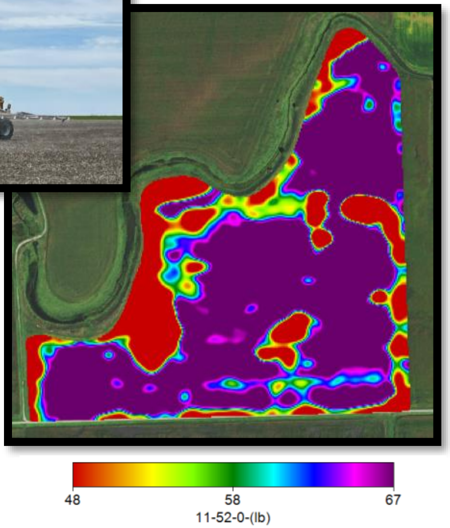
Precision Soil Sampling Methods: Who Grids, Who Zones, Who Cares?

AGVISE CANADIAN SOIL SEMINARS

MARCH 12, 14, 2024

PORTAGE LA PRAIRIE & SASKATOON



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AG GEEK SPEAK
with Sarah Lovas and Jodi Boe
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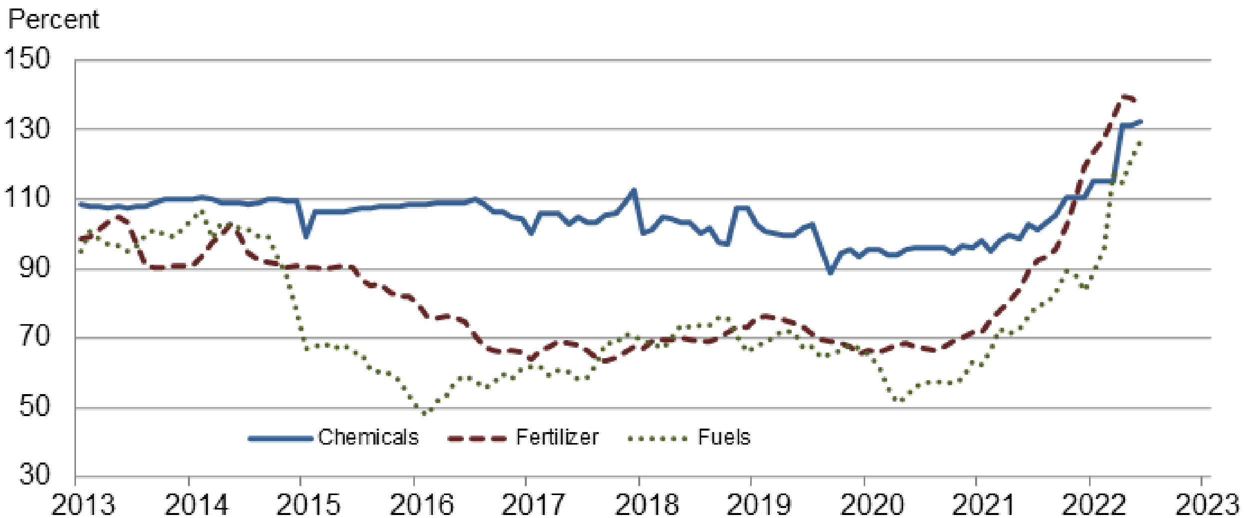
Cost of Fertilizer Has Gone UP (2022)

Paid Indexes by Non-farm Origin and Month, Chemicals, Fertilizer, and Fuels – United States: 2011=100



https://www.nass.usda.gov/Charts_and_Maps/Agricultural_Prices/prod1.php

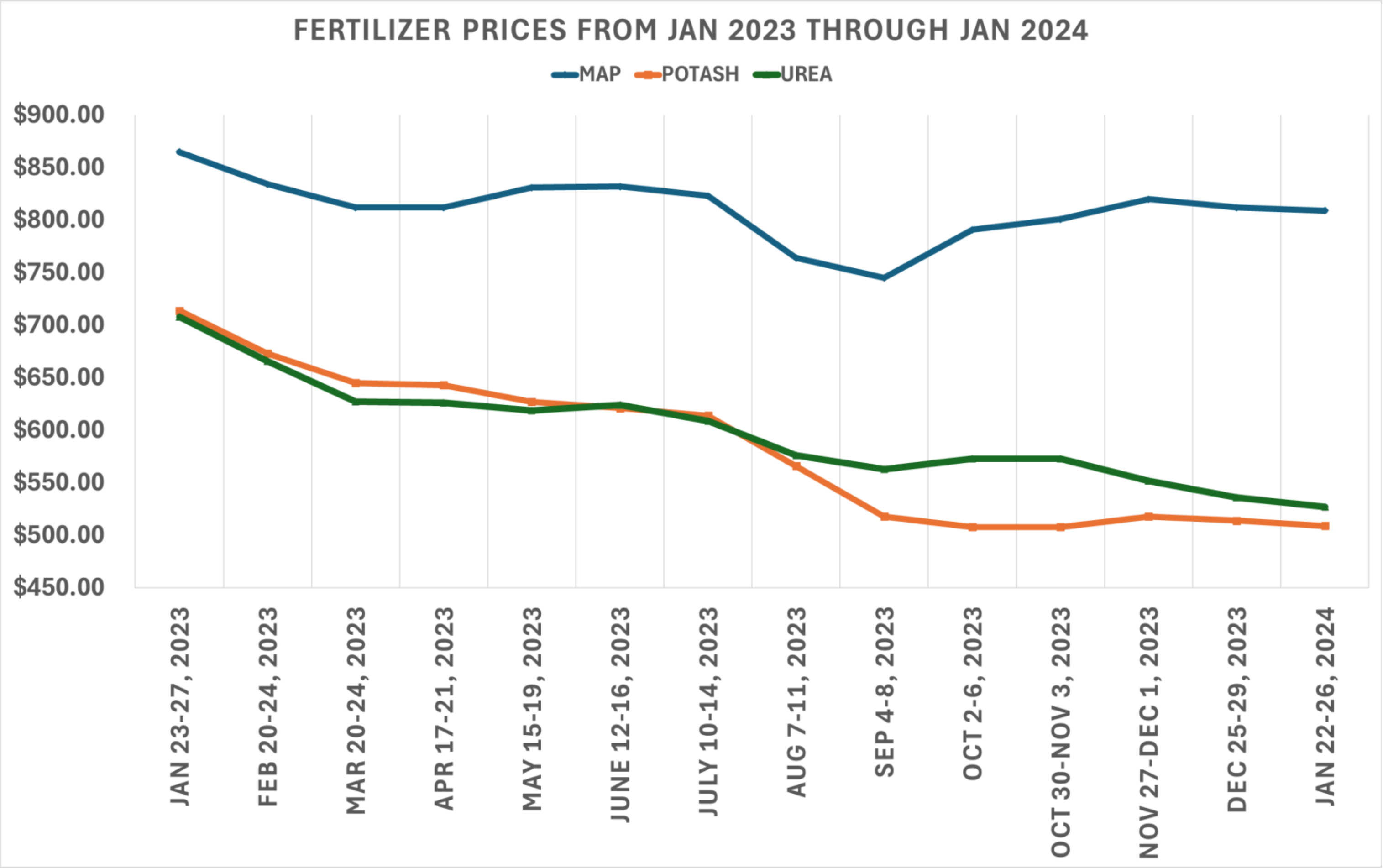
USDA – NASS
07/29/2022

46-0-0 = $600-650/ton

11-52-0 - $900-1000/ton

0-0-60 - $800/ton

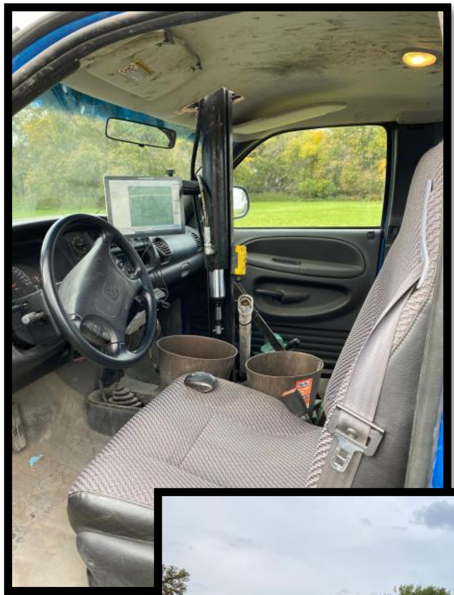
Cost of Fertilizer is Volatile (2024)

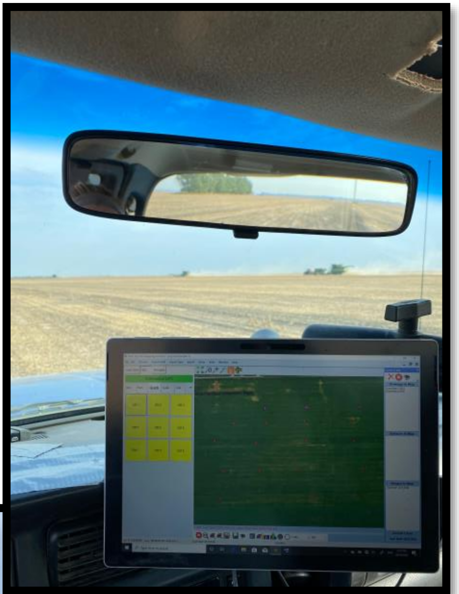


https://www.dtnpf.com/agriculture/web/ag/crops/article/2024/02/07/fertilizer-prices-continue-move-week
Progressive Farmer by DTN/ Author Russ Quinn

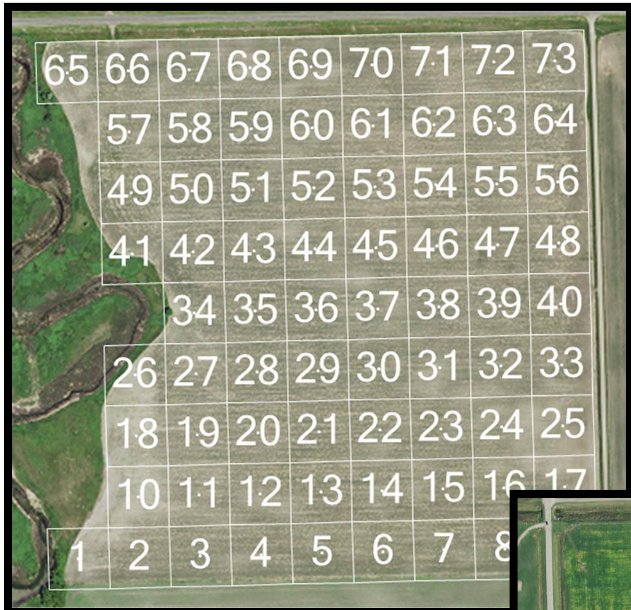
Acid Washed, High-Waist Jeans from the 1980's are back in style….

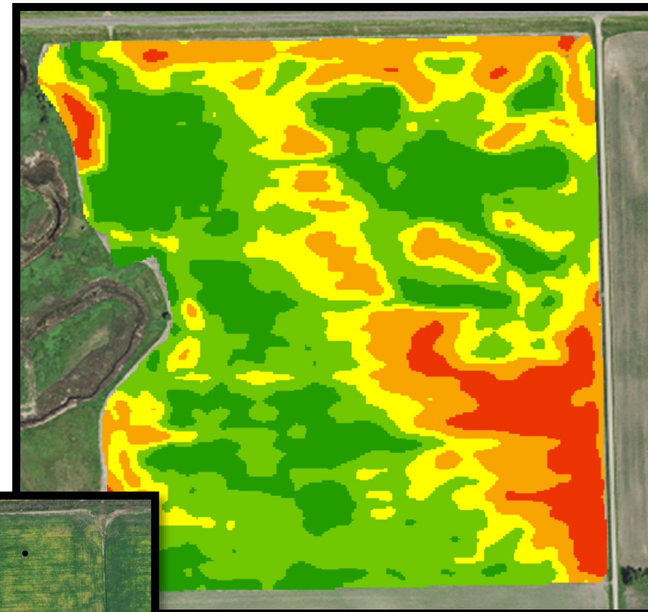
Soil Sampling is Cool Again!





