Site-Specific Nutrient Management for Onion Production: Soil Fertility and Fertilizer Usage Comparison

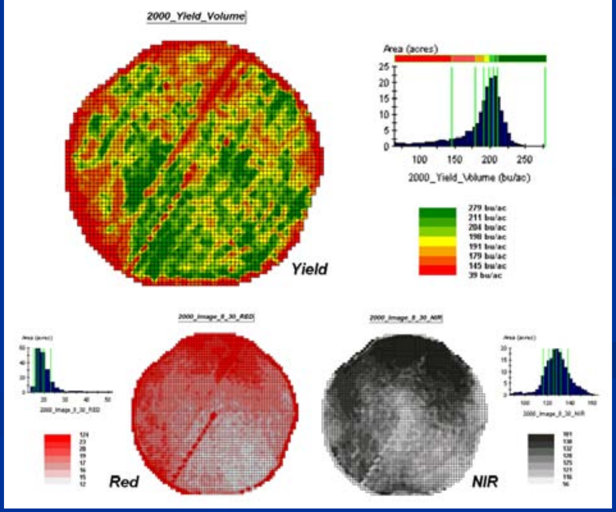
California Garlic and Onion Symposium 2010

Andre Biscaro and Steve Orloff
UC Cooperative Extension

Tulare, February 8th 2010

Site-Specific Management (SSM) - Precision Agriculture

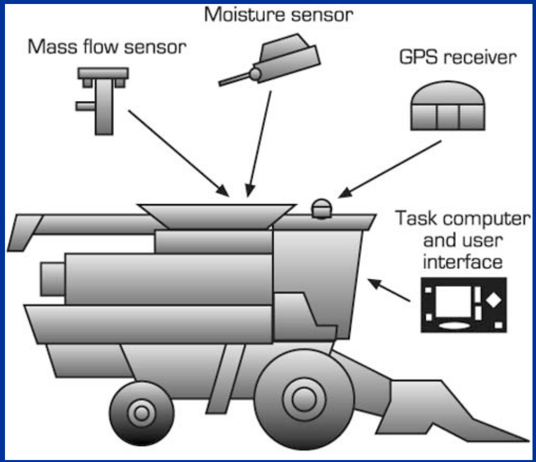
- Integration of 'spatial technology' tools to agronomic practices in order to **<u>identify and manage soil and crop variability</u>**



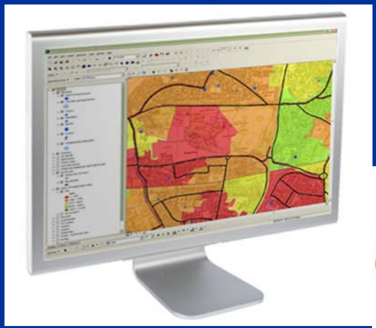
How did SSM start?

1980’s and mostly 1990’s:

Yield monitors for grain crops
- Midwest

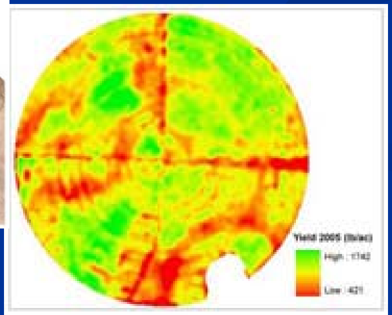


GIS development

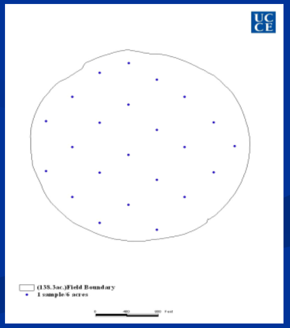


GPS open for civilian use + more accurate

Yield maps

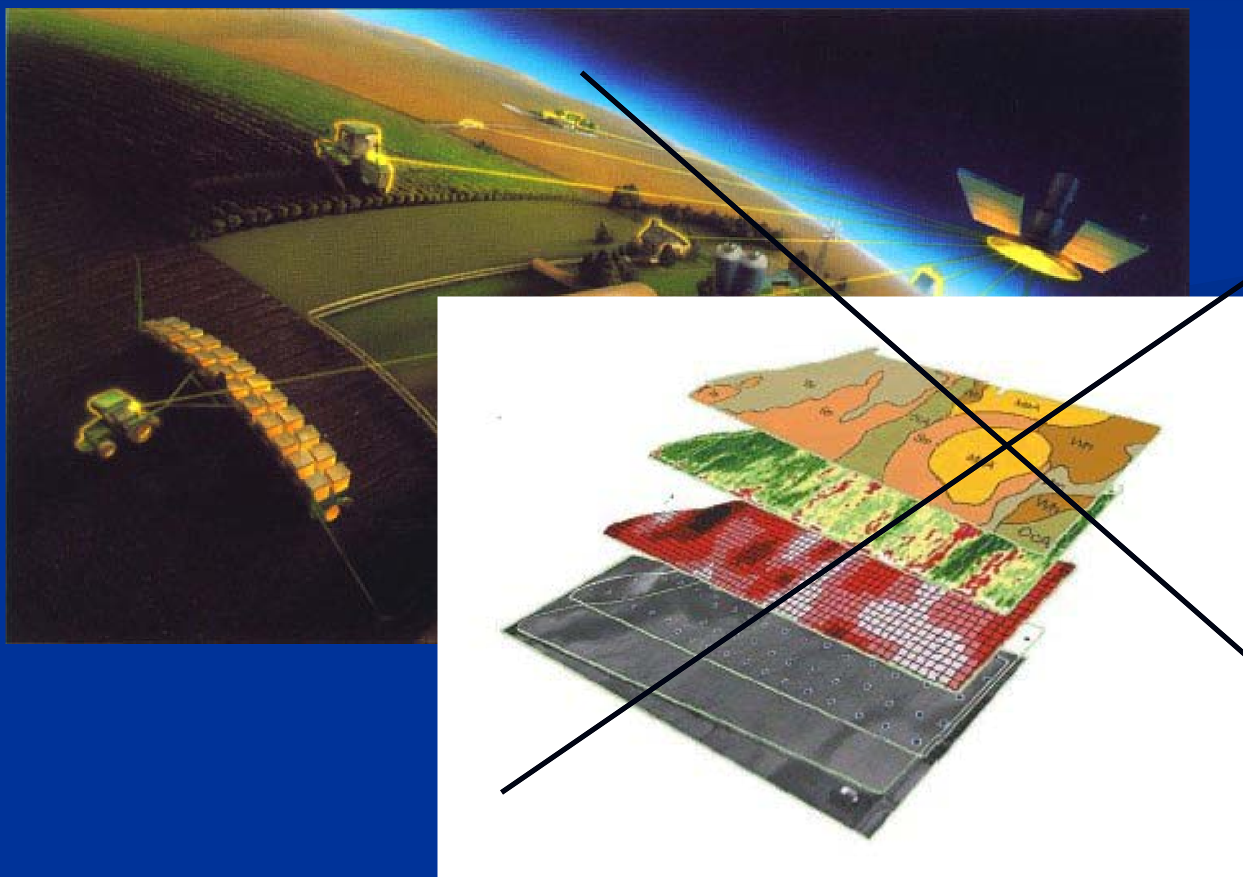


Sampling Grid



Products were launched in the Ag. market

Lack of technical support = frustration and skepticism

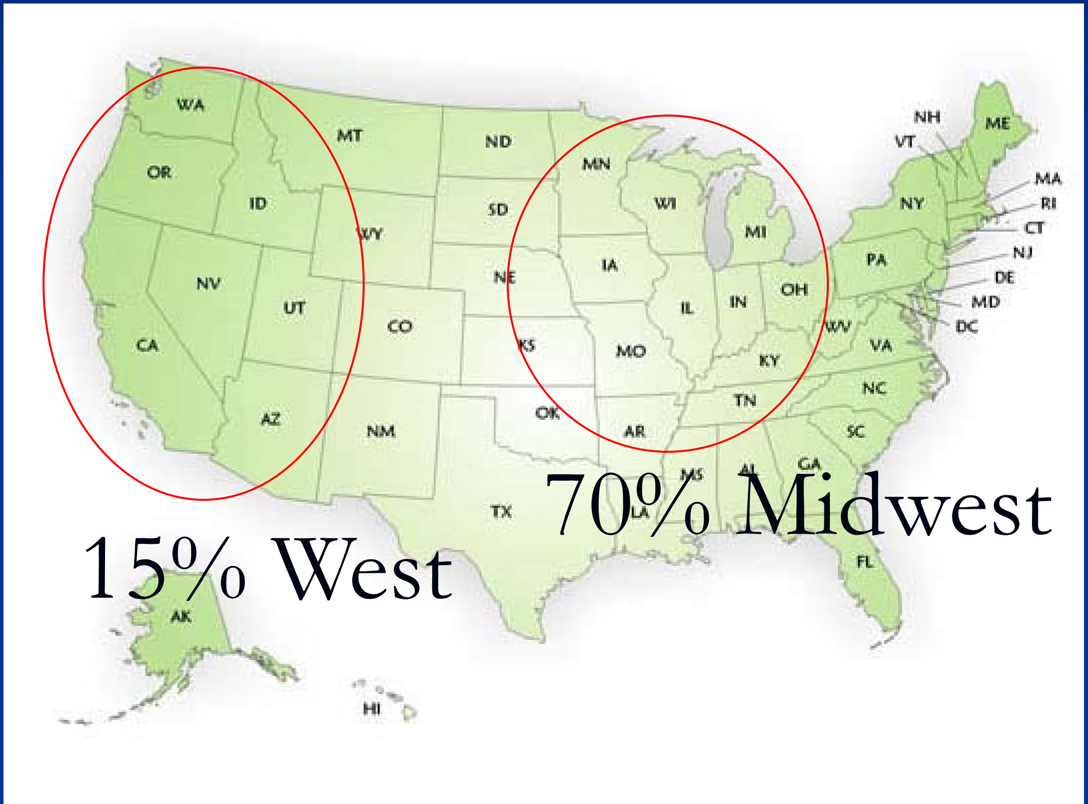


SSM Today

- Recognized by science societies and research institutes
- Education opportunities are increasing
- More options of equipment and more user friendly
- Technical support is more readily available

\- Growers should expect SSM services from <u>Crop consultants, Cooperatives and Fertilizer dealers</u>

Early adopters are today's main users:



Why?

- Where tech. developed
- Type of crops
- Farm sizes
- Support from Univ., coops and dealerships

(Whipker and Akridge, 2008)

Possible Barriers

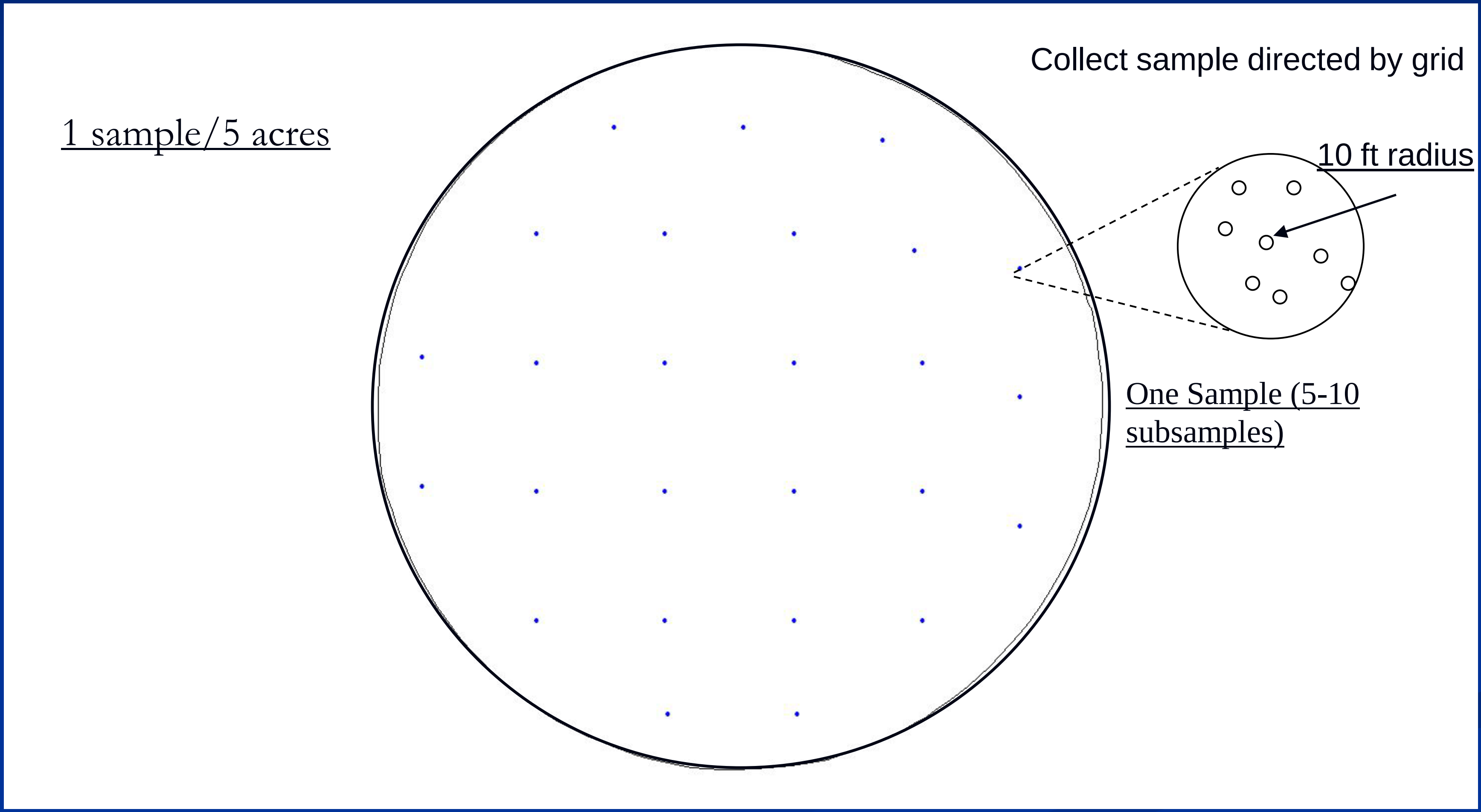
- Lack of understanding and educational programs?
- Western growers unaware of the variability that can occur in their fields?
- Perceived cost involved?

