3800: Pachic Udertic Argiustolls

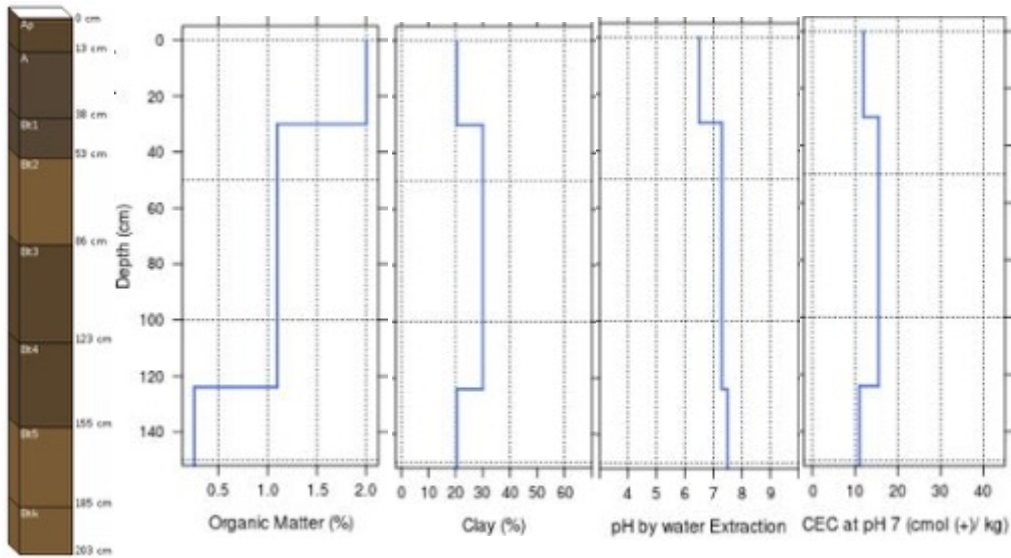


### 3801: Pachic Udertic Argiustolls



Wind Erodibility Group:	6
Wind Erodibility Index:	48
T Erosion Factor:	5
Runoff:	Medium
Drainage:	Moderately well drained
Hydric Rating:	No
Hydrologic Group:	Group C
Parent Material:	loess
Total Plant Available Water (cm):	36.03
Land Capability Class (non-irrigated):	2-e
Land Capability Class (irrigated):	2-e
Map Unit Name:	Crete silt loam, 1 to 3 percent slopes, loess plains and breaks

### 5893: Pachic Argiustolls



Map Unit Name:	Farnum loam, 1 to 3 percent slopes
Wind Erodibility Group:	6
Wind Erodibility Index:	48
T Erosion Factor:	5
Runoff:	Low
Drainage:	Well drained
Hydric Rating:	No
Hydrologic Group:	Group B
Parent Material:	alluvium
Total Plant Available Water (cm):	26.48
Land Capability Class (non-irrigated):	2-c
Land Capability Class (irrigated):	1-
Ecological Site Description:	Loamy Plains

