Sensor-Guided Nitrogen Application: A Changing Landscape

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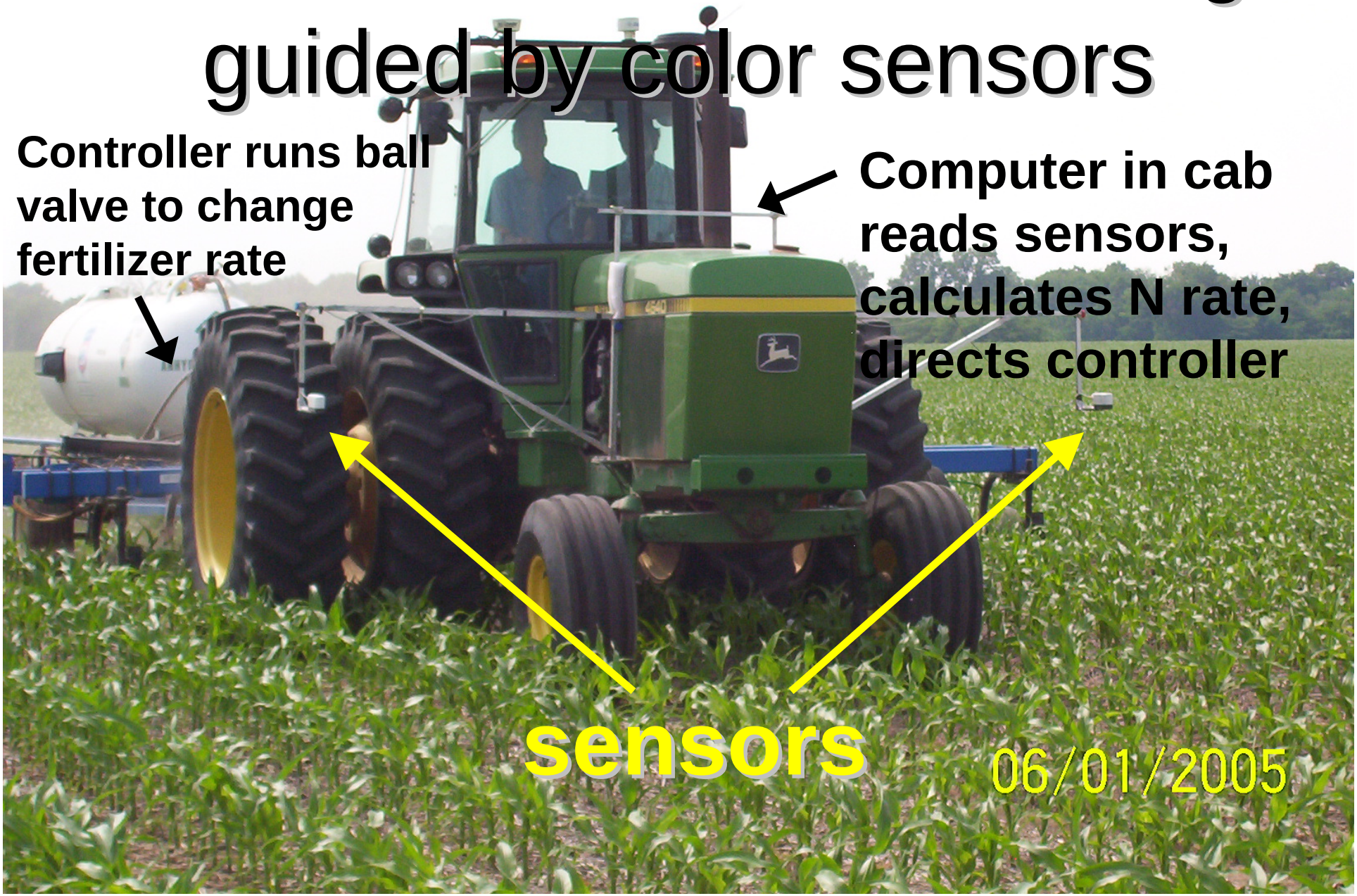
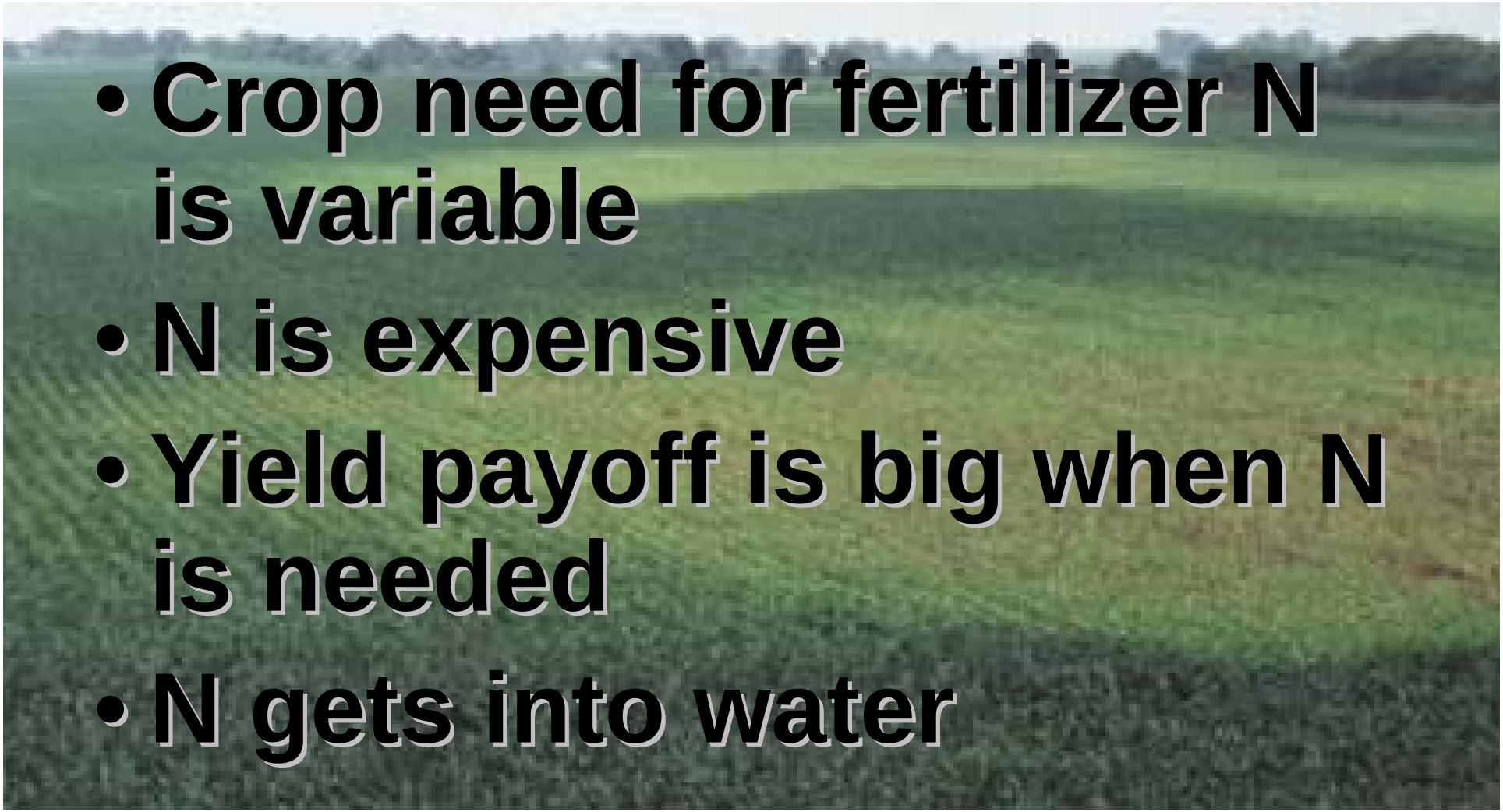
Variable-rate N sidedressing guided by color sensors



Why?

