Influence of Precision Agriculture on Sustainability

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University of Tennessee

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Challenge or Opportunity?

Growing population

Water quality

Climate change

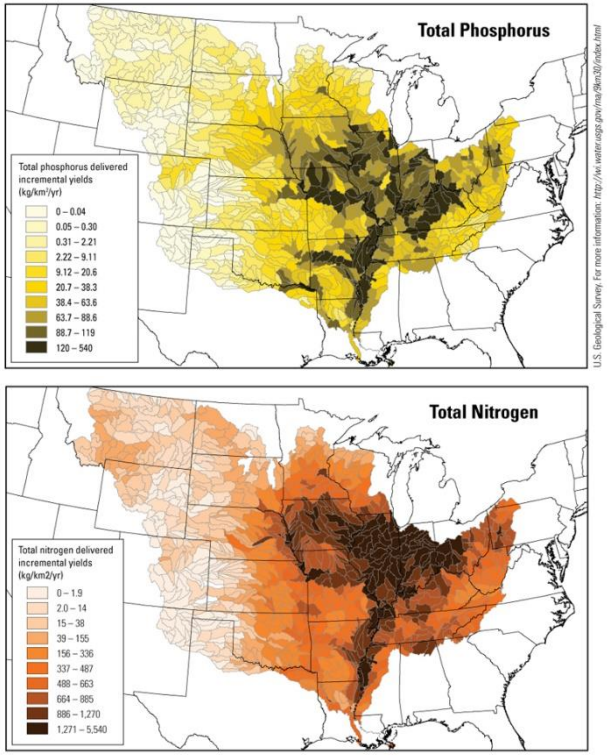
Regulatory pressure

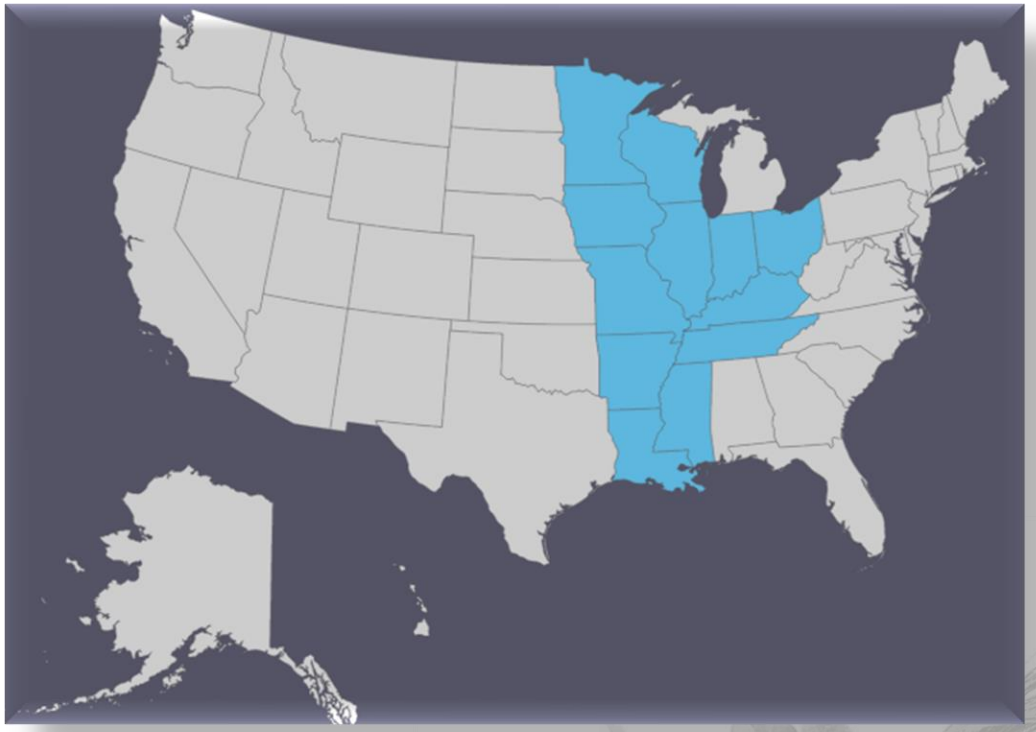
Soils and biodiversity

Economics/markets

Environmental Considerations

TN Nutrient Reduction Framework





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NRCS Natural Resources Conservation Service

TENNESSEE DEPARTMENT OF AGRICULTURE

TDEC TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Iowa

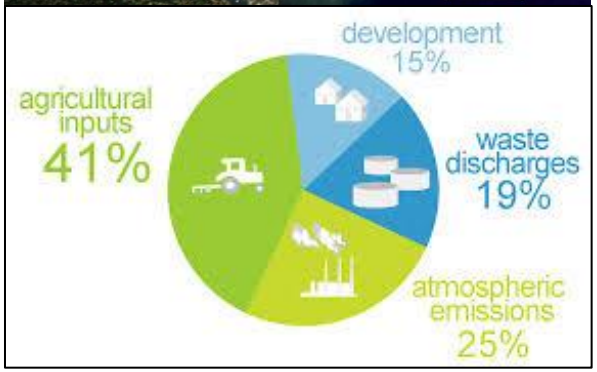
- Des Moines Water Works
  - ~$1.5 million/yr to remove nitrates
  - New equipment ~$180 million
- Lawsuit against 3 counties

Lake Erie

- Toledo shut off water supply for days
- Ohio State Law
  - >50 acres, must be certified to apply fertilizer
  - Record-keeping

Chesapeake Bay

- Require NMP
- All sources N and P regulated
- Inspect 10% per year –fines and penalties
- Setbacks, etc



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Environmental Considerations

New EPA Lawsuit

December 16, 2020

Mr. Andrew Wheeler, Administrator
Environmental Protection Agency
Office of the Administrator
Mail Code 1101A
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

Mr. David Ross, Assistant Administrator
Environmental Protection Agency
Office of Water
Mail Code 4101M
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

Re: Petition for Rulemaking to Set Water Quality Criteria & Produce a TMDL to Protect the Ohio River from Nutrients

Dear Mr. Wheeler and Mr. Ross:

Enclosed please find a petition for rulemaking to set water quality criteria for nitrog and phosphorus and establishment of a Total Maximum Daily Load (TMDL) for the River. We appreciate your attention to this matter, and respectfully request EPA's careful consideration and prompt response to this matter.

We are eager to meet with the appropriate EPA officials after the agency has had opportunity to review our petition. Please feel free to contact me at 859-879-0020 my cell at 859-229-4033 with any questions or for additional information.

Sincerely,

Changing Tastes

When shopping for food, consumers prize family satisfaction above all else, but increasingly, they consider sustainability as an important factor in their buying decisions.

More than

8 in 10

Americans consider sustainability when buying food and would like to see more options available that protect the environment.[10]

Similarly, consumers are looking to companies to help them understand their impact on the environment – with

nearly 3/4

of consumers stating they want companies to do a better job explaining how their purchases impact the planet.[11]

Increasingly, we're seeing Millennials (19- to 36-year old consumers) voting with their wallets, with

6 out of 10

willing to pay more for environmentally friendly products.[12]

Millennial consumers = ages 24-39
Generation Z consumers = ages 14-23

More Sustainable

In the green: these climate goals put the world on a pathway to 1.5 degrees or less of warming

LEVI'S — 80 points
AEO — 73 points

In the yellow: these climate goals put the world on a path to 2 degrees or less of warming

BURBERRY, H&M, GAP — 61-65 points
asics, KERING, PUMA, NIKE — 56-60 points
patagonia, The North Face — 51-55 points
EILEEN FISHER, adidas, new balance, PVH — 46-50 points
TARGET — 43 points

In the orange: climate goals on a path to 2 degrees of warming

ARC'TERYX, ESPRIT, GANT, GANNI, GUESS, INDITEX — 36-40 points
M&S, MARMOT, OTTO, SALOMON, skunkfunk, Walmart

In the red: these companies' climate goals will put the world on a path to climate catastrophe, with 3+ degrees of warming

lululemon athletica — 27 points
ALDO, Hanes — 16-25 points
C&A, Columbia Sportswear Company, Disney, DYMI, macy's, Pentland, REI — 1-15 points
JCPenney, LANDS' END, L.L.Bean, MEC, NORDSTROM, PRIMARK, Under Armour — 0 points