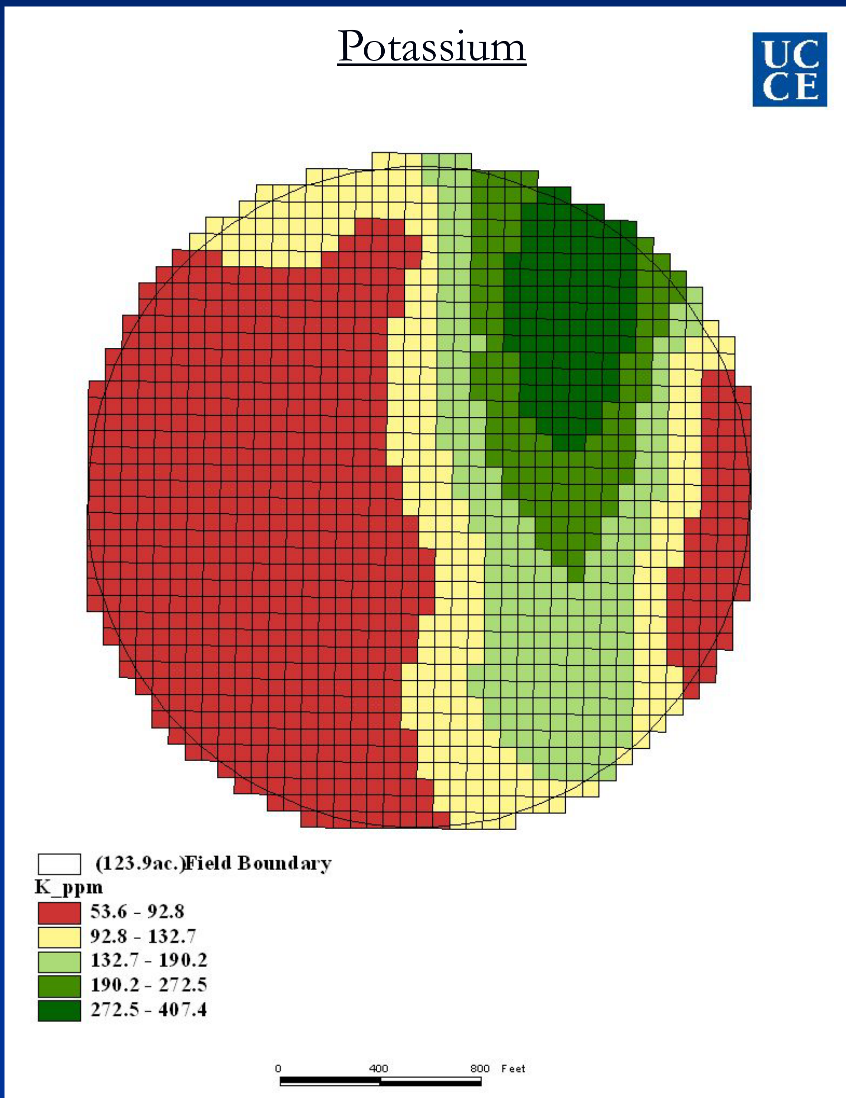
Project's scope

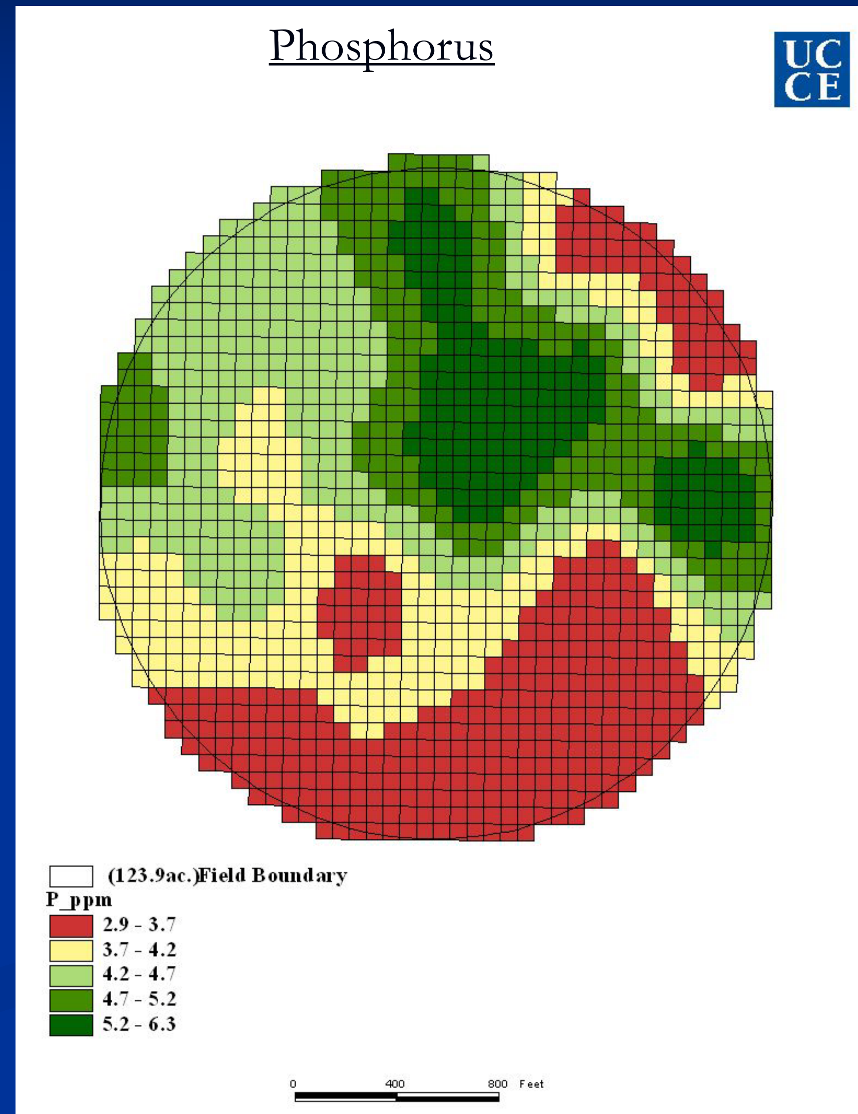
- Document the degree of variability that occurs in onion fields in the High Desert
- Explore the benefits of variable rate fertilization
- Assess the number of soil samples that need to be collected to characterize a field

- North and South Fields, Lancaster, CA
- 6 onion fields, ~400 acres
- Soil P and K
- 1 sample/5 acres

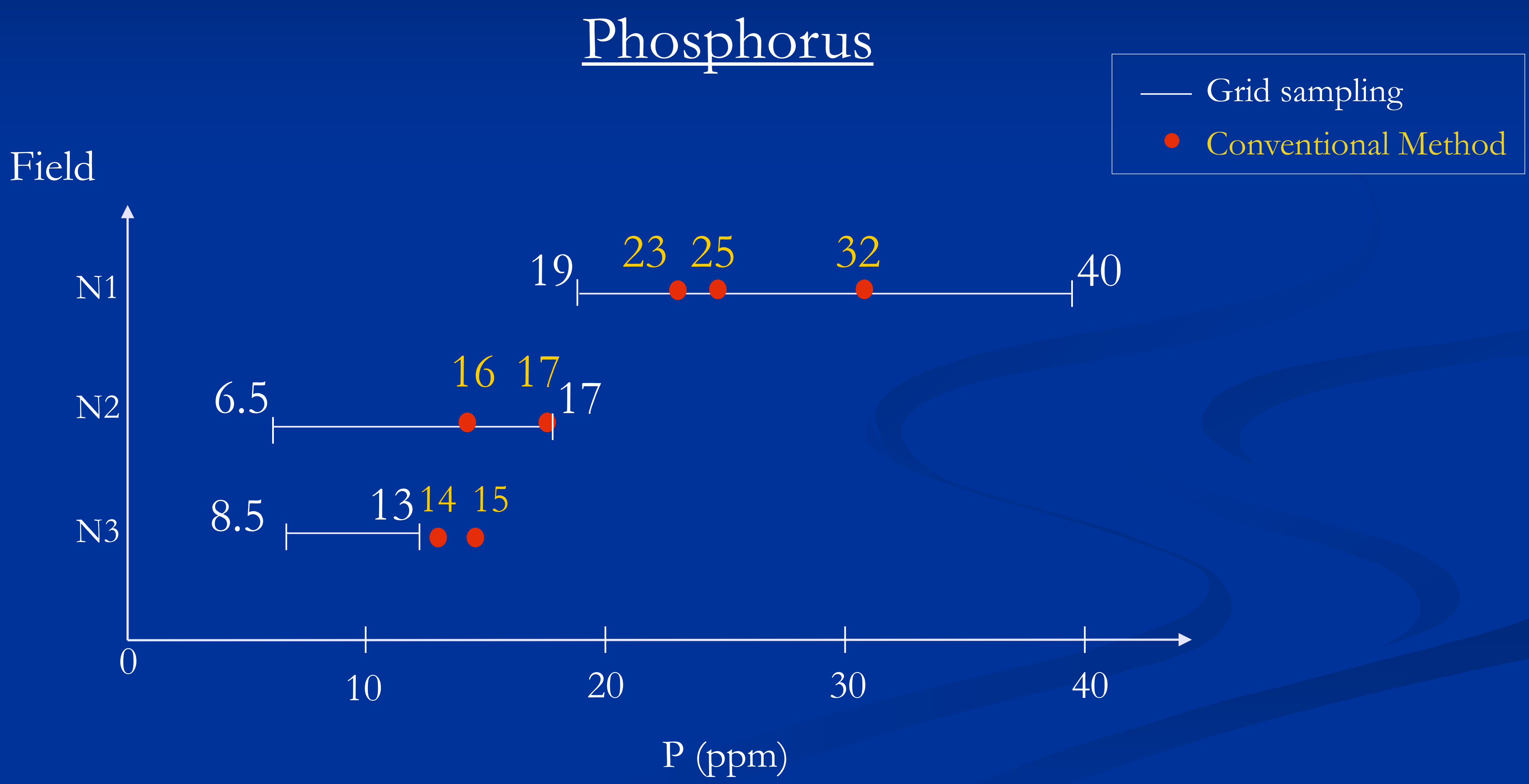
Detecting Soil P and K Variability



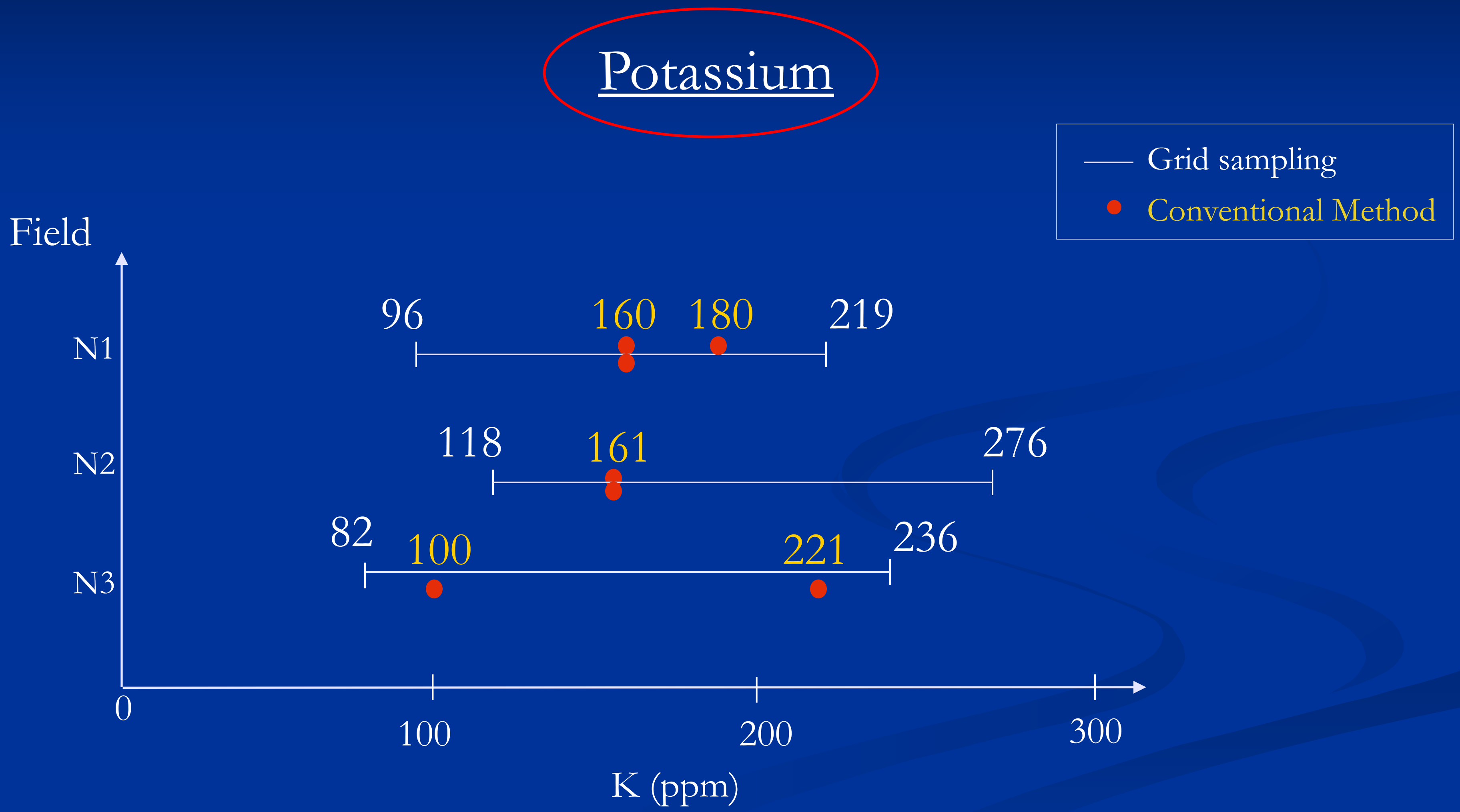

Potassium
UC CE
(123.9ac.)Field Boundary
K_ppm
53.6 - 92.8
92.8 - 132.7
132.7 - 190.2
190.2 - 272.5
272.5 - 407.4
0
400
800 Feet


Phosphorus
UC CE
(123.9ac.)Field Boundary
P_ppm
2.9 - 3.7
3.7 - 4.2
4.2 - 4.7
4.7 - 5.2
5.2 - 6.3
0
400
800 Feet

