Agronomic Lessons from Data Analysis

Personal Background

- IA farm – ISU – wholesale fertilizer sales – 3 years, retail dealership – 8 years.
- CEO – IFCA – Agribusiness Association of Iowa. Lobbyist, lead in public policy debates.
- Business consulting – led to creation of Premier Crop – 17 crop years ago
- "you explain things the way they understand"

Presentation outline

- Share who is Premier Crop and what we do
- Share examples of how growers and advisors are using data analysis to make better agronomic decisions and some lessons learned along the way
- Share some ideas on the future

Premier Crop's mission - ***To assist growers and their trusted agronomic advisors in creating real value from their geo-referenced agronomic data by converting data to knowledge supporting improved production decisions in an economic and sustainable manner.***

Premier Crop background

- Started with the 1999 crop year (in our 17th crop year).
- Historically have marketed through select retailers and advisors. An agronomy company that looks like a software company
- Own our software. Web-based. Unlimited geography but primarily focused on crops with yield files.
- Any layer – agronomic, economic, weather, etc.

Premier Crop Customers

- Our customers are some of the largest and most successful retailers in their market areas.
- Many are considered the industry leaders in precision ag and offering quality agronomic advice to growers.
- Premier Crop is their behind-the-scenes technology provider

GPS technology has allowed us to begin to measure spatial variability of many layers of agronomic data across our fields.

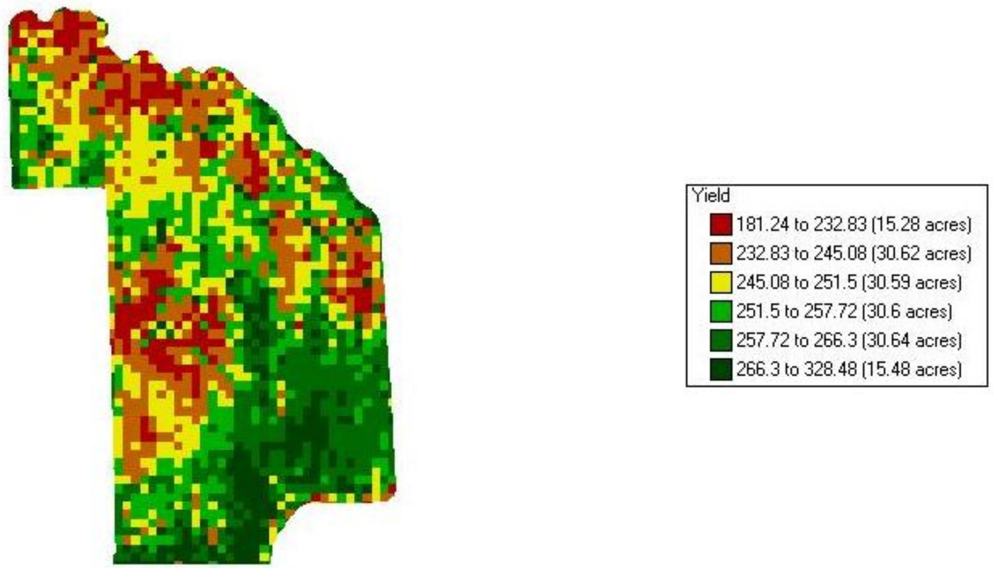
Many growers are accumulating reams of data with notebooks full of maps and hard drives full of computer files.

Beyond “pretty maps”

Field TopTen

Premier Crop Systems | Demo Data | Penny-Pinching Paul | Home Farm | North of Crib | 2009

Premier Crop Systems®



Correlation to Dry Yield

Soil Type	0.44
Potassium (K)	0.42
Phosphorus (P)	0.41
Organic Matter (OM)	0.36
Corn Suitability Rating (CSR)	0.35
Calcium (Ca)	0.35
Base Saturation - K	0.34
CEC	0.26
pH	0.19
Texture	0.18
Planting Speed	0.15

Yield by Soil Type

Soil Type	Avg CSR	Avg Yield	Acres
Mahaska	95	258	64.1
Otley	84	248	60.3
Colo	75	242	17.1
Gara	19	242	11.6
Entire Field	**83**	**251**	**153.1**

Yield by Hybrid - Primary Soil Test Attributes

Company	Variety	Avg pH	Avg P	Avg K	Avg OM	Avg CEC	Avg Yield	Harv Mois	Acres
Crows	4688VT3	6.64	37	260	3.04	18.47	251	24.4	153.1
Entire Field		**6.64**	**37**	**260**	**3.04**	**18.47**	**251**	**24.4**	**153.1**

Primary Soil Test Attributes by Yield Range

	Dry Yield Range	Avg Yield	Avg pH	Avg P	Avg K	Avg OM	Avg CEC	Acres	
	181-233	225	6.67	27	236	2.85	17.84	15.3	
	233-245	240	6.55	26	238	2.95	18.10	30.6	
	245-252	248	6.53	29	247	3.00	18.30	30.6	
	252-258	255	6.56	34	259	3.07	18.59	30.6	
	258-266	262	6.83	50	288	3.17	18.82	30.6	
	266-328	273	6.83	60	295	3.13	19.17	15.5	
	Entire Field	**251**	**6.64**	**37**	**260**	**3.04**	**18.47**	**153.1**	

Secondary Soil Test Attributes by Yield Range

	Dry Yield Range	Avg Yield	Avg Ca	Avg Mg	Avg S	Avg Zn	% K Sat	Ca:Mg Sat	Acres	
	181-233	225	2357	464	N/A	N/A	3.51	3.06	15.3	
	233-245	240	2371	454	N/A	N/A	3.49	3.13	30.6	
	245-252	248	2402	447	N/A	N/A	3.53	3.19	30.6	
	252-258	255	2461	447	N/A	N/A	3.64	3.28	30.6	
	258-266	262	2653	445	N/A	N/A	3.93	3.56	30.6	
	266-328	273	2710	464	N/A	N/A	3.93	3.50	15.5	
	Entire Field	**251**	**2485**	**452**	**N/A**	**N/A**	**3.66**	**3.29**	**153.1**	

Applied Nutrients / Ac by Yield Range (AVGs include zero rate areas)

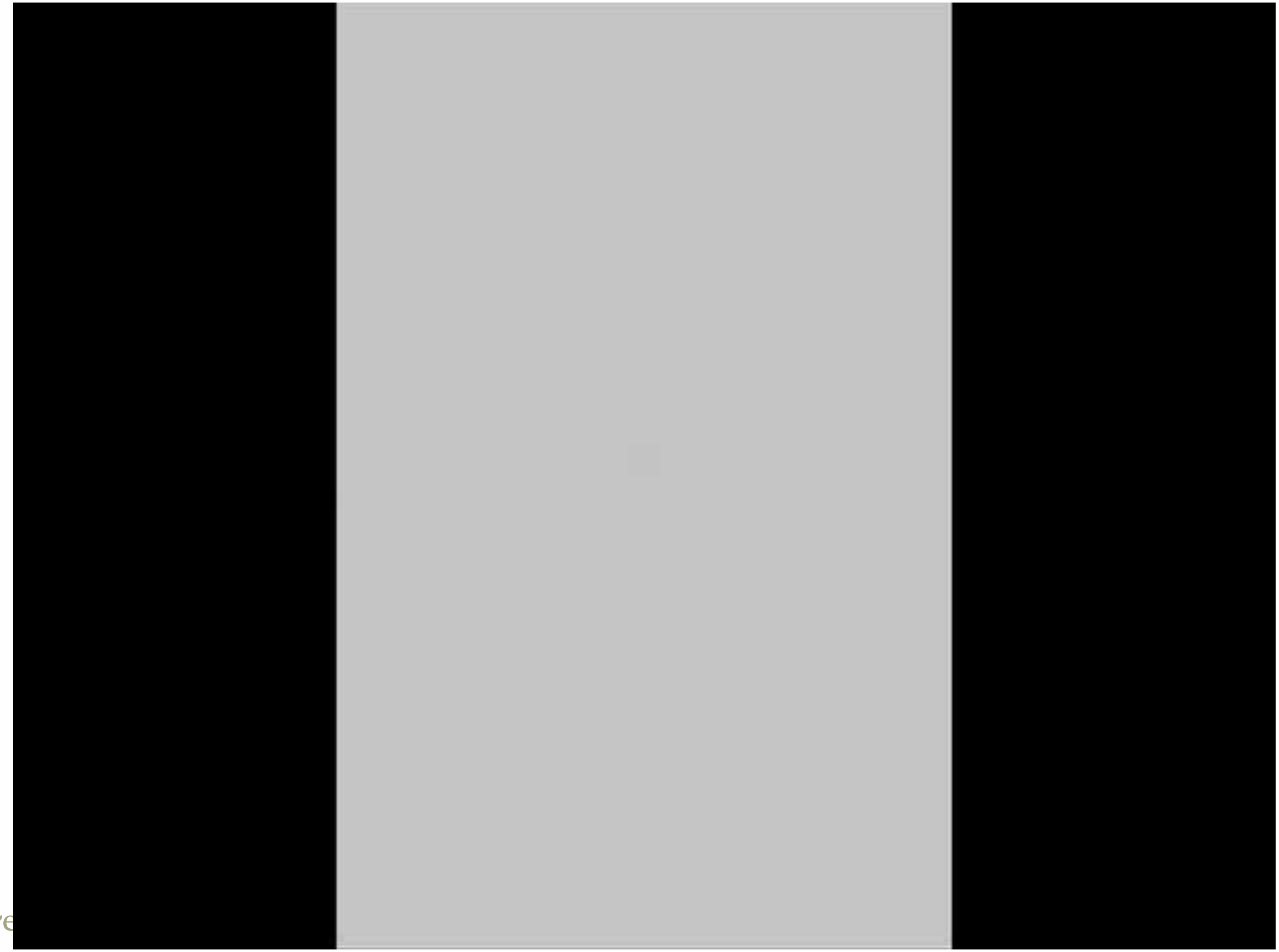
	Dry Yield Range	Avg Yield	Avg N	Avg P	Avg K	Avg Lime	# N/Bu	Ndex™	Acres	
	181-233	225	220	3	2	0	0.98	230	15.2	
	233-245	240	220	3	2	0	0.92	261	30.5	
	245-252	249	220	3	2	0	0.88	283	30.6	
	252-258	255	220	3	2	0	0.86	297	30.6	
	258-267	262	220	3	2	0	0.84	312	30.6	
	267-302	273	220	3	2	0	0.81	337	15.5	
	Entire Field	**251**	**220**	**3**	**2**	**0**	**0.88**	**285**	**153.0**	

Management Factors By Yield Range

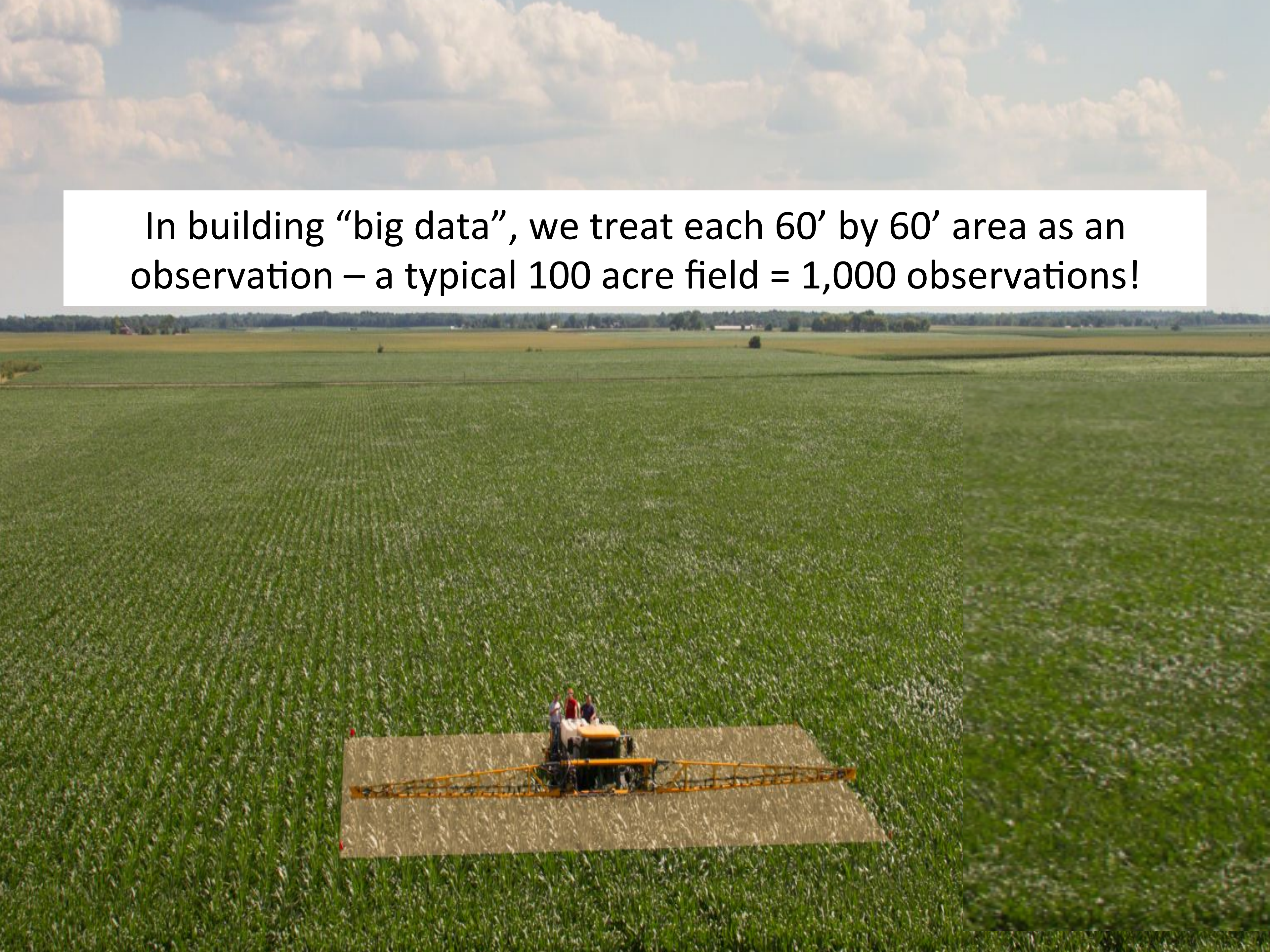
	Dry Yield Range	Avg Yield	Avg Population	Avg Plant Speed	Avg Plant Date	Acres	
	181-233	225	32334	4.87	04/23/2008	15.2	
	233-245	240	32234	4.94	04/23/2008	30.5	
	245-252	249	32219	5.00	04/23/2008	30.6	
	252-258	255	32256	5.02	04/23/2008	30.6	
	258-267	262	32154	5.02	04/23/2008	30.6	
	267-302	273	32076	4.96	04/23/2008	15.5	
	Entire Field	**251**	**32213**	**4.98**	**04/23/2008**	**153.0**	