Why use nitrogen sensors?

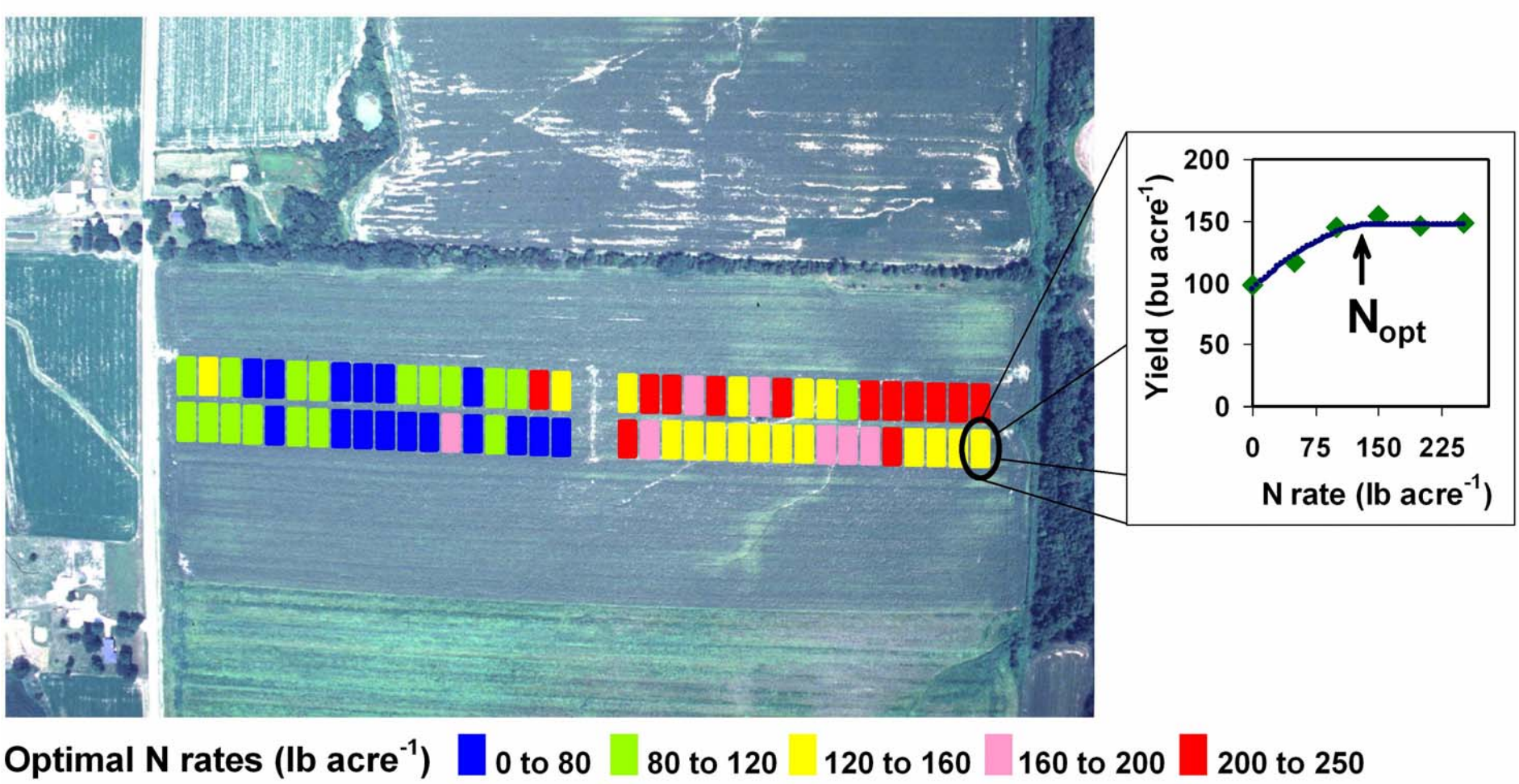


- Crop need for fertilizer N is variable
- N is expensive
- Yield payoff is big when N is needed
- N gets into water

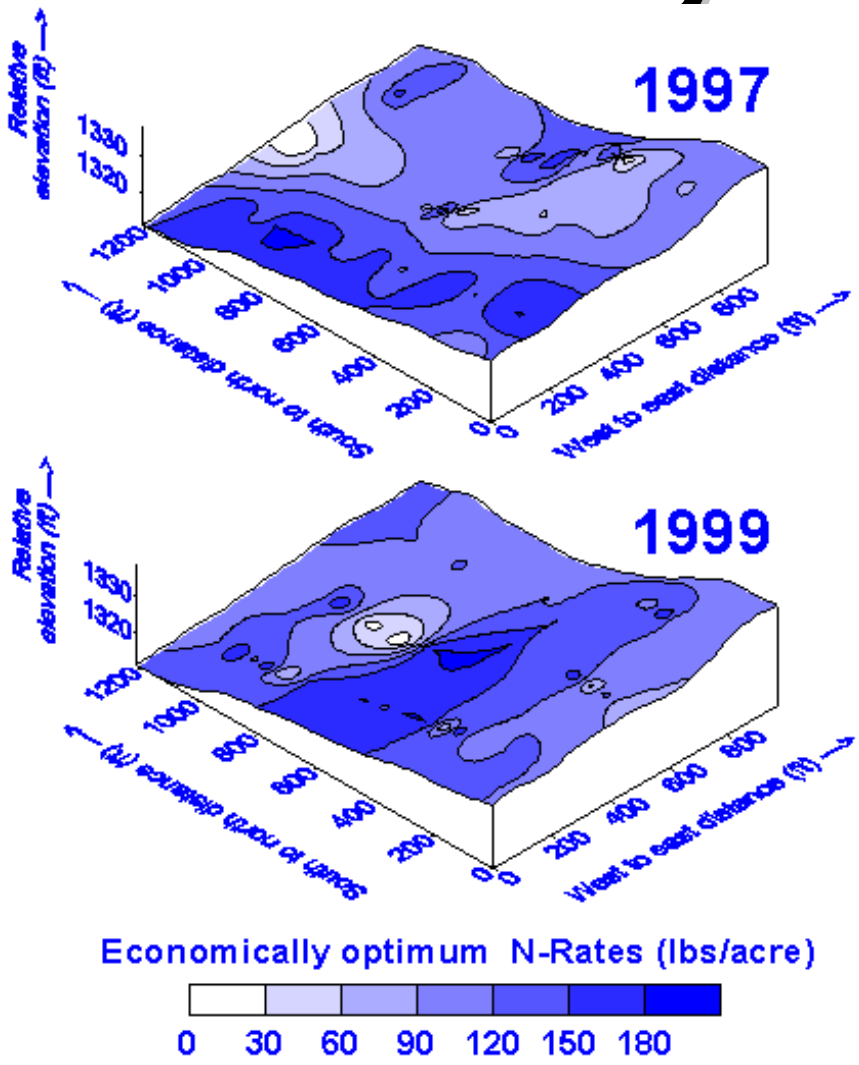
Crop N need is variable: from one field to another

