Impact of Soil Sampling Grid Size on Efficacy and Economics of Site-Specific Nutrient Application in Cotton

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Introduction

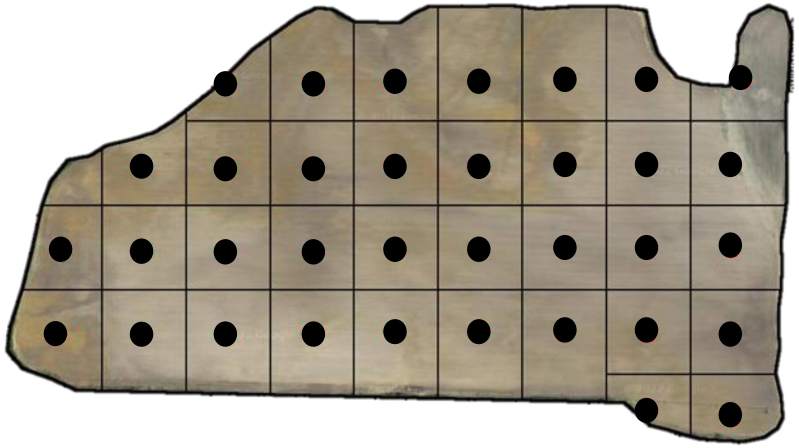
- Most agricultural fields in the southeastern US have large inherent spatial variability –
  - Soil texture and color
  - Nutrients
  - Topography

- This spatial variability also results in crop characteristics –
  - Plant population
  - Crop growth
  - Crop Yield

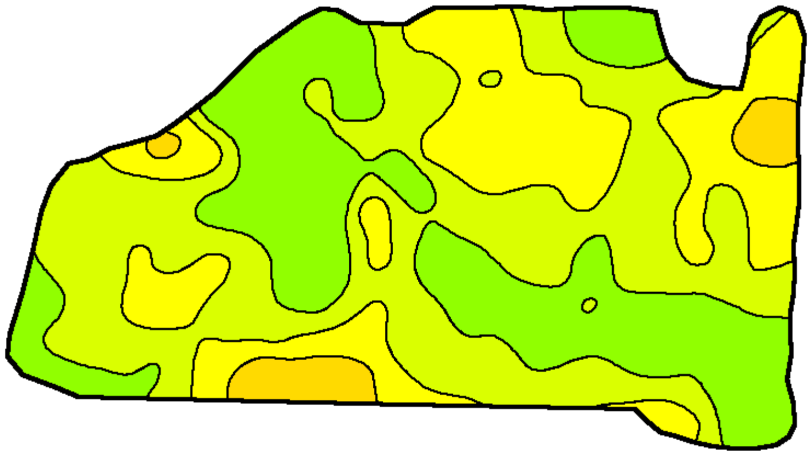
PRECISION SOIL SAMPLING

- Use of precision soil sampling methods –
  - capture soil variability
  - digital map of soil nutrients
  - inform site-specific nutrient prescription (Rx) maps

- Variable rate application of nutrients –
  - Combat variability
  - Right Rate and Right Place (4R's)
  - Only as good as the Rx map



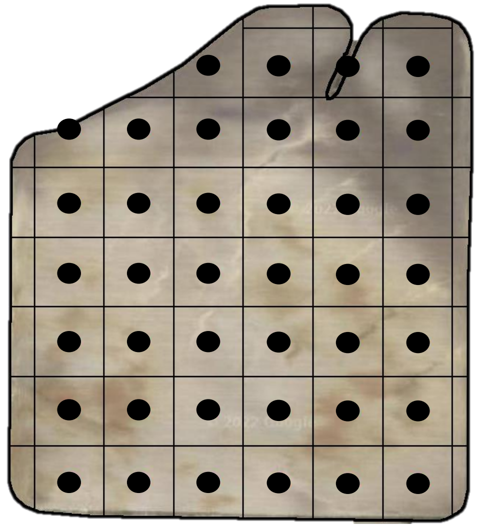
Grid soil sampling map



Interpolated Soil K map

SOIL SAMPLING TRENDS & GROWER QUESTIONS

- Grid sampling remains the most commonly used soil sampling method. *(ease of implementation)*
- The size of soil sampling grid is increasing to reduce soil sampling costs.
- Growers are interested in making data-driven and want to ensure they are using quality data.



Can I save money by choosing a coarse grid?

How does that affect nutrient application accuracy?

Is there an optimal grid size that is cost-effective and accurate?

Hypothesis

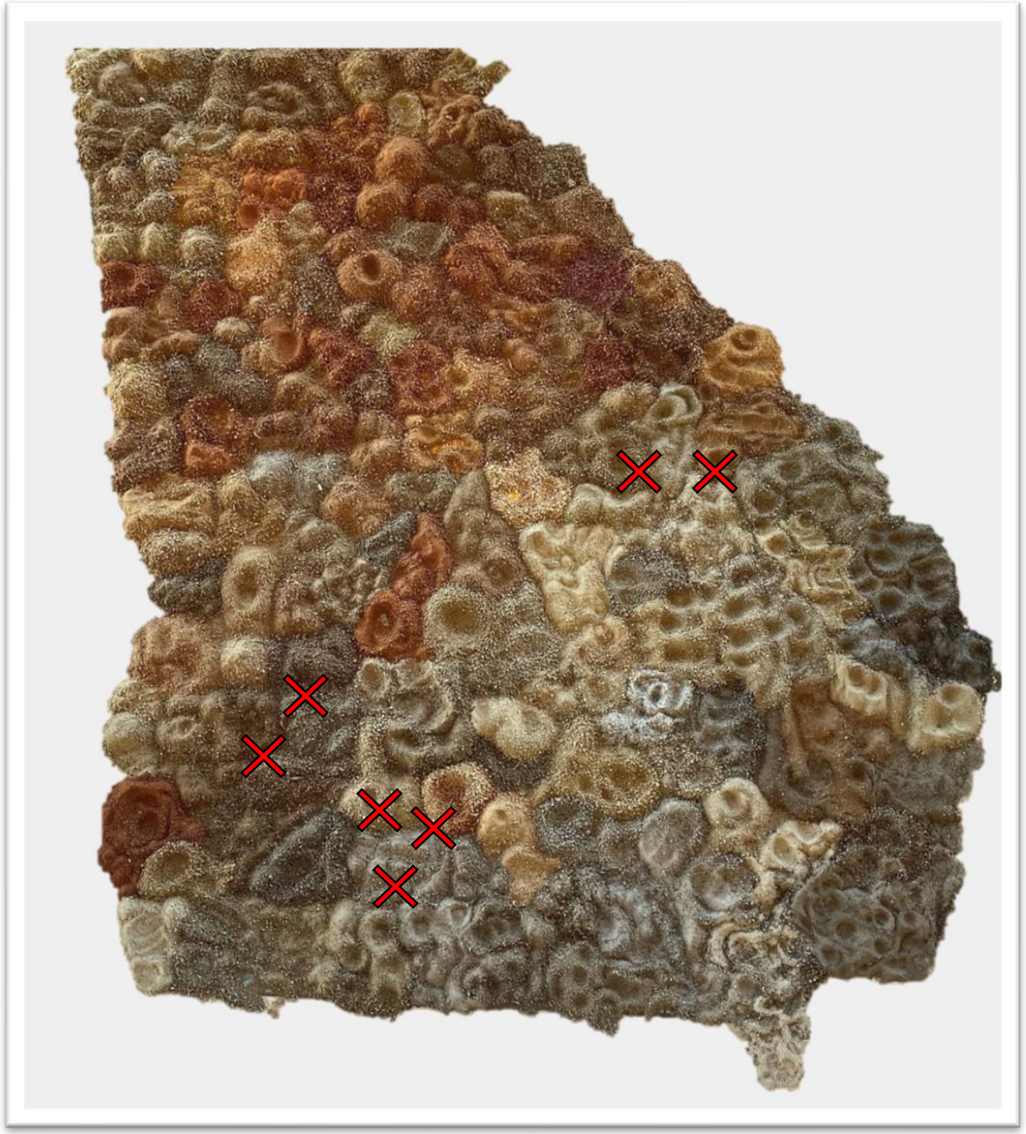
- As increase in grid size will decrease depiction of actual spatial nutrient variability and the accuracy of fertilizer application.
- Large grid sizes will help reduce soil sampling costs but will also increase fertilizer costs due to inaccurate applications.

