How to Use Precision Technology to Make Data-Informed Decisions

Keith Wendte

Discussion Topics

- History/Background
- Farm operation
- Data management
  - Data formats
  - Types & usage
  - Digital platforms & storage Solutions
  - Soil test methodology
  - VRT fertilizer prescriptions
- Data analysis examples
- Plot design
- Metrics used for evaluating farm operation
- Questions

History/Background

- Grew up on the farm
- BS/MS Agricultural Engineering University of Illinois
- 37 Years with IH/Case/CNH – Burr Ridge, IL
  - Test, Reliability, Design and Innovation Groups
  - Tractors, combines, tillage, planters, precision ag
- Currently live in the SW suburbs of Chicago
- Farm responsibilities include:
  - Collecting & organizing data
  - Data analysis
  - Creation of application maps
  - Aid in planning for next season

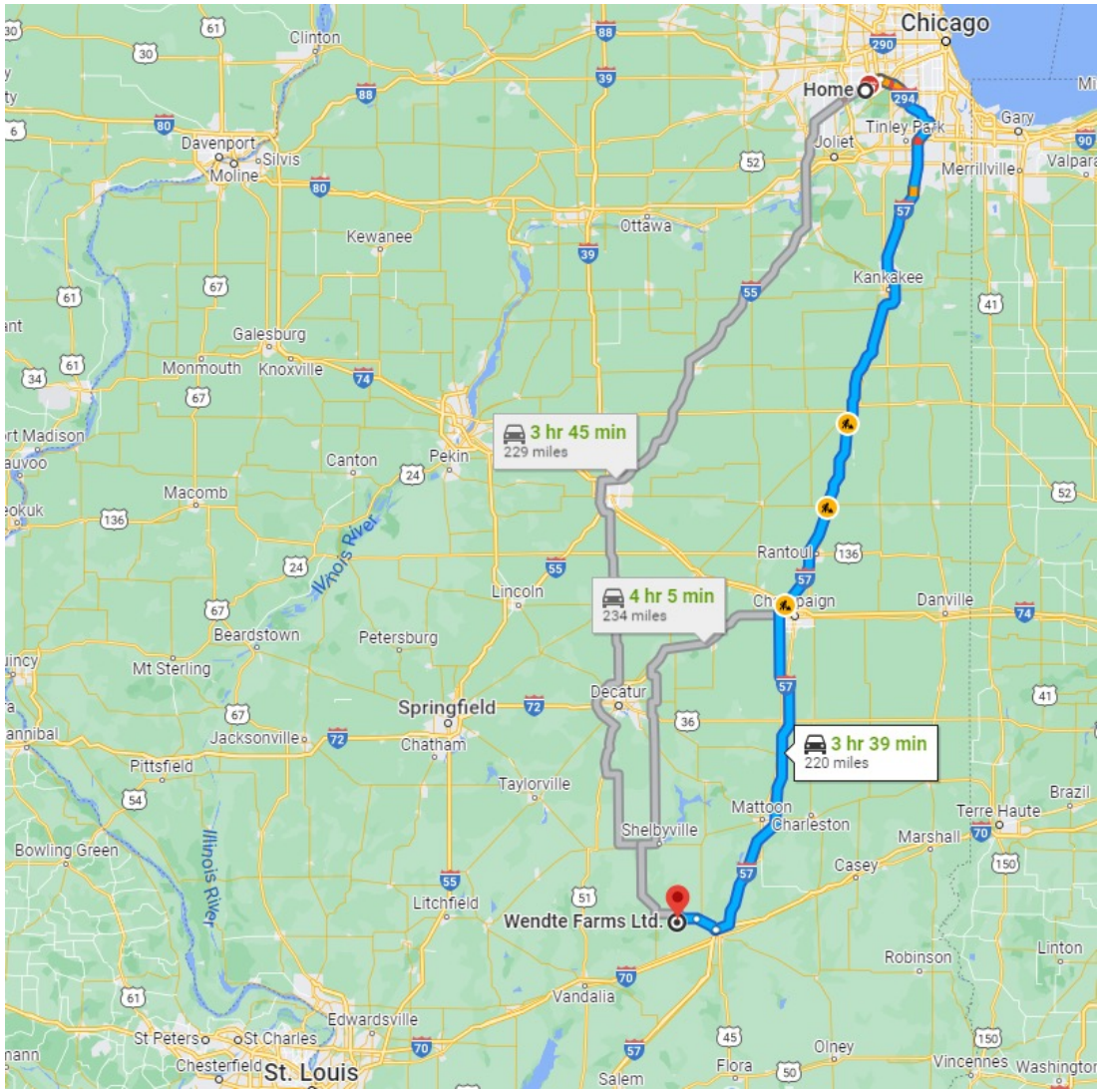
Farm Operation

- 7,000-acre grain farm located in Effingham county (90 miles east of St. Louis)
- Subchapter S corporation, owned by 3 generations of family members
- Operated by 6 family members, 1 full time employee and seasonal help
- Corn, soybeans, winter wheat & double crop soybeans
- Precision ag products
  - 1994 Yield monitor
  - 1997 GPS & Grid soil sampling
  - 2005 VRT fertilizer application
  - 2012 Auto guidance w/RTK
  - 2020 High speed planter with individual shutoff row units on 20” rows
  - 2023 Drone (Future)

Farm Location

220 Miles
3.5 Hour Drive

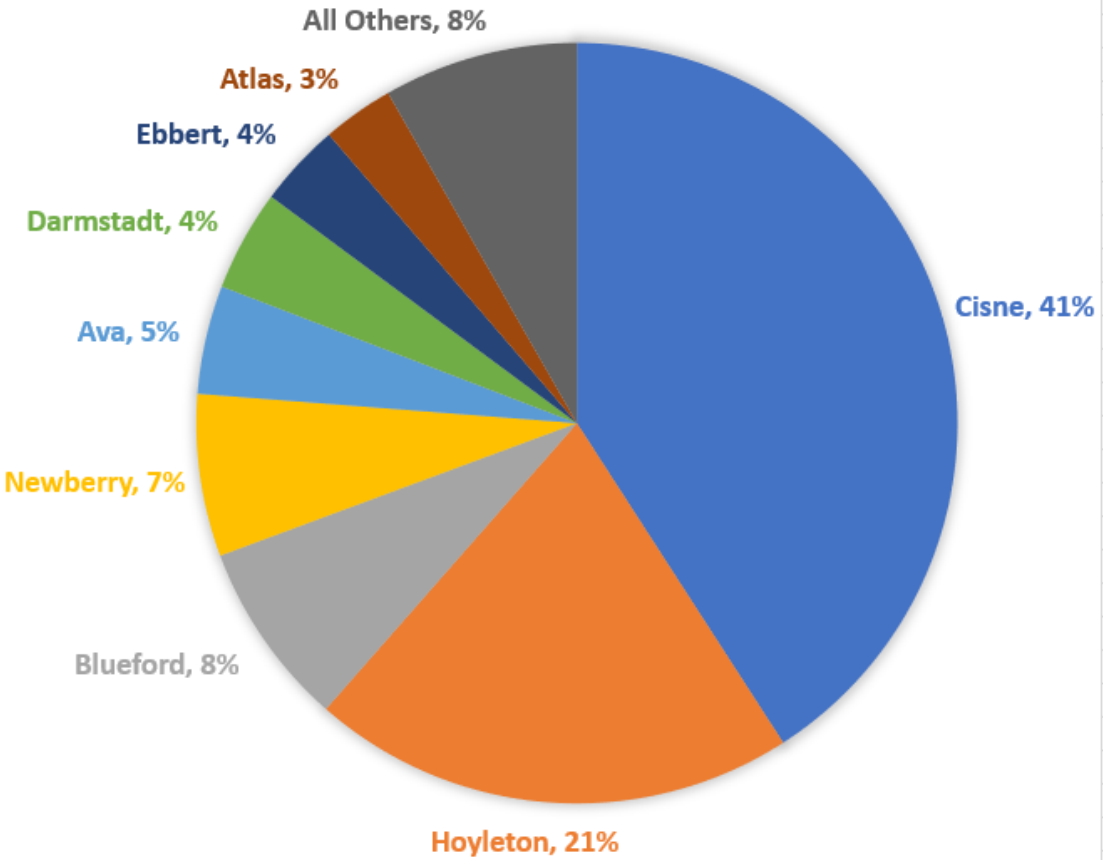
“No Problem”



Wendte Farms Ltd

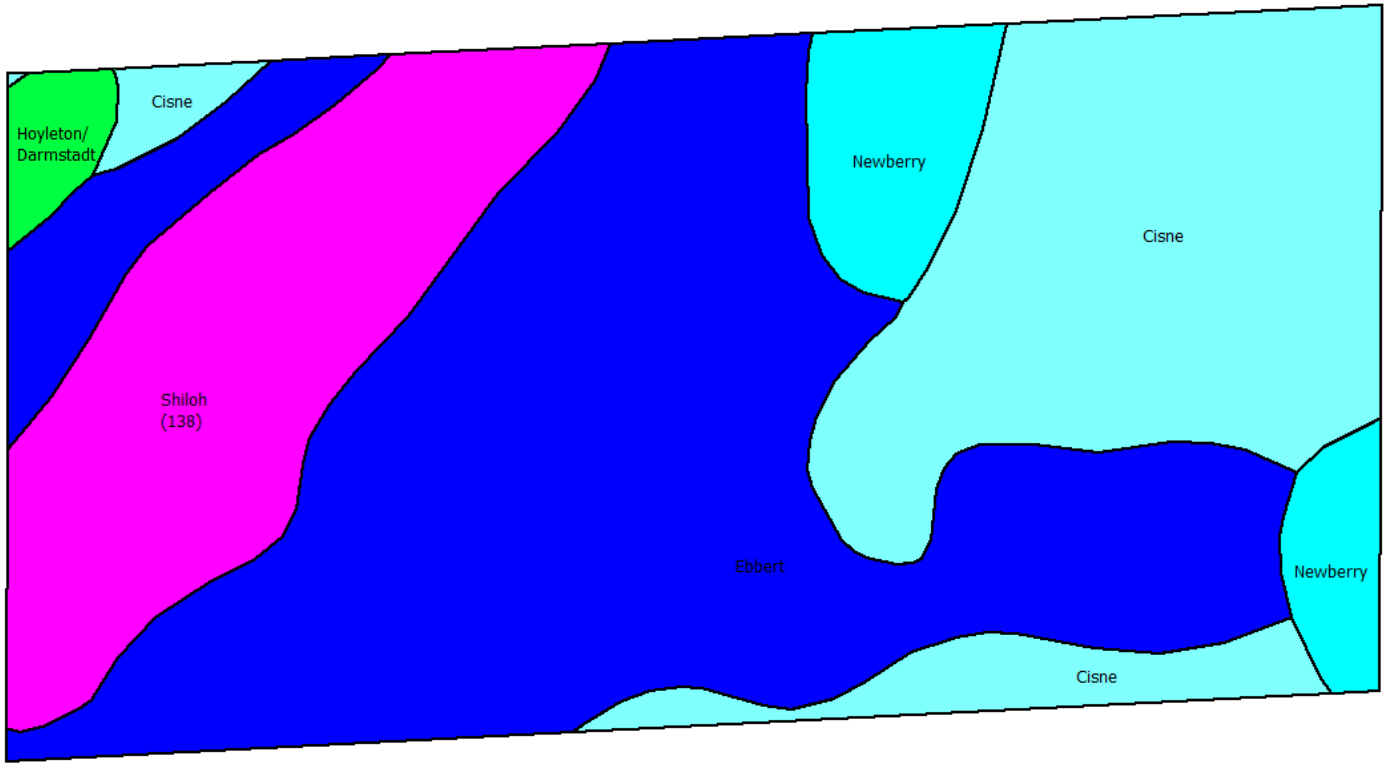
Family & Farm Crew

Wendte Farms Soil Types



- 76% of the soil types are either Cisne, Hoyleton, Bluford or Newberry, 0-2% slope
- Classified as silty loam, 2-3% OM
- Corn productivity index average 119 - 120
- Claypan at 12” - 18” depth
- Poorly drained, requires surface drainage

Two Examples of Soil Types



- **Shiloh**
  - **140 Corn Productivity Index**
  - **37% Clay, 55% Silt, 8% Sand**
  - **2021 Corn yield +13 bu/acre over Cisne soil type in 2021**
- **Cisne**
  - **119 Corn Productivity Index**
  - **15% Clay, 79% Silt, 6% Sand**
  - **2020 Corn yield +23 bu/acre over Shiloh soil type**
  - **2.7” more rain in July, 2020 vs July, 2021**

Data Management – Sources & Transmission

- USB flash drives - uploaded to Dropbox
- Telematic data transfer (Climate FieldView, AFS Connect)
- Web based data
  - Rainfall/field health images (Climate FieldView, Intellicast, satellite, etc)
  - Soil test laboratory
  - Aerial applied fungicide/insecticide
  - FSA maps
  - Soil type
- Field survey records (courthouse records)
- Scouting (iPad FieldView)
- Images from drone camera

Data Management

Data Format Imports/Exports

- CaseIH – .yld, .vyg, .ens, .cn1, ISO XML
- Ag Leader - .ilf, .irx
- AGCO - .shp
- Trimble - .fld, .agf
- Precision Planting - .dat
- Agri-Spray Drone - .kml
- Kuhn Litter Spreader - .rds
- Soil test laboratory - .txt, .csv
- Images - .jpg, .gif, .png, bmp