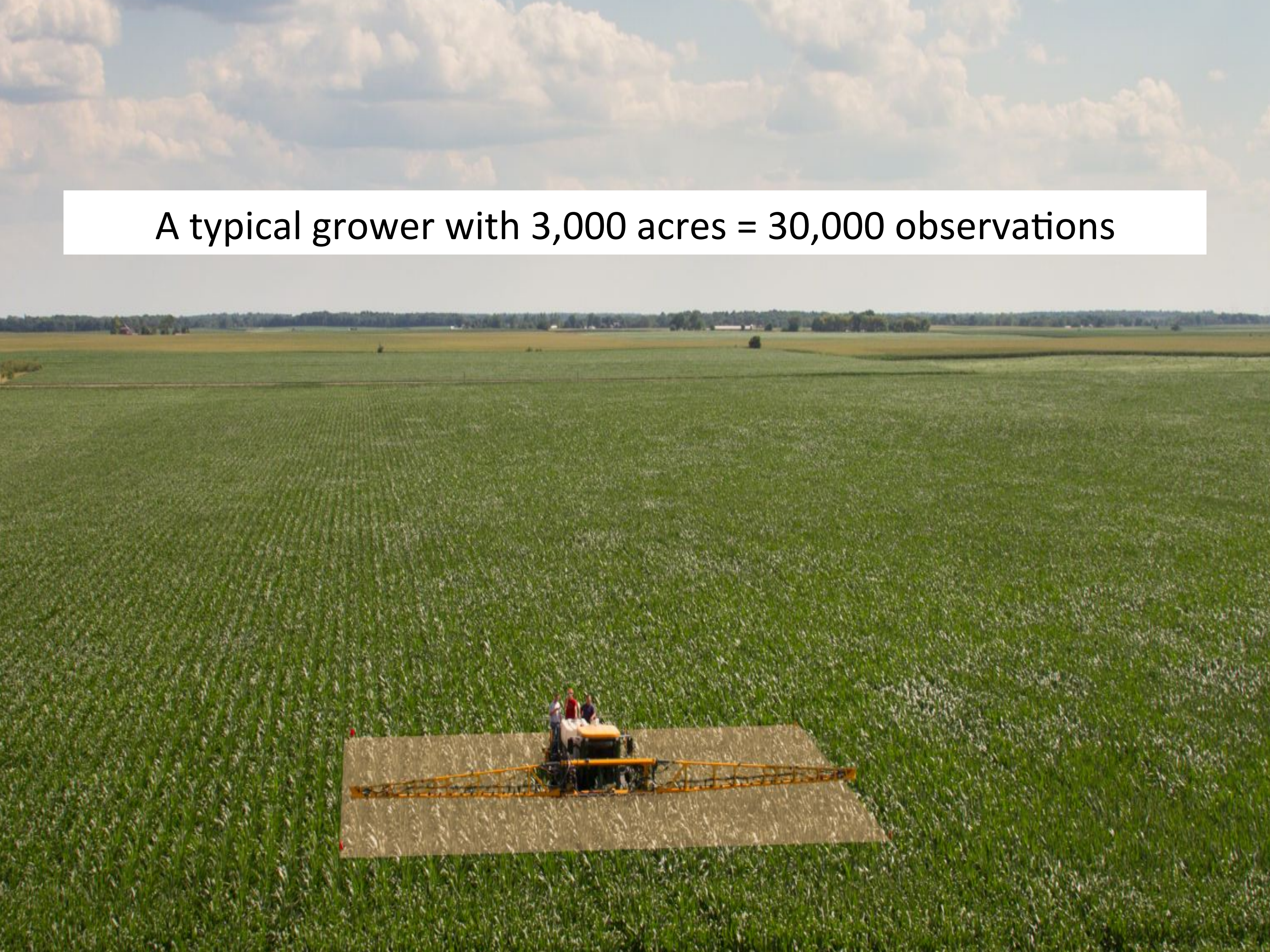
Real world agronomy is integrated and complex

Depth before width…

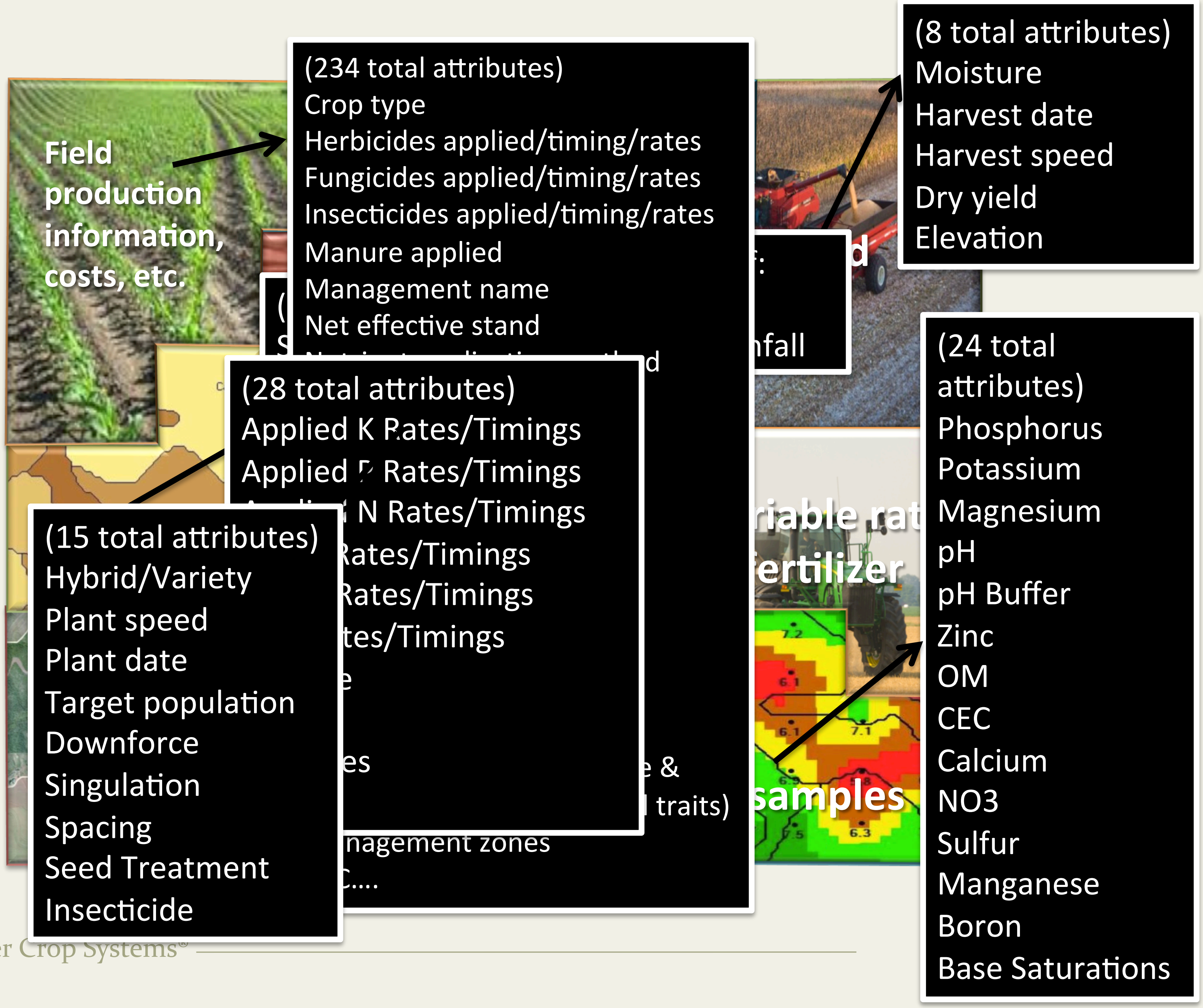


In building "big data", we treat each 60' by 60' area as an observation – a typical 100 acre field = 1,000 observations!




A typical grower with 3,000 acres = 30,000 observations

A Premier Crop customer with 100,000 acres in their program = 1 million local yield observations each year. 5 years of data = 5 million local agronomic observations


Field production information, costs, etc.
(234 total attributes)
Crop type
Herbicides applied/timing/rates
Fungicides applied/timing/rates
Insecticides applied/timing/rates
Manure applied
Management name
Net effective stand
nagement zones
(8 total attributes)
Moisture
Harvest date
Harvest speed
Dry yield
Elevation
nfall
(28 total attributes)
Applied K Rates/Timings
Applied P Rates/Timings
N Rates/Timings
Rates/Timings
Rates/Timings
tes/Timings
traits)
(15 total attributes)
Hybrid/Variety
Plant speed
Plant date
Target population
Downforce
Singulation
Spacing
Seed Treatment
Insecticide
ertilizer
samples
(24 total attributes)
Phosphorus
Potassium
Magnesium
pH
pH Buffer
Zinc
OM
CEC
Calcium
NO3
Sulfur
Manganese
Boron
Base Saturations

Premier Crop

- Organizes data into a database structure that allows you to see the relationship between all the layers of data that you can collect.
- Provides tools that show previously hidden relationships.
- Provides analysis at the field and grower level and across thousands of confidentially pooled acres.

Understanding data uses & limitations

- Correlation does not always equal cause and effect.
- With Premier Crop - using “observational or evidence-based data” vs. “traditional replicated treatments”.

Correlation-not always cause and effect

Understanding data uses & limitations

- Examples of disciplines that rely on observational or evidence-based data
  - Economics, epidemiology, insect and human behavioral sciences
  - Human medicine (both)
  - Genomics (both) – SCA (single gene mutation) vs. aging

Since 2005 - our fastest growing trend – Variable Rate Planting

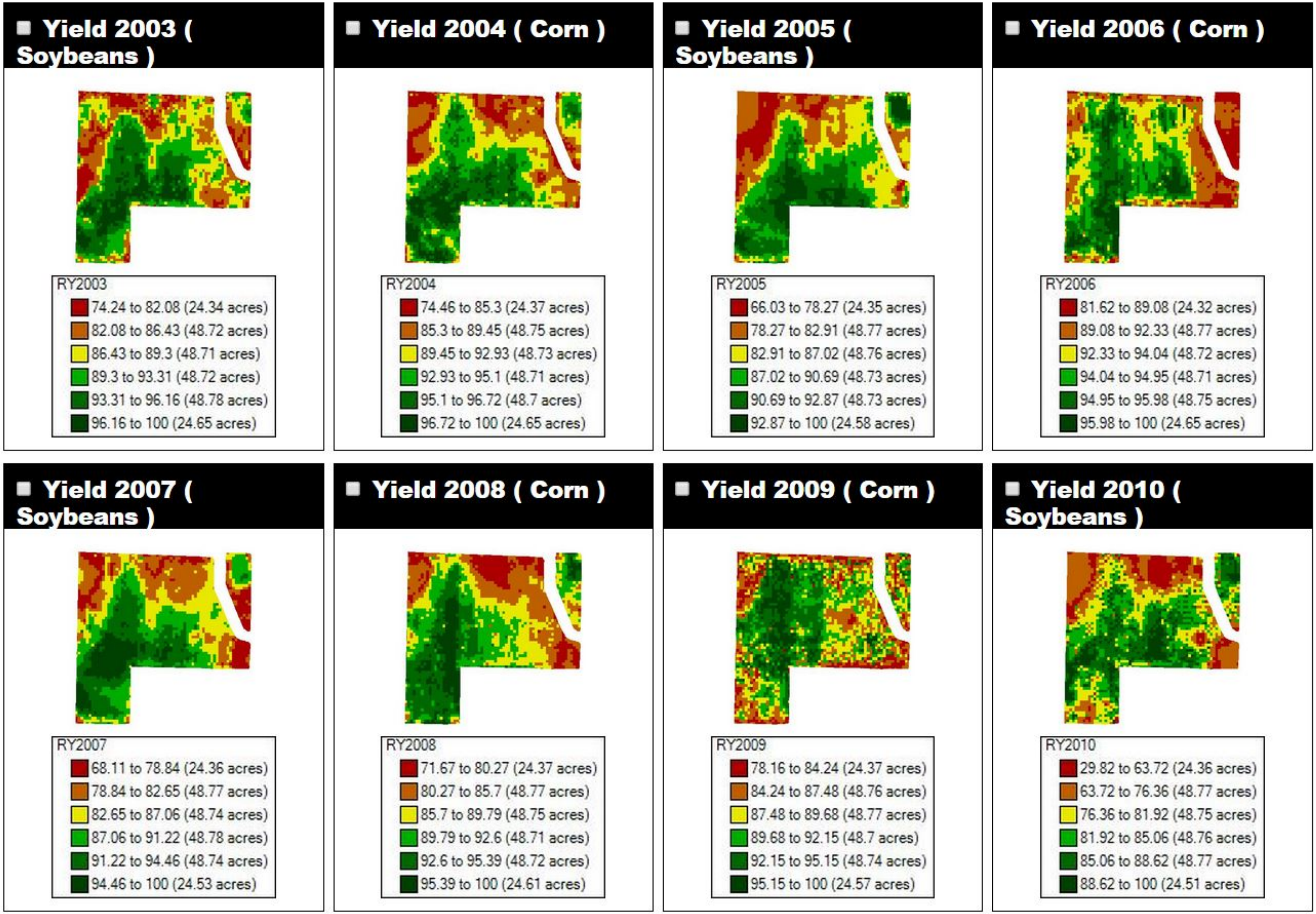
- Visual – growers love using their historic yield data
- Simple message – A, B, C's
- Checking our work – Learning Blocks™
- Synergy – with nutrients

“ABC’s” of Management Zones

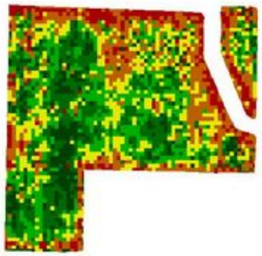
- A Zone: **Highest Productivity.** The best of the best. Growers should be aggressive with inputs on these areas – better chance of high return on investment.