Governance & Accountability Institute Research Results
S&P 500® Companies Sustainability Reporting
Reporters
Non-Reporters
80%
20%
47%
53%
28%
72%
25%
75%
19%
81%
18%
82%
15%
85%
14%
86%
2011
2012
2013
2014
2015
2016
2017
2018
Source: Governance & Accountability Institute, Inc. 2018 Research — www.ga-institute.com

Nike
2018 Sustainability Report

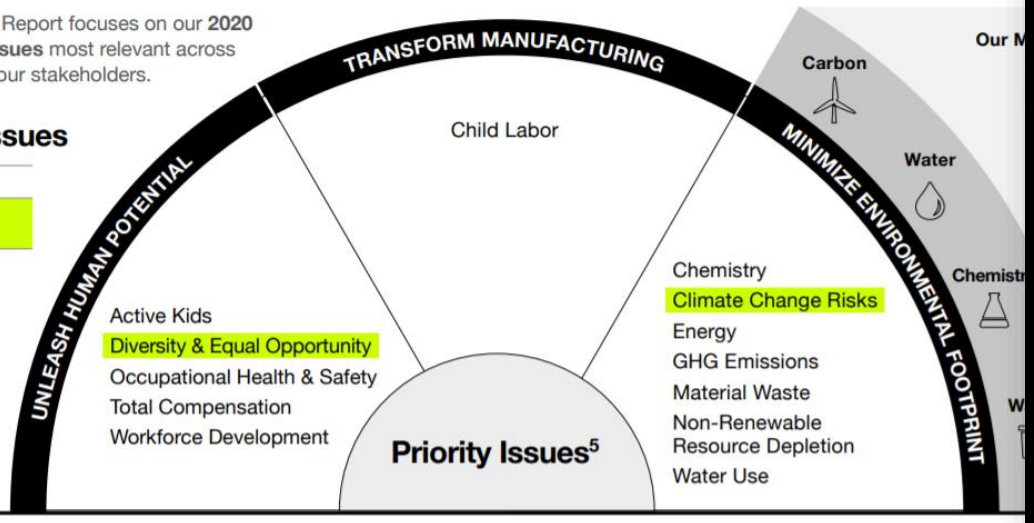
Report Content

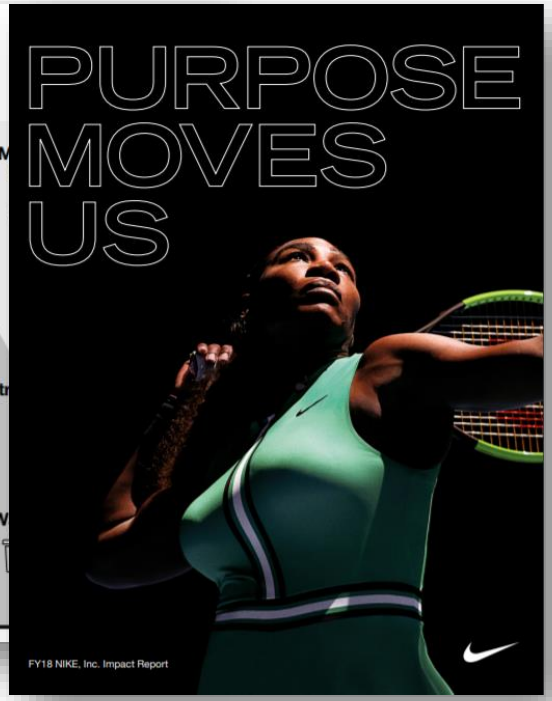
The FY18 NIKE Impact Report focuses on our **2020 Targets** and **Priority Issues** most relevant across our value chain and to our stakeholders.

FY18 Priority Issues

Existing Priority Issue

Issues with Increased Relevance in FY18[4]





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Example Reduction Targets

MINIMIZE ENVIRONMENTAL FOOTPRINT							
Metric	Unit of Measurement	FY15 Baseline	FY16	FY17	FY18	FY18 Change vs. Baseline	FY20 Target
Product							
Average Product Carbon Footprint[10]	kg CO_2e/ unit	7.33	7.19	7.15	**7.45**	△ 2%[11]	▼ 10%
Product Scored on Sustainability Performance	%	27%	68%	71%	**73%**	▲ 46 p.p.	80%
Materials							
Sustainable Materials[12] – Apparel (AP)	%	19%	21%	33%	**34%**	▲ 15 p.p.	▲
Sustainable Materials[12] – Footwear (FW)	%	31%	33%	32%	**31%**	0 p.p.	▲
Cotton Sourced More Sustainably[13]	%	24%	35%	53%	**58%**	▲ 34 p.p.	100%
Carbon and Energy							
Renewable Energy – Owned or Operated[14]	%	14%	20%	22%	**19%**[15]	▲ 5 p.p.	100%[16]
Energy Consumption Per Unit – Key Operations[17]	kWhe/unit	4.74	4.29	4.74	**4.39**	▼ 7%	▼ 25%
Carbon Emissions Per Unit – Key Operations[17]	kg CO_2e/ unit	1.75	1.62	1.75	**1.71**	▼ 2%	▼ 25%
Energy Consumption Per Kg – Textile Dyeing and Finishing[18]	kWhe/kg	15.86	15.46	14.95	**14.40**	▼ 9%	▼ 35%
Carbon Emissions Per Kg – Textile Dyeing and Finishing[18]	kg CO_2e/ kg	4.78	4.68	4.55	**4.33**	▼ 9%	▼ 35%

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Brand and Retailer Targets

	Cotton Procurement			
	100% Organic	100% sustainable	100% US grown	Increase in sustainable
Gap Inc.		x		
HANES Brands Inc			x	
H&M		x		
IKEA		x		
LEVI STRAUSS & CO.		x		
NIKE		x		
THE NORTH FACE		x		
patagonia	x			
prAna	x			
TARGET		x		
Walmart		x	x	
Wrangler		x		

U.S. COTTON TRUST PROTOCOL
SUSTAINABILITY

50 Brand and retailer members

U.S. COTTON TRUST PROTOCOL

Byford · Levi's · GAP · next · Dockers · ATHLETA · GILDAN · BANANA REPUBLIC · Liverpool · LEVI STRAUSS & CO. · TESCO · OLD NAVY · HILL CITY

Additional major brand and retailer members will be announced soon.

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Real. Life. Solutions.

