Using GreenSeeker® to Drive Variable Rate Application of Nitrogen, PGRs and Defoliants on Cotton

George Vellidis

The University of Georgia

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Research Partners

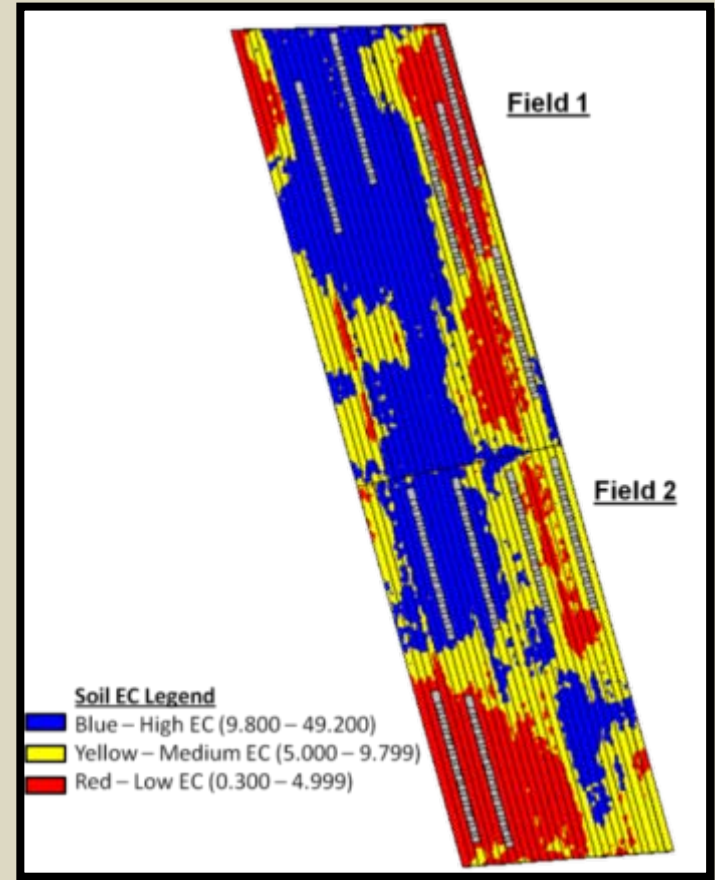## University of Georgia

- Dr. Glen Harris

- Mr. Herman Henry

- Mr. Rodney Hill

- Mr. Calvin Perry

- Dr. Glen Ritchie

- Ms. Heather Savelle

- Mr. Sergio Villagran

## Financial Support

- Georgia Cotton

  Commission

- Cotton, Inc.

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Why VRA in Georgia Cotton?

Soil EC Legend
Blue – High EC (9.800 – 49.200)
Yellow – Medium EC (5.000 – 9.799)
Red – Low EC (0.300 – 4.999)

Field 1

Field 2

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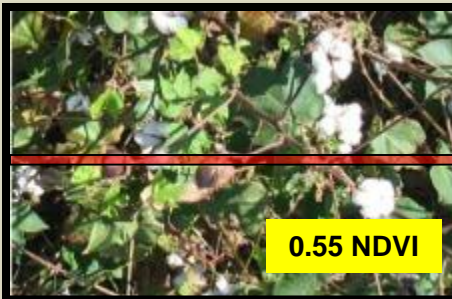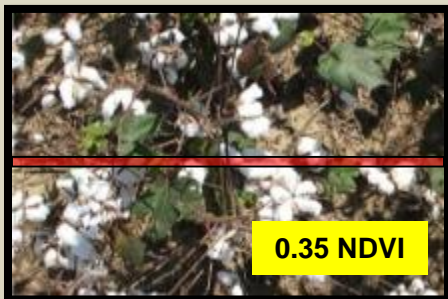
GreenSeeker®

- Generates light at two wavelengths
  - Red and NIR
  - measures the light reflected from the plants

- Reflectance used to calculate NDVI

- NDVI = Normalized Difference Vegetative Index

  - Most common Vegetative Index
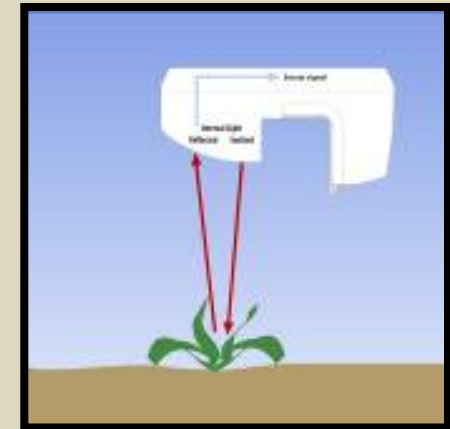
$$NDVI = \frac{NIR_{reflectance} - Red_{reflectance}}{NIR_{reflectance} + Red_{reflectance}}$$

GreenSeeker® Sensors "look" straight over row/crop and NDVI values change based upon size and vigor of crop.