- Twenty on-farm N rate experiments in Missouri, corn after soybean, no manure
- Most profitable N rates were 109, 114, 175, 0, 90, 190, 244, 63, 119, 300, 0, 146, 146, 180, 52, 175, 112, 149, 136, 114 lb N/acre

Crop N need is variable: within a field



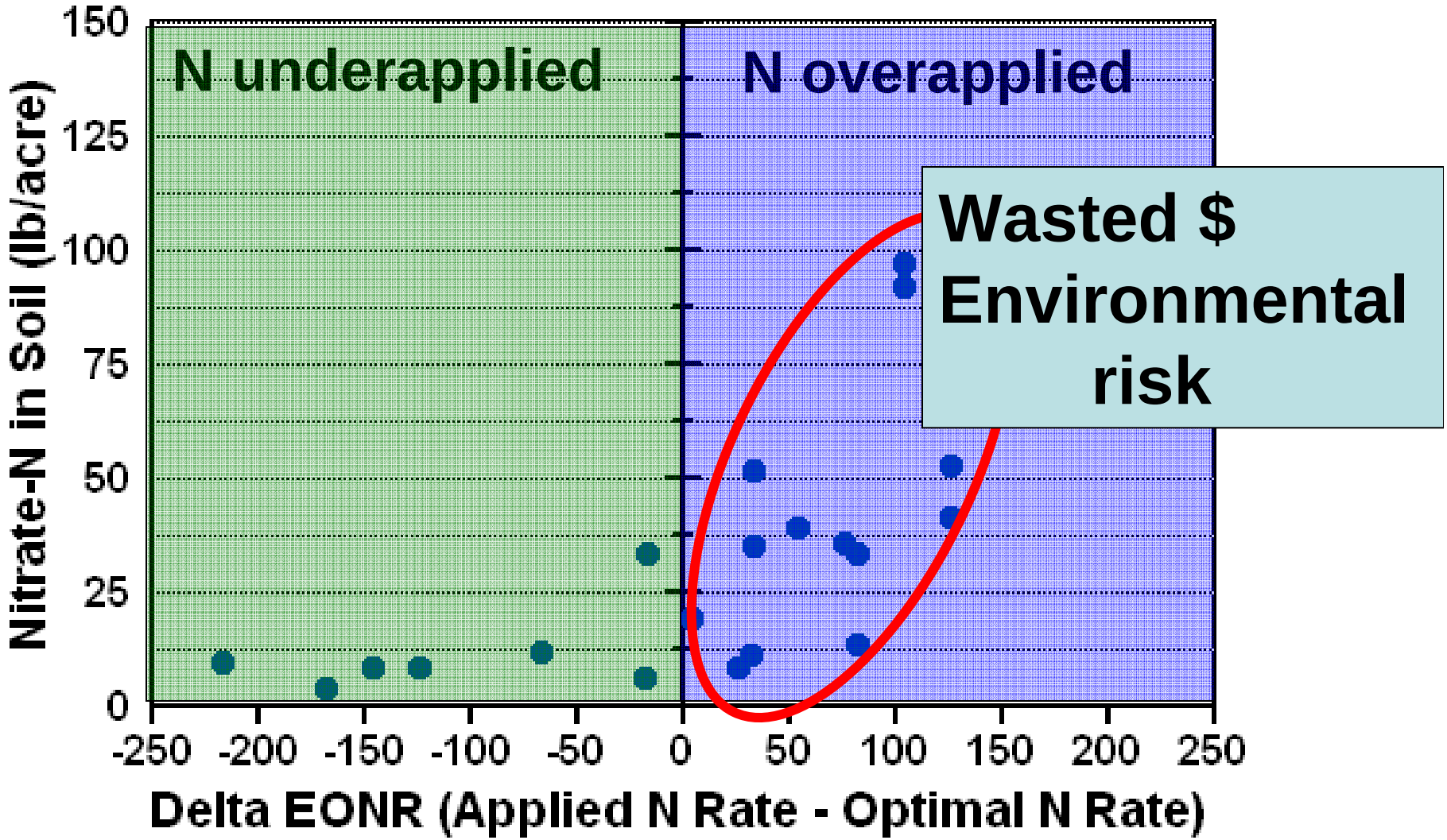
Crop N need is variable: from year to year



Minnesota corn: the places that needed the most and least N were not the same in the two years

G. Malzer data from Doerge (2002) Crop Mgmt. doi. 10.1094/cm-2002-0905-01-RS

Overapplication = leftover N in soil



N gets into water

Spatially intensive diagnosis is needed

How?

Diagnosing where to put more N

Predictor	% of variability in N need explained
Yield	2 to 20
Soil nitrate	17 to 25
Soil N quick tests	0 to 18
Soil conductivity	8
Corn color	53 to 77

Translating sensor measurements to N rates

- Tricky
- No agreement at a national scale
- Still a slight obstacle to successful sensor use

Translating sensor measurements to N rates

Oklahoma State, N-Tech:

sensor

↓

yield

↓

yield increase to N

↓

N rate

Translating sensor measurements to N rates

Oklahoma State, N-Tech:

