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

George Vellidis

The University of Georgia

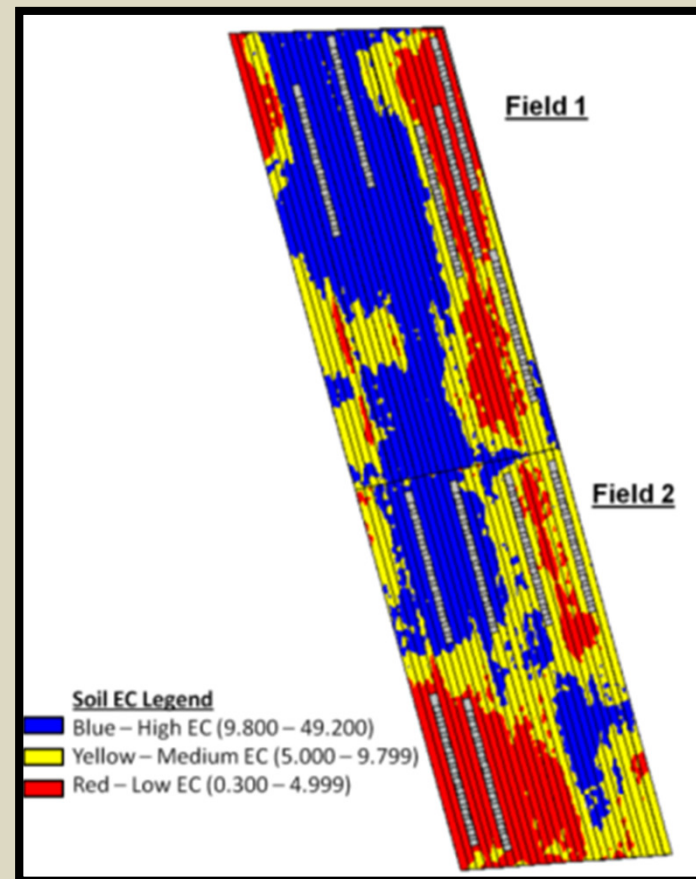# Research Partners

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.

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)

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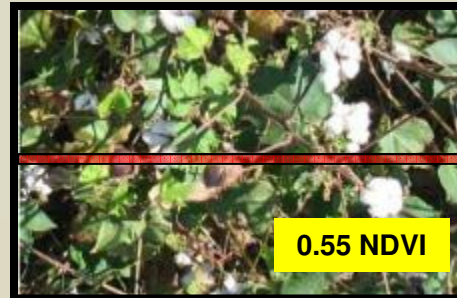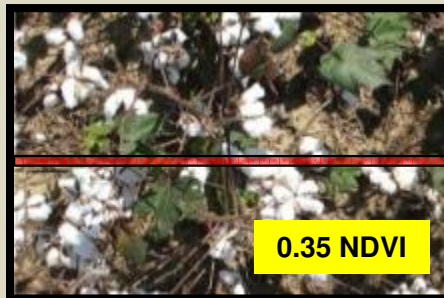
GreenSeeker®

- **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

$$NDVI = \frac{NIR_{reflectance} - Red_{reflectance}}{NIR_{reflectance} + Red_{reflectance}}$$
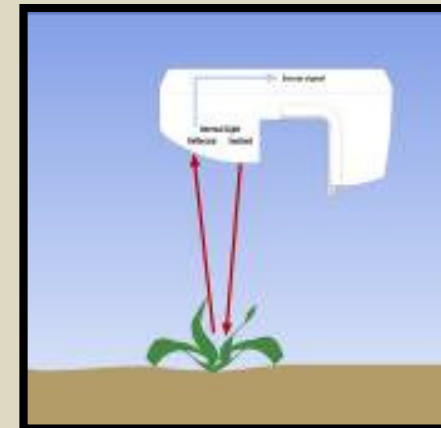
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GreenSeeker® Sensors "look" straight over row/crop and NDVI values change based upon size and vigor of crop.