Objectives

- To evaluate the effectiveness of different soil sampling grid sizes in depicting soil nutrient variability in cotton fields.
- To perform an economic analysis among different grid sizes to determine a cost-effective soil sampling strategy.

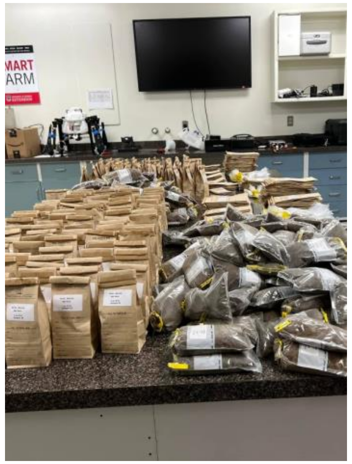
Study Locations

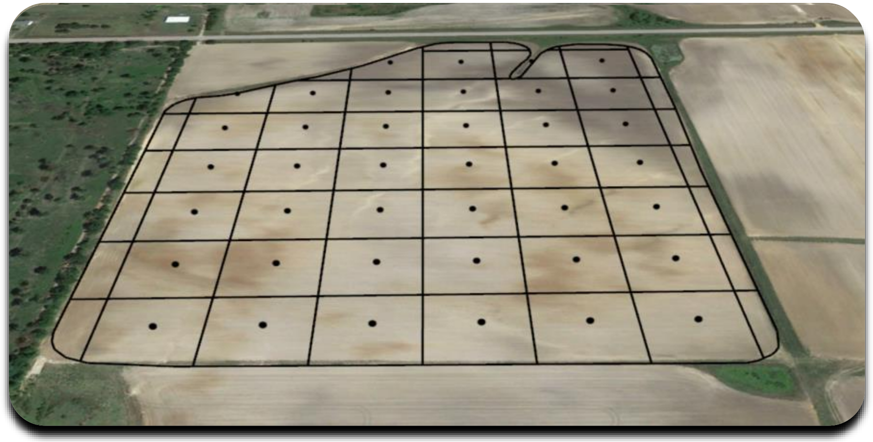
- 9 cotton fields in south Georgia (SE and SW)
- Represented different prevalent soil types of the region (430.1 total acres)
  - Colquitt Co (92.92 ac, 22.59 ac)
  - Terrell Co (62.91 ac)
  - Tift Co (55.34 ac)
  - Worth Co (31.43 ac)
  - Burke Co (22.48 ac)
  - Sumter Co (30.63 ac, 20.50 ac)
  - Jefferson Co (91.27 ac)



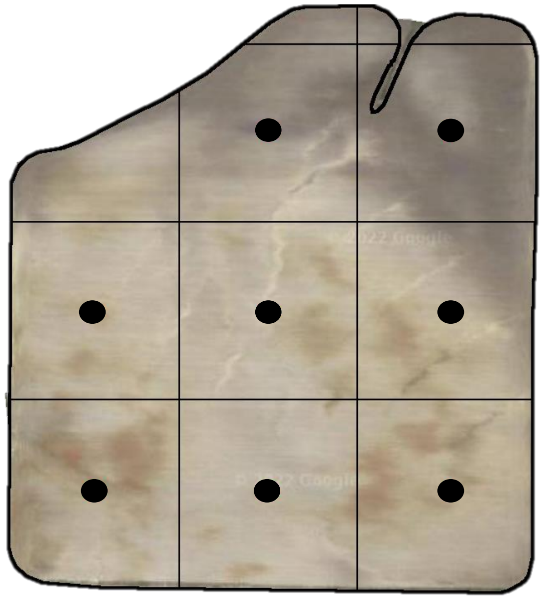
Soil Sampling Methods

- Grid Sampling
  - Five different grid sizes – 1.0, 2.5, 5.0, 7.5, and 10 ac
  - Point sampling method (30 ft from center)
  - 6" depth
  - 12-15 cores