Field to Market

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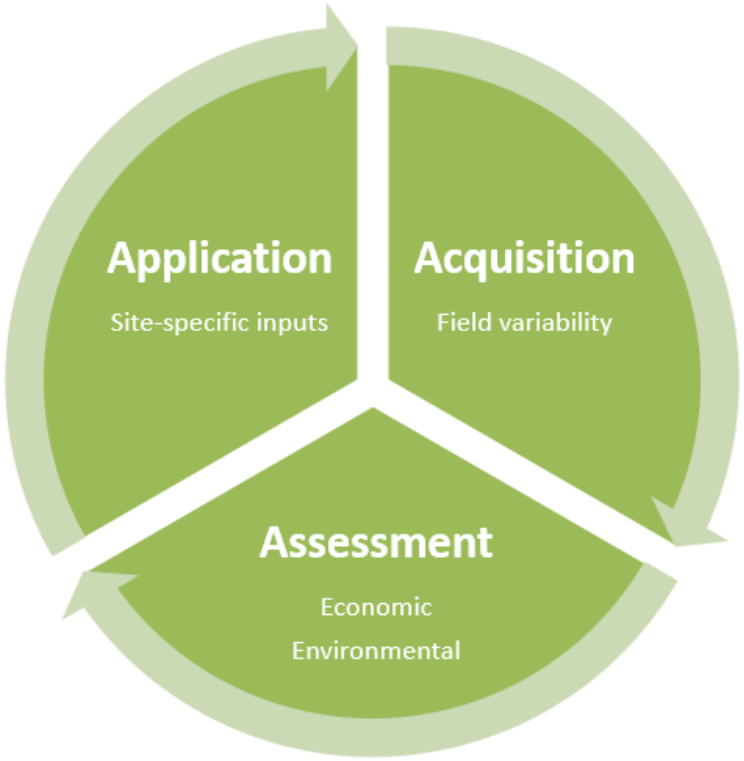
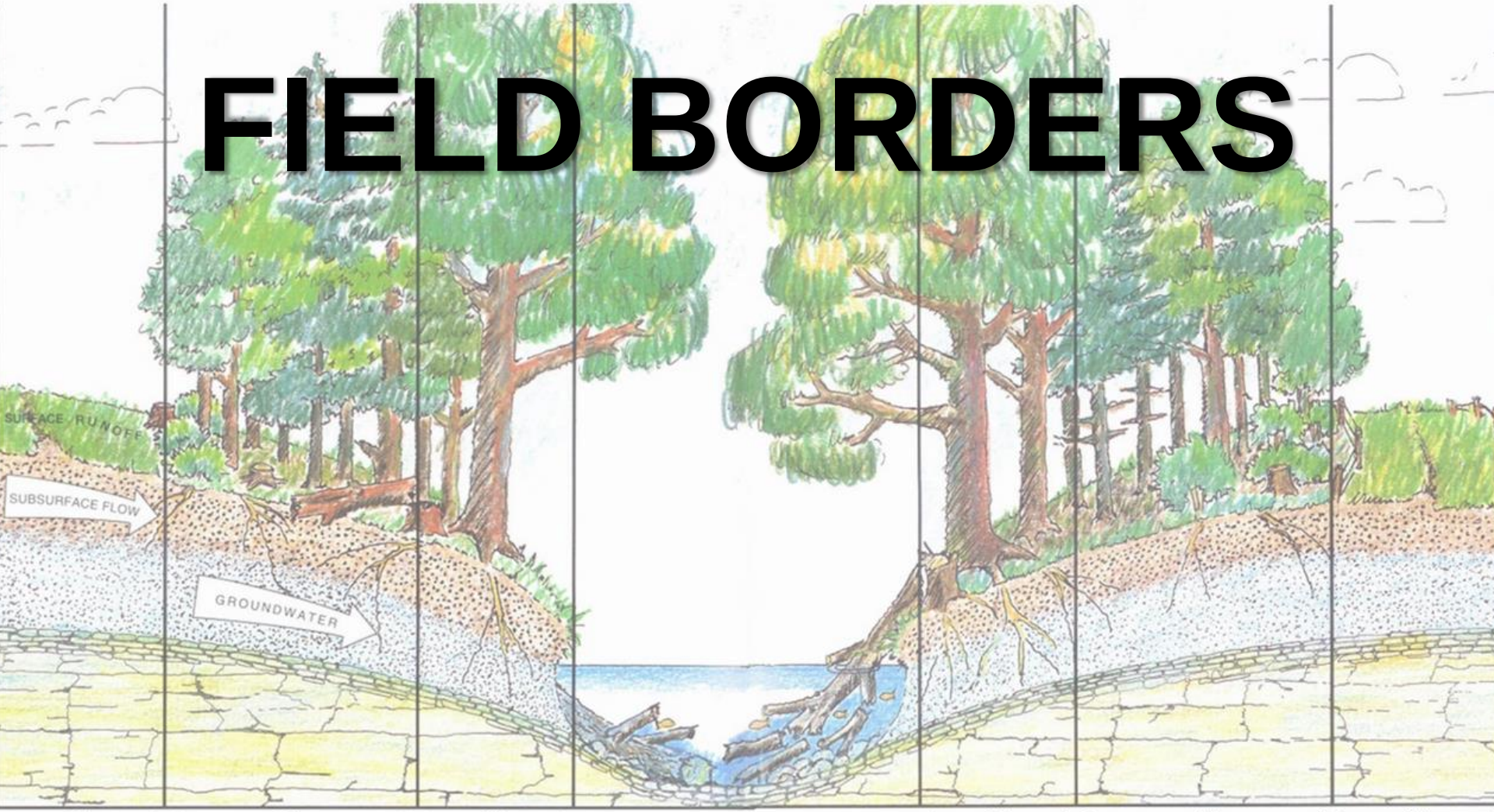
Precision Agriculture

Site-specific assessment and application of crop inputs, including water, seed, nutrients, pesticides traffic, etc.



FIELD BORDERS



20'	60'	15'		15'	60'	20'
ZONE 3 RUNOFF CONTROL	**ZONE 2 MANAGED FOREST**	**ZONE 1 UNDISTURBED FOREST**	**STREAM BOTTOM**	**ZONE 1 UNDISTURBED FOREST**	**ZONE 2 MANAGED FOREST**	**ZONE 3 RUNOFF CONTROL**
Concentrated flows are converted to dispersed flows by water bars or spreaders, facilitating ground contact and infiltration.	Filtration, deposition, plant uptake, anaerobic denitrification and other natural processes remove sediment and nutrients from runoff and subsurface flows.	Maturing trees provide detritus to the stream and help maintain lower water temperature vital to fish habitat.	Debris dams hold de - t ritus for processing by aquatic fauna and provide cover and cooling shade for fish and other stream dwellers.	Tree removal is generally not permitted in this zone.	Periodic harvesting is necessary in Zone 2 to remove nutrients sequestered in tree stems and branches and to maintain nutrient uptake through vigorous tree growth.	Controlled grazing or haying can be permitted in Zone 3 under certain conditions.

Field Borders

Economic Benefits

- Tree Lines
  - Low yields
  - High input costs

- >30% yield reduction

  (University of Missouri Extension, 2008)

Field Borders

Analysis

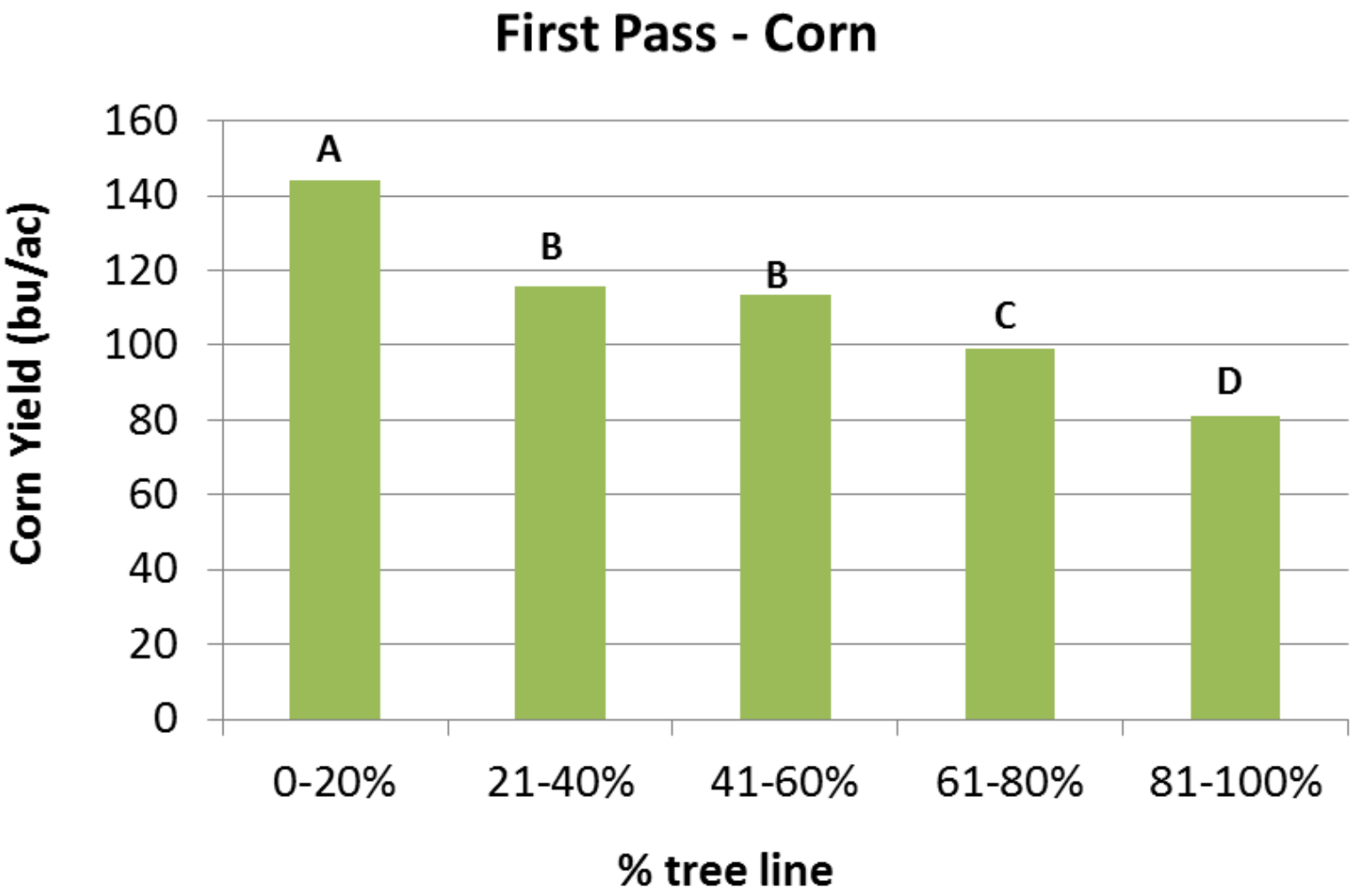
- Yields
  - Whole field average
  - 1st pass
  - Tree line
- Yield data
  - 134 crop years corn
  - 137 crop years soybeans