## Landscape characterization

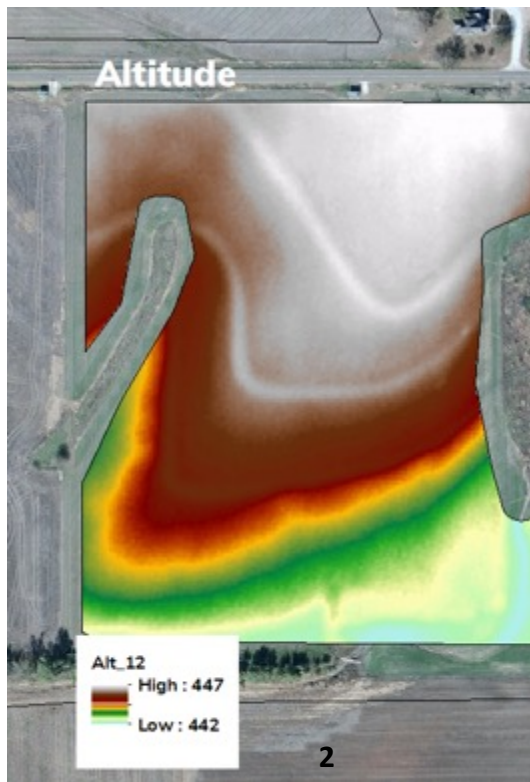
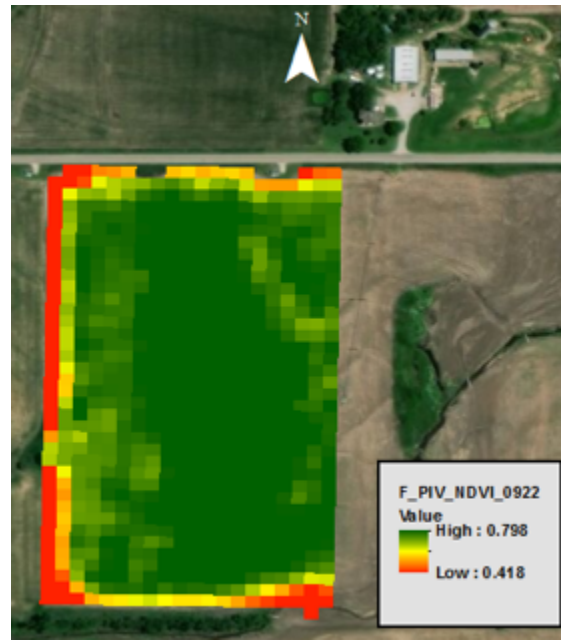
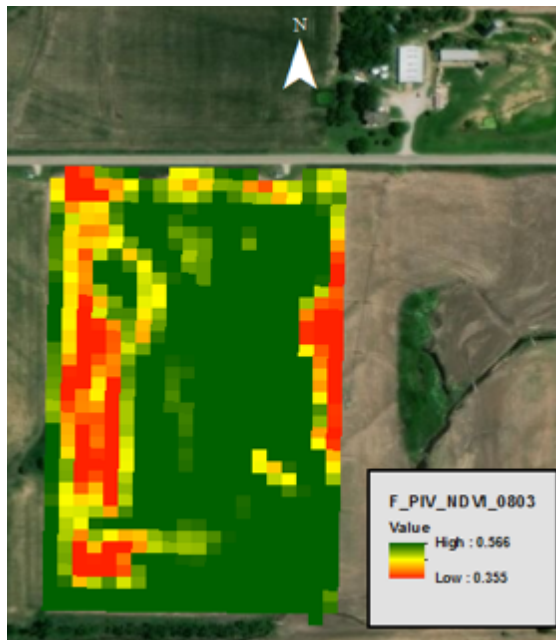


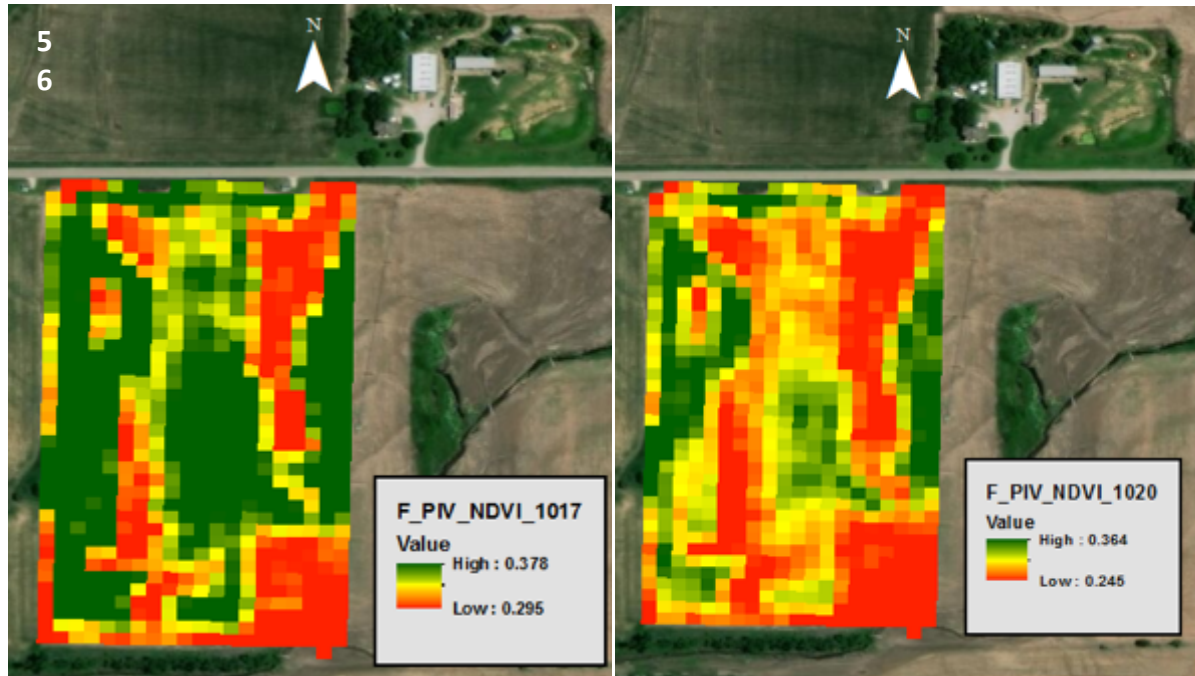
Figure 2: Altitude (meters)