sensor

↓

yield

↓

yield increase to N

↓

N rate

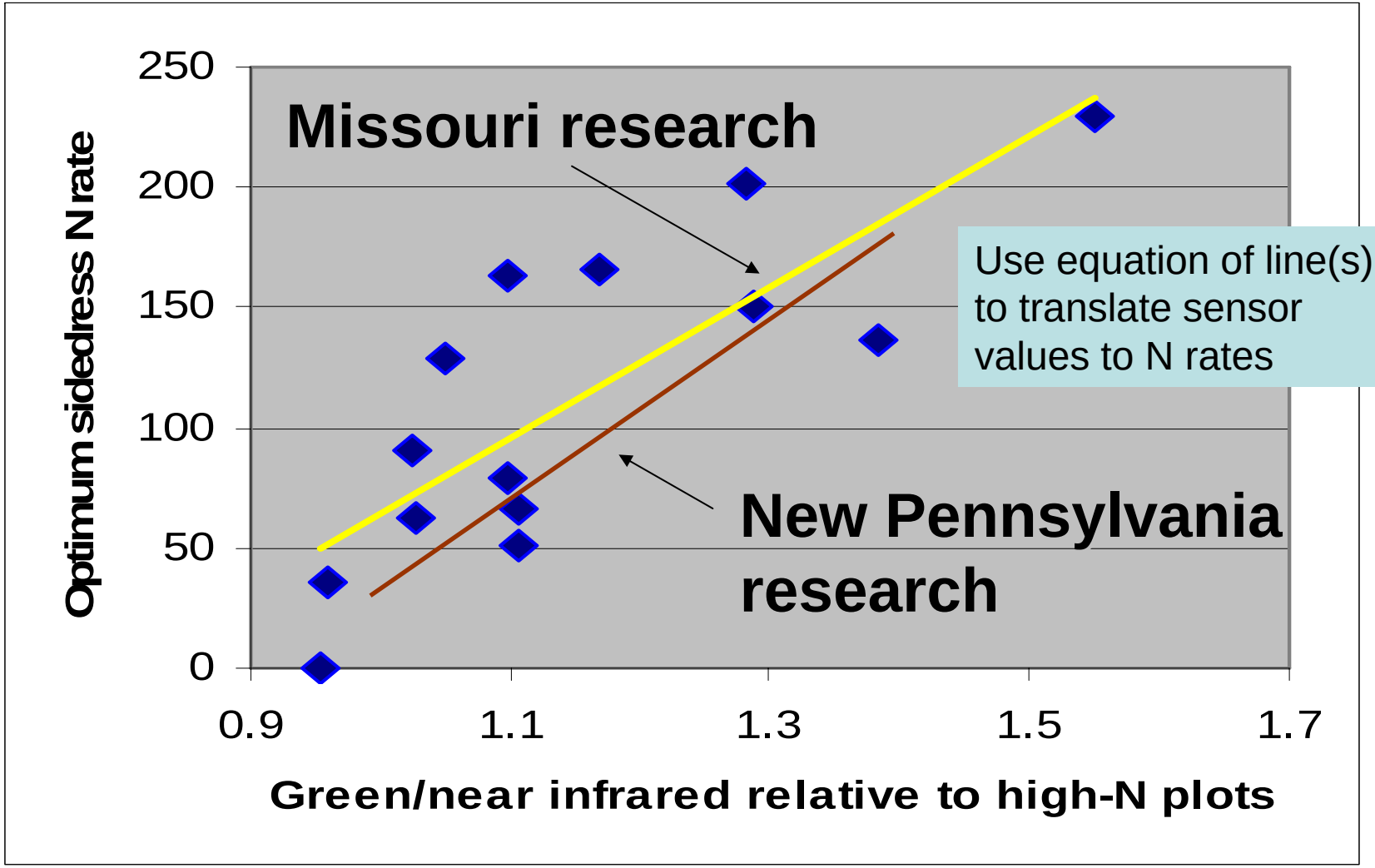
Missouri, Pennsylvania, international:

sensor

↓

best N rate

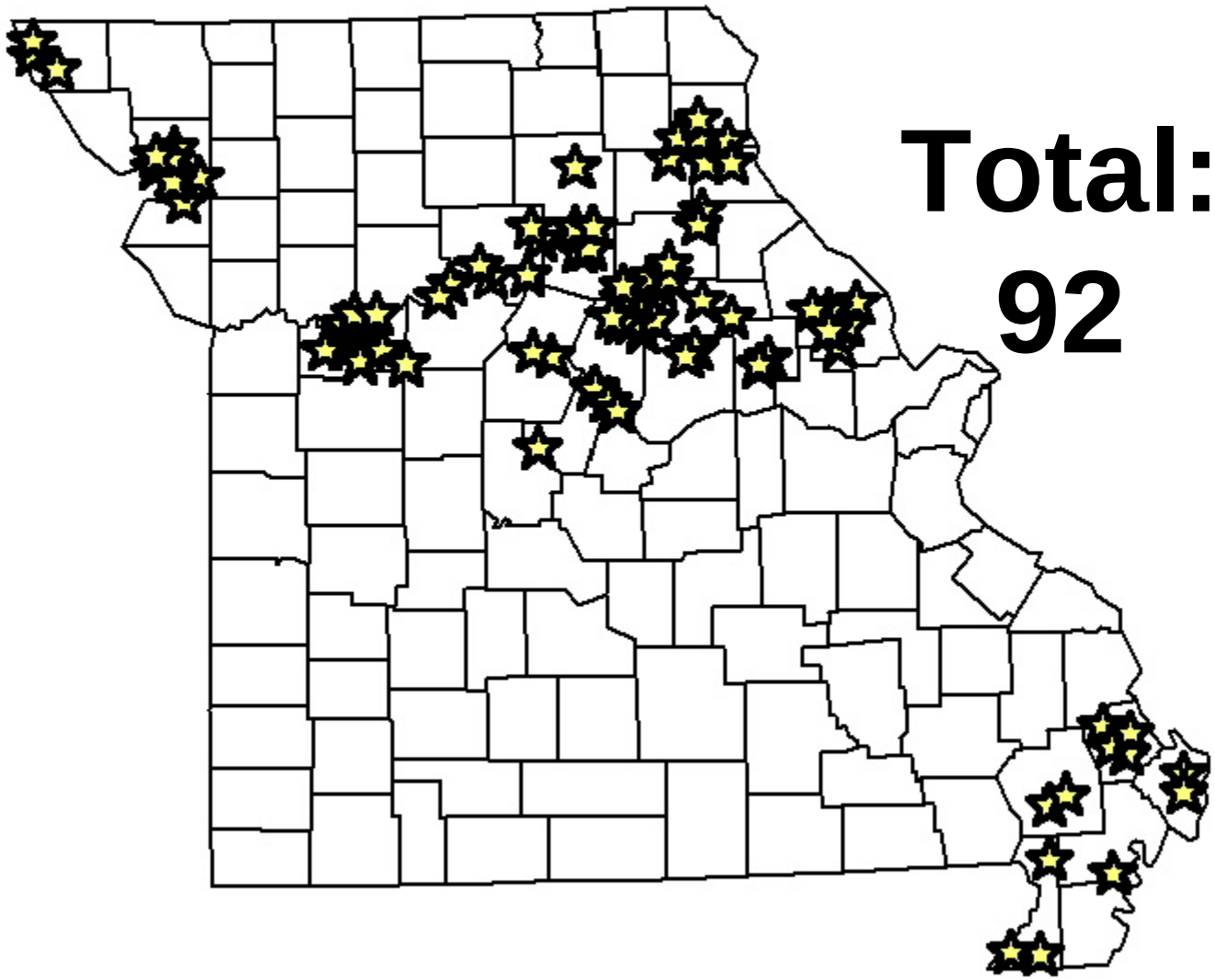
Translating sensor measurements to N rates



Sensors for N management

- Research shows promise
- Next step: try it in production fields with production equipment

Locations of sensor demonstration fields 2004-2008



Total: 92

21 with USDA Spra-Coupe, 2004-2007

56 with producer-owned applicators, 2005-2008

15 with retailer-owned applicators, 2006-2008

Demo Objectives

1. Support producers, retailers, & consultants in planned sidedress operations from 1 foot to 6 foot height
2. Evaluate outcome using sensors relative to outcome with current producer practice (strip trials)

Demo Program

- What we provide:
  - Loan of sensors, computer, cables, stand
  - Brackets to place sensors in the right place
  - Computer program to translate sensor readings to N rates
  - Expertise
  - Data analysis
- Help overcome the steep learning curve
- Give producers & retailers a chance to ‘demo’ this practice without a large investment of time & money

Nitrogen sensor dem

What kind of N applicator can you use sensors with?