GreenSeeker RT200
Variable Rate Application and Mapping System

0.25 NDVI

0.35 NDVI

0.55 NDVI

0.70 NDVI

Photos courtesy of Ted Mayfield

NDVI Mapping

- GreenSeeker® RT200 six-sensor system
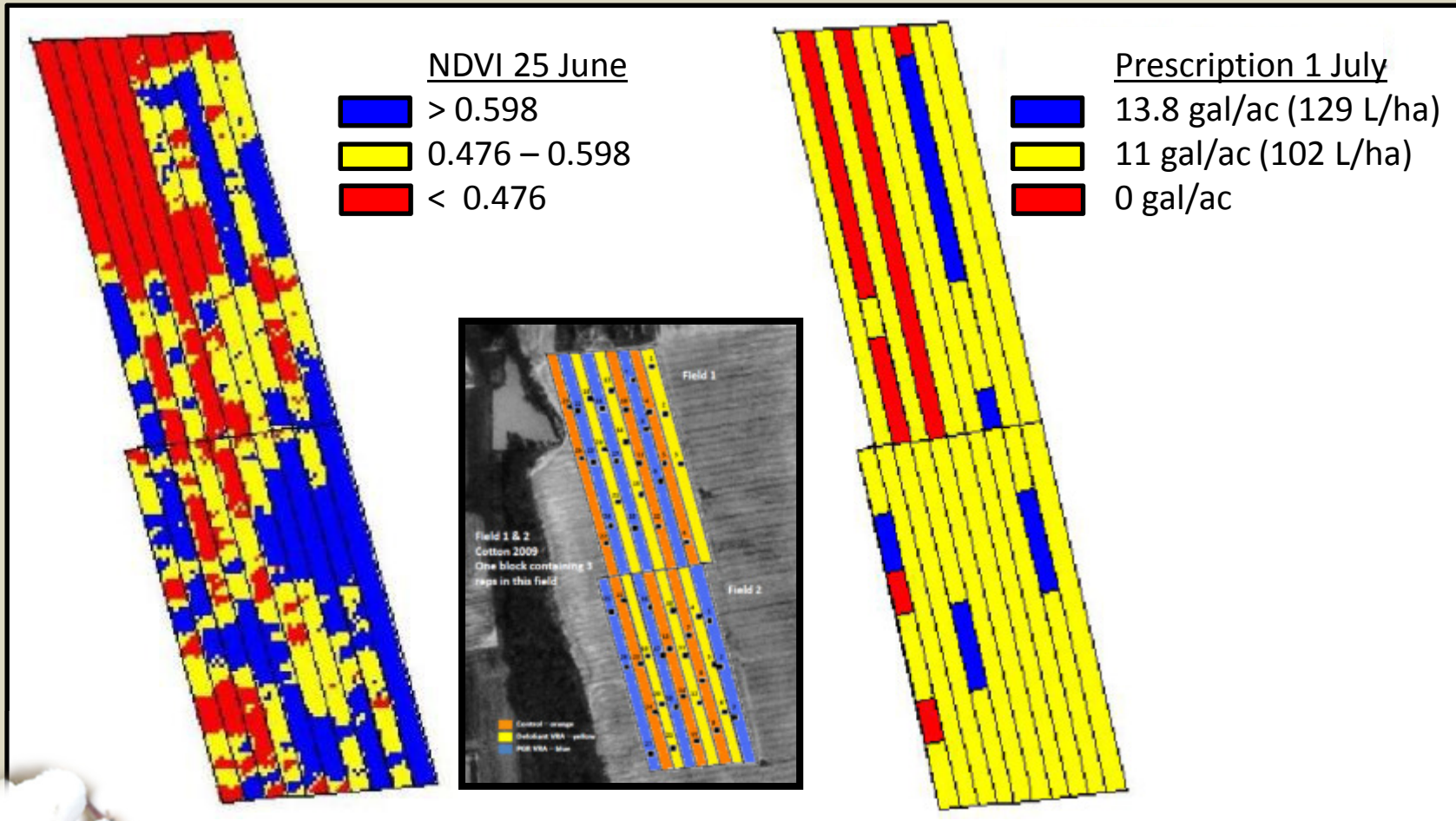
- Trimble® DGPS

VRA of PGRs and Defoliant

- MidTech Legacy ® variable rate controller

- Trimble ® DGPS

PGR NDVI Maps

NDVI 25 June
- > 0.598
- 0.476 – 0.598
- < 0.476

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

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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
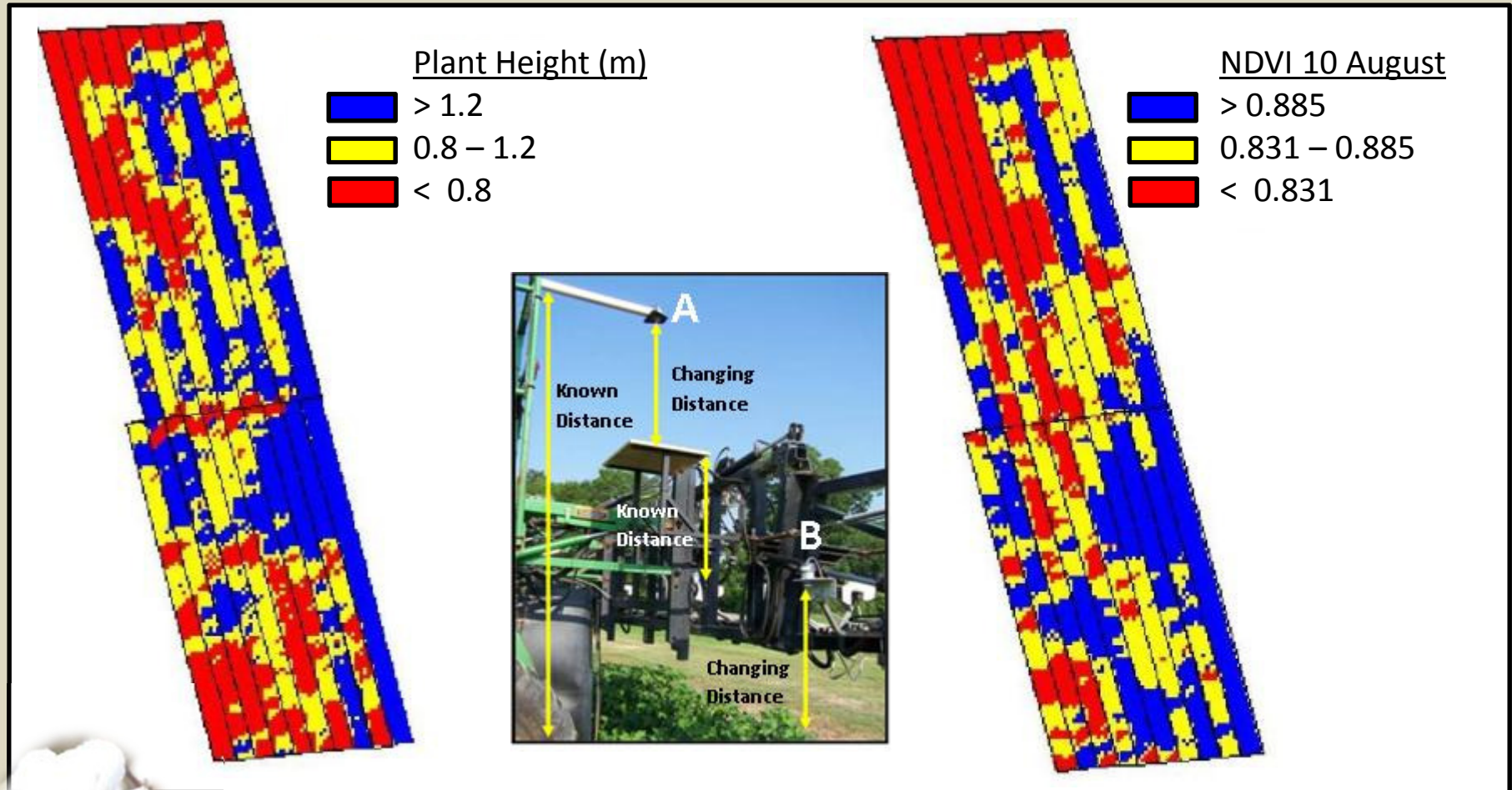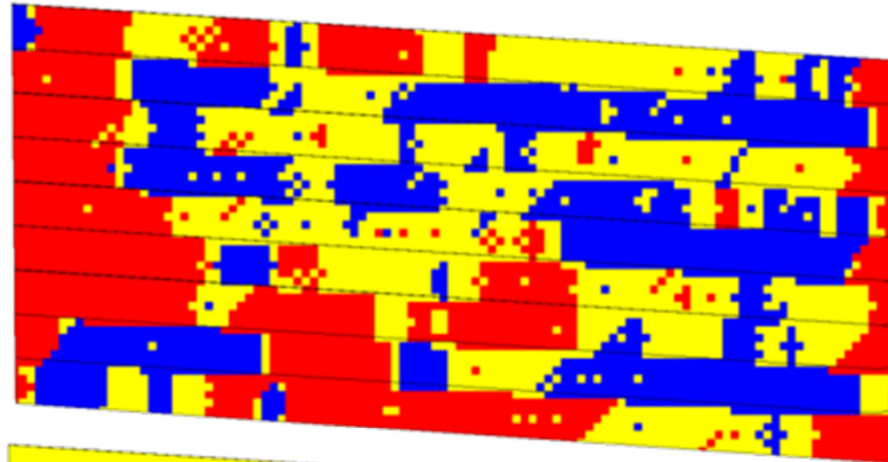
Defoliant Prescription Maps
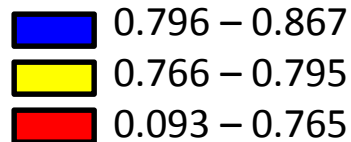
Field 3 NDVI 22 Sept 09