0.25 NDVI

0.35 NDVI

0.55 NDVI

0.70 NDVI

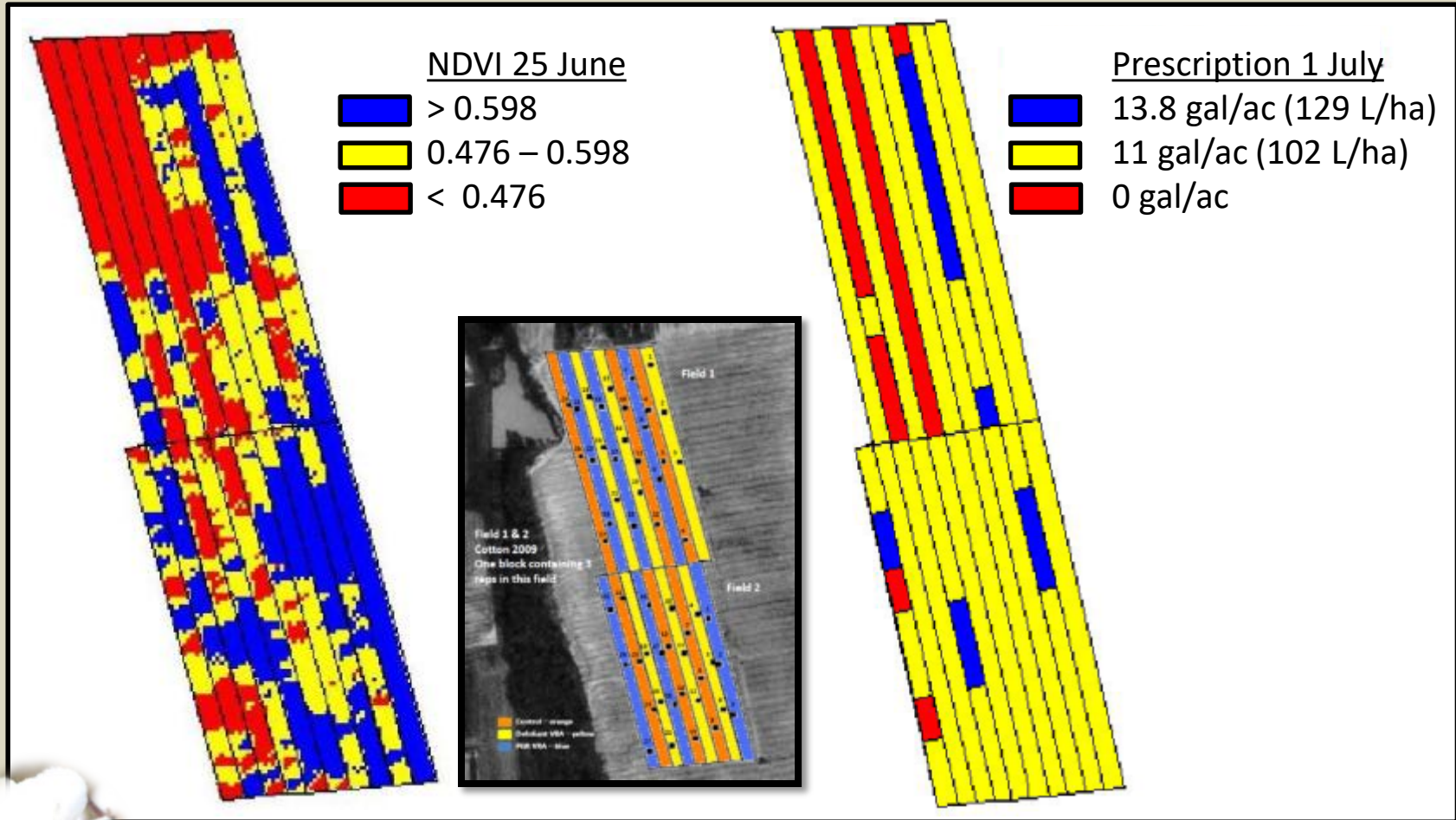Photos courtesy of Ted Mayfield
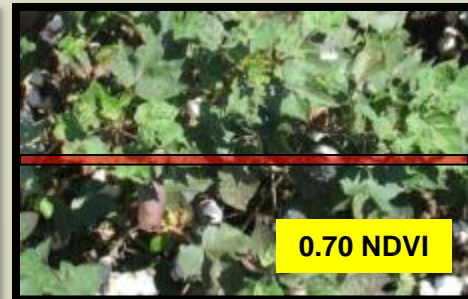
NDVI Mapping

- GreenSeeker® RT200 six-sensor system

- Trimble ® DGPS

VRA of PGRs and Defoliant

- MidTech Legacy ® variable rate controller
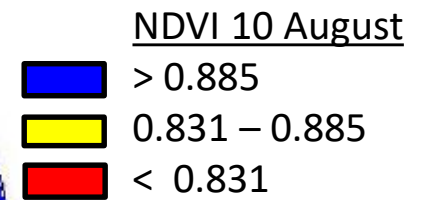
- Trimble ® DGPS

PGR NDVI Maps

NDVI 25 June
- > 0.598 (blue)
- 0.476 – 0.598 (yellow)
- < 0.476 (red)

Prescription 1 July
- 13.8 gal/ac (129 L/ha) (blue)
- 11 gal/ac (102 L/ha) (yellow)
- 0 gal/ac (red)

PGR NDVI Maps

Plant Height (m)
- 🟦 > 1.2
- 🟨 0.8 – 1.2
- 🟥 < 0.8

NDVI 10 August
- 🟦 > 0.885
- 🟨 0.831 – 0.885
- 🟥 < 0.831

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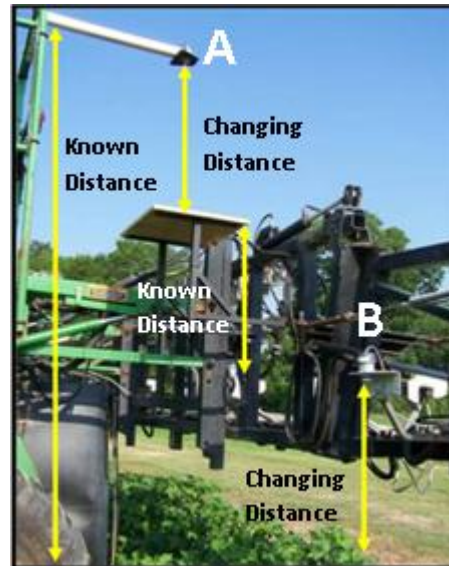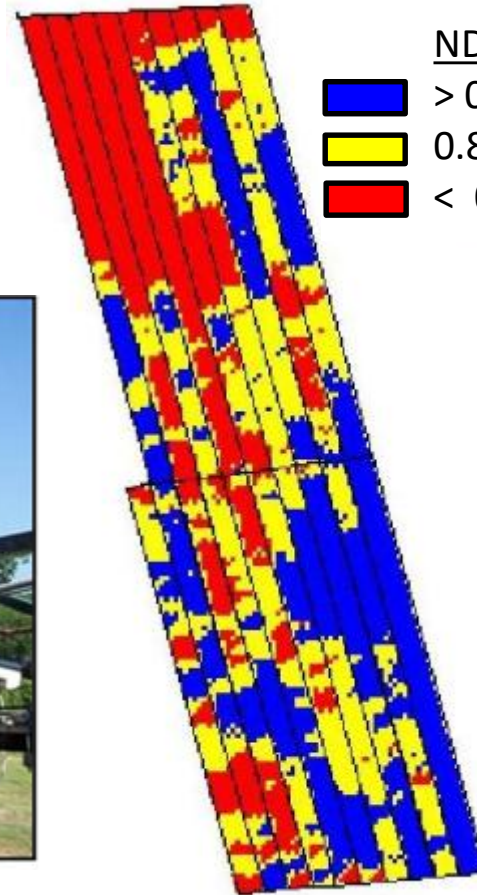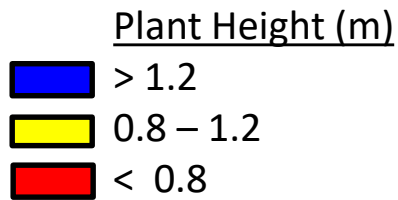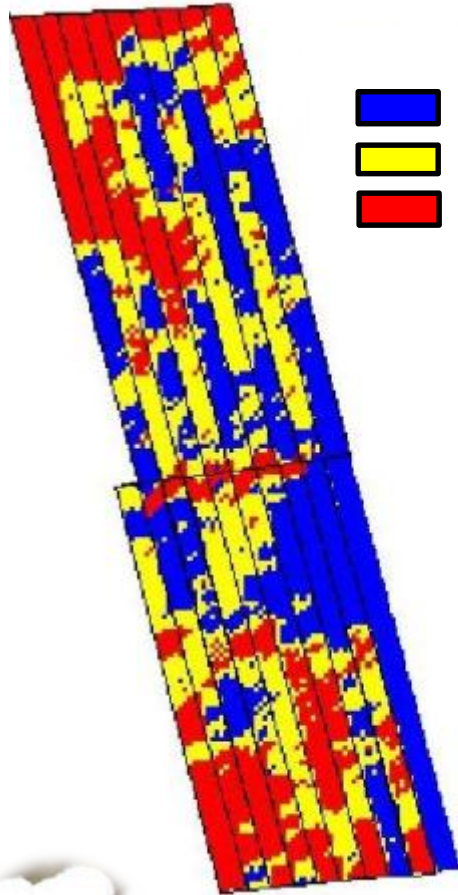
Defoliant Prescription Maps
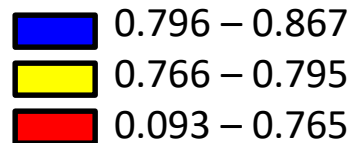
Field 3 NDVI 22 Sept 09