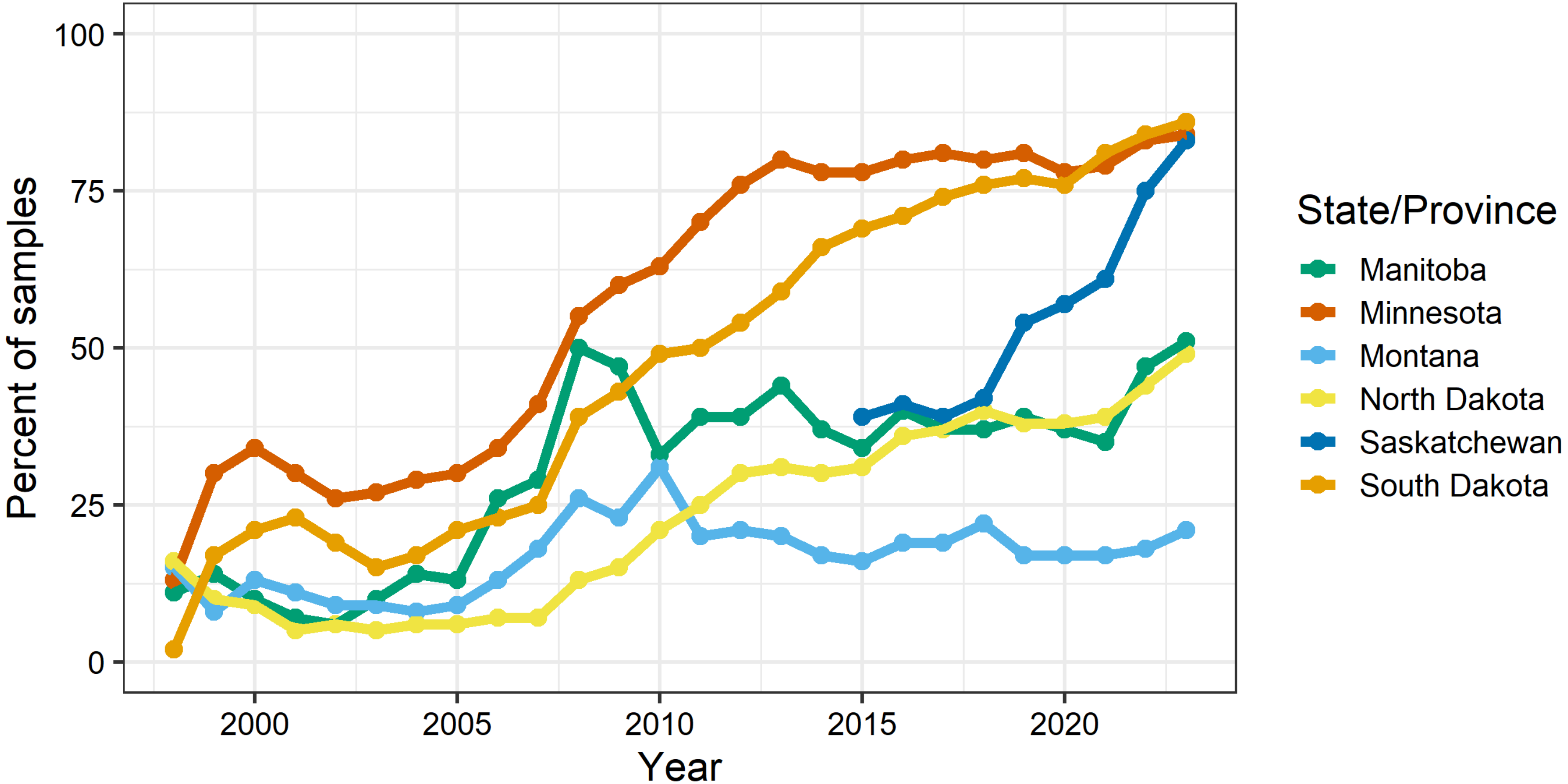
Grids or Zones or Composite?





Soil samples collected as a precision sample (grid or zone)

Trend from 1998 to 2023



Data not shown where n< 100
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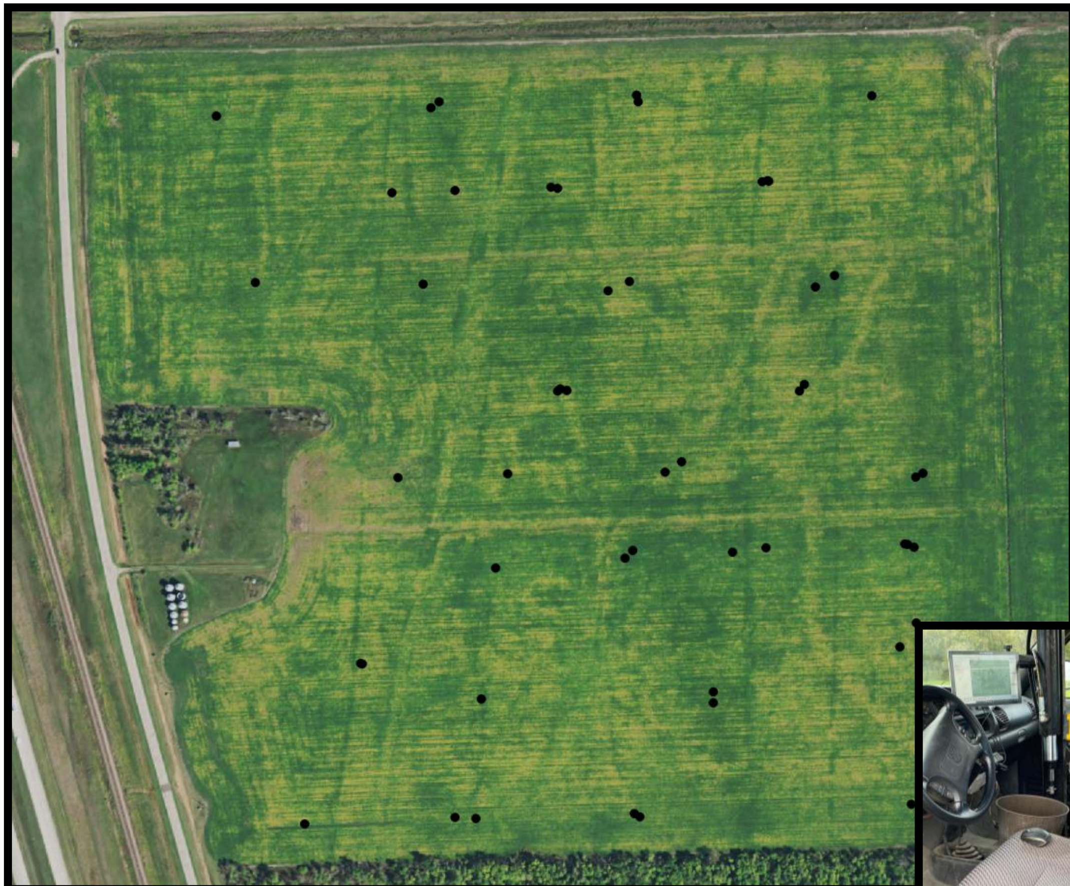
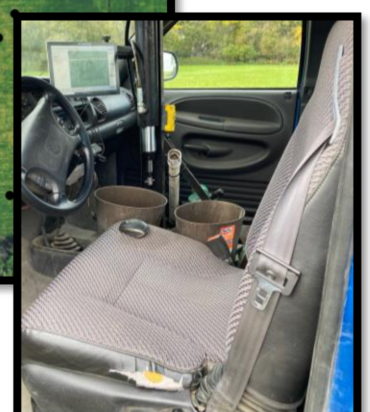
Composite Soil Sampling





Approximately 20-25 cores per quarter section in “average” spots

The Soil Sampling Explains the Average of the Field

Composite Soil Sampling

Nutrient In The Soil			Interpretation (VLow / Low / Med / High)
Nitrate	0-6" 6-24" 0-24"	11 lb/acre 12 lb/acre 23 lb/acre	*********
Phosphorus	Olsen	19 ppm	************************
Potassium		499 ppm	************************
Chloride	0-24"	28 lb/acre	***********
Sulfur	0-6" 6-24"	10 lb/acre 72 lb/acre	********* ************************
Boron		1.0 ppm	***************
Zinc		0.67 ppm	*************
Iron		23.1 ppm	************************
Manganese		2.4 ppm	*******************
Copper		2.11 ppm	********************
Magnesium		1445 ppm	************************
Calcium		5816 ppm	************************
Sodium		27 ppm	****
Org.Matter		5.2 %	*********************
Carbonate(CCE)		0.6 %	****
Sol. Salts	0-6" 6-24"	0.4 mmho/cm 0.43 mmho/cm	********** **********

General Comments: Soil texture is not estimated on high pH soils.

Grid Sampling

- Each Grid is its own “field”
- Approximately 10-15 cores per grid
- Can be 2 depths, but more frequently 0-6”
- There has been some Grid Sampling in our area, but more frequently done in the Corn Belt States
- Works well for areas with man-made variability like manure or explaining variability not described well by zones

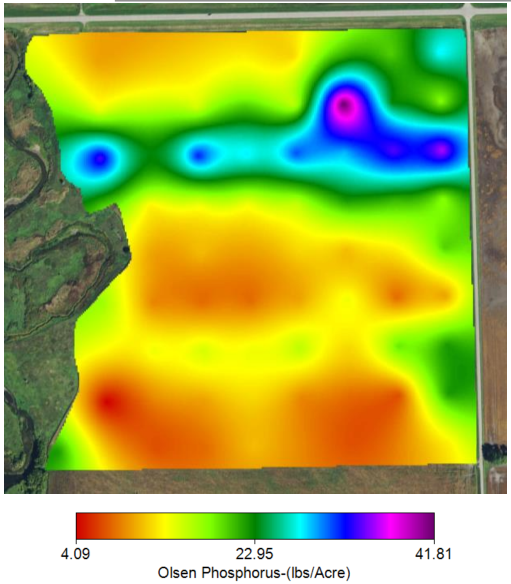
The Soil Sampling Explains the Variability of the Soil