Soil Fertility Data –
North Fields

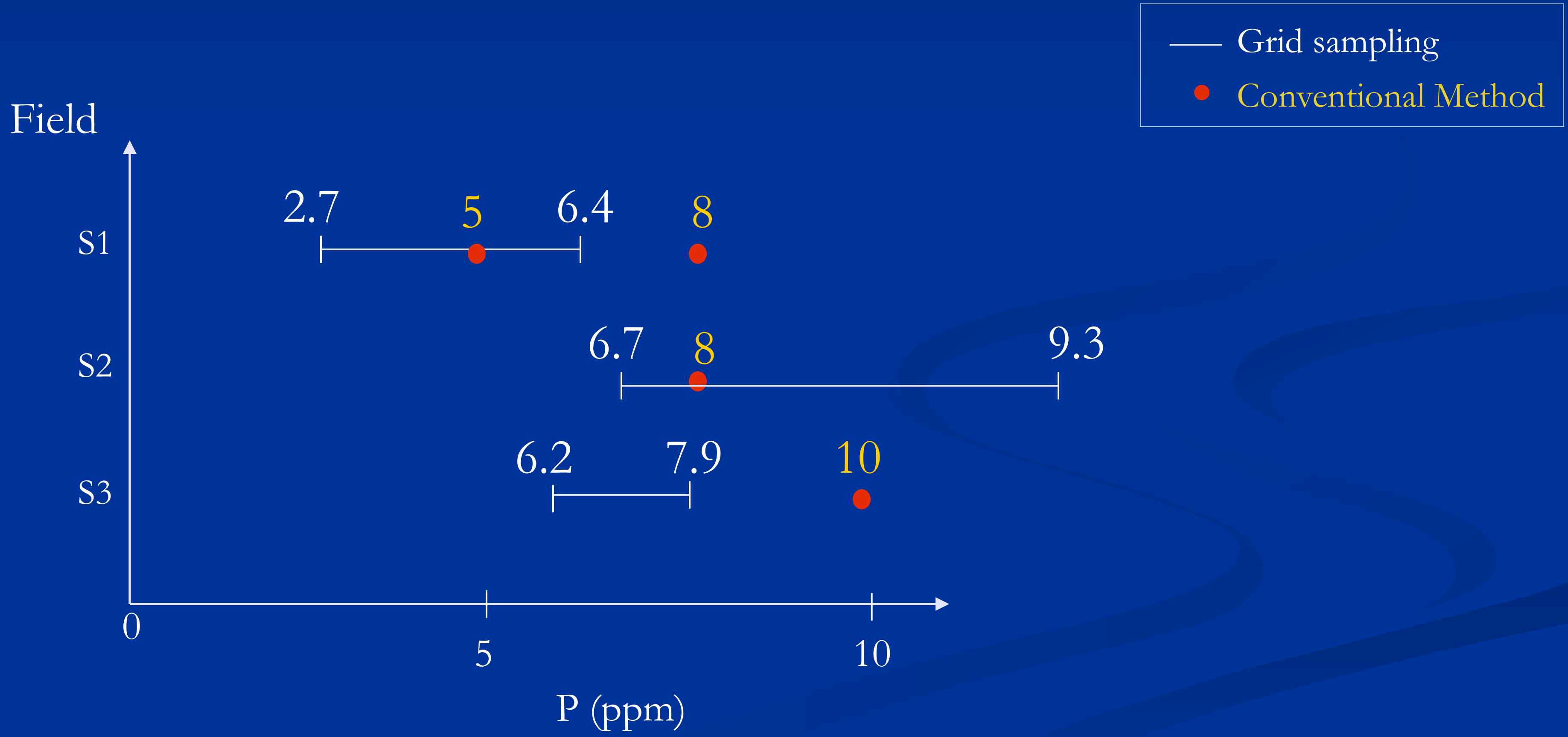


Soil Fertility Data –
North Fields

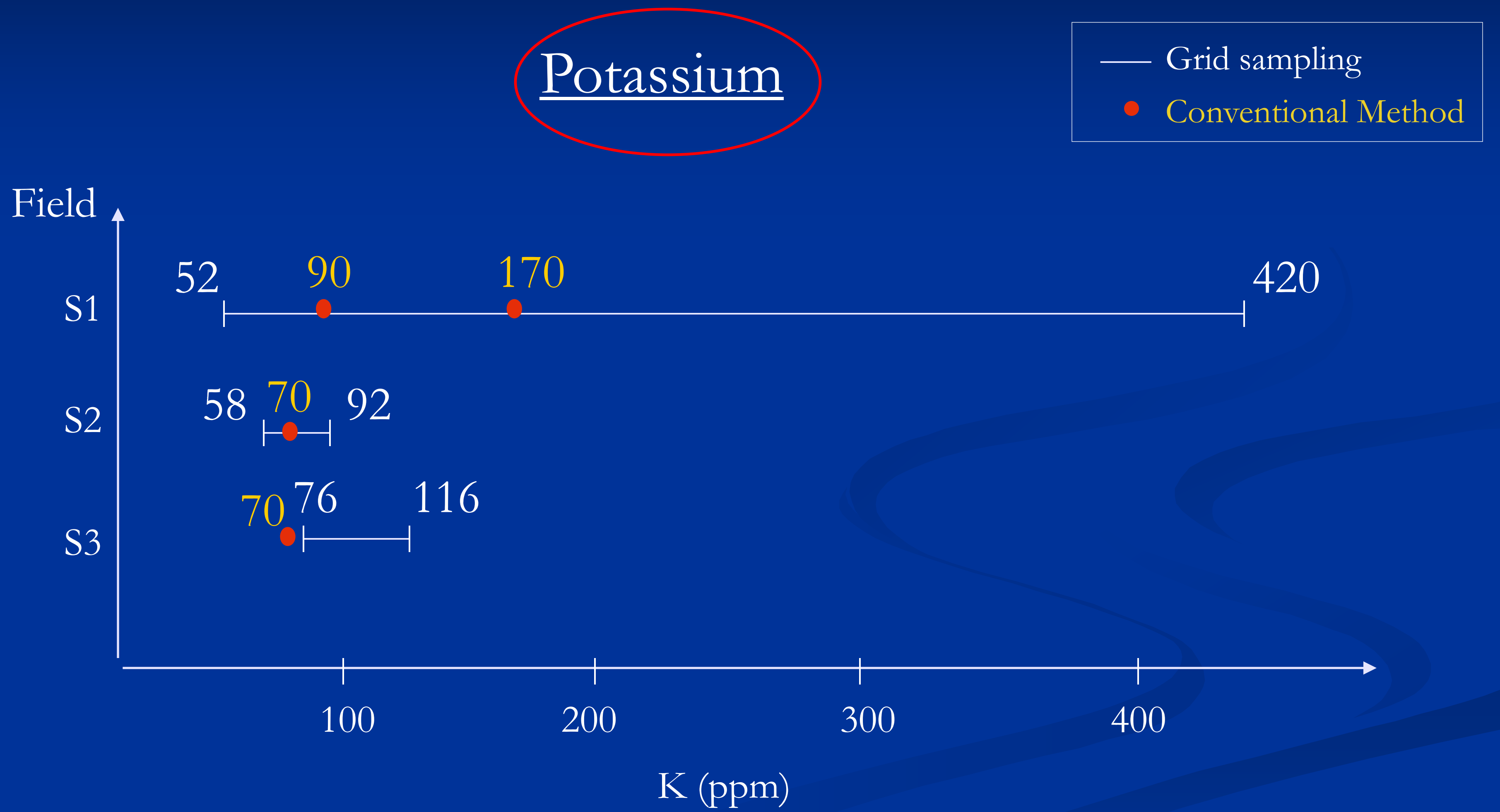


Soil Fertility Data – South Fields

Phosphorus



Soil Fertility Data –
South Fields



Phosphate Fertilization Method

$$\{[300 - (P\_ppm*4.6)] * 1.92\}*0.66$$

where:

- 300 = goal of P2O5 in the soil (ppm);
- P_ppm = amount of soil P (ppm) assessed through chemical analysis;
- 4.6 = 2.3 * 2, where 2.3 was used to convert P to P2O5, and 2 was used to convert ppm to lbs of P2O5 per acre;
- 1.92 = the proportion between lbs of P2O5 and lbs of 11-52-0 (fertilizer used);
- 0.66 = since the fertilizer was banded, only the area of the beds was considered.

Potash Fertilization Method

{[117 – (K_ppm * 2.4) + 100] * 2} * 0.66

where:

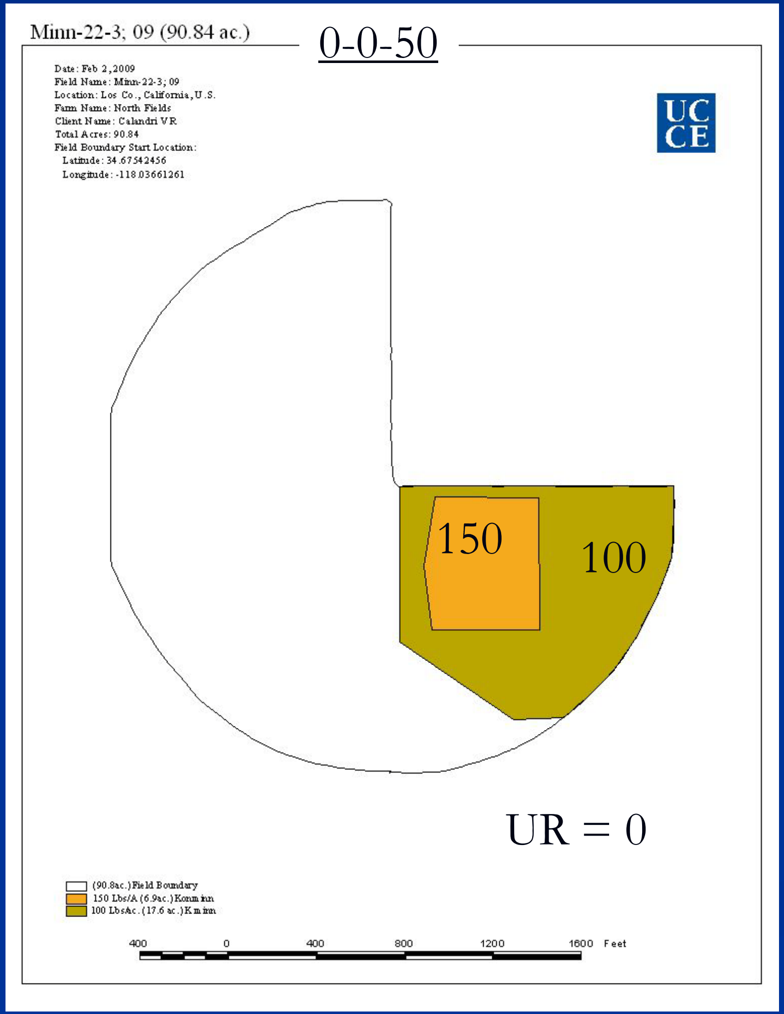
- 117 = goal of K_2O in the soil (ppm);
- K_ppm = amount of soil K (ppm) assessed through chemical analysis;
- 2.4 = 1.2 * 2, where 1.2 was used to convert K to K_2O, and 2 was used to convert ppm to lbs of K_2O per acre,
- 100 = accounts for an addition of 100 extra units of K_2O
- 2 = the proportion between lbs of K_2O and lbs of 0-0-50 (fertilizer used);
- 0.66 = banded fertilizer

*CEC = 6meq/100g

Recommendation Maps

<u>$1,468 More with VR</u>

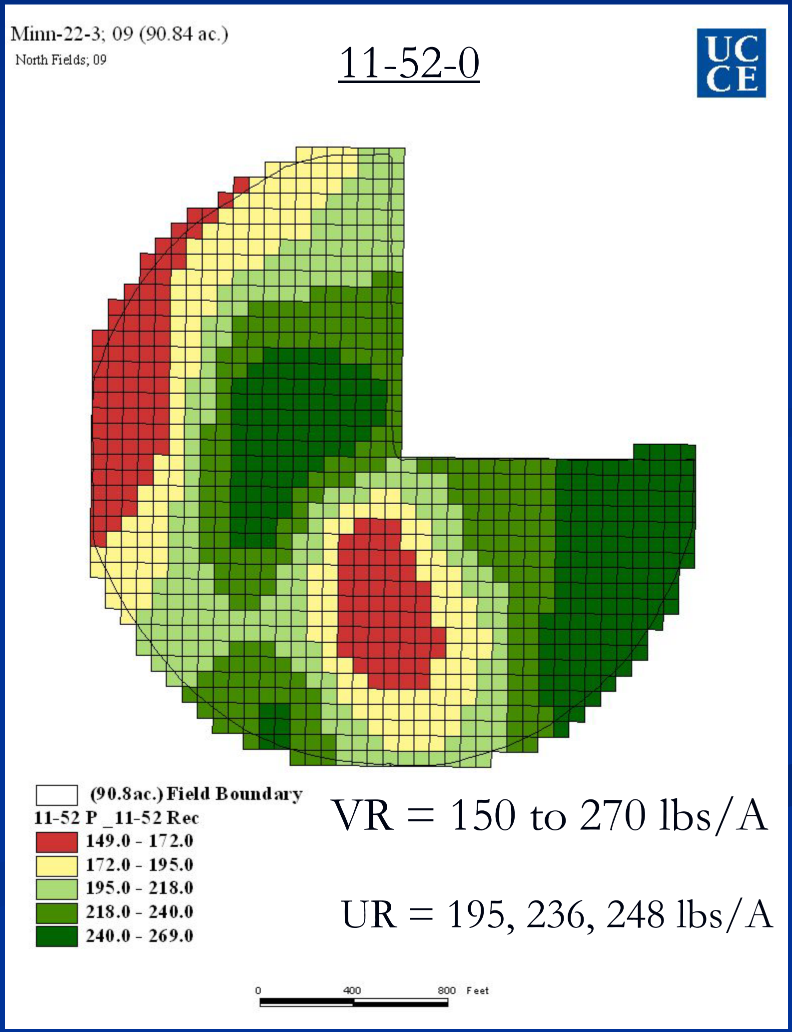
- Avoid under-fertilize 25 acres by 100 to 150lbs/A