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

Field 3 Defoliant Rx Map 01 Oct 09

Defoliant Rx Rates
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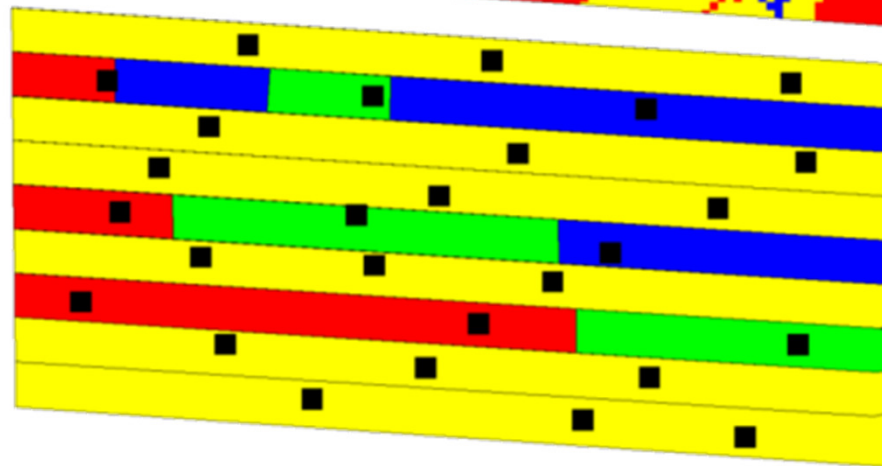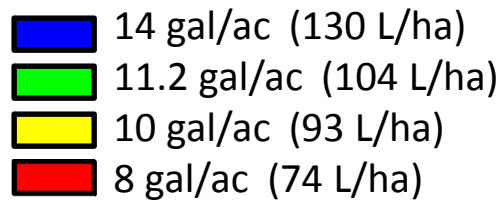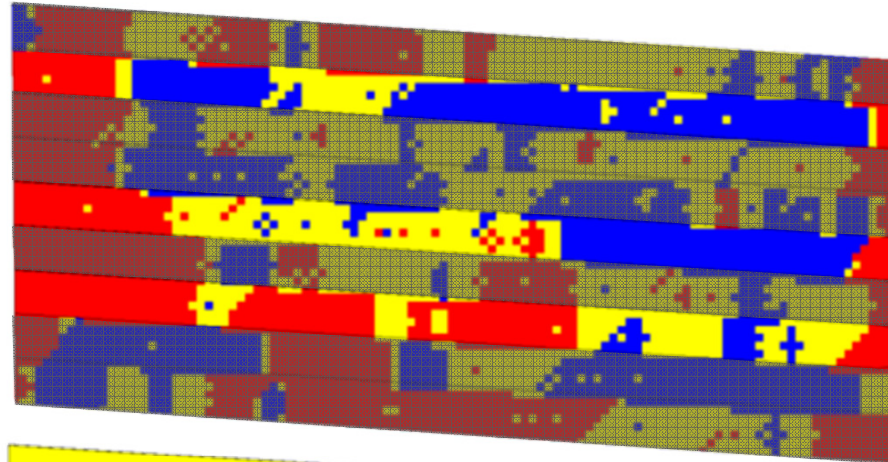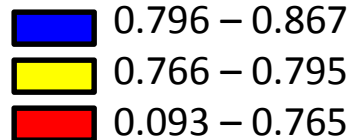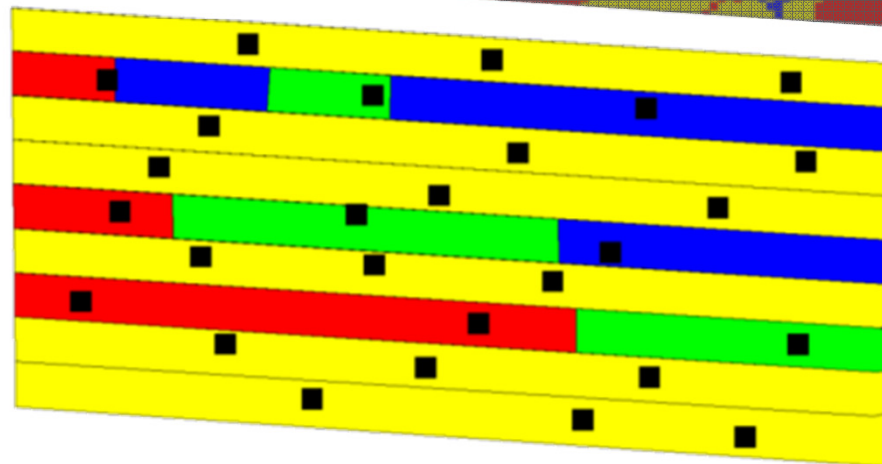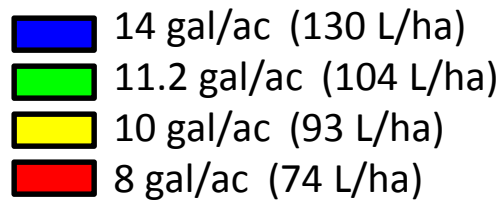
PGR Comparisons – Uniform vs VRA