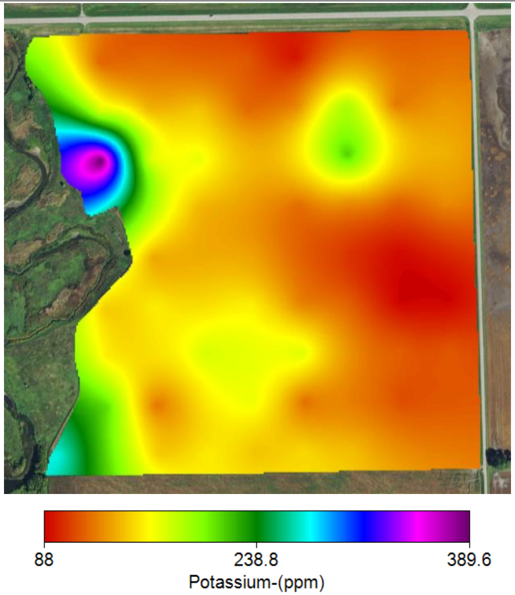
Grid Sampling

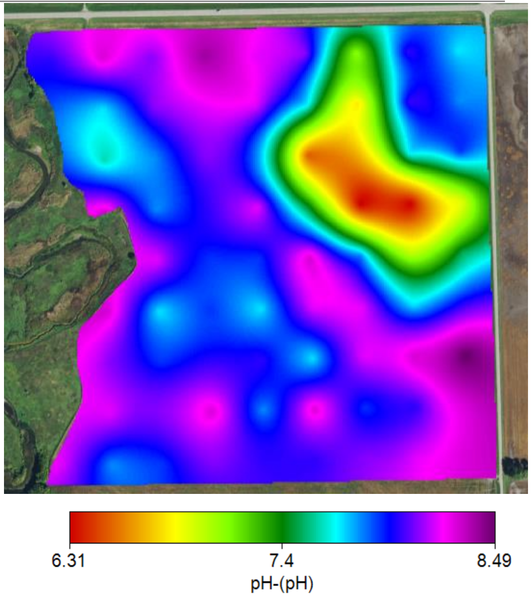
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Ref No	GrowerID	Fld ID(1st	Sample ID	County	Twp	Qtr(11)	Sect No	Acres	pH	BpH	OM	N1 lb	N2 lb	N3 lb	N-(N1+N2	P-O ppm	P-B1 ppm
2	987081	Lovas Far	Schoolho	1	Traill	145N	NE	26		8.1		3.9	10			10	10	
3	987082	Lovas Far	Schoolho	2	Traill	145N	NE	26		7.9		4.8	12			12	5	
4	987083	Lovas Far	Schoolho	3	Traill	145N	NE	26		8		4.4	10			10	4	
5	987084	Lovas Far	Schoolho	4	Traill	145N	NE	26		8.1		4.5	14			14	6	
6	987085	Lovas Far	Schoolho	5	Traill	145N	NE	26		8.1		4.6	17			17	5	
7	987086	Lovas Far	Schoolho	6	Traill	145N	NE	26		8.1		4.2	13			13	5	
8	987087	Lovas Far	Schoolho	7	Traill	145N	NE	26		8.1		4	13			13	5	
9	987088	Lovas Far	Schoolho	8	Traill	145N	NE	26		8.2		3.9	14			14	5	
10	987089	Lovas Far	Schoolho	9	Traill	145N	NE	26		8.3		3.5	12			12	7	
11	987090	Lovas Far	Schoolho	10	Traill	145N	NE	26		8.2		3.6	11			11	20	
12	987091	Lovas Far	Schoolho	11	Traill	145N	NE	26		8.2		3.6	12			12	9	
13	987092	Lovas Far	Schoolho	12	Traill	145N	NE	26		8.3		3.5	11			11	6	
14	987093	Lovas Far	Schoolho	13	Traill	145N	NE	26		8.1		4.4	14			14	7	
15	987094	Lovas Far	Schoolho	14	Traill	145N	NE	26		8.1		3.6	13			13	7	
16	987095	Lovas Far	Schoolho	15	Traill	145N	NE	26		8		4.1	16			16	7	
17	987096	Lovas Far	Schoolho	16	Traill	145N	NE	26		8.4		3.7	11			11	15	
18	987097	Lovas Far	Schoolho	17	Traill	145N	NE	26		8.5		3.3	13			13	15	
19	987098	Lovas Far	Schoolho	18	Traill	145N	NE	26		8.6		2.7	5			5	8	
20	987099	Lovas Far	Schoolho	19	Traill	145N	NE	26		8.1		4.1	11			11	7	
21	987100	Lovas Far	Schoolho	20	Traill	145N	NE	26		8.4		4.5	10			10	12	
22	987101	Lovas Far	Schoolho	21	Traill	145N	NE	26		8.2		4.4	19			19	17	
23	987102	Lovas Far	Schoolho	22	Traill	145N	NE	26		8		4.3	11			11	7	
24	987103	Lovas Far	Schoolho	23	Traill	145N	NE	26		8.3		3.5	9			9	19	
25	987104	Lovas Far	Schoolho	24	Traill	145N	NE	26		8.5		2.9	8			8	12	
26	987105	Lovas Far	Schoolho	25	Traill	145N	NE	26		8.6		2	8			8	24	
27	987106	Lovas Far	Schoolho	26	Traill	145N	NE	26		8.4		2.5	15			15	17	
28	987107	Lovas Far	Schoolho	27	Traill	145N	NE	26		8.1		4.1	10			10	5	
29	987108	Lovas Far	Schoolho	28	Traill	145N	NE	26		8.2		5	10			10	6	
30	987109	Lovas Far	Schoolho	29	Traill	145N	NE	26		7.8		4.9	12			12	8	
31	987110	Lovas Far	Schoolho	30	Traill	145N	NE	26		8.3		3.4	9			9	10	
32	987111	Lovas Far	Schoolho	31	Traill	145N	NE	26		8.5		2.6	9			9	10	
33	987112	Lovas Far	Schoolho	32	Traill	145N	NE	26		8.1		2.2	7			7	7	
34	987113	Lovas Far	Schoolho	33	Traill	145N	NE	26		8.3		2.3	9			9	14	
35	987114	Lovas Far	Schoolho	34	Traill	145N	NE	26		8.5		3	8			8	15	
36	987115	Lovas Far	Schoolho	35	Traill	145N	NE	26		7.9		4.7	13			13	14	
37	987116	Lovas Far	Schoolho	36	Traill	145N	NE	26		8.1		4.4	12			12	13	

	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	K ppm	Ca ppm	Mg ppm	S1 lb	S2 lb	Zn ppm	Salt1	Salt2	Cl-1 lb	Cl-2 lb	Cl (Tot)	Cu ppm	B ppm	Fe ppm	Mn ppm	Na ppm	CEC meq	CCE% D1
2	303	5507	1043	4		0.86	0.38		3		3	1.27	1.26	12.37	3.46	48	37.21	5.7
3	189	4379	731	4		0.81	0.35		6		6	0.71	1.08	9.43	3.12	47	28.68	0.4
4	175	3687	777	8		1.43	0.24		5		5	0.72	1.06	9.5	5.22	33	25.5	0.3
5	160	4750	844	6		0.65	0.37		6		6	0.67	1.37	7.89	4.02	44	31.38	1.7
6	139	4087	878	12		0.74	0.28		3		3	0.71	1.65	7.87	3.96	54	28.34	0.6
7	150	4819	741	10		1.02	0.27		6		6	0.68	1.44	7.17	3.62	49	30.87	1.4
8	142	4538	838	108		0.81	0.59		4		4	0.63	1.67	6.88	3.45	50	30.25	1.8
9	131	4734	888	24		0.73	0.34		3		3	0.63	1.54	7.38	3.65	76	31.74	1.6
10	106	3561	1203	26		0.6	0.3		3		3	0.66	1.73	6.84	3.68	85	28.47	1.1
11	232	5113	756	6		1.3	0.33		3		3	0.78	1.21	8.96	3.77	40	32.63	4.9
12	148	4729	827	4		0.47	0.31		5		5	0.67	1.39	7.39	3.9	40	31.09	3.5
13	156	4532	1017	6		0.36	0.32		2		2	0.62	1.62	5.61	2.96	64	31.81	4.7
14	139	3905	1042	50		0.62	0.37		6		6	0.67	1.86	7.23	2.95	116	29.07	0.8
15	132	4619	968	4		0.64	0.31		7		7	0.76	1.47	15.25	3.77	32	31.64	4
16	119	3685	800	6		0.66	0.28		2		2	0.57	1.25	7.62	2.95	49	25.61	0.6
17	98	3693	1154	12		0.5	0.22		6		6	0.58	1.79	4.94	2.97	64	28.61	1.4
18	108	3486	1531	8		0.33	0.28		3		3	0.69	2.56	4.62	3.2	68	30.76	2.7
19	204	4501	1105	8		1.84	0.21		6		6	0.74	1.26	5.62	3.4	33	32.38	9.3
20	141	4660	696	4		0.64	0.25		6		6	0.7	1.32	9.02	3.6	45	29.66	1.5
21	192	4120	1372	12		0.54	0.25		6		6	0.8	2.19	5.73	5.18	49	32.74	3.1
22	148	4118	1328	10		0.77	0.27		21		21	0.7	1.98	5.45	3.81	43	32.22	2.5
23	149	3057	710	8		0.66	0.22		3		3	0.62	1.23	8.01	3.65	32	21.72	0.2
24	124	3869	1344	14		0.42	0.22		2		2	0.63	1.63	5.1	3.14	50	31.08	1.9
25	90	3479	1340	12		0.54	0.22		5		5	0.59	1.85	5.66	3.08	50	29.01	1.7
26	82	2917	1412	24		4.52	0.25		27		27	0.58	1.71	4.56	2.94	64	26.84	2
27	219	4291	892	6		0.81	0.28		4		4	0.75	0.99	6.89	3.69	26	29.56	8.2
28	163	4336	675	8		0.61	0.22		2		2	0.59	1.31	7.49	3.3	36	27.88	0.9
29	146	4245	915	8		5.09	0.22		6		6	0.67	1.56	8.03	4.03	69	29.52	0.7
30	130	3298	857	6		1.54	0.19		4		4	0.64	1.22	9.33	4.02	51	24.19	0.2
31	109	4139	1002	8		0.42	0.22		2		2	0.64	1.64	6.34	3.24	50	29.54	1.8
32	96	3555	1296	8		0.33	0.19		4		4	0.61	1.98	4.45	3.12	46	29.02	3.1
33	73	3532	661	6		0.38	0.18		3		3	0.44	0.9	6.75	2.49	29	23.48	0.9
34	84	3239	844	8		0.36	0.22		9		9	0.5	1.16	6.99	2.87	51	23.67	0.8
35	138	4235	1231	12		0.91	0.24		3		3	0.74	1.47	7.06	4.17	58	32.04	6.6
36	145	3564	874	10		0.86	0.24		5		5	0.75	1.45	10.04	5.25	40	25.65	0.4
37	147	3395	1180	10		0.68	0.22		1		1	0.7	1.76	7.45	4.66	46	27.39	0.5