NDVI Legend
- 0.796 – 0.867
- 0.766 – 0.795
- 0.093 – 0.765

Field 3 Defoliant Rx Map
01 Oct 09

Defoliant Rx Rates
- 14 gal/ac (130 L/ha)
- 11.2 gal/ac (104 L/ha)
- 10 gal/ac (93 L/ha)
- 8 gal/ac (74 L/ha)

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NDVI & Prescription Maps
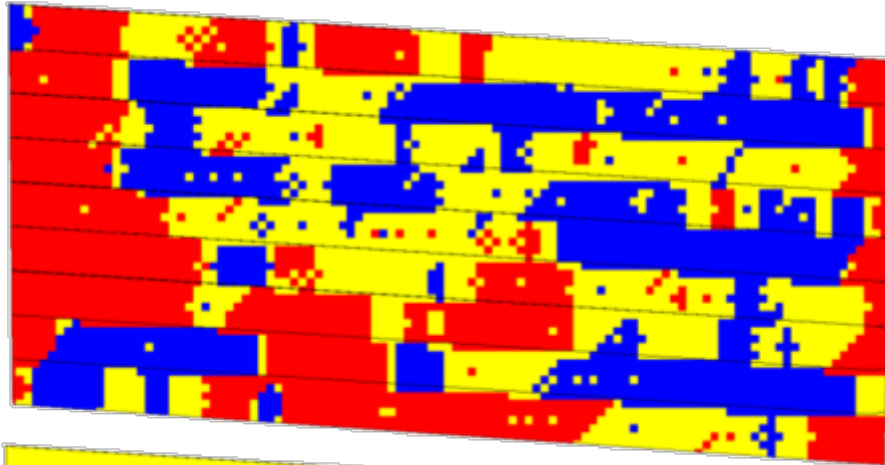

Field 3 NDVI 22 Sept 09

NDVI Legend

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- 0.766 – 0.795
- 0.093 – 0.765
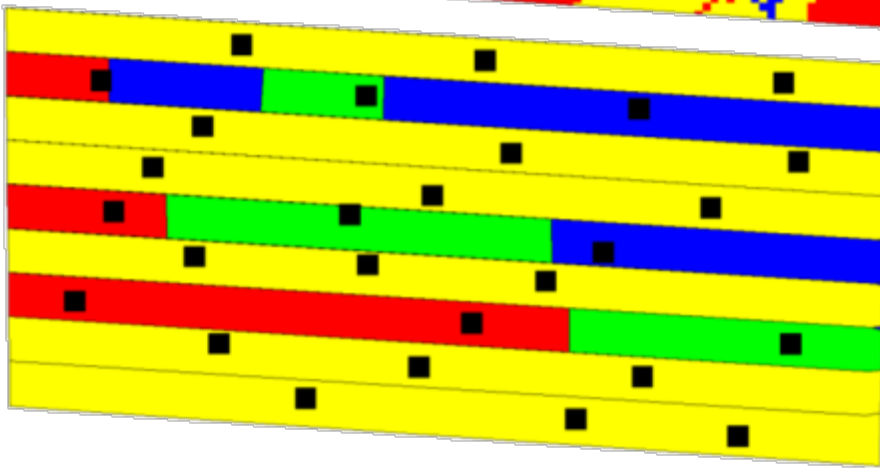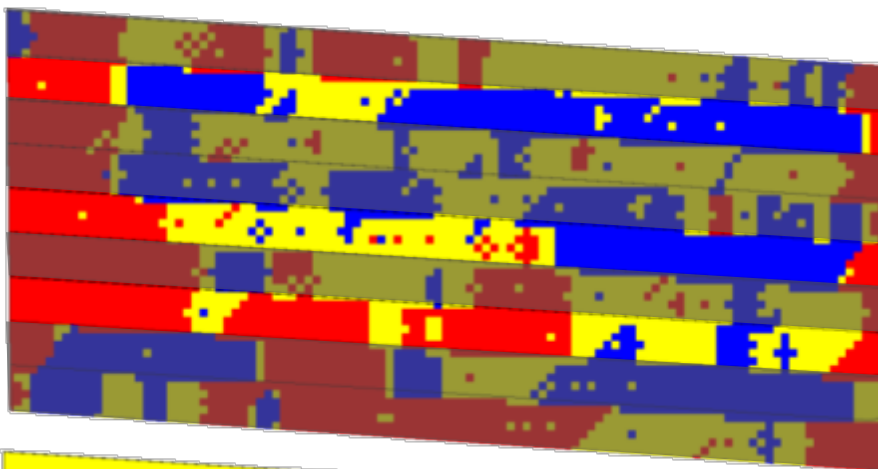
Field 3 Defoliant Rx Map
01 Oct 09

Defoliant Rx Rates

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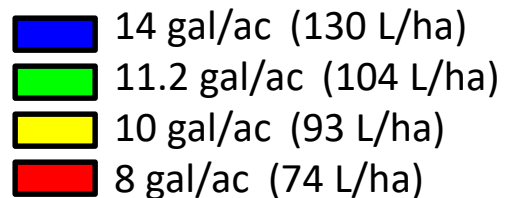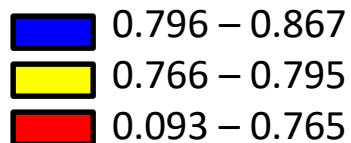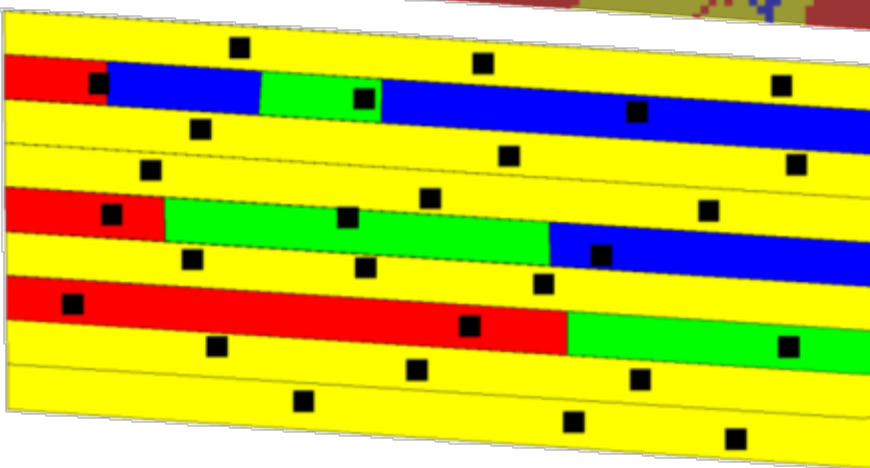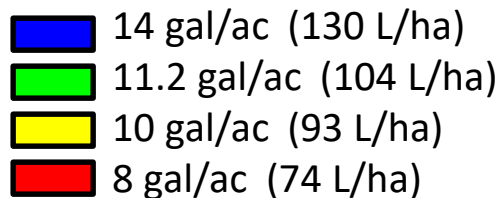
PGR Comparisons – Uniform vs VRA