- B Zone: **Average Productivity**. Consistent and stable production. Growers should maintain their “average” management practices in these zones.

- C Zone: **Below-Average Productivity.** Yield-limiting factors are preventing top production. Growers should be conservative with inputs – low return on investment.

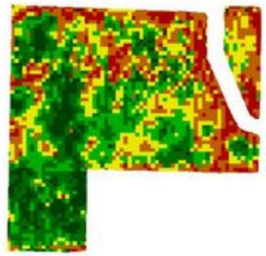

Yield 2003 (Soybeans)
RY2003
74.24 to 82.08 (24.34 acres)
82.08 to 86.43 (48.72 acres)
86.43 to 89.3 (48.71 acres)
89.3 to 93.31 (48.72 acres)
93.31 to 96.16 (48.78 acres)
96.16 to 100 (24.65 acres)
Yield 2004 (Corn)
RY2004
74.46 to 85.3 (24.37 acres)
85.3 to 89.45 (48.75 acres)
89.45 to 92.93 (48.73 acres)
92.93 to 95.1 (48.71 acres)
95.1 to 96.72 (48.7 acres)
96.72 to 100 (24.65 acres)
Yield 2005 (Soybeans)
RY2005
66.03 to 78.27 (24.35 acres)
78.27 to 82.91 (48.77 acres)
82.91 to 87.02 (48.76 acres)
87.02 to 90.69 (48.73 acres)
90.69 to 92.87 (48.73 acres)
92.87 to 100 (24.58 acres)
Yield 2006 (Corn)
RY2006
81.62 to 89.08 (24.32 acres)
89.08 to 92.33 (48.77 acres)
92.33 to 94.04 (48.72 acres)
94.04 to 94.95 (48.71 acres)
94.95 to 95.98 (48.75 acres)
95.98 to 100 (24.65 acres)
Yield 2007 (Soybeans)
RY2007
68.11 to 78.84 (24.36 acres)
78.84 to 82.65 (48.77 acres)
82.65 to 87.06 (48.74 acres)
87.06 to 91.22 (48.78 acres)
91.22 to 94.46 (48.74 acres)
94.46 to 100 (24.53 acres)
Yield 2008 (Corn)
RY2008
71.67 to 80.27 (24.37 acres)
80.27 to 85.7 (48.77 acres)
85.7 to 89.79 (48.75 acres)
89.79 to 92.6 (48.71 acres)
92.6 to 95.39 (48.72 acres)
95.39 to 100 (24.61 acres)
Yield 2009 (Corn)
RY2009
78.16 to 84.24 (24.37 acres)
84.24 to 87.48 (48.76 acres)
87.48 to 89.68 (48.77 acres)
89.68 to 92.15 (48.7 acres)
92.15 to 95.15 (48.74 acres)
95.15 to 100 (24.57 acres)
Yield 2010 (Soybeans)
RY2010
29.82 to 63.72 (24.36 acres)
63.72 to 76.36 (48.77 acres)
76.36 to 81.92 (48.75 acres)
81.92 to 85.06 (48.76 acres)
85.06 to 88.62 (48.77 acres)
88.62 to 100 (24.51 acres)

Yield 2011 (Corn)



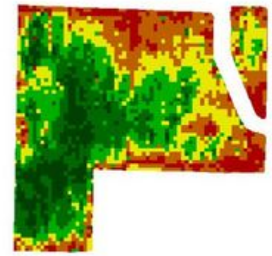
RY2011
- 77.94 to 85.57 (24.33 acres)
- 85.57 to 88.86 (48.71 acres)
- 88.86 to 90.25 (48.75 acres)
- 90.25 to 91.28 (48.73 acres)
- 91.28 to 92.72 (48.75 acres)
- 92.72 to 100 (24.65 acres)

Yield 2012 (Corn)



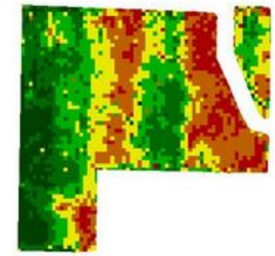
RY2012
- 67.7 to 77.3 (24.31 acres)
- 77.3 to 82.2 (48.76 acres)
- 82.2 to 85.8 (48.73 acres)
- 85.8 to 88.7 (48.72 acres)
- 88.7 to 92.5 (48.74 acres)
- 92.5 to 100 (24.65 acres)

Yield 2013 (Corn)



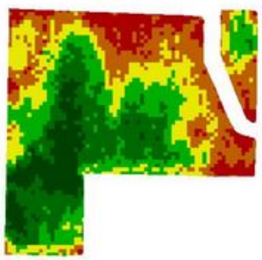
RY2013
- 50.75 to 64.34 (24.35 acres)
- 64.34 to 72.13 (48.77 acres)
- 72.13 to 77.67 (48.71 acres)
- 77.67 to 82.96 (48.72 acres)
- 82.96 to 88.82 (48.77 acres)
- 88.82 to 100 (24.6 acres)

Yield 2014 (Corn)



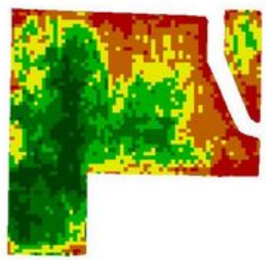
RY2014
- 65.77 to 73.14 (24.36 acres)
- 73.14 to 78.07 (48.71 acres)
- 78.07 to 82.78 (48.75 acres)
- 82.78 to 86.94 (48.78 acres)
- 86.94 to 93.31 (48.77 acres)
- 93.31 to 100 (24.55 acres)

Yield All



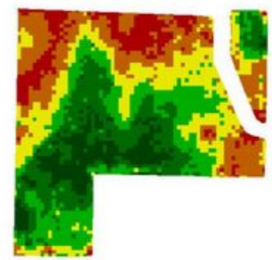
RYCombo
- 74.26 to 80.75 (24.37 acres)
- 80.75 to 84.03 (48.71 acres)
- 84.03 to 87.02 (48.72 acres)
- 87.02 to 89.57 (48.71 acres)
- 89.57 to 91.81 (48.73 acres)
- 91.81 to 94.55 (24.67 acres)

Yield Corn



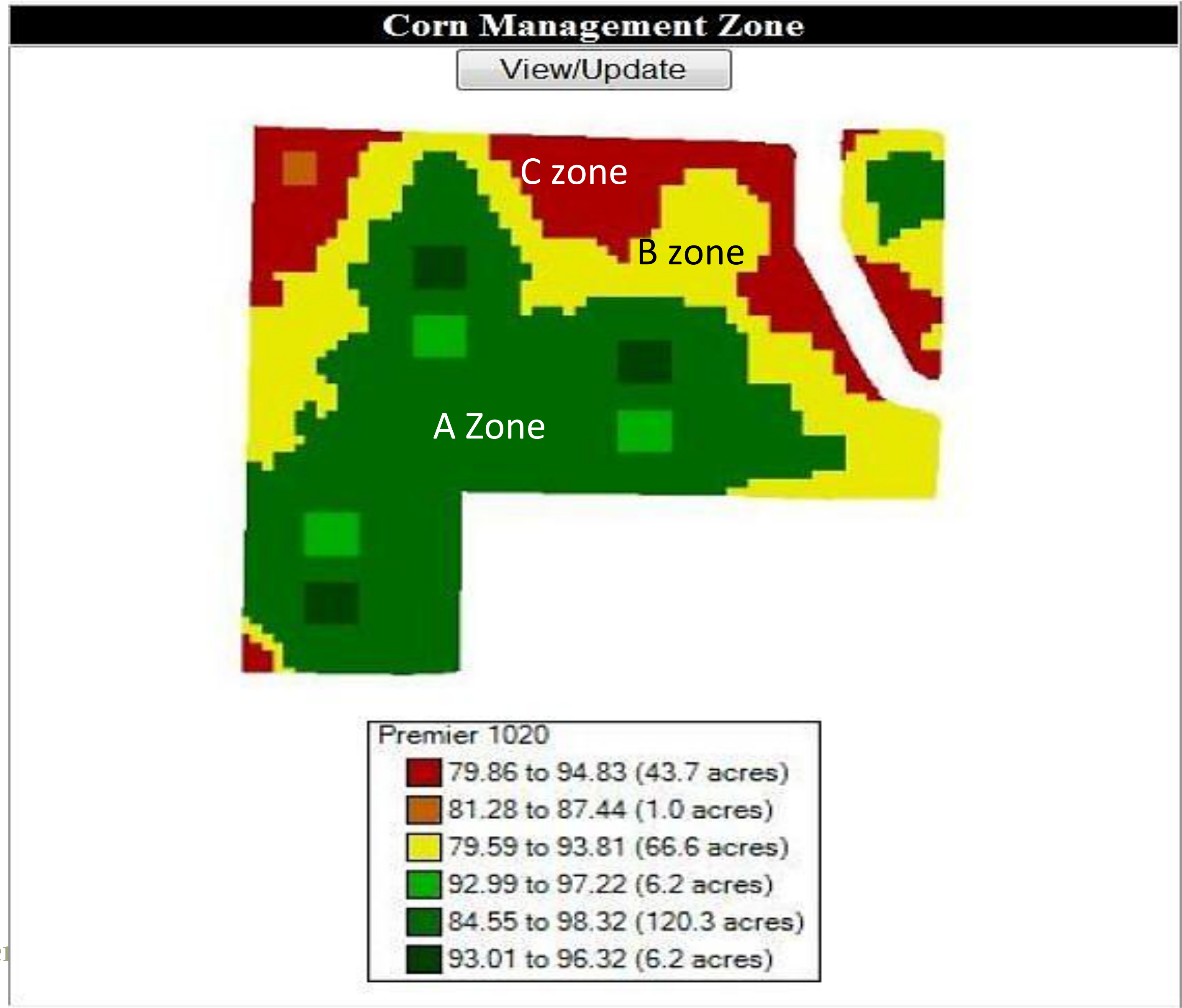
RYCorn
- 76.58 to 81.94 (24.38 acres)
- 81.94 to 85.11 (48.76 acres)
- 85.11 to 87.76 (48.78 acres)
- 87.76 to 89.71 (48.77 acres)
- 89.71 to 92.06 (48.72 acres)
- 92.06 to 94.73 (24.51 acres)

Yield Soybean



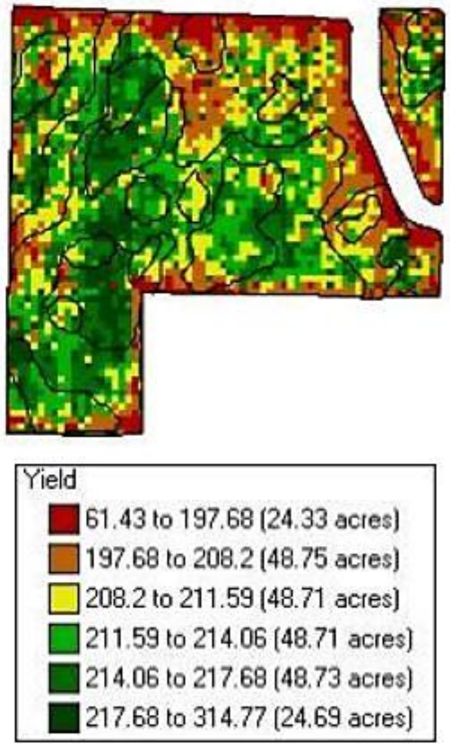
RYSoybean
- 65.51 to 77.07 (24.31 acres)
- 77.07 to 81.82 (48.74 acres)
- 81.82 to 85.87 (48.73 acres)
- 85.87 to 89.81 (48.75 acres)
- 89.81 to 92.41 (48.74 acres)
- 92.41 to 97.21 (24.65 acres)