Injecting anhydrous ammonia


injecting solution
(tractor)

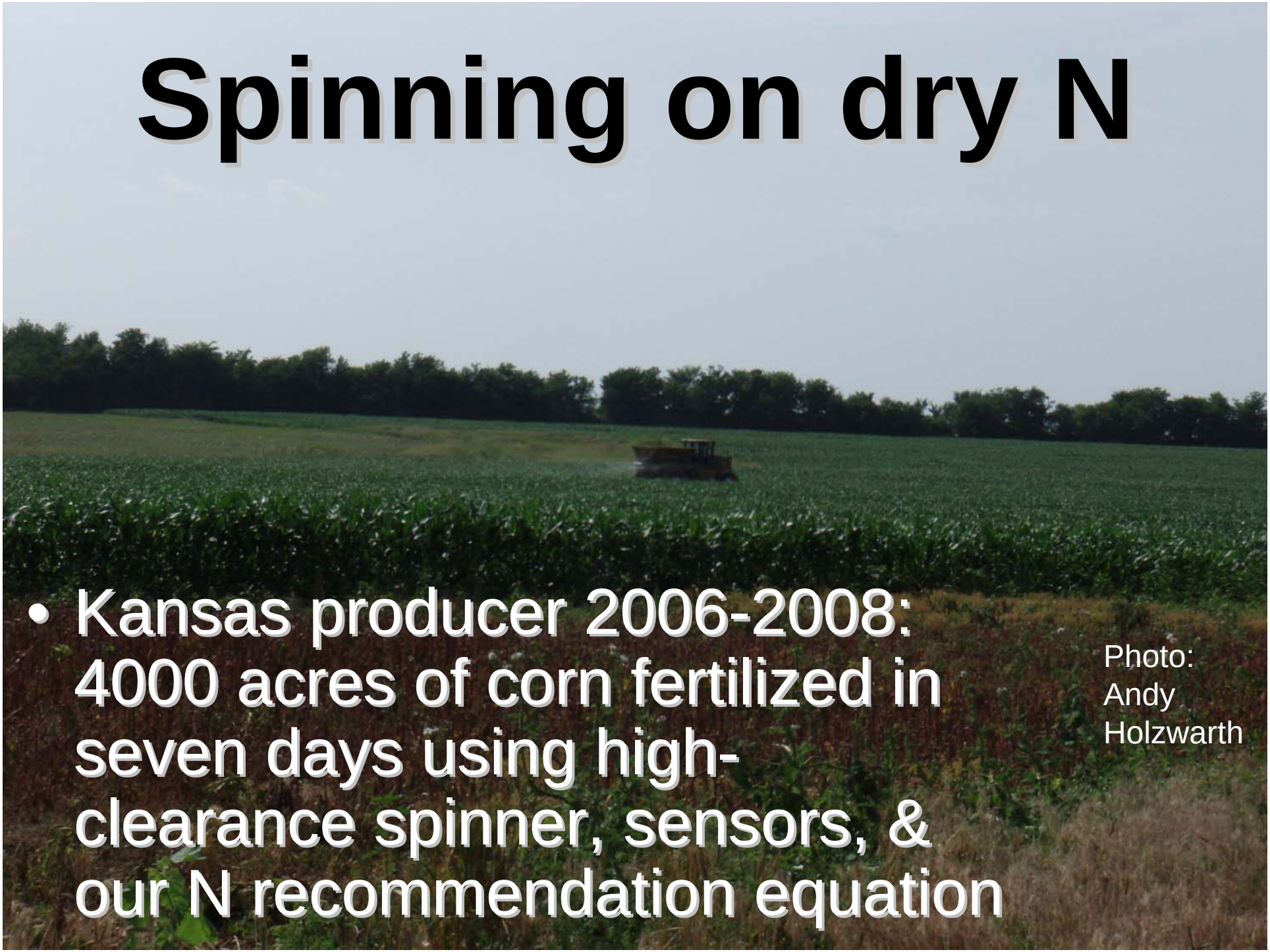
injecting solution (high-clearance)

Dribbling solution

Spinning on dry N

(easier to get a wide range of rates)

Spinning on dry N



- Kansas producer 2006-2008: 4000 acres of corn fertilized in seven days using high-clearance spinner, sensors, & our N recommendation equation

Photo: Andy Holzwarth

On-farm sensor demos 2004-2007

N rate system	Average yield	Average N rate
Producer rate	157	
Sensor-controlled		
$ to sensor		

On-farm sensor demos 2004-2007

N rate system	Average yield	Average N rate
Producer rate	157	
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On-farm sensor demos 2004-2007

N rate system	Average yield	Average N rate
Producer rate	157	
Sensor-controlled	157	
$ to sensor	-$2	

On-farm sensor demos 2004-2007

N rate system	Average yield	Average N rate
Producer rate	157	145
Sensor-controlled	157	
$ to sensor	-$2	

On-farm sensor demos 2004-2007

N rate system	Average yield	Average N rate
Producer rate	157	145
Sensor-controlled	157	122
$ to sensor	-$2	

On-farm sensor demos 2004-2007

N rate system	Average yi	Average N
Producer rate	1	
Sensor-controlled	1	
$ to sensor	-$2	+$15

2007 prices: +$13/ac to sensors

On-farm sensor demos 2004-2007

N rate system	Average y	Average N
Producer rate	1	
Sensor-controlled	1	
$ to sensor	-$2	+$5

2002 prices: +$3/ac to sensors

Increasing N prices have made sensors more economically viable


What about water quality?

Missouri EQIP support available

- 2007: $20/acre x 3 years = $60/acre
- 2008: $19/acre x 2 years = $38/acre
- 2009: $33/acre x 2 years = $66/acre

What else happened in 2008?

2008: Sidedress N kicks butt

2008: Sensors applied more N than producer rate in most demo fields (normal background N lost due to high rainfall)

Good odds for increased yield

2008: Our first cotton demo

2006-07: Calibration research, looks great

2008 demo: Saved 45 lb N/acre, looks great!!

Keys to success

- Research base
- Programmer
- Learn with producers
  - There are lots of twists you won’t think of in small-plot research

What have we learned?

- Power of visual reinforcement
  - The machine does what they would do
  - Dark crop = low N rate, light crop = high N
  - But automated to reduce operator fatigue
- Importance of preparation
  - Everything has to be slick
  - We calculate producer time at $11,000/day during spring & fall rush times

What have we learned?

