LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

Precision Ag Research
(On Farm Data)

Louisiana Agricultural Consultants Association

2020

Luciano S. Shiratsuchi

Associate Professor – Precision Agriculture

LSU AgCenter

February 13th, 2020

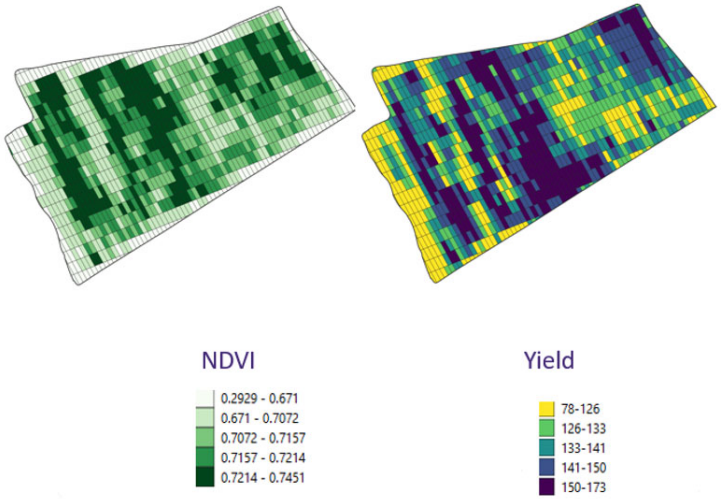
LSU

Precision Agriculture

SUMMARY

- Why On Farm Precision Ag Research?
- Preliminary results from on farm trials – Hardwick's Example
- Grid sampling and modeling studies
- Model influence on map generation
- LSU Precision Ag initiatives on Soil Testing Laboratory (STPAL)
- Research Efforts using proximal soil sensors

Why ON FARM research?



- Need of **large areas** to evaluate spatial variability
- Experimental condition of **small plot in station** are very **different** from farmers fields
- **Better farm equipment**, pesticides, crop scouting and conducting compared to university standards
- We need to analyze those **colorful maps** with better statistical procedures
- We have to work with a **large amount of data** to support VRT applications
- Help farmers be **profitable**

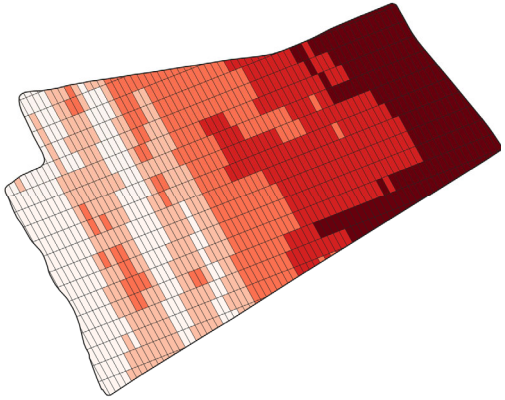
LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

Preliminary results for Corn, Cotton and Soybeans Season 2019

Farmers: Mead, Marshall and Jay Hardwick

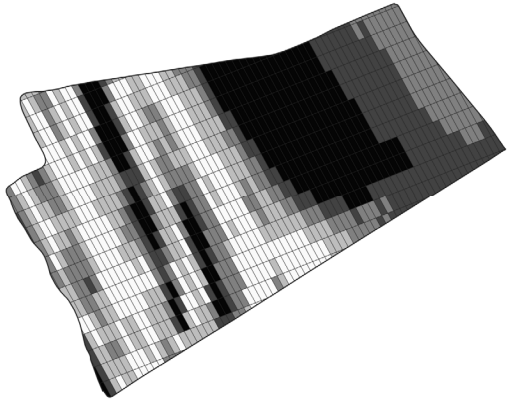
LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

Spatial Layers – Visual Comparisons



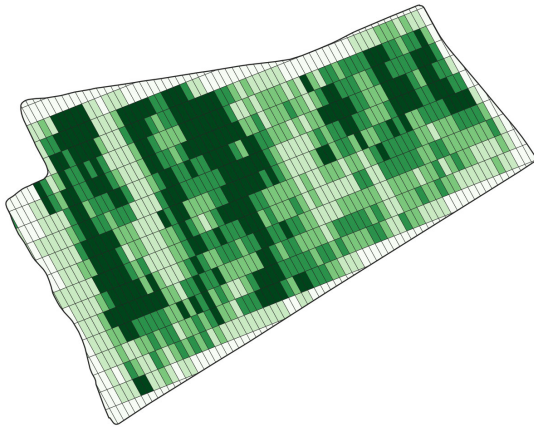
Elevation

- 67.25 - 74.74
- 74.74 - 76.21
- 76.21 - 78.18
- 78.18 - 78.88
- 78.88 - 80.76



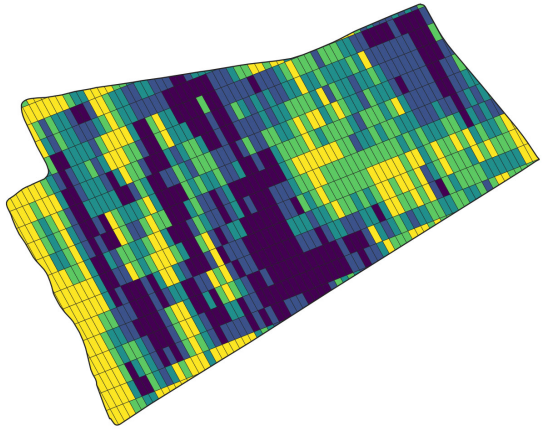
CEC

- 33.3 - 54.4
- 54.4 - 63.2
- 63.2 - 71.5
- 71.5 - 83.1
- 83.1 - 103.7



NDVI

- 0.2929 - 0.671
- 0.671 - 0.7072
- 0.7072 - 0.7157
- 0.7157 - 0.7214
- 0.7214 - 0.7451



Yield

- 78-126
- 126-133
- 133-141
- 141-150
- 150-173

LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

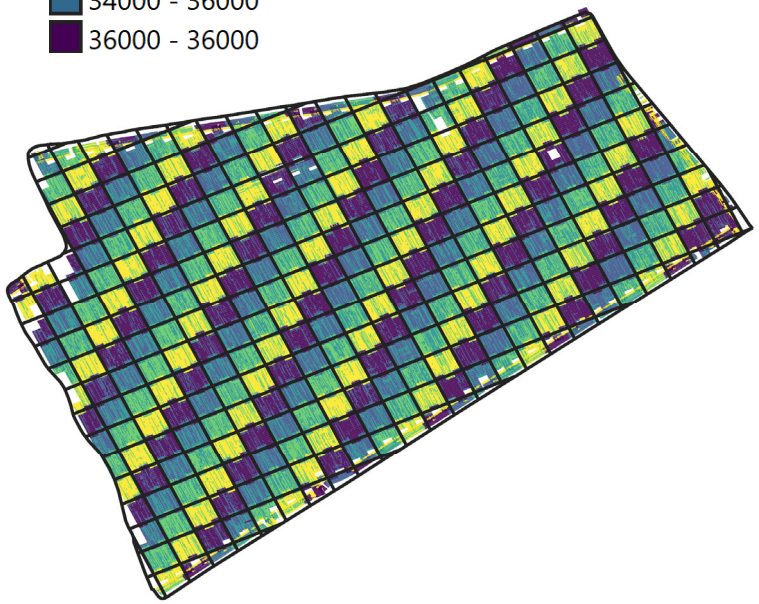
On Farm Precision Experiment Area = 172 acres

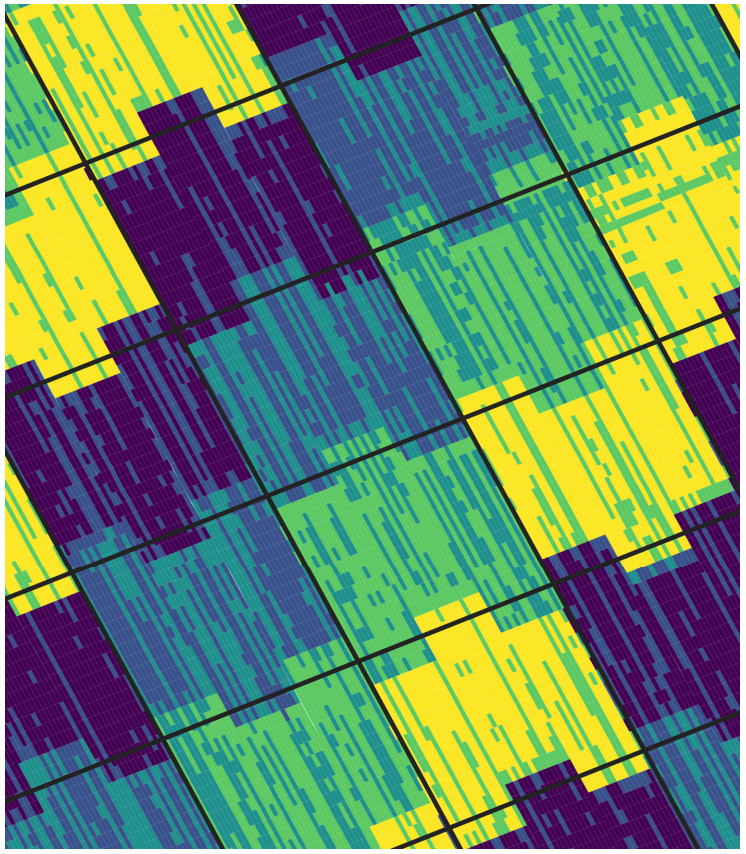
Each plot of 140 x 150ft (0.45 acres)

