

Crop Sensors to Guide Nitrogen Fertilizer Application: Reduce N Loss, Not Yield

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Why?

N gets into water

Mouth of
Mississippi River

A satellite image of the Gulf of Mexico. The top left portion of the image is a bright, yellowish-green color, representing a massive algal bloom. This bloom extends from the top left towards the center. A white arrow points from the text 'Mouth of Mississippi River' to the edge of this bloom. The rest of the Gulf of Mexico is a dark blue color. The text 'Huge algal bloom' is located below the bloom, with a white arrow pointing to the yellowish-green area. The text 'Gulf of Mexico' is in the bottom right corner.

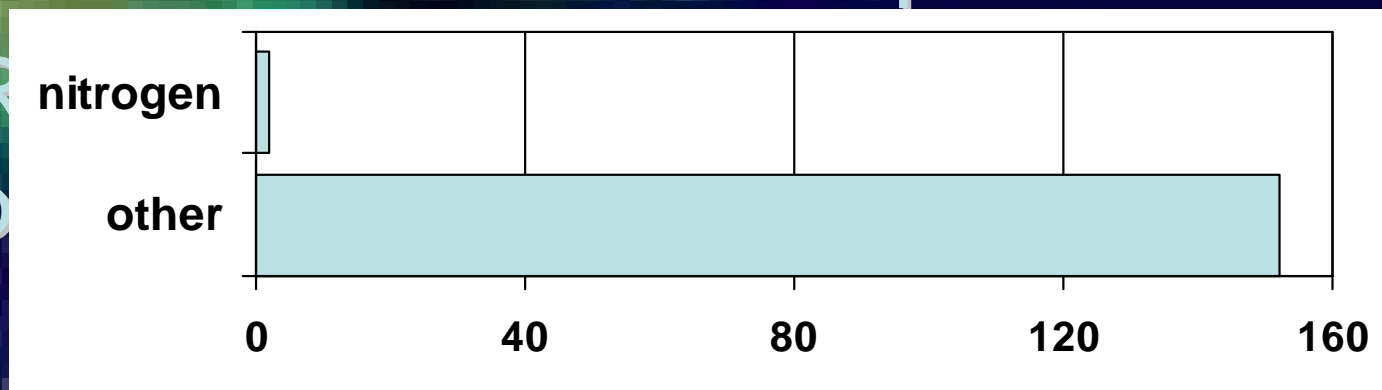
Huge algal
bloom

Gulf of Mexico

Gulf Hypoxia:

Water quality poster child

- Rates the General Session for this meeting
- Lots of popular press, very visual
- N is the issue (in textbooks 30 years ago)
- National **Ag Water** Conference: surely potential solutions will be presented?
- CSR (hypoxia)



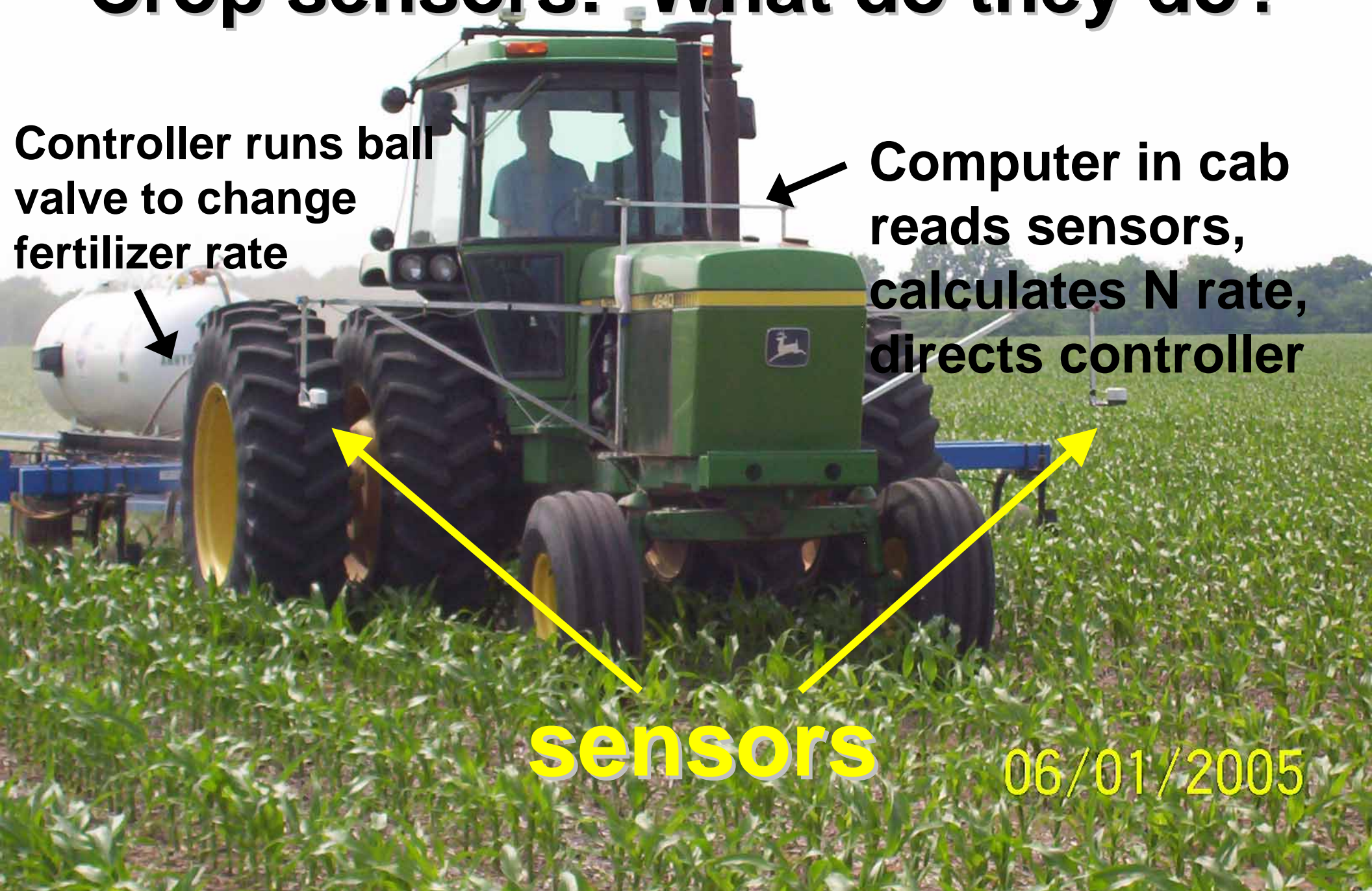
Crop sensors: What do they do?