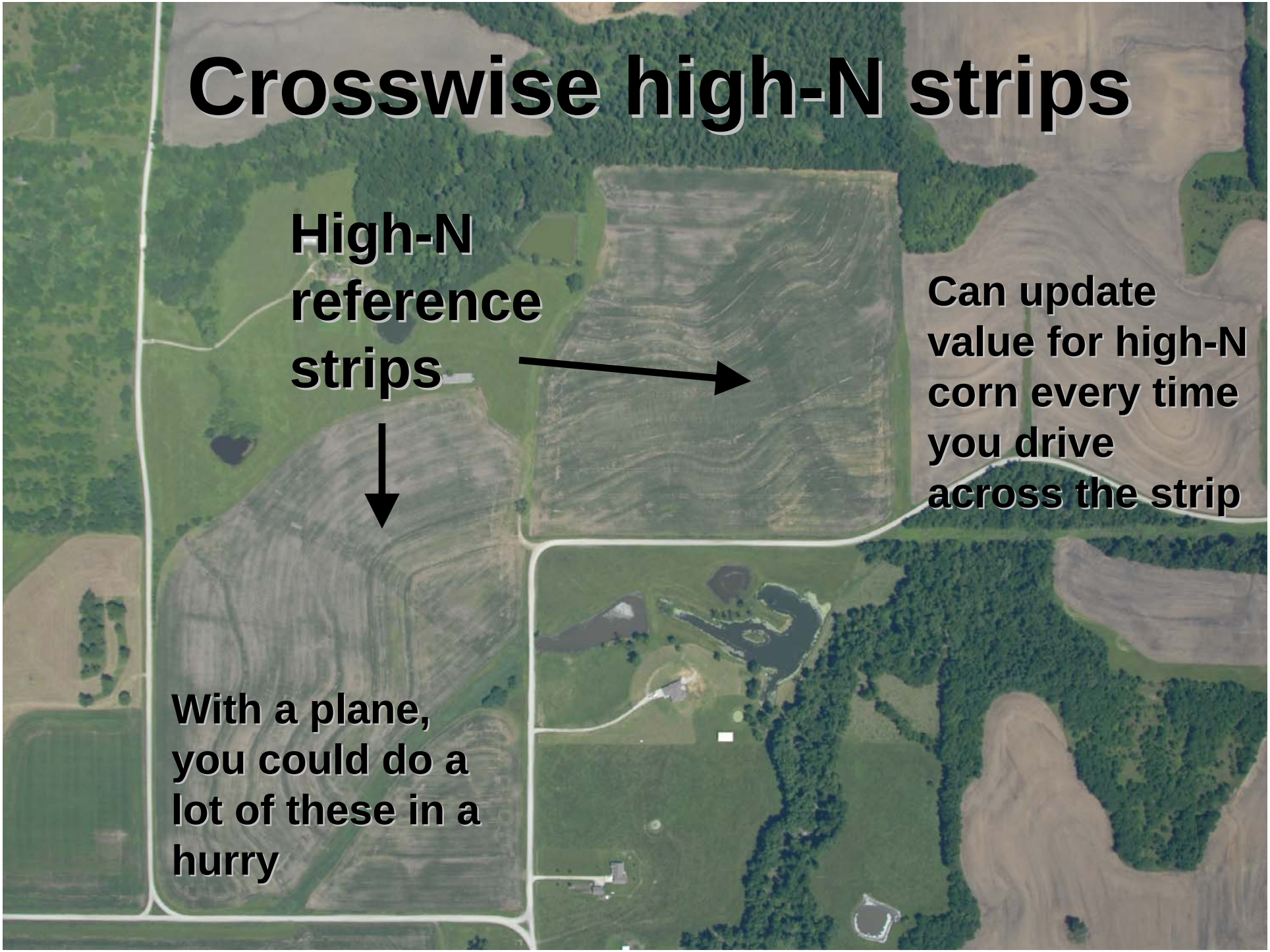
- Sensors can maintain productivity while reducing N use
  - Cut back in smart places
- Sensors can identify places/years that need more N (than the normal producer rate)

What have we learned?

- Obstacles:
  - Good recommendation equations
  - Weed interference (control early)
  - Limited range of rates with liquid
    - New spring-loaded nozzle bodies will help

What have we learned?

- Obstacles:
  - High-N reference area
    - Hassle of installing
    - Bad results if installed poorly (too late or unmarked or too early)
  - Drift of sensor rates during the day
    - Hassle of driving back to high-N reference area to correct this drift
      - May be avoided with crosswise high-N strips


Crosswise high-N strips
High-N reference strips
Can update value for high-N corn every time you drive across the strip
With a plane, you could do a lot of these in a hurry

Adoption

- Slow but increasing
- Adopters doing contract work for neighbors

The Future

- More Missouri demos in 2009
  - Let me know if you or a customer may be interested

The Future

- Greenseeker available
  - Record Harvest in Nevada is a dealer

The Future

- Greenseeker avail
  - Record Harvest in Ne
- Crop Circle
  - Sales via Ag Leader
  - New model/new wavelengths (be careful!)

The Future

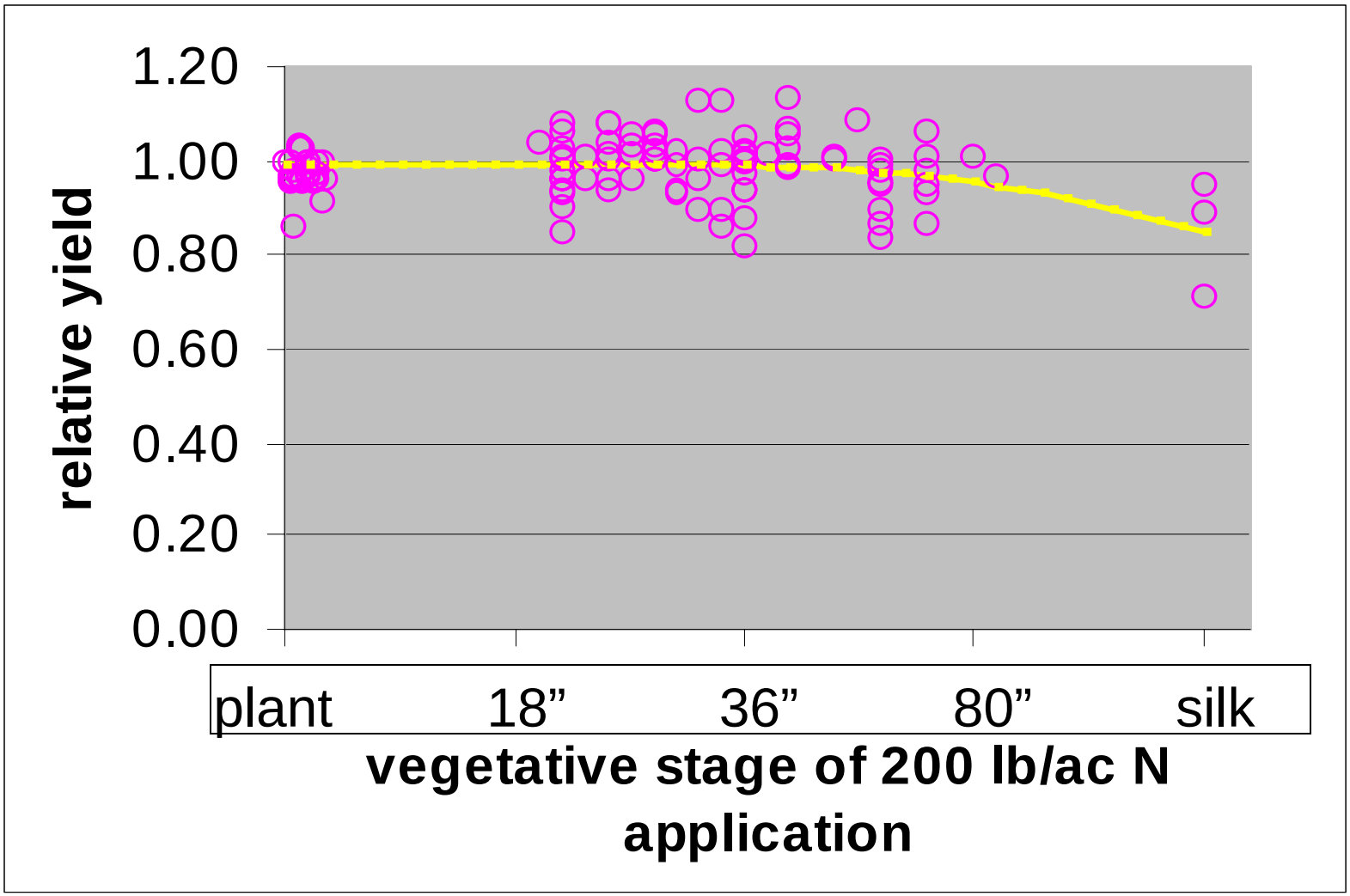
- Greenseeker available
  - Record Harvest
- Crop Circle
  - Sales via Ag Lea
  - New model/new
- Toshiba entering the market?
  - Re-engineered Yara (Hydro) sensor