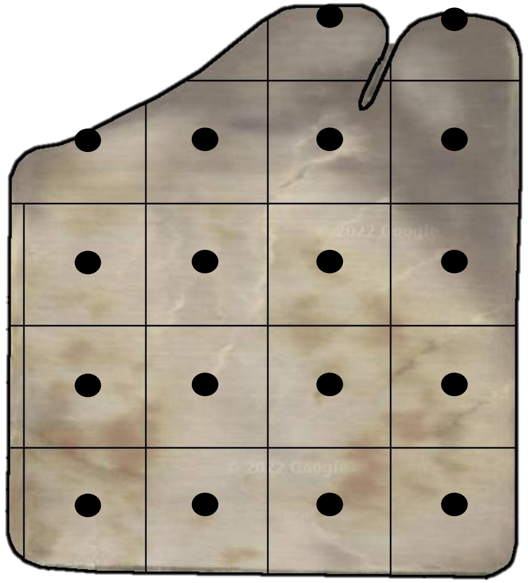




Soil Sampling Maps

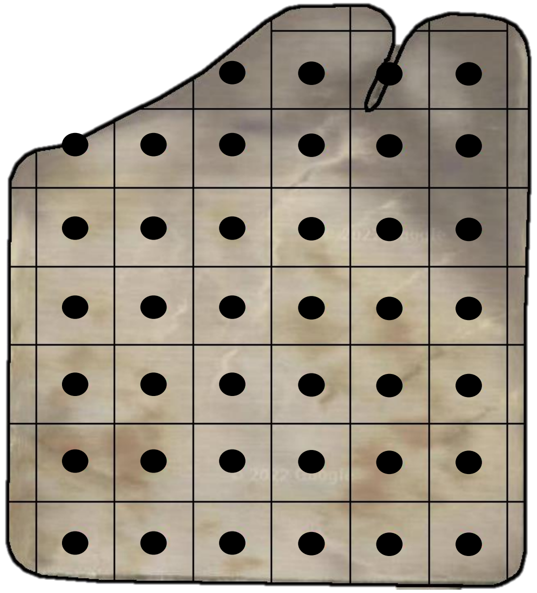


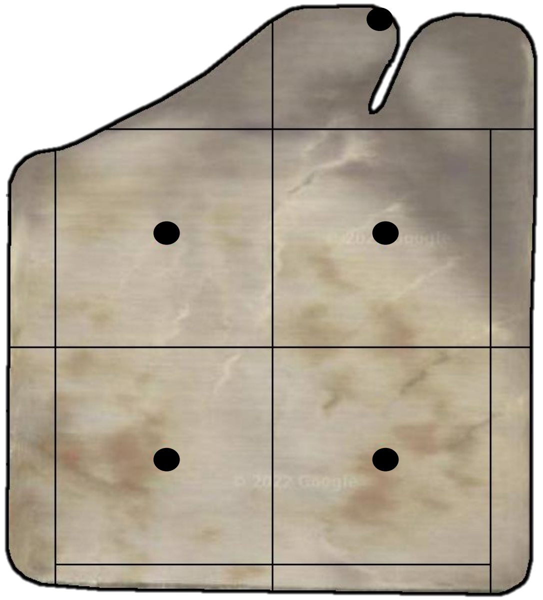
5.0 ac
(8 Samples)



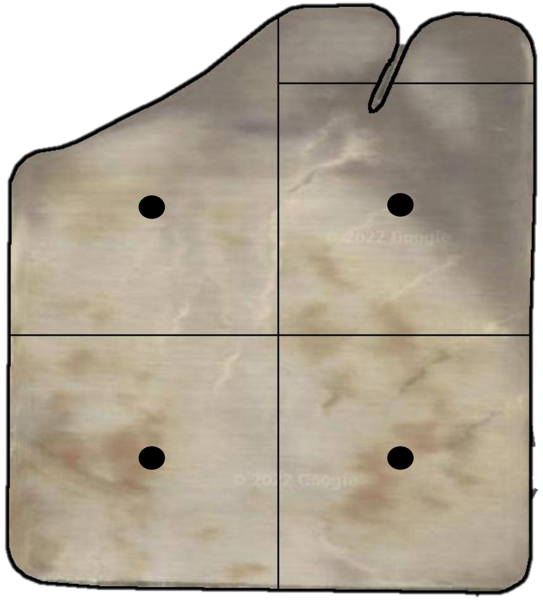
2.5 ac
(18 Samples)

1 ac (40 Samples)





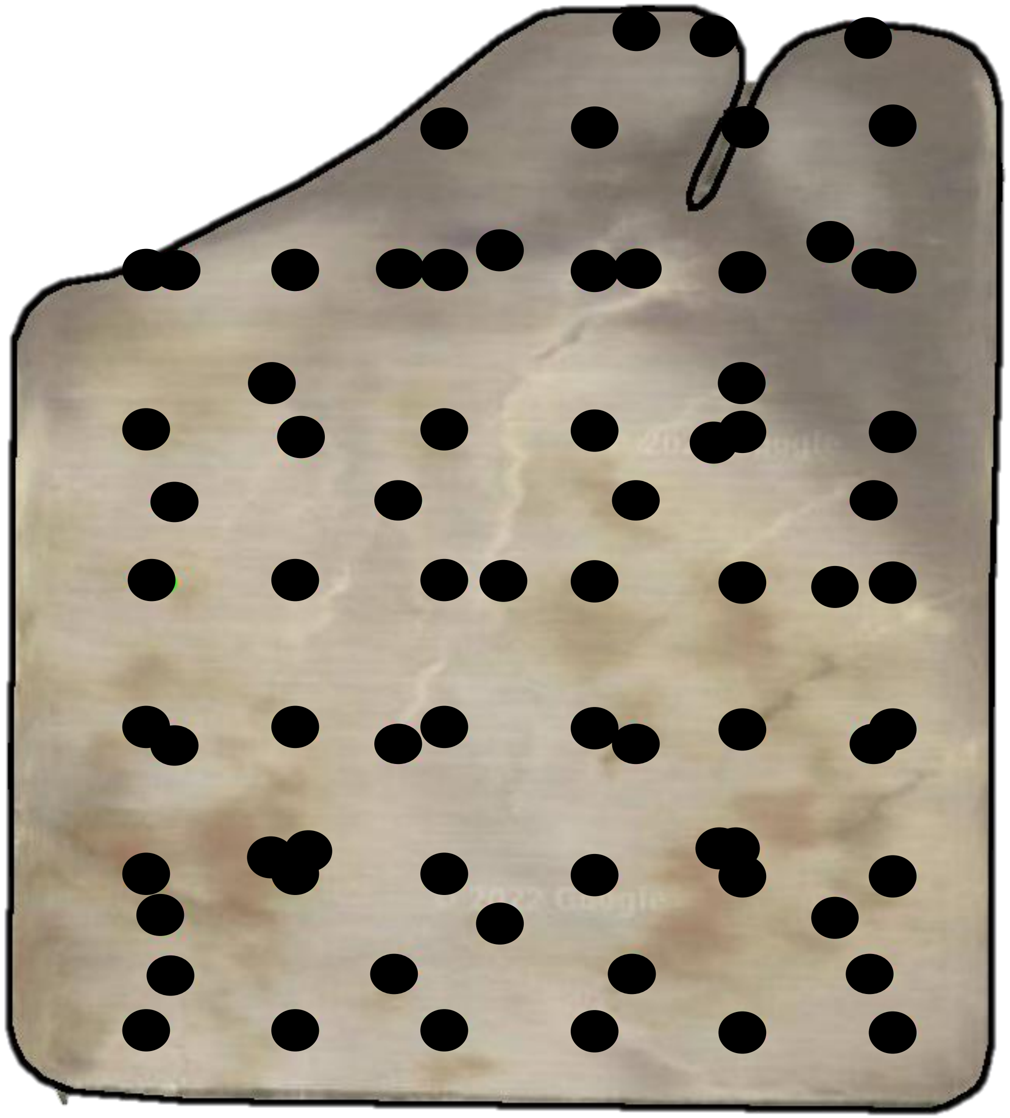
7.5 ac
(4 Samples)