Controller runs ball valve to change fertilizer rate

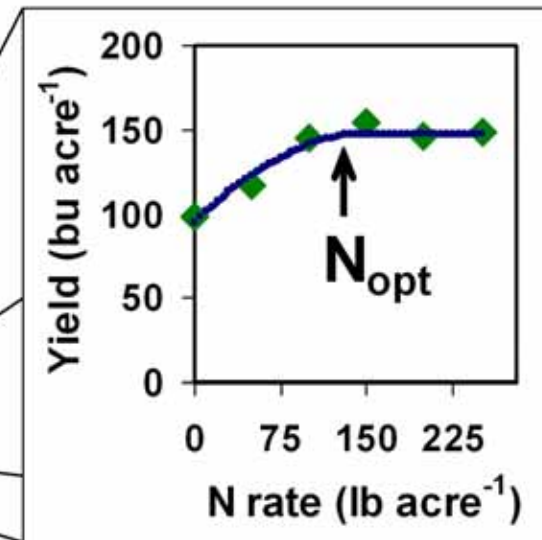
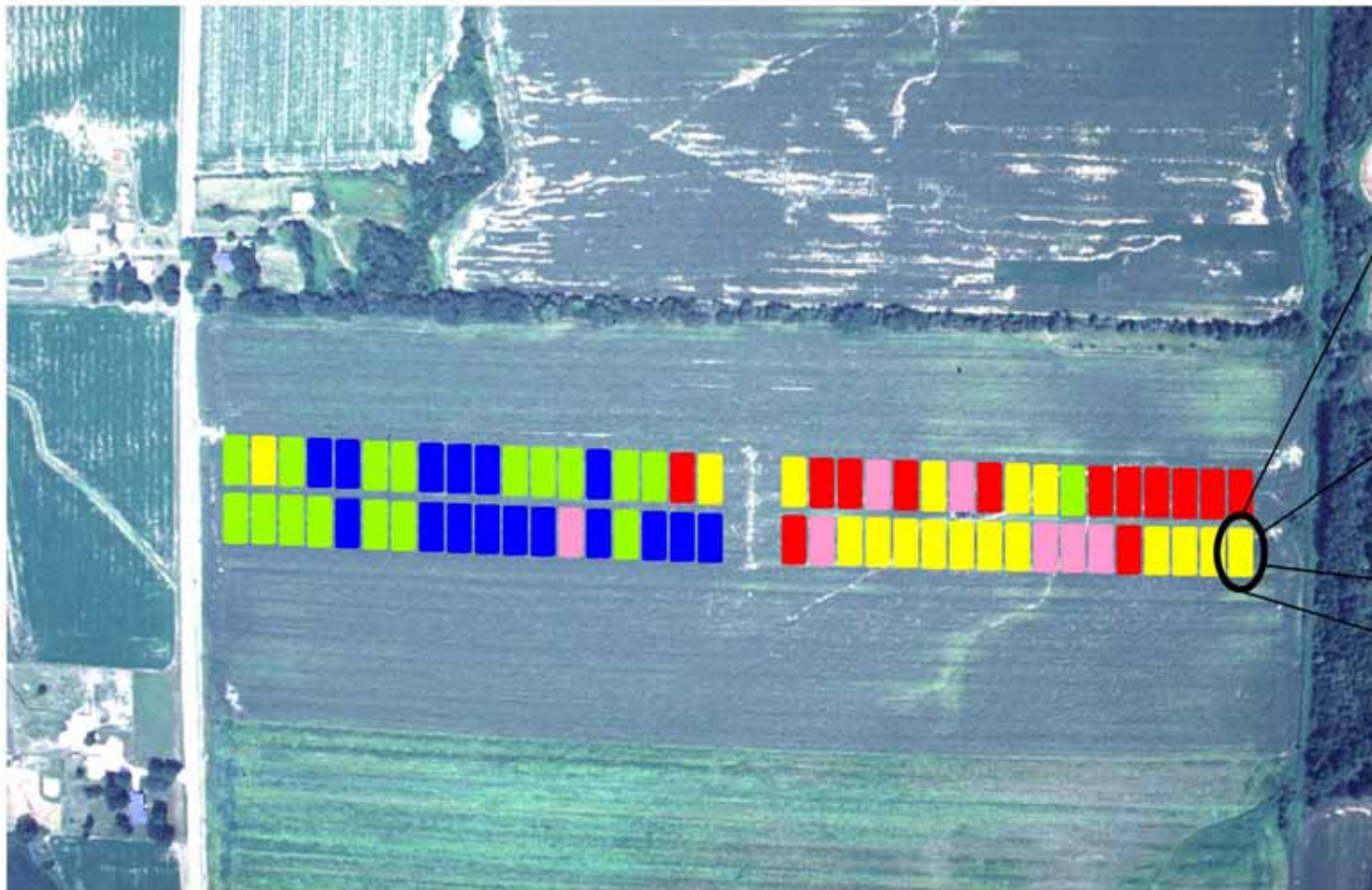
Computer in cab reads sensors, calculates N rate, directs controller