92% TREE LINE

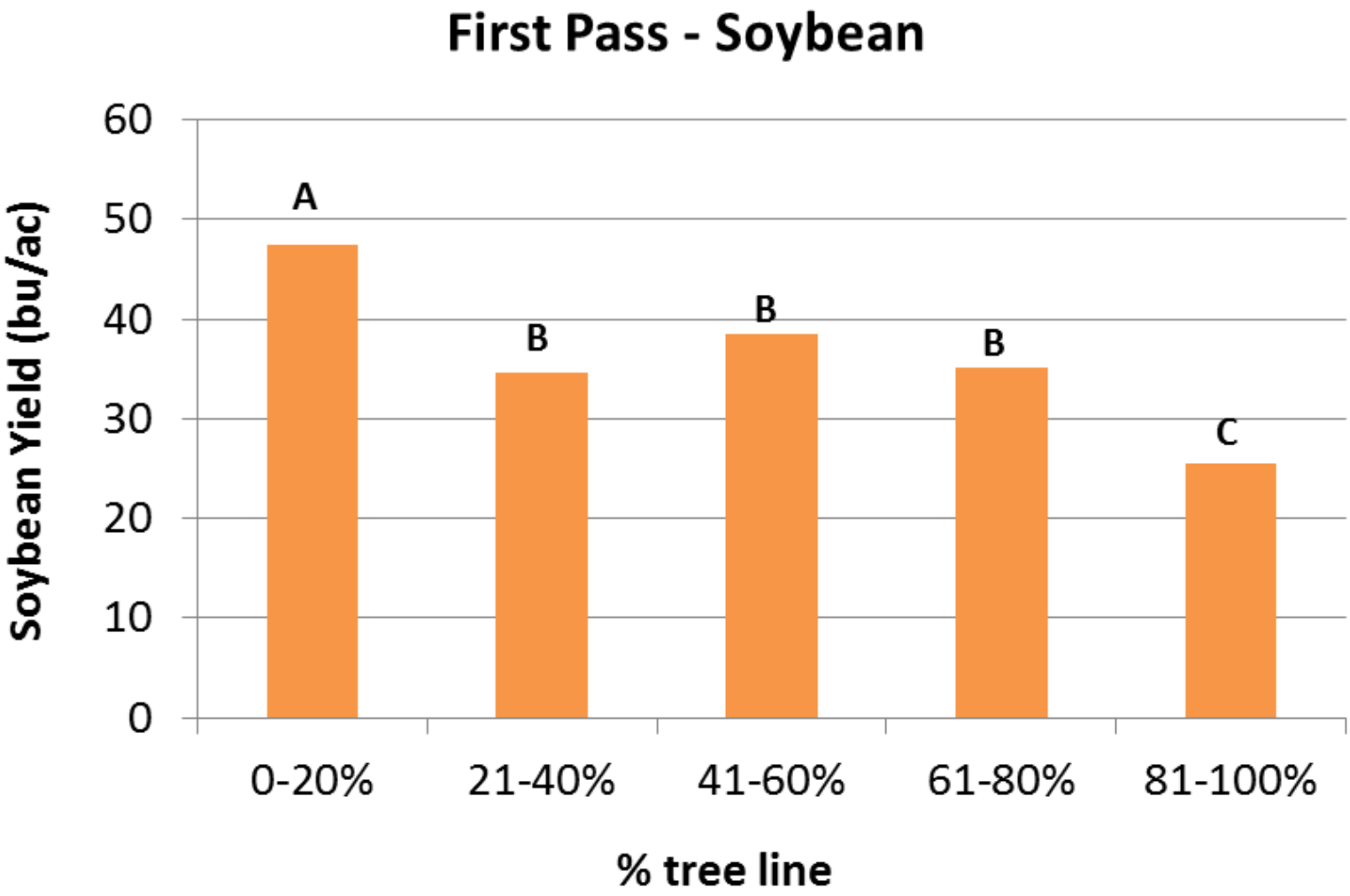
Yields (bu/A)	Field Avg.	1st Pass	Tree Line
2010 SB	44	24	23
2011 SB	35	26	25
2012 Corn	125	57	49

16 % TREE LINE

Yields (bu/A)	Field Avg.	1st Pass	Tree Line
2010 SB	47	42	25
2011 Corn	158	156	84
2012 SB	53	53	43



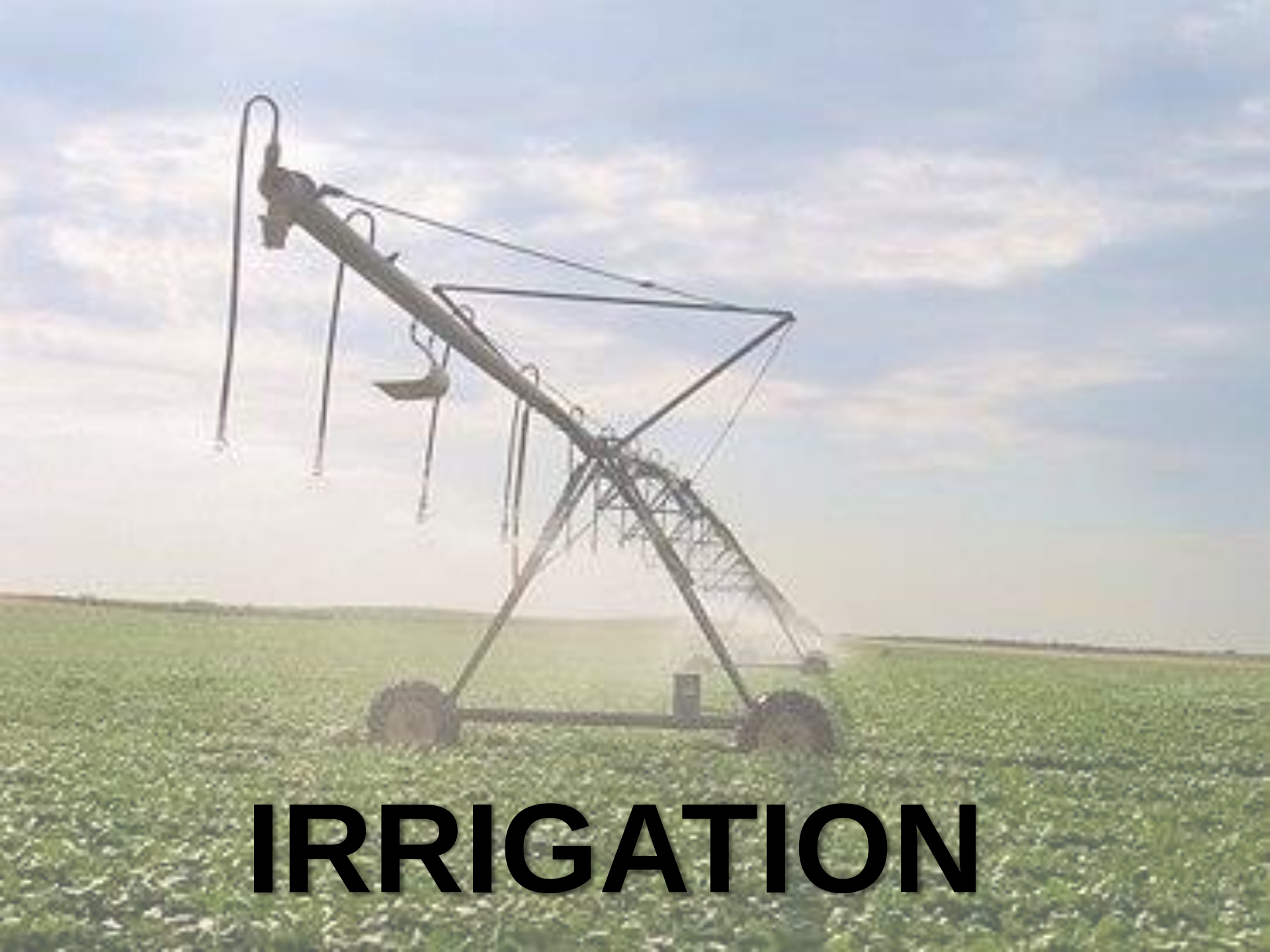
*Means with the same letter are not significantly different according to Fisher's protected LSD at p<0.05.