10.0 ac
(4 Samples)

Actual Nutrient Variability

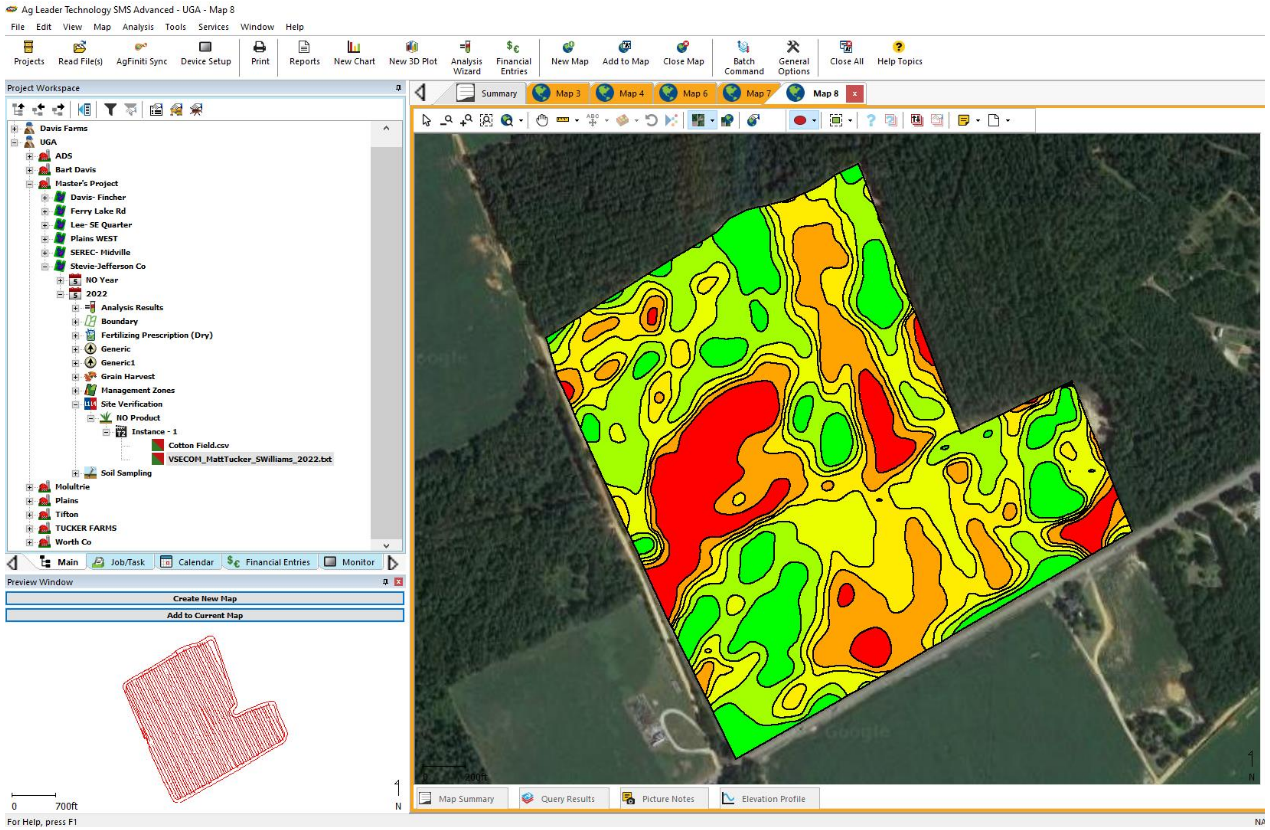
Soil sampling points from all grid sizes (1.0, 2.5, 5.0, 7.5 and 10.0 ac) were combined in this map.



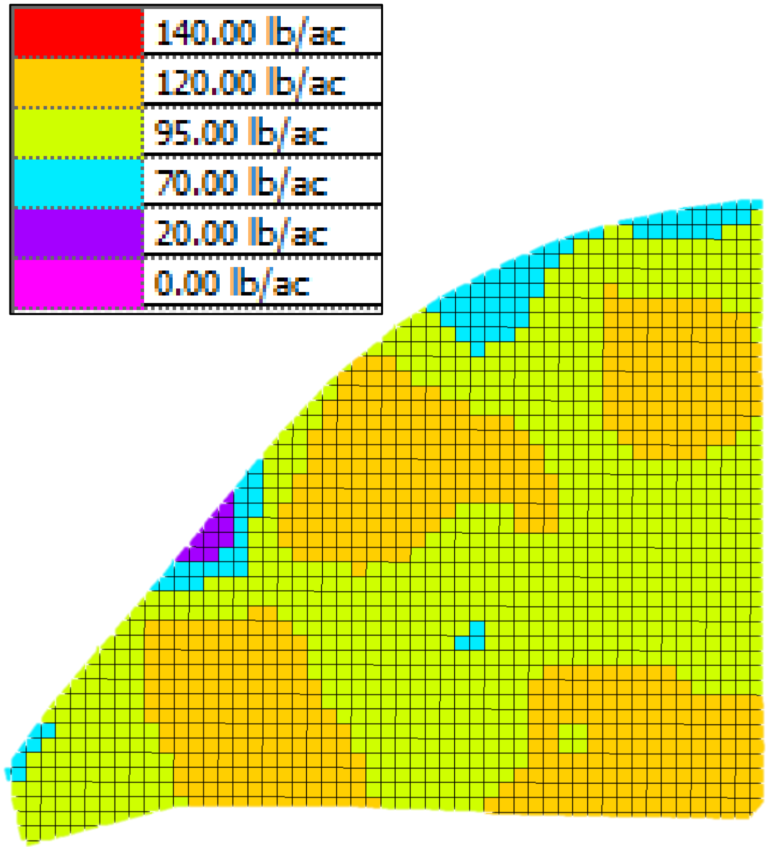
This high-density map (2 samples/ac) was assumed to represent actual nutrient variability.

Data and Spatial Analysis

- Soil test results from each grid strategy were imported into (IDW) in AgLeader SMS Advanced.
- Spatial nutrient maps were generated using IDW interpolation method.
- Prescription (Rx) maps were created for Lime, Phosphorus, and Potassium using **cotton yield goal of 1200 lbs/ac and UGA Cotton Fertility recommendations.**
- Difference maps were created to display and analyze the accuracy of the fertilizer recommendation both numerically and spatially.