Difference in Volume Used:

- July 1: 14% less/acre
- July 24: 6.5% less/acre
- August 11: 1% less/acre
- **Season Total: 7% less/acre**

PGR Cost Difference per Acre:

Field 1&2:
- Uniform rate: $1.62/ac ($4/ha)
- VRA rate: $1.48/acre ($3.7/ha)
- **Uniform - VRA: +$0.14/ac ($0.35/ha)**

Field 3:
- Uniform rate: $1.62/ac ($4/ha)
- VRA rate: $1.53/ac ($3.8'ha)
- **Unifrom - VRA: +$0.10/ac ($0.25/ha)**

Average Difference: +$0.12/ac ($0.30/ac)

* + indicates net gain as a result of using VRA

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PGR Results

Plant Growth Parameters: VRA Compared to Uniform

Legend: Fruit Biomass, Total Biomass, Plant Height, LAI

x-axis: Sampling Date (1, 2, 3, 4)

y-axis: % Difference from Uniform Application (80–125)
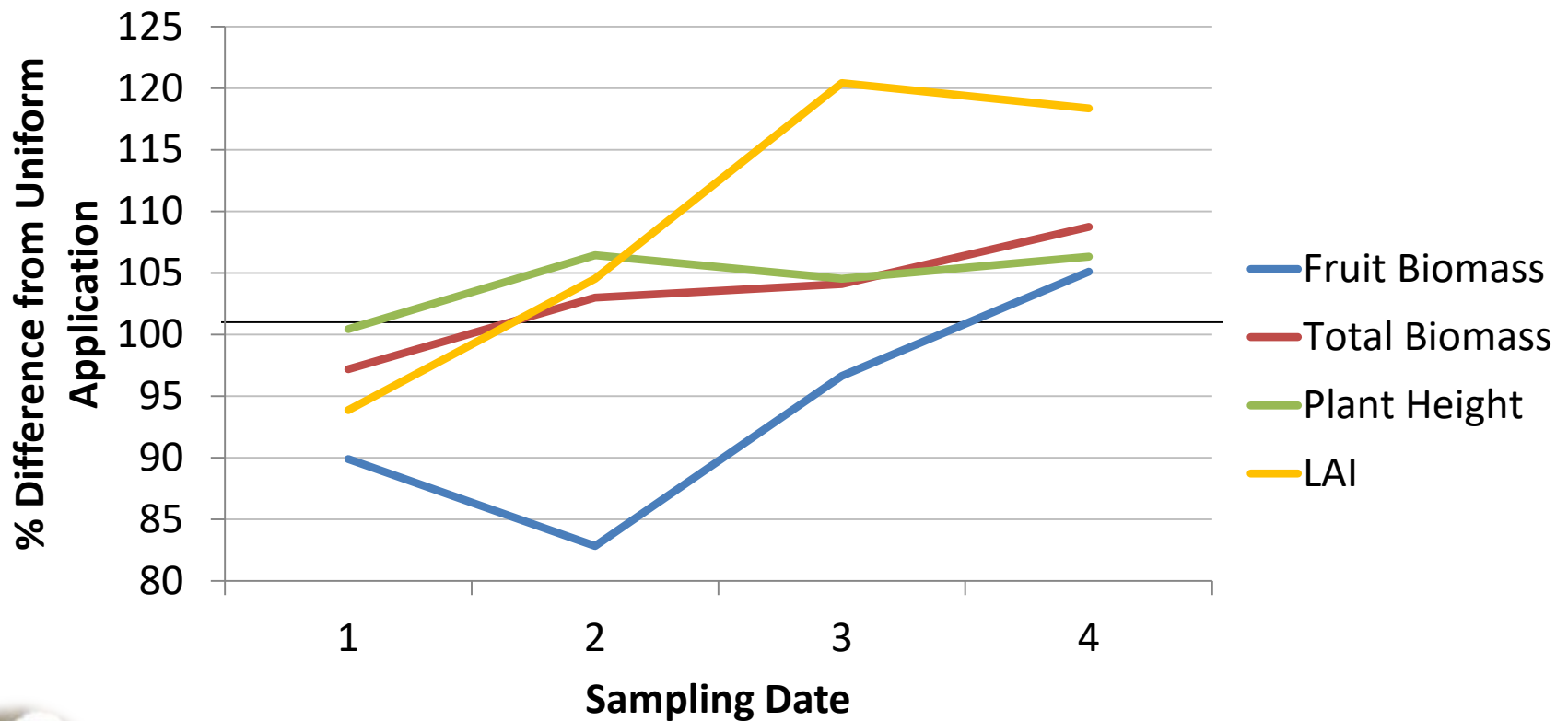
Defoliation Formulations

Uniform Rate	Prep	Dropp	Folex
Fields 1, 2, 3	32 (oz/ac)	2 (oz/ac)	6 (oz/ac)

Fields 1&2	Prep (oz/ac)	Dropp (oz/ac)	Folex (oz/ac)
High (100%) 14 gal/ac	32	2.4	10
Med (71.4%) 10 gal/ac	22.9	1.7	7.1
Low (57.1%) 8 gal/ac	18.3	1.4	5.7

Field 3	Prep (oz/ac)	Dropp (oz/ac)	Folex (oz/ac)
High (100%) 14 gal/ac	32	2	8
Med (80%) 11.2 gal/ac	25.6	1.6	6.4
Low (57.1%) 8 gal/ac	18.3	1.1	4.6

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Defoliation Results

Plant Growth Parameters: PGR vs. Uniform

- ### LAI
  - Uniform rate: 98% reduction
  - VRA: 96% reduction

- ### Leaf Biomass
  - Uniform rate: 97.8% reduction
  - VRA: 95% reduction

- ### Boll Opening

Field	% Bolls Opened Between Defoliation and Harvest (14 days)			
	VRA Prep Application Rate			Uniform Prep Rate
	High	Medium	Low	
Field 1	-	71%	70%	82%
Field 2	55%	80%	44%	83%
Field 3	62%	42%	70%	66%