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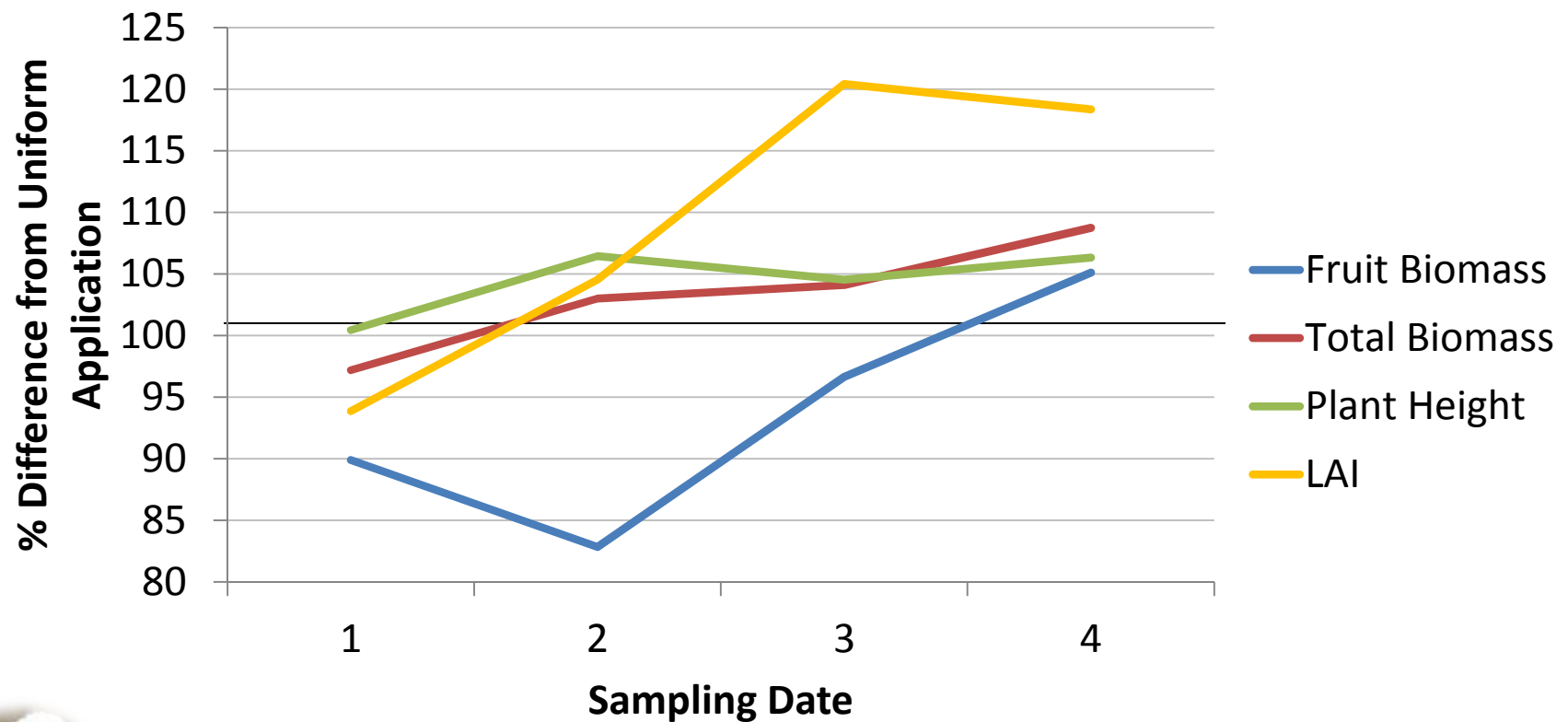
GreenSeeker® Sensors "look" straight over row/crop and NDVI values change based upon size and vigor of crop.

NTech Industries, Inc.

GreenSeeker® RT200
Variable Rate Application and Mapping System

0.25 NDVI

0.35 NDVI

0.55 NDVI

0.70 NDVI
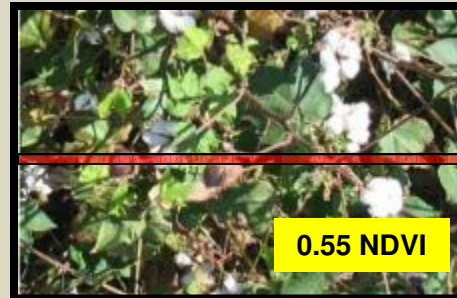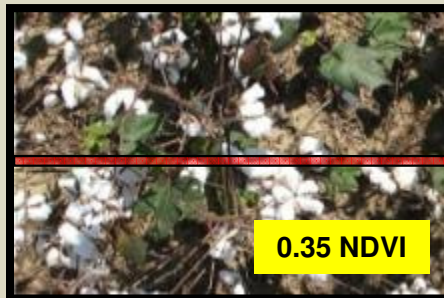
Photos courtesy of Ted Mayfield

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

- Boll Opening

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

| 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)