Data Management

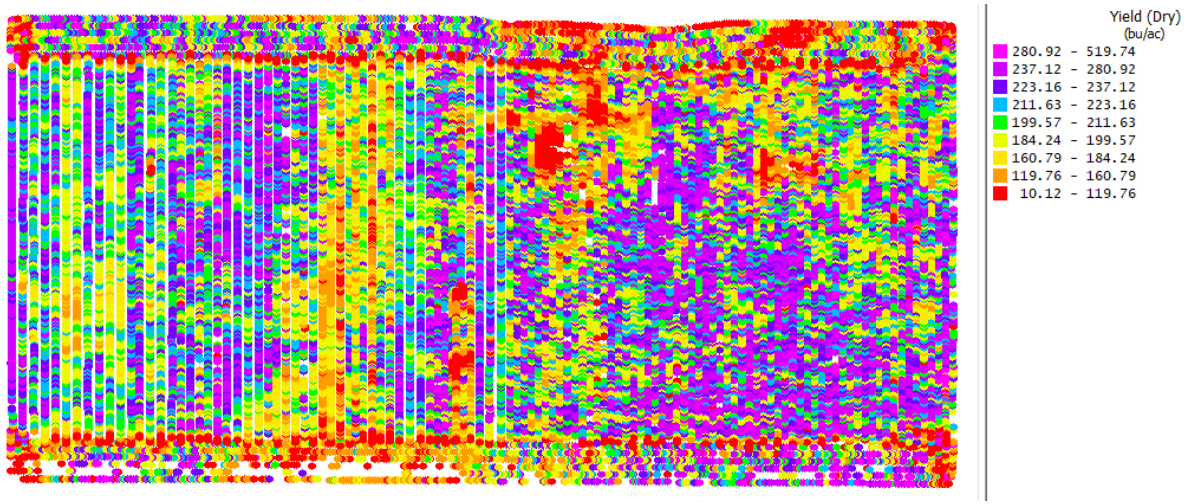
Digital Platforms & Storage Solutions

- AFS Connect Farm – Cloud Storage (Harvest, Spraying, Anhydrous)
- Climate FieldView – Cloud Storage (Harvest, Planting, Spraying)
- Farm Business Network – Harvest & Planting Data uploaded at end of season
- Ag Leader SMS Basic – All data; used for plot analysis - 90 GB of data
- Raw Data Files
  - Microsoft OneDrive – All data; Auto syncs with hard drive; $100/year, Software for 5 computers
  - Computer solid state hard drive (safer & faster vs mechanical hard drives)
  - 2 TB Passport external drive used for backup
    - Set up for automatic backup
    - Stores old versions of data file in case of a “whoops” moment
  - Dropbox – Free limited temporary storage; also used to transfer files that are too large for email

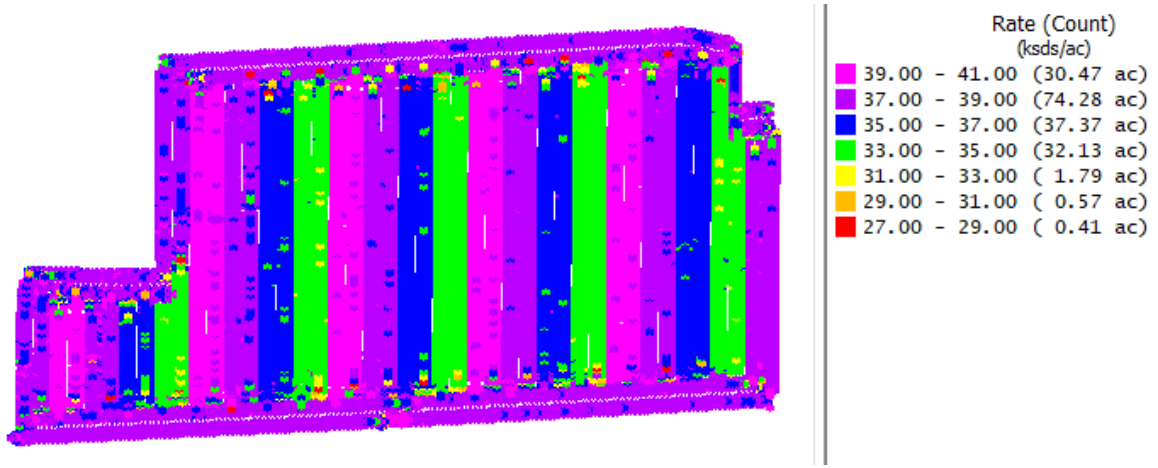
Data Management

Types of Data & Usage

Yield Map – Plot Data Analysis



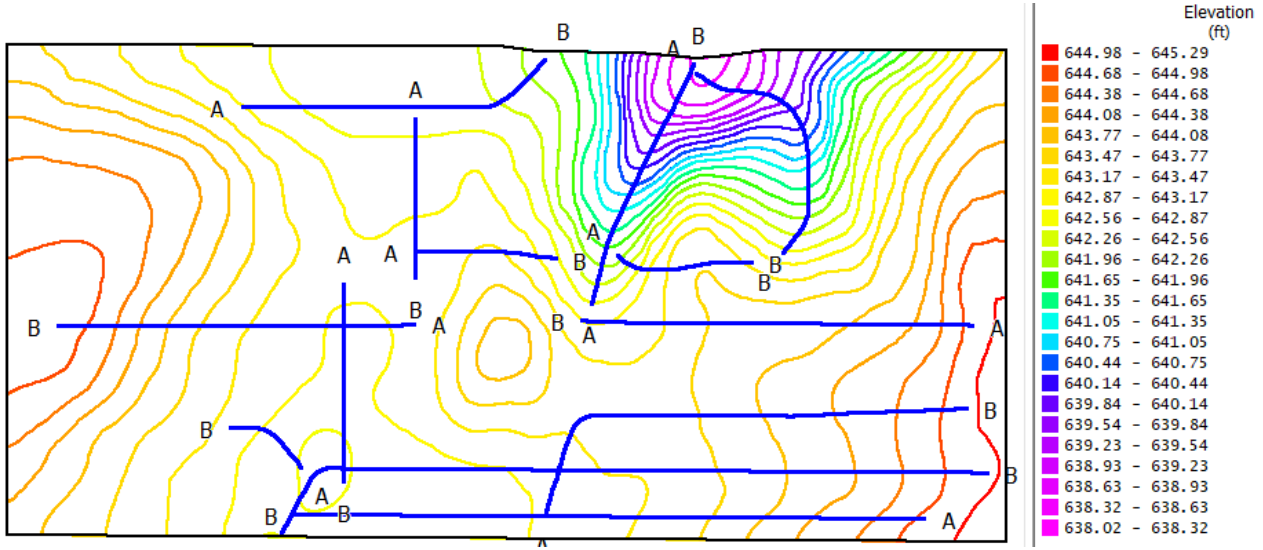
Crop Inputs As-Applied – Plot Data Analysis



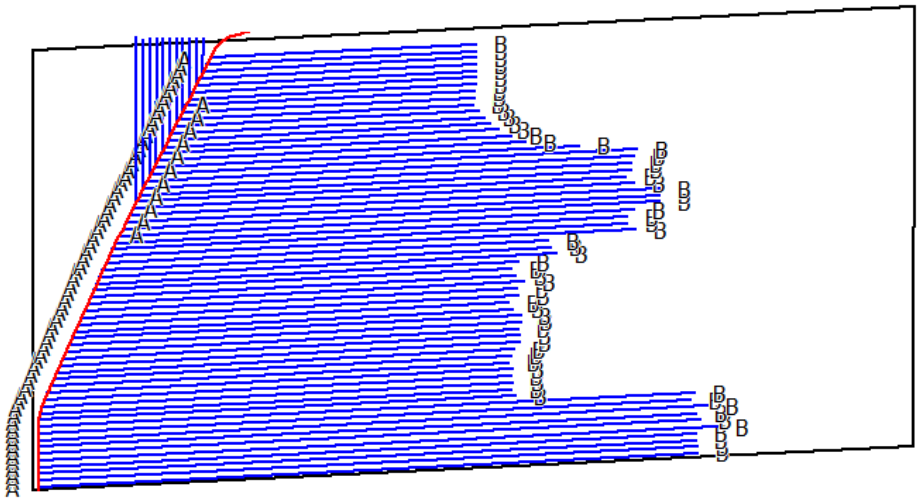
Data Management

Types of Data & Usage

Elevation Contour Maps
Locate Surface Drainage Ditches



Tile Line Location
Used for repairing tile line failures & calculating ROI

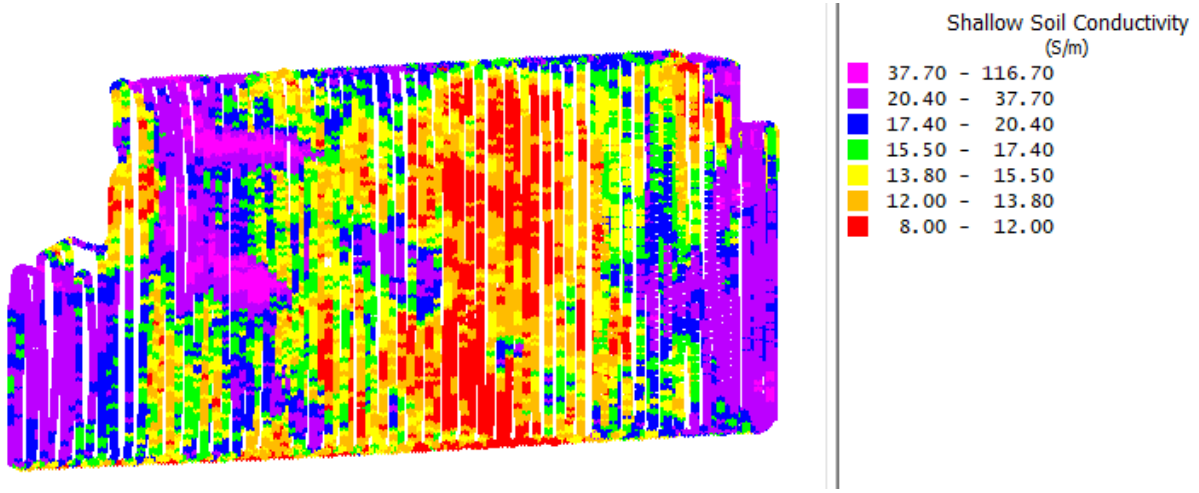


Data Management

Types of Data & Usage

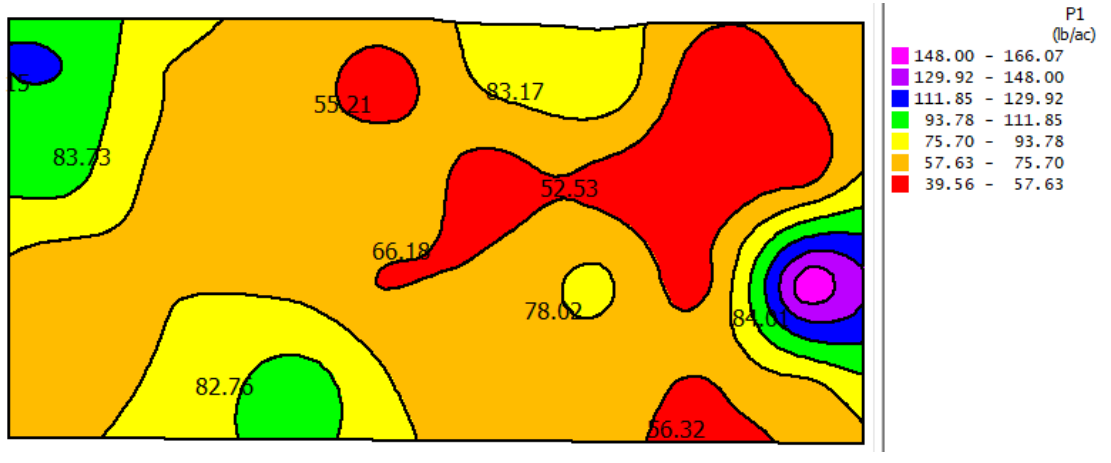
Soil Conductivity (Veris)