*Means with the same letter are not significantly different according to Fisher's protected LSD at p<0.05.

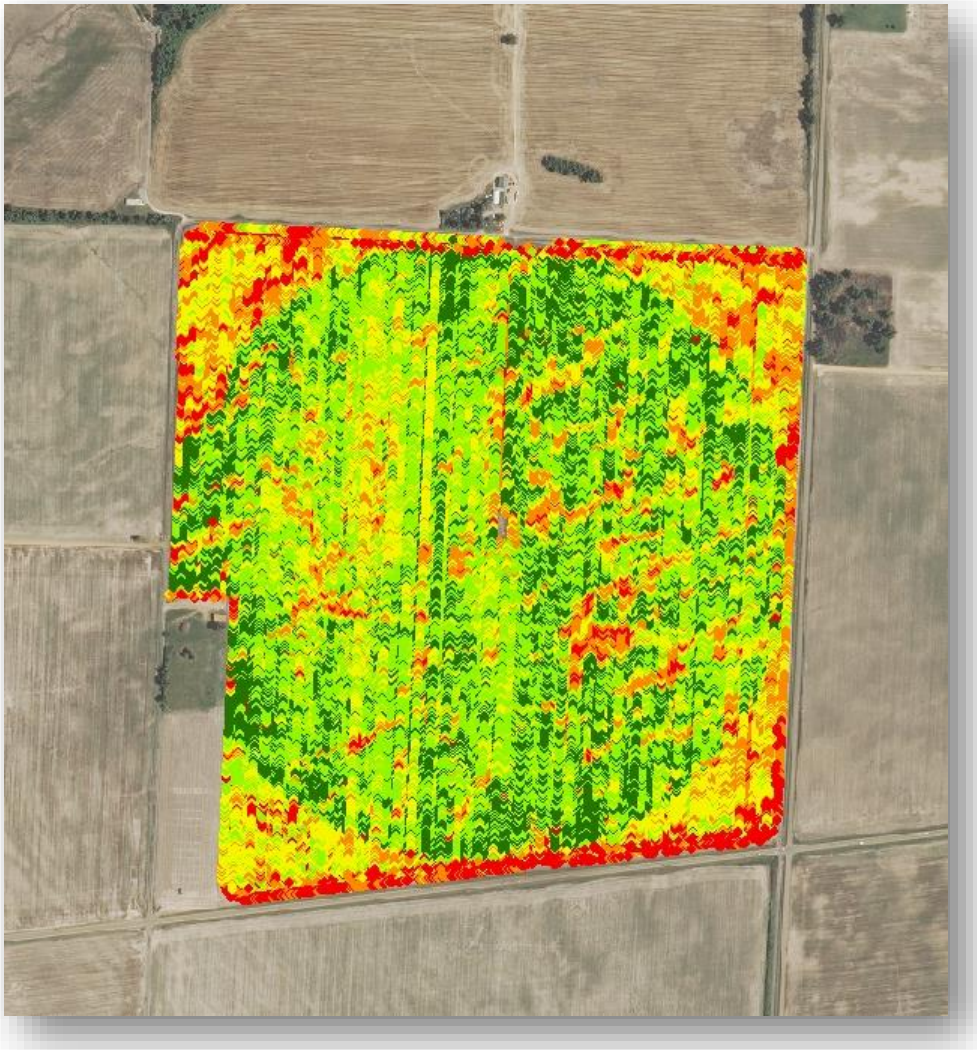
Field Borders

- >20% tree line will lose a significant amount of yield
- >80% tree line loses significantly more yield
- Field borders or buffers for wildlife habitat and potential nutrient runoff mitigation