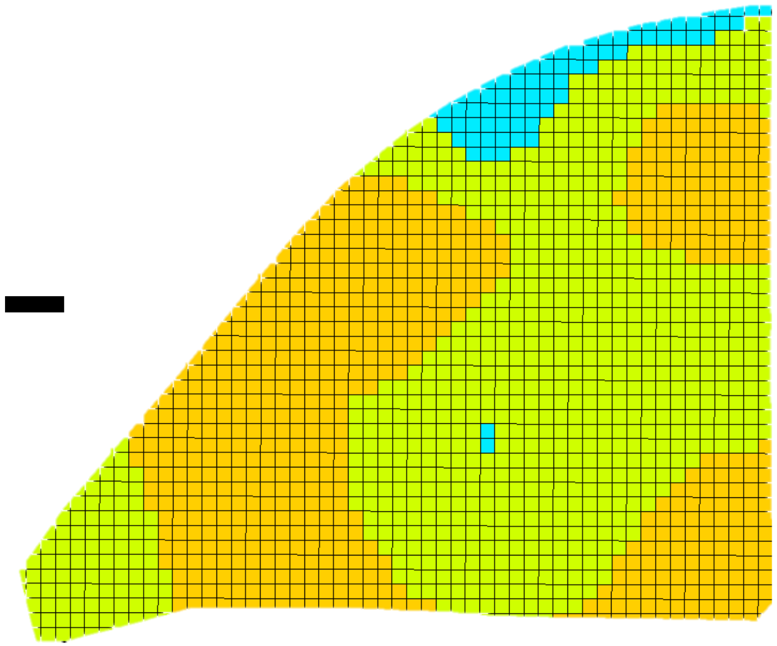


DATA ANALYSIS AND GIS



K Prescription Map
(All points representing actual nutrient variability)

–



K Prescription Map
(2.5 ac grid sampling)

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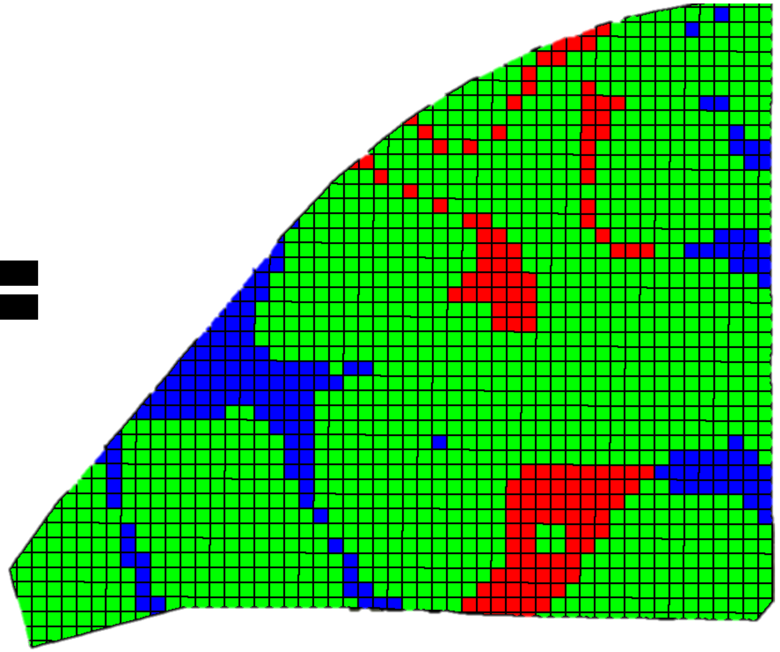

Map showing on-target, under- and over-application areas

Under Applied **On Target** **Over Applied**

Economic Analysis

- The total cost per acre for soil sampling strategy based on each grid size was calculated.
- Fertilizer prices were obtained from the 2022 UGA Cotton Enterprise Budgets (Lime = $50/ton, P = $0.67/lb, K = $0.68/lb).
- Soil sampling costs were based on average fees charged by consultants and soil analysis fees charged by labs. (Soil sampling = $4/ac, Sample analysis = $6.0/sample)

Grid Size (ha)	Samples (#)	Sampling Cost ($/ac)	Analysis Cost ($/ac)	Fertilizer Costs (lb/ac)	Fertilizer Costs ($/lb)	Fertilizer Costs ($/ac)	Total Cost ($/ac)
All	163	4	11	1290	0.025	32	47
1.0	90	4	6	1321	0.025	33	43
2.5	35	4	2	1140	0.025	29	35
5.0	17	4	1	1028	0.025	26	31
7.5	13	4	1	1116	0.025	28	33
10.0	8	4	1	1475	0.025	37	41

Total Cost ($/ac)

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Soil Sampling Cost ($/ac)

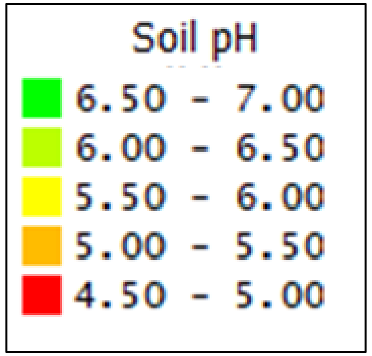
+

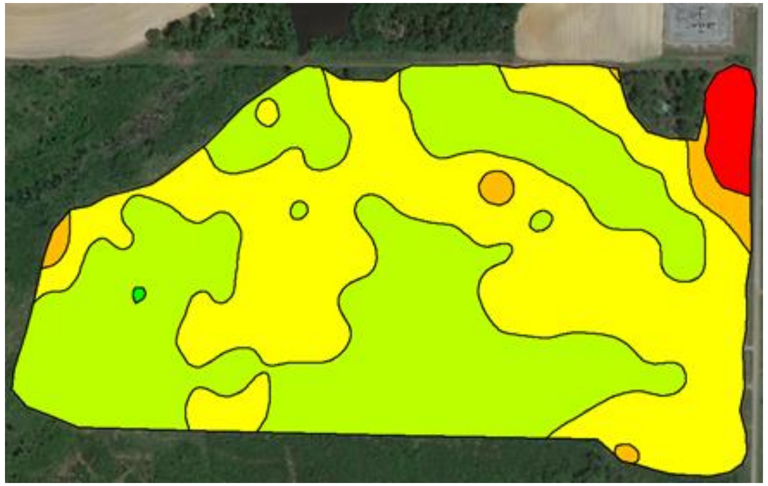
Soil Analysis Cost ($/ac)

+

Fertilizer Cost ($/ac)