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

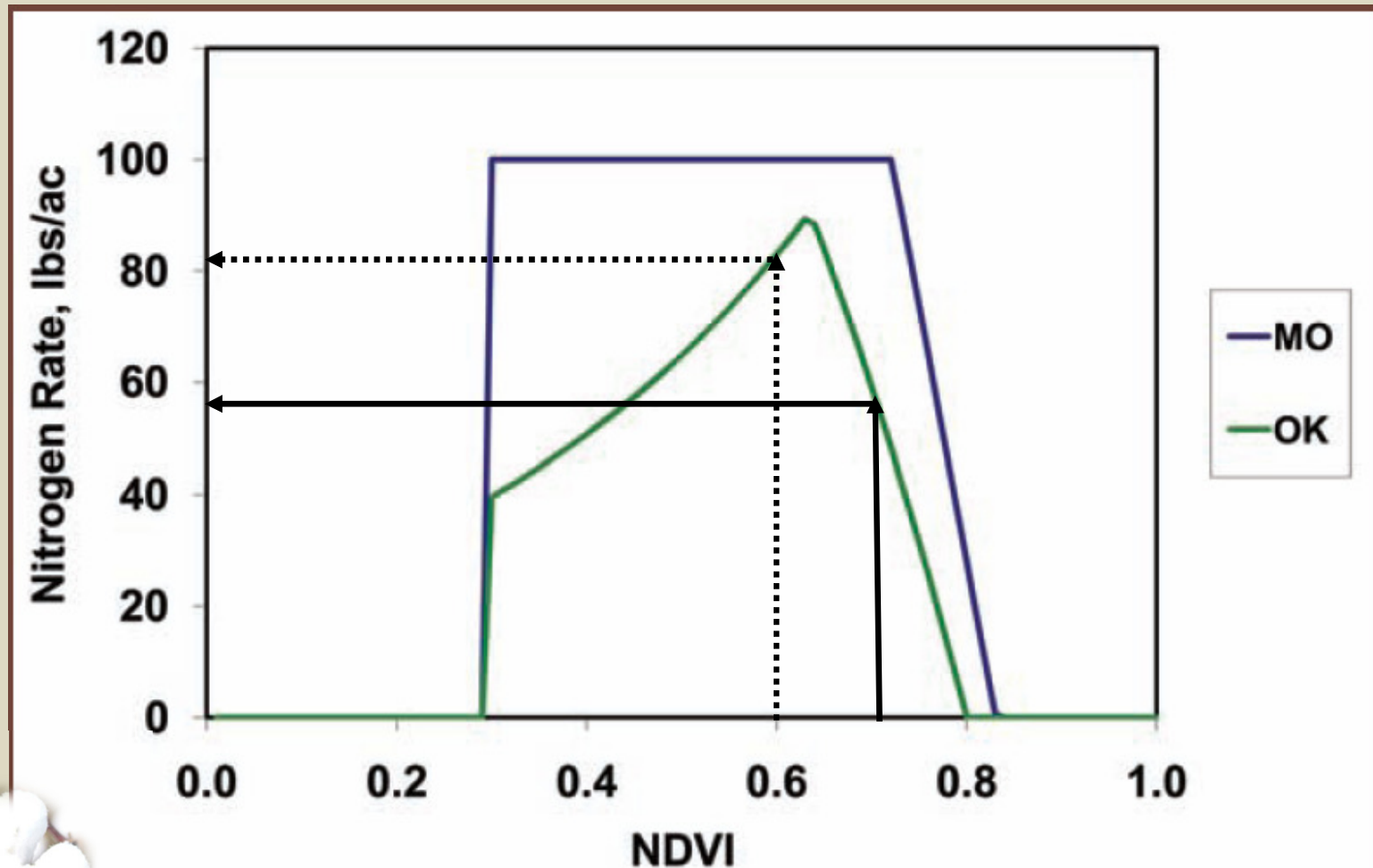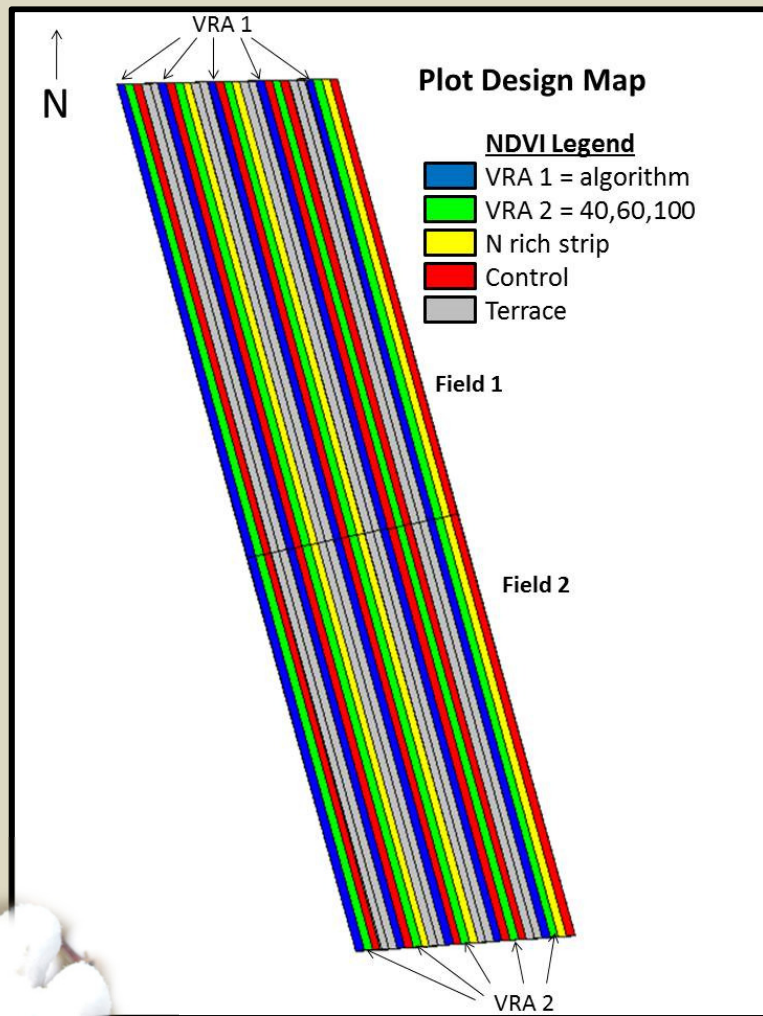- Most important fertilizer used in cotton