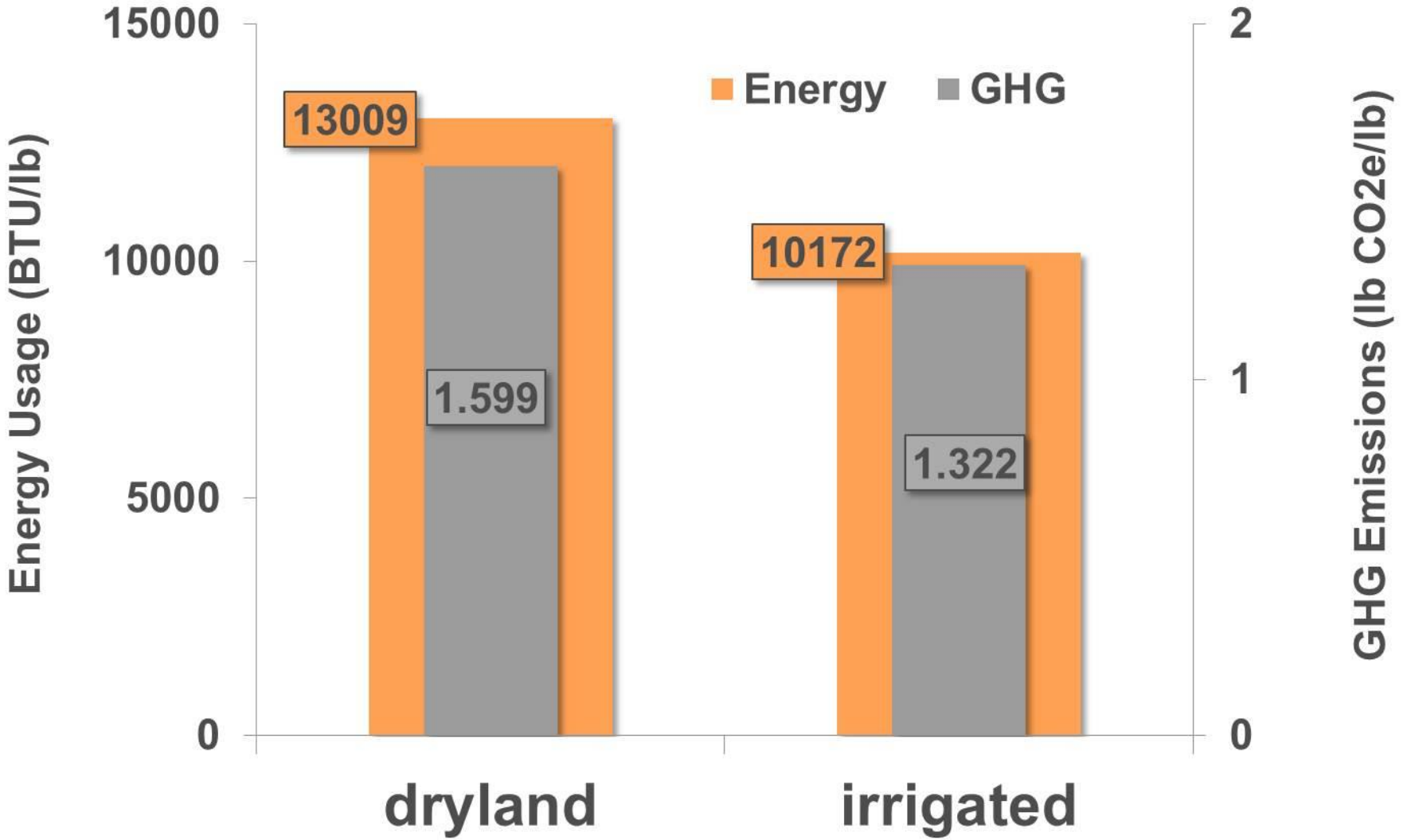

IRRIGATION

Irrigation Example

- Average irrigated yield—**1125** lb/ac
- Average dryland yield—**750** lb/ac



Irrigation Example



Field to Market

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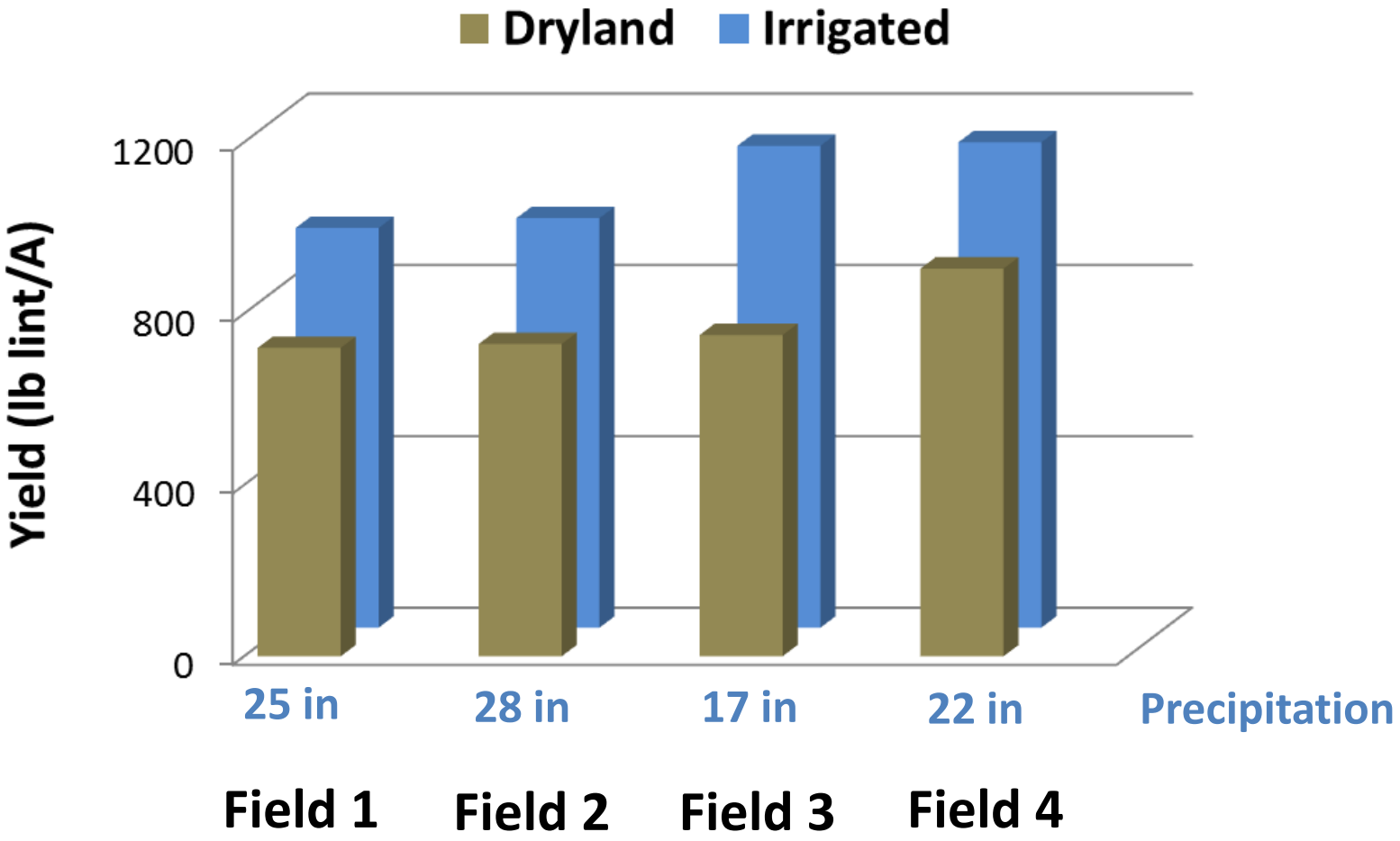
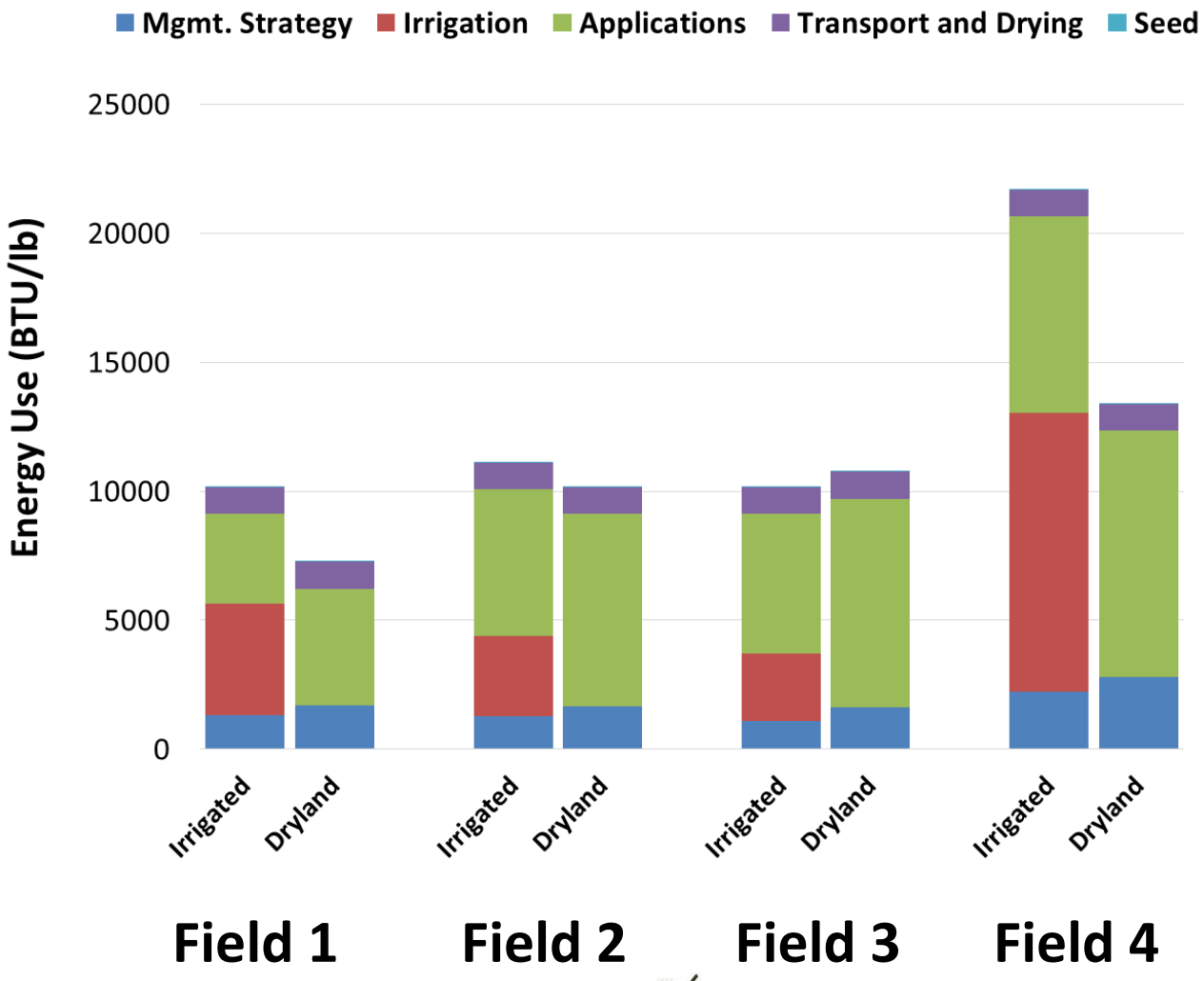
Irrigation Example