Results



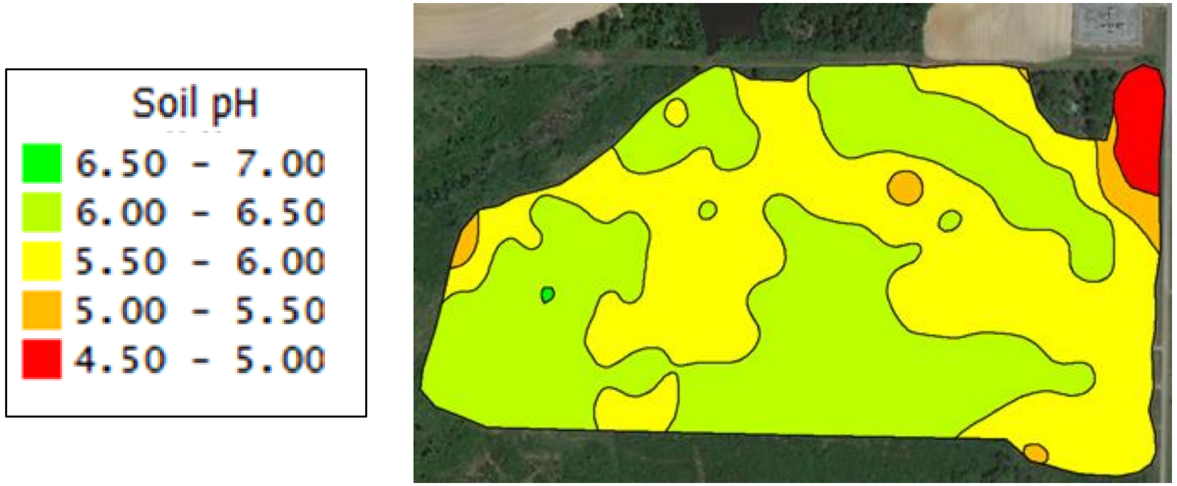


Actual Soil pH Variability (163 Samples)

1 ac (92 samples)

2.5 ac (35 samples)

5 ac (17 samples)

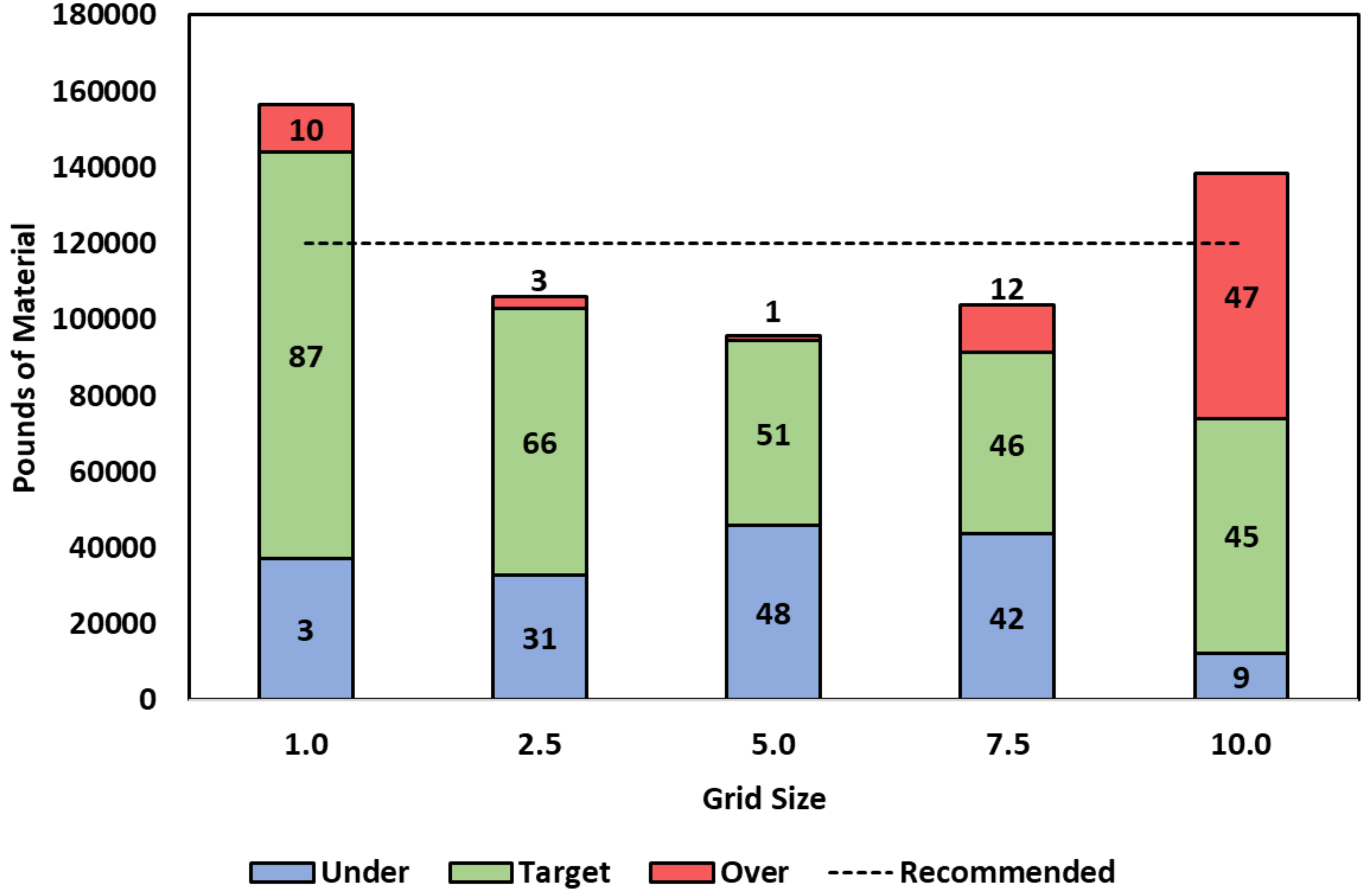


7.5 ac
(13 samples)

10 ac
(8 samples)