sensors

06/01/2005

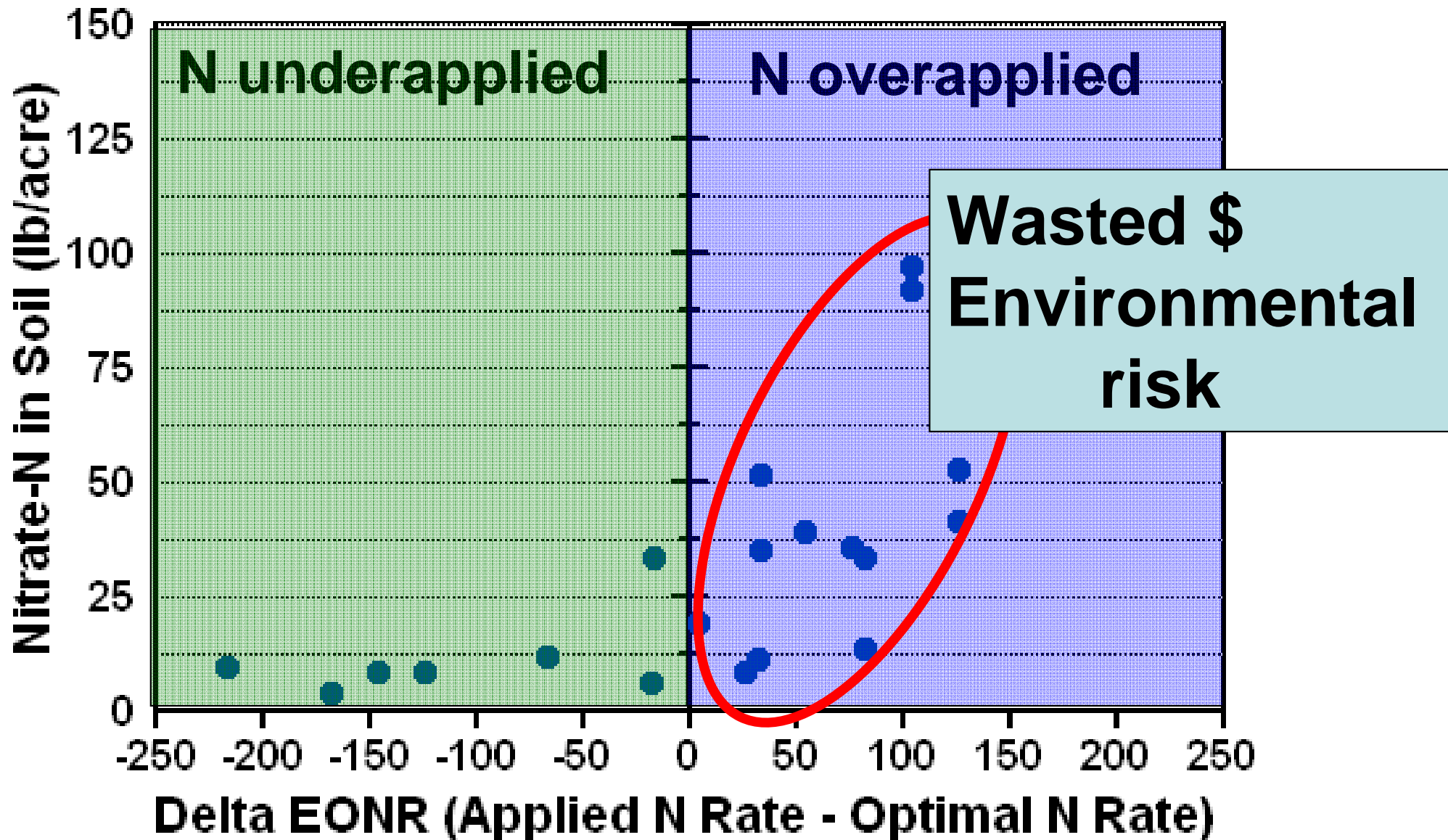


Crop N need is variable: within a field



Optimal N rates (lb acre⁻¹) **Blue** 0 to 80 **Light Green** 80 to 120 **Yellow** 120 to 160 **Pink** 160 to 200 **Red** 200 to 250