- 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

VRA 1

N

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

Field 1

Field 2

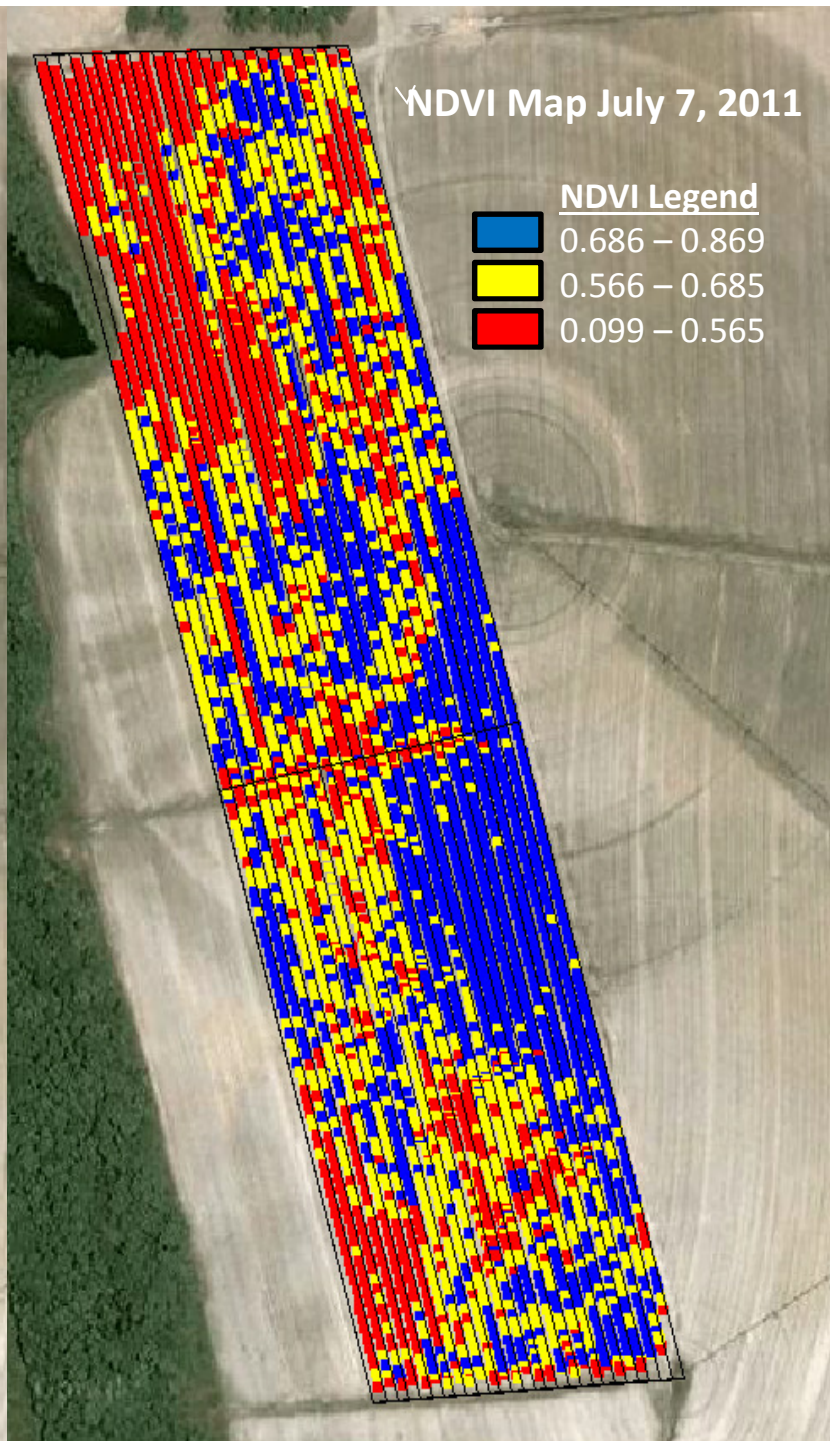VRA 2

- 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
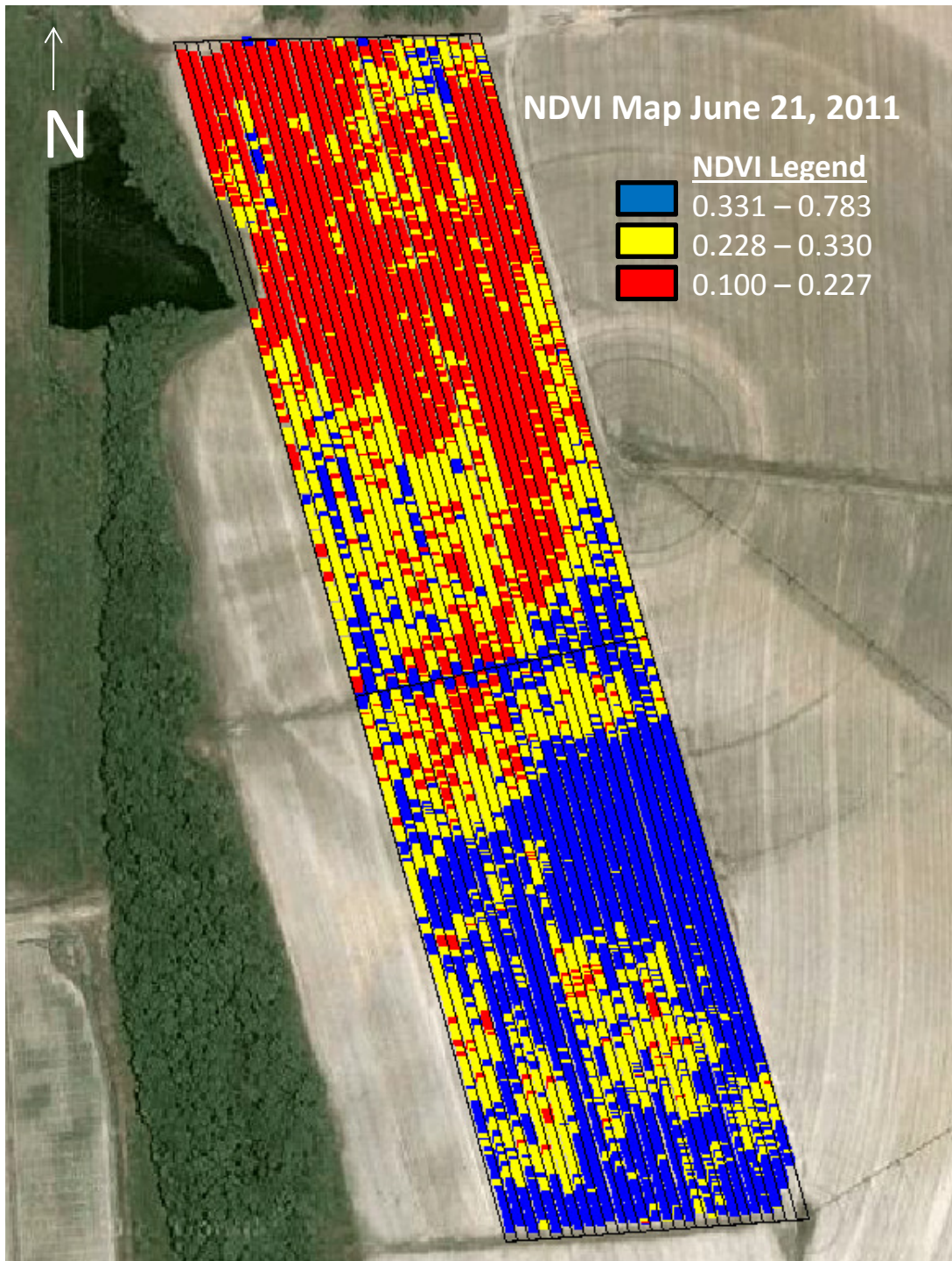
Prescription Maps