## NDVI SATELLITE IMAGERY:

Summer NDVI Soybean 2018







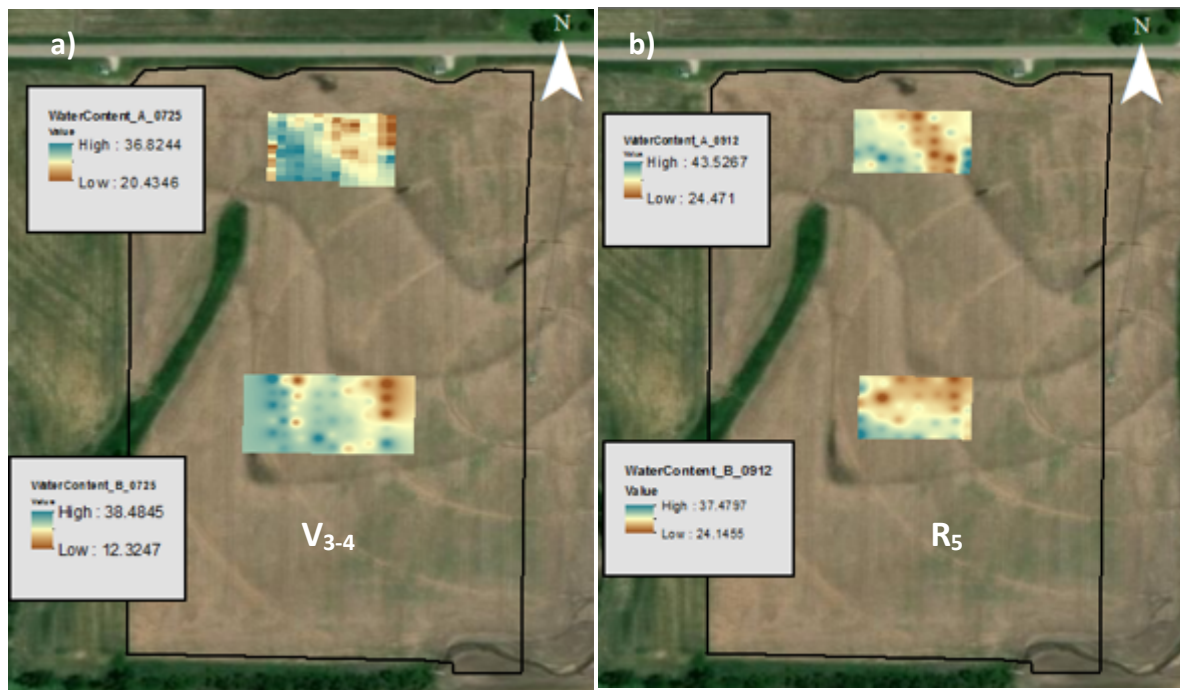
**Figure 3:** NDVI S2 August 3<sup>th</sup> - Phenology (**R<sub>2-3</sub>**)

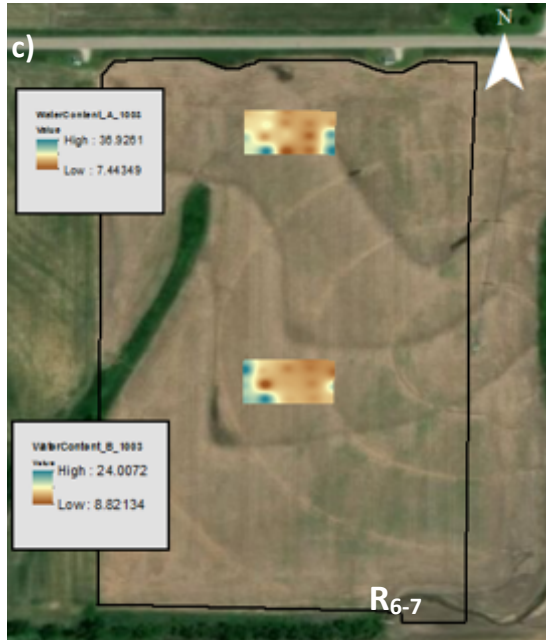
**Figure 4:** NDVI S2 September 22<sup>th</sup> - Phenology (**R<sub>5-6</sub>**)

**Figure 5:** NDVI S2 October 17<sup>th</sup> - Phenology (**R<sub>6-7</sub>**)

**Figure 6:** NDVI S2 October 20<sup>th</sup> - Phenology (**R<sub>7</sub>**)

**Water Content:**





**Figure 7.** Volumetric water content in **a)** July (vegetative stage), **b)** September (beginning of grain filling) and **c)** October, 2018 (close to physiological maturity), for two potential yield environments **A** (medium) and **B** (high) chosen for the study of seeding rates in soybean.