Overapplication = leftover N in soil



**Putting the right fertilizer rate
in the right place:**

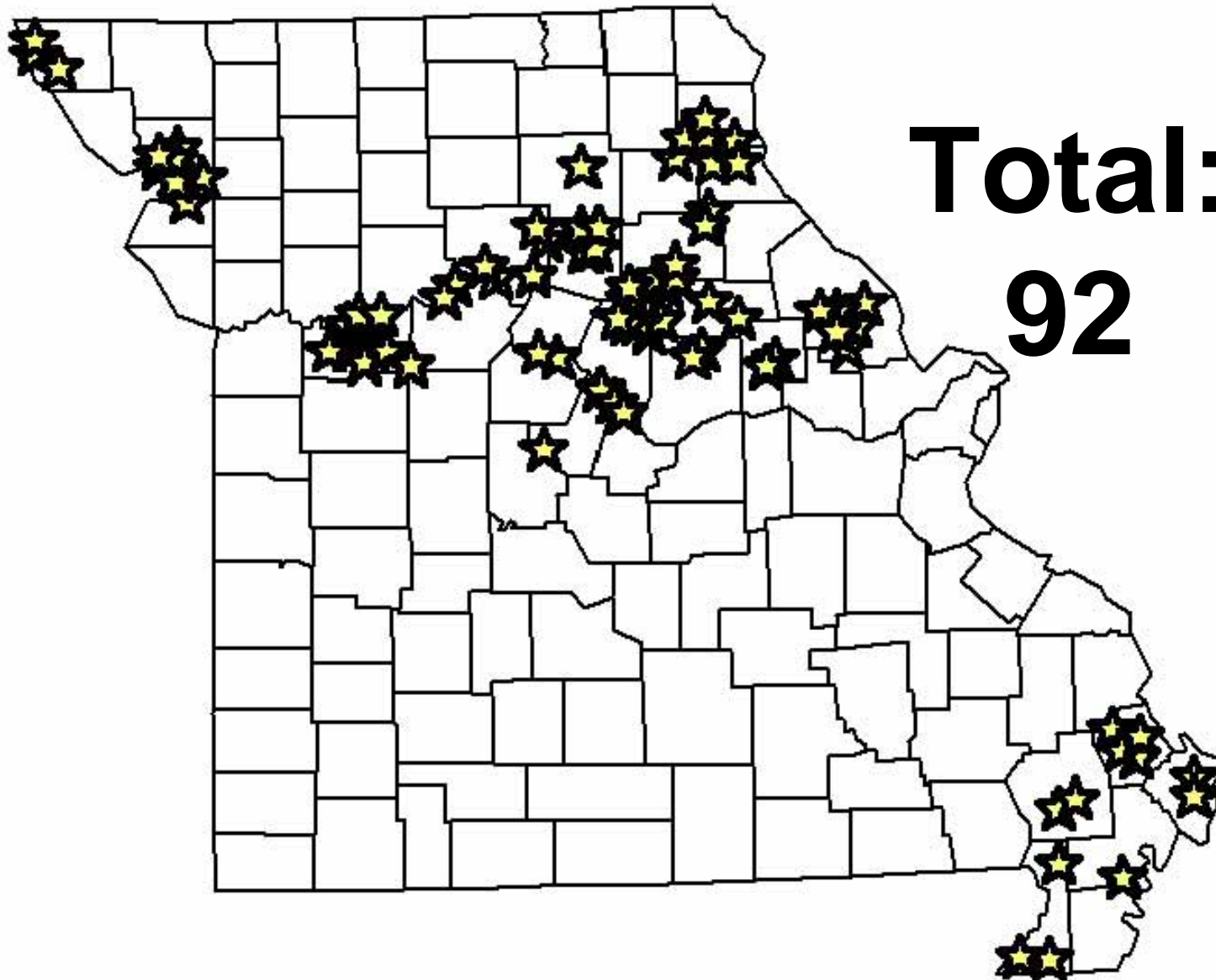
**Spatially intensive
diagnosis is needed to
protect water quality**