Fine Tune Soil Type Maps



Soil Test Results

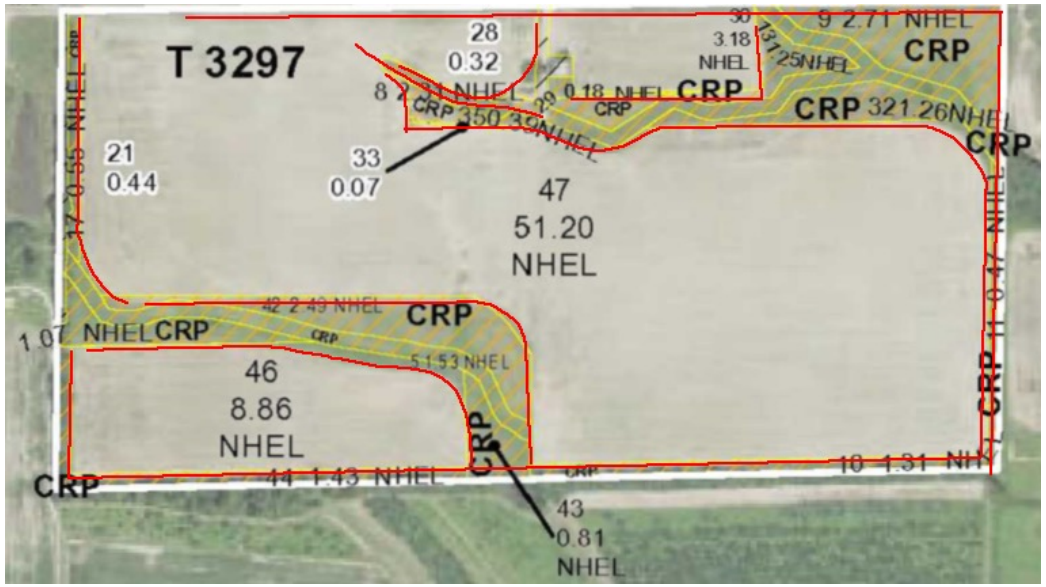
Fertilizer & Lime VRT Maps



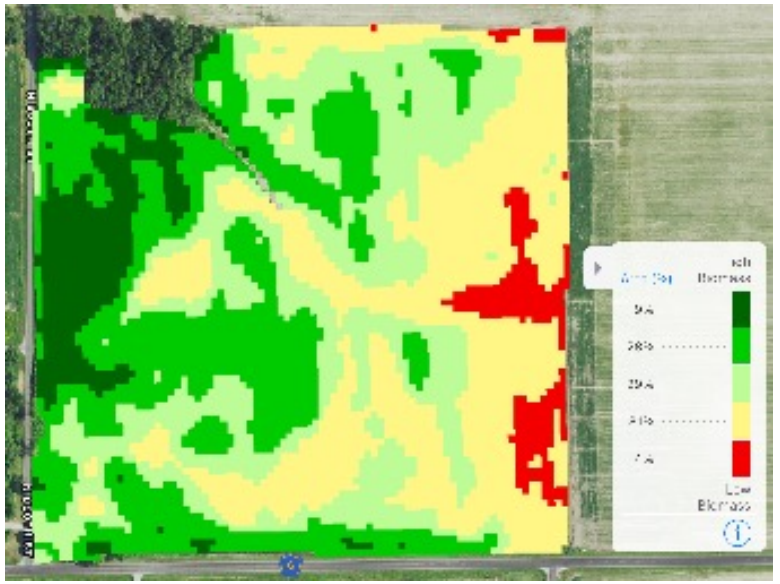
Data Management

Types of Data & Usage

FSA Maps - CRP - AB Lines)



Field Health – Evaluation of "Fixes"



Data Management

Types of Data & Usage

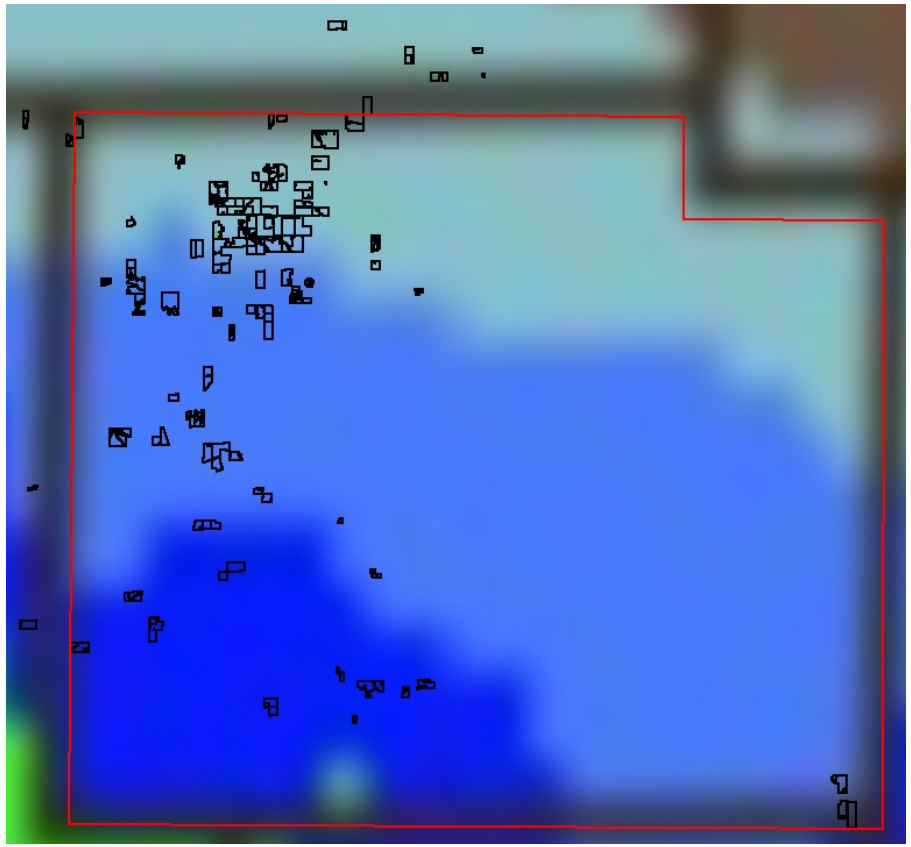
Geo Referenced Precipitation Map

(Intellicast Web Site)

Mid - August Rainfall

Dark Blue = 1.0”

Light Blue - <.25”