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Defoliation Cost Comparison

Product	Uniform Application ($/ac)	VRA Application ($/ac)		Difference (Uniform –VRA) ($/ac)	
		Field 1&2	Field 3	Field 1&2	Field 3
Dropp	$2.70	$2.28	$2.15	+$0.42*	+$0.55
Folex	$2.87	$3.42	$3.08	-$0.55	-$0.21
Prep	$6.19	$4.44	$4.98	+$1.75	+$1.21

* + indicates net gain as a result of using VRA

Difference in Volume of Product Used

Dropp: 17% less/acre

Folex: 15% more/acre

Prep: 25% less/acre

Difference in Cost (Uniform – VRA)

Fields 1&2: +$1.62/ac ($4/ha)

Field 3:   +$1.55/ac ($3.8/ha)

Average: +$1.58/ac ($6.2/ha)

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Cost Comparison

Products	Difference in Cost (VRA – Uniform) ($/ac)	
	Field 1&2	**Field 3**
PGR	+$0.14	+$0.10
Defoliants	+$1.62	+$1.55
TOTAL	+$1.76	+$1.65

Production Application:

- Average Difference = +$1.71/ac
- Savings on 2000 acres = $3420
- Cost of GreenSeeker = $15,000

Pay for Technology in less than 5 years
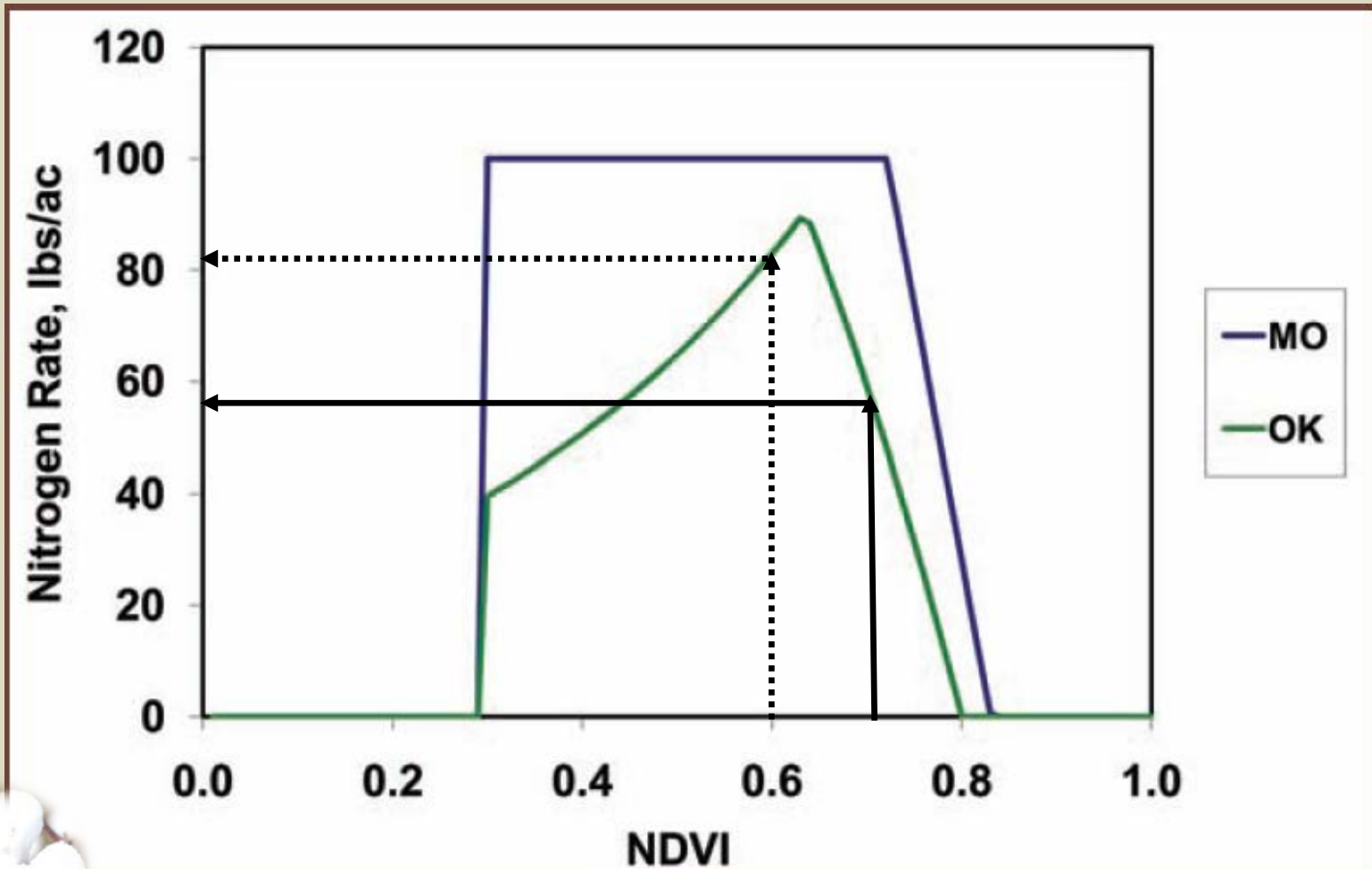
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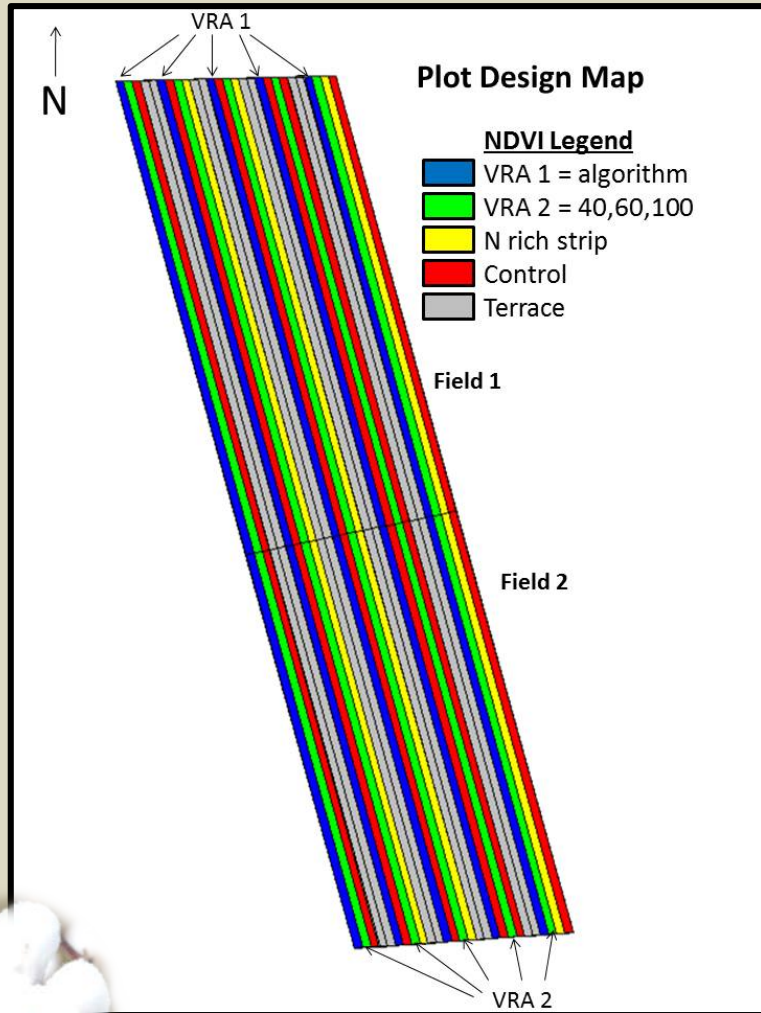
Nitrogen Use in Georgia