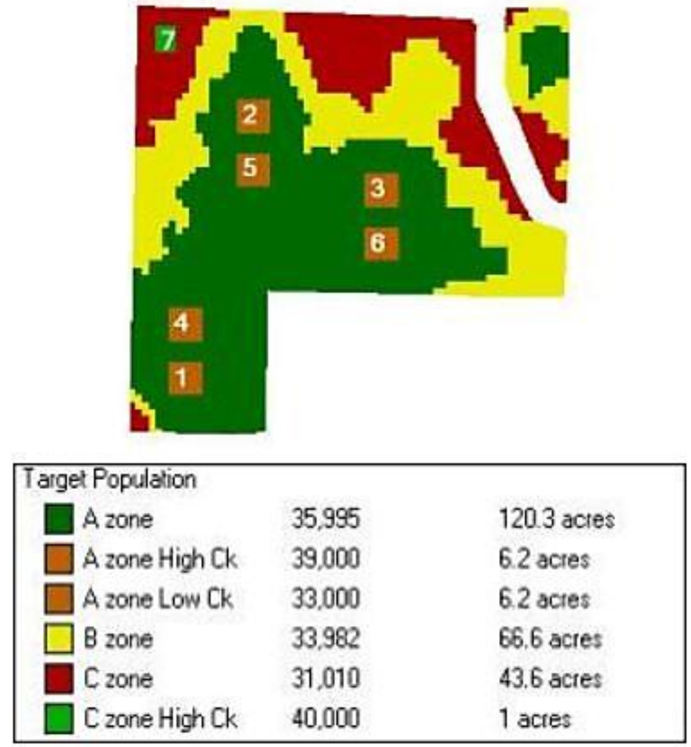
Final Management Zone Map



Field Variable Rate Population Report

Report calculated on: Monday, February 20, 2012 10:51 PM





Yield by Mgmt Zone			
Zone	Target Pop.	Avg Yield	Acres
A zone	35996	212	132.7
B zone	33982	208	66.6
C zone	31188	200	44.6
Entire Field	34501	209	243.9

Yield by Target Population				
Acre %	Target Pop. Range	Target Pop. Avg	Avg Yield	Acres
10%	31000 - 31000	31000	200	43.6
20%	31000 - 34000	33921	208	72.8
20%	34000 - 36000	36000	212	120.3
20%	36000 - 36000			0
20%	36000 - 36000			0
10%	36000 - 40000	39138	213	7.2
Entire Field	31000 - 40000	34501	209	243.9

Learning Blocks Results are numbered on the map above and to the right

Learning Blocks Results are numbered on the map above and to the right

Learning Block #1

Learning Block Yield Comparison	Target Population	Avg Yield	Acres
A zone High Ck	39000	214	2.1
Neighboring Cells	36000	215	4.6

Learning Block #2

Learning Block Yield Comparison	Target Population	Avg Yield	Acres
A zone High Ck	39000	217	2.1
Neighboring Cells	36000	216	4.6

Learning Block #3

Learning Block Yield Comparison	Target Population	Avg Yield	Acres
A zone High Ck	39000	210	2.1
Neighboring Cells	36000	214	4.6

Learning Block #4

Learning Block Yield Comparison	Target Population	Avg Yield	Acres
A zone Low Ck	33000	213	2.1
Neighboring Cells	36000	215	4.6

Learning Block #5

Learning Block Yield Comparison	Target Population	Avg Yield	Acres
A zone Low Ck	33000	214	2.1
Neighboring Cells	36000	215	4.6

Learning Block #6

Learning Block Yield Comparison	Target Population	Avg Yield	Acres
A zone Low Ck	33000	214	2.1
Neighboring Cells	36000	215	4.6

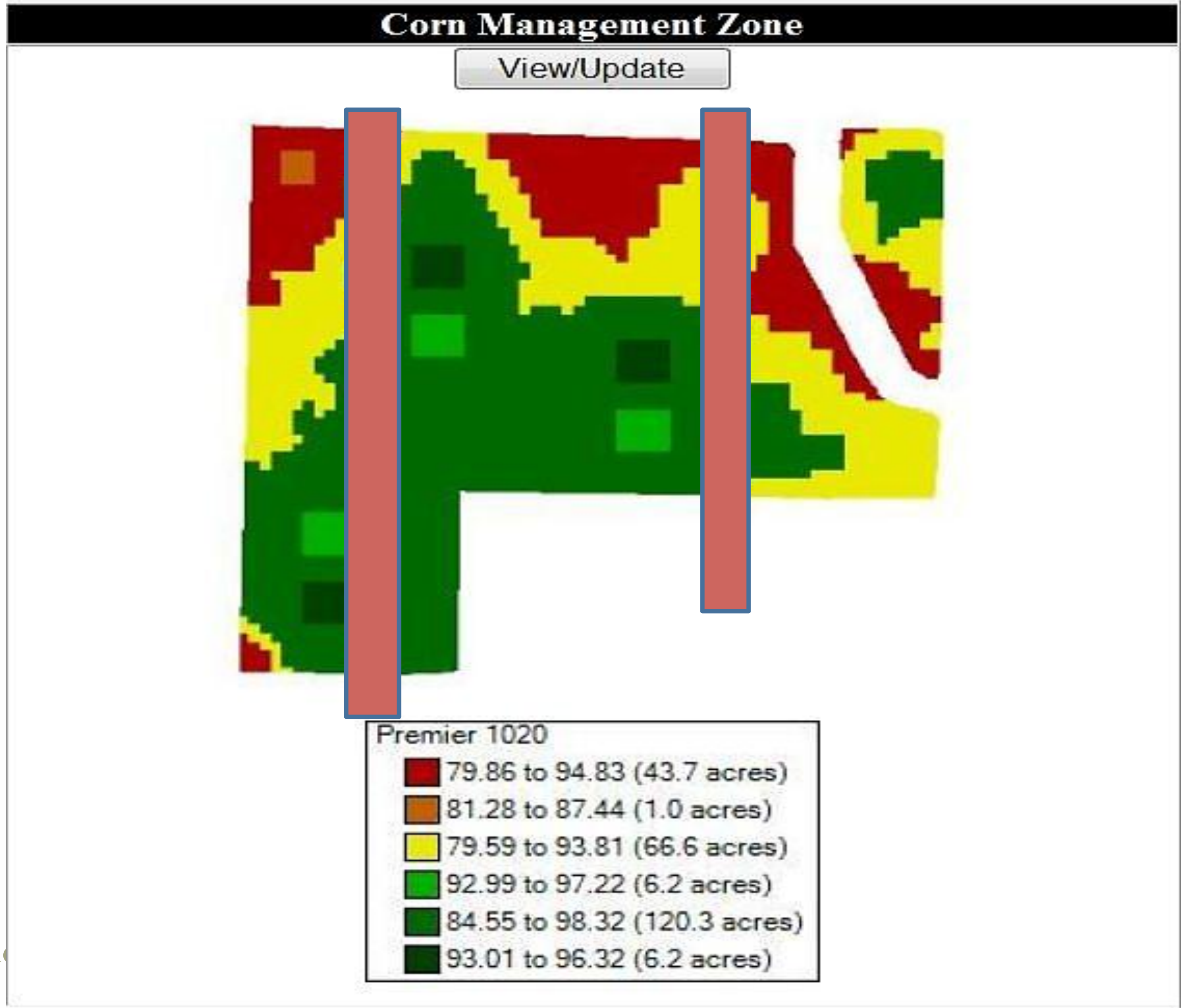
Learning Block #7

Learning Block Yield Comparison	Target Population	Avg Yield	Acres
C zone High Ck	40000	212	1
Neighboring Cells	31000	206	1.5

Learning Blocks vs. Replicated Strip Trials

- Learning Blocks
  - Match real world field conditions
  - Doing research where it needs to be done
- Replicated Strip Trials
  - Designed to generate "average" results
  - Strip treatments cross ABC zones

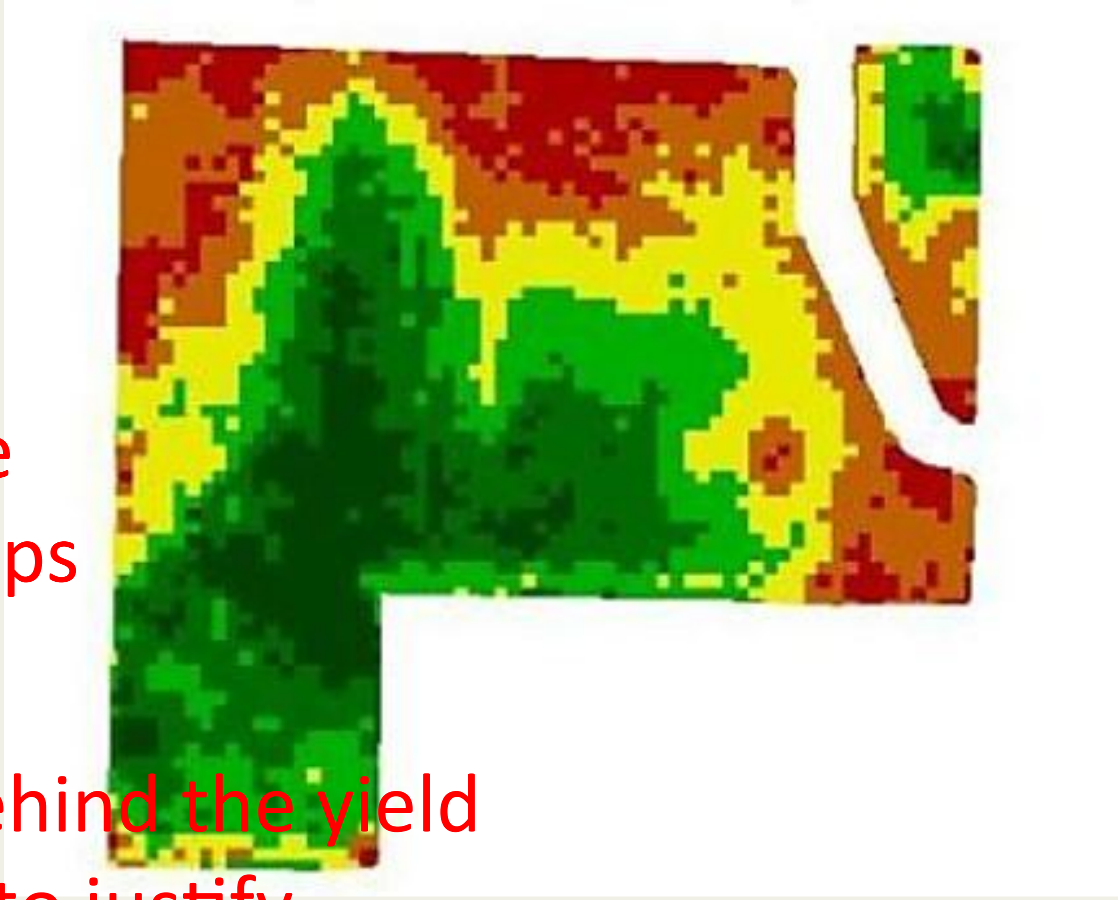
Don’t We Already Know Better?



Lesson #1 – Maps are a great way to visualize data but…

…legends matter…

…growers and advisors can visually correlate some relationships but..

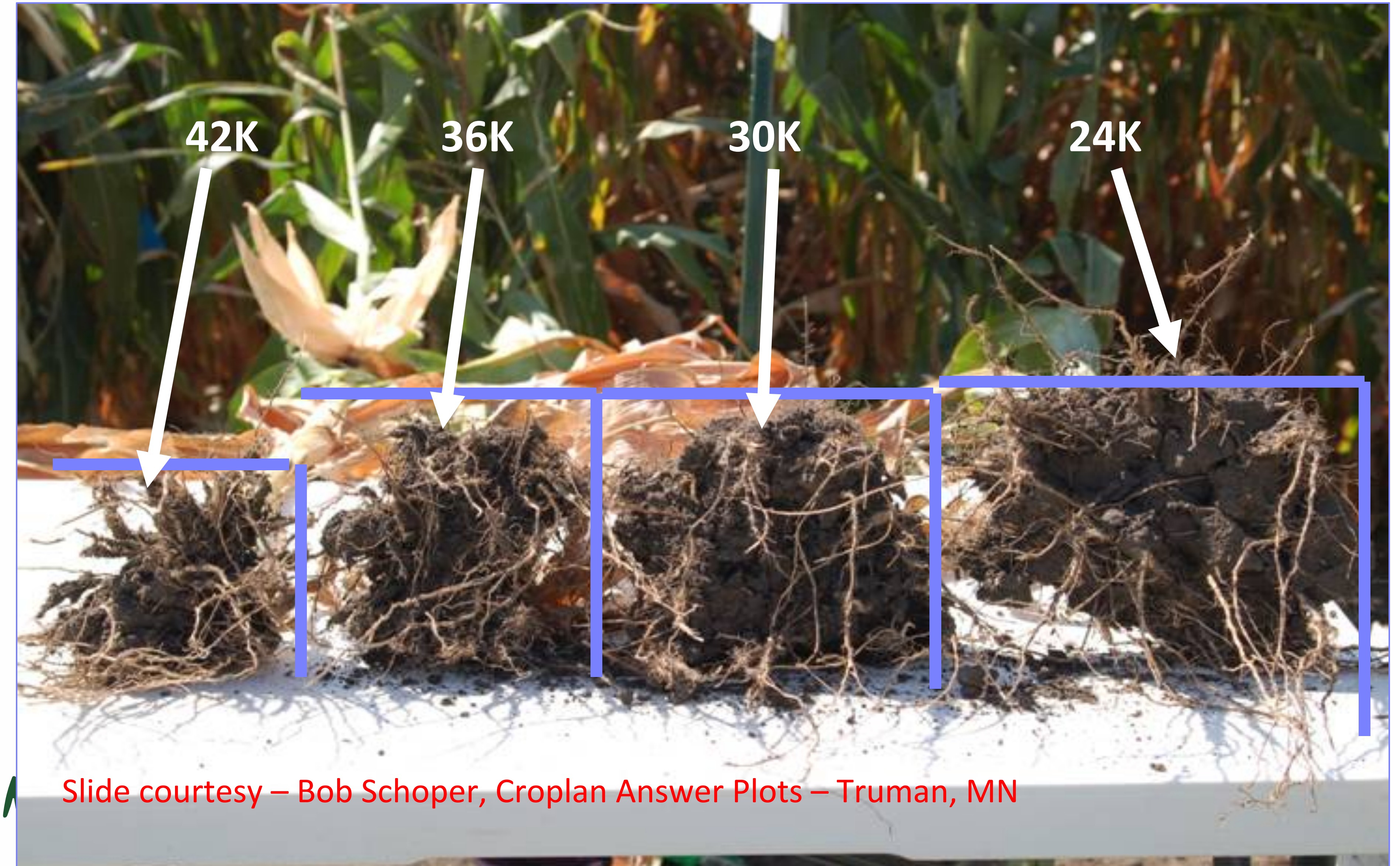


…the data file behind the yield map provided $ to justify drainage

Agronomic Synergy

- Synergy – The Marriage of Variable Rate Planting and Variable Rate Nutrients.
- Synergy – What's Been "Missing" in the VR Population Recipe for Success
- Synergy - Integration of the Right Population, Right Nutrients, and Right Genetics at Specific Sites Within The Field.
- Agronomic Synergy – Premier Crop's Goal/Direction for Current and Future Development