Irrigation Example



Field to Market

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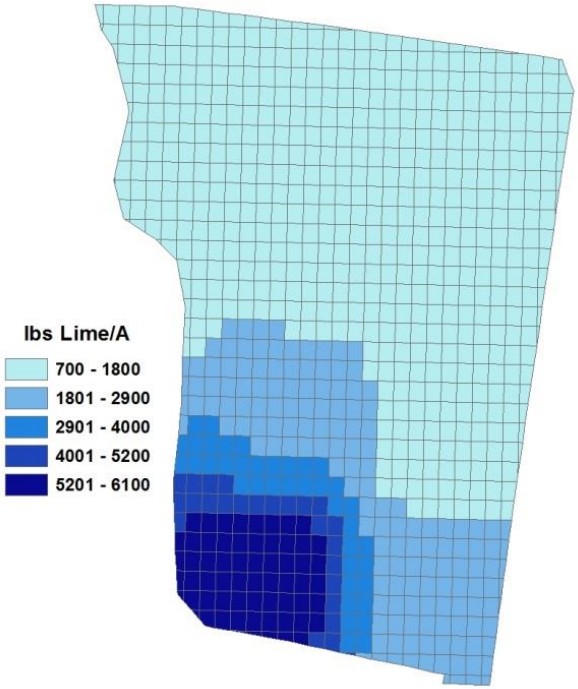
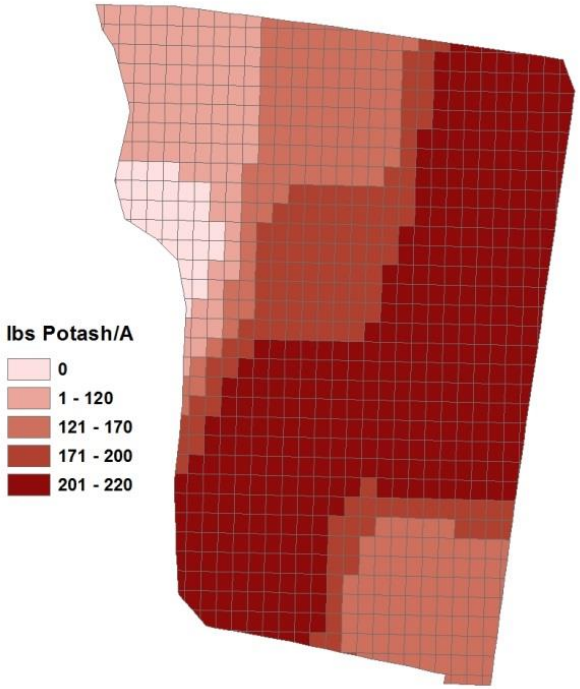
NUTRIENTS

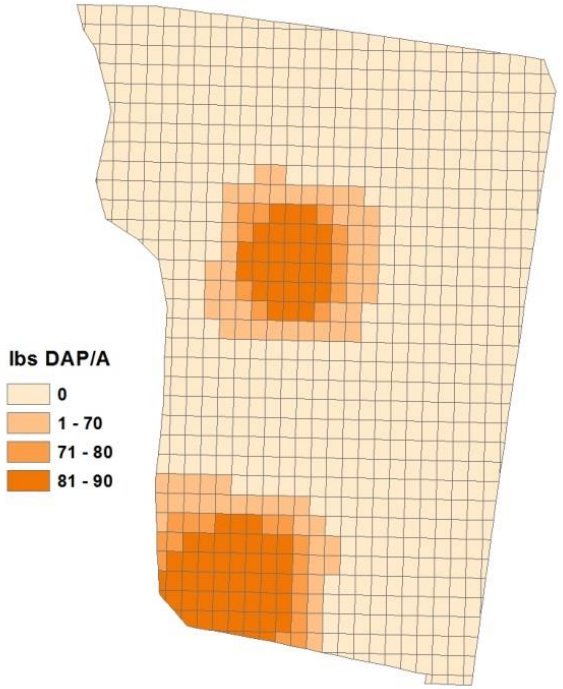
If we used blanket rates of…



2500 lb/A
(+$6/A)



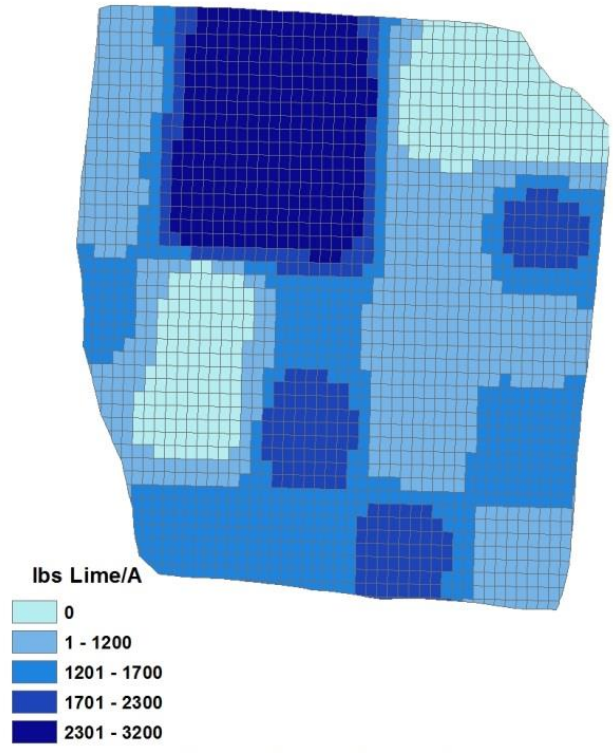
200 lb/A
(+$5/A)



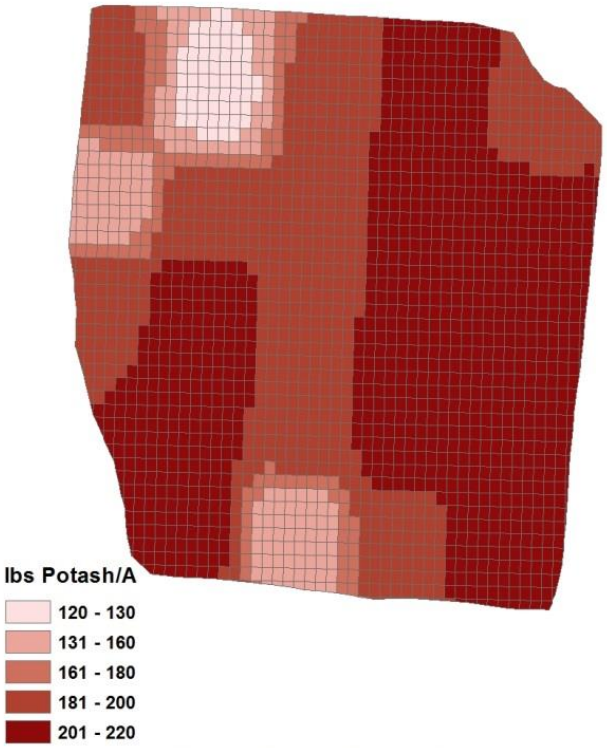
30 lb/A
(+$2/A)

VRA saves **$13/A** and **145 lbs P_2O_5**

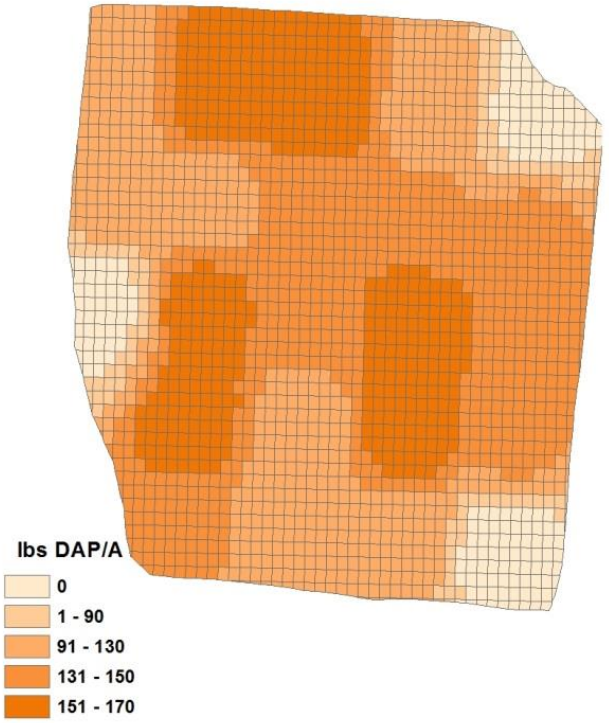
If we used blanket rates of…



2000 lb/A
(+$8/A)



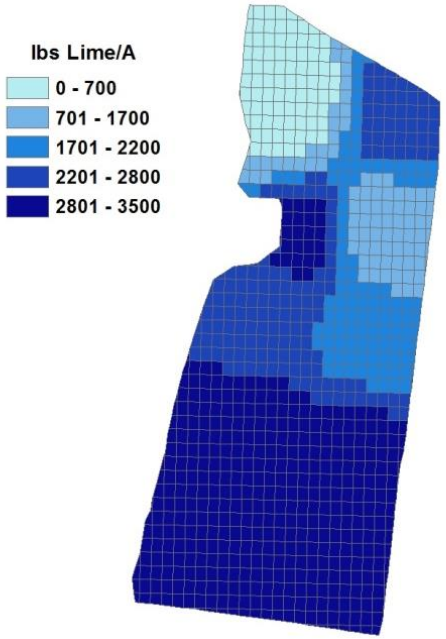
200 lb/A
(-$2/A)