The Future

- N prices, environmental pressures will continue to push tighter N management

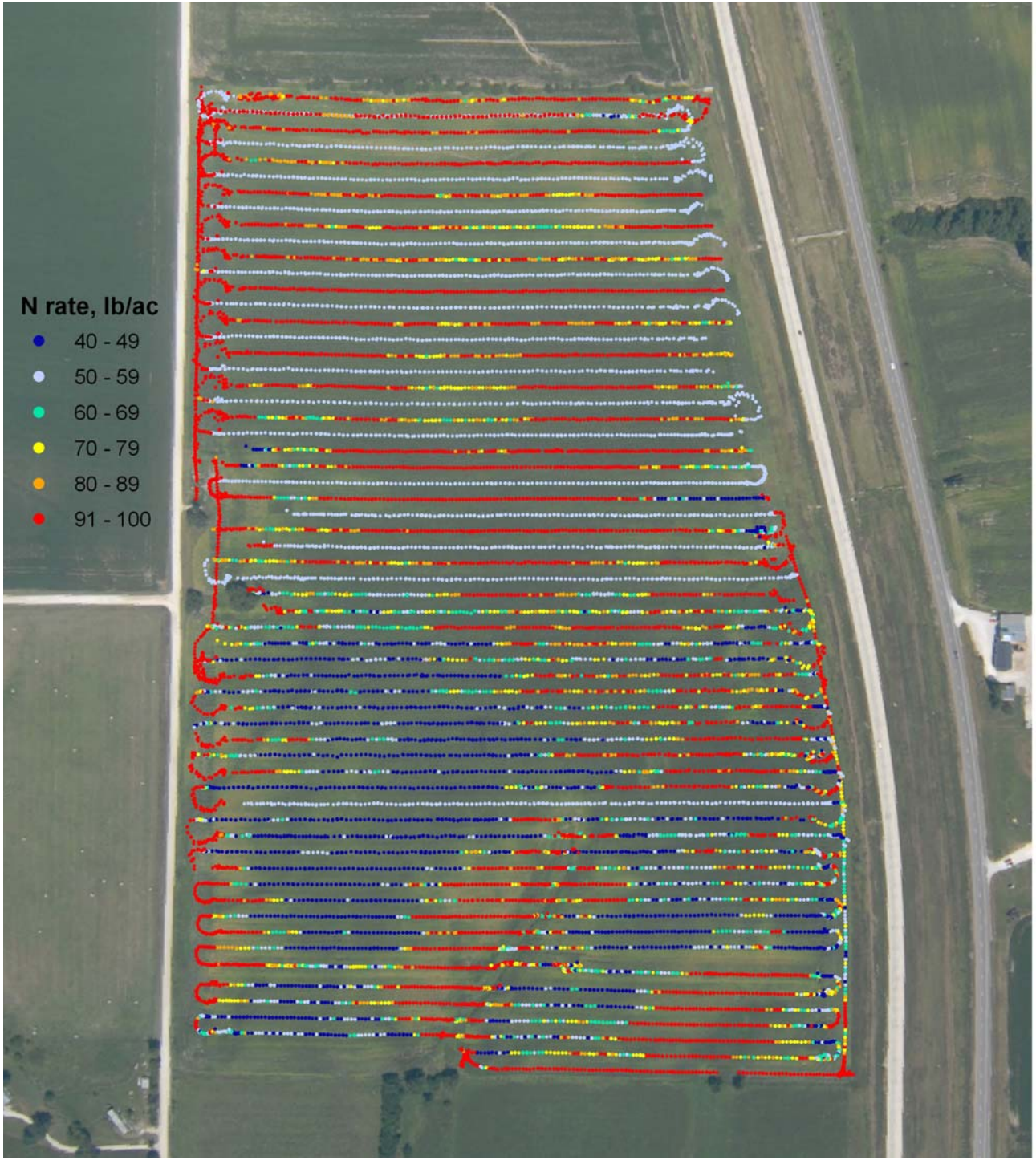
Corn yield is not as sensitive to late N application timing as you might think

28 small-plot trials in producer fields, Missouri, 1997-1999



Sensor Benefits:

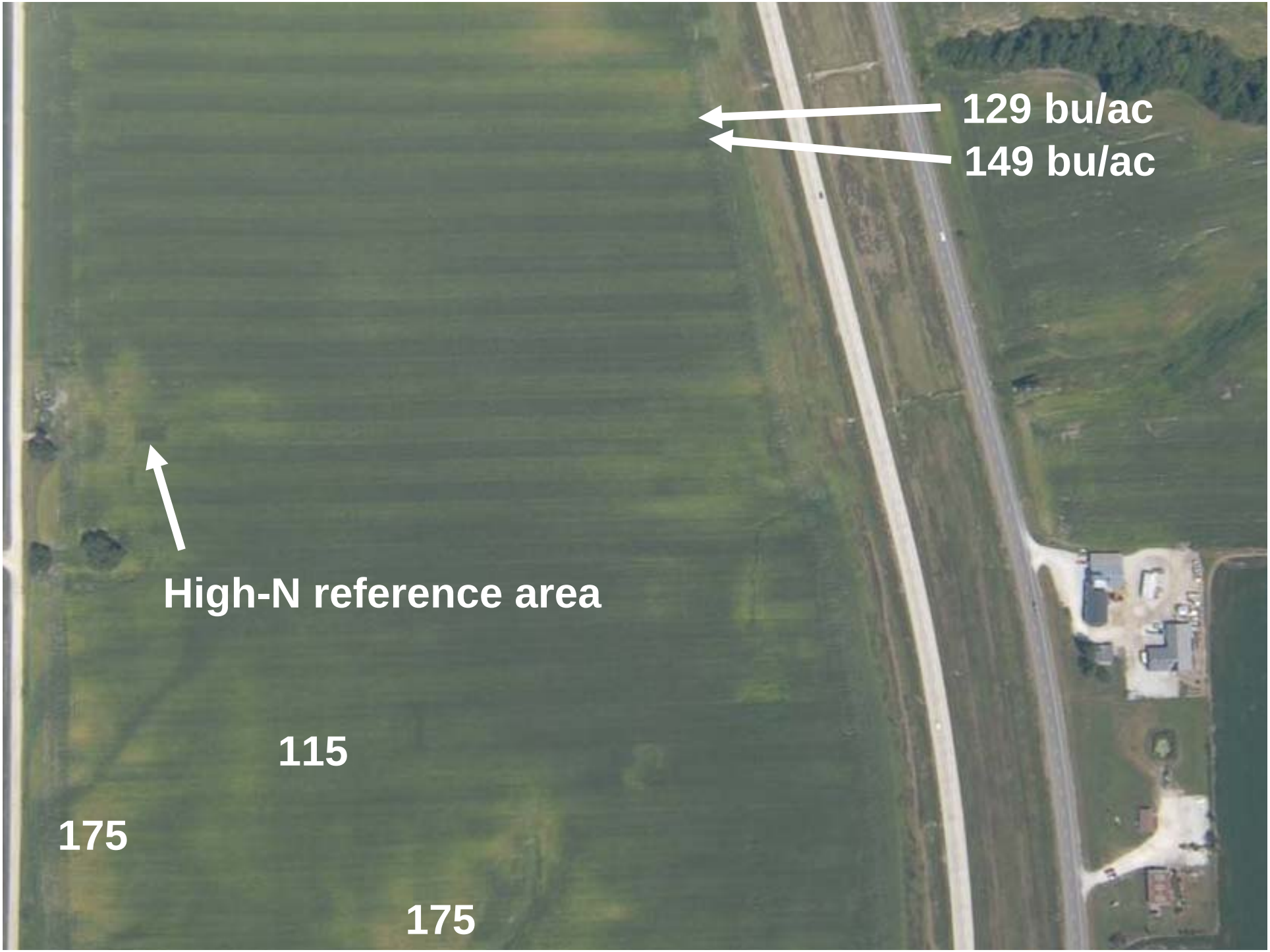
- Make sure enough N is applied
- Avoid unneeded N application



N application to head-high corn

N rate map

June 20, 2007


129 bu/ac
149 bu/ac
High-N reference area
115
175
175

Sensor Benefits:

- Make sure enough N is applied
- Avoid unneeded N application

Pounds of Nitrogen As Applied Via UAN on 6/13/07
Becker Farm - Laddonia, MO

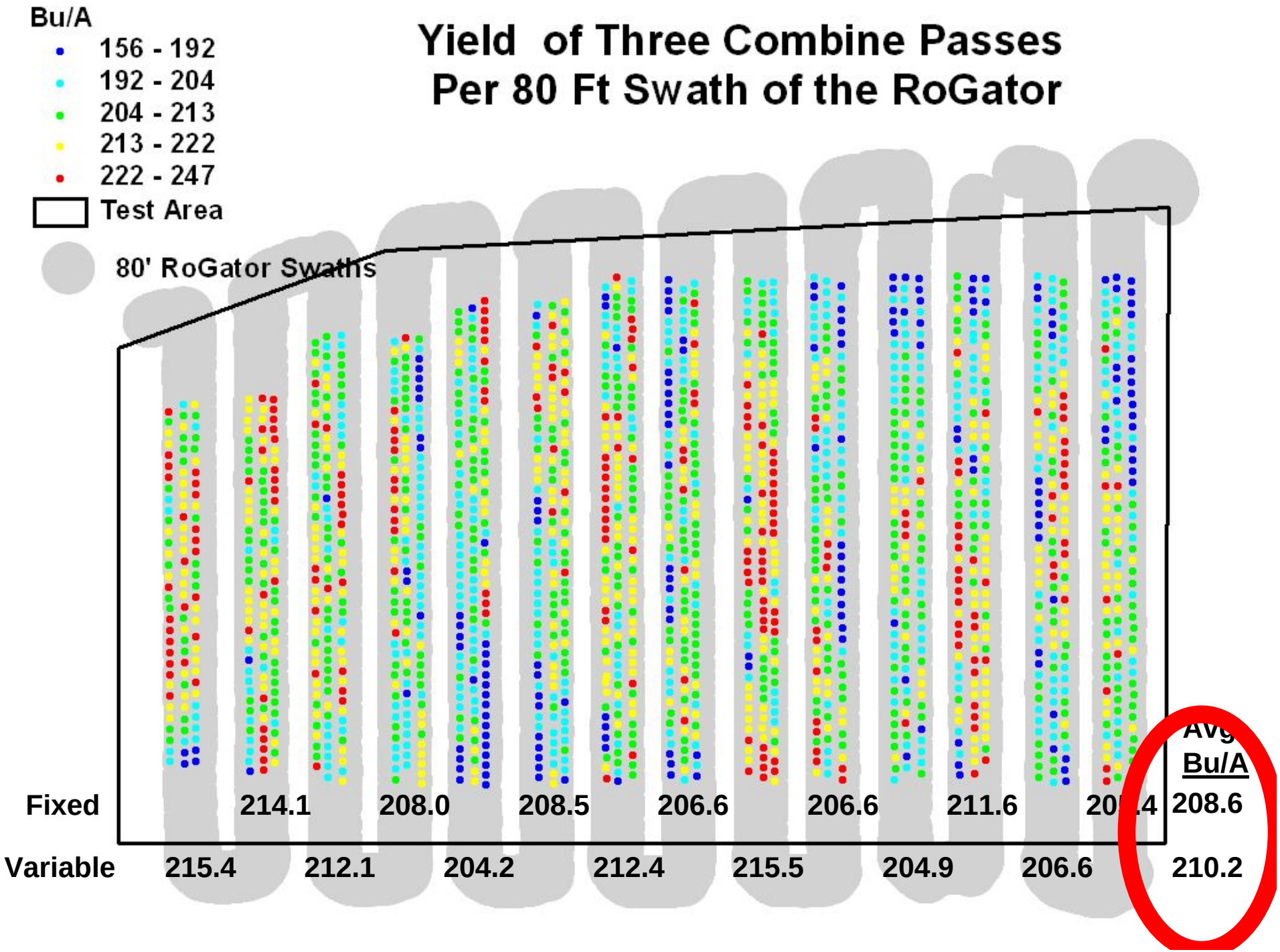
As Applied

- 60-81
- 82 - 111
- 112 - 137
- 138 - 164
- 165 - 180

N
W E
S

August 1 Aerial Photo after the June 13 UAN Application

Yield of Three Combine Passes Per 80 Ft Swath of the RoGator




Questions?
06/08/2006