For immobile nutrients – Uptake is driven by root length



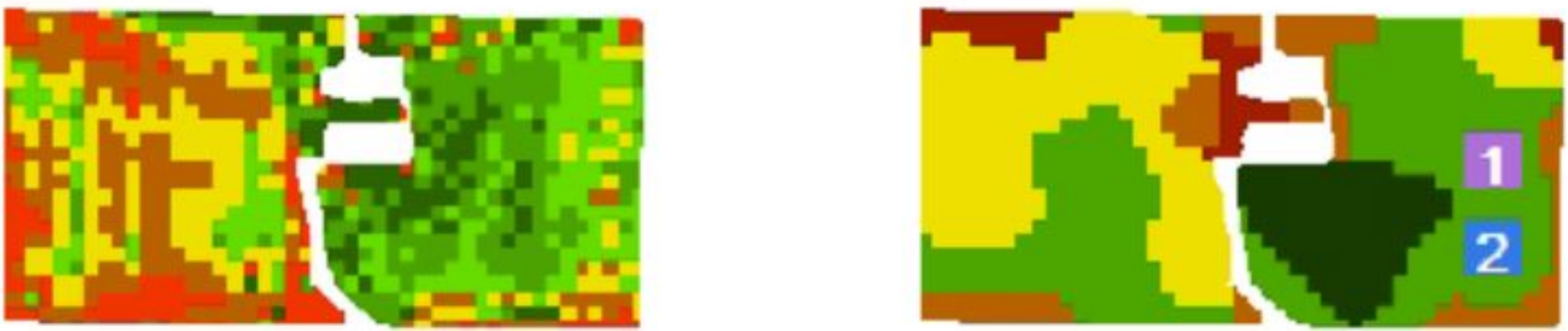
Slide courtesy – Bob Schoper, Croplan Answer Plots – Truman, MN

Synergy with Nutrients

- "if you invite more people to dinner, you'll need extra food"
- Nutrient Learning Blocks™ – just as popular

Nitrogen Learning Block™ Report

Report Calculated on: Thursday, November 13, 2014 8:05:37 PM



Learning Block #1

Learning Block yield comparison	Target nutrient rate	Average yield	Acres
N High Ck	160	228	2
Neighboring cells	114	228	4.6

Learning Block #2

Learning Block yield comparison	Target nutrient rate	Average yield	Acres
N Low Ck	80	218	2
Neighboring cells	110	227	4.6

Learning Block #1

Learning Block Yield Comparison	Target Nutrient Rate	Avg Yield	Acres
P high ck	99	248	1.5
Neighboring Cells	48	230	1.8

Learning Block #2

Learning Block Yield Comparison	Target Nutrient Rate	Avg Yield	Acres
P high ck	99	249	1.5
Neighboring Cells	47	220	1.8

Learning Block #1

Learning Block Yield Comparison	Target Nutrient Rate	Avg Yield	Acres
P high ck	175	239	2.1
Neighboring Cells	109	228	4

Learning Block #2

Learning Block Yield Comparison	Target Nutrient Rate	Avg Yield	Acres
P high ck	175	246	2.1
Neighboring Cells	114	236	4.6

Learning Block #1

Learning Block Yield Comparison	Target Nutrient Rate	Avg Yield	Acres
K high ck	159	222	2.1
Neighboring Cells	103	210	4.6

Learning Block Yield Comparison	Target Nutrient Rate	Avg Yield	Acres
K high ck	246	224	0.7
Neighboring Cells	207	216	1.3

Lesson#2

- Checking your work– your recommendation with a Learning Block™ type concept keeps you grounded but it genuinely refreshing to growers.

Lesson#3 – surrogate data layers – the role of advisors-growers

Planting speed (mph)	*Dry yield bu./acre*
3.4	145.6
3.6	152.8
3.9	175.6
4.5	195.4
4.7	198.7
5.1	202.3

It's an important lesson that many miss. Sometimes, a data layer is actually a "surrogate" for another layer that you may not have captured. Planting speed was a surrogate for the condition of the planting bed. High soil pH is a surrogate for cyst nematode. Correlation to slope could be a surrogate for an eroded area within a soil type or the best part of the field because excess water escaped in a wet year.

Analysis can and does provide insights, creating new agronomic knowledge that allows growers and advisers to understand relationships that were impossible to see before. Yet big data analytics is not the crystal ball that removes local context. Rather, the power of big data analytics is handing the crystal ball to advisers who have local context.

Real-world agronomy is complex — very complex. It's where soil science, soil supplied and applied fertility, plant pathology, entomology, weed science, and soil and water conservation all collide with technology, allowing you to measure, analyze and deliver site-specific solutions. CSD

Lesson #4 – don't exclude the grower

- Growers love to be part of the process – that takes time – slows you down – you need to charge them. How awful – you have to spend more time with your best customers☹
- Most growers have insights that improve your "algorithm"

Lesson #5 & #6 & #7

- Value creation depends on perspective
  – A seed company values data analysis that shows an overall yield advantage vs. a competitor
  – A grower values data analysis that shows yield results from fields like mine
- Easy to create apples to oranges comparisons
- "the more local - the better"

59 locations – in Answer Plot "north" group

- DKC 52-59

From 59 locations	Yield	Value per Acre	% Win	Test Weight	Moisture %
	194.5	$1,148.57	67%	56.9	17.4%

- 59 locations x 3 reps x 25' = 177 observations

Big Data Analytics

Min. Sites: [ ] **Min. Acres:** 3000 [Filter]

Hybrid or Variety	Sites	Std Dev	Average	Area
5338VT3	121	23.89	206.71	6,846.78
DKC50-66	101	24.87	203.13	4,140.48
DKC52-59	575	23.78	202.40	30,781.01
DKC50-35	101	18.14	202.30	4,541.72
421VT3	100	20.33	199.98	4,486.03
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35F44	131	23.34	195.72	6,833.04
DKC52-40	142	21.61	193.31	7,003.31
DKC48-37	153	22.96	191.27	6,518.95
DKC51-45	207	22.32	190.06	6,970.54
36V75	121	28.49	189.20	7,040.40
DKC51-39	95	23.18	188.80	4,262.98
Mix	272	26.38	188.41	11,547.89
36V51	151	26.74	187.89	6,152.92
37Y14	157	24.86	187.34	6,671.92
DKC52-47	99	22.28	186.46	5,088.62
DKC46-60	103	25.28	186.14	5,011.13
DKC50-20	94	25.95	184.24	4,754.79
				176,005.61

Premier Crop's North Group = 307,781 observations

Sub-Query Report: Canisteo

Query Name: North C on C Hybrid by Soils

Group Name: All yrs North C on C 1-2011

Average Column: Dry Yield

Area Column: Acre

Min. Yield: 0

Additional Filters

Min. Sites: **Min. Acres:** 500 Filter

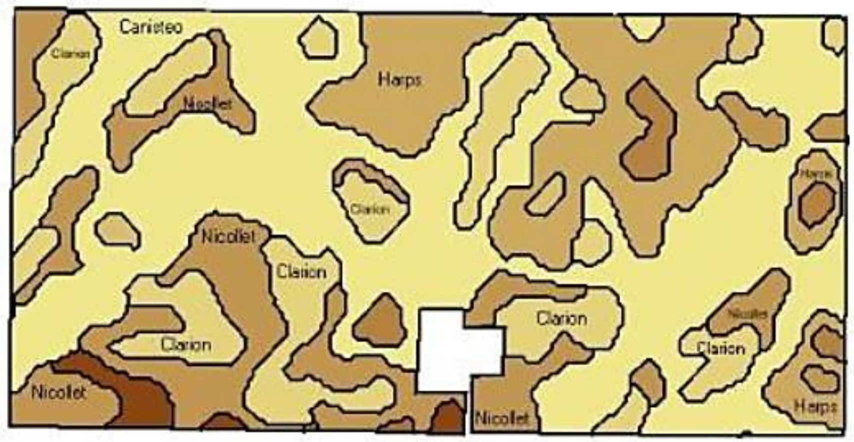
Seed Company	Hybrid	Soil Type	Sites	Std Dev	Average	Area
Dekalb	DKC52-59	Canisteo	96	28.32	186.19	1,832.54
Dekalb	DKC52-62	Canisteo	57	23.08	186.01	627.25
Pioneer Hi-Bred	34A20	CANISTEO	12	24.57	184.82	549.78
Dekalb	DKC52-43	Canisteo	69	27.17	181.87	1,283.84
Dekalb	DKC52-40	Canisteo	53	27.04	175.95	1,151.19
Pioneer Hi-Bred	35F44	Canisteo	48	23.72	174.07	720.92
Pioneer Hi-Bred	37Y14	Canisteo	45	24.49	173.65	894.44
Pioneer Hi-Bred	33W84	Canisteo	29	24.81	173.31	881.74
Dekalb	DKC51-39	Canisteo	28	19.66	170.39	691.53
Mix	Mix	Canisteo	42	30.49	164.51	516.90
						14,277.12

Even by a single soil type and corn on corn – 18,325 observations!!!

Return to Top Performer Reports | Field's Other Reports

Top Performers Report

Grower	
Farm	
Field	
Year	2012
Group	All yrs North C on C 1-2011
P	13.87 - 66.92
K	40.55 - 231.1
Soil Type	Canisteo, Harps, Nicollet
Plant Dates	4/11 - 5/11
RM	95 - 107
Crop	Corn
Company #	35
Min. Yield	80
Row Spc	30 & greater
Planting Pop	32000 - 40000
Applied N	140 - 200



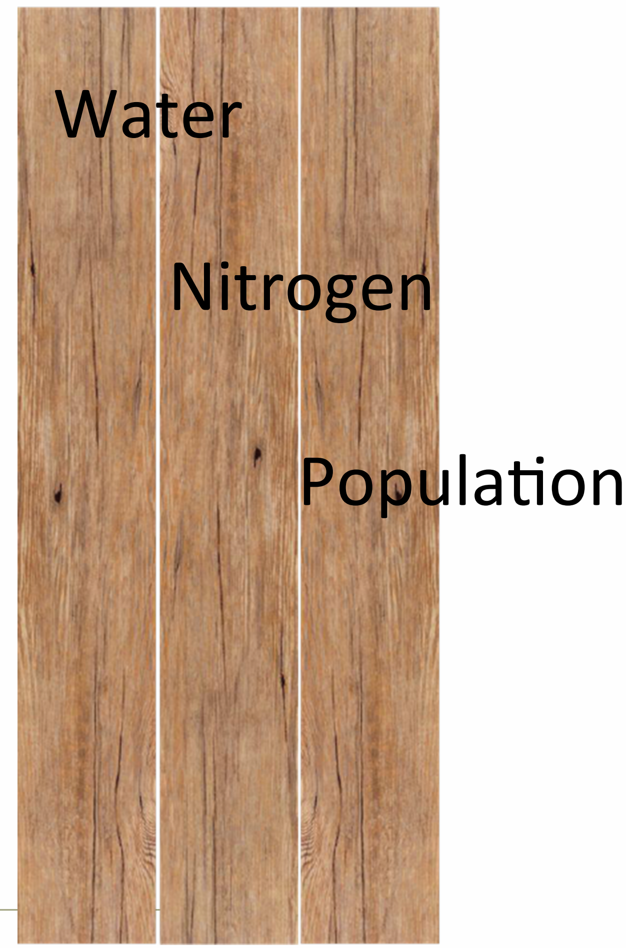
Company: All Min. Sites: Min. Area: 65 Filter

Company	Variety	Pest Res	Chem Res	Sites	Std Dev Yield	Avg Yield	Harv Mois	Area
Dekalb	DKC50-19	YGVT3	RR2	8	21.08	193.74	21.57	101.59
Dekalb	DKC50-66	YGVT3	RR2	12	20.26	193.07	17.45	116.33
Dekalb	DKC53-41	YGVT3	RR2	4	26.14	192.09	20.15	75.00
Croplan Genetics	5237SS	SSTX	RR2/LL	5	10.39	190.93	15.60	73.72
Crows	1929VT3	YGVT3	RR2	3	10.67	184.32	26.46	111.60
Dekalb	DKC48-37	YGVT3	RR2	16	19.53	182.57	16.22	208.70
Dekalb	DKC52-43	YGVT3	RR2	12	17.64	181.98	15.29	105.39
Dekalb	DKC52-59	YGVT3	RR2	29	28.40	180.80	18.97	360.24
Dekalb	DKC52-40	YGPL	RR2	22	27.23	179.88	16.30	367.15
Dekalb	DKC52-62	NONE	RR2	18	20.06	178.49	18.18	138.95
Croplan Genetics	4338VT3	YGVT3	RR2	5	28.28	178.43	18.06	103.32
Pioneer Hi-Bred	35F44	HXX	RR2/LL	13	16.39	175.13	21.70	114.90
Dekalb	DKC54-49	YGVT3	RR2	2	18.53	172.90	20.82	83.52
Dekalb	DKC46-60	YGVT3	RR2	8	13.44	170.21	14.75	188.58
Pioneer Hi-Bred	37Y14	HXX	RR2/LL	10	27.91	170.17	20.82	82.99
Dekalb	DKC54-46	YGPL	RR2	4	16.44	168.48	15.97	103.25
Golden Harvest	H-8265CB/LL	YGCB	LL	3	14.02	167.42	21.21	71.94
Dekalb	DKC51-39	YGPL	RR2	7	13.23	167.01	15.98	102.68
Croplan Genetics	421RR2/BT	YGCB	RR2	5	13.87	166.53	15.14	117.31
Wyffels	W2681	YGVT3	RR2	1	9.97	162.93	18.69	65.96
Pioneer Hi-Bred	P9990XR	HXX	RR2/LL	8	22.10	161.93	15.92	116.86
Dekalb	DKC50-44	YGVT3	RR2	19	32.42	161.18	17.74	276.52
Dekalb	DKC51-45	NONE	RR2	6	39.91	149.77	17.25	84.23
								3,170.73

Lesson #8 – selectional bias

Nitrogen timing	Dry yield/acre	Acres
Fall-applied	219.67	47,880
Spring-applied	203.78	60,523
Split (include sidedress)	195.44	43,465

Lesson #9 – can’t make what is truly complex simple – easy but not simple



NITROGEN DOESN'T DO WELL ON ITS OWN

Nitrogen (N) is a plant nutrient that is essential for higher yields and for increased farmer profits, but if other nutritional needs of the crop are unmet, its benefits are reduced. Consequently, farmers and their advisers must ensure crops are getting complete nutrition to make the most of their nitrogen applications.