**Yield Data: Soybean study - Plots.**

	Final Plant Density	Dry Yield
Environment	0.0006	0.0014
Seeding Rate (SR)	<0.0001	NS
Variety	NS	<0.0001
Environment x SR	NS	NS
CV	9.97	5.69

**p-value<0.05**

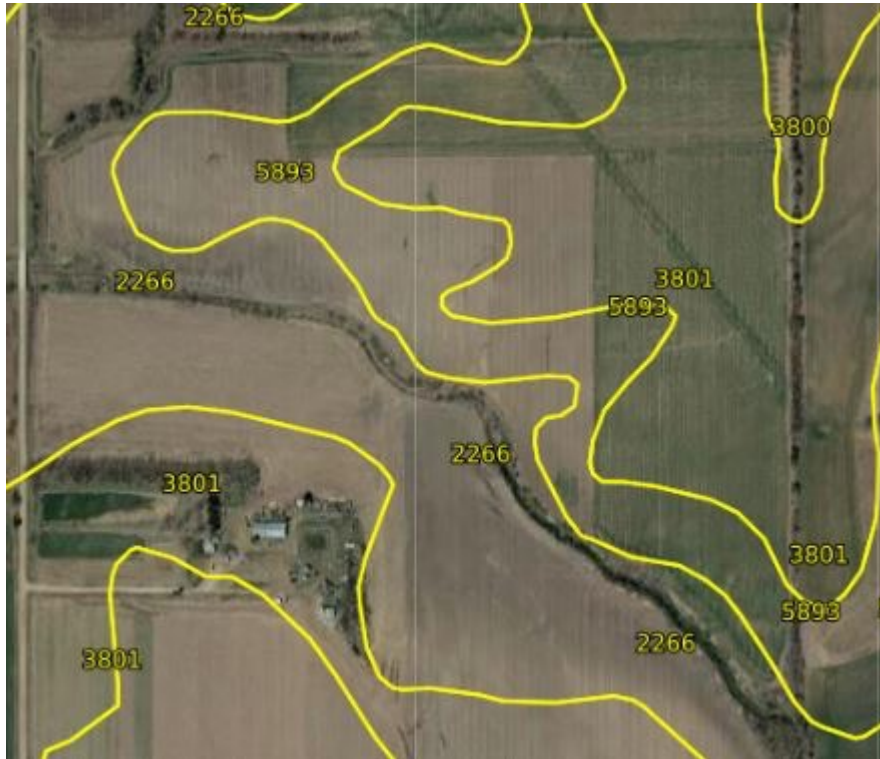
Environment	Plant Density	Dry Yield
<b>HIGH</b>	<b>123807</b>	<b>43.3</b>
<b>LOW</b>	108512	40.4
LSD (0.05)	7966	1.61

Seeding Rate	Final Plant Density
<b>130</b>	96848
<b>160</b>	112820
<b>190</b>	138811
<b>LSD (0.05)</b>	9756

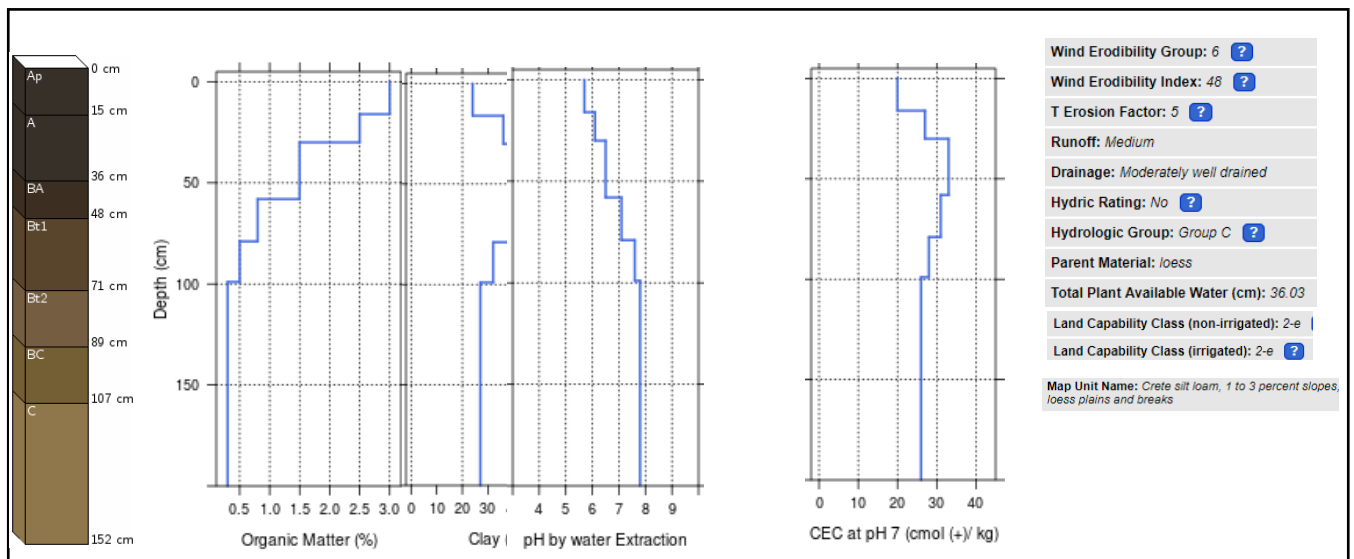
Variety	Dry Yield
<b>Pioneer</b>	<b>44.64</b>
<b>Asgrow</b>	37.77
LSD (0.05)	1.61