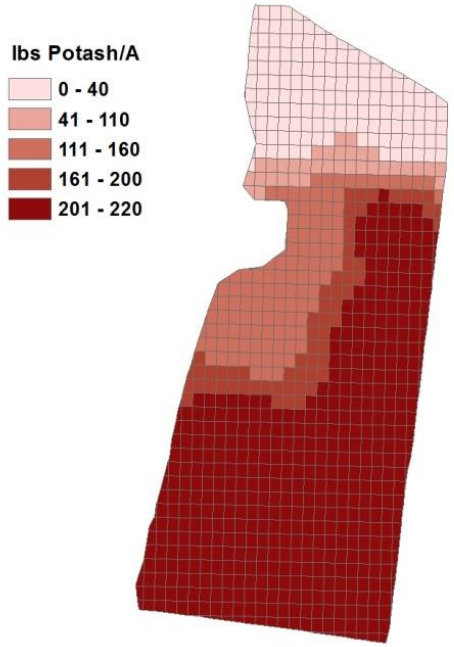
150 lb/A
(+$6/A)

VRA saves **$12/A** and **716 lbs P_2O_5**

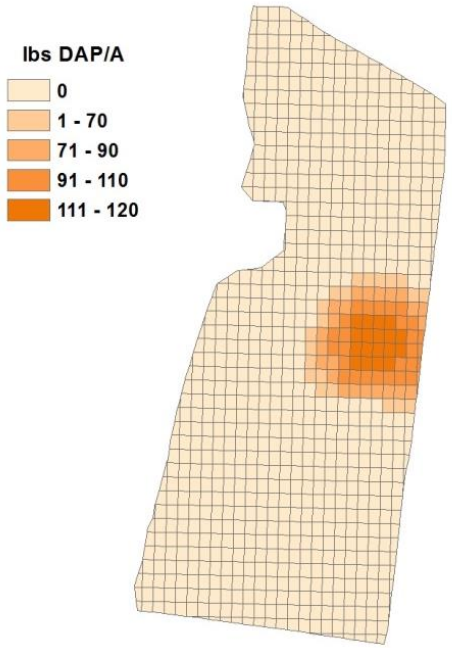
If we used blanket rates of…



2750 lb/A
(+$4/A)



200 lb/A
(+$9/A)

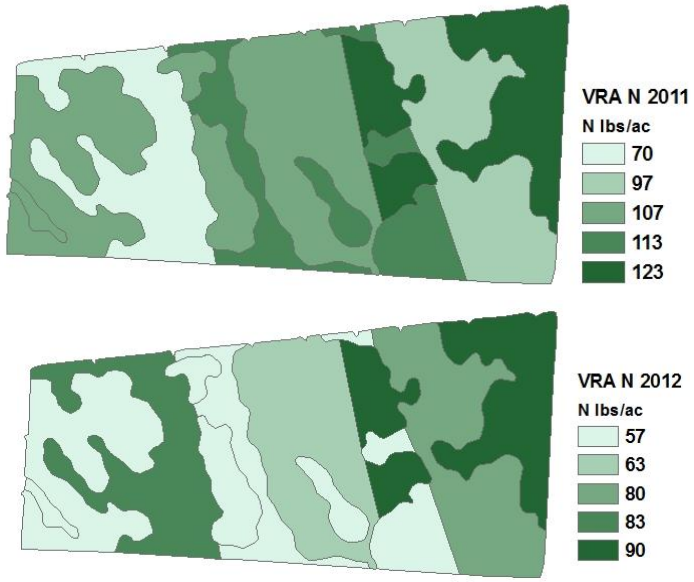


30 lb/A
(+$4/A)

VRA saves **$17/A** and **233 lbs P_2O_5**

Variable Rate Nutrients

- Adoption of zone management and VRA nutrients in 2011
- 2011—1195 lbs/ac
- 2012—1140 lbs/ac



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Variable Rate Nutrients

	N (lbs/ac)	P_2O_5 (lbs/ac)	K_2O (lbs/ac)
Traditional (uniform rate)	120	30	90
2011 (average VR)	104	0	60
2012 (average VR)	71	30	73

Variable Rate Nutrients

In two years on approx. 500 ac, this producer saved:

425,000 lb CO_2e

4.2 billion BTU

19 tons of N and
15 tons of P_2O_5

$60,000*

Field to Market

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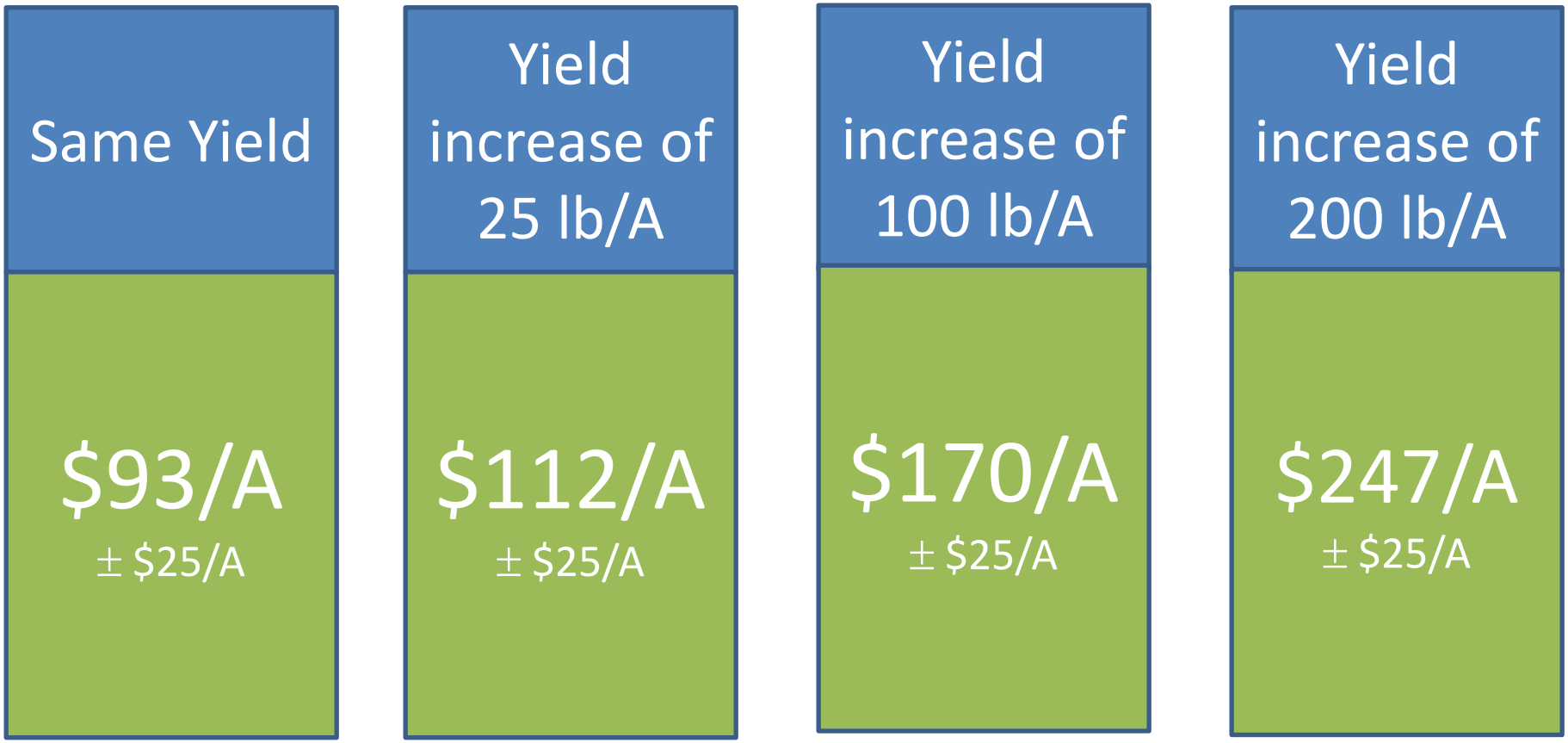
* Savings calculated solely from fertilizer cost

Variable Rate Nutrients



*partial budget analysis based on responses to 2013 Southern Cotton Farm Survey

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Past Progress and Future Opportunities

Land Use
31%

Soil Erosion
44%

Irrigation
82%

Energy Use
38%

Emissions
30%

Yield
42%

From 1980-2015, to produce one pound of lint…

Lori Duncan, PhD

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