Cereal crops like rice, wheat, and corn get the nitrogen they need from either the supply in the soil or from other sources like fertilizer and manure. When the nitrogen supply in the soil is insufficient, these crops will produce a fraction of what they could yield if supplied with enough.

How much will yield increase for each pound of nitrogen applied? It depends. Examples are shown in column two in the table below. They range from 0.09 bushels of sorghum grain per pound of nitrogen to 0.36 bushels of corn grain per pound of nitrogen.

Increase in agronomic efficiency of nitrogen for several cereal crops when phosphorus and potassium were applied.

	Yield increase per pound of applied N		
Crop	N alone	N plus P and K	Increase from the additional P and K
	(bushels of grain per pound of applied N)		(%)
Rice (wet season)	0.31	0.60	93
Rice (summer)	0.24	1.8	636
Wheat	0.18	0.33	82
Corn (maize)	0.36	0.70	95
Sorghum	0.09	0.22	140

Ladha, J.K. et al. 2003. Adv. Agron. 87:85-156. Abbreviations: bu = bushel, N = nitrogen, P = phosphorus, K = potassium.

ONLINE HELP FOR N RATES AN INTERNET CALCULATOR BASED ON NITROGEN-RATE RESEARCH CAN HELP YOU APPLY NITROGEN FERTILIZER FOR THE BEST PAYOFF.

Midwest corn farmers now have an easy-access way to help determine nitrogen (N) fertilizer rates. It's an online calculator in which they put their location, cost of nitrogen, expected selling price of corn, and whether the corn is rotated or not. Using university N-rate response research, the calculator provides a recommendation for the right amount of nitrogen to maximize returns.

"In the past, there were different guideline approaches for nitrogen rates across the states," says John Sawyer, an Iowa State University (ISU) Extension soil fertility specialist who has helped lead the effort. "Some were based on yield goals, some on table values, and some on expected N removal rates. We got our heads together to standardize the approach."

The result is an online tool called the Corn Nitrogen Rate Calculator that uses the Maximum Return to Nitrogen (MRTN). The approach incorporates economic return in the rate determination. It's based on a database of N-rate trials from university projects.

"You talk about big data, well, that's the database behind our calculator," says Sawyer. "Right now, we have over 1,500 N-rate yield response trials from seven states. That's around 36,000 individual plots, and we're adding more trials all the time."

Over 90% of the trials are from the last 15 years, he says, supporting the data's validity in light of recent yield advances and climate changes.

The states participating now are Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin. Sawy[e]

says there's no reason the same system can't be adapte[d] to other crops or agronomic practices like seeding rates.

Find the Corn Nitrogen Rate Calculator at extensi[o] agron.iastate.edu/soilferti[lity/] nrate.aspx. Or, do an Inte[rnet] search for "Maximum Re[turn] To Nitrogen" or "Corn Nitrogen Rate Calculator."

"It's a challenge to farm[ers] to get their hands around t[he] correct rate of nitrogen,"

Photography: Kacey Birchmier, Rich Fee

This is likely the largest N rate response dataset in world

university projects.

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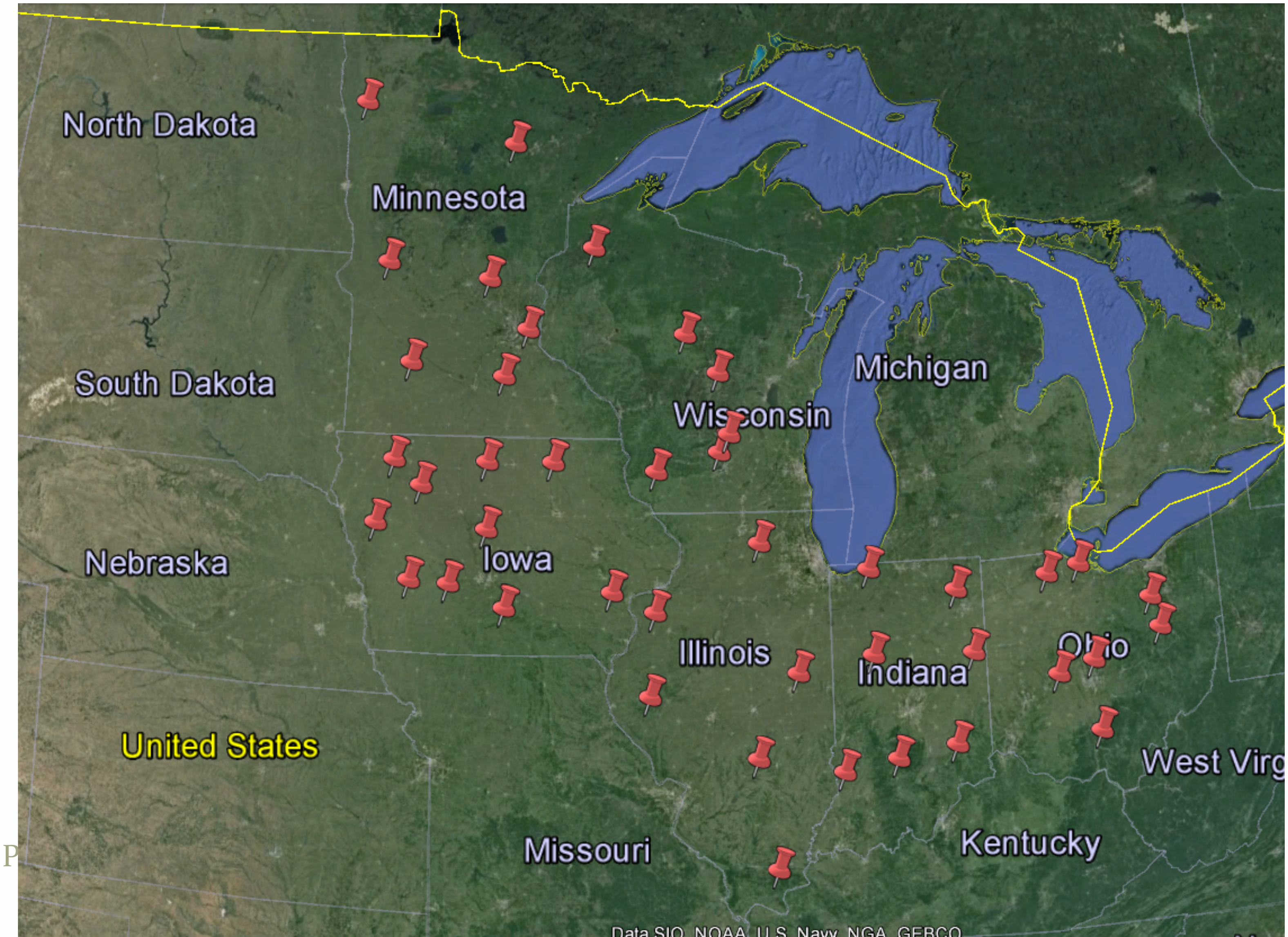
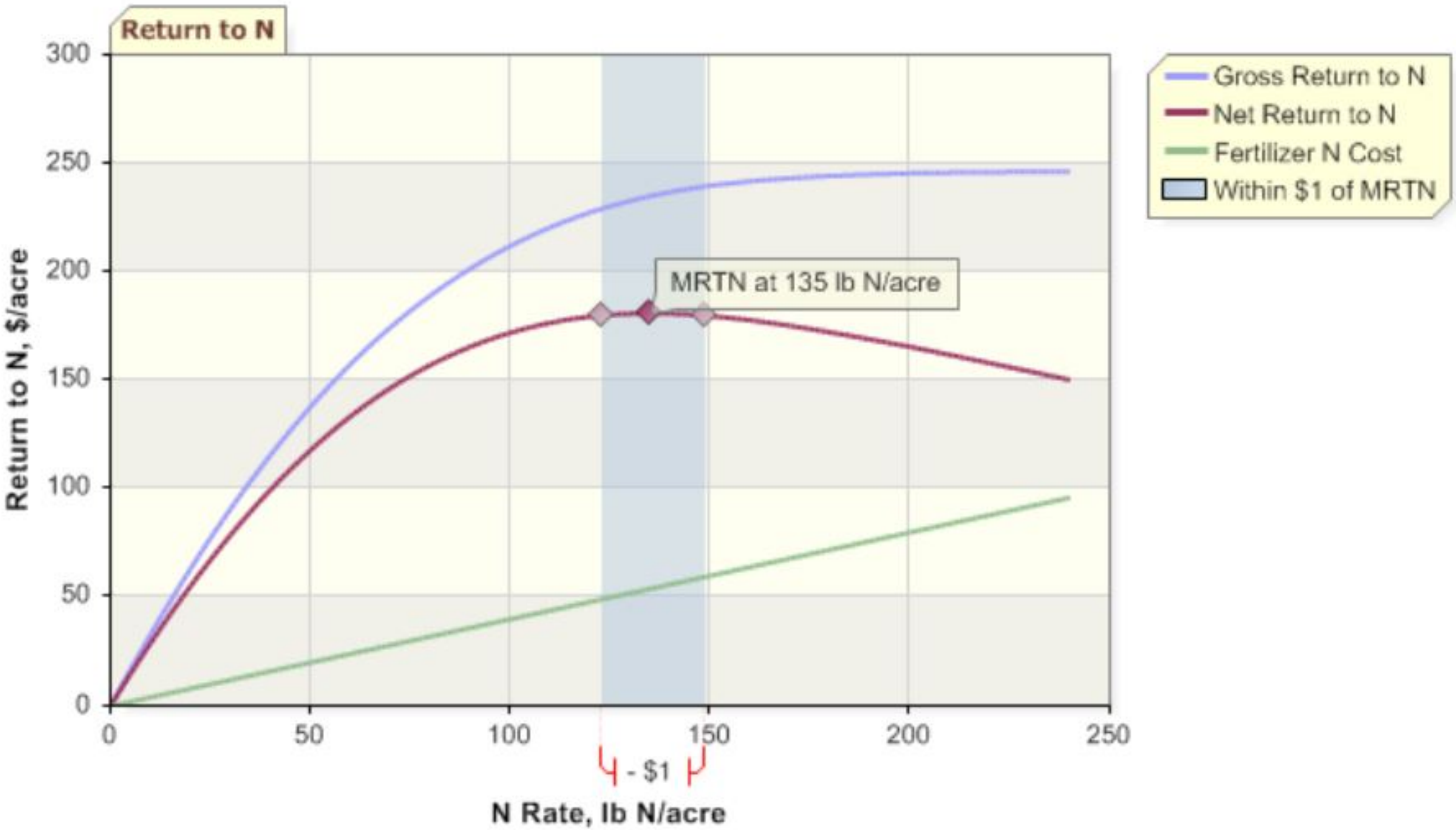
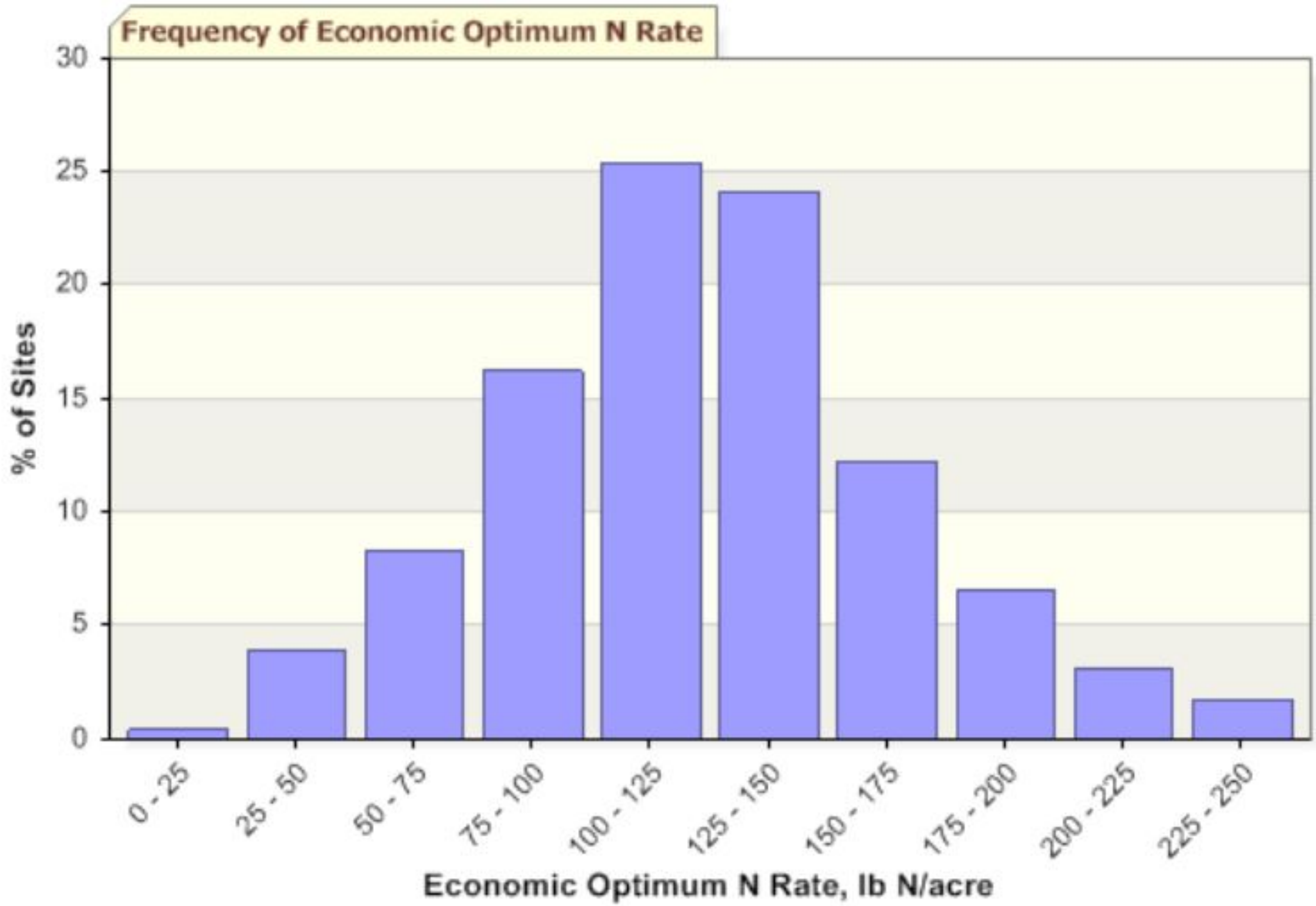
"It's a challenge to farm to get their hands around t correct rate of nitrogen,"