**FLICKNER SDI**  
**Season 2018**

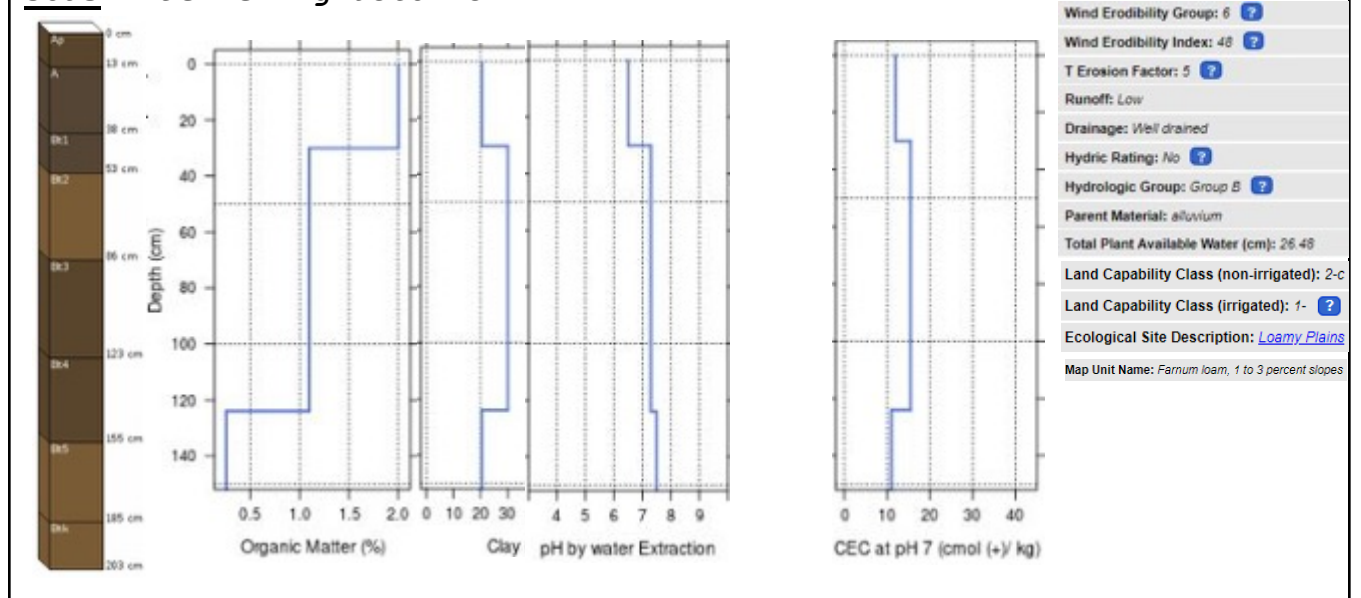
**SSURGO**



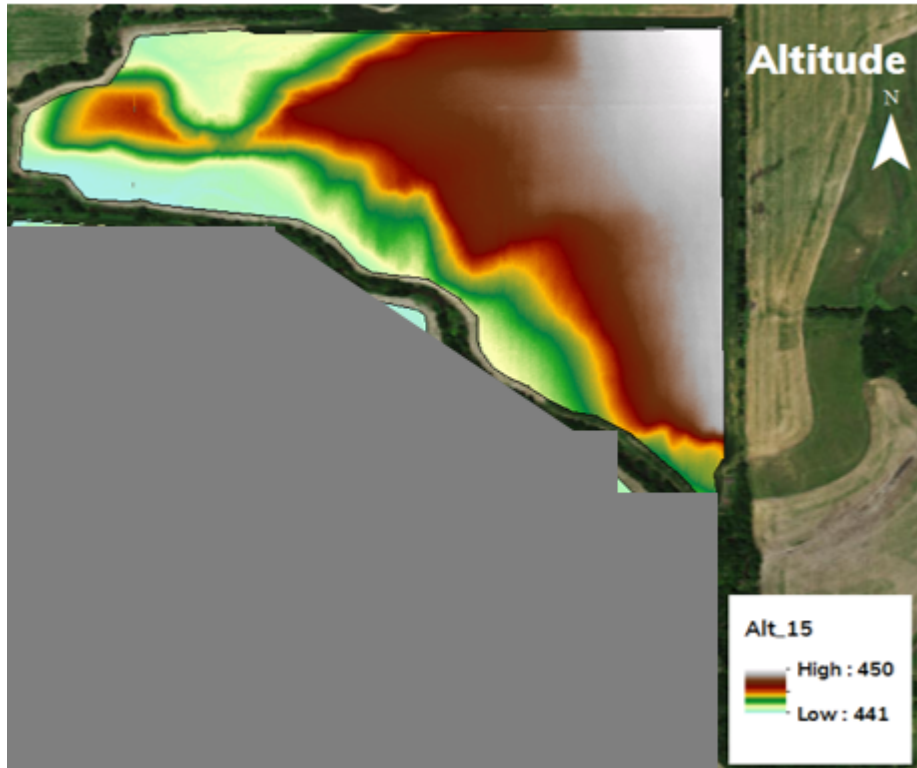
**3801: Pachic Udertic