4 combine passes
3 planter passes

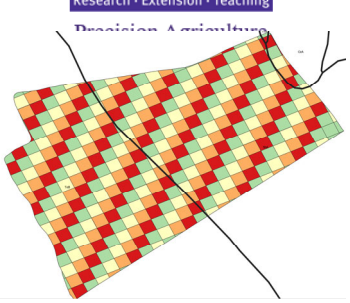
Seeds / acre

- 30000 - 32000
- 32000 - 34000
- 34000 - 36000
- 36000 - 36000





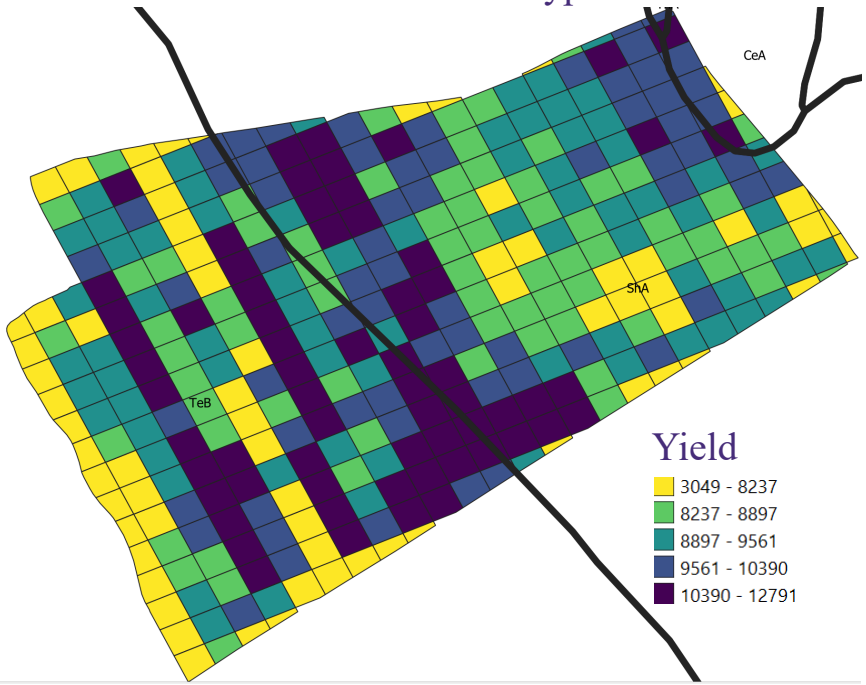
Example of the use of state of art to design trials to generate variable rate N algorithms



Seed Rate

- 30000
- 32000
- 34000
- 36000

CORN (150 acres)
Yield x N rates x Soil Type

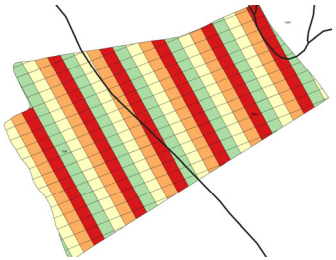


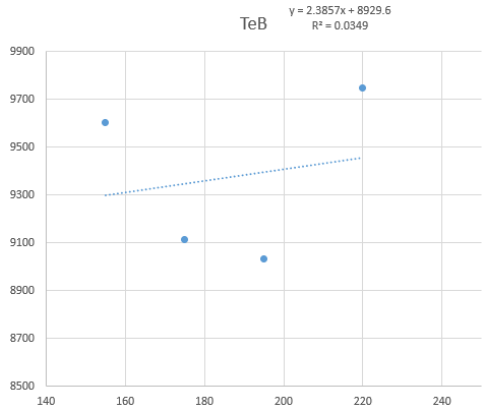
Yield

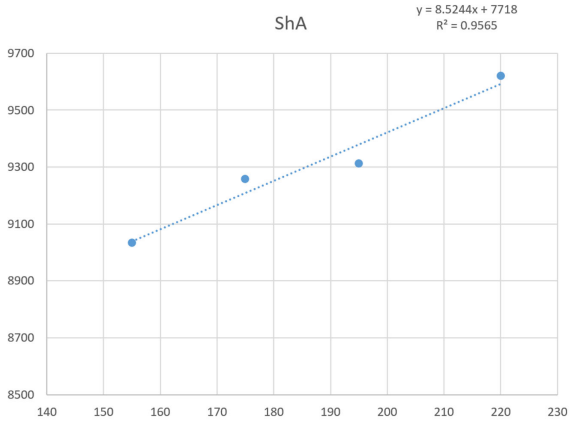
- 3049 - 8237
- 8237 - 8897
- 8897 - 9561
- 9561 - 10390
- 10390 - 12791

N rates

- 155
- 175
- 195
- 220

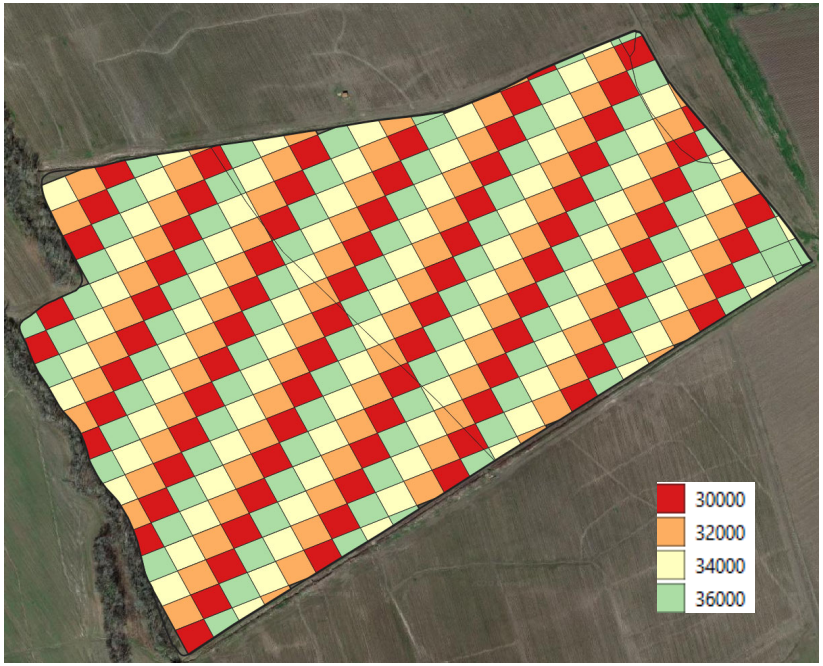


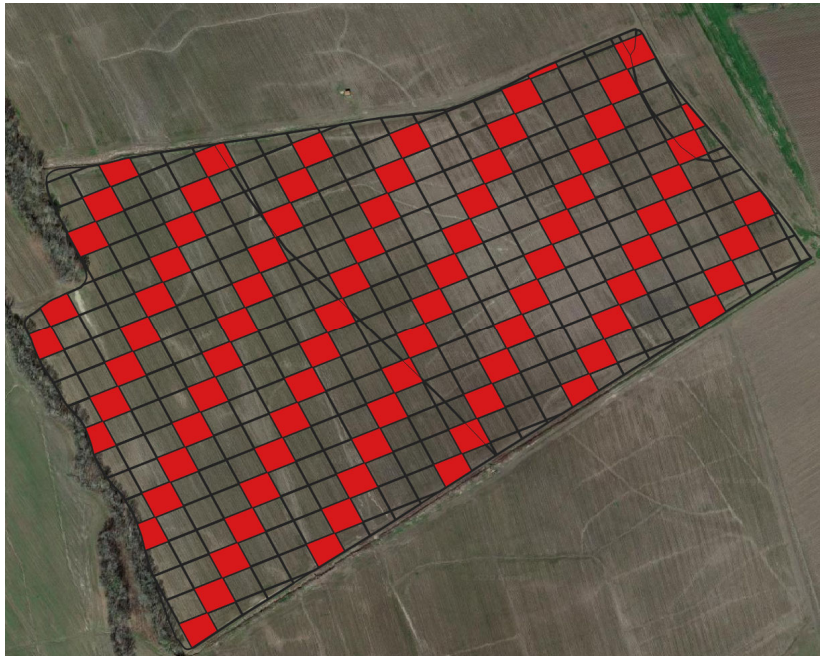




LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

Example of grid pattern using only 30 kseeds / acre

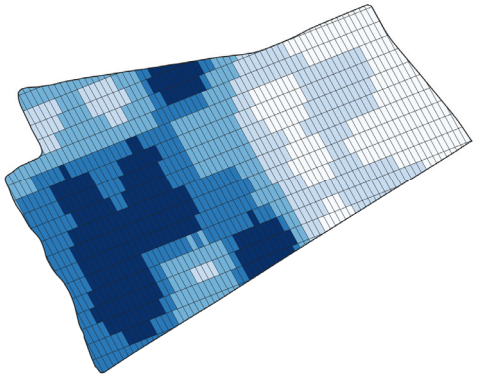




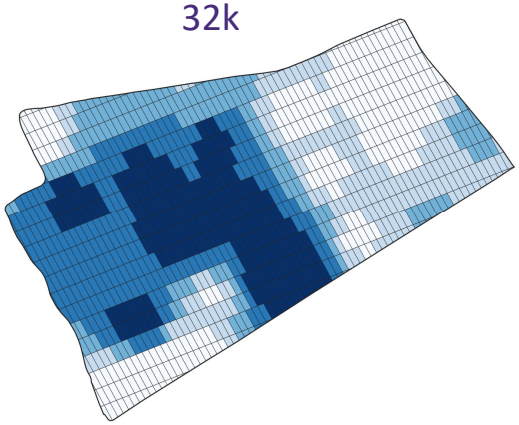
LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