1500 N rate trials over 15 years over 7 states

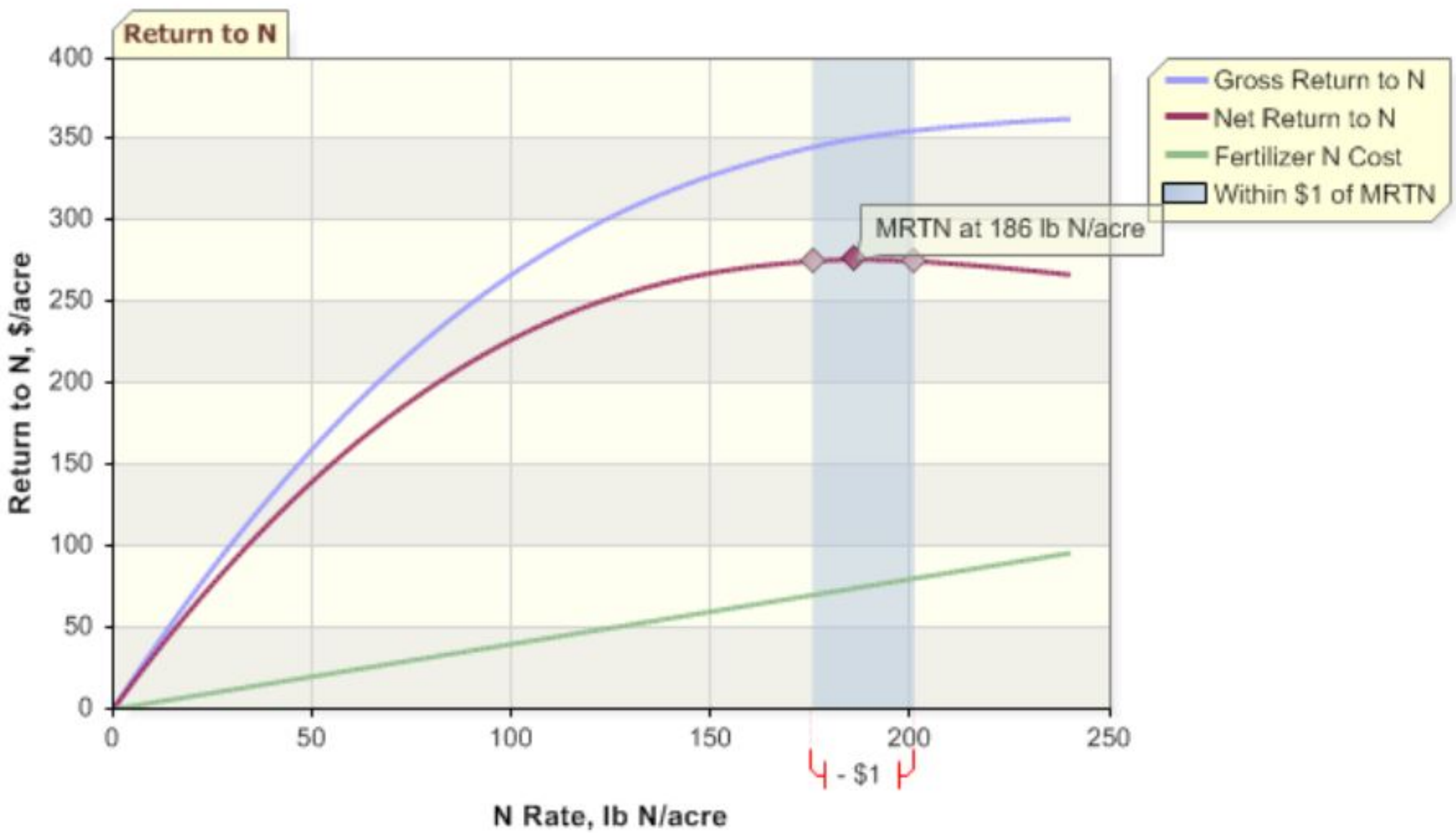


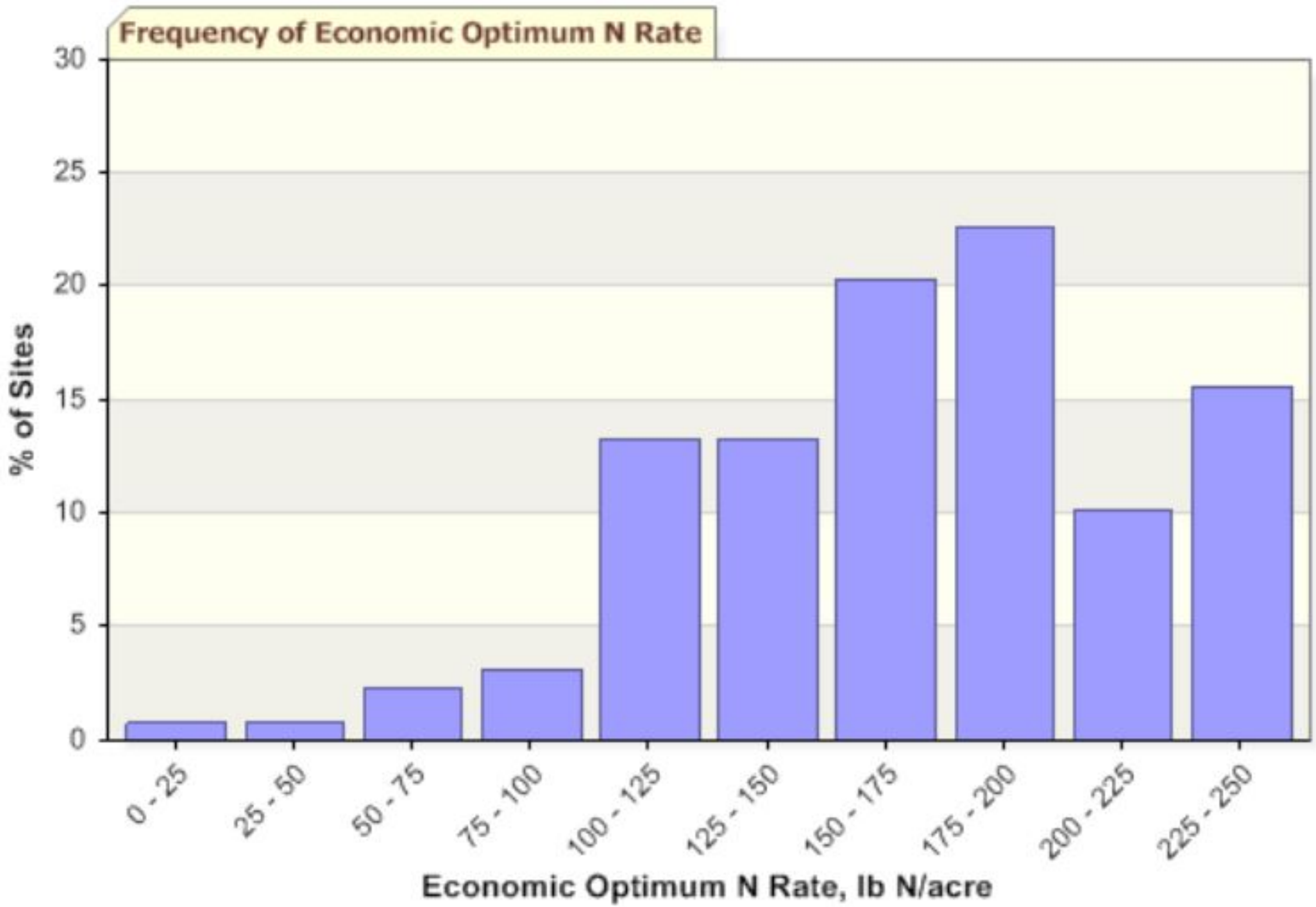
Data ranges are very wide





Frequency of Economic Optimum N Rate
30
25
20
15
10
5
0
% of Sites
0 - 25
25 - 50
50 - 75
75 - 100
100 - 125
125 - 150
150 - 175
175 - 200
200 - 225
225 - 250
Economic Optimum N Rate, lb N/acre

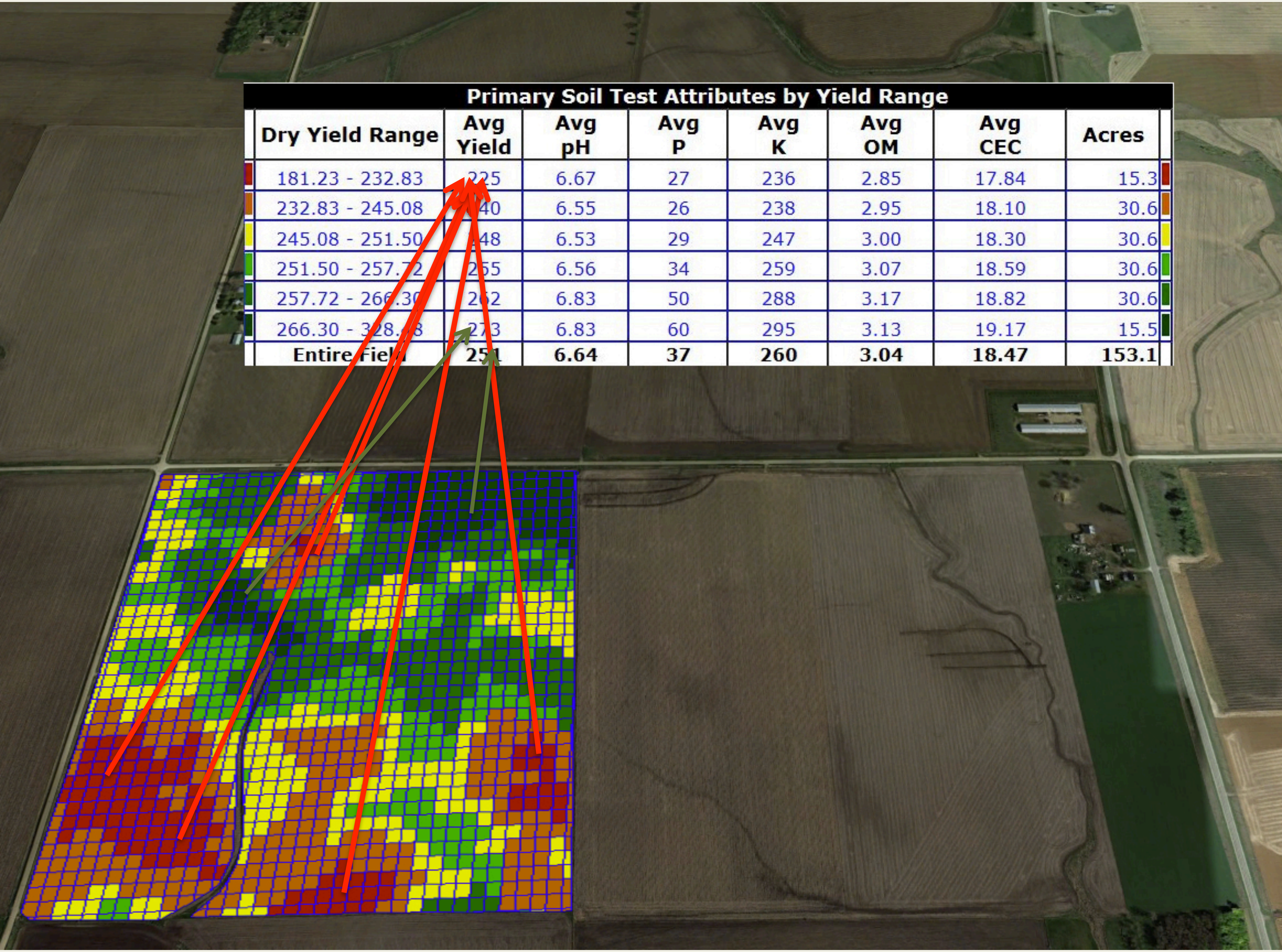

Return to N
Gross Return to N
Net Return to N
Fertilizer N Cost
Within $1 of MRTN
MRTN at 186 lb N/acre
Return to N, $/acre
400
350
300
250
200
150
100
50
0
0
50
100
150
200
250
- $1
N Rate, lb N/acre