Data Management

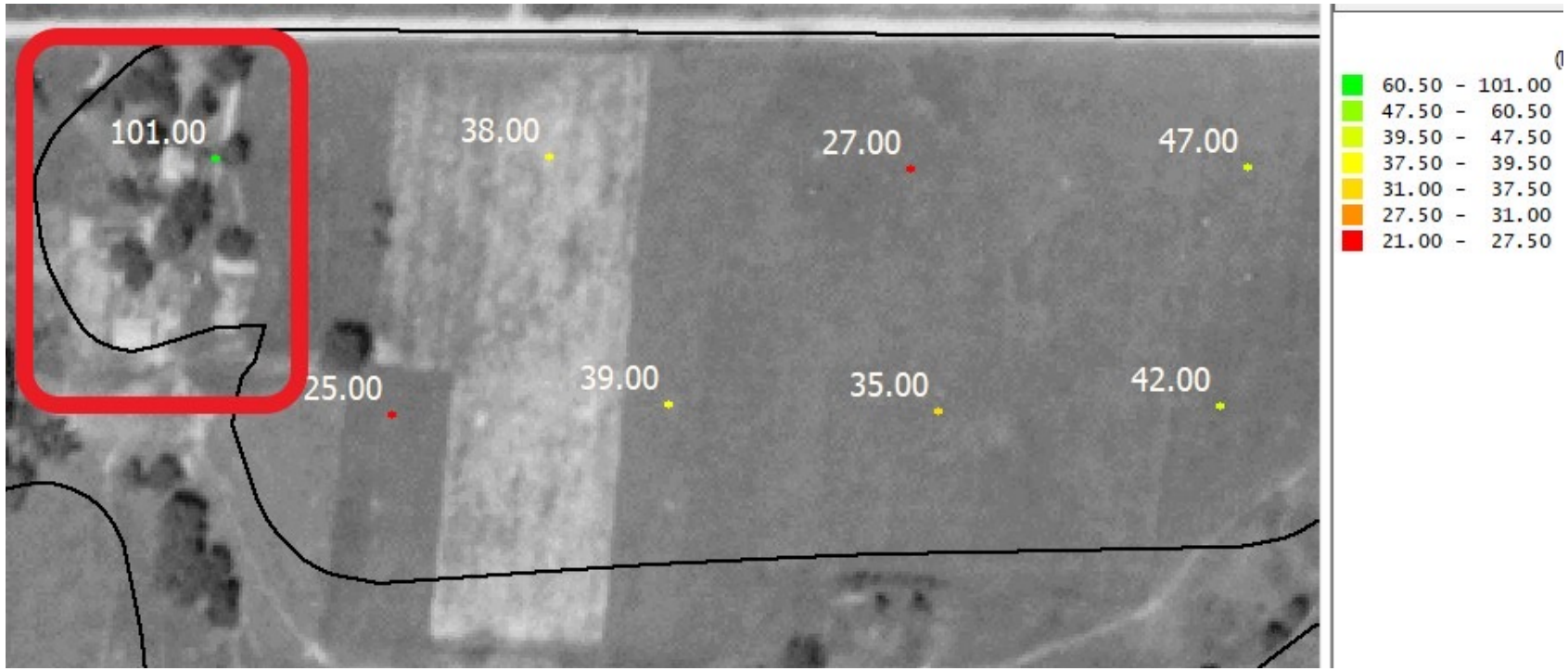
Types of Data & Usage

2020 P Soil Test – Unexplained High Test

Data Management

Types of Data & Usage

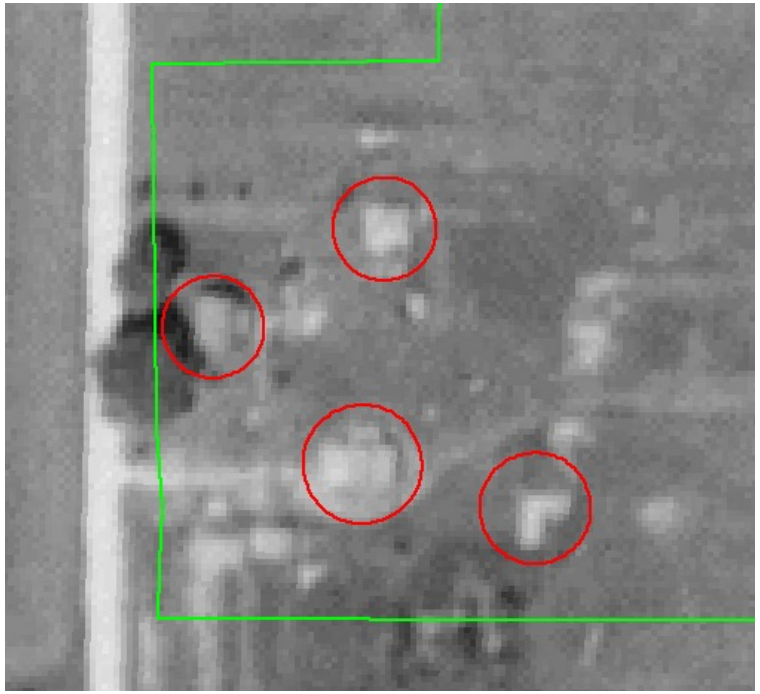
Image From 1938



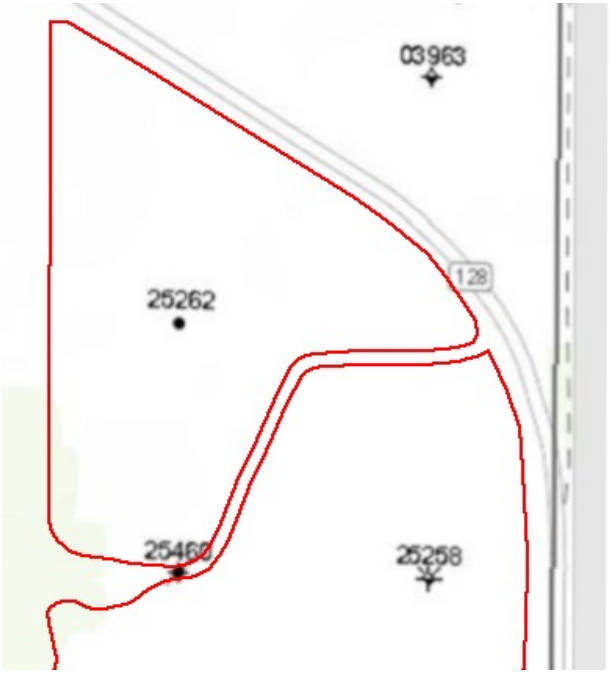
Data Management

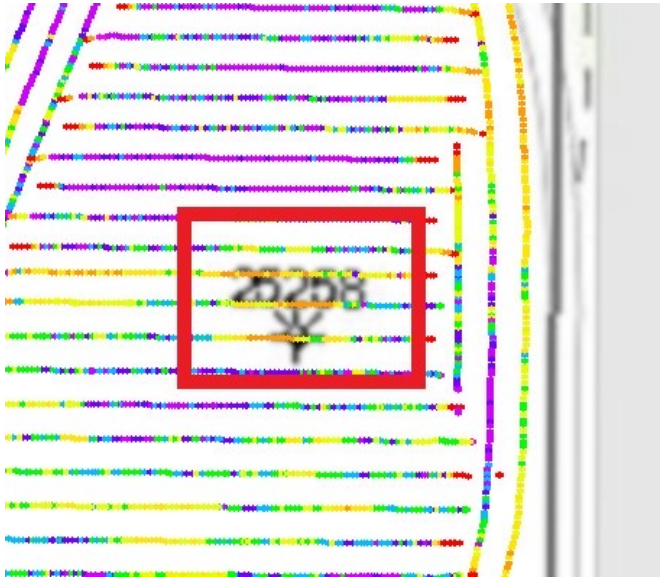
Types of Data & Usage

Old Building Foundations



Abandoned Oil Wells

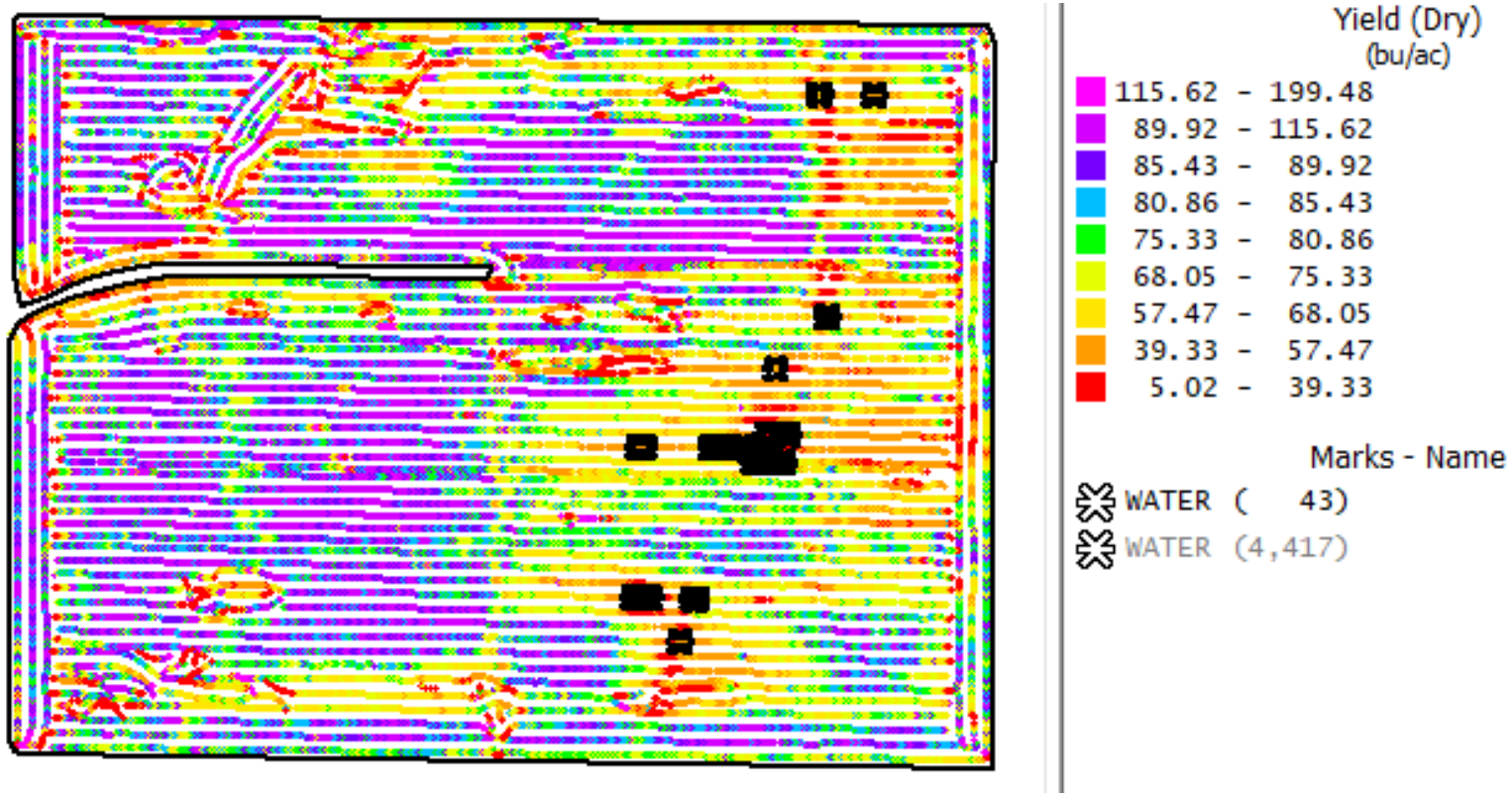




Data Management

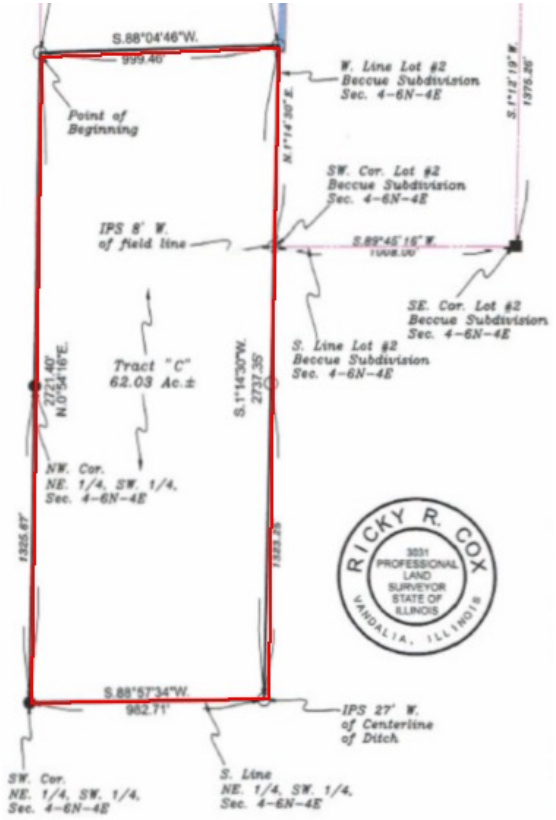
Types of Data & Usage

Wet Spots Tagged During Harvest – Locate Surface Ditches



Data Management

Types of Data & Usage

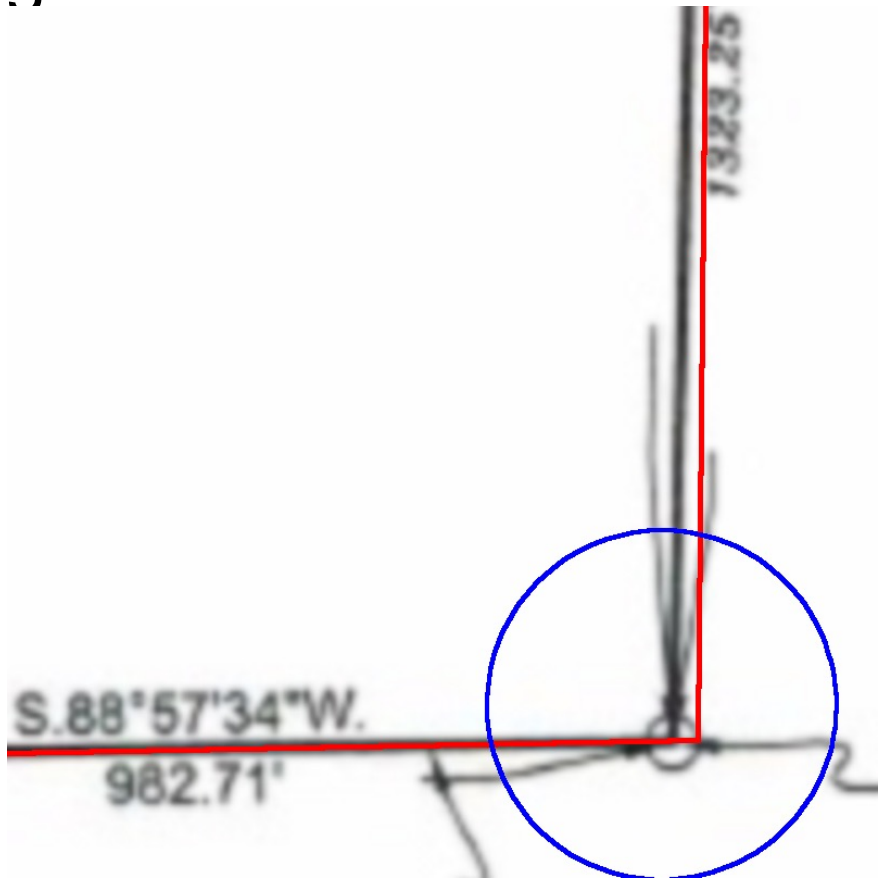


Survey Maps

20’ Discrepancy

½ Mile Ends

1.3 Acres



Data Management

Types of Data & Usage

- **Tillage treatments**
- **Scouting (rock, weeds, obstacles, etc)**
- **In season tissue sampling**
- **Aerial images after a heavy rain (reflection)**

Data Management

Soil Tests Methodology

- **2.5 acre grids**
- **Always done in the fall after soybean crop**
- **Use the same lab for analysis**
- **Every 2 years on fields receiving chicken litter applications**
- **Every 3 years for Soybean/Wheat-Double Crop Soybean/Corn rotation**
- **Every 4 years for Soybean/Corn/Soybean/Corn**
- **Use University of Illinois goals for P, K, Lime, Micronutrients**
- **Use spreadsheet to calculate fertilizer requirement**
- **Import soil test data and fertilizer requirement into Ag Leader SMS database**
- **Use SMS to create prescription maps**

Data Management

VRT Fertilizer Prescriptions

Year of Soil Test (Every 3-4 Years)

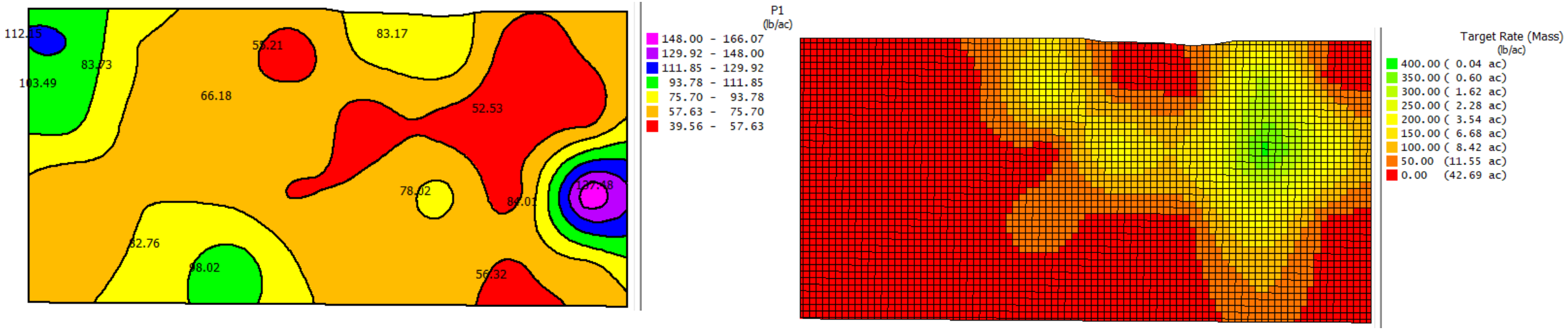
Goal – Test Result + Catchup + Next year crop requirement

2-4 Years After Soil Test

Goal – Test Result + Catchup + Previous Crop(s) Usage – Fertilizer applied + Next year crop requirement

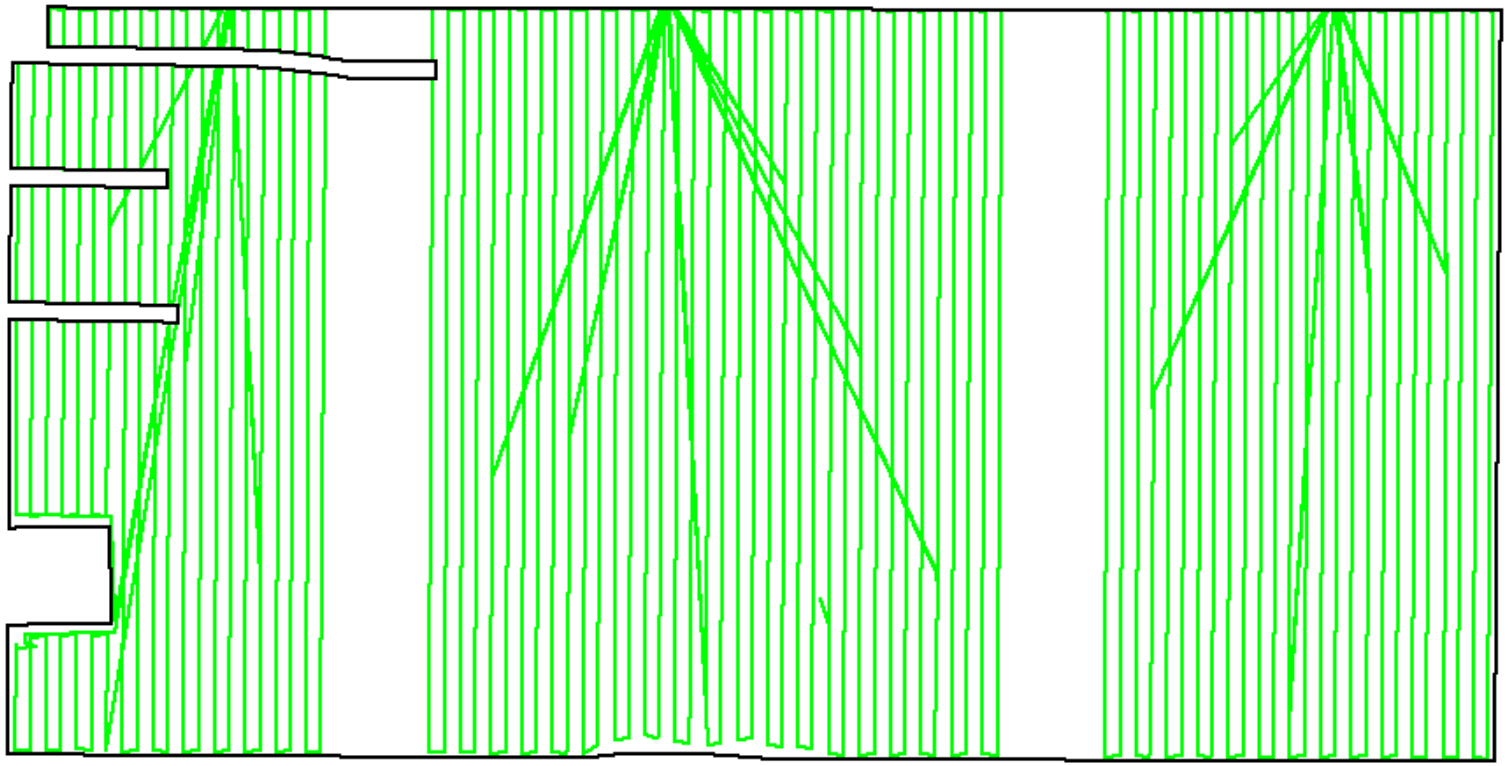
Data Management

Typical Soil Test Map & Prescription (P Goal = 70 lb/acre)