Yield response for Seed Rate (seeds/acre) using 220 lbN/acre

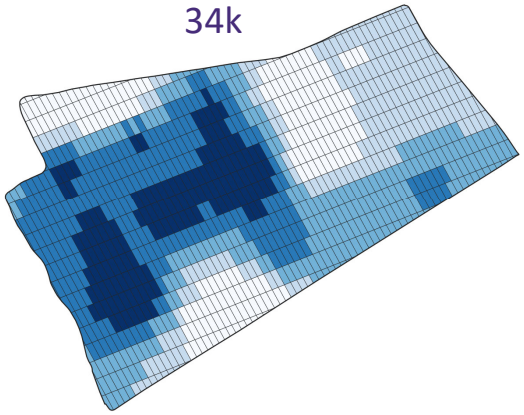
30k



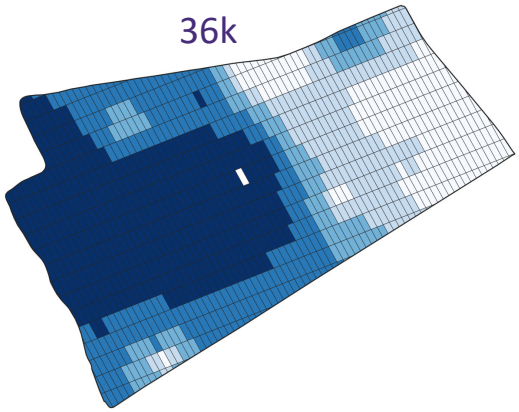
32k



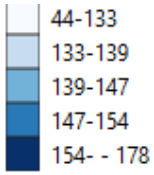
34k



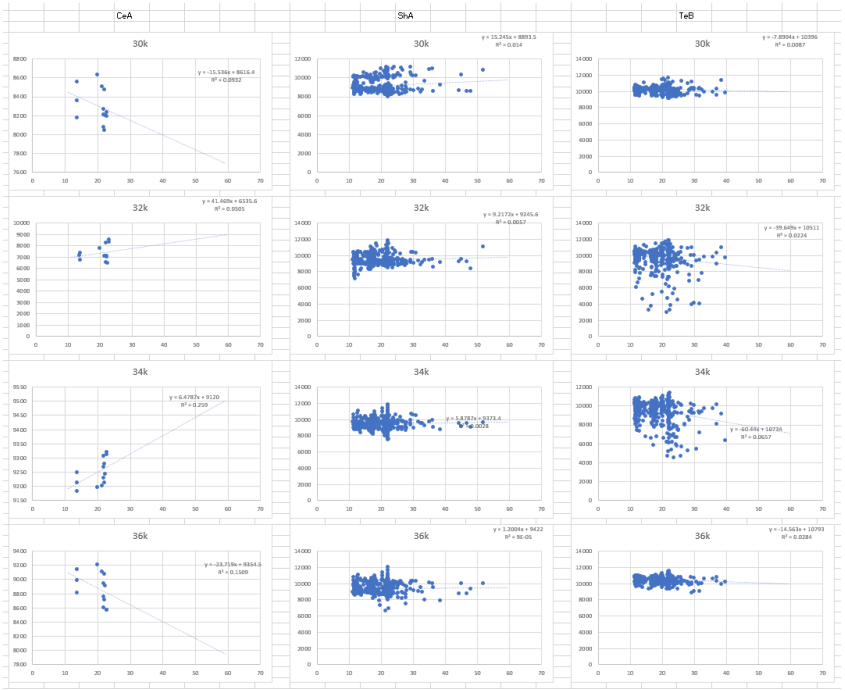
36k

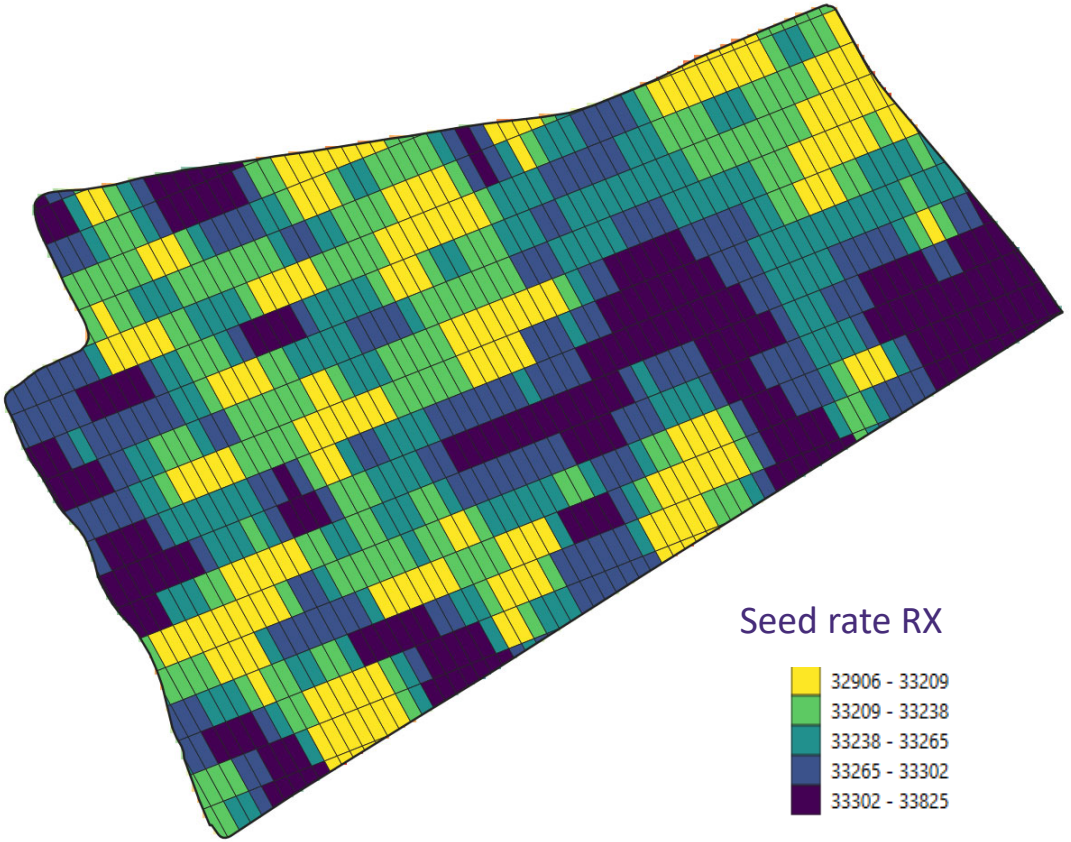


Yield (bu/acre)



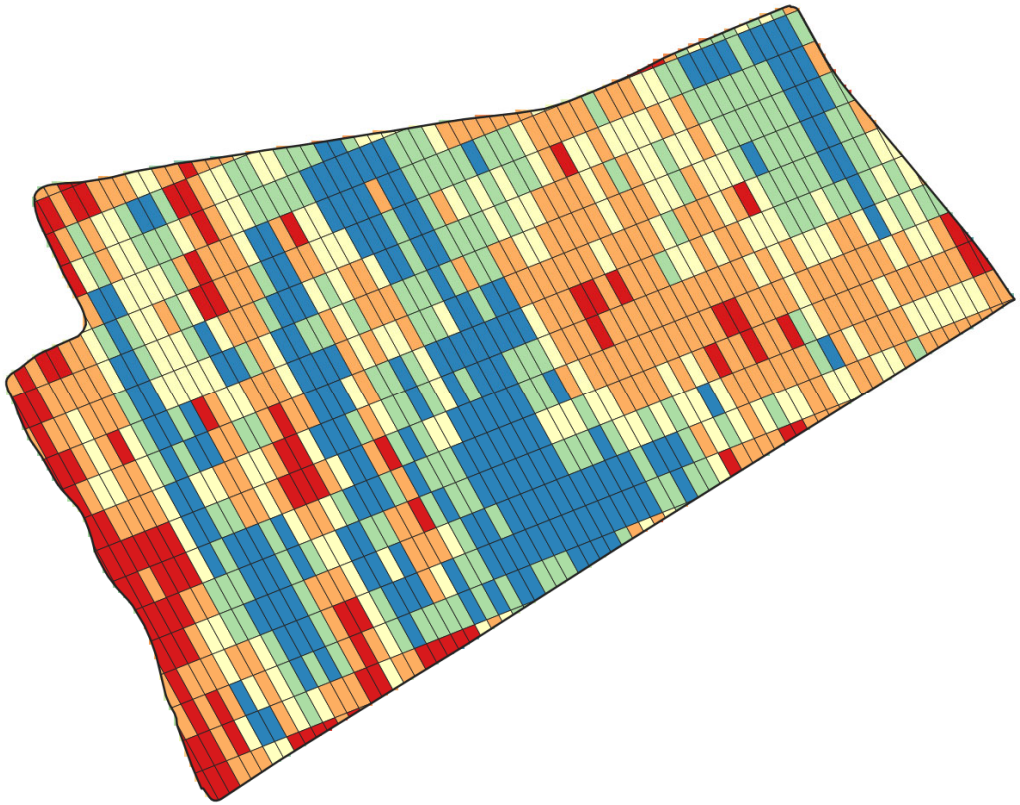
Geographical Weight Regression (GWR) to generate Seed RX





Spatial Profit Scenario

Spatial cost
Seeds= 3.13 per kseeds
N= 0.43 per lb N



Corn price= 2.97
Breakeven= 144bu/ac

Profit
bu/acre

-47.5 - 0
0 - 15.2
15.2 - 24
24 - 33.5
33.5 - 56.9

US$/acre

-141 - 0
0 - 45
45 - 71
71 - 99
99 - 169

Corn price= 4.25
Breakeven= 96bu/ac

Profit
bu/acre

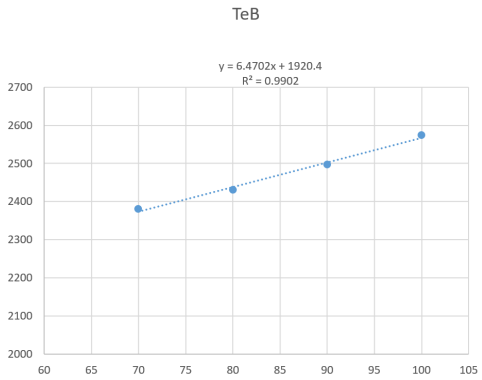
-15.5 - 0
0 - 47.2
47.2 - 56
56 - 65.5
65.5 - 88.9