- Most important fertilizer used in cotton

- Most difficult to manage

- Low rates → reduce yield and quality

- Excessive N → rank growth, boll rot, delayed maturity, poor quality and yield

- Recommended in GA: 105 lb/ac (117 kg/ha)

  - 25 lb/ac at pre-plant or at planting (28 kg/ha)
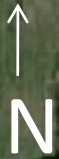
  - 80 lb/ac side-dress (90 kg/ha)

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OK State / Clemson Algorithm

N-Rich Strips

Plot Design Map

NDVI Legend
- VRA 1 = algorithm
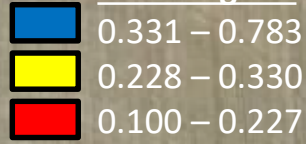- VRA 2 = 40,60,100
- N rich strip
- Control
- Terrace

Field 1

Field 2

VRA 1

VRA 2

N

- 105 lb N/ac applied 08 June 2011

- 28% liquid N

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N

NDVI Map June 21, 2011

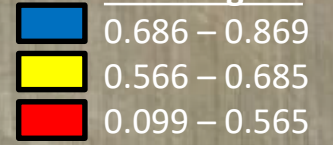**NDVI Legend**
- 0.331 – 0.783
- 0.228 – 0.330
- 0.100 – 0.227

NDVI Map July 7, 2011

NDVI Legend
- 0.686 – 0.869
- 0.566 – 0.685
- 0.099 – 0.565
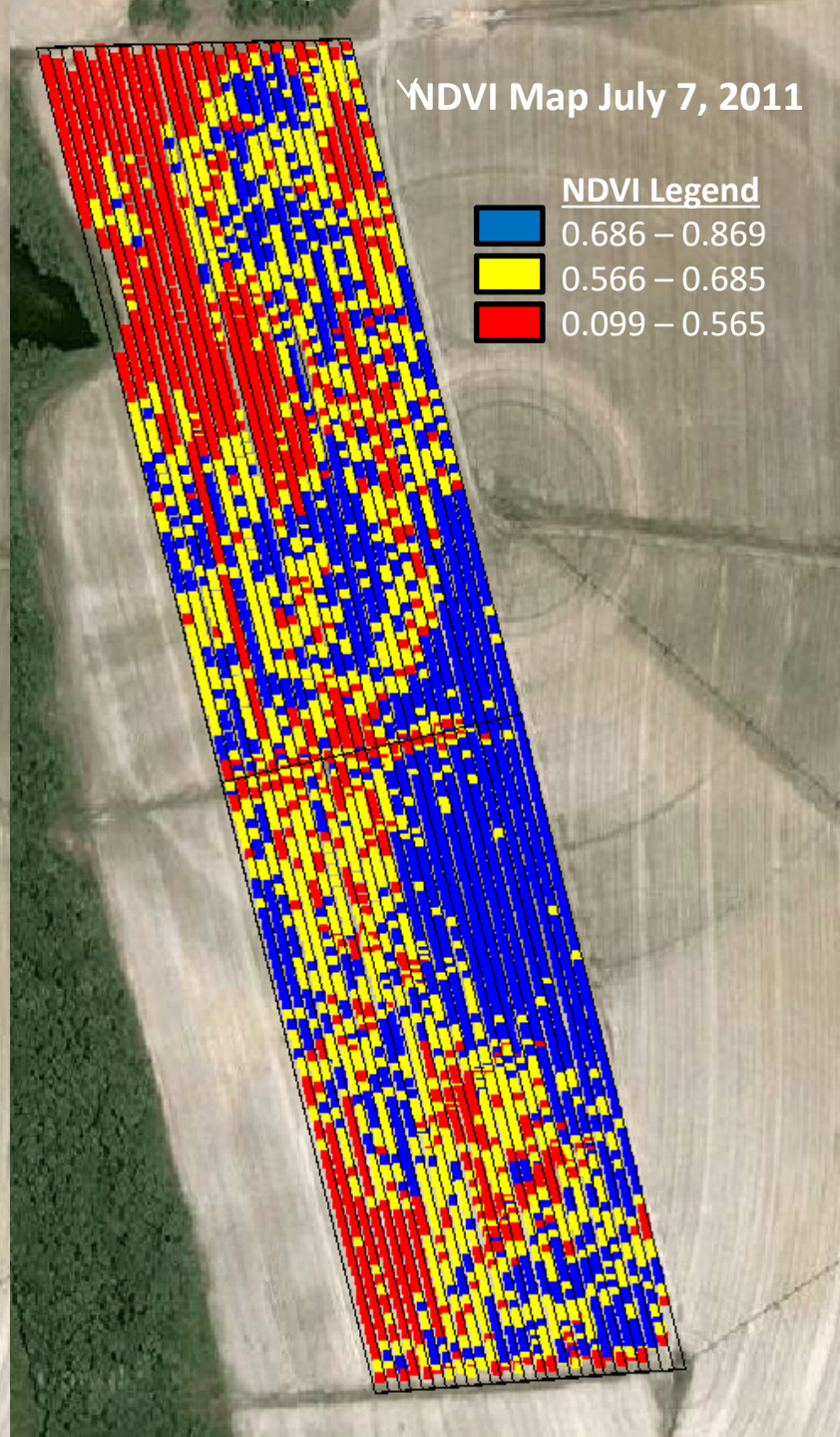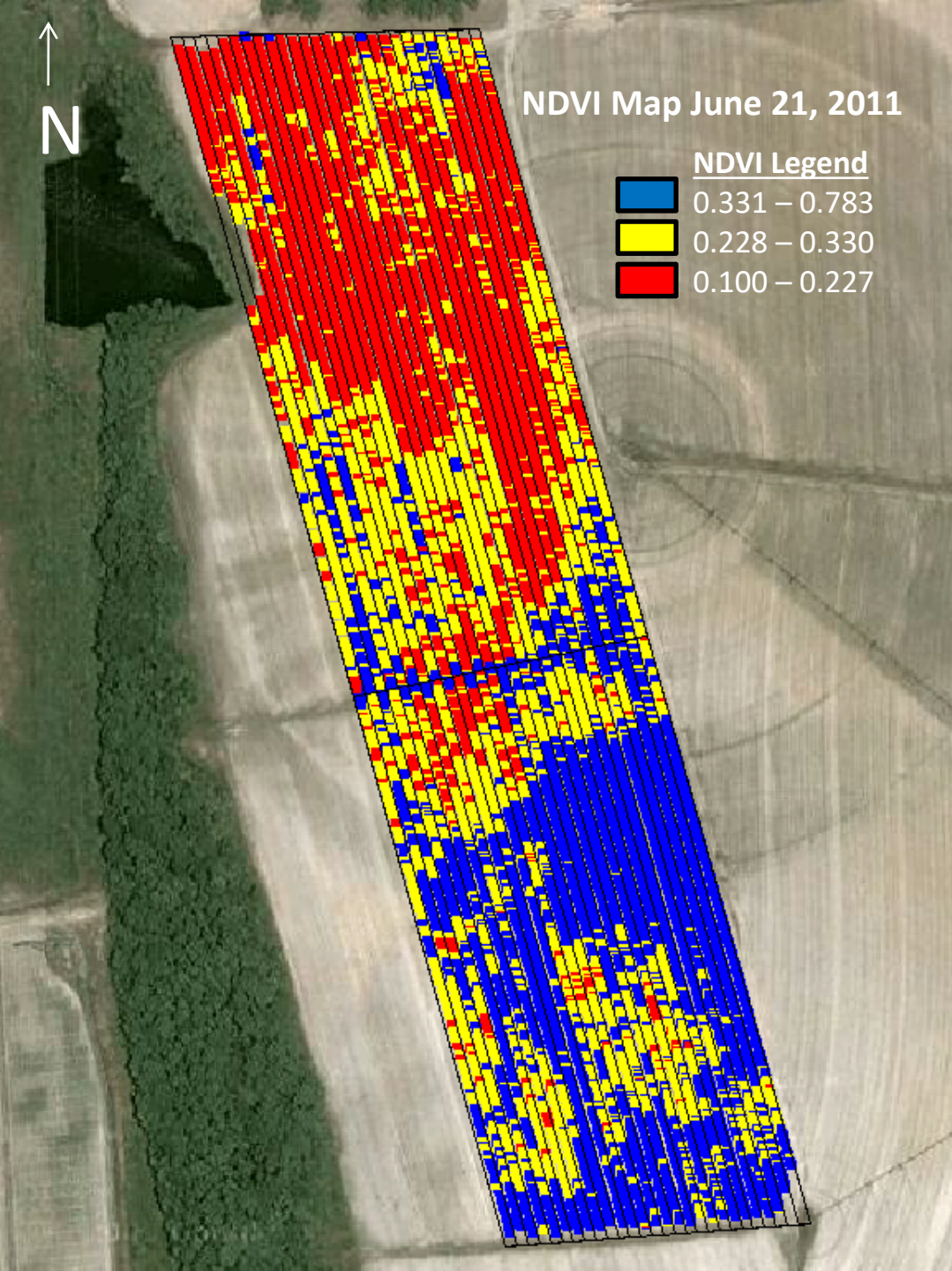
Prescription Maps