<u>$320 Savings with VR</u>

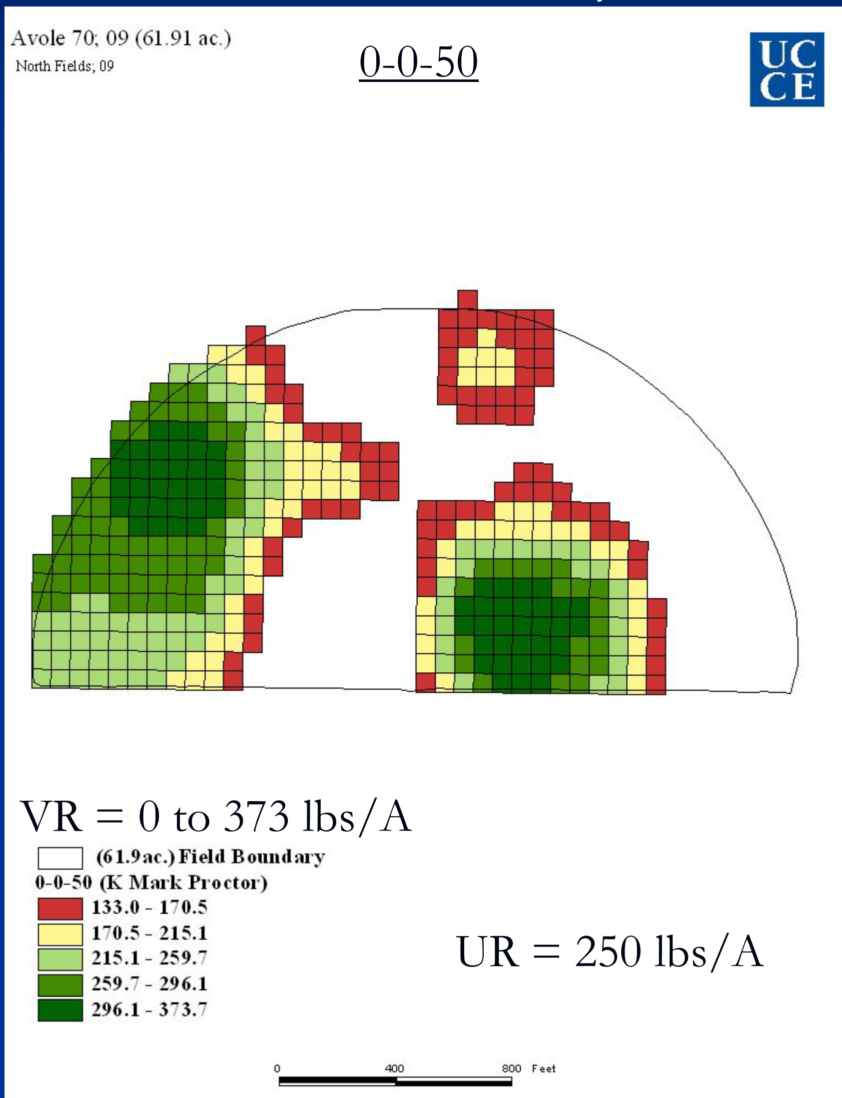
- <u>Avoid over-fertilize 31 acres by 50 lbs/A</u>

* <u>Great fertilizer relocation</u>



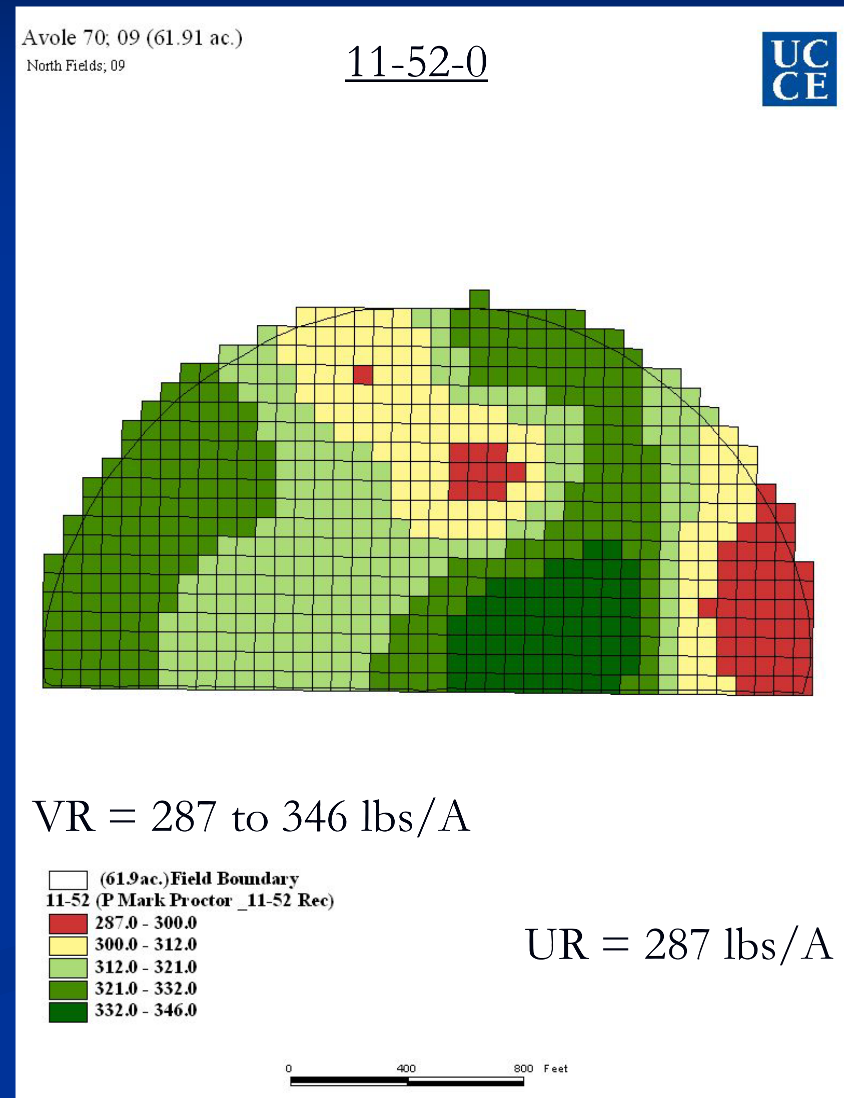
$4,000 Savings with VR

- Avoid over-fertilize 37 acres by 250 lbs/A
- Avoid under-fertilize 21 acres by 50 to 130 lbs/A



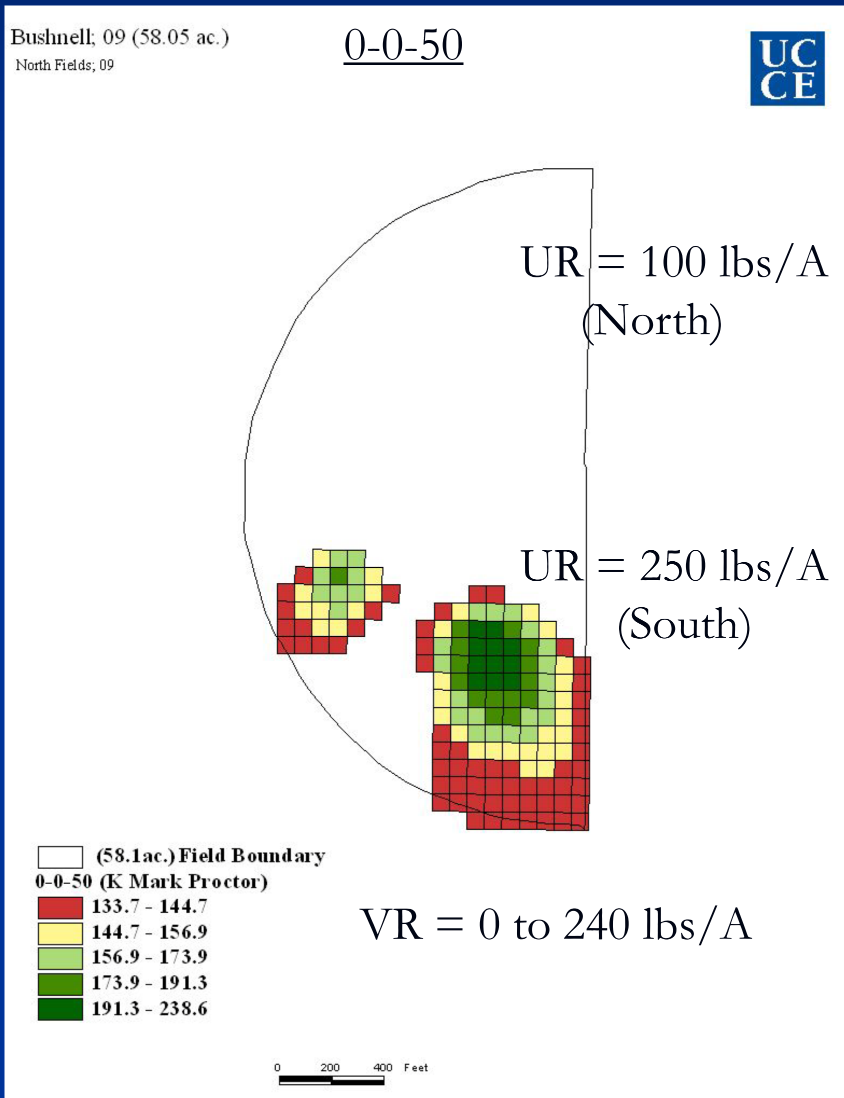
$635 More with VR

- Avoid under-fertilize 50 acres by 25 to 50 lbs/A



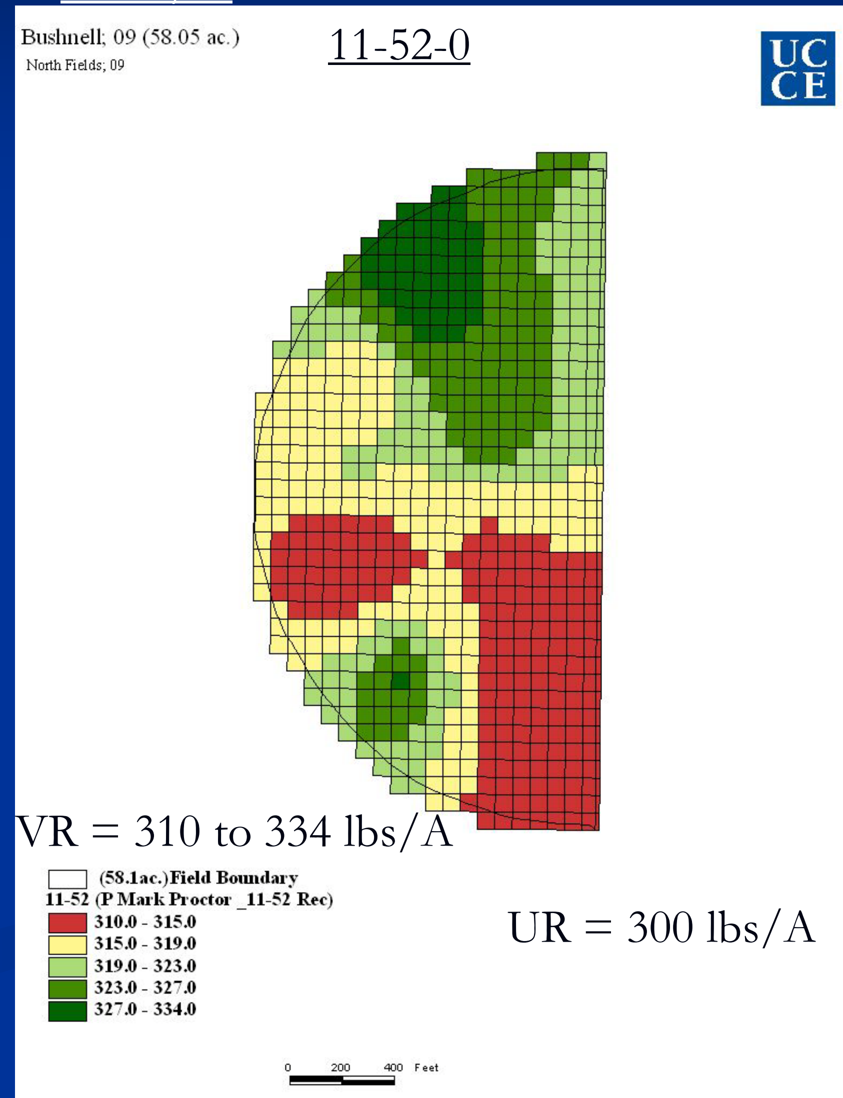
$2,765 Savings with VR

- Avoid over-fertilize 55 acres by 50 to 120lbs/A



$415 More with VR

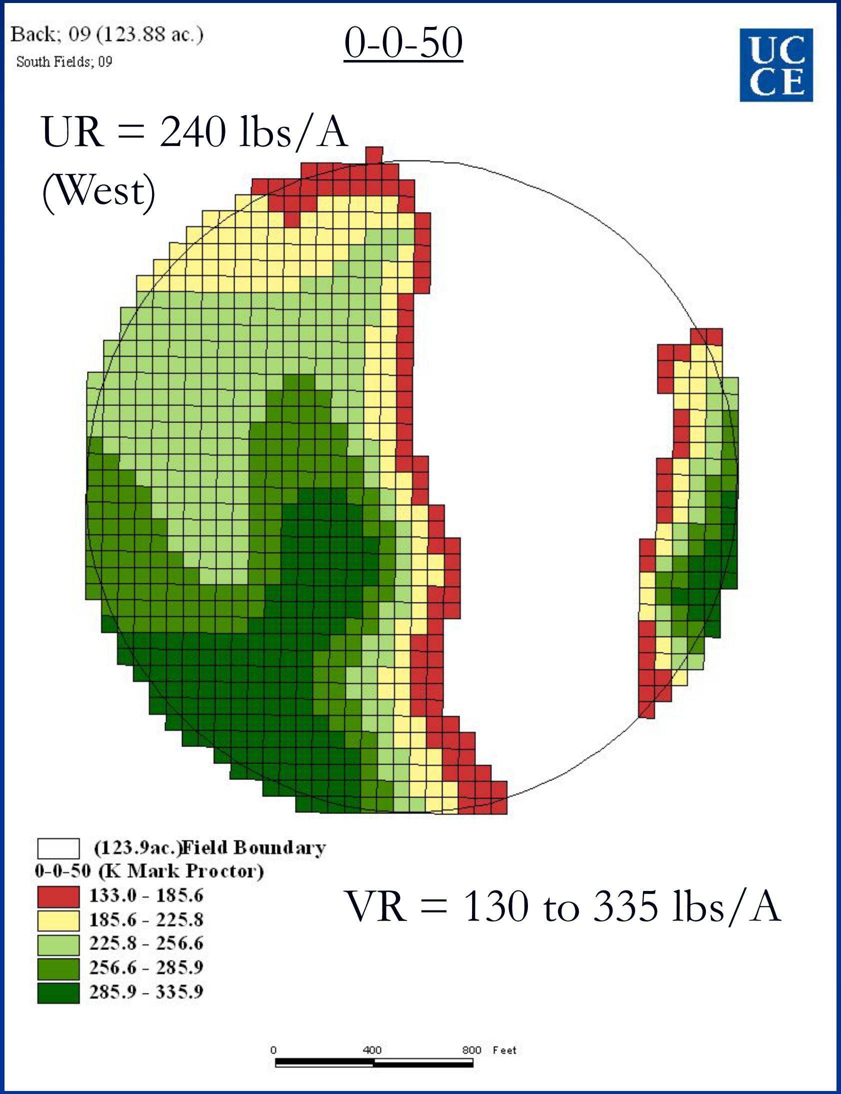
- Avoid under-fertilize 58 acres by 30lbs/A