Grid Sampling

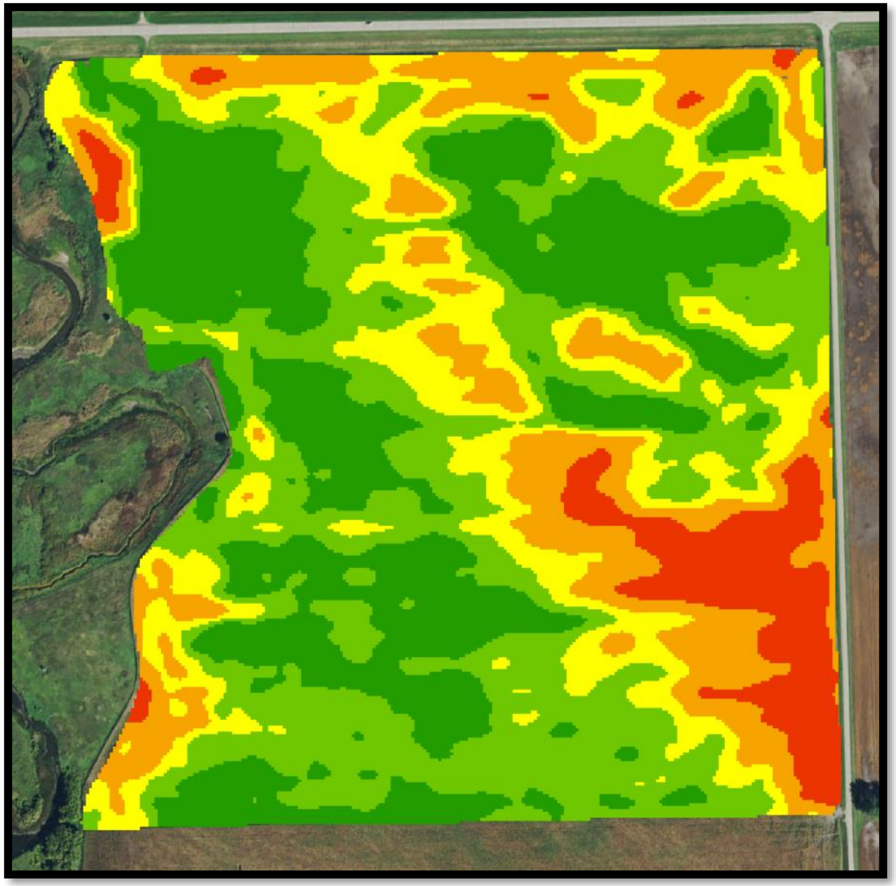






The Soil Sampling Explains the Variability of the Soil

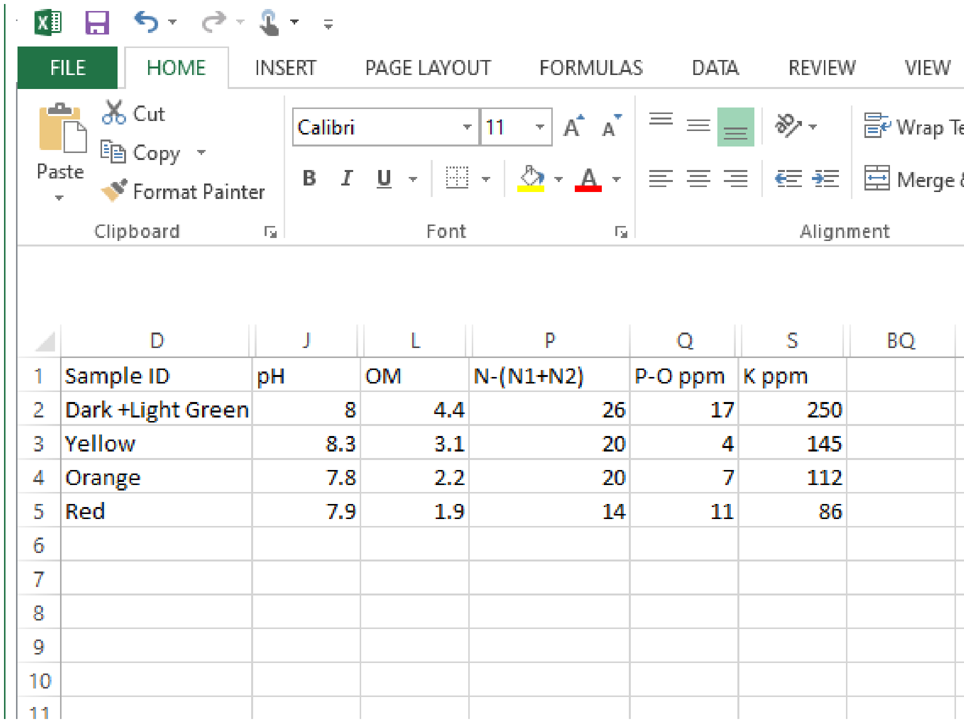
Zone Soil Sampling



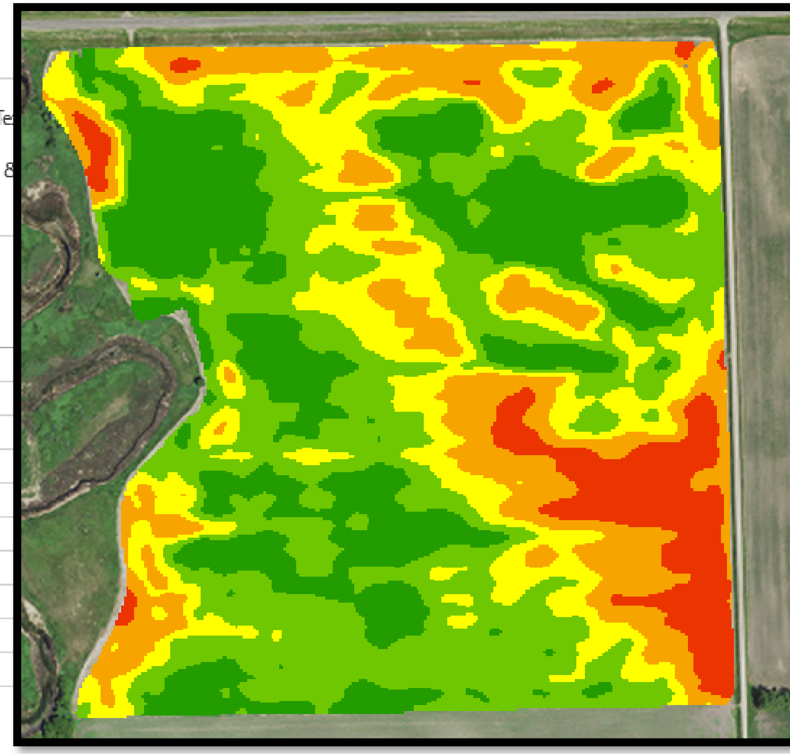
- Combine data to describe field variability
- Each Zone considered its own field
- Approximately 15-20 cores per zone

The Data Describes the Field Variability

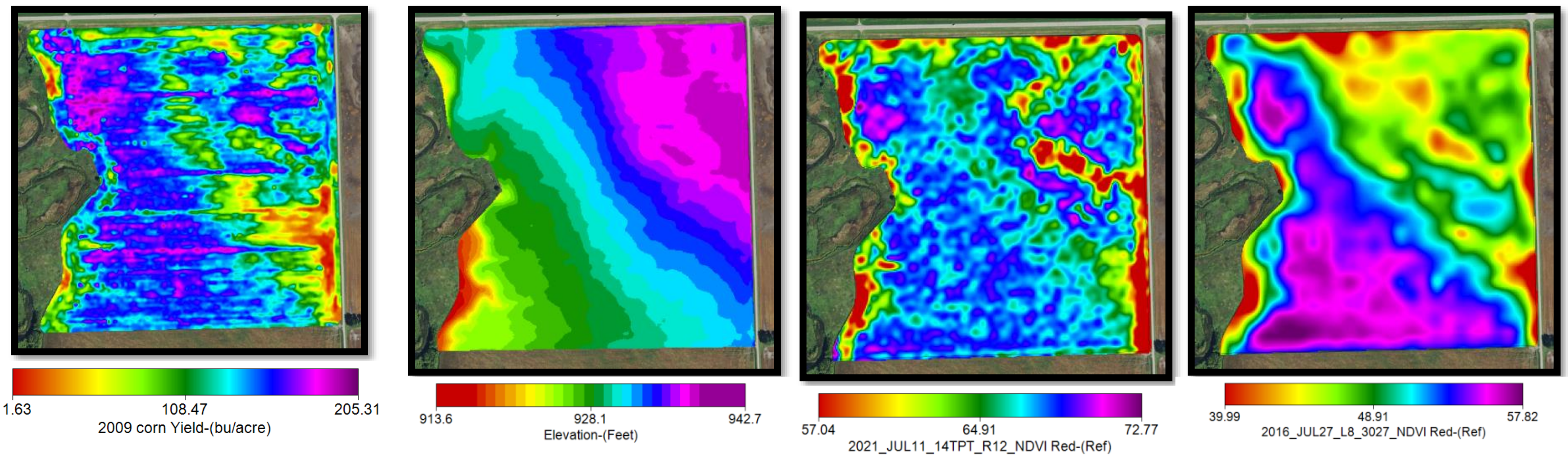
Zone Soil Sampling



	D	J	L	P	Q	S	BQ
1	Sample ID	pH	OM	N-(N1+N2)	P-O ppm	K ppm	
2	Dark +Light Green	8	4.4	26	17	250	
3	Yellow	8.3	3.1	20	4	145	
4	Orange	7.8	2.2	20	7	112	
5	Red	7.9	1.9	14	11	86	