Argiustolls**



**5893: Pachic Argiustolls**



**Landscape characterization**

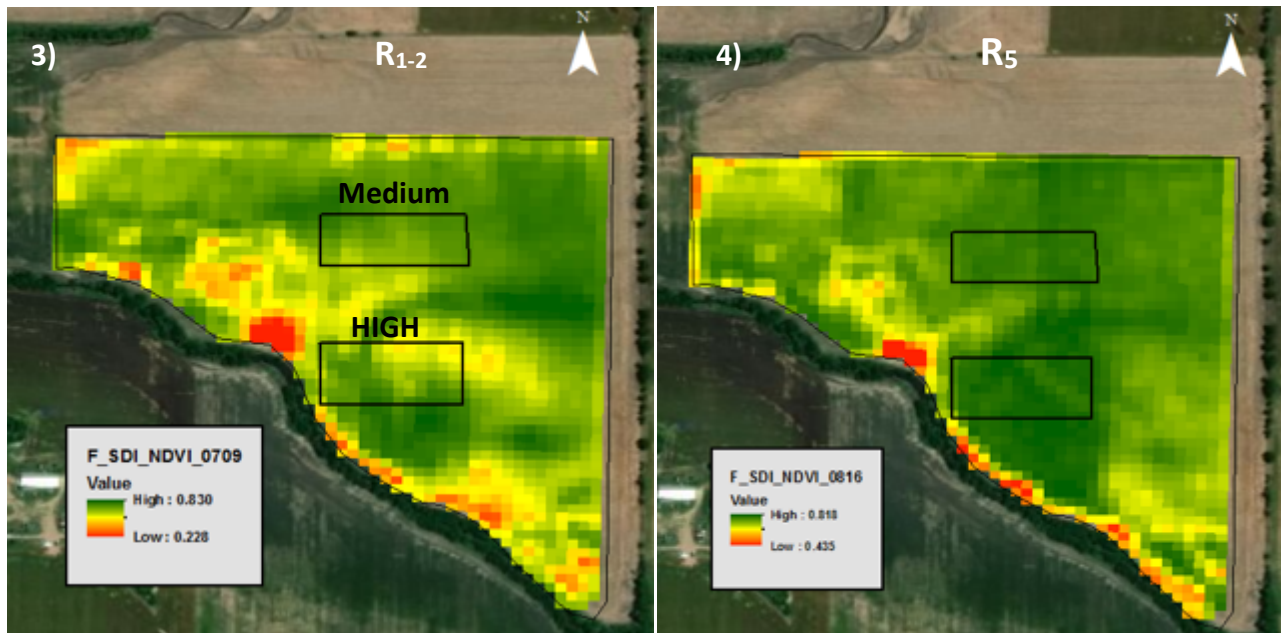


**Figure 2:**  
Altitude

(meters)