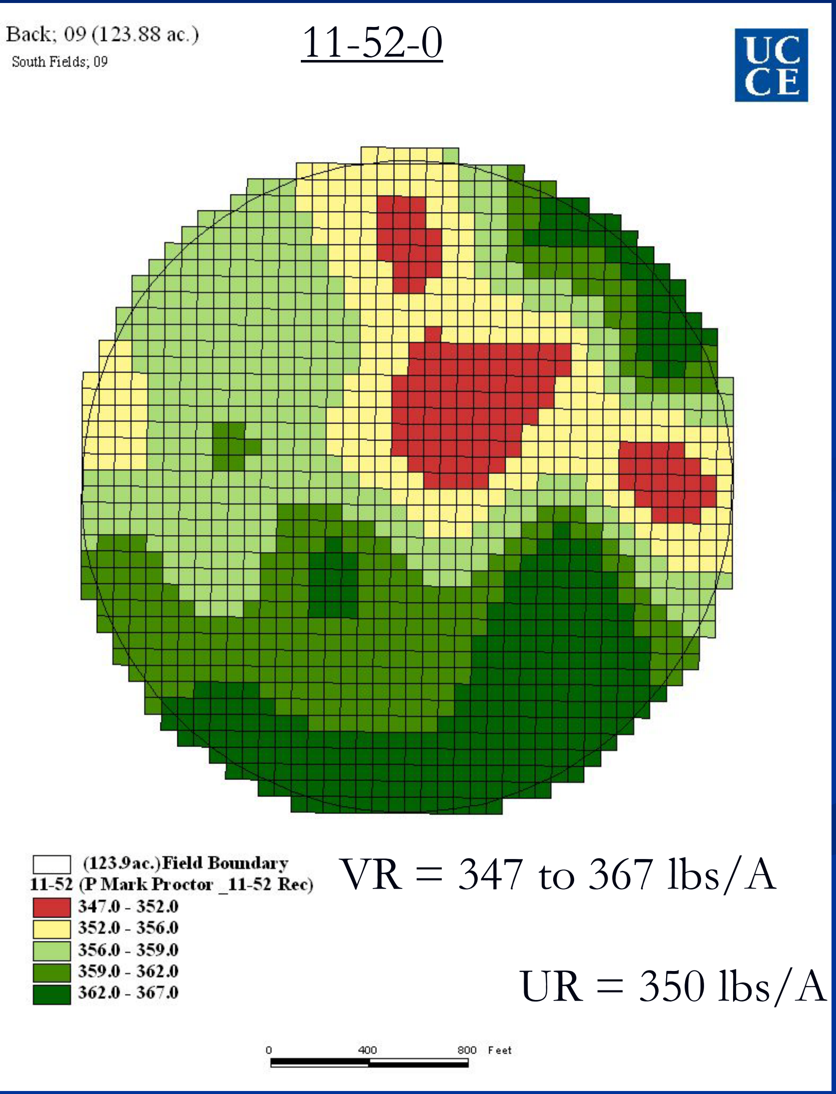


$2,275 More with VR

$300 More with VR

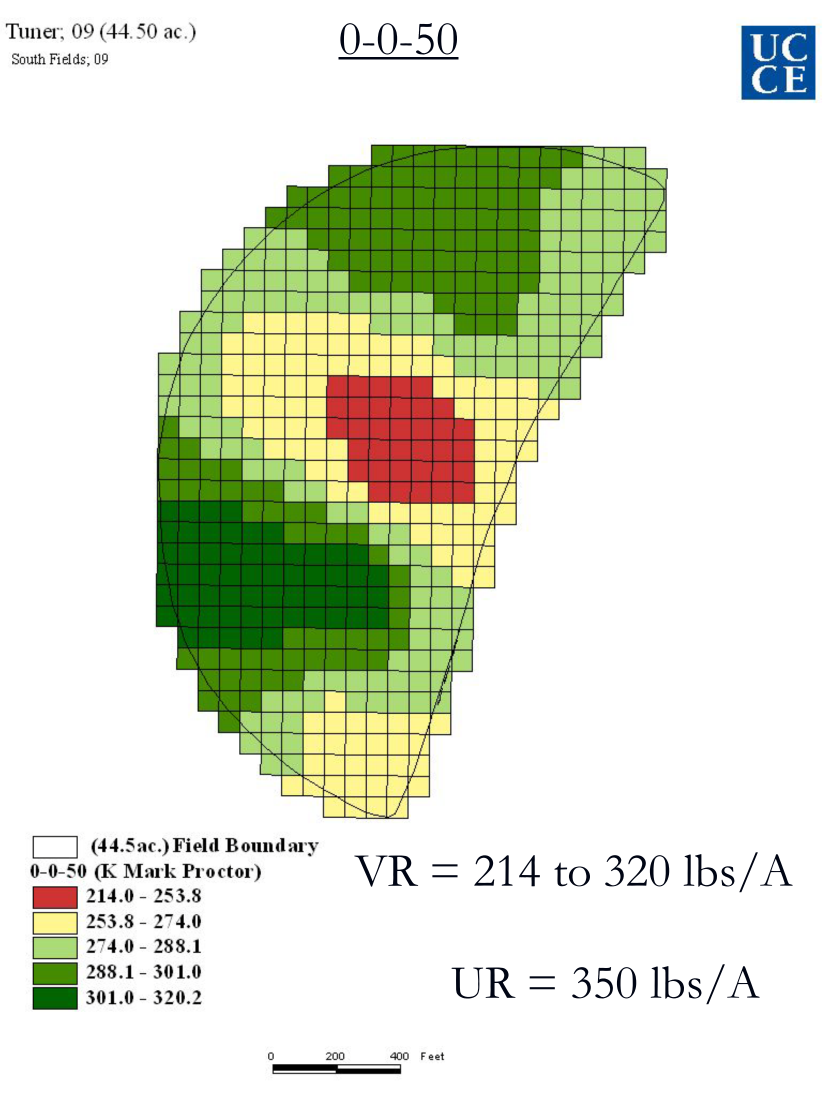
- Avoid under-fertilize 30 acres by 30 to 100 lbs/A
- Avoid over-fertilize 25 acres by 20 to 100 lbs/A





$362 Savings with VR

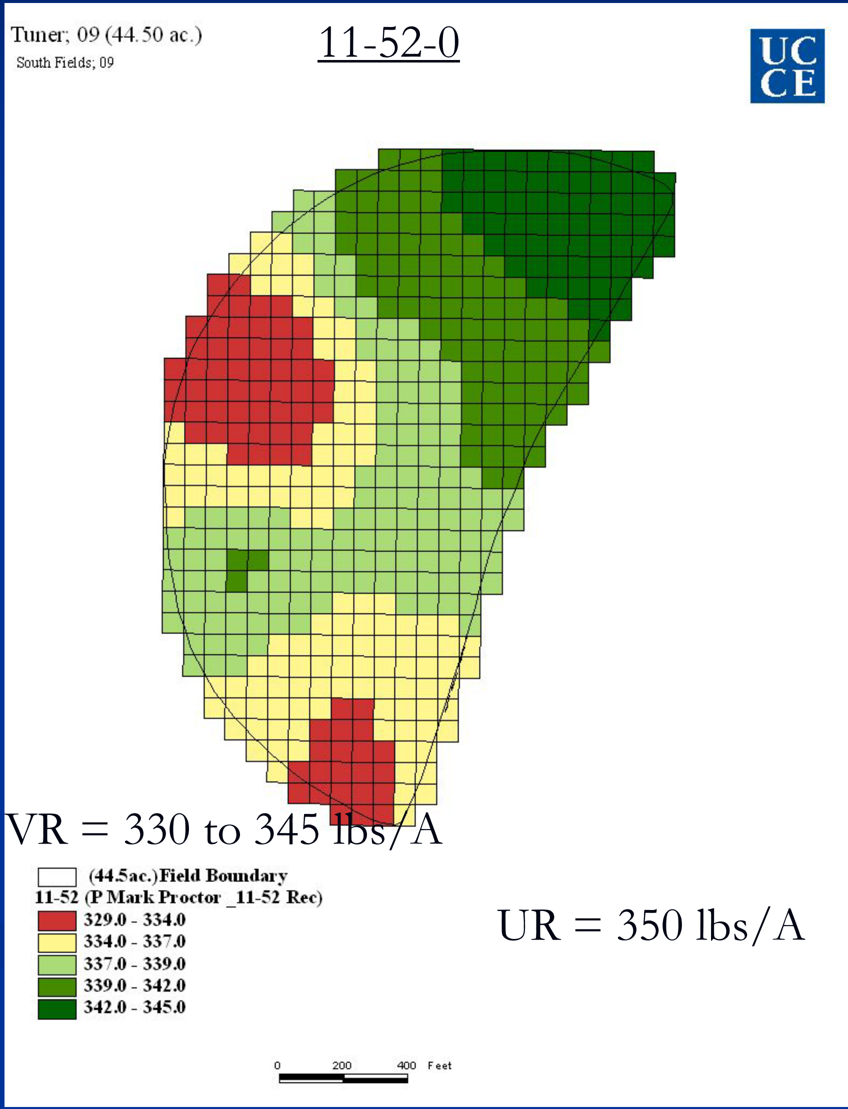
- Avoid over-fertilize 44 acres by 30 to 135 lbs/A



VR = 214 to 320 lbs/A

UR = 350 lbs/A

$90 Savings with VR

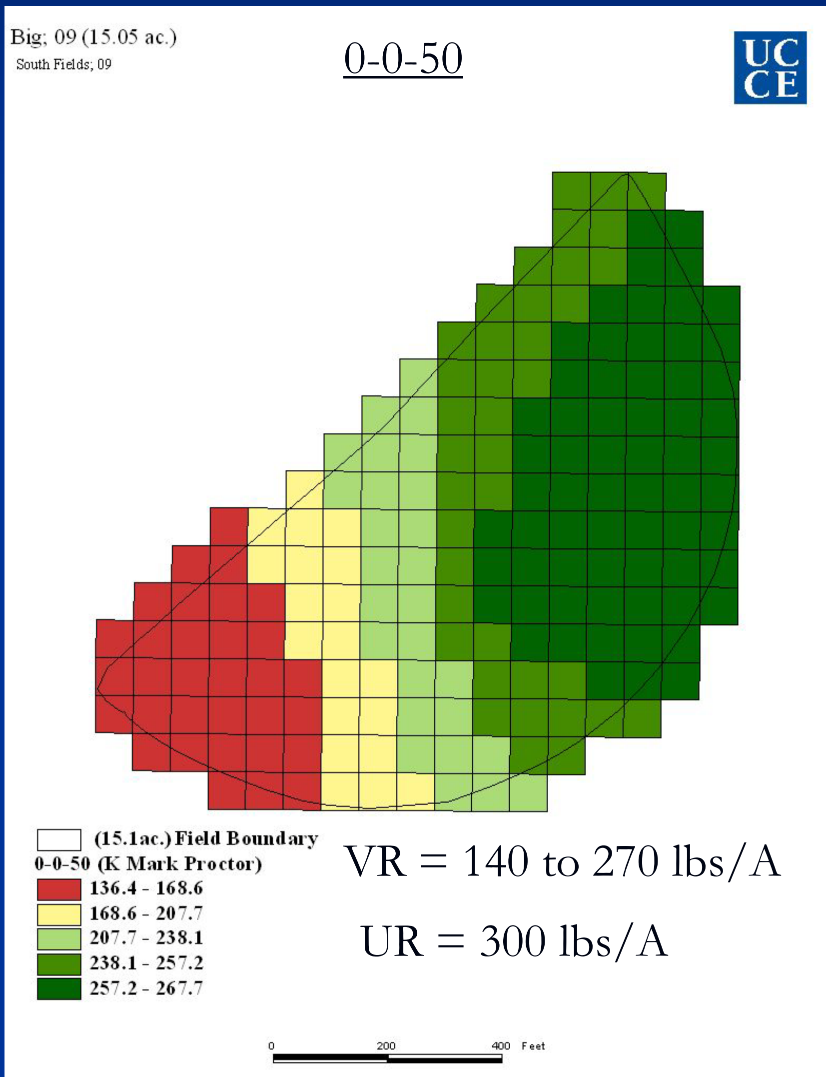


VR = 330 to 345 lbs/A

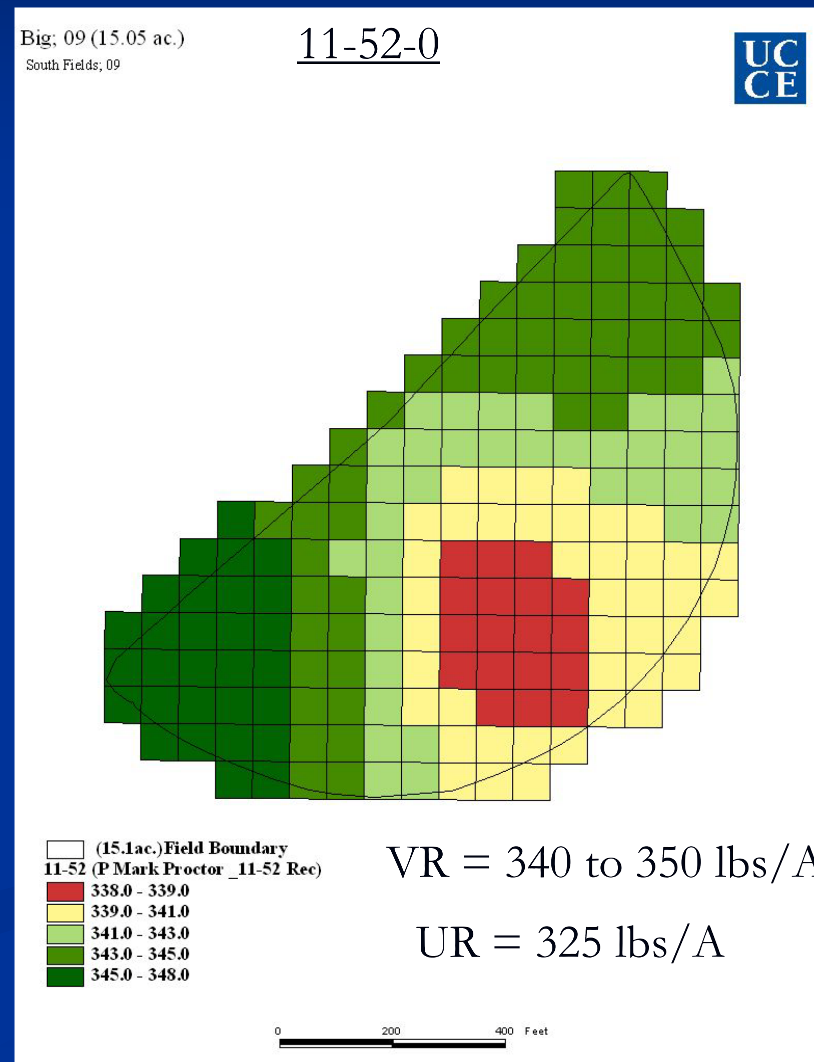
UR = 350 lbs/A

$600 Savings with VR

- Avoid over-fertilize 15 acres by 30 to 160 lbs/A



$60 More with VR



Fertilizer Cost Summary

North Fields

		Application Method		
Fertilizer Type	*Field (acres)*	**Uniform Rate (UR)**	**Variable Rate (VR)**	
		(U$)		
Potash [†]	N1 (90.8)	0	1,468	
Potash	N2 (61.9)	8,525	4,526	*Potash*
Potash	N3 (58.1)	3,195	430	*Difference*
	Subtotal	*11,720*	*6,424*	***5,296***
Phosphate [††]	N1 (90.8)	5,500	5,180	
Phosphate	N2 (61.9)	4,781	5,415	Phosphate
Phosphate	N3 (58.1)	4,706	5,121	*Difference*
	Subtotal	*14,987*	*15,716*	***-729***
			Total Difference	***4,567***