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

Locations of sensor demonstration fields 2004-2008



21 with USDA Spra-Coupe, 2004-2007



56 with producer-owned applicators, 2005-2008



06/01/2005

16 with retailer-owned
applicators, 2006-2008



06/08/2006

Sensor outcomes

- 2004-2007: +\$15/ac on corn (41-field ave)
 - Broke even on yield
 - Saved 24 lb N/acre
- 2008: +\$29/ac (12-field average)
 - 9 bu yield increase (152 to 161)
 - Used 16 lb extra N
 - **Adjusted for wet weather and N loss!**
- 2009-2010: more sensor demos
 - Interested? Let me know



N timing in 2008—Columbia

This image shows a cornfield where 180 lbs of nitrogen was applied at planting. The plants are shorter and less dense than those in the adjacent image. The text 'Where did it go?' is overlaid on the image, suggesting that the nitrogen was not effectively used by the plants.

Where did it go?

**180 N at
planting: LOST!!**



+38 bushels

**110 N at knee high:
DELIVERED!**

Missouri EQIP support available

- 2007: \$20/acre x 3 years = \$60/acre
- 2008: \$19/acre x 2 years = \$38/acre
- 2009: \$36/acre x 2 years = \$72/acre



Questions?

06/08/2006

The Future

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

An aerial photograph showing a river bottom area with lush green vegetation. A road runs vertically through the center of the image. The vegetation appears dense and somewhat chaotic, suggesting a natural or semi-natural state. The text is overlaid on the top half of the image.

Nitrogen loss in 2008: What a mess!

Northwest Missouri, Missouri R. bottom, August 2

**What kind of N
applicator can
you use
sensors with?**

Injecting anhydrous ammonia



06/01/2005

injecting solution (tractor)



injecting solution (high-clearance)



Dribbling solution



06/08/2006

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

2008: Our first cotton demo



2006-07: Calibration research, looks great
2008 demo: Saved 45 lb N/acre, looks great!!

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?