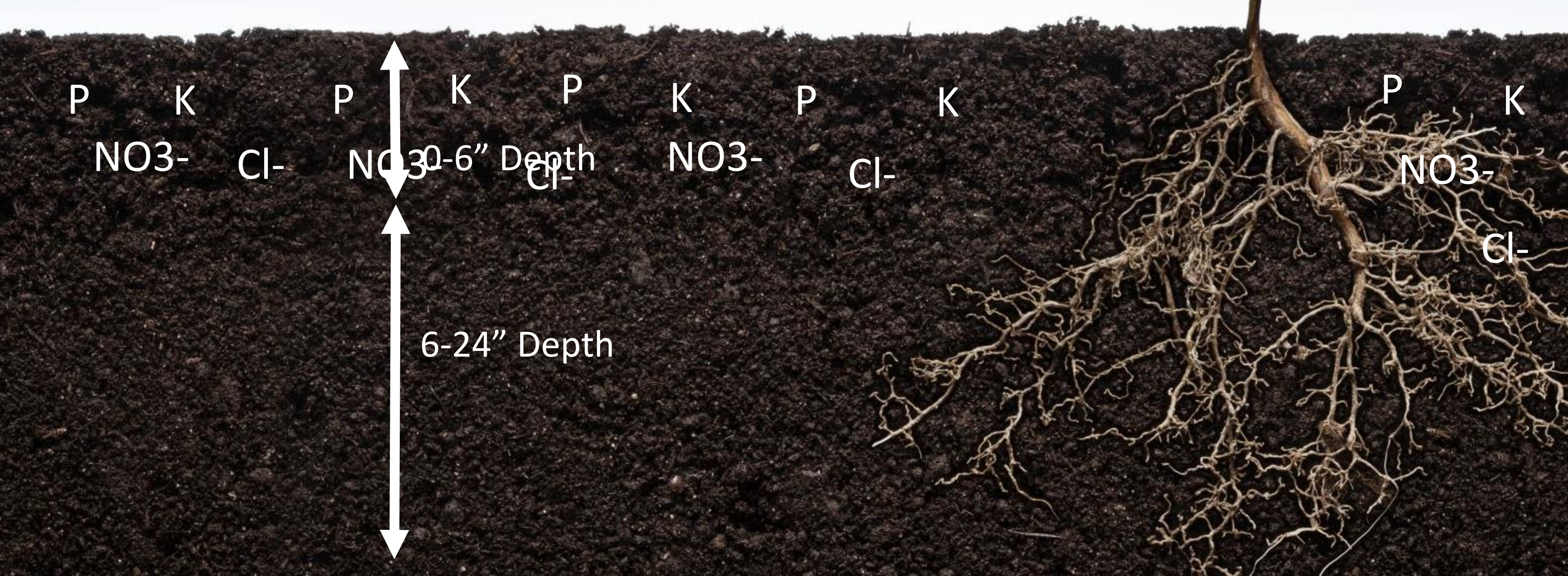


Zone Creation- Critical Component



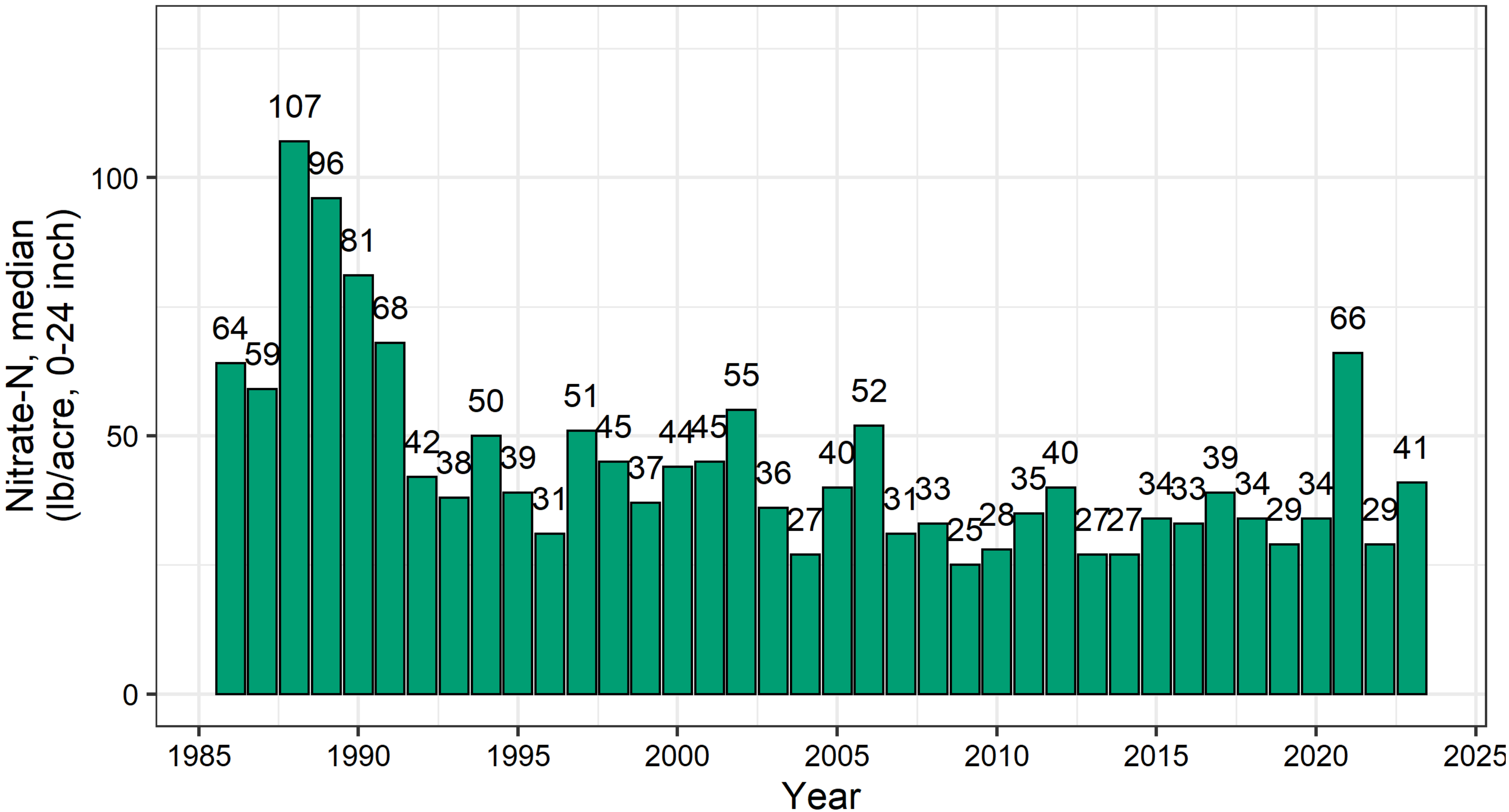
- **Data Explains Variability**
- ACCURATE ZONES REQUIRED- INNACURATE ZONES = INACCURATE APPLICATIONS

Soil Mobility of Nutrients & Soil Sampling Depth



Residual nitrate following wheat

Trend from 1986 to 2023



Data not shown where n< 100
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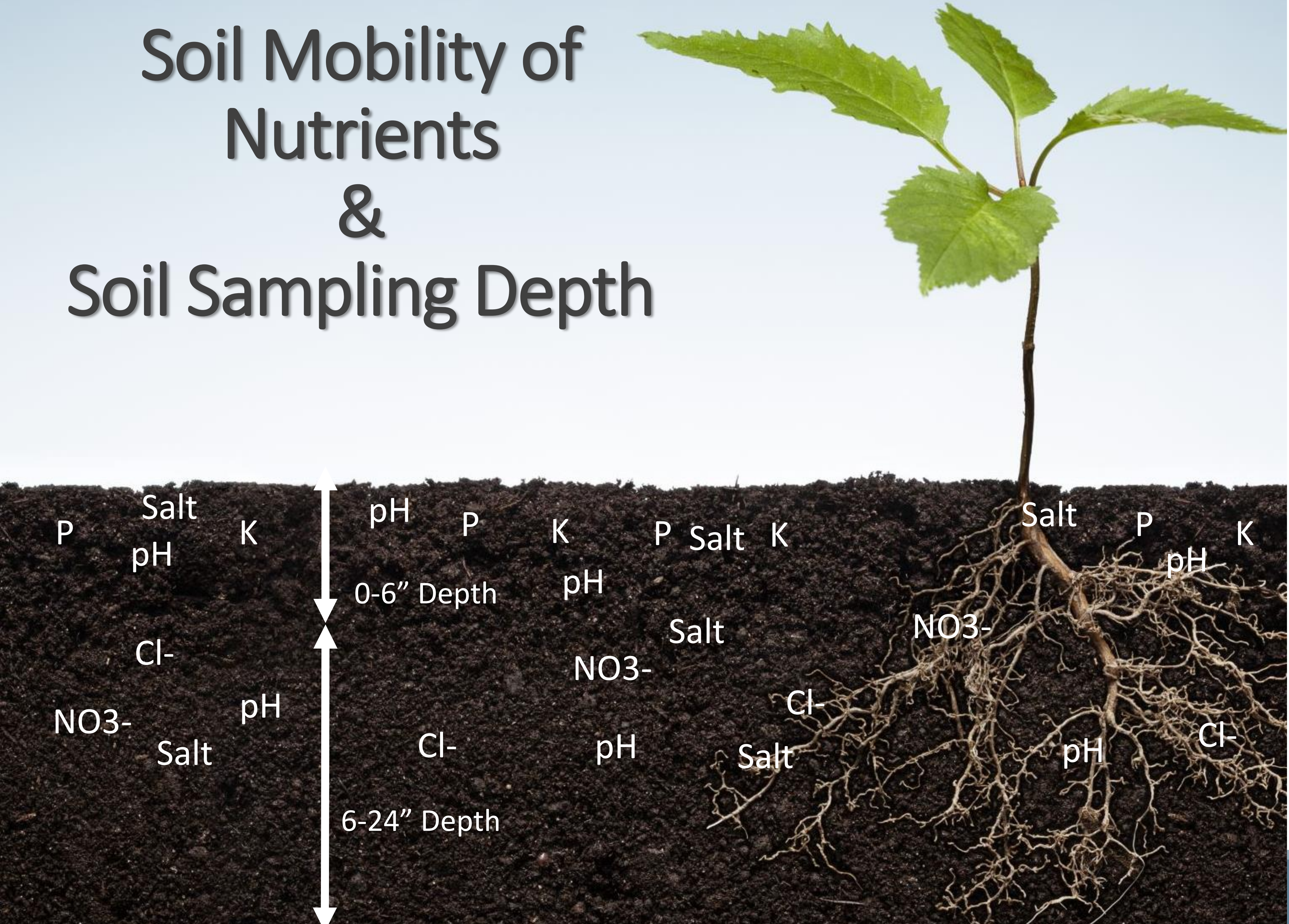
Soil Mobility of Nutrients & Soil Sampling Depth



Composite

Flat Fields

Minimal Soil Type Changes

One Soil Type

Common Sample Depth- 0-6, 6-24”:
- Soil mobile & non-mobile nutrients

Least Expensive

Least Labor

Zones

Large Fields with Variability

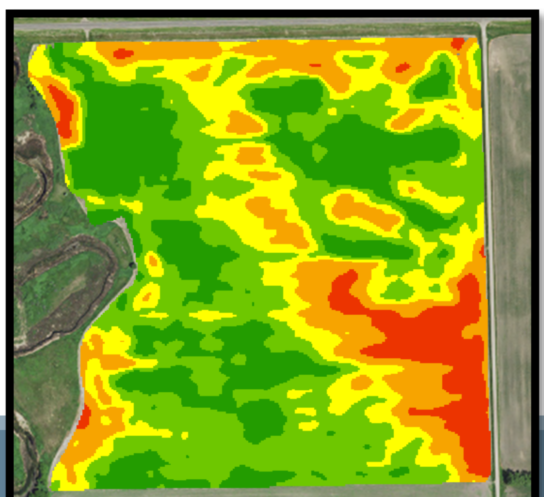
Naturally Occurring Variability

Diverse Soil Types

Common Sample Depth – 0-6, 6-24”
- Soil mobile & non-mobile nutrients

Moderate Expense

Moderate Labor



Grid

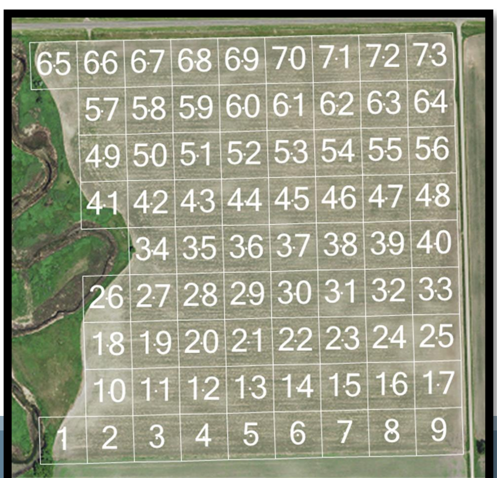
Zones do not describe variability well

Man-made Variability – ie- manure

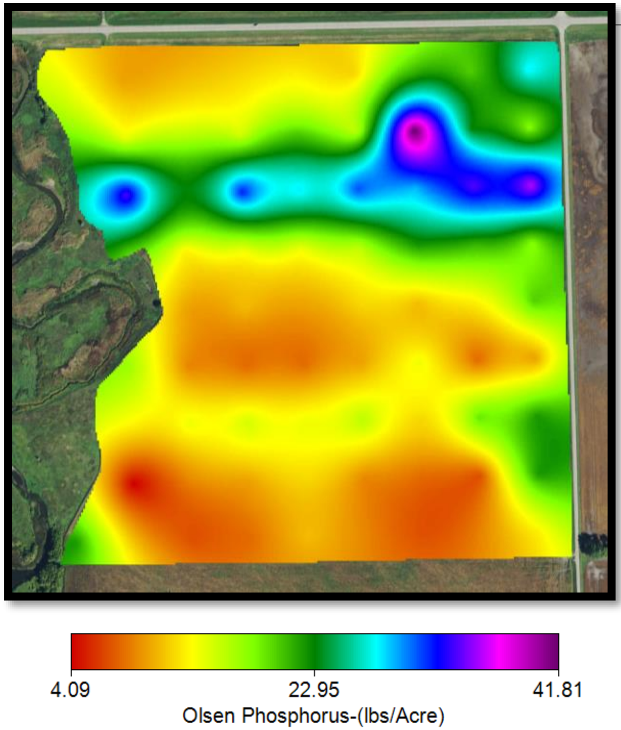
Common Sample Depth – 0-6”
- Soil Non-mobile nutrients