Application Accuracy and Cost

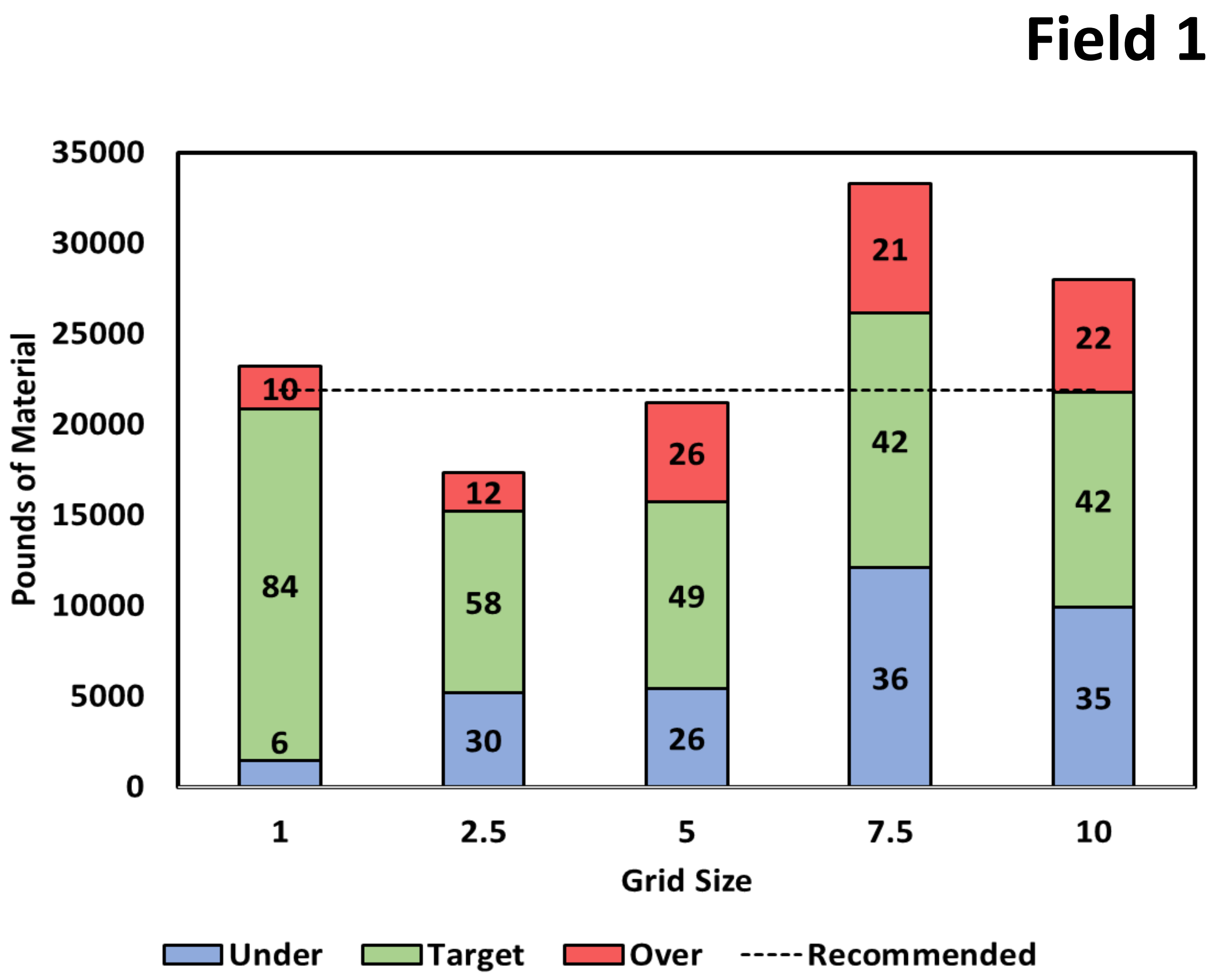
Field 1 - Lime



Grid Size (ac)	Analysis Cost ($/ac)	Lime Cost ($/ac)	Total Cost ($/ac)
1.0	10	33	43
2.5	6	29	35
5.0	5	26	31
7.5	5	28	33
10.0	5	37	41

***Sampling cost ($4/ac) was constant among all grid sizes.**

Total Fertilizer Applied

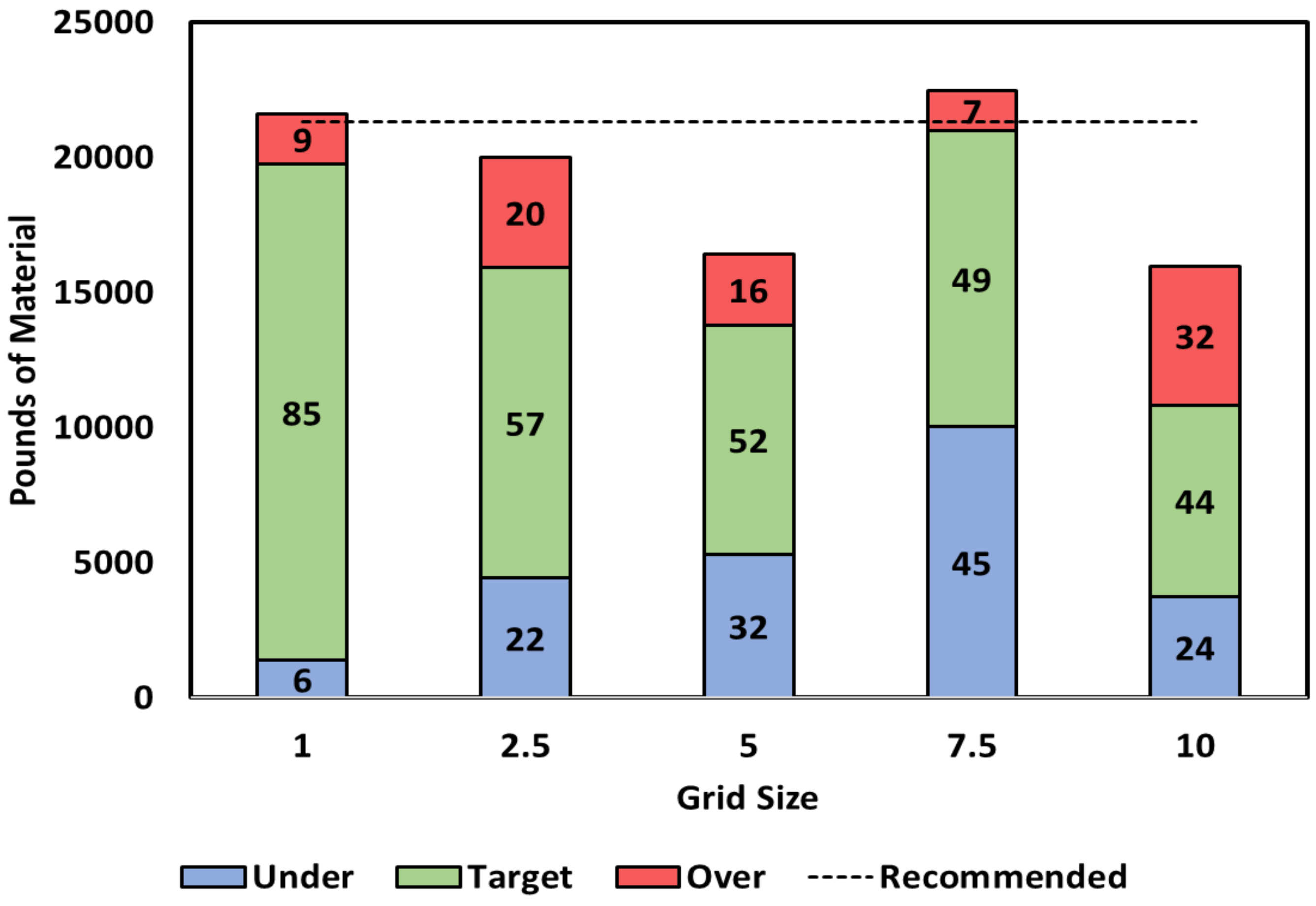


Grid Size (ac)	Analysis Cost ($/ac)	P Cost ($/ac)	Total Cost ($/ac)
1.0	10	27	37
2.5	6	21	27
5.0	5	26	31
7.5	5	20	24
10.0	5	18	23