- ## 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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NDVI Map July 7, 2011

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

Field 1

Field 2

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
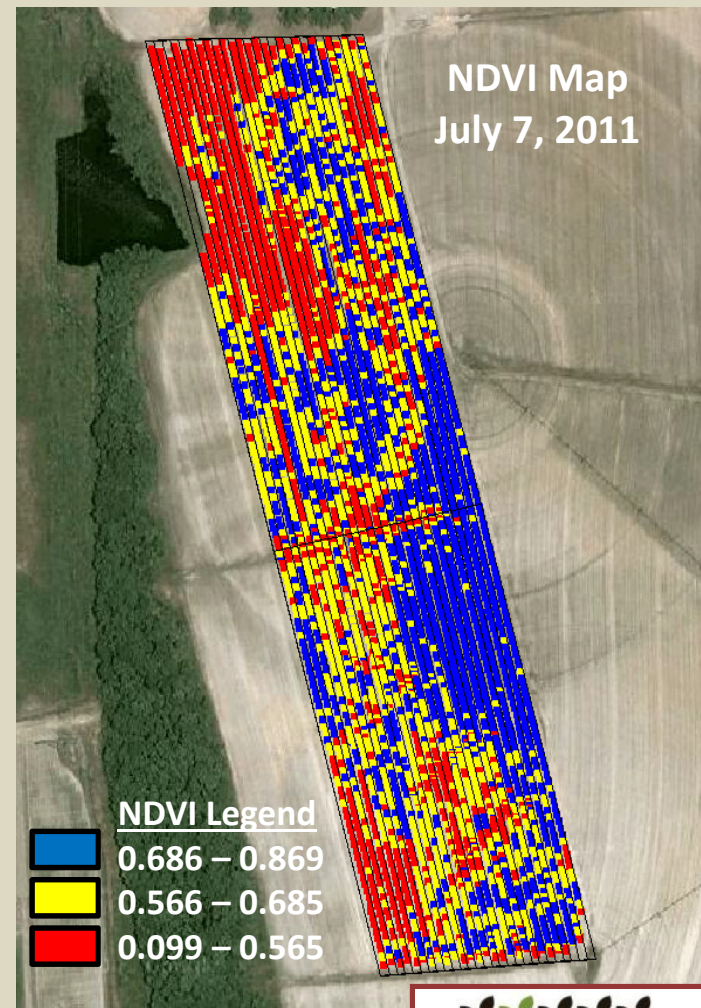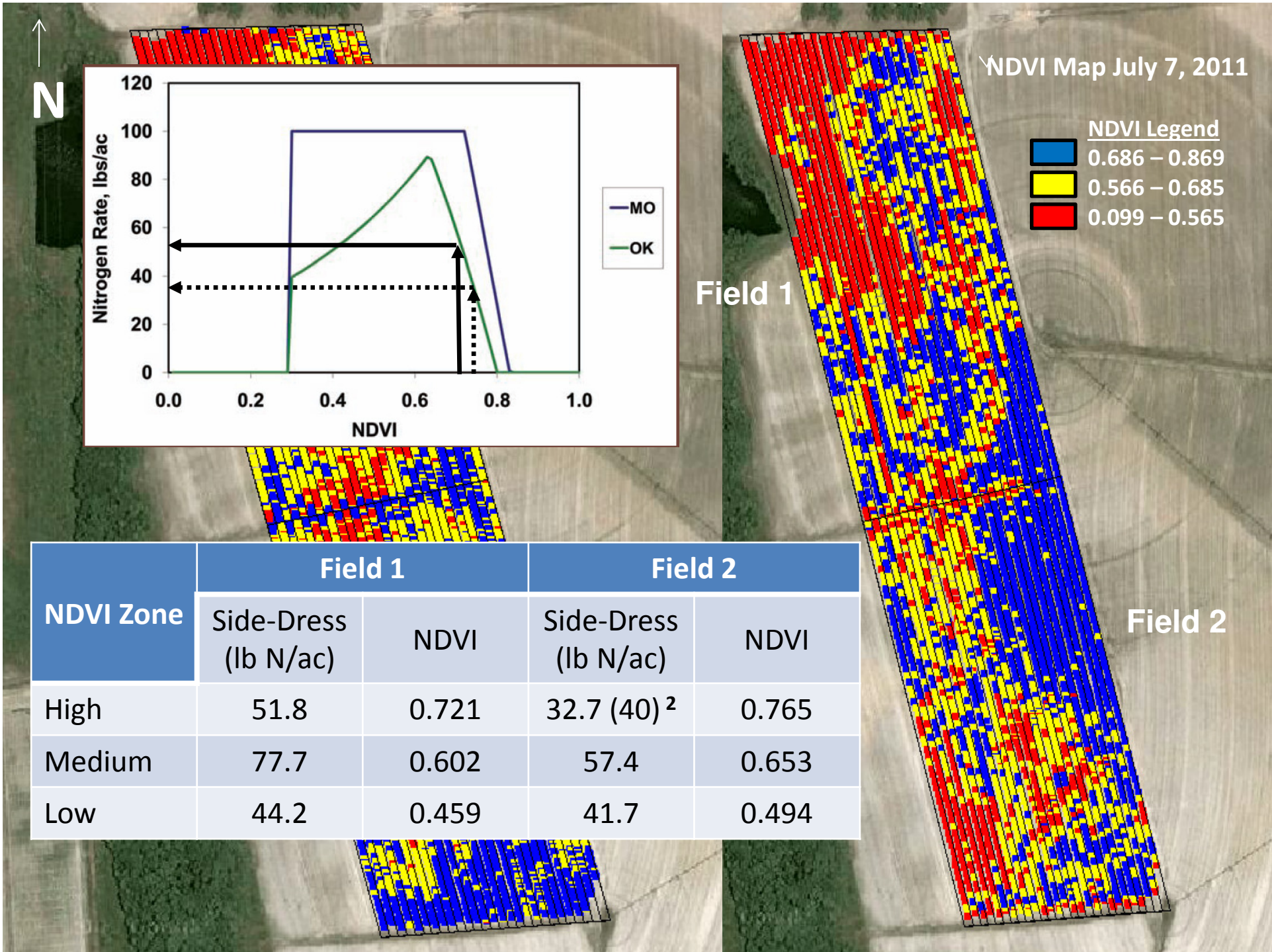
Applying Side-Dress N