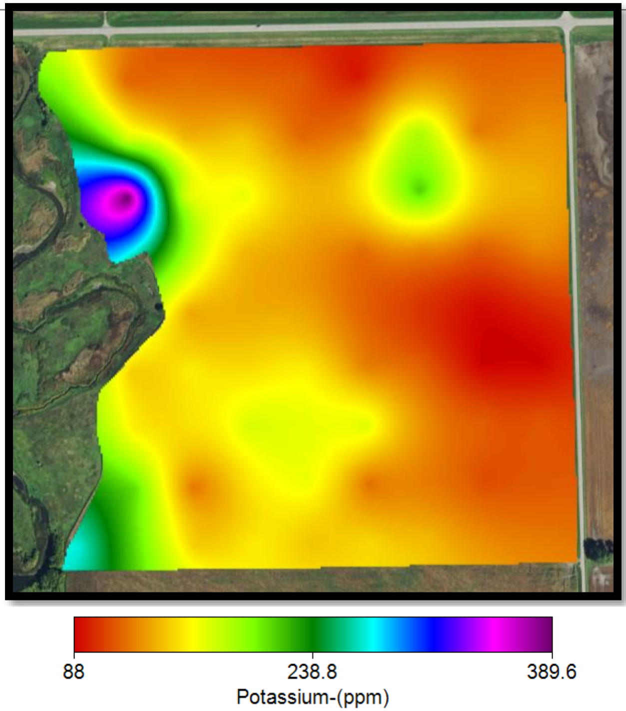
Most Expensive

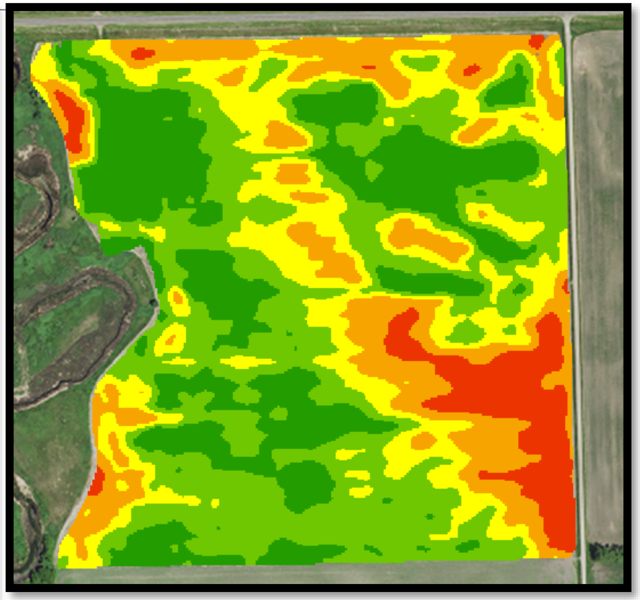
Most Labor



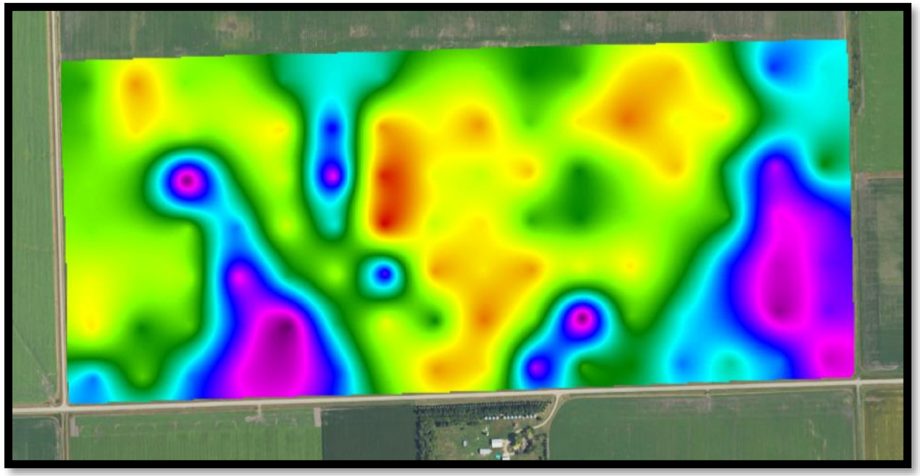
Grid versus Zones

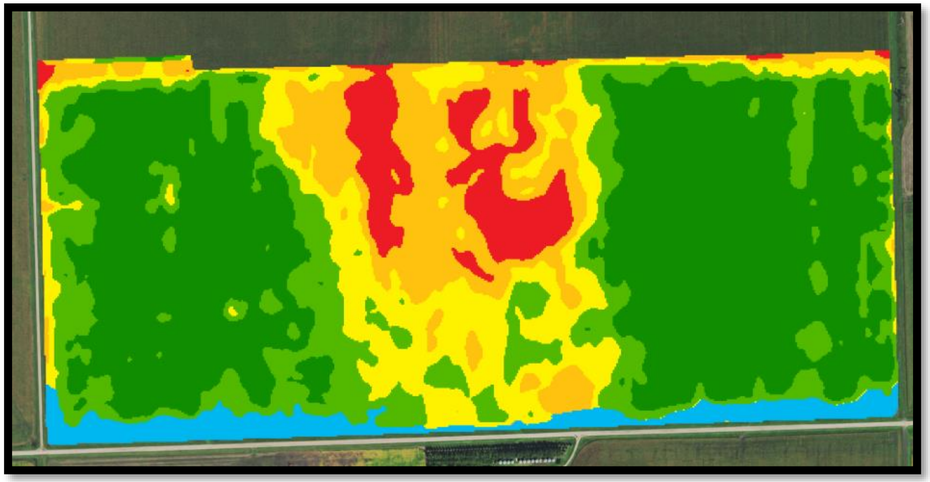


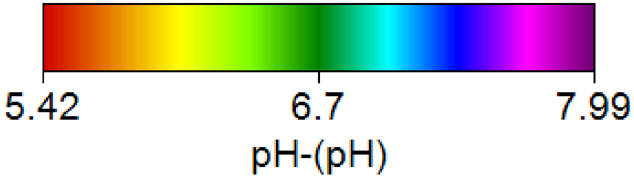




Where Grids Fit In



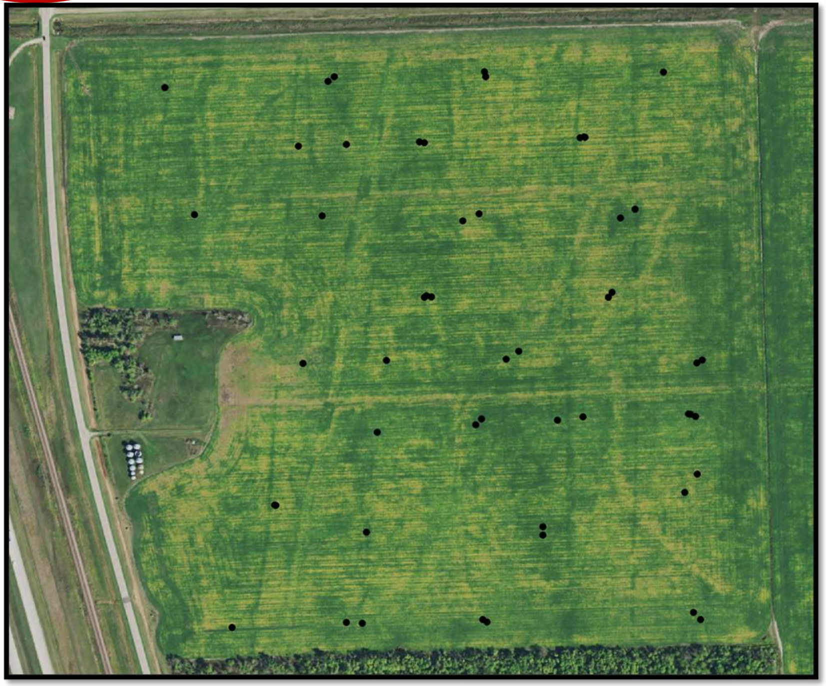




Stability in Composite Sample Results

Year	pH	OM	N1 lb	N2 lb	N-(N1+N2)	P-O ppm	K ppm	Ca ppm	Mg ppm	S1 lb	S2 lb	Zn ppm
2014	7.8	5.2	11	12	23	19	499	5816	1445	10	72	0.67
2014 (redo)	7.7	5.1	10	6	16	14	372	6575	1526	6	18	0.54
2015	7.5	4.9	4	9	13	13	342	4415	1265	4	30	0.58

- Mark Sample Point
- Sample Same Points Every year
- Speeds up Soil Sampling
- Monitor soil non-mobile nutrients
  - P and K levels should be relatively stable
  - Also allows to monitor whether nutrients are being mined from the soil



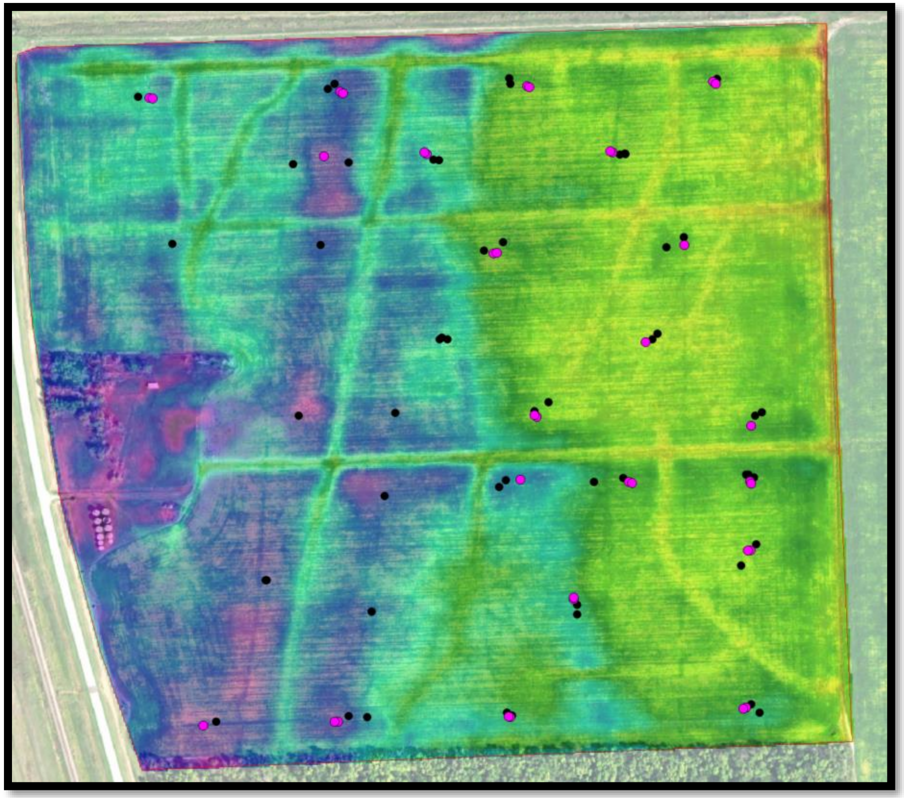
What is Variability

Lab Analysis Error

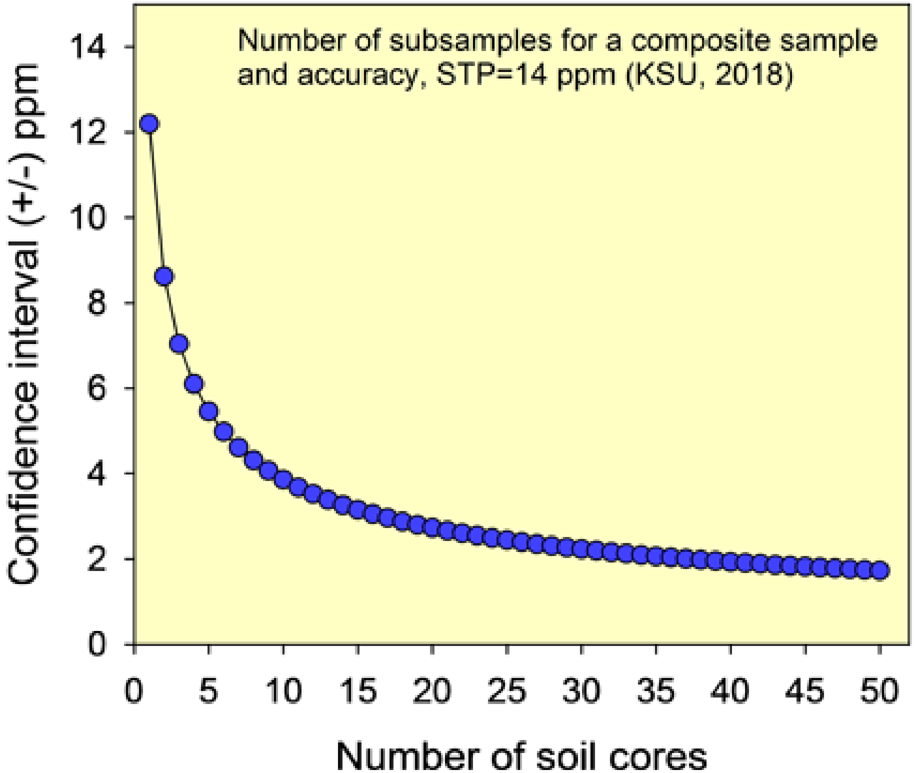
- Olsen-P:
  - 1-2 ppm on soils < 10 ppm
  - up to 2 ppm between 11-40 ppm