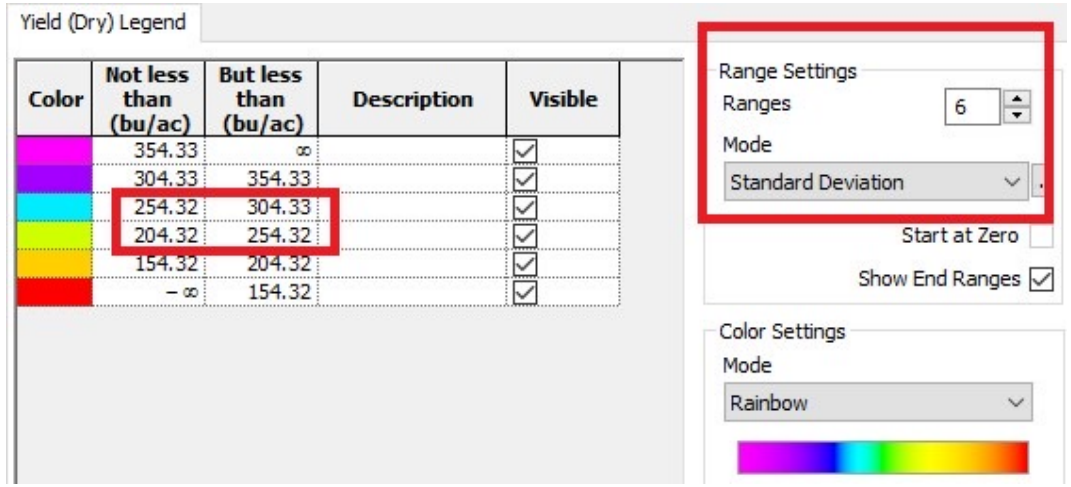
Plot Data Analysis Example

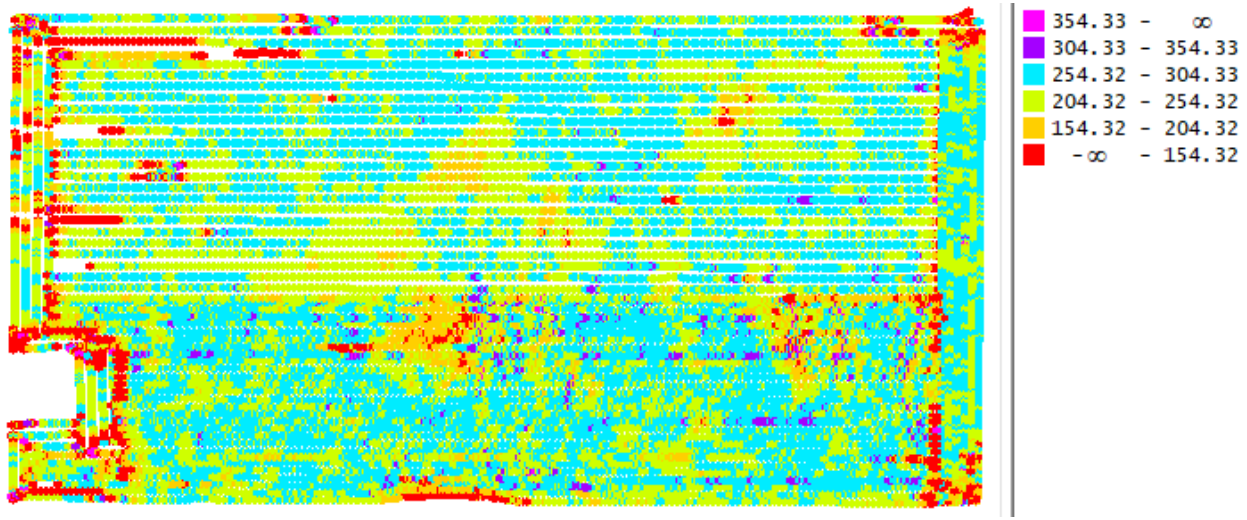
Fungicide Application Evaluation



Plot Data Analysis Example

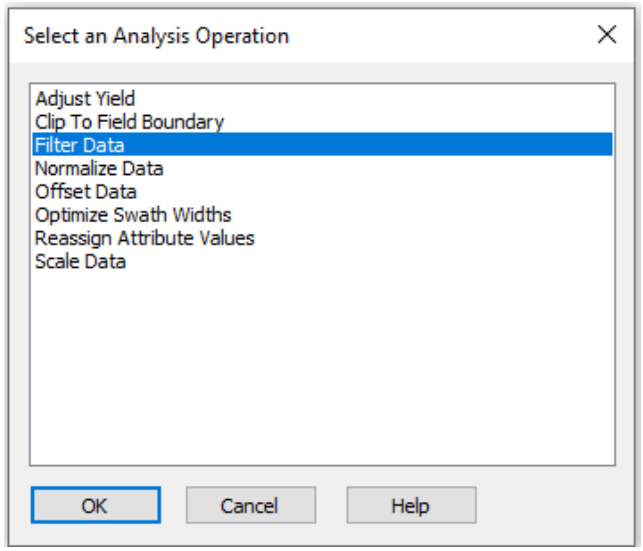
1) Locate extraneous data (3 std dev)

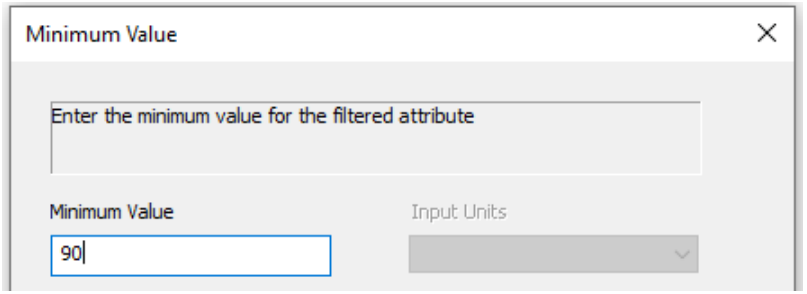


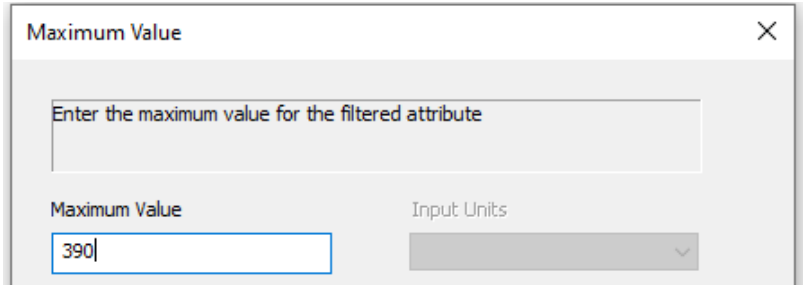


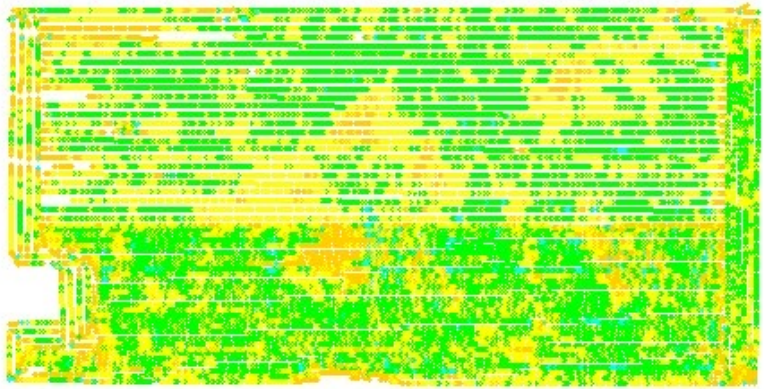
Plot Data Analysis Example

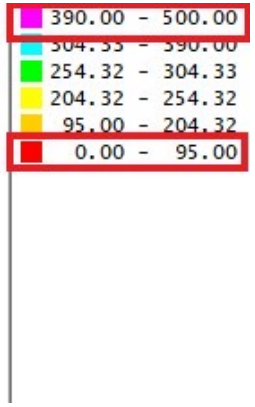
2) Eliminate extraneous data (3 std dev)