[†] Potash = 0-0-50 (U$0.55/Lb)

[††] Phosphate = 11-52-0 (U$0.27/Lb)

[†††] Difference = UR minus VR

Fertilizer Savings with VR

South Fields

Fertilizer Type	Field (acres)	Application Method: Uniform Rate (UR)	Application Method: Variable Rate (VR)	
		(U$)		
Potash	S1 (124)	8,184	10,459	
Potash	S2 (44.5)	7,342	6,980	*Potash*
Potash	S3 (15.1)	2,491	1,885	*Difference*
	Subtotal	*18,017*	*19,324*	***-1,307***
Phosphate	S1 (124)	11,718	12,019	
Phosphate	S2 (44.5)	4,205	4,112	Phosphate
Phosphate	S3 (15.1)	1,325	1,385	*Difference*
	Subtotal	*17,248*	*17,516*	***-268***
			Total Difference	***-1,575***

More Fertilizer with VR

†Potash = 0-0-50 (U$0.55/Lb)

††Phosphate = 11-52-0 (U$0.27/Lb)

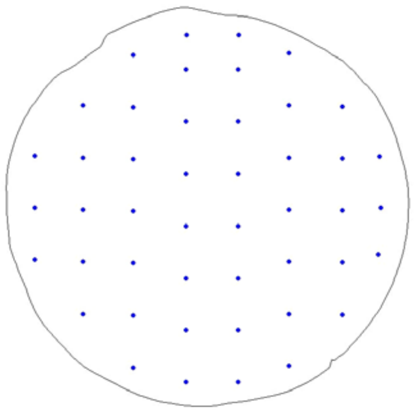
††† Difference = UR minus VR

Improve farm management:

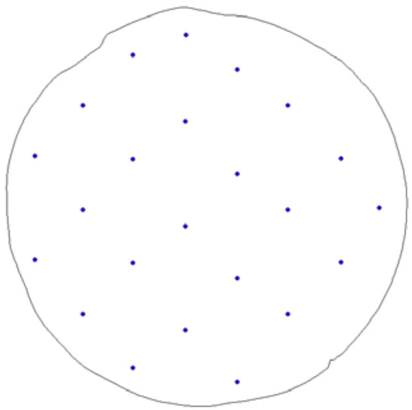
- Agronomical perspective:
  - Yield increases in portions of the fields by avoiding under-fertilization and improving crop nutritional status
  - Better quality: reducing or eliminating over-fertilization

- Economical perspective:
  - Potential fertilizer savings by avoiding over-fertilization = $4,600 saved on 3 onion fields (North Region)

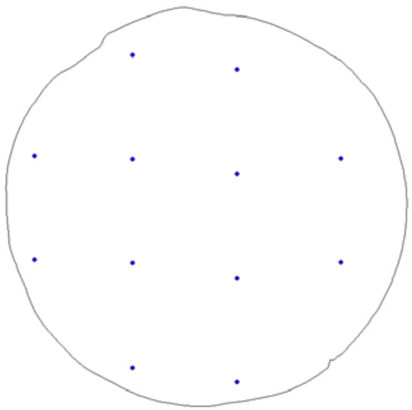
Sampling Density Comparison



1 sample/3 acres

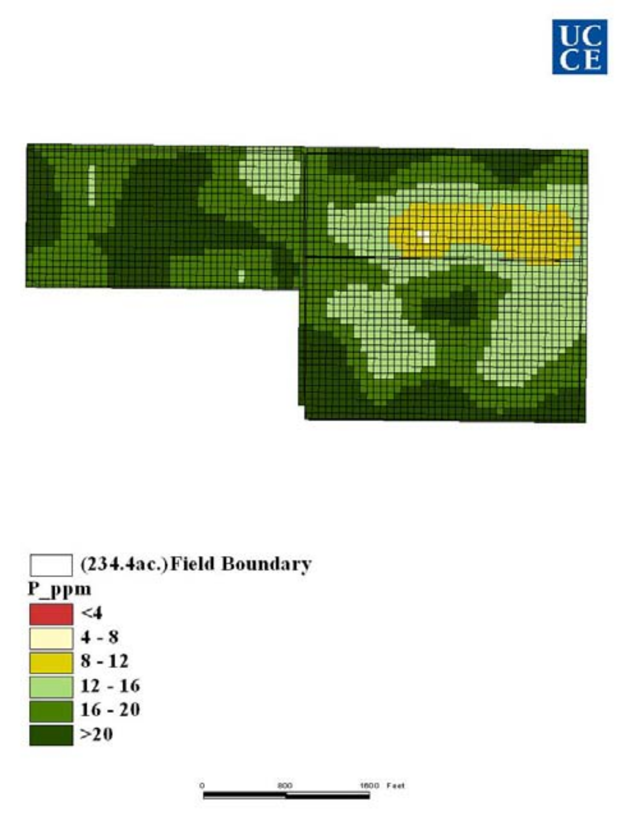


1 sample/6 acres

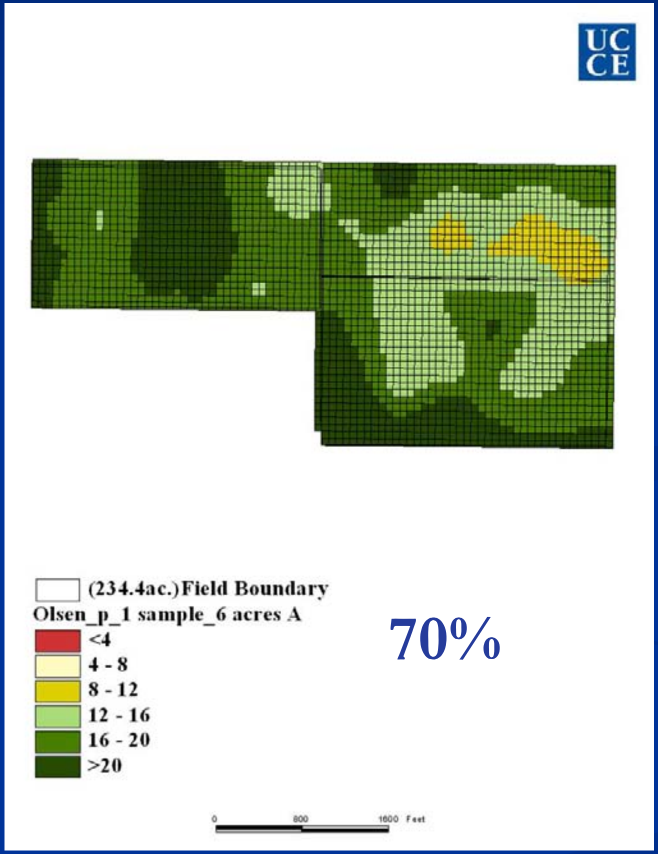


1 sample/12 acres

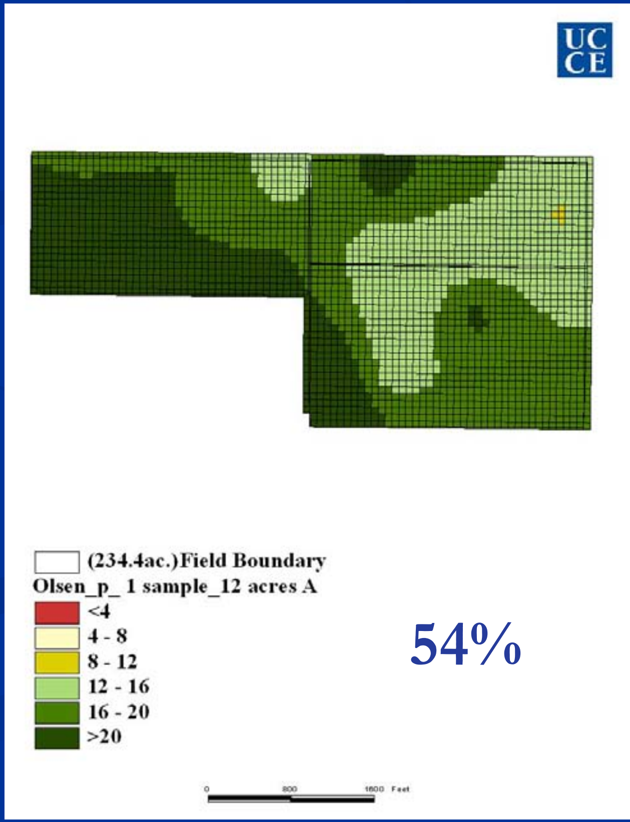
1 sample/3 acres



1 sample/6 acres

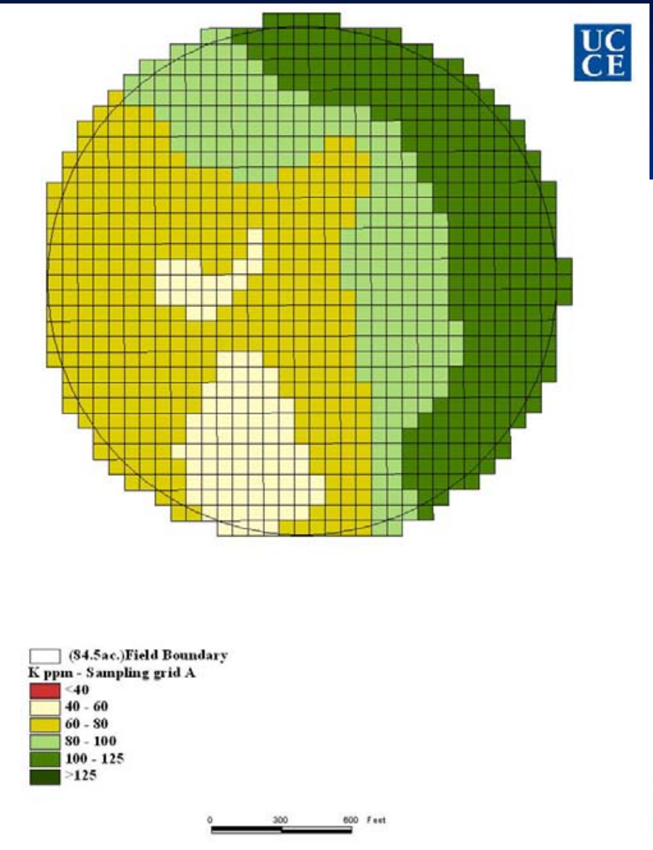


1 sample/12 acres

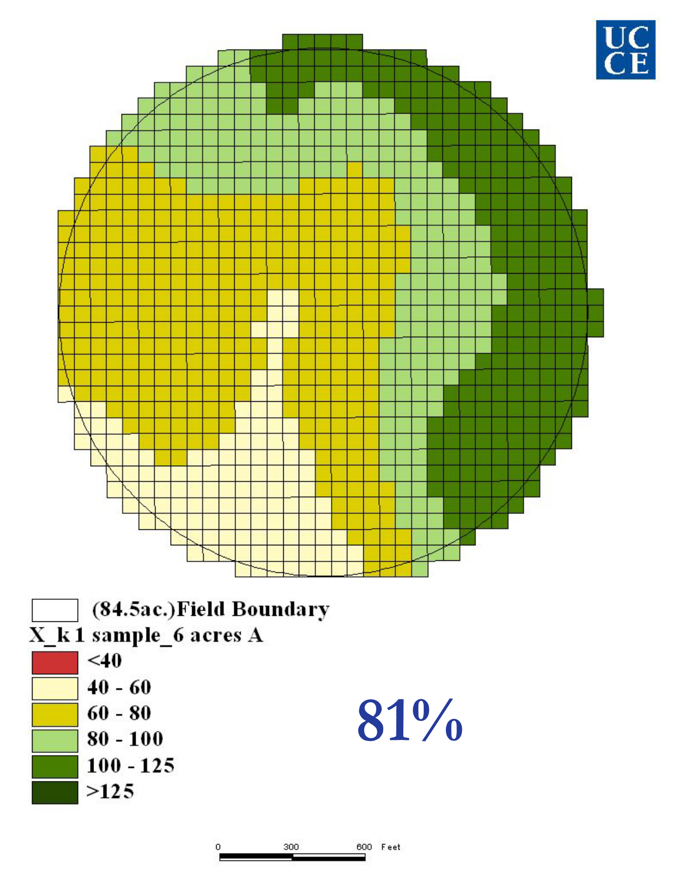


Obs: Alfalfa field (234 acres), High Desert, CA

1 sample/3 acres

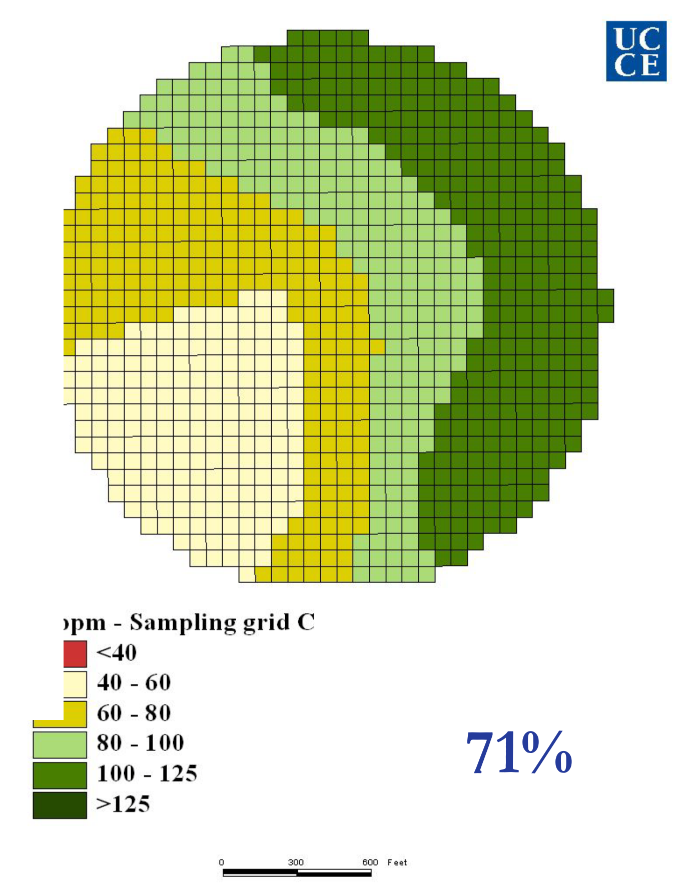


1 sample/6 acres



81%

1 sample/12 acres



71%

Obs: Alfalfa field (85 acres), Intermountain Region, CA

Soil Analysis Costs

1 sample/5 acres

- $11/analysis (P, K, pH, CEC, Ca, Mg, S)