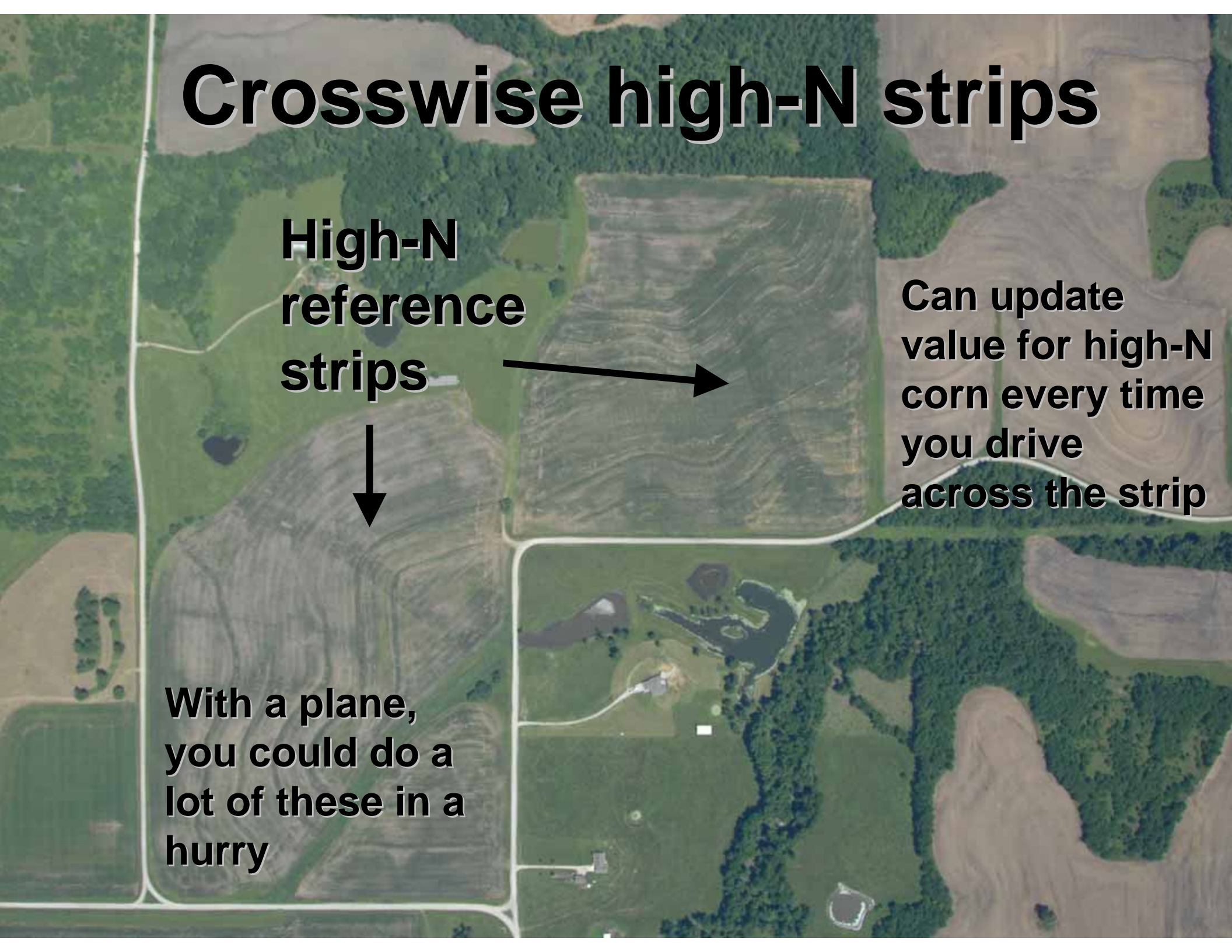
- Obstacles:
 - High-N reference area
 - Hassle of installing
 - Use—Greenseeker uses best 3 seconds in a round, artificially inflates target appearance