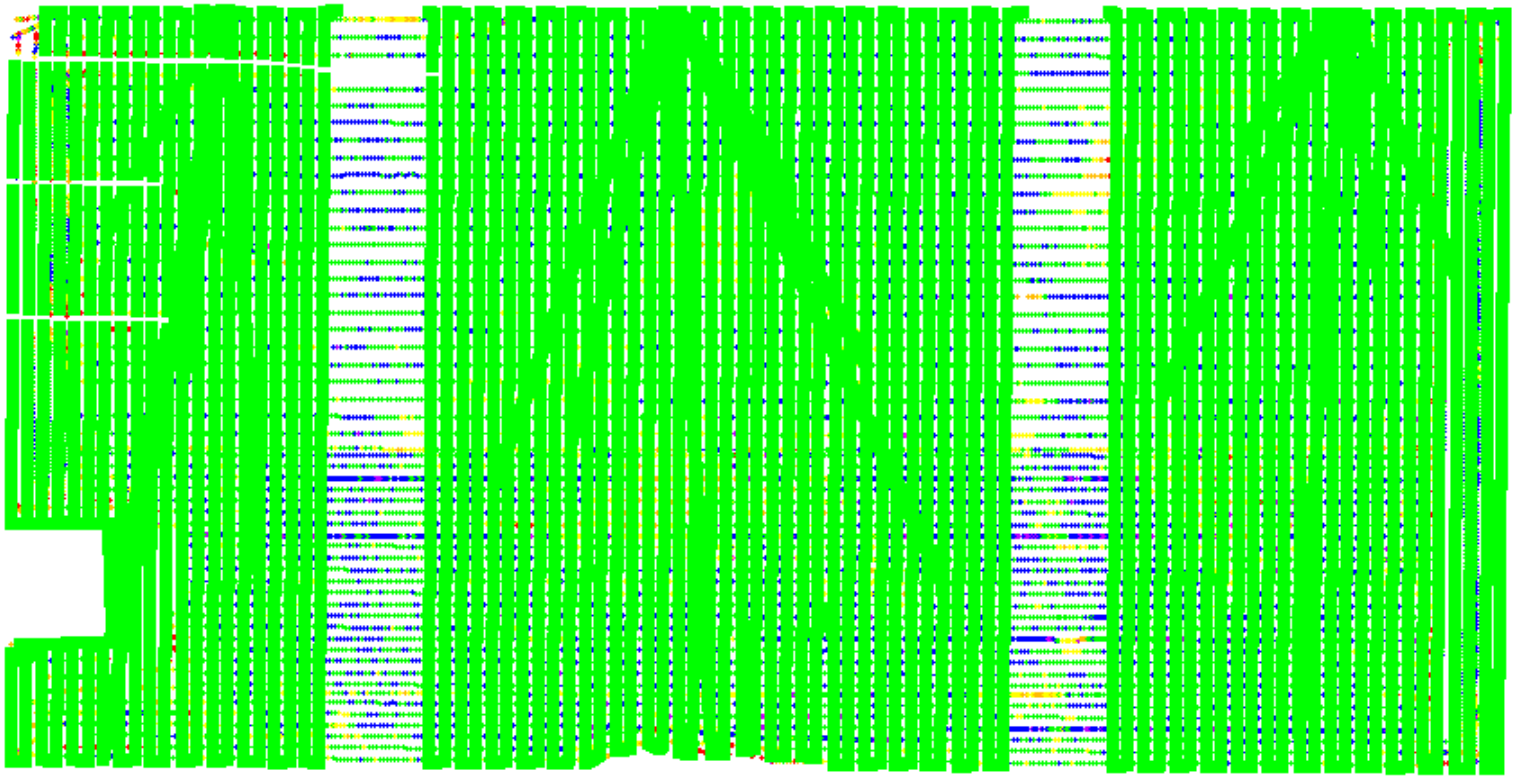






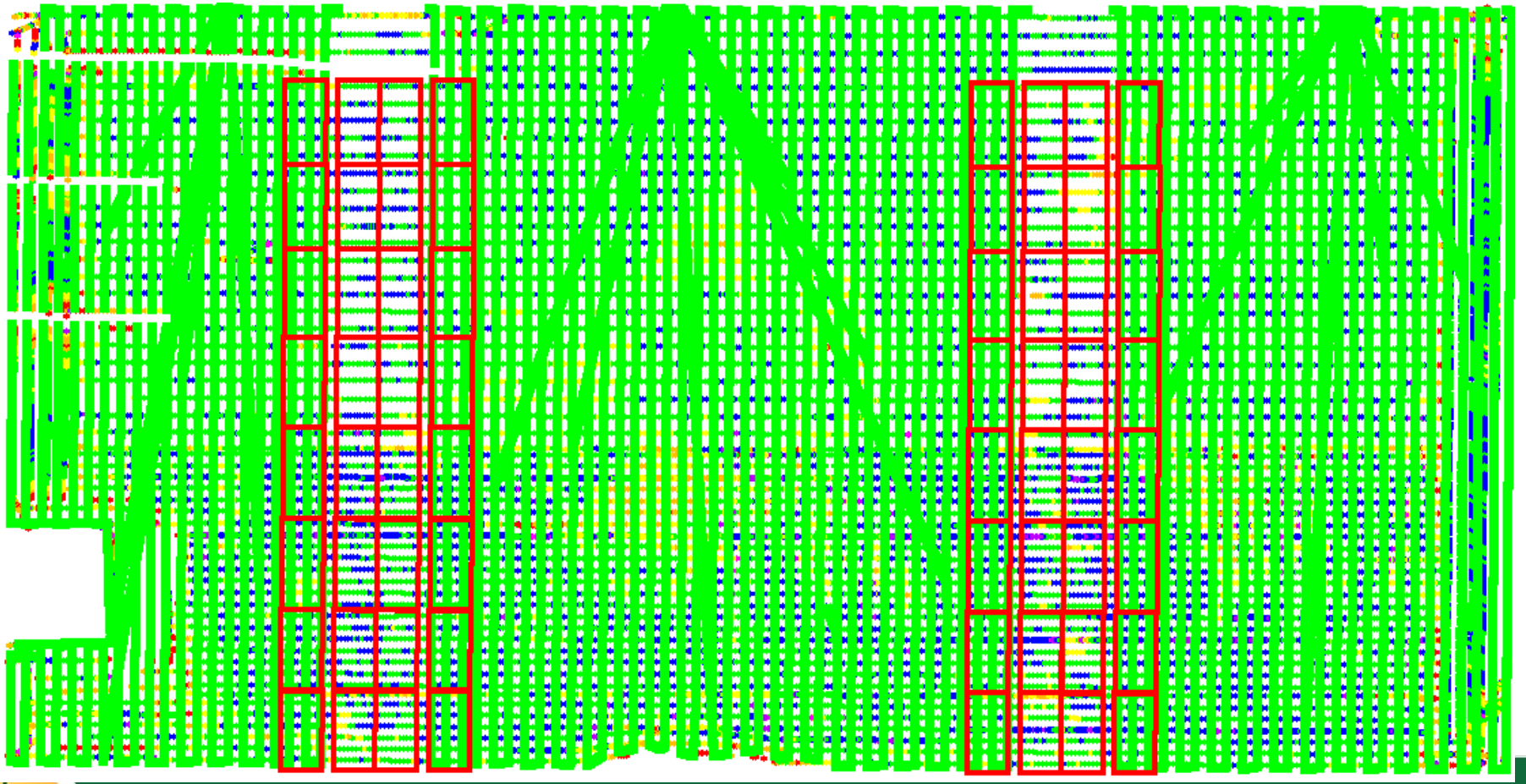
Plot Data Analysis Example

3) Add the as-applied layer (Drone) over yield map
(Note advantages to applying inputs perpendicular to rows)



Plot Data Analysis Example

4) Layout subsample areas for applied area vs control area



Plot Data Analysis Example

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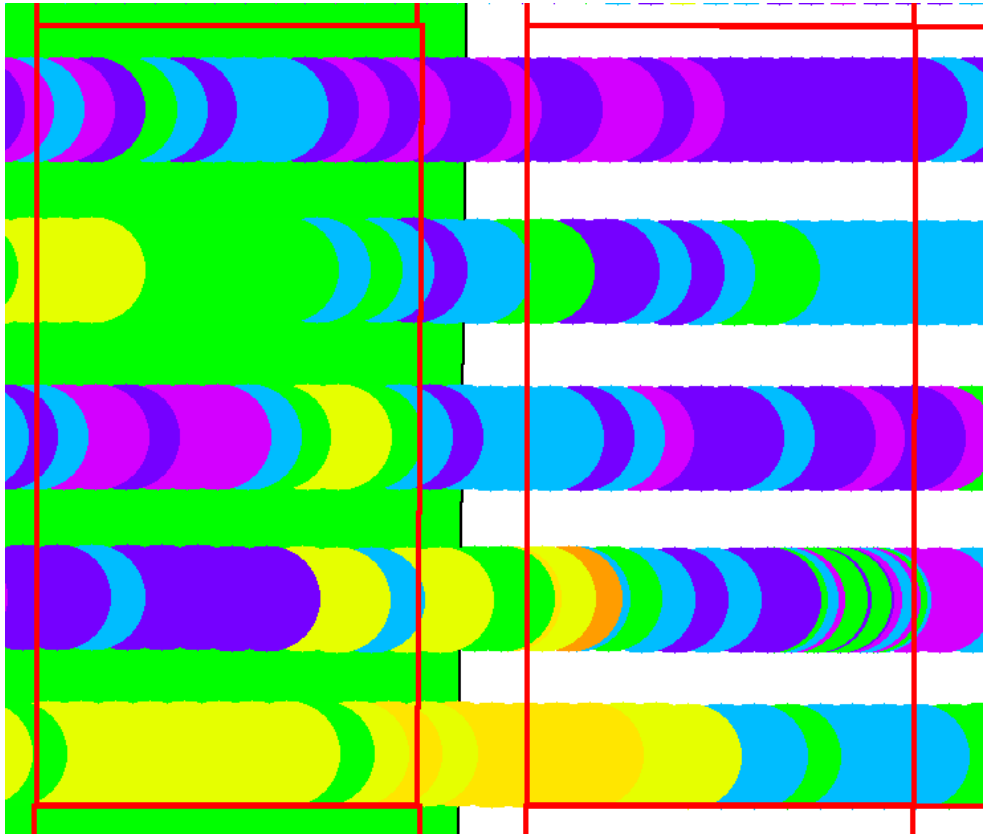
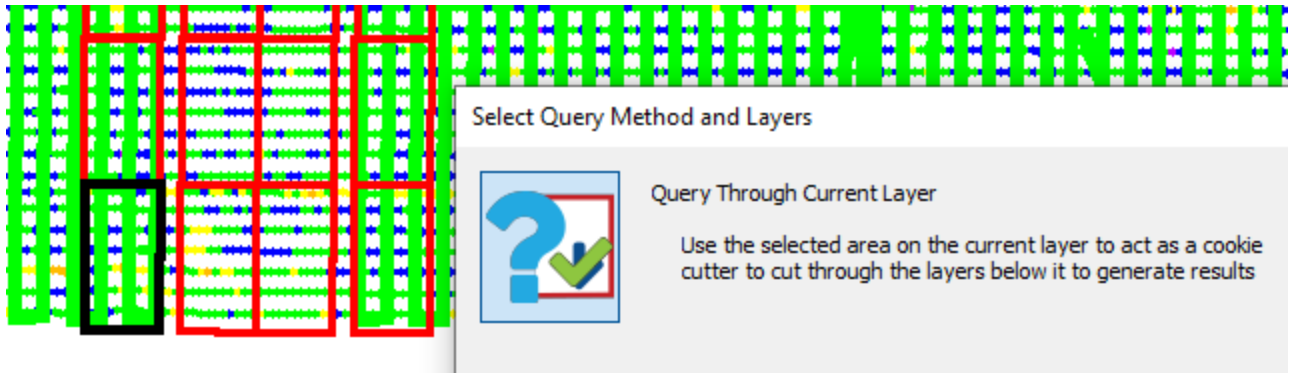


Green Area = Treated area
White Area = Untreated

Leave gap between subsample areas in order to allow for yield lag from the yield monitor.

Plot Data Analysis Example

5) Select subsample area and choose “Query Through Current Layer”
Repeat for all remaining subsample areas



Layer 3 - Harvest - 1 | Corn | 2022

Main Layer

Total area	0.21 ac
Length	508.61 ft
Count	88

Description	Average	Total	Minimum	Maximum
Yield (Dry)	252.02 bu/ac	53.72 bu	161.63 bu/ac	304.00 bu/ac
Moisture	17.92 %		16.10 %	19.50 %
Elevation	616.54 ft		615.05 ft	617.73 ft

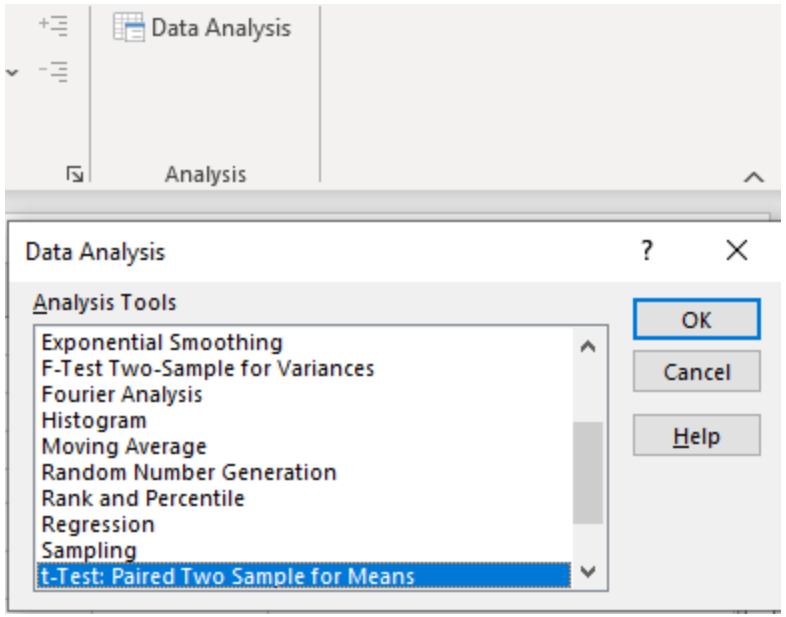
Plot Data Analysis Example

6) **Transfer query data to Excel spreadsheet**

Veltyma+Baythroid (7/18/22)				
Control Group		Fungicide/Insecticide		Yield
Yield	Moisture	Yield	Moisture	Advantage
262.07	17.63	256.52	17.58	5.55
259.03	17.39	258.21	17.53	0.82
262.25	17.12	257.53	16.95	4.72
262.26	16.67	252.78	16.81	9.48
257.07	16.77	247.52	17.11	9.55
258.47	17.10	254.28	17.17	4.19
256.13	17.25	243.14	17.34	12.99
243.04	16.88	239.84	16.06	3.20
267.08	17.05	261.04	17.03	6.04
247.38	16.74	256.32	16.95	8.94
261.18	17.59	254.32	17.74	6.86
252.72	17.67	261.65	17.89	8.93
261.77	18.02	262.97	17.84	1.20
255.91	17.89	262.85	18.01	6.94
241.80	17.55	252.02	17.92	10.22
248.30	17.90	260.77	18.20	12.47
245.66	16.36	259.68	17.03	14.02
243.61	16.07	221.63	15.80	21.98
252.63	15.95	269.10	17.59	16.47
223.53	16.06	236.41	16.31	12.88
249.90	17.75	261.92	17.58	12.02
256.94	17.62	261.20	17.58	4.26
246.94	17.46	257.44	17.44	10.50
262.67	17.87	255.38	18.14	7.29
245.24	16.92	272.43	17.44	27.19
267.03	17.12	264.75	16.89	2.28
255.25	17.99	255.44	18.27	0.19
257.97	18.12	267.77	18.43	9.80
256.88	17.63	250.66	17.91	6.22
245.28	17.38	267.90	17.74	22.62
238.90	17.11	245.01	17.58	6.11
251.14	17.23	257.82	17.80	6.68
253.00	17.25	255.82	17.43	2.82

Data Analysis Example

7) Use Excel Data Analysis Add-On to analyze data and produce Analysis of Variance Table (Using t-test, α=.15, 70% CL)

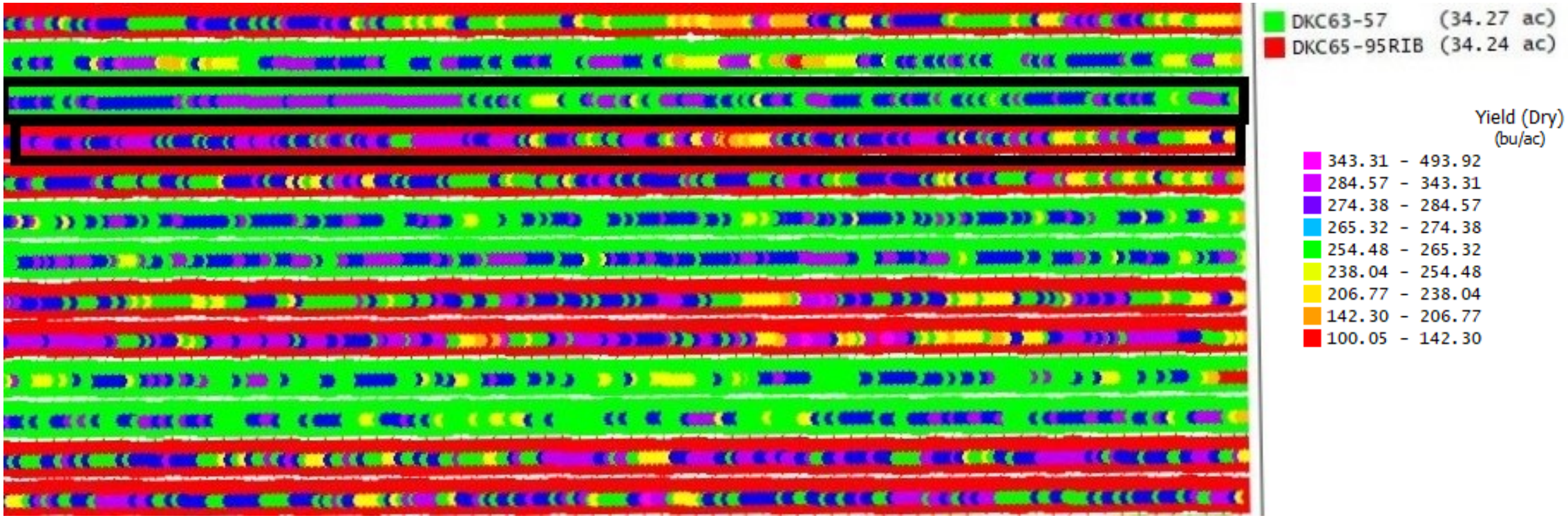


t-Test: Paired Two Sample for Means		
	Variable 1	*Variable 2*
Mean	255.949118	253.2332353
Variance	101.29073	83.94151346
Observations	34	34
Pearson Correlation	0.38397345	
Hypothesized Mean Difference	0	
df	33	
t Stat	1.48046529	
P(T<=t) one-tail	0.07411709	
t Critical one-tail	1.05297898	
P(T<=t) two-tail	0.14823418	
t Critical two-tail	1.47384307	

If t Stat > t Critical one-tail, then the difference in averages is statistically significant at the 70% confidence level.