Obs: Approx. 7 min/sample

- North fields: 211 acres = 42 samples = $462 (soil analysis); fertilizer savings = $4,600
- South fields: 183 acres = 36 samples = $396 (soil analysis); fertilizer savings = - $1,575
- Overall (400 acres): $858 analysis and $3,000 fertilizer savings (in addition to possible yield increases)

✓ Next sampling: direct only a few samples inside of each fertility zone

Conclusions

- The onion fields assessed on this study presented significant soil P and K variability
- Whether or not VR application results in an actual fertilizer savings is secondary, and depends on whether conventional sampling (UR) generally over or underestimates the fertility level

Conclusions

- The important point is that with grid sampling the VR fertilizer application better matches the actual fertility needs of the field

- Sampling every 6 acres was sufficient to characterize soil P and K spatial variability for the majority of the fields of this study

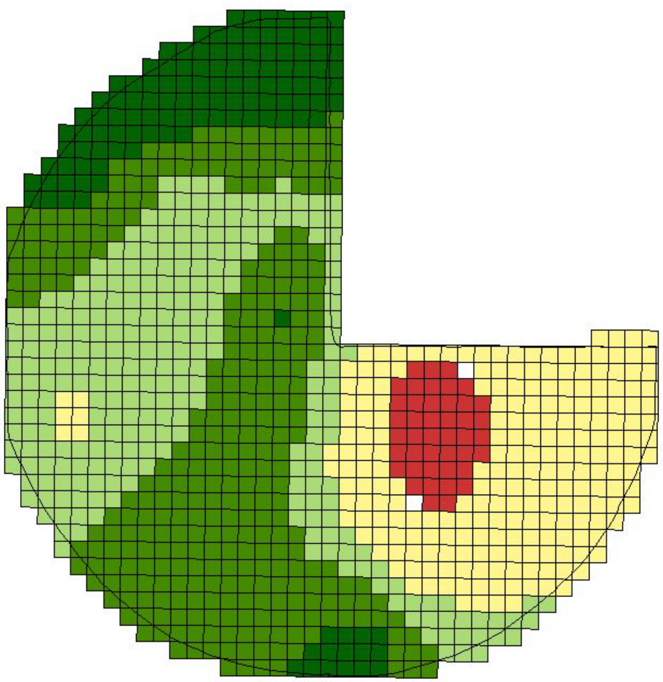
Questions/Comments?

Thank you!

Fertility Maps

91 acres

Potassium



(90.8ac.) Field Boundary

K_ppm

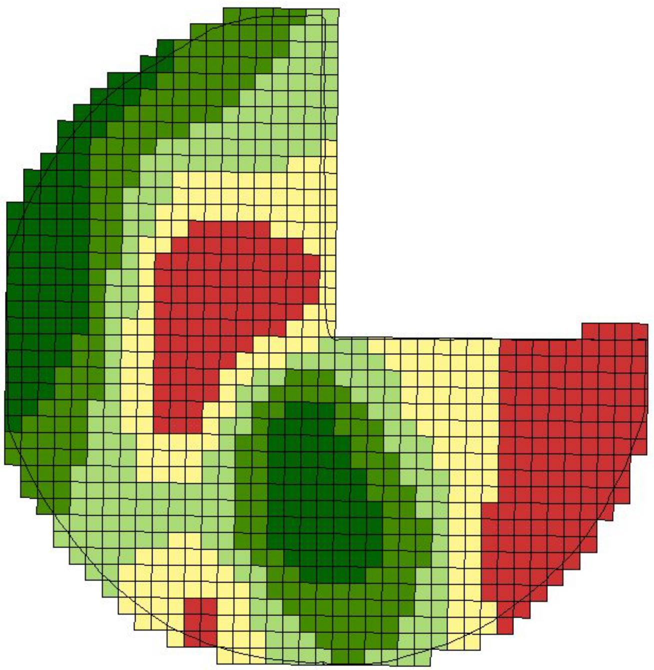
- 101.4 - 126
- 126.7 - 164.5
- 164.5 - 181.9
- 181.9 - 200.2
- 200.2 - 219.0

GS: 100 to 219ppm

CS: 160, 180, 180 ppm

0 400 800 Feet

Phosphorus



(90.8ac.) Field Boundary

P_ppm

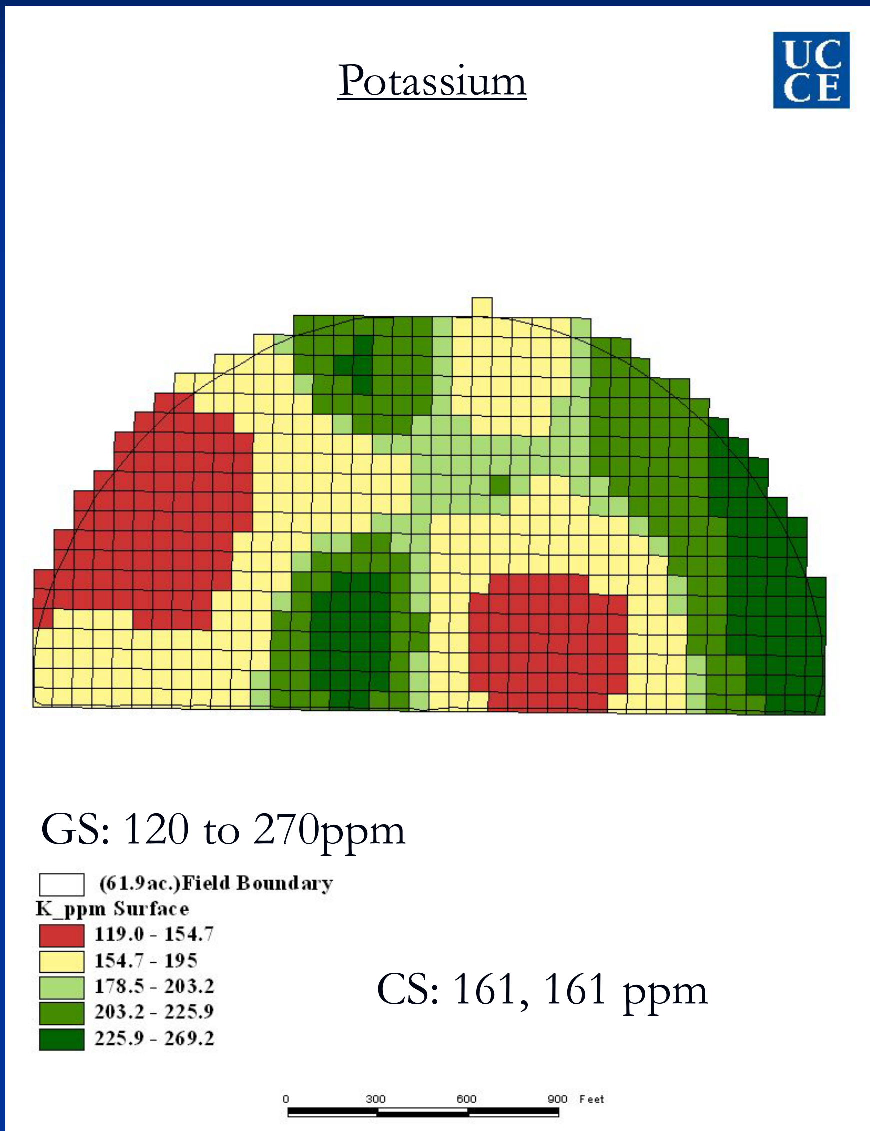
- 19.6 - 24.3
- 24.3 - 27.9
- 27.9 - 31.7
- 31.7 - 35.7
- 35.7 - 40.0

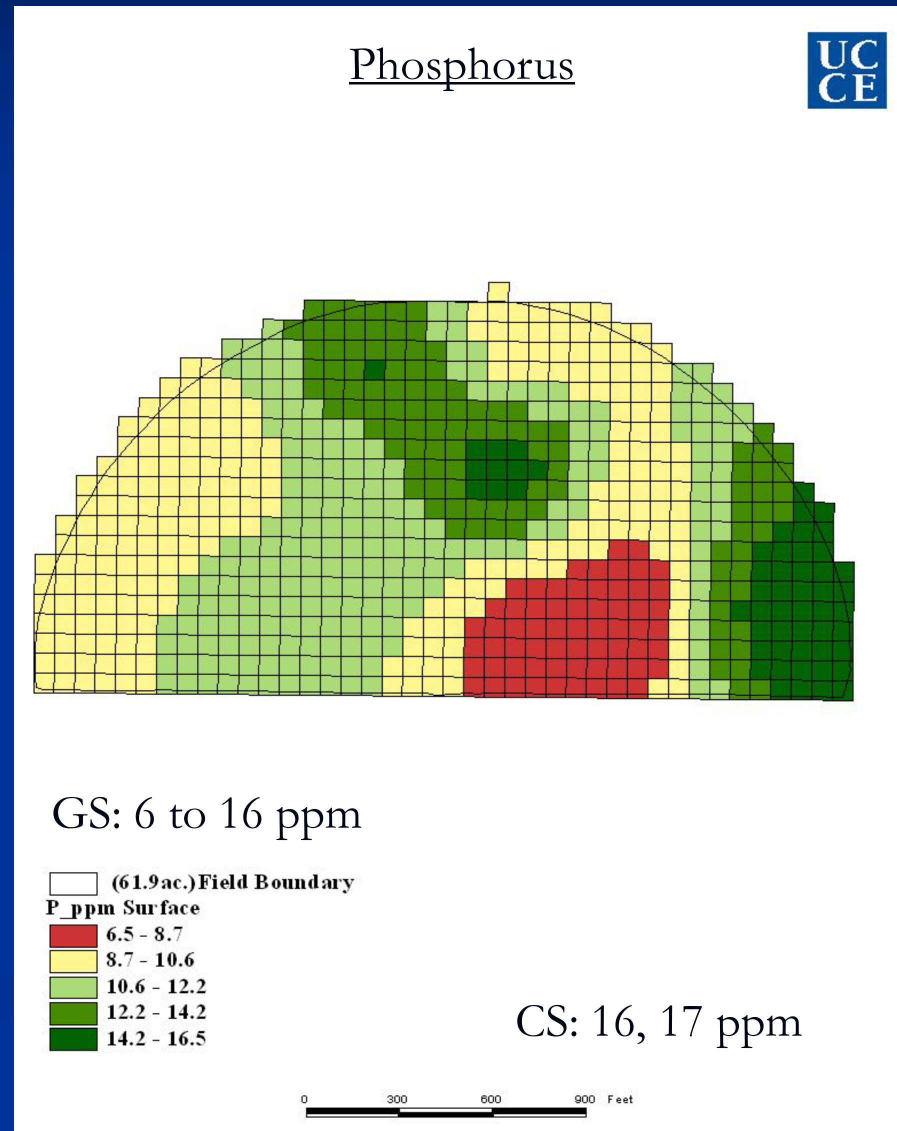
GS: 20 to 40ppm

CS: 23, 25, 32 ppm

0 400 800 Feet

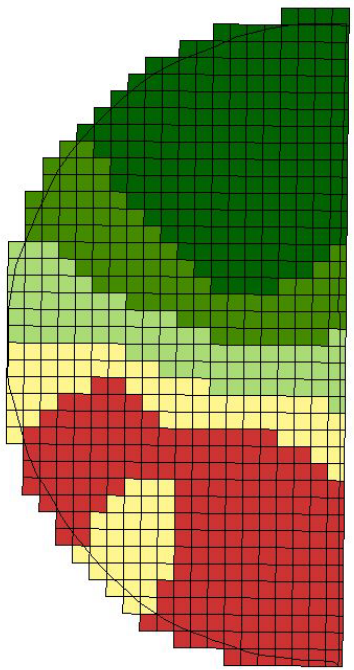
62 acres


Potassium
UC CE
GS: 120 to 270ppm
(61.9ac.)Field Boundary
K_ppm Surface
119.0 - 154.7
154.7 - 195
178.5 - 203.2
203.2 - 225.9
225.9 - 269.2
CS: 161, 161 ppm
0 300 600 900 Feet


Phosphorus
UC CE
GS: 6 to 16 ppm
(61.9ac.)Field Boundary
P_ppm Surface
6.5 - 8.7
8.7 - 10.6
10.6 - 12.2
12.2 - 14.2
14.2 - 16.5
CS: 16, 17 ppm
0 300 600 900 Feet