 - Drift of sensor rates during the day

Crosswise high-N strips

High-N
reference
strips

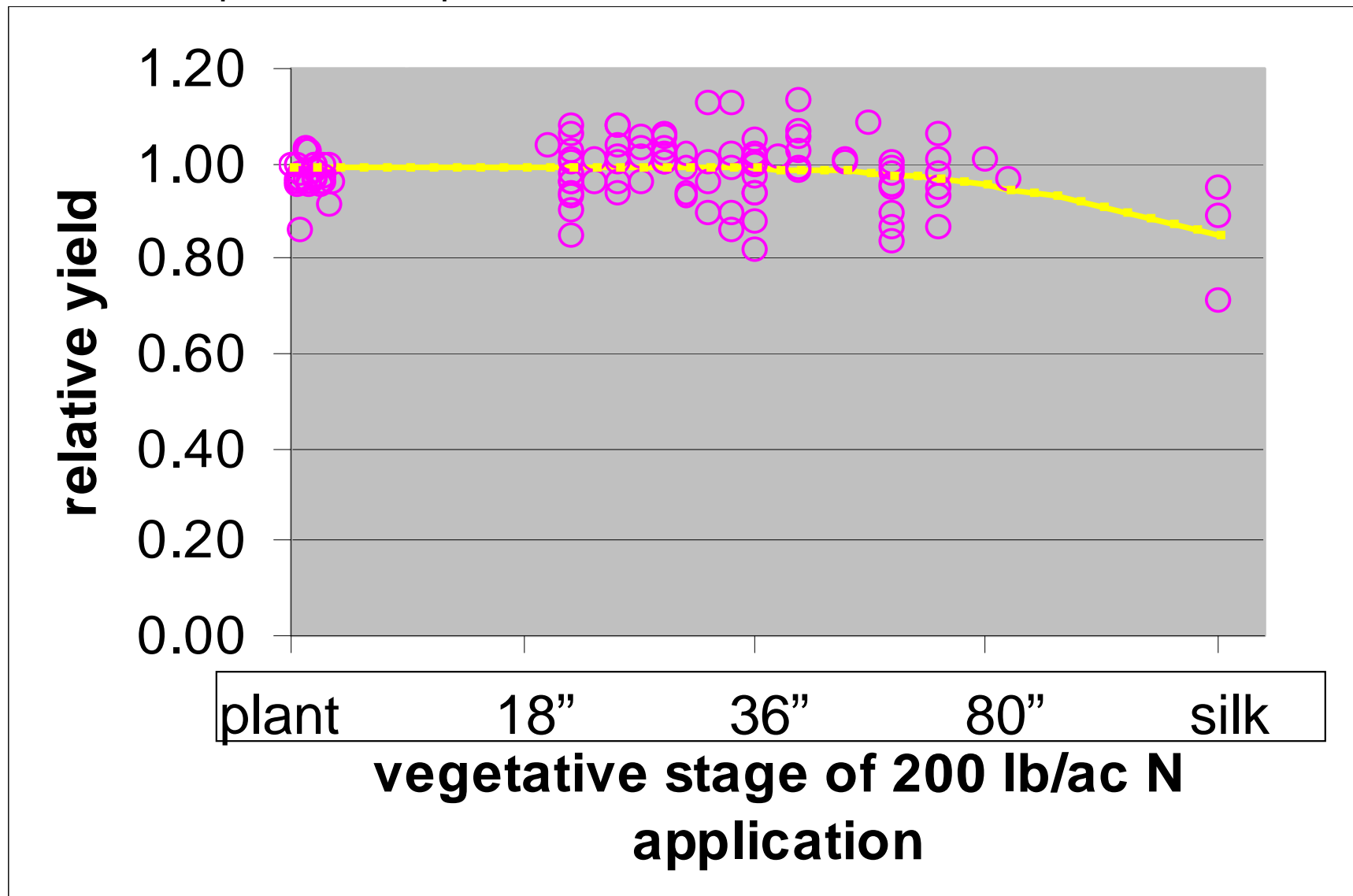
Can update
value for high-N
corn every time
you drive
across the strip