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

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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User Selected Rates

VRA Treatment 2 (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	100	33.4	100	33.4
Medium	60	20	60	20
Low	40	13.4	40	13.4
Control	85	28.3	85	28.3

[1] 28% liquid N

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2011 Results

- No significant differences in tissue sample N concentration prior to side-dress application

- Strips harvested with 4-row cotton picker equipped with Ag Leader yield monitor

- Significant differences in yields of treatments

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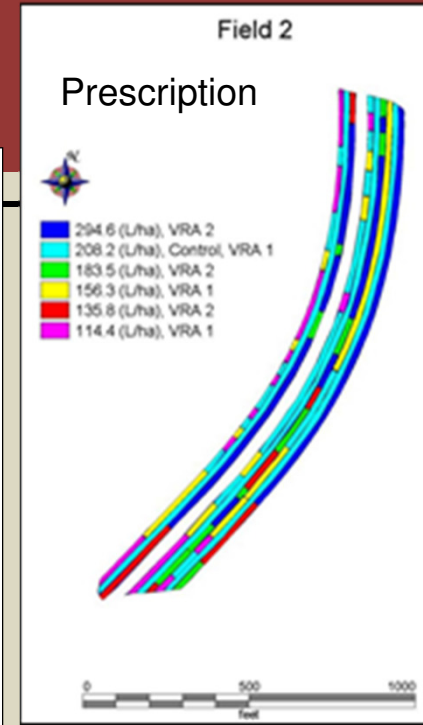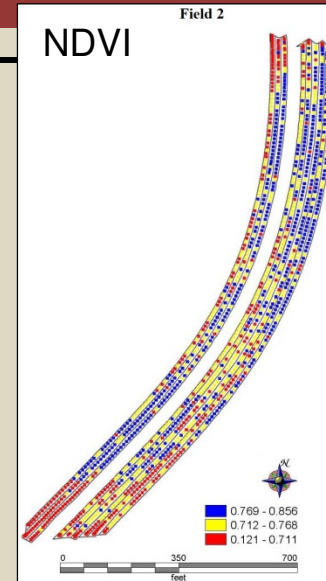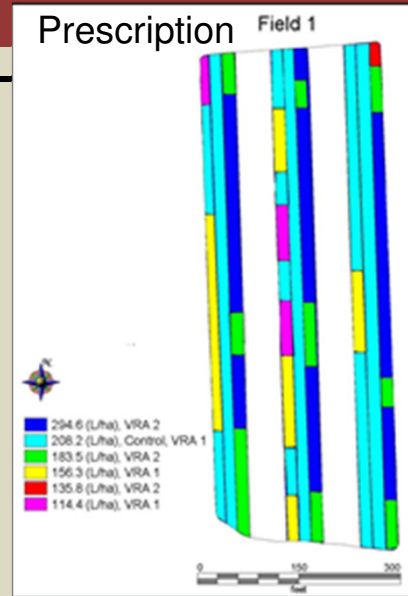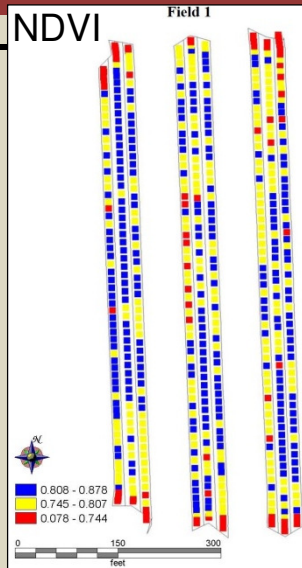PRECISIONAGTEAM

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)		NDVI	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

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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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