58 acres

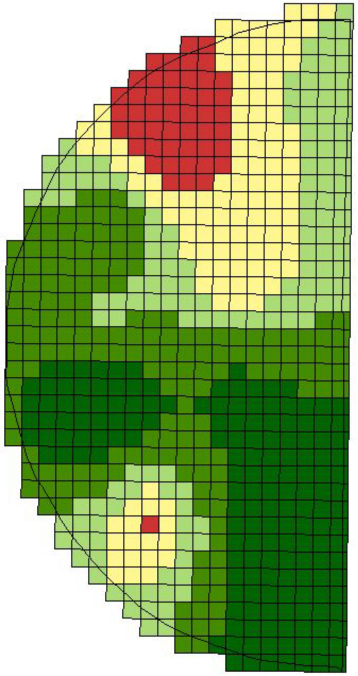
Potassium



GS: 84 to 235 ppm

CS: 100, 221 ppm

Phosphorus

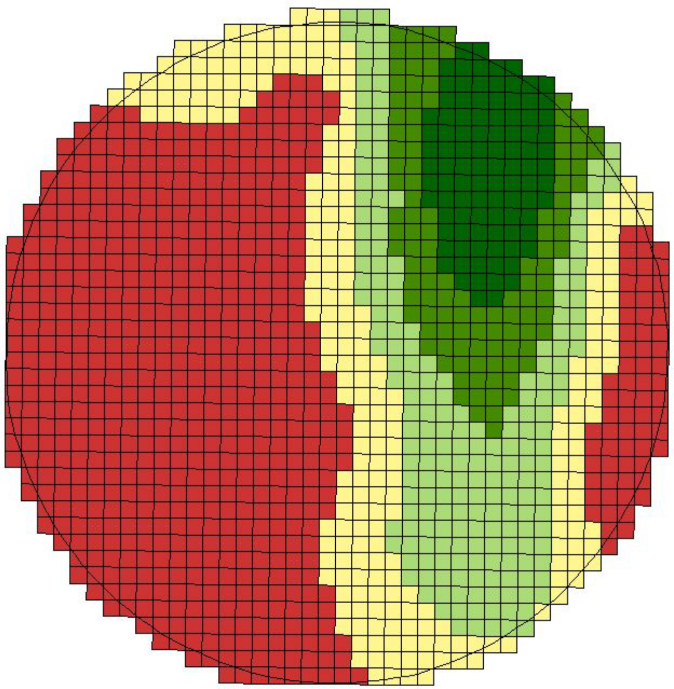


GS: 8 to 12 ppm

CS: 14, 15 ppm

124 acres

Potassium



(123.9ac.)Field Boundary

K_ppm

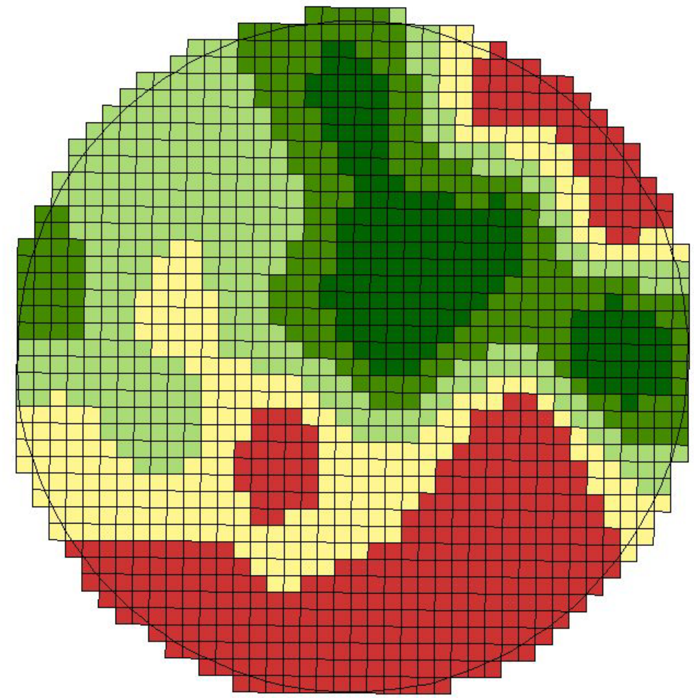
- 53.6 - 92.8
- 92.8 - 132.7
- 132.7 - 190.2
- 190.2 - 272.5
- 272.5 - 407.4

GS: 54 to 407 ppm

CS: 90, 170 ppm

0 400 800 Feet

Phosphorus



(123.9ac.)Field Boundary

P_ppm

- 2.9 - 3.7
- 3.7 - 4.2
- 4.2 - 4.7
- 4.7 - 5.2
- 5.2 - 6.3

GS: 3 to 6 ppm

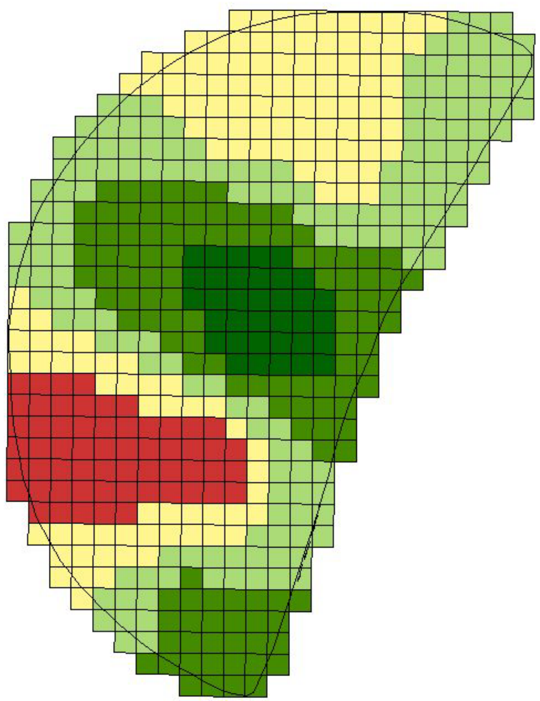
CS: 5, 8 ppm

0 400 800 Feet

44 acres

Potassium

UCCE



(44.5ac.) Field Boundary

K_ppm

- 58.5 - 64.4
- 64.4 - 68.4
- 68.4 - 72.9
- 72.9 - 79.0
- 79.0 - 91.6

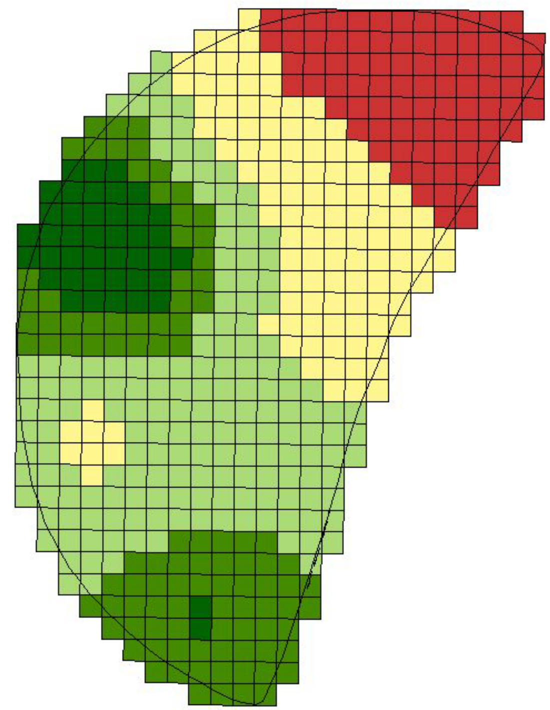
GS: 59 to 92 ppm

CS: 70 ppm

0 200 400 Feet

Phosphorus

UCCE



(44.5ac.) Field Boundary

P_ppm

- 6.7 - 7.1
- 7.1 - 7.6
- 7.6 - 8.1
- 8.1 - 8.5
- 8.5 - 9.3

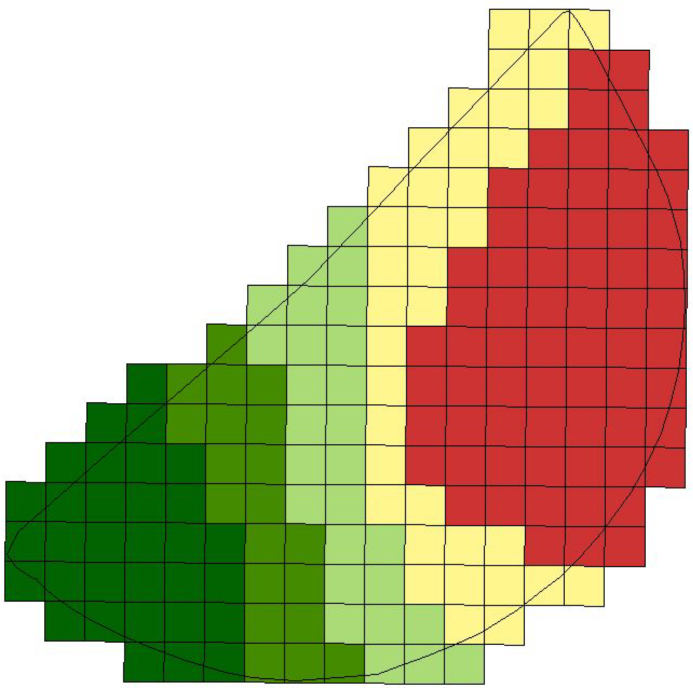
GS: 6 to 9 ppm

CS: 8 ppm

0 200 400 Feet

15 acres

Potassium



(15.1ac.) Field Boundary

K_ppm

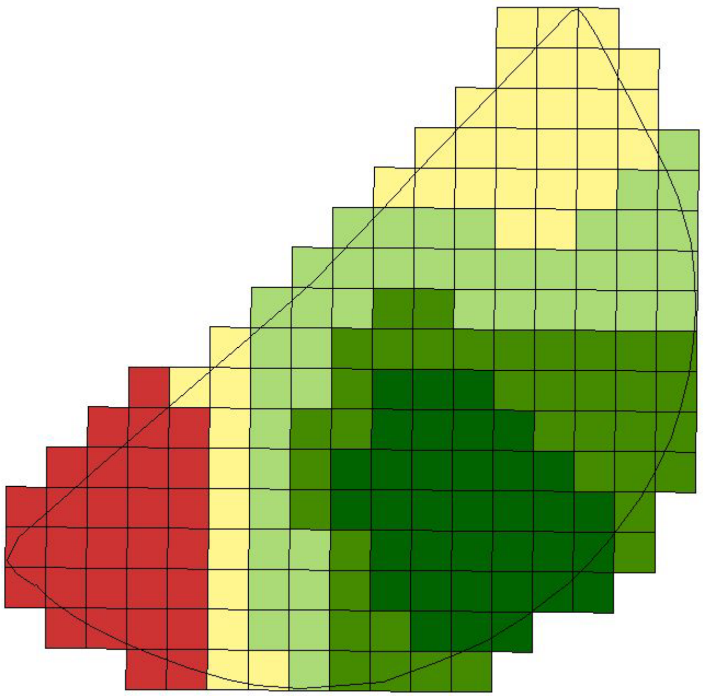
- 74.9 - 78.2
- 78.2 - 83.4
- 83.4 - 93.4
- 93.4 - 105.2
- 105.2 - 116.0

0 200 400 Feet

GS: 75 to 116 ppm

CS: 70 ppm

Phosphorus



(15.1ac.) Field Boundary

P_ppm

- 6.2 - 6.5
- 6.5 - 6.8
- 6.8 - 7.1
- 7.1 - 7.4
- 7.4 - 7.8

0 200 400 Feet

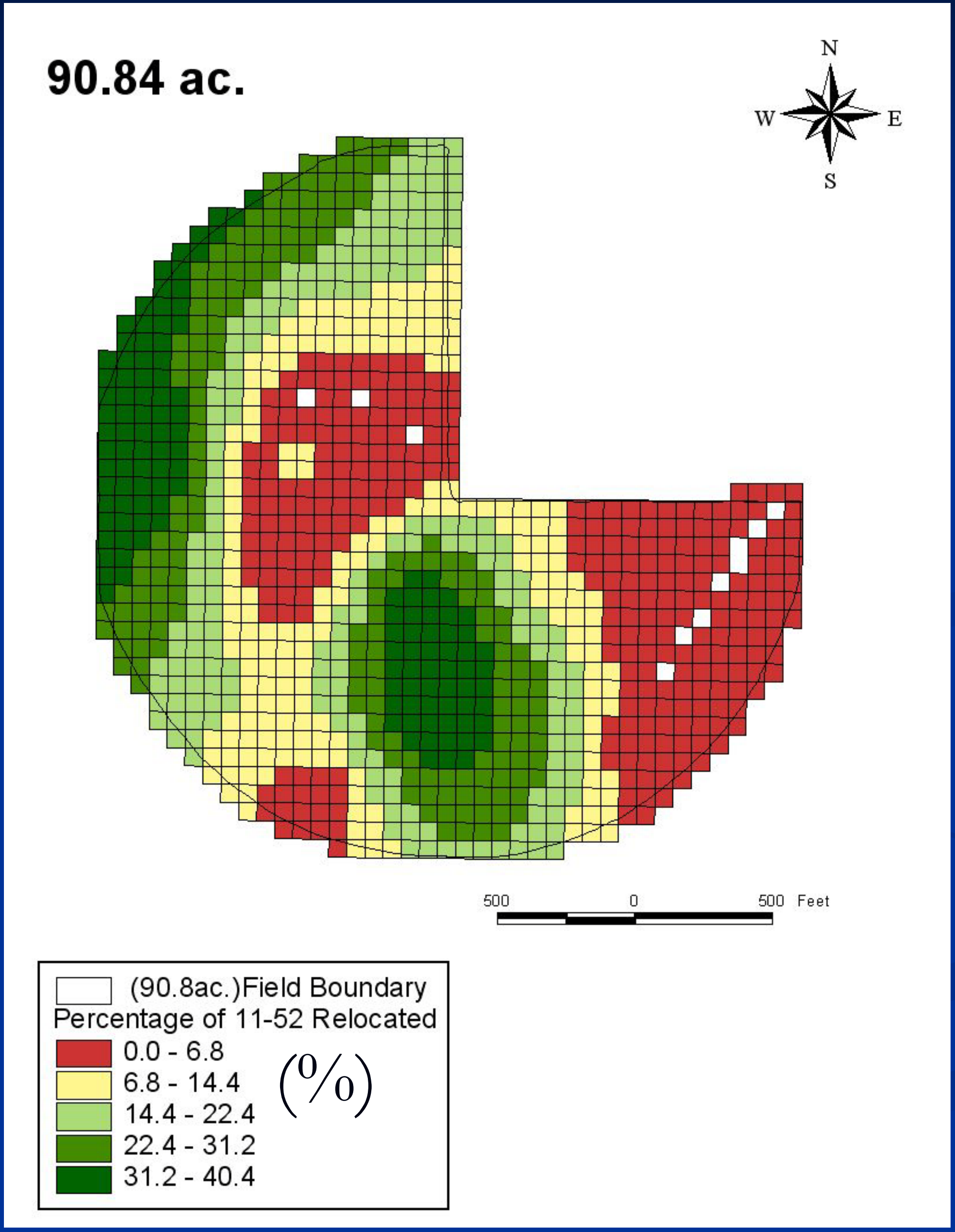
GS: 6 to 8 ppm

CS: 10 ppm

Conventional Vs Grid Sampling

	Soil Fertility (ppm)					
	UR	VR (range)	UR	VR (range)	UR	VR (range)
	North Fields					
	N1		N2		N3	
P	25, 32, 23	19.1 - 40.1 (21)	16, 16.9	6.4 - 16.9 (10.5)	13.9, 15	8.5 - 12.9 (4.4)
K	160, 180, 180	96 - 219 (123)	161, 161	118 - 276 (158)	100, 221	82 - 236 (154)
	South Fields					
	S1		S2		S3	
P	8, 5	2.7 - 6.4 (3.7)	8	6.7 - 9.3 (2.6)	10	6.2 - 7.9 (1.7)
K	170, 90	52 - 420 (368)	70	58 - 92 (34)	70	76 - 116 (40)

11-52-0 Relocation due to VR



$5,500 Vs $5,200
(RR Vs VR)

Variable Rate Cycle

2) DATA MANAGEMENT
Create Fertility Maps
(Desktop)

3) FERT. RECOM.

+ <u>Fert. Method</u>

4) APPLICATION

1) DATA COLLECTION

Soil Fertility Data – North Fields

Potassium