***Sampling cost ($4/ac) was constant among all grid sizes.**

Total Fertilizer Applied

Field 1 - K



Grid Size (ac)	Analysis Cost ($/ac)	K Cost ($/ac)	Total Cost ($/ac)
1.0	10	46	56
2.5	6	48	54
5.0	5	42	48
7.5	5	36	41
10.0	5	51	55

***Sampling cost ($4/ac) was constant among all grid sizes.**

Grid Size – Effectiveness vs Cost

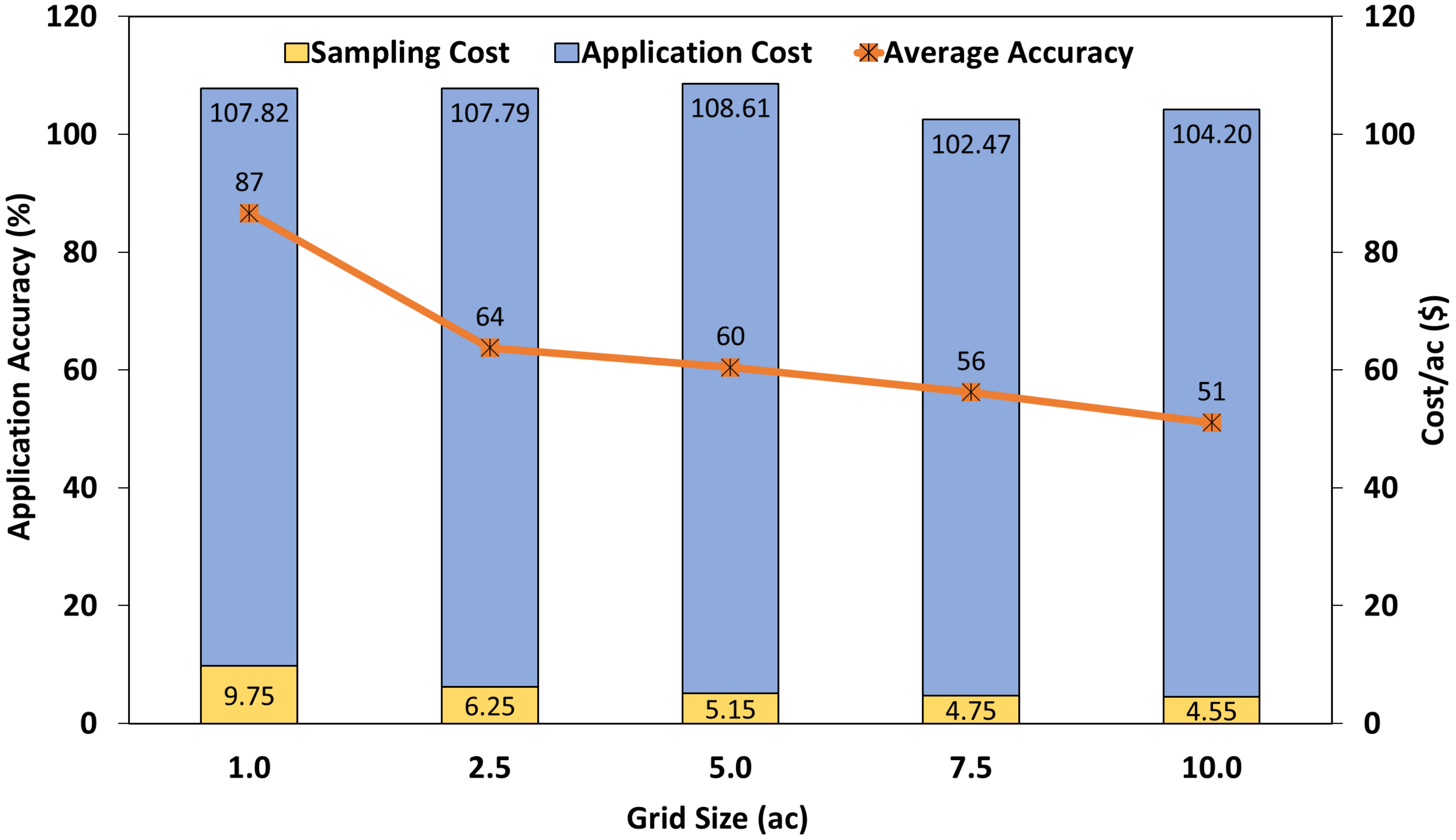
Application Accuracy (%)

Grid Size	F1	F2	F3	F4	F5	F6	F7	F8	F9
1.0	87	89	95	90	95	75	91	90	91
2.5	66	85	92	78	93	82	41	70	13
5.0	51	75	75	81	87	80	68	65	77
7.5	46	66	94	11	92	75	41	70	81
10.0	45	34	65	54	30	75	41	48	76

Application Costs ($/ac)

Grid Size	F1	F2	F3	F4	F5	F6	F7	F8	F9
1.0	43	20	34	33	34	43	40	38	56
2.5	35	14	28	27	30	41	31	33	64
5.0	31	15	23	26	32	41	35	36	55
7.5	33	20	30	5	30	42	30	31	51
10.0	41	17	22	18	39	42	30	22	55

Are Larger grid sizes really cost-effective?



Conclusions

- Highest application accuracy (>80%) was observed for the 1-ac grid size while the accuracy decreased below 60% for grid sizes of 5.0, 7.5 and 10.0 ac.
- While soil sampling cost decreased (from $9.75 to $4.45) with an increase in grid size, the total application costs were still comparable among different grid sizes.
- Results showed that precision soil sampling on smaller grid size (1.0 – 2.5 ac) is more cost-effective and optimal for ensuring high application accuracy.

Future Work

Evaluate the use of remote sensed spatial data to delineate management zones for soil sampling to reduce cost of sampling and increase accuracy of nutrient maps.

Thank You!

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