## NDVI SATELLITE IMAGERY:

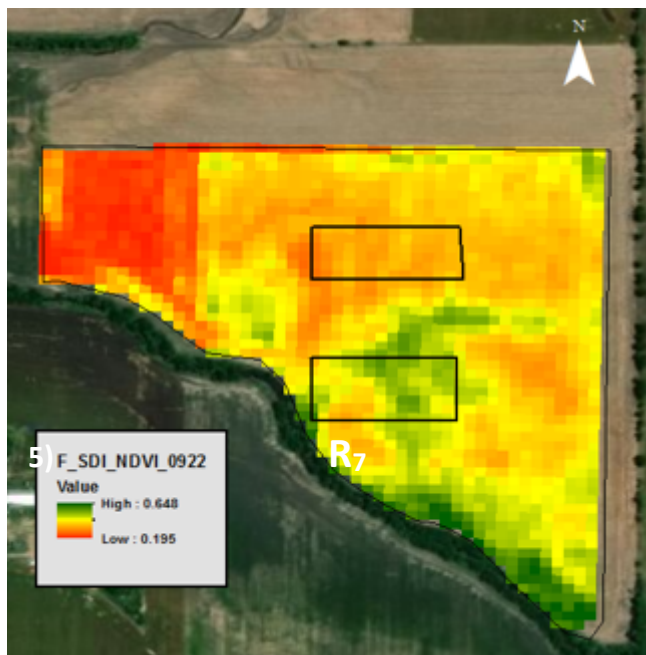


Summer NDVI Soybean 2018

**Figure 3:** NDVI S2 July 9<sup>th</sup> - Phenology (**R<sub>1-2</sub>**)

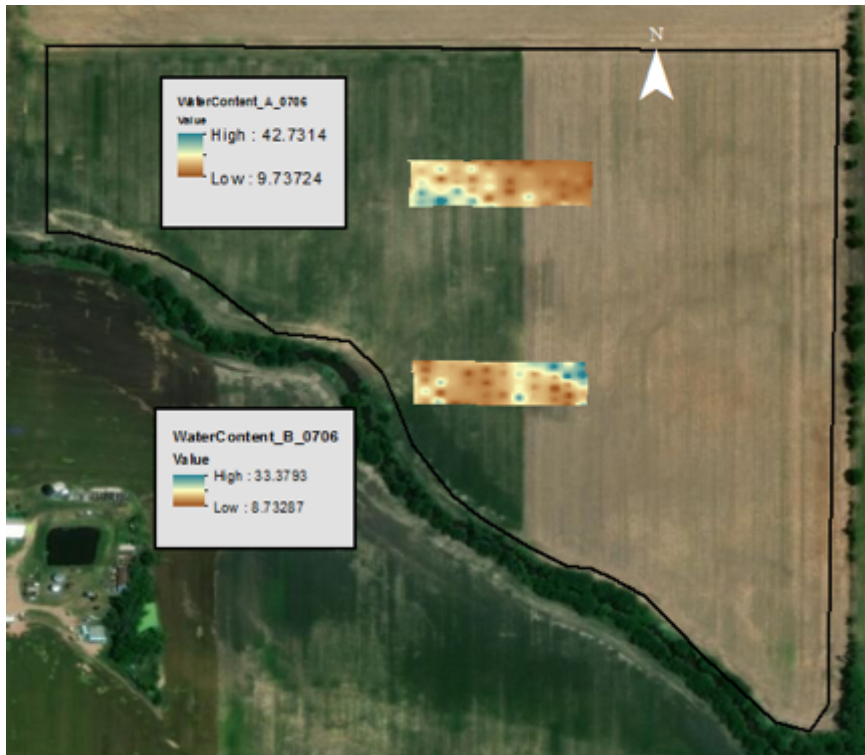
**Figure 4:** NDVI S2 August 16<sup>th</sup> - Phenology (**R<sub>5</sub>**)

**Figure 5:** NDVI S2 September 22<sup>th</sup> - Phenology (**R<sub>7</sub>**)



These figures represent the evolution in season of NDVI images for Soybean, during reproductive stages of the crop. With black rectangles, the macro parcels selected for the study of seeding rates are delineated. Two potential environments with different levels of productivity (**medium** and **high**) were identified based on historical analysis of yield maps and validated by soil information (SSURGO) and field altimetry.