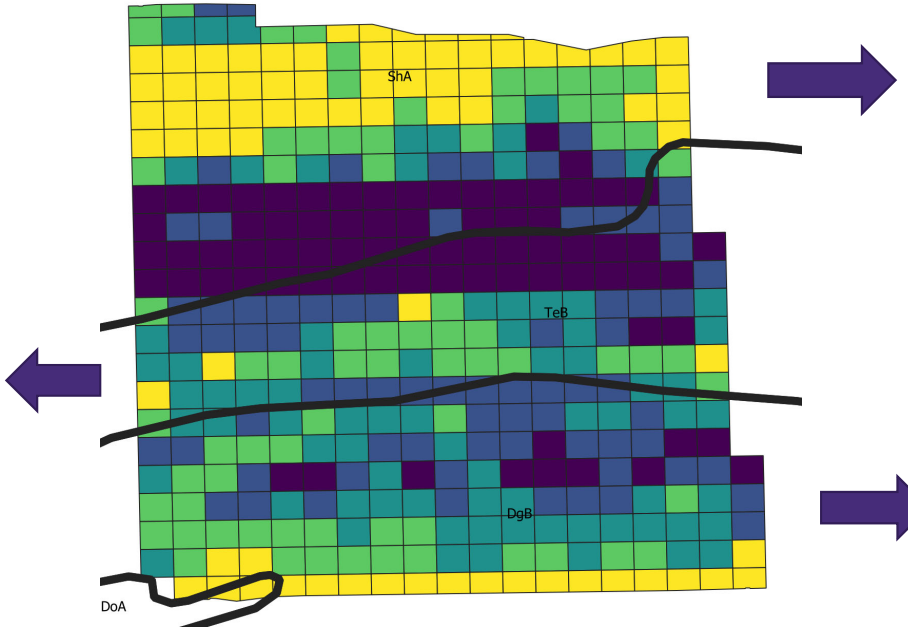
US$/acre

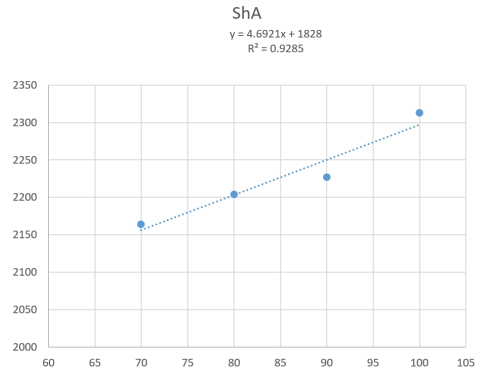
-66 - 0
0 - 201
201 - 238
238 - 278
278 - 378

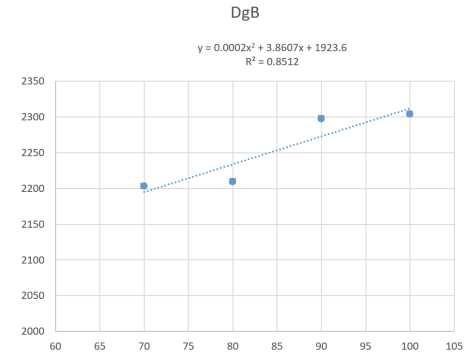
LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

COTTON (583 acres)
(below is only part of the area ~ 200acres)
Yield x N rates x Soil Type



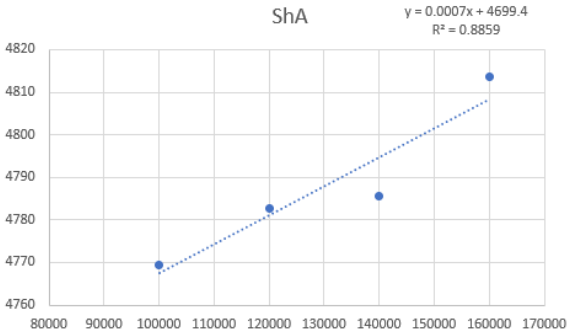


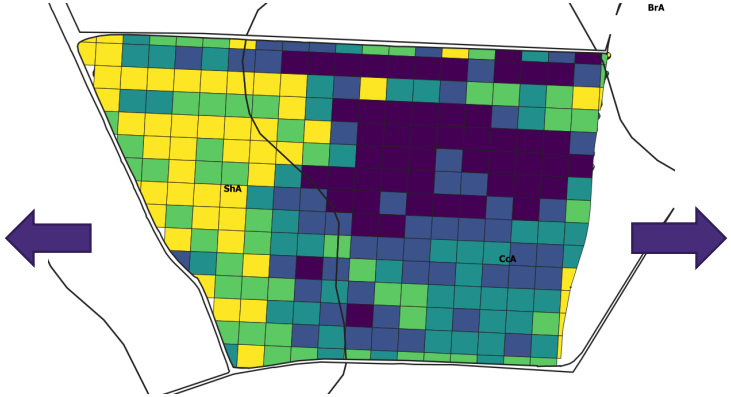


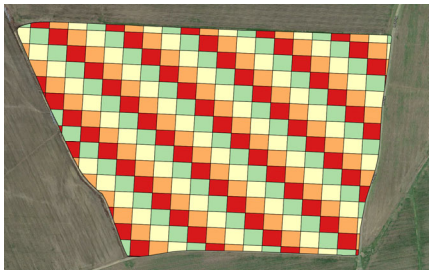


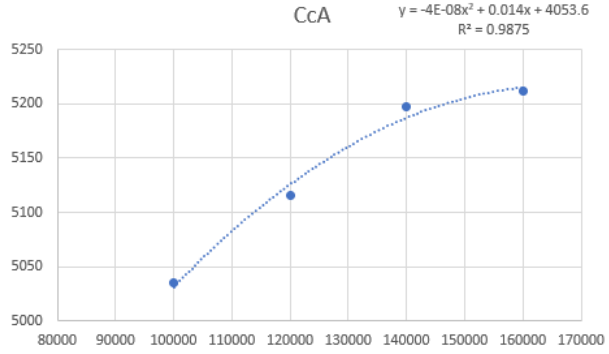
LSU AgCenter
Research · Extension · Teaching
Research · Extension · Teaching
Precision Agriculture

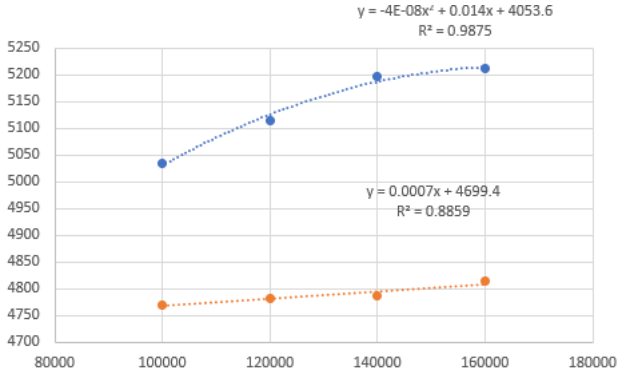
SOYBEANS (106 acres)
Yield x Seed Rates x Soil Type











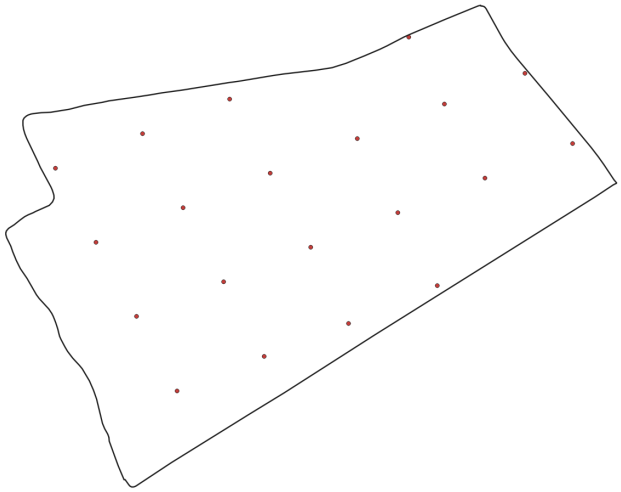
LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

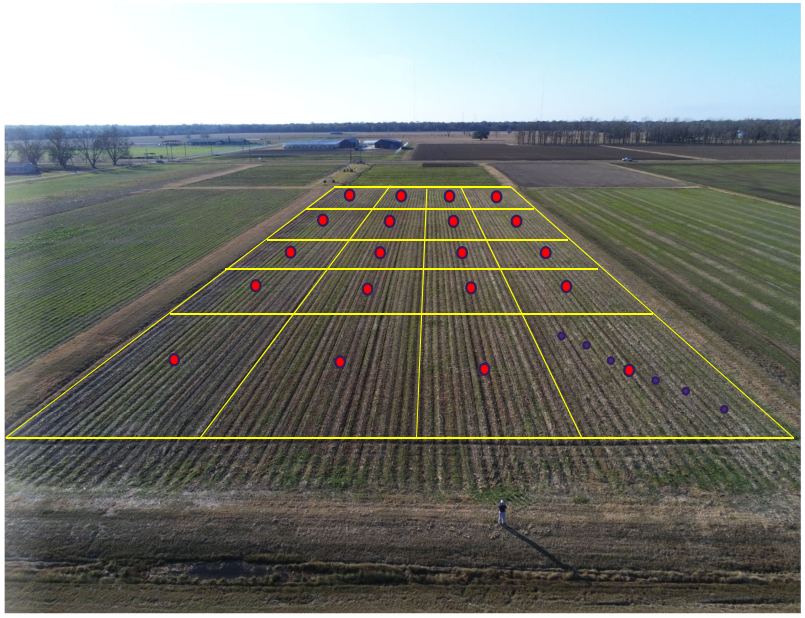
Grid Soil Sampling and Modeling Studies

Precision Agriculture

What is the reading of grid soil sampling?

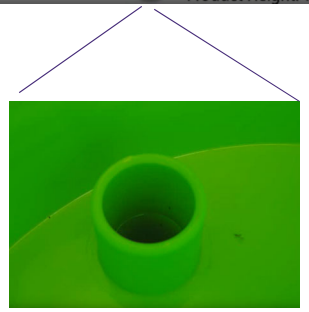
1) Best representation of nutrient quantity compared to sensors or zoning
2) Science based prescriptions validated by several universities
3) Resolution using proper models are enough to be cost effective and be the best strategy to save money with enough spatial resolution
4) Cheapest EVEN with lab costs





LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

GRID SOIL SAMPLING NEEDS



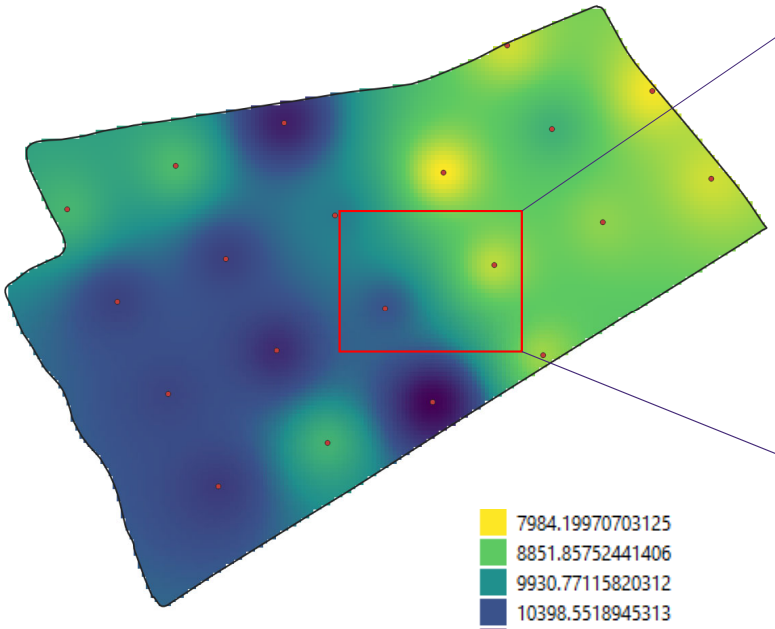
- GPS coordinates tied to sample
- Good plastic bag
- Bar code identification preferable

LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

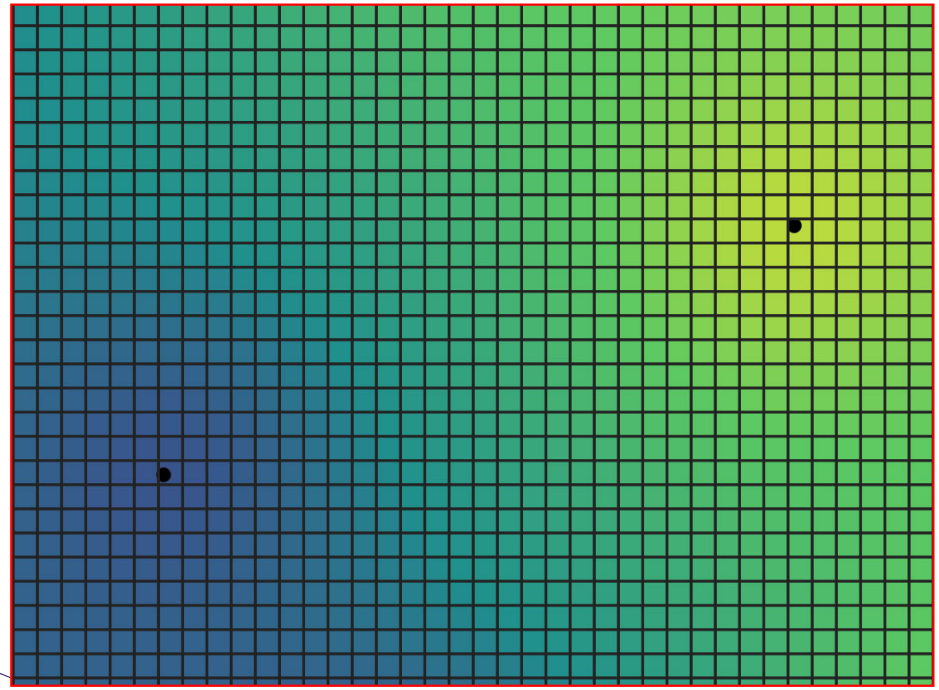
What's a digital map?

LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

Digital Map



INTERPOLATION



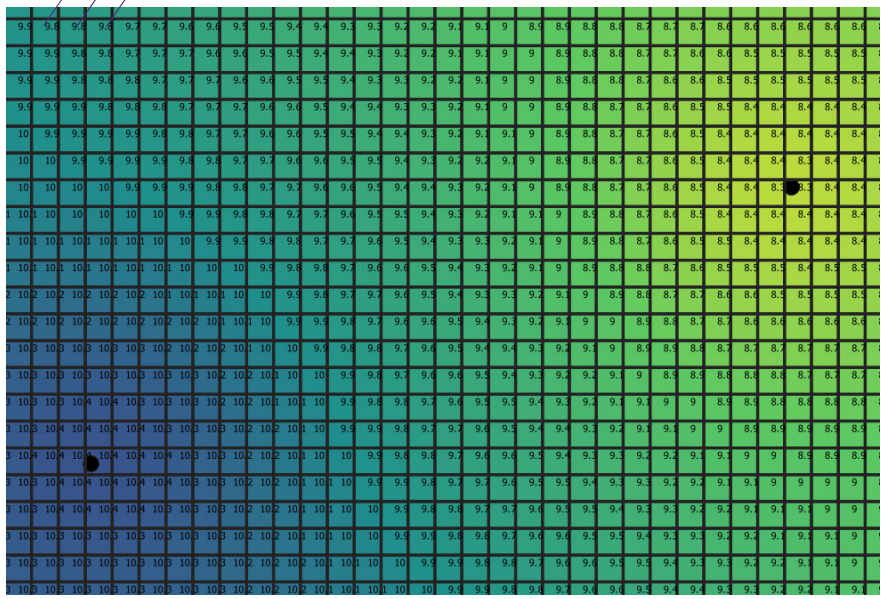
LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

Inverse Distance Weight Interpolation

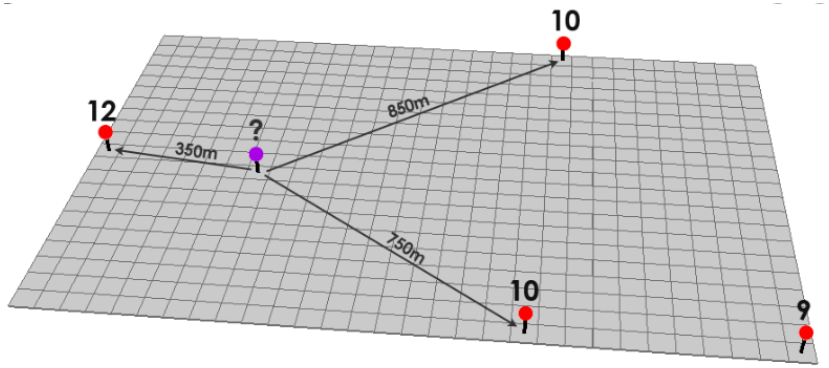
IDW

$$z_p = \frac{\sum_{i=1}^{n} \left(\frac{z_i}{d_i^p}\right)}{\sum_{i=1}^{n} \left(\frac{1}{d_i^p}\right)}$$

P1 P2 P3….

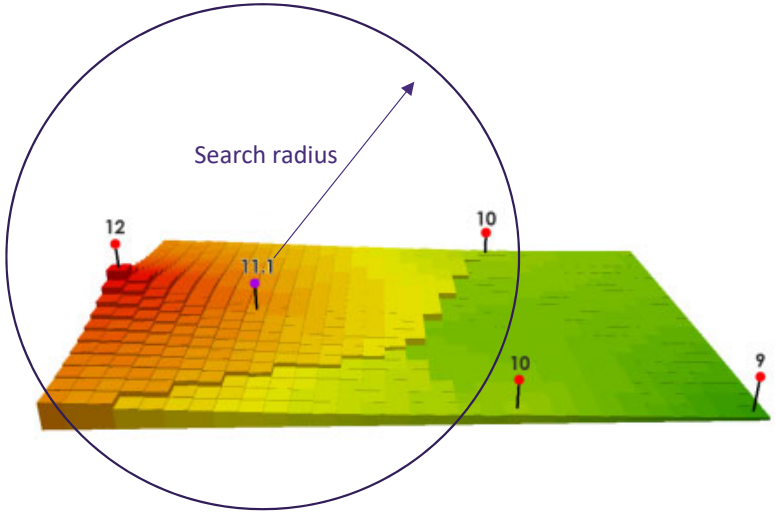


P1 = (12/350 + 10/850 + 10/750) /
(1/350 + 1/850 + 1/750)



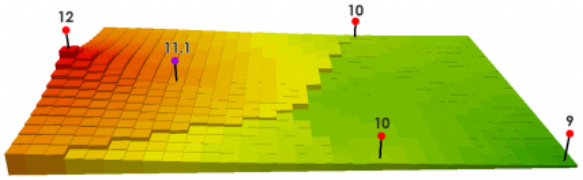
Precision Agriculture

Questions about radius of search and Power for the distance???
Commercial Softwares Default Interpolation is IDW



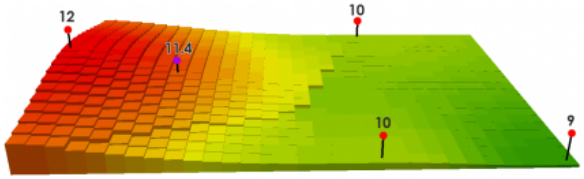
For a **power of 1**, that cell value is equal to:

((12/350) + (10/750) + (10/850)) / ((1/350) + (1/750) + (1/850)) = 11.1



For a **power of 2**, that cell value is equal to:

= ((12/350²) + (10/750²) + (10/850²)) / ((1/350²) + (1/750²) + (1/850²)) = 11.4

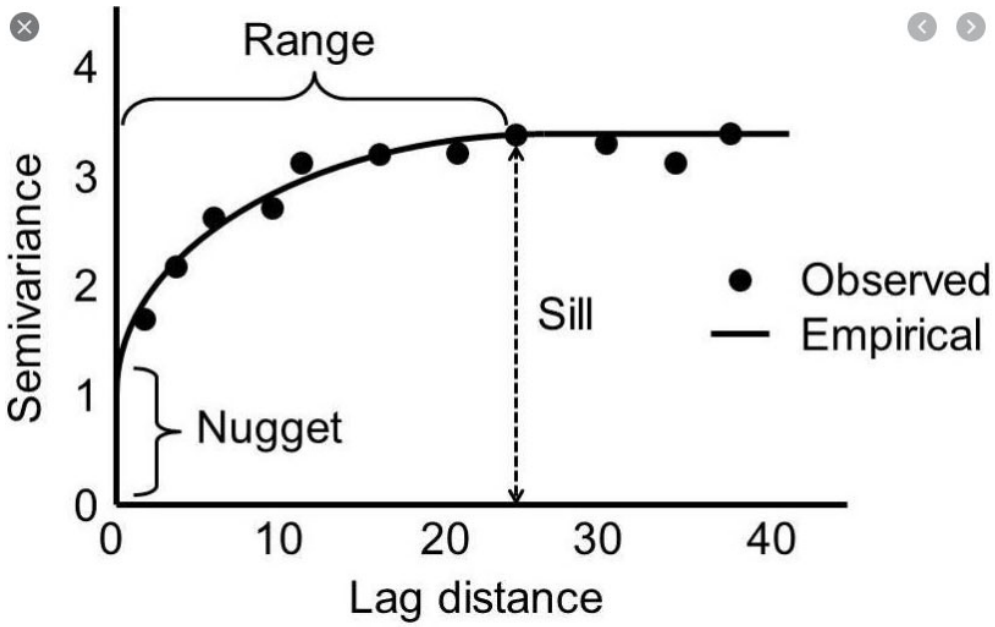


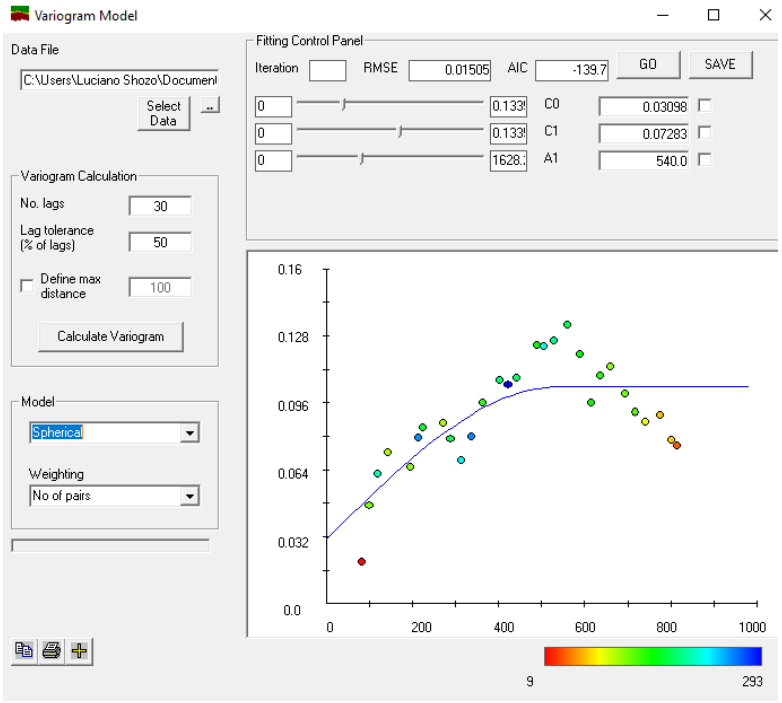
Bigger the power
More influence from neighbor points

Precision Agriculture

Commercial Softwares – Majority uses IDW
Is this the best method???? No, it is NOT!

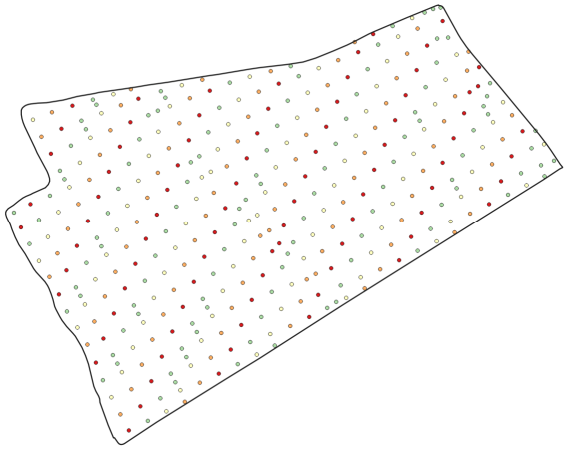
KRIGING INTERPOLATION



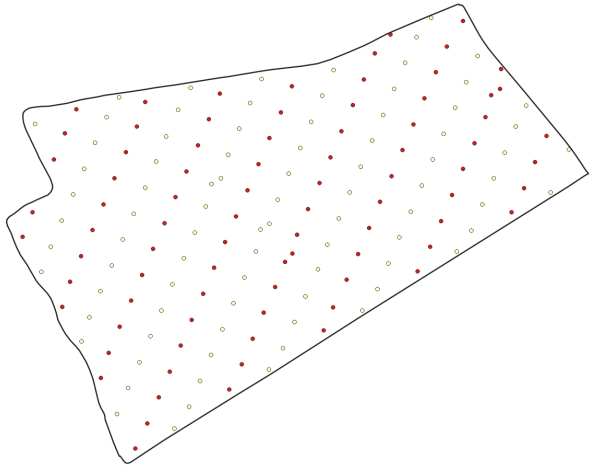


LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

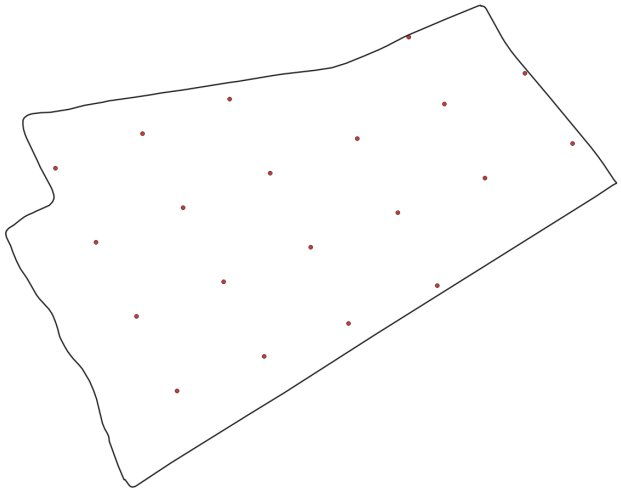
Grid Size and Variable Rate Fertilization Prescription Maps Generation



0.5 acre grid



2.5 acres grid

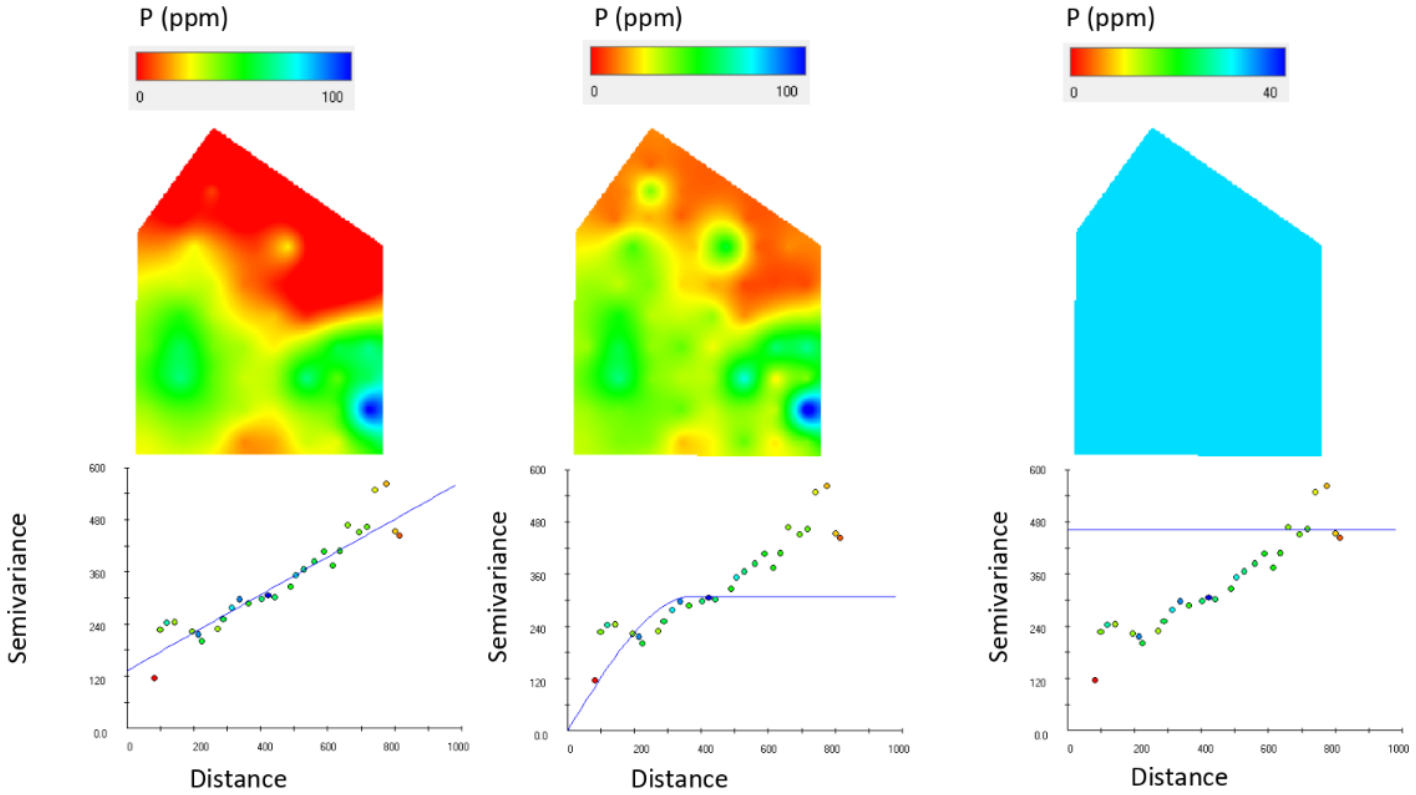


8 acres grid

LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

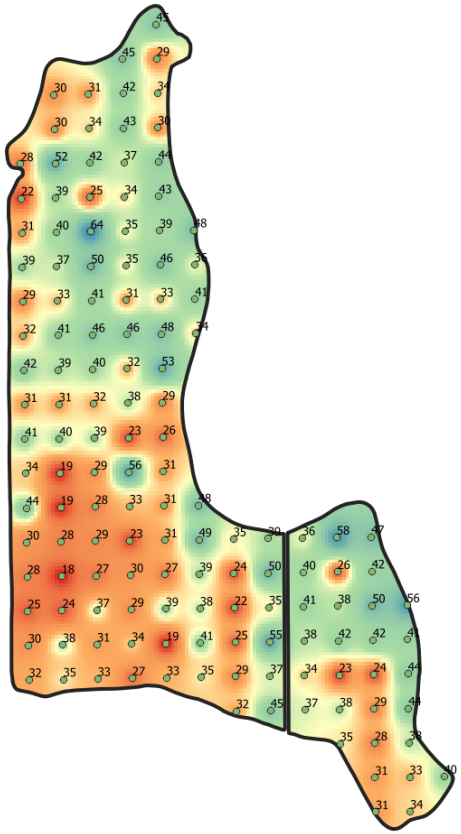
Modeling effects on map generation?