- Based on 07 July NDVI map
  - Use NDVI to assess yield potential
  - N-rich strips not effective
- Two VRA treatments
  - OK State / Clemson algorithm applied to each field
  - User-selected rates

NDVI Map
July 7, 2011

NDVI Legend
0.686 – 0.869
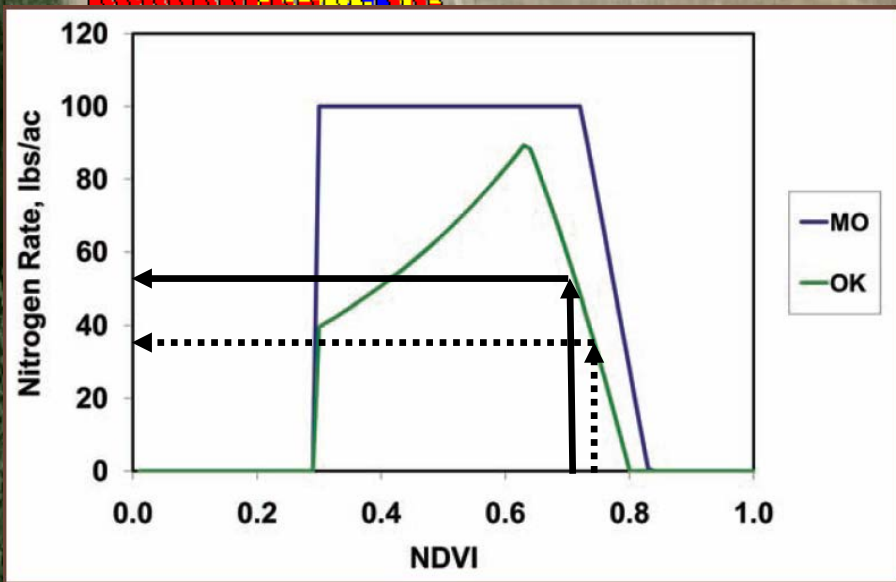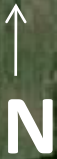0.566 – 0.685
0.099 – 0.565

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N

NDVI Map July 7, 2011

Field 1

Field 2

NDVI Legend
0.686 – 0.869
0.566 – 0.685
0.099 – 0.565
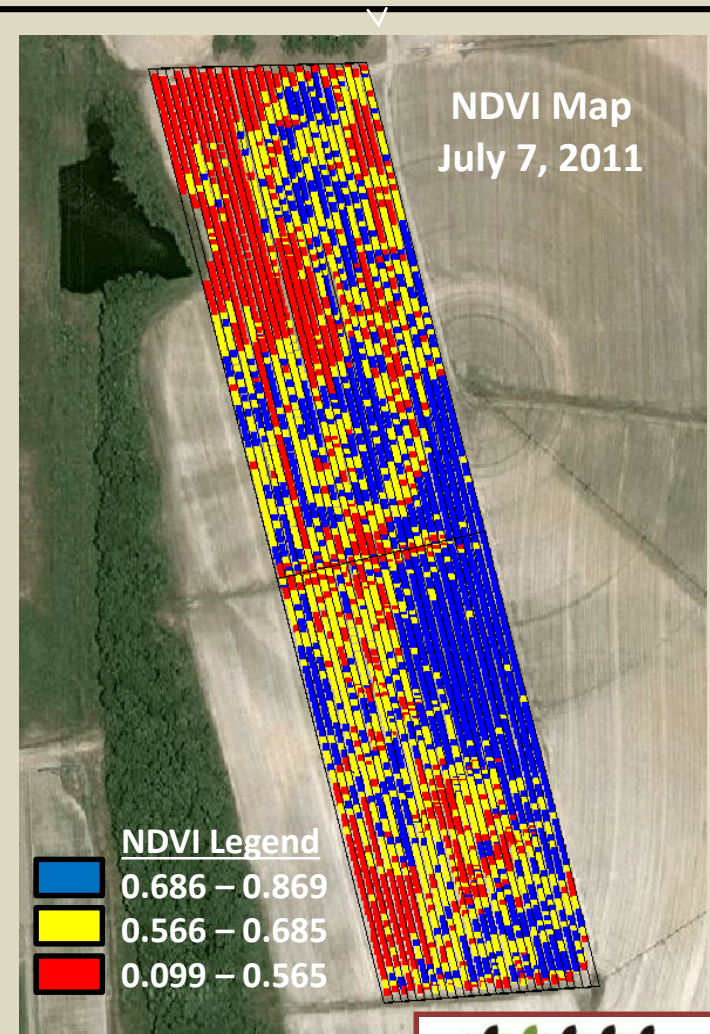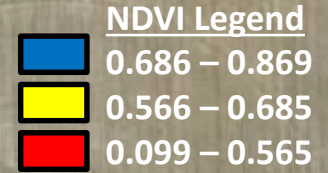
NDVI Zone	Field 1		Field 2	
	Side-Dress (lb N/ac)	NDVI	Side-Dress (lb N/ac)	NDVI
High	51.8	0.721	32.7 (40) [2]	0.765
Medium	77.7	0.602	57.4	0.653
Low	44.2	0.459	41.7	0.494