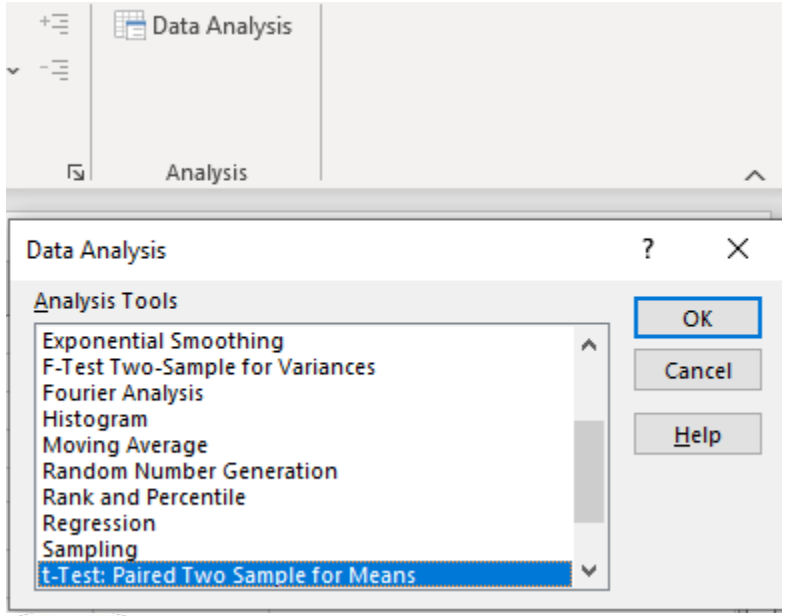
Data Analysis Example

Split Planter Variety Analysis



Data Analysis Example

Split Planter Variety Analysis
Use Excel Data Analysis Add-On to analyze data and produce Analysis of Variance Table (Using t-test, α=.30, 70% CL)



If t Stat > t Critical two-tail, then the difference in averages is statistically significant at the 70% confidence level.

t-Test: Paired Two Sample for Means		
	Variable 1	*Variable 2*
Mean	265.28	263.0253333
Variance	361.1486	199.0146981
Observations	15	15
Pearson Correlation	0.89881658	
Hypothesized Mean Difference	0	
df	14	
t Stat	0.98727996	
P(T<=t) one-tail	0.17013104	
t Critical one-tail	1.07628024	
P(T<=t) two-tail	0.34026207	
t Critical two-tail	1.52309506	

Data Analysis Summary Table

Inputs/Plot Trials	Variety	Avg Yield Adv (Bu/Acre)	# Tests	# Stat Test Sig	Input Cost/Acre	Labor & Appl Cost/Acre	Gross $ Gain/Acre	Net Return Per Acre
Early Planted Corn	Various	53.32	53	0	$0.00	$0.00	$ 399.90	$399.90
Tile	All	14.60	5	5	$0.00	$0.00	$109.50	$109.50
10% Higher Pop on Outside Rows	Various	13.27	8	0	$7.67	$0.00	$99.53	$91.86
Increased Nitrogen	DKC 66-18 RIB	15.10	1	1	$29.00	$7.00	$113.25	$77.25
Additional 50#/acre of NH3	DKC 66-18 RIB	9.83	1	1	$12.50	$0.00	$73.73	$61.23
10% Higher Population	DKC 63-57 RIB	7.61	3	2	$10.83	$0.00	$57.08	$46.25
Dust Seed Trmnt	DKC 60-80 RIB	5.46	4	4	$0.05	$0.00	$40.95	$40.90
Corn Variety	Various	4.40	19	10	$0.00	$0.00	$33.00	$33.00
Magma Hume	Various	2.60	3	3	$18.00	$0.00	$19.50	$1.50
Foliar Fertilizer	DKC 63-91 RIB	0.56	1	0	$3.00	$0.00	$4.20	$1.20
Additional AMS & Urea	DKC 70-27 RIB	4.77	1	0	$28.65	$7.00	$35.78	$0.13
VRT vs Fixed Population	Various	(0.42)	5	1	$11.64	$0.00	($3.15)	($14.79)
Seed treatment	DKC70-27 & 67-44	(1.32)	3	0	$5.00	$0.00	($9.90)	($14.90)
V6 Fertilizer Y-Drop Treatmnet	DKC 66-18 RIB	6.53	1	1	$92.31	$0.00	$48.98	($43.34)
ATS & 0-0-20 (Melted 0-0-60)	DKC 64-65RIB	(3.01)	1	0	$25.04	$5.00	($22.58)	($52.62)
In Furrow Fertilizer	DKC 63-91 RIB	(4.37)	3	2	$32.40	$0.00	($32.78)	($65.18)

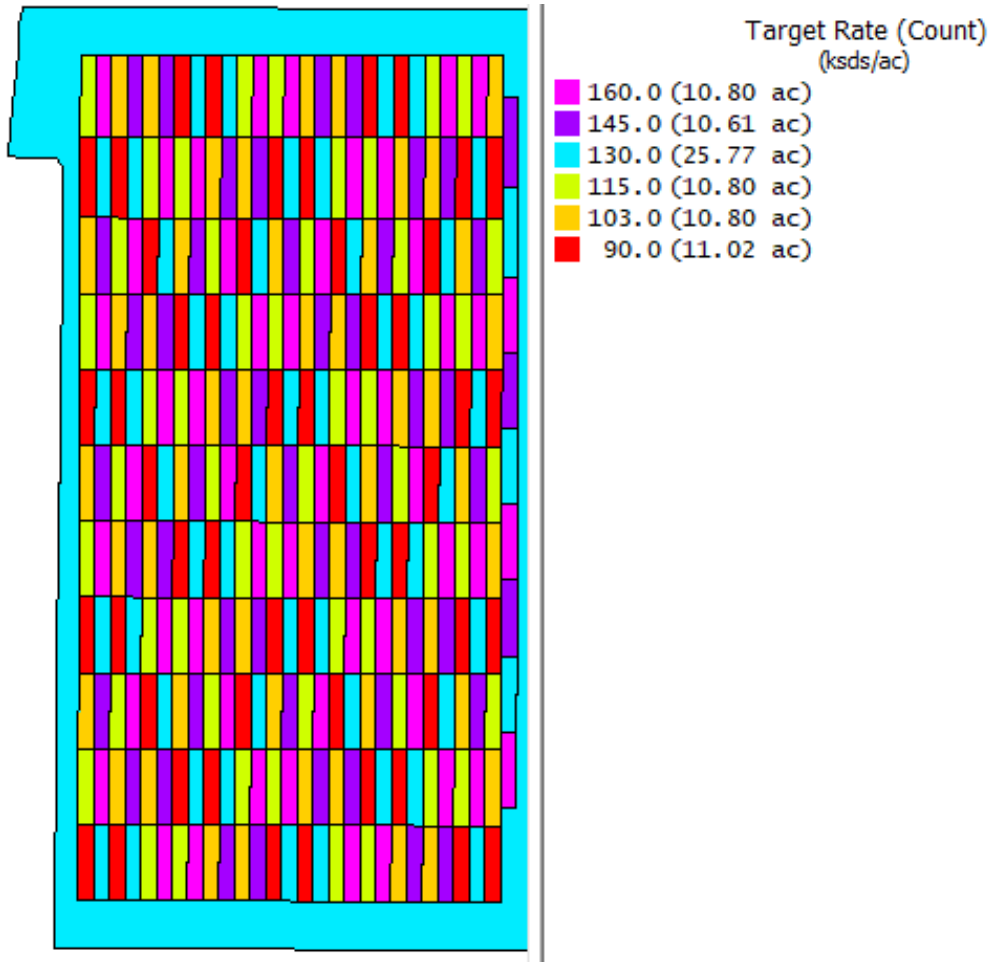
Plot Design 101

- Choose a field that is relatively uniform
- Avoid waterways, old farmsteads, areas prone to flooding, etc
- Try to make plot width equal to combine header width; if cannot do that, make sure plot width is at least twice the width of the header
- Randomize within a block
- Replicate at least 4 blocks across the field, preferably more
- More replications make it easier to find statistically significant differences
- If possible, apply crop input perpendicular to rows or harvest diagonally
    - Negates the multiple combine effect
    - Negates wheel track, tillage pass and fertilizer variation effects
    - Multiple varieties possible

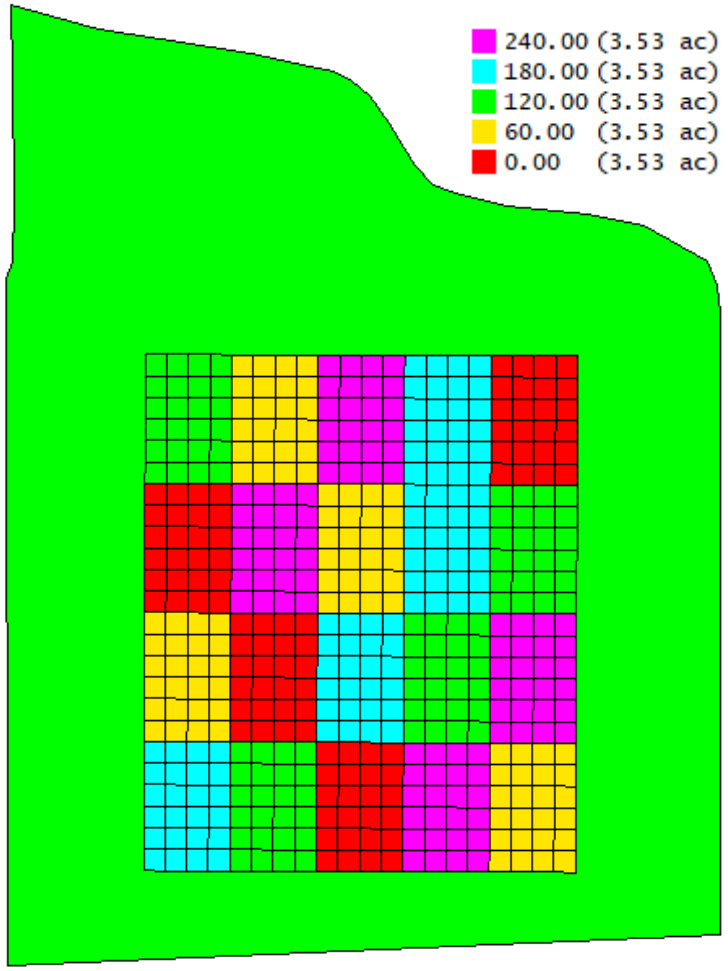
Plot Design Example

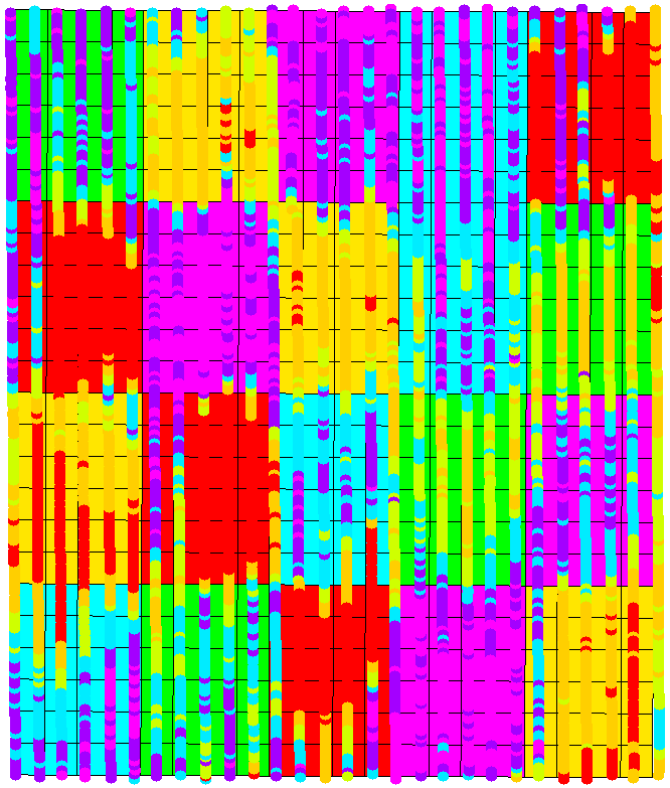
Plot layouts Data-Intensive Farm Management (DIFM)
Project University of Illinois 2017 – 2022

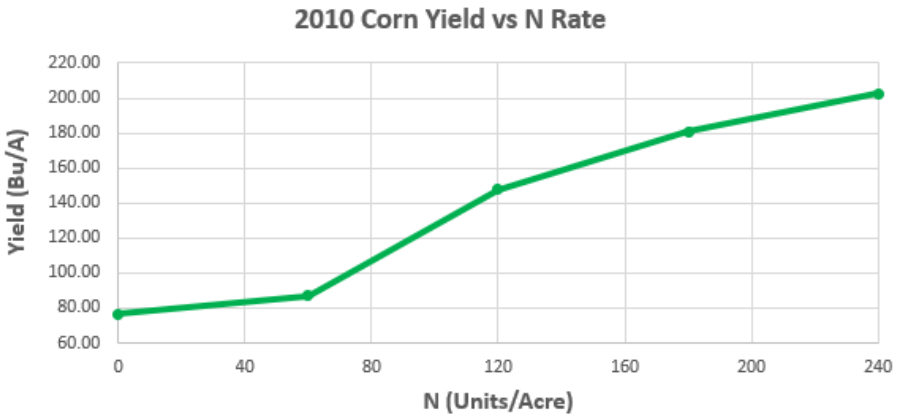
- **Soybean plots = 42.5’ x 200’ plots (.21 acres)**
- **45’ Grain Platform**
- **60’ Planter with individual row unit population control**
- **Soybeans – Population**
- **Corn – Population + Nitrogen**