LSU AgCenter
Research · Extension · Teaching
Precision Agriculture



LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

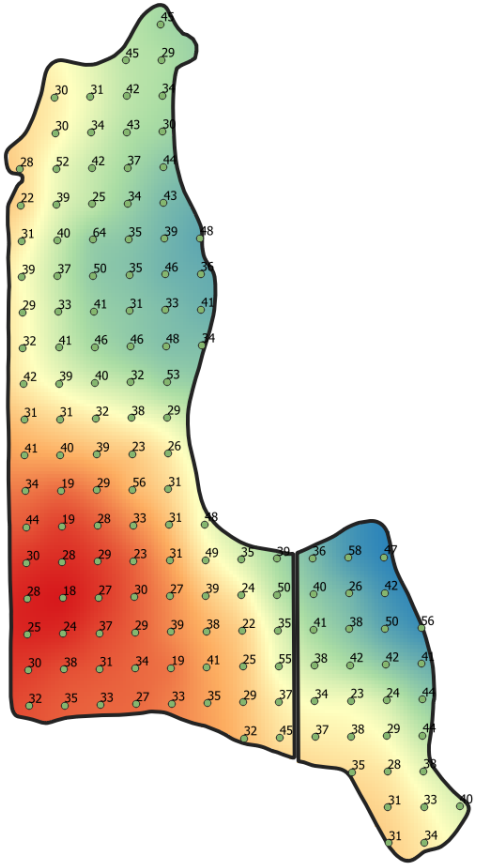
IDW
Power 2
12 neighbors



P (ppm)

- 18.5671977996826
- 32.574084072113
- 35.6465623512268
- 38.7642241344452
- 63.7055184001923

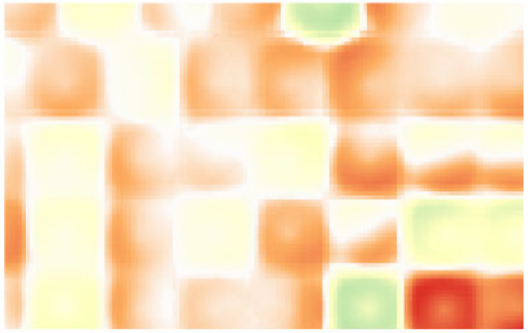
Kriging using the
best fitted model

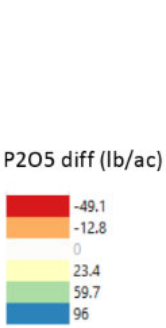


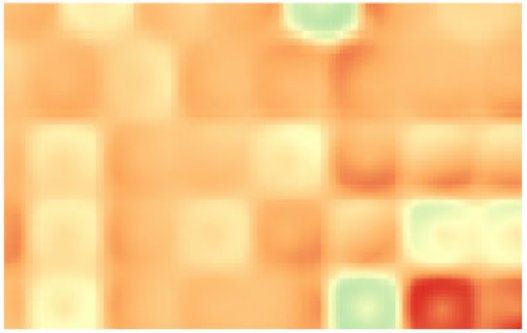
P (ppm)

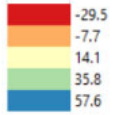
- 18.5671977996826
- 32.574084072113
- 35.6465623512268
- 38.7642241344452
- 63.7055184001923

Precision Agriculture









Considering DAP price = US$560 / ton
US$ / lb = 0.6

Errors can be very high in big areas: Example is a farmer in Talullah – LA with a field mapped with 190 acres.

Making calculations this map error can represent US$ 5,830 only in P fertilizer

LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

PRECISION AGRICULTURE INITIAVE AT STPAL

Soil Testing & Plant Analysis Lab

8:00 a.m. - 4:30 p.m. 225-578-2110 225-578-1403 104 Sturgis Hall 137 J.C. Miller Hall Baton Rouge, LA 70803

LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

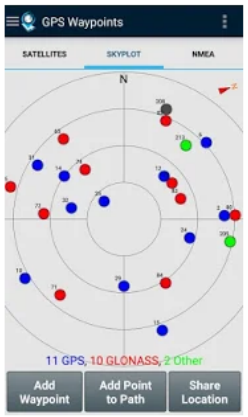
GPS Waypoints

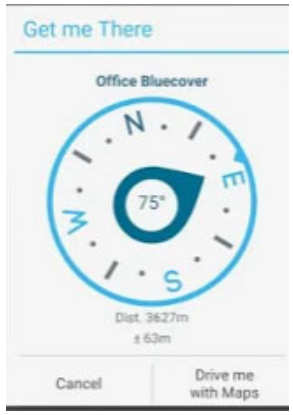
Bluecover Technologies Tools

Everyone

Contains Ads · Offers in-app purchases

This app is compatible with all of your devices.





Steps:

1) Use GPS Waypoints to collect samples in the field or other similar cell phone App
2) Export the point coordinates in decimal degrees
3) Send the samples with the same ID for the STPAL
4) Select Variable Rate RX Maps as optional service

MODELS were generated by soil type and calibrate by itself once the farmer repeat the same field consecutively.

LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

Essential is to send coordinates and sample ID

long	lat	SampleID	pH	BpH	OM	CEC	P	K	Ca	Mg
-91.275	32.204	106	6.2	6.6	4.4	30.6	41	253	3921	794
-91.276	32.204	107	6.2	6.6	4.3	31.1	42	277	4020	790
-91.277	32.204	108	5.9	6.4	3.9	32.2	42	276	3845	830
-91.278	32.204	109	5.7	6.1	4	38.7	38	309	4468	895
-91.279	32.204	110	6.1	6.5	4.1	32.9	55	360	4173	780
-91.28	32.204	111	4.9	6.1	3.4	36.4	25	253	2486	879
-91.281	32.204	112	6	6.6	4	24.8	41	293	2677	833
-91.282	32.204	113	5.4	6.2	3.3	24.8	19	242	2022	835
-91.283	32.204	114	5	6.1	3.5	41.9	34	326	3073	1022
-91.284	32.204	115	6.1	6.6	4.3	25.9	31	306	2797	908
-91.285	32.204	116	5.9	6.4	4.4	29.7	38	337	3303	881
-91.287	32.204	117	6.1	6.4	5.1	36.2	30	300	4525	920
-91.287	32.204	118	5.8	6.4	3.5	30.6	32	328	3088	1018
-91.285	32.204	119	6.1	6.5	4.7	30.7	35	305	3575	929
-91.284	32.204	120	5.8	6.3	4.9	35.3	33	231	3805	1083
-91.283	32.204	121	5.7	6.2	3.6	33.9	27	250	3553	1006
-91.282	32.204	122	6.3	6.7	4.3	25.2	33	253	2986	839
-91.281	32.204	123	5.2	6.1	4.3	34.1	35	273	2907	850
-91.28	32.204	124	5.9	6.5	4	23.6	29	270	2407	824
-91.279	32.204	125	6.4	6.7	4.5	21.5	37	324	2349	837
-91.278	32.204	126	6.2	6.6	3.8	26.4	34	308	3000	893
-91.277	32.204	127	5.7	6.4	3.8	25.9	23	290	2450	900
-91.276	32.204	128	6.2	6.7	3.5	22.3	24	265	2414	825
-91.275	32.204	129	6.4	6.7	3.9	27.4	44	262	3542	777
-91.275	32.203	130	6.7	6.8	3.9	28.9	44	254	3963	857
-91.276	32.203	131	6.1	6.5	3.7	31.3	29	249	3667	955

LSU Official Recommendations

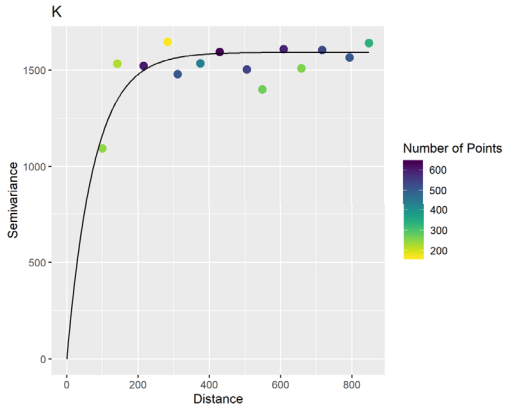
Cotton

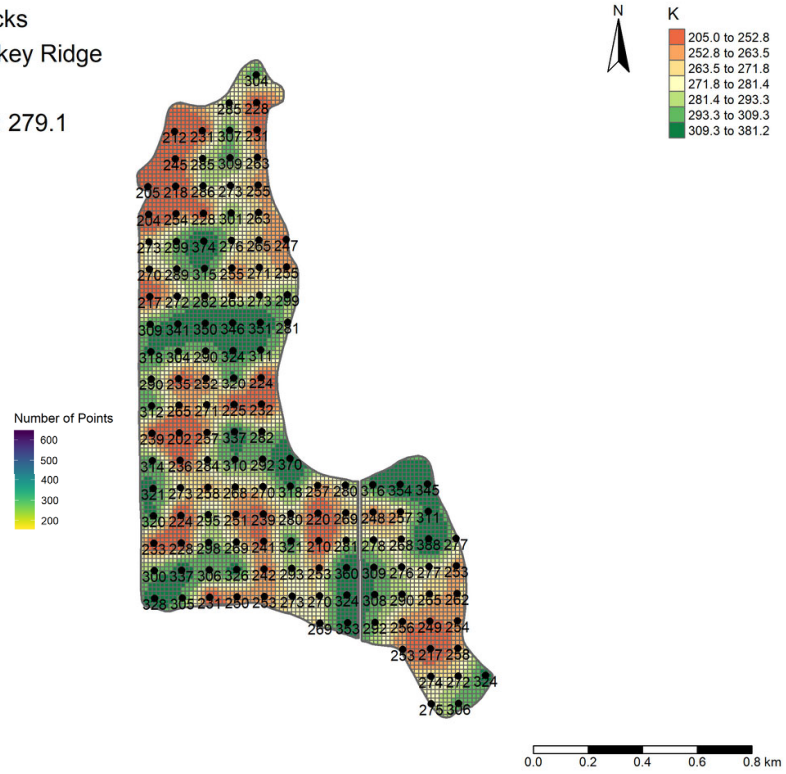
Interpretation	Soil Test P ppm	P_2O_5 Recommendation, lbs/ac			
		Alluvial		Upland	
		Irrigated	Non	Irrigated	Non
clay, silty clay, silty clay loam, clay loam					
Very low	10 and <	90	80	90	80
Low	11-20	70	60	70	60
Medium	21-35	50	40	50	40
High	36-60	0	0	0	0
Very High	>60	0	0	0	0
silt loam, loam, very fine sandy loam, fine sandy loam, sandy loam, loamy sand					
Very low	10 and <	100	80	100	80
Low	11-20	80	60	80	60
Medium	21-35	60	40	60	40
High	36-60	0	0	0	0
Very High	>60	0	0	0	0