Volumetric Water Content:

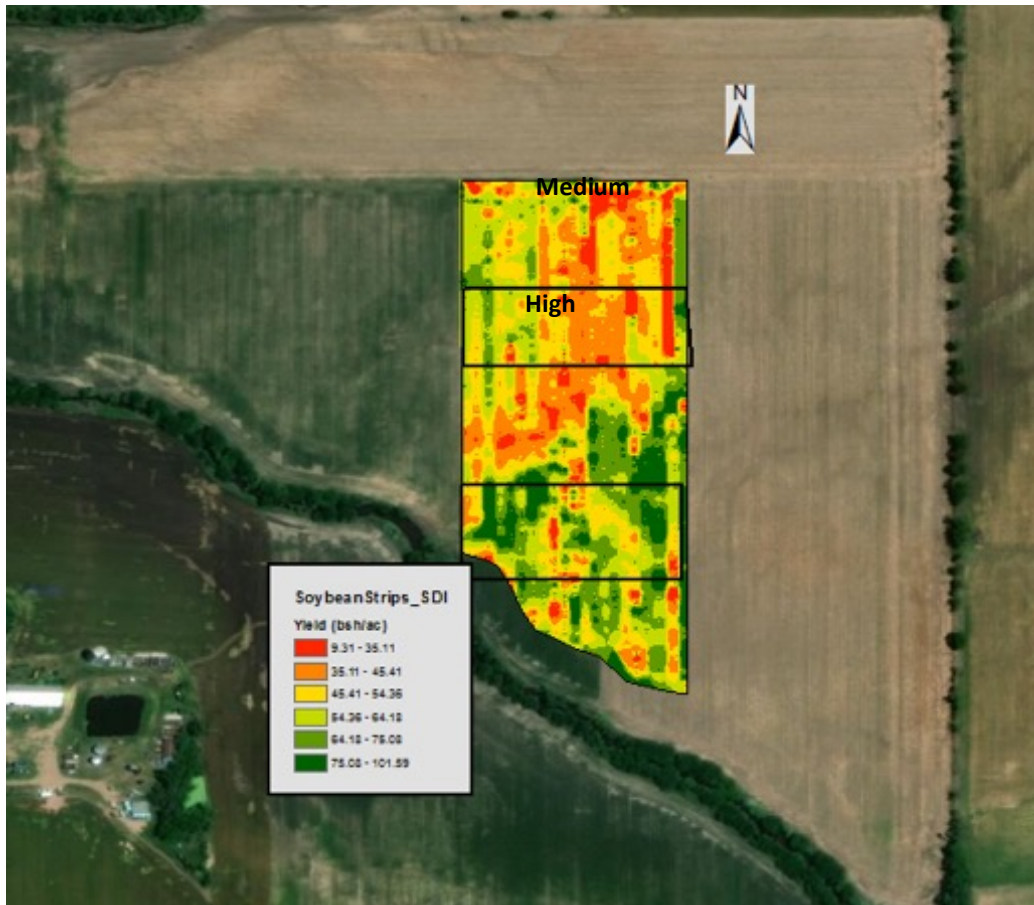


**Figure 24.** Volumetric water content on **a)** July 6<sup>th</sup> 2018 (beginning of flowering), and **b)** July 25<sup>th</sup> 2018 (beginning of set pods), for two potential yield environments **A** (medium) and **B** (high) chosen for the study of seeding rates in soybean.



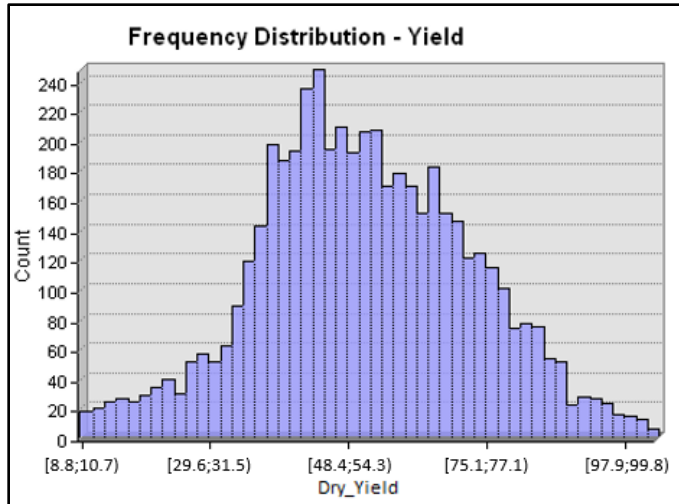
Yield Data:

Dry Yield- Soybean 2018



**Figure 19. Final dry yield map.** Black rectangles indicate the location and potential productivity of each environment (medium and high), where the experimental plots were located.

Environment	Yield (mean)	Standard Deviation
Total Strips	54.97	13.9



**Table 1.** Dry yield summary.

Seeding rate study

	Final Plant Density	Dry Yield
Environment	NS	0.016
Seeding Rate (SR)	<0.0001	0.0384
Environment x SR	NS	NS
CV	4.80	8.78

p-value <0.05

Environment	Dry Yield
HIGH	65.5
Medium	55.36
LSD (0.05)	5.44

Seeding Rate	Final Plant Density	Dry Yield
130	73181 a	57.1 a
160	85378 b	60.7 ab
190	100768 c	66.2 b
LSD (0.05)	5217	6.66