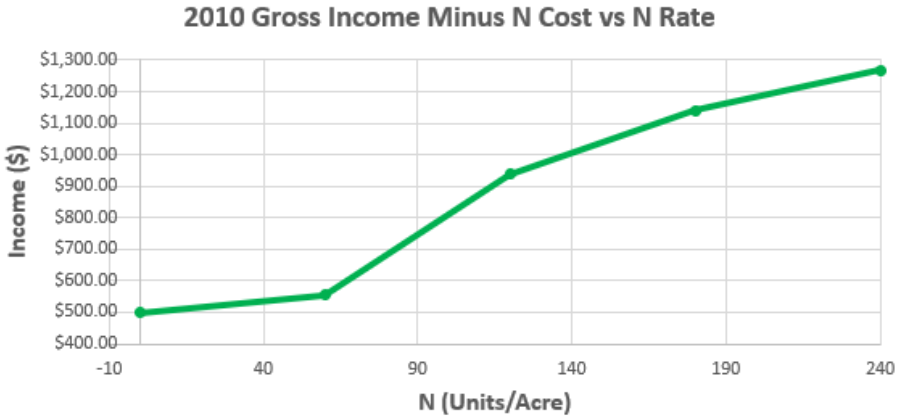


Plot Design Example (2010)

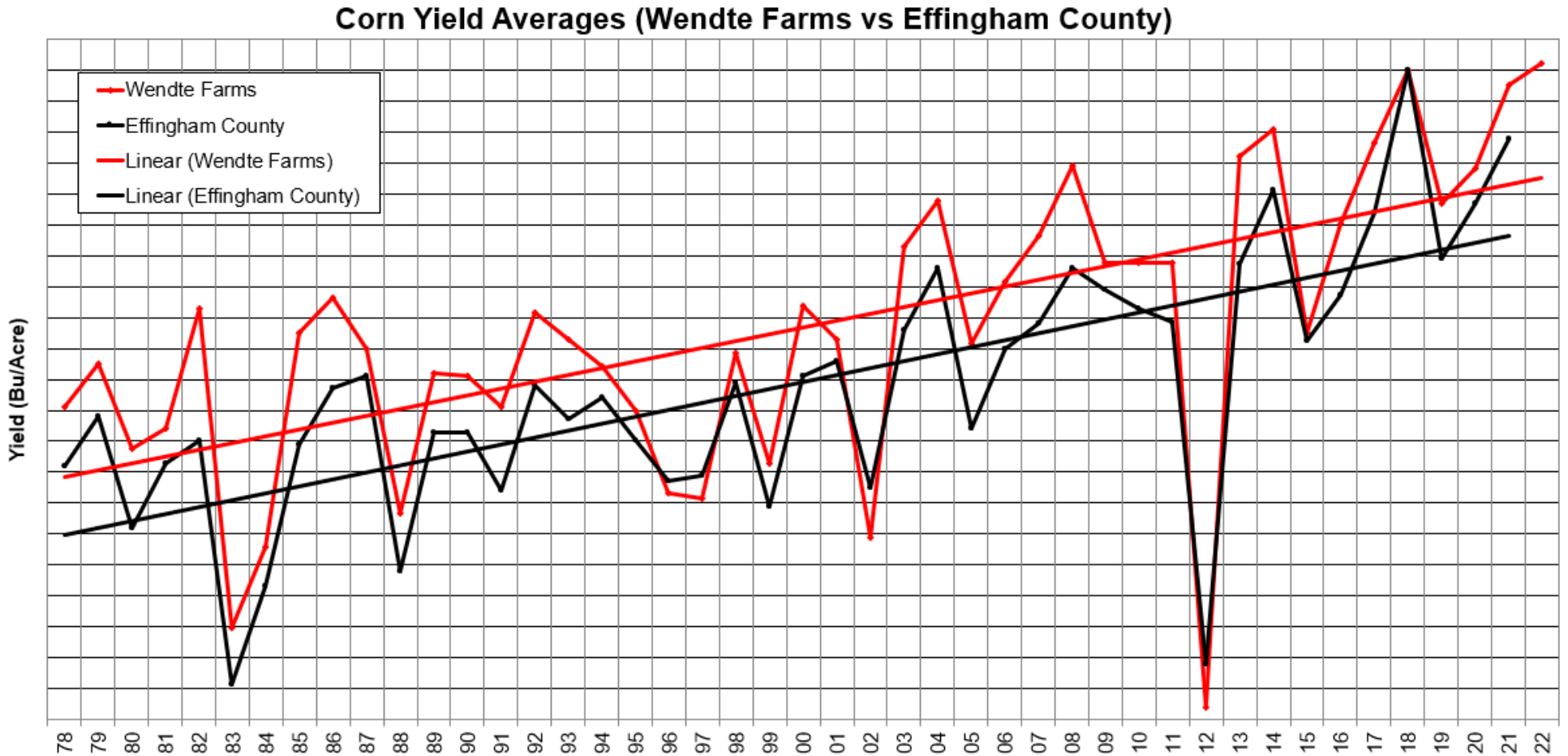








Metrics



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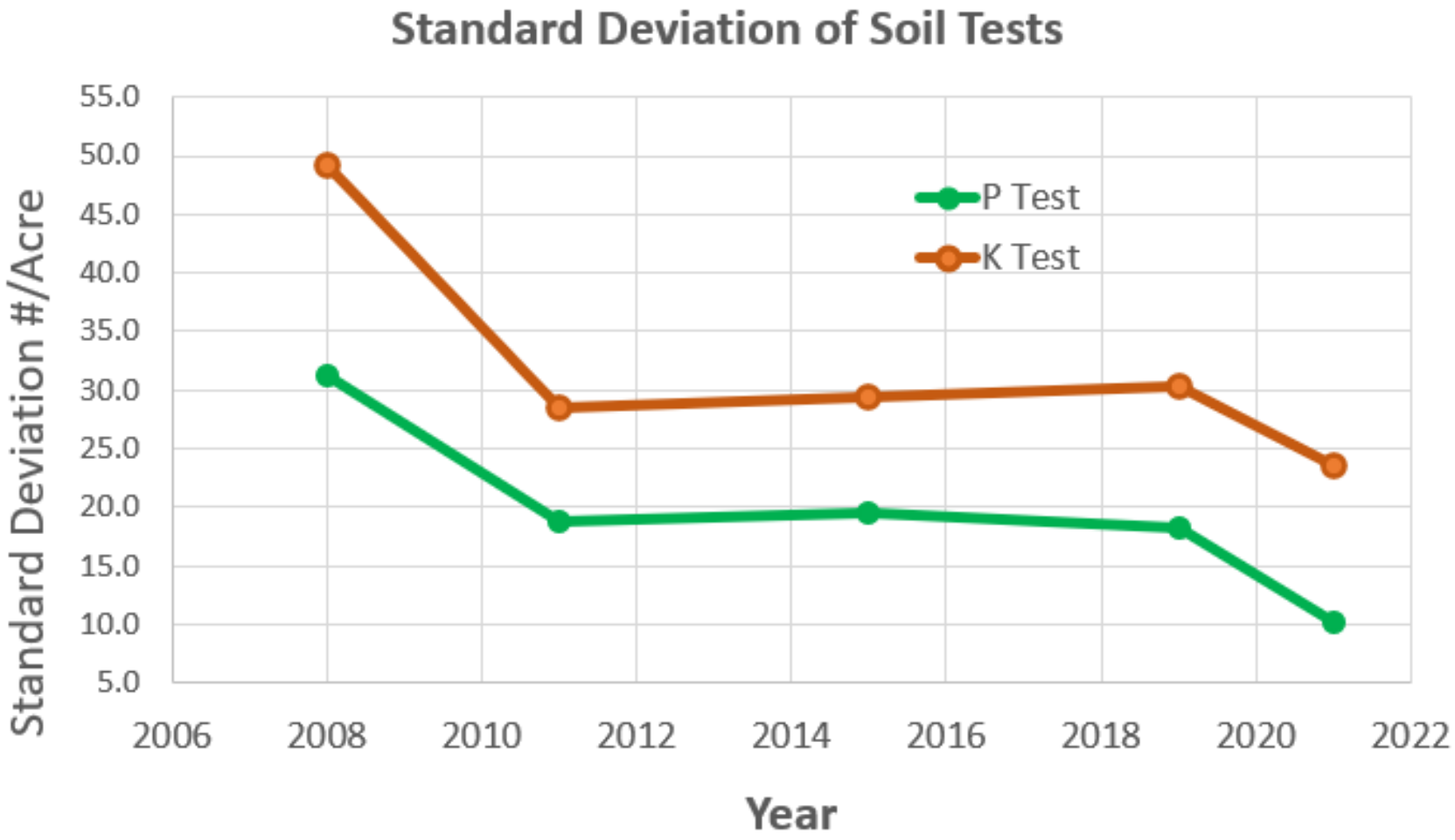
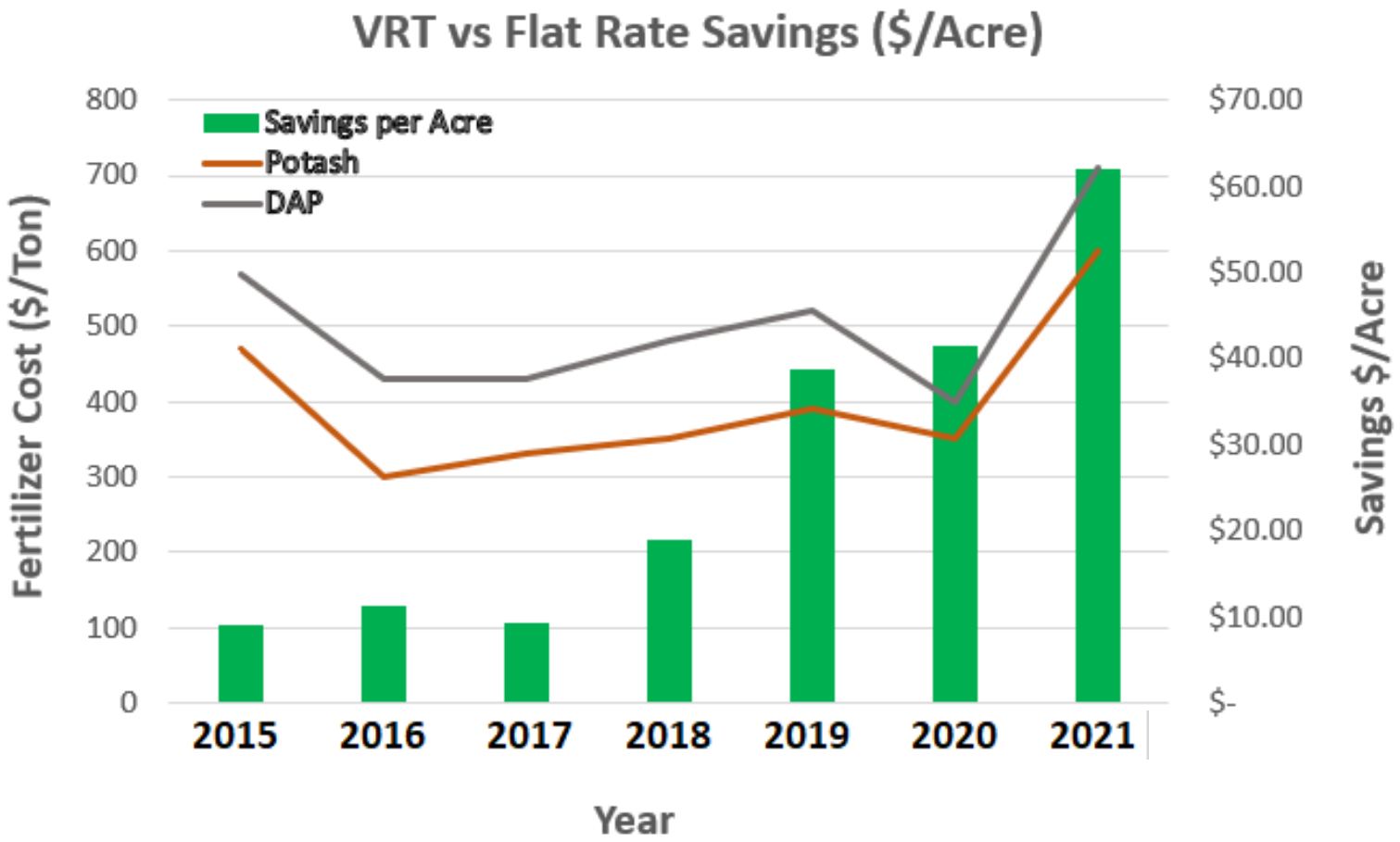


Metrics



Useful Web Sites

Illinois Plat Books by County

https://idaillinois.org/digital/collection/IllinoisPlats/search/

1937-1947 Illinois Historical Aerial Photography

https://clearinghouse.isgs.illinois.edu/data/imagery/1937-1947-illinois-historical-aerial-photography

FSA

https://www.fsa.usda.gov/online-services/farm-plus/index

Precipitation Map

https://www.wunderground.com/maps/precipitation/daily/spi

Illinois Oil Wells

(http://maps.isgs.illinois.edu/ILOIL/)

Questions