Applying Side-Dress N

- Capstan® variable rate system driven by an Ag Leader® Insight variable rate controller

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OK State / Clemson Algorithm

VRA Treatment 1 (5 strips in each field)

NDVI Zone	Field 1		Field 2	
	Side-Dress N Rate		Side-Dress N Rate	
	(lb/ac)	(gal/ac)[1]	(lb/ac)	(gal/ac)
High	51.8	17.3	32.7 (40) [2]	13.4
Medium	77.7	25.9	57.4	19.1
Low	44.2	14.7	41.7	13.9
Control	85	28.3	85	28.3

[1] 28% liquid N
[2] Algorithm calculated 32.7 lb N/ac but we overrode and applied 40 lb N/ac

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2011 Yield Results

NDVI Zone	Field 1		Field 2	
	Side-Dress N Rate	Average Yield	Side-Dress N Rate	Average Yield
	(lb/ac)	(lb/ac)	(lb/ac)	(lb/ac)
VRA 1	44, 78, 52[1]	3031	42, 57, 40[1]	3032
VRA 2	40, 60, 100[1]	2920	40, 60, 100[1]	3330
Control	85	2849	85	3361
N-Rich	85[2]	2782	85[2]	3309

[1] Rates for Low, Medium, High NDVI zones. N applied July 7.
[2] Applied June 8.
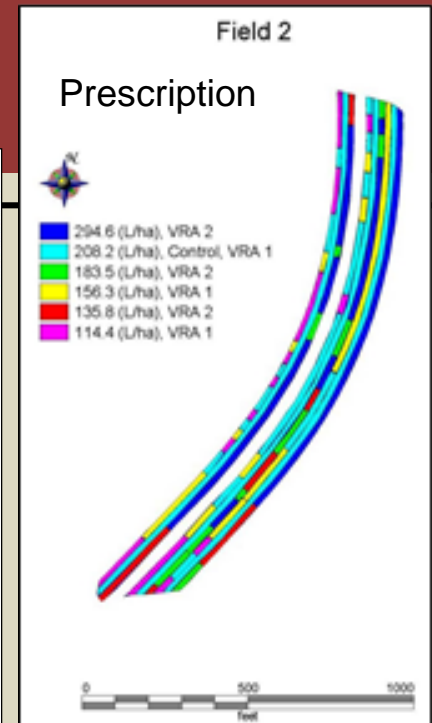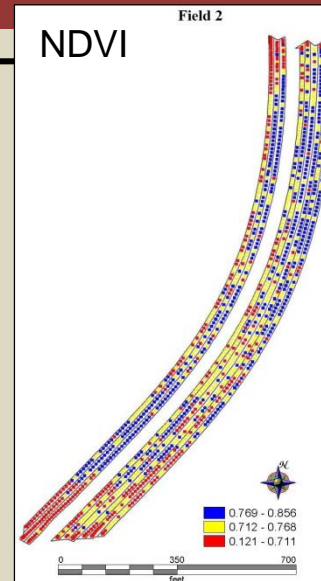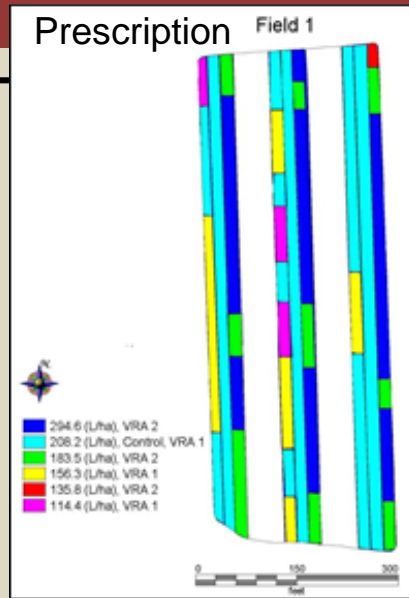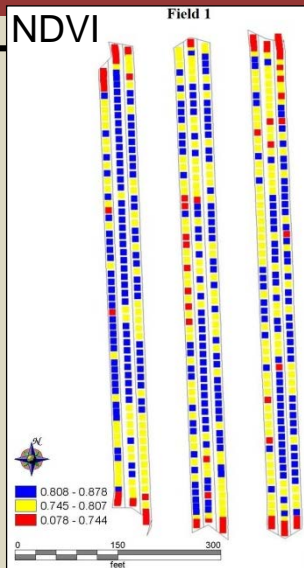
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2012 Results

	Yield	Soil ECa (mS/m)			As Applied	Return[1]	Difference[2]
Treatment	(lb/ac)	0-30 cm	0-90 cm	NDVI	N (gal/ac)	($/ac)	($/ac)
Fld 1 VRA1	3078	9.40	21.39	0.738	22.0	874	+48
Fld 1 Control	2940	8.37	14.28	0.756	25.2	826	-
Fld 1 VRA2	3125	10.88	18.19	0.762	28.9	873	+47
Fld 2 VRA1	2593	6.33	12.51	0.714	19.9	340	+71
Fld 2 Control	2752	7.98	16.28	0.729	25.3	269	-
Fld 2 VRA2	2499	5.84	12.81	0.710	26.6	164	-105

[1] Return = Yield × Lint Price − N Cost; [2] Difference = Control - VRA

Conclusions

- VRA on cotton has great potential for improving efficiency

- N-rich strips do not work in Georgia because of pre-plant fertilizer

- Non-uniform management can distort NDVI data leading to inaccurate prescriptions

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