Example of output from STPAL

Precision Agriculture

Farm: Hardwicks
Field: 04 - Turkey Ridge
Variable: K
Field Average: 279.1
CV: 9%





Status:

1) Programming for kriging interpolation ready
2) Modeling framework ready
3) Servers to provide cloud service ready
4) Official Recommendations adapted for Variable rate ready
5) Working on the development of a Web platform to enable user to upload GPS coordinates with sample IDs and STPAL database organization

LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

LSU Precision Ag Team

Research with Proximal Soil Sensors

Precision Agriculture

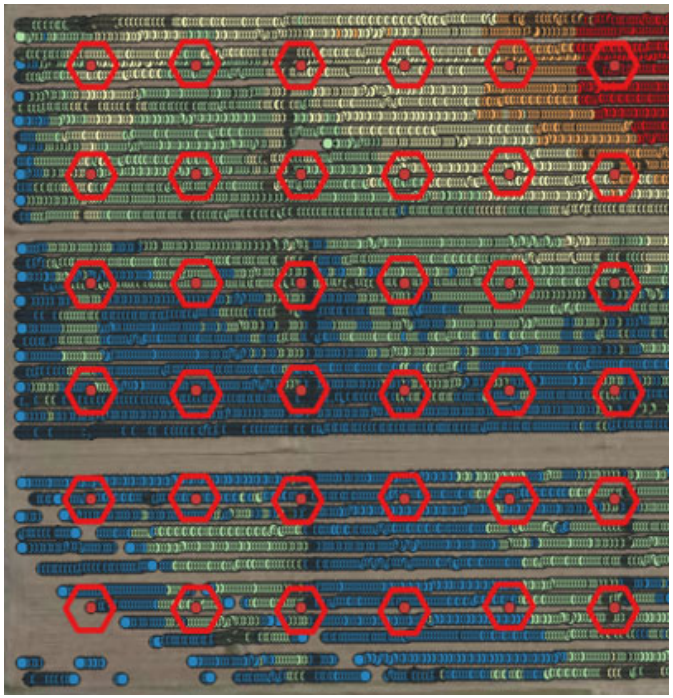
AGRO 4092 (Precision Agriculture)

Using Electrical Conductivity Methods for Predicting Soil Nutrients and Organic Matter

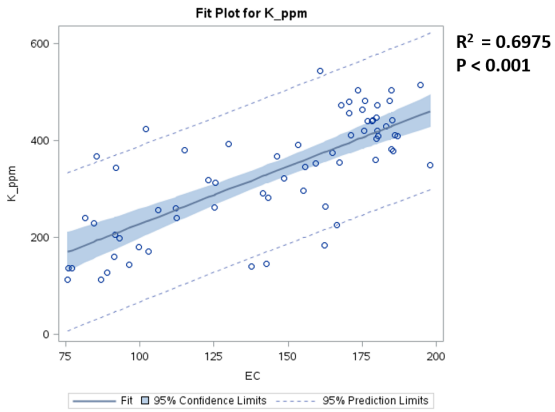
By M. Mulcahy, D. Rebong, A. Athelly, C. Muela & H. Mendoza

LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

Correlation between grid and sensor readings

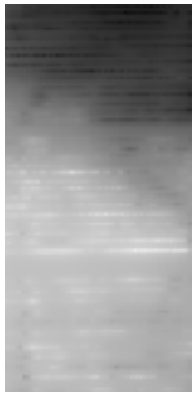


K (ppm)

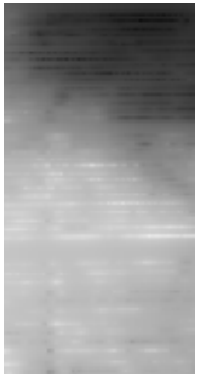


Status: Developing pedotransfer functions using different EC frequencies to predict K and CEC.

10Khz



K map

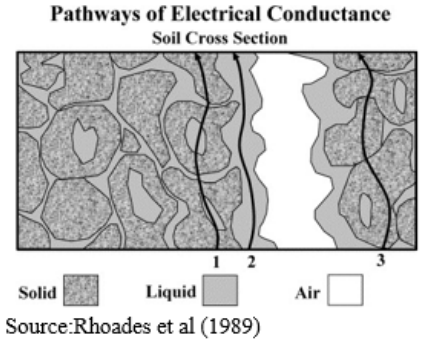


USE OF PRECISION AG SENSOR TECHNOLOGY FOR SWEET POTATO YIELD ESTIMATION

Luciano Shiratsuchi and Arthur Villordon

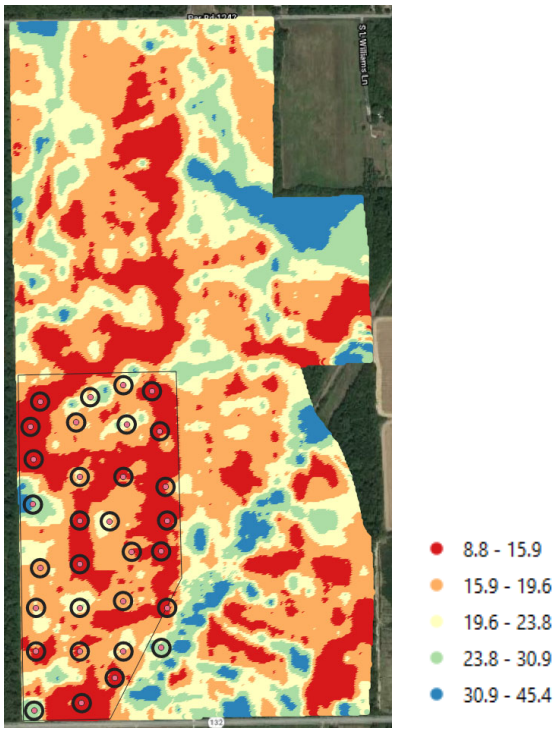
Acknowledgments: Louisiana Sweet Potato Commission and Black Gold Farms

Precision Agriculture

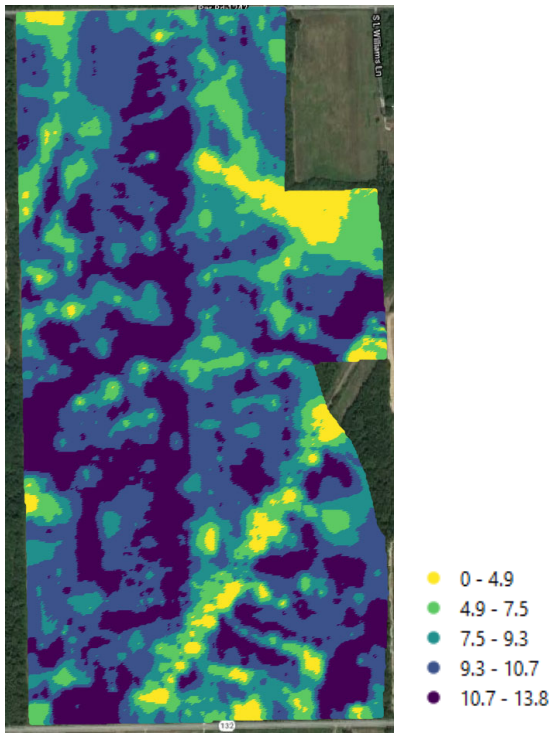


Source:Rhoades et al (1989)

Profiler 15 khz

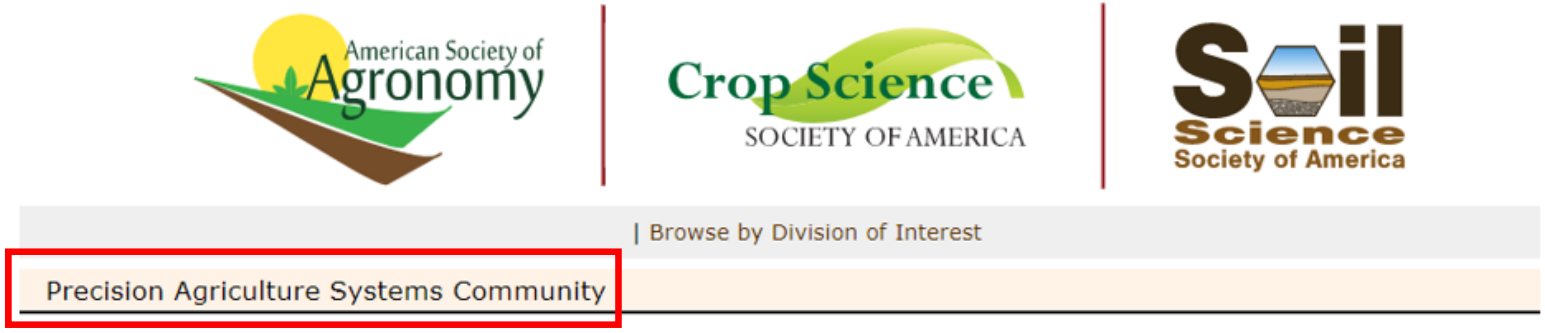


Sweet Potato Yield



Precision Agriculture

ASA, CSSA and SSSA International Annual Meetings (2020):



Phoenix - AZ

Symposium 2020 – Smart Farming Enabled by Remote Sensing Big Data
Organizers: Leader (Sanaz Shafian), Vice-Leader (Luciano Shiratsuchi)
Moderator: Luciano Shiratsuchi

Salt Lake City - UT

Symposium 2021 – Smart Farming Enabled by Proximal Soil Sensors
Organizers: Leader (Luciano Shiratsuchi), Vice-Leader (election pending)

LSU AgCenter
Research · Extension · Teaching
Precision Agriculture

Acknowledgments

Cooperator farmers

Hardwicks
Garret Marsh

STPAL Staff

Michael Breithaupt
Sue Chin

LSU Faculty

Brenda Tubana

LSU Precision Ag Team

Felippe Karp
Mario Sassaki