Sampling Error

- Sampling Depth
  - Are you pulling a 6” sample?
- How many soil cores per field?
  - Minimum 15 cores
  - Between 20-30 is best
- Sampling Location
  - GPS error
  - Human Error

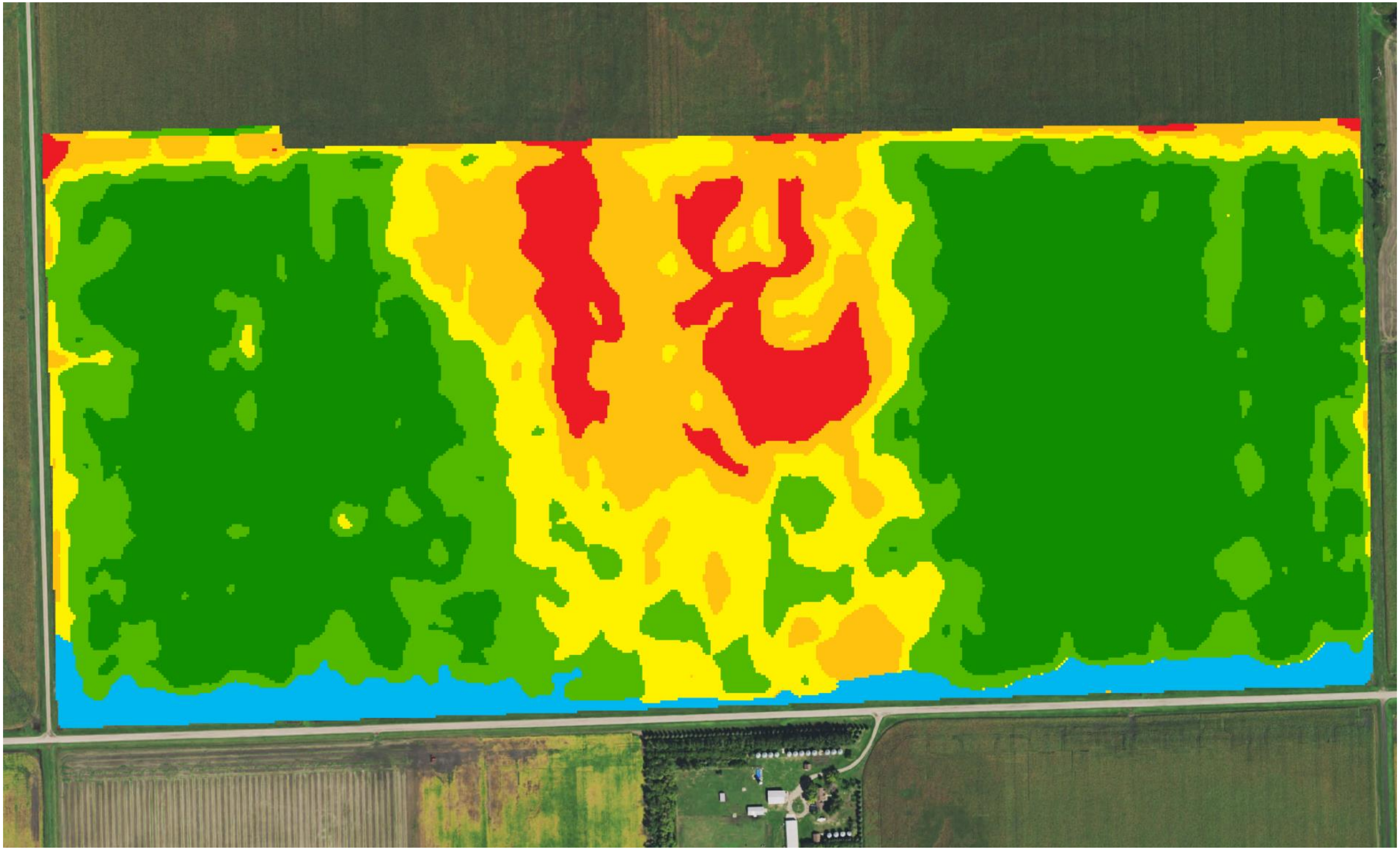


How many Soil Cores for Accurate Sample Results



- Kansas State – Dr. Dorivar Ruiz Diaz
- Composite Samples: at least 15 samples
- 20-30 cores is best
- Small areas (2-4 acres) 12-15 cores – Grid Sampling?


97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112
81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64
33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16



Cost and Labor- 265 Acre Field

Grids

- 2.37 acres/Grid
- 112 Grids and 10 cores per grid
  - 1,120 cores to pull
  - 4-5 hours to pull this field with Wintex 1000
- Analysis Fee -$14.55 per Grid
  - $1,862.40 (Total Analysis Fee)
  - (P, K, Zn, pH, SOM -0-6”)
- Labor Costs
  - $5-6/acre -$1,860
- **Total Cost - $3,722.40**

Zones

- 6 Zones per field
- 15 cores per zone and 6 zones
  - 90 cores to pull
  - 1-1.5 hours to pull 0-6” and 6-24”
- Analysis Fee – $55.34 per zone
  - $332.04 (Total Analysis Fee)
  - Agvise Complete - 2 depths
- Labor
  - $100-200 per field
- **Total Cost = $432.04**

Composite

- Sample the whole field
- 30 cores total- 2 depths (45 min)
- Soil Analysis Cost- $55.34 total
  - Complete -2 Depths
- Labor - $75.00 per field
- **Total Cost - $130.00**

Corn Belt States and North Dakota: They Are Different

Soil Sampling is different

- Grids versus Zones
- Sample Depth- Corn Belt soil samples down to 6” and North Dakota samples down to 2’

Planters versus AirSeeders

Adoption rates of Precision Agriculture are greater in the Corn Belt compared to areas dominated by wheat production

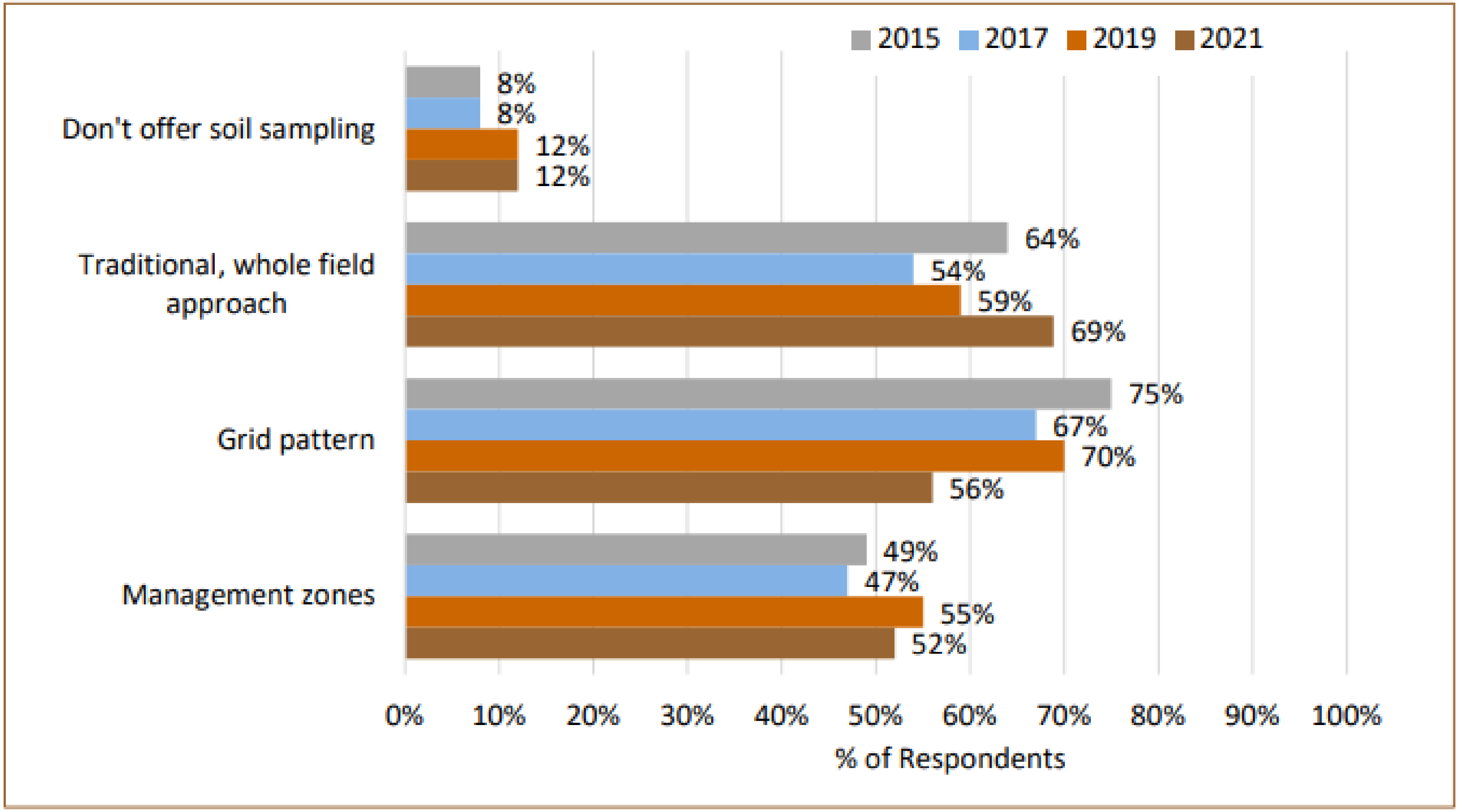
Field Size and Farm Acreage is different:

- Indiana Farm averages 269 acres versus 1,512 acres in North Dakota

Land values are different:

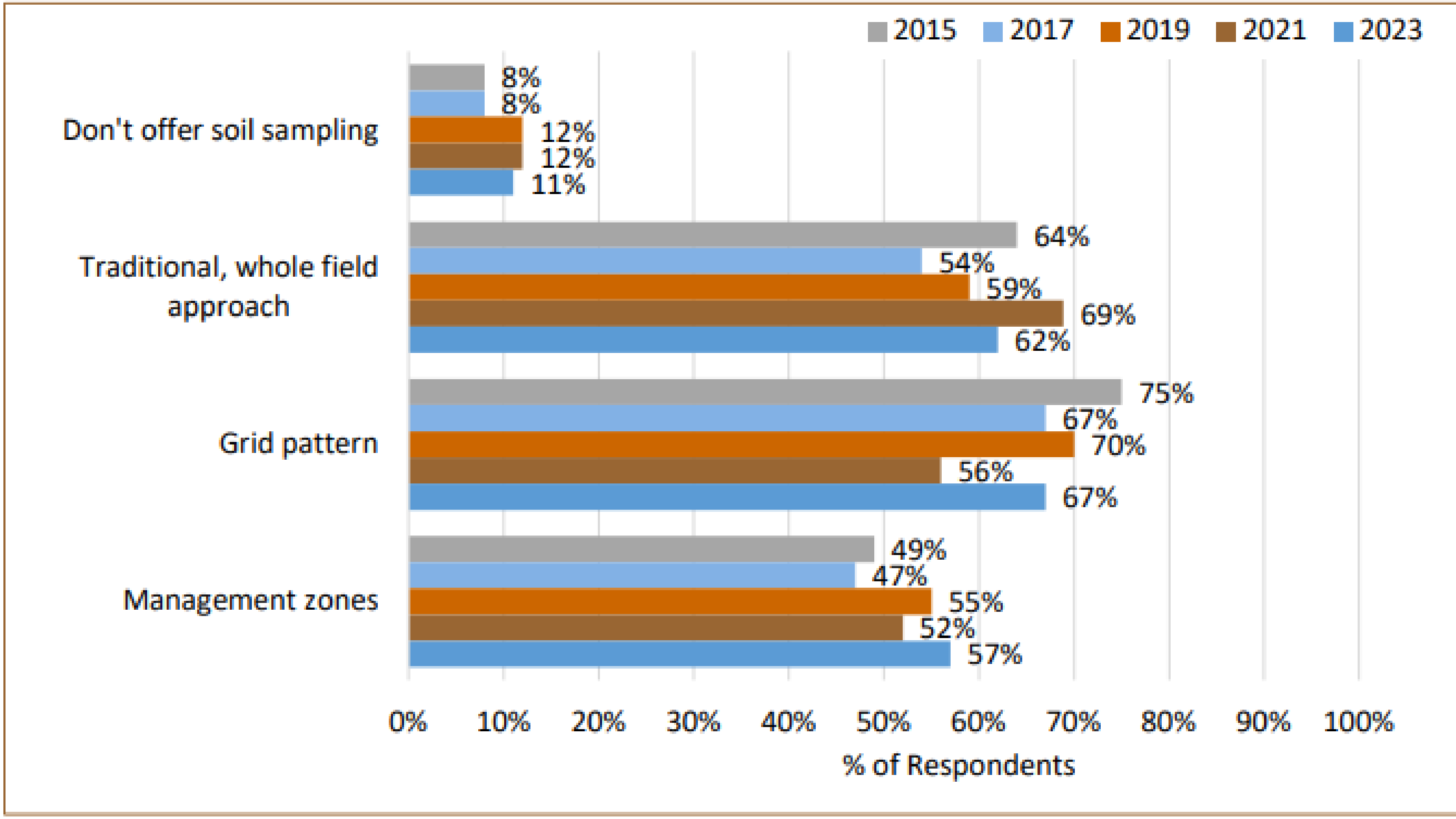
- 2021 Corn Belt states cropland value average: $6,880/acre
- 2021 Northern Plains states cropland value average:$3,070/acre

Changes in Soil Sampling Practices?



Types of soils sampling services offered by retailers. CropLife Magazine/Purdue University 2021 Precision Agriculture Dealership Survey

Changes in Soil Sampling Practices?

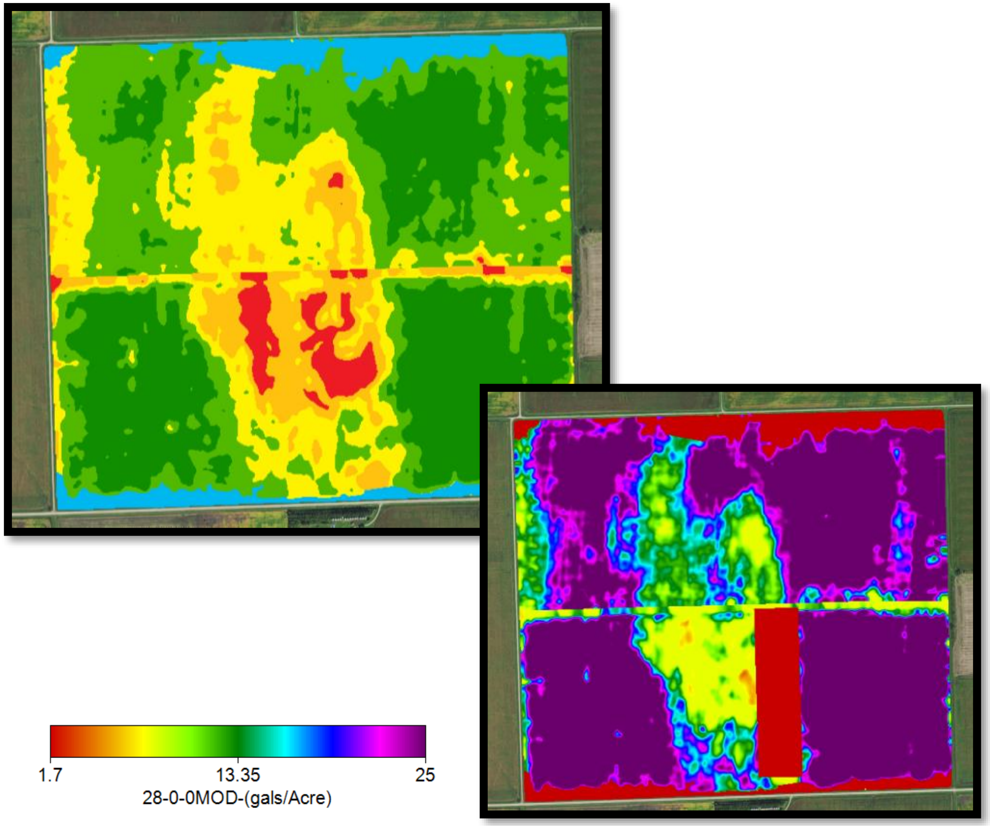


Types of soils sampling services offered by retailers. CropLife Magazine/Purdue University 2023 Precision Agriculture Dealership Survey

Information Intensive Technologies:

Require specialized skills to interpret data and create efficient ways to use agronomic inputs.

ie- VRT applications and zone creation



Embodied Knowledge Technologies:

Do not require additional skills for operation.

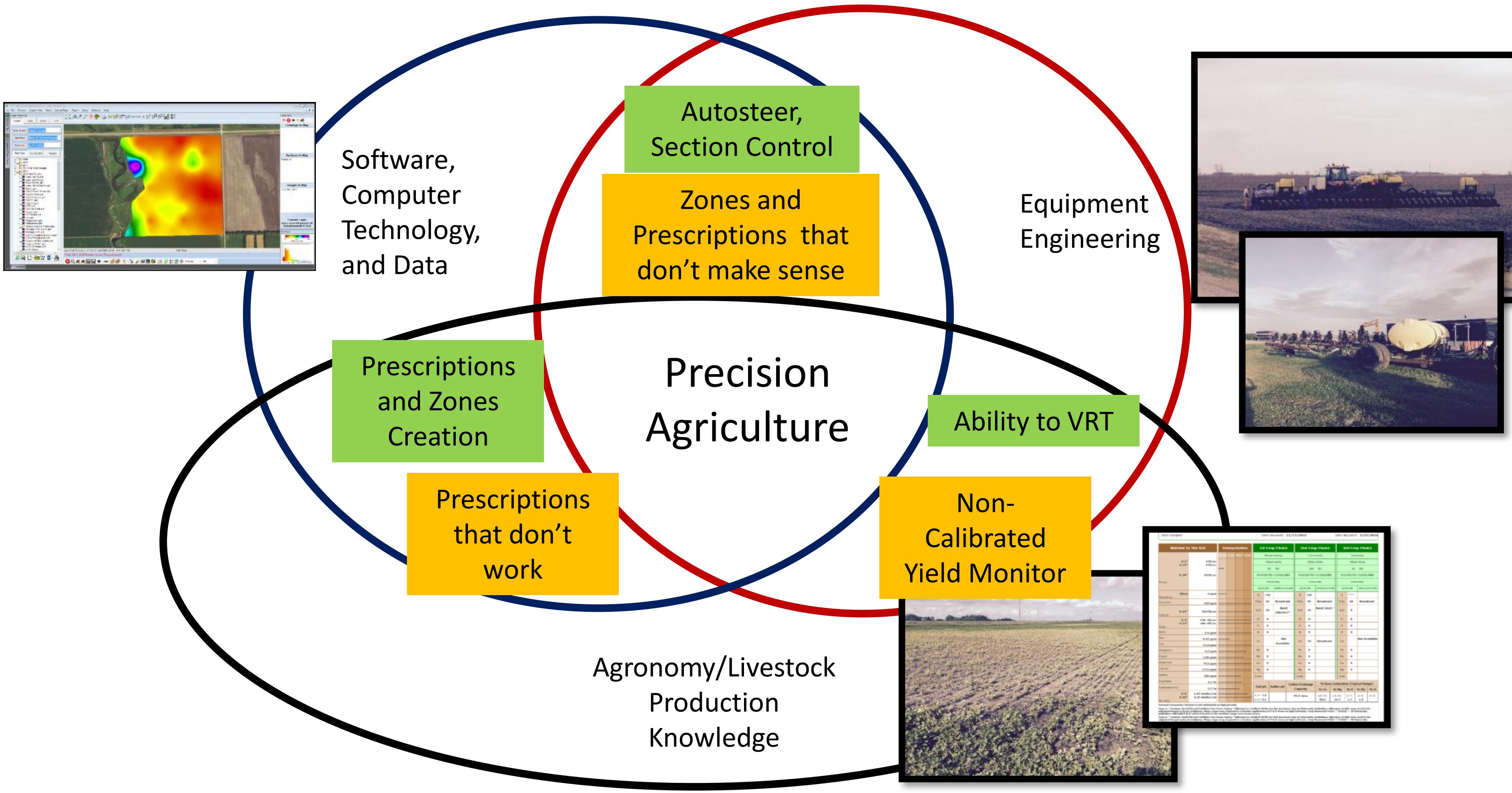
ie- autosteer, section control

Autosteer versus VRT

Autoguidance and autocontrols on inputs are now mostly standard equipment across dealerships, partially because they are relatively simple to use and the benefits are relatively obvious. Guidance and section controllers don't depend on site-specific information to extract value, only location and previous applications. They help reduce input costs by reducing skips, overlaps and duplicate applications. In contrast, the information-intensive side of precision farming continues to lag in demonstrating value. Using site-specific information from fields, such as remote sensing imagery, soil test results, soil or yield maps, to characterize and understand field variability and its impact on crop performance, and then to act upon that by variably managing fields—has been a greater challenge than many would have predicted two decades ago.

Page 18 from 2020 Agriculture Dealership Survey (CropLife Magazine & Purdue University)

Successful Precision Agriculture Programs Require…



Summary

- Composite Sampling – Georeference your points and monitor variability
  - Georeference the sample points
  - Monitor variability from year to year
- Zones
  - Great way to get start describing field variability
  - Moderate expense and labor
  - Must have accurate zones to work well
- Grids
  - Great way to describe man-made variability and further describe variability that zones is not handling well
  - Most expensive and labor intensive
- Successful Precision Agriculture Programs Include:
  - Agronomy Knowledge, Software Knowledge, Equipment Knowledge


Questions??