Frequency of Economic Optimum N Rate
30
25
20
15
10
5
0
% of Sites
0 - 25
25 - 50
50 - 75
75 - 100
100 - 125
125 - 150
150 - 175
175 - 200
200 - 225
225 - 250
Economic Optimum N Rate, lb N/acre

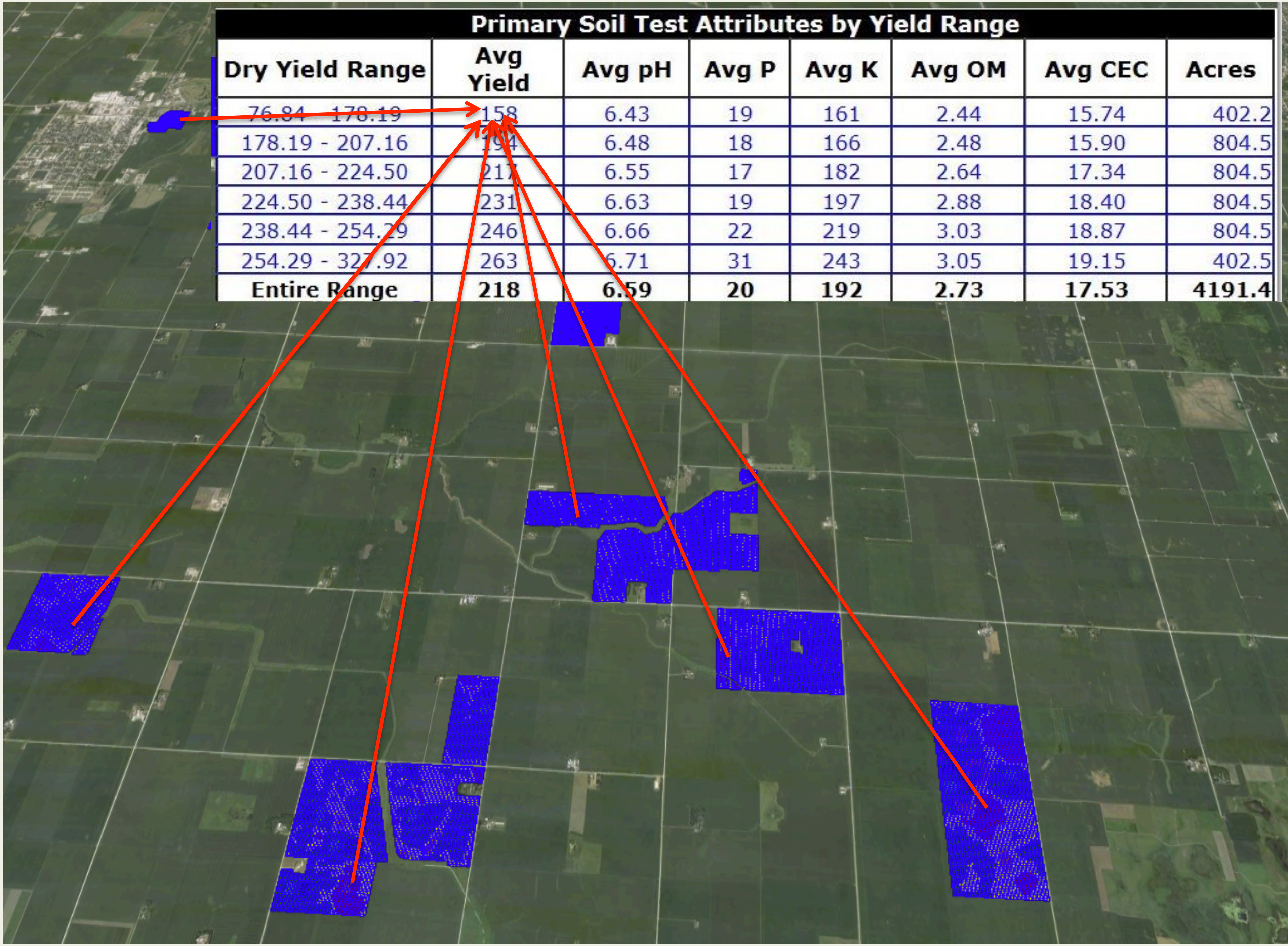
We have to do better than averaging the responses from tiny plots and pretending that those results fit across huge spatial variability that exists within fields

The future

- Do you ever stop to think about why we are doing any of this? What is our end goal? What got you involved?
- For me – this is about a progression to the perfect recommendation.
- Agriculture is set to be regulated by one-size-fits-all recommendations



Primary Soil Test Attributes by Yield Range							
Dry Yield Range	Avg Yield	Avg pH	Avg P	Avg K	Avg OM	Avg CEC	Acres
181.23 - 232.83	225	6.67	27	236	2.85	17.84	15.3
232.83 - 245.08	240	6.55	26	238	2.95	18.10	30.6
245.08 - 251.50	248	6.53	29	247	3.00	18.30	30.6
251.50 - 257.72	255	6.56	34	259	3.07	18.59	30.6
257.72 - 266.30	262	6.83	50	288	3.17	18.82	30.6
266.30 - 328.48	273	6.83	60	295	3.13	19.17	15.5
Entire Field	**251**	**6.64**	**37**	**260**	**3.04**	**18.47**	**153.1**



Primary Soil Test Attributes by Yield Range							
Dry Yield Range	**Avg Yield**	**Avg pH**	**Avg P**	**Avg K**	**Avg OM**	**Avg CEC**	**Acres**
76.84 - 178.19	158	6.43	19	161	2.44	15.74	402.2
178.19 - 207.16	194	6.48	18	166	2.48	15.90	804.5
207.16 - 224.50	217	6.55	17	182	2.64	17.34	804.5
224.50 - 238.44	231	6.63	19	197	2.88	18.40	804.5
238.44 - 254.29	246	6.66	22	219	3.03	18.87	804.5
254.29 - 327.92	263	6.71	31	243	3.05	19.15	402.5
Entire Range	**218**	**6.59**	**20**	**192**	**2.73**	**17.53**	**4191.4**

The future

- Science Friday – Ira Flatow
- **Fruit Flies Aid Efforts to Develop Personalized Cancer Treatments** By Christine Gorman | August 15, 2013

Can “precision ag” become agriculture’s fruit fly?

- The genes that are important for such developments in **fruit flies are close enough on the molecular level to those found in people** that studying the pathways in the insect will give you a lot of insight about what’s going in people.
- Indeed, biologists have gotten **so good at producing fruit flies with specific genetic mutations** that they can now order their own custom-designed insects from various supply houses via computer and have them delivered straight to the laboratory door.

Can "precision ag" become agriculture's fruit fly?

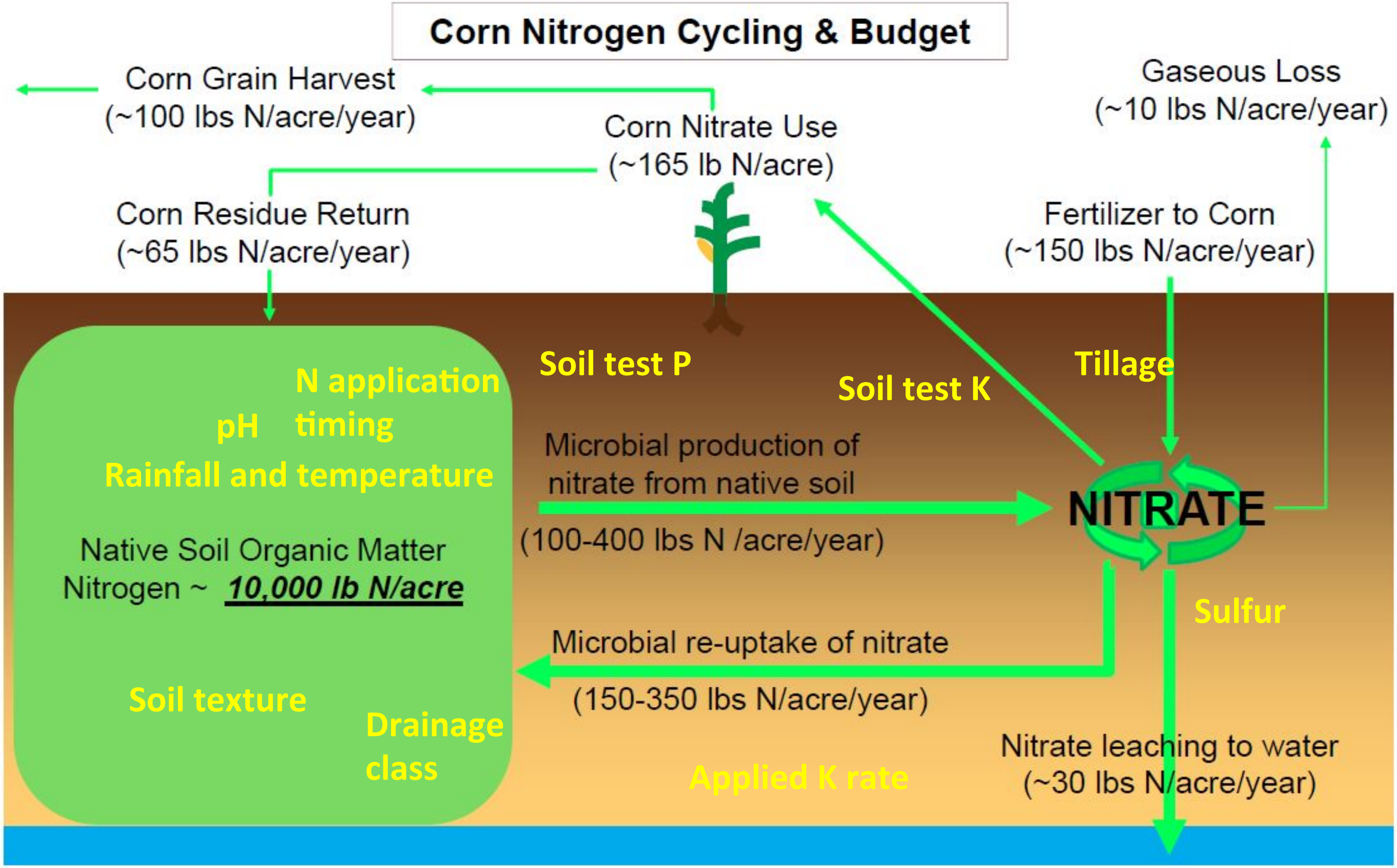
- In other words, some of the mutated genes found in a tumor are acting as "**drivers**" of cancer growth and spread while others are "**passengers**" that pop up as the cells becomes more and more disorganized and mutations start to accumulate. The trouble comes when clinicians find that an individual patient's tumor has 200 or more mutated genes—which ones should they be focusing their attention on and which can they safely ignore?

Can "precision ag" become agriculture's fruit fly?

- On average, they find 180 matching genes in the flies. Then they go to a computer and order up 180 fruit fly lines—each one of which is specifically bred to have the same Ras and Src mutations plus one rare variant, based on the genetic profile of the human patient's tumor.
- Eventually they whittle the number of genes down to about ten that seem to matter. Those ten genes (including the *Ras* and *Src* genes) produce a cancerous growth in the fly that most closely resembles the one in the human being. In other words, as Cagan says, "We're building personalized flies."

Can “precision ag” become agriculture’s fruit fly?

- The beauty of these highly detailed fruit fly experiments is that they allow researchers to start tackle the real-world complexity of malignant tumors rather than having to simplify everything, treating all breast cancers or all colon cancers alike and being disappointed when the results aren’t more predictable.”


Corn Nitrogen Cycling & Budget
Corn Grain Harvest (~100 lbs N/acre/year)
Corn Nitrate Use (~165 lb N/acre)
Gaseous Loss (~10 lbs N/acre/year)
Corn Residue Return (~65 lbs N/acre/year)
Fertilizer to Corn (~150 lbs N/acre/year)
N application timing
pH
Rainfall and temperature
Soil test P
Soil test K
Tillage
Microbial production of nitrate from native soil
(100-400 lbs N /acre/year)
NITRATE
Native Soil Organic Matter Nitrogen ~ 10,000 lb N/acre
Sulfur
Microbial re-uptake of nitrate
(150-350 lbs N/acre/year)
Soil texture
Drainage class
Applied K rate
Nitrate leaching to water (~30 lbs N/acre/year)

Can "precision ag" become agriculture's fruit fly?

- The answer is "yes" – that's the promise of precision ag!
- *Most fundamental change – precision ag's history is applying existing knowledge spatially vs. using spatial data to create new complex agronomic knowledge that can be used in the most site specific applications possible.*

Premier Crop's mission - *To assist growers and their trusted agronomic advisors in creating real value from their geo-referenced agronomic data by converting data to knowledge supporting improved production decisions in an economic and sustainable manner.*

Thank you

Dan Frieberg
Premier Crop Systems®