With a plane,
you could do a
lot of these in a
hurry



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

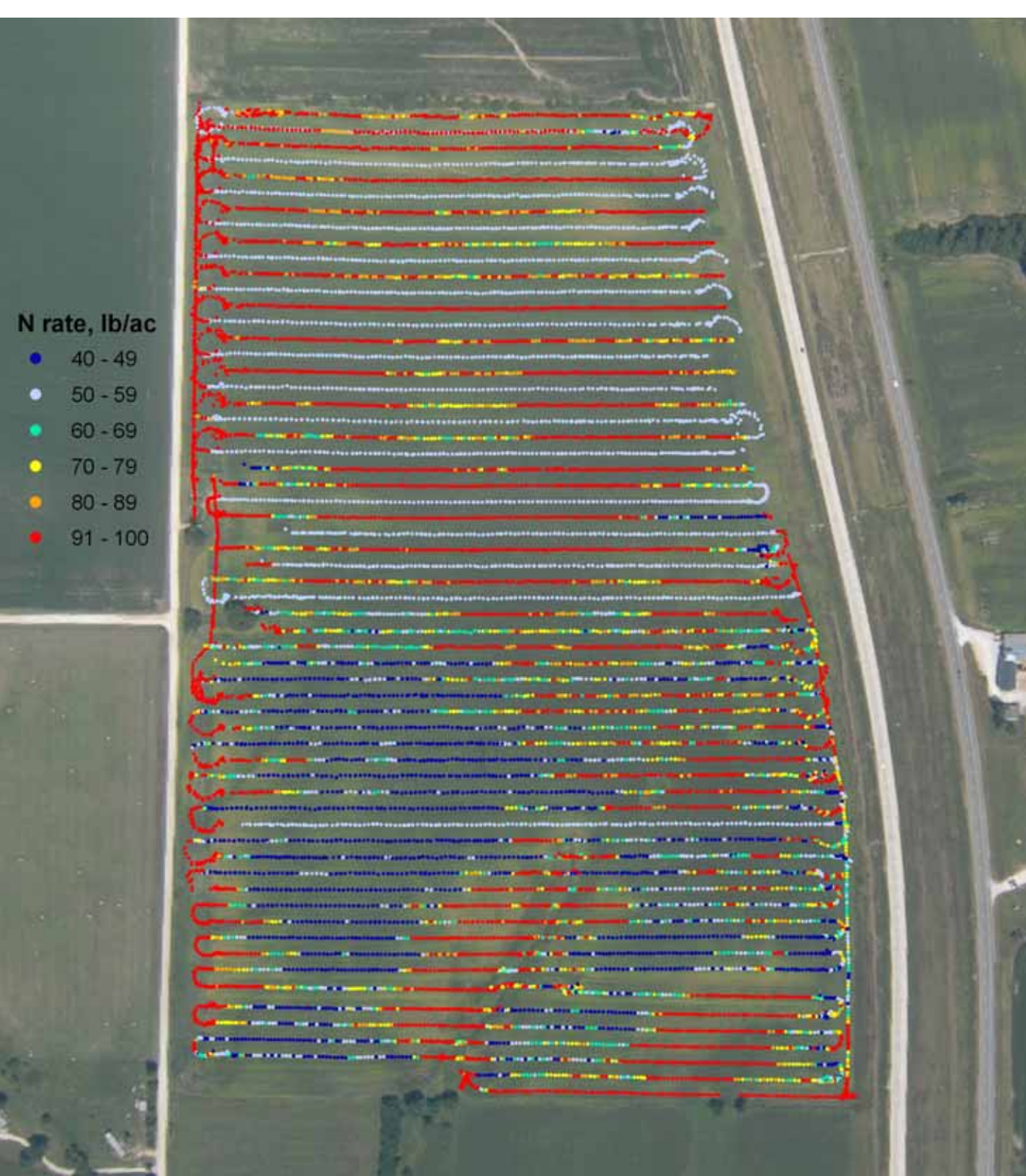


Sensor Benefits:

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



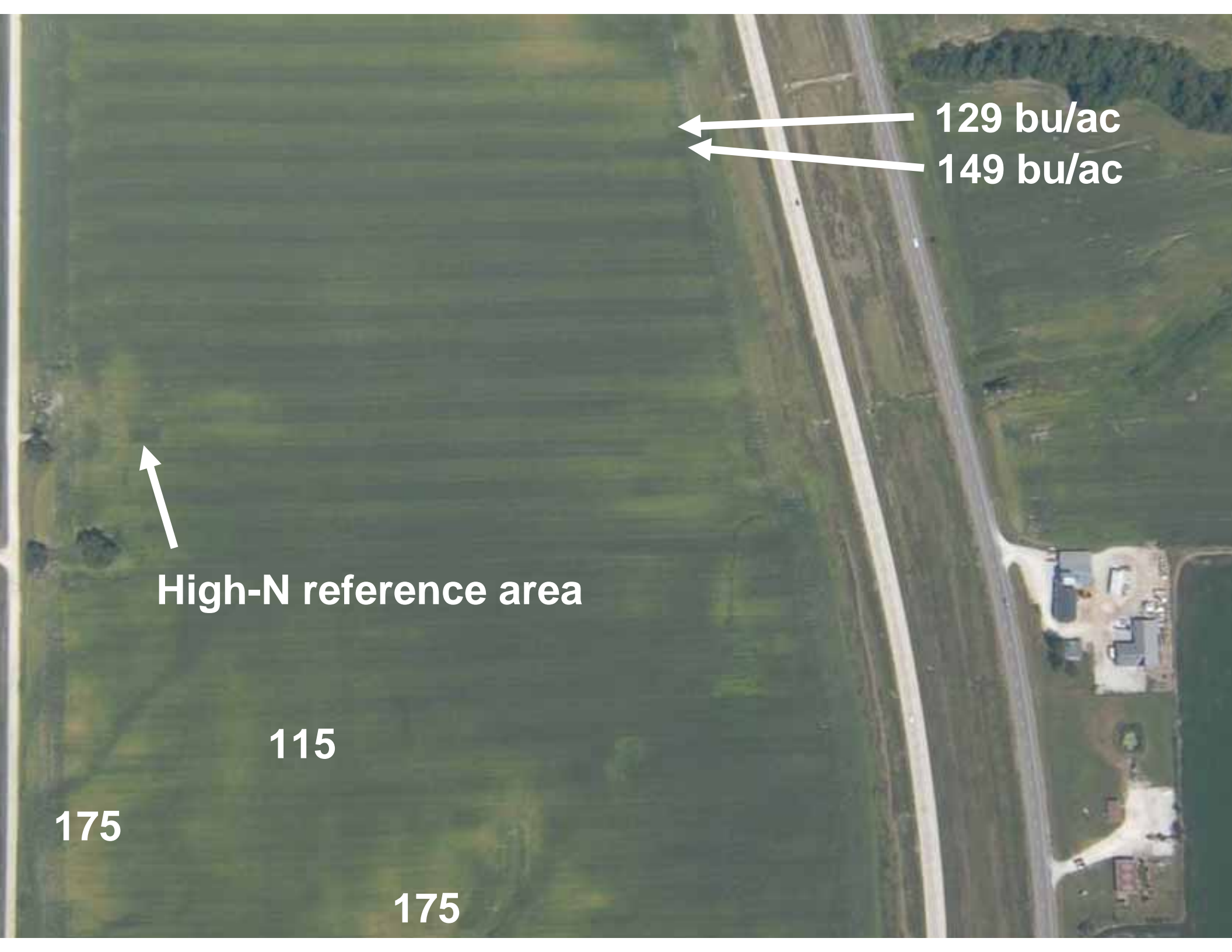




N application to head-high corn

N rate map

June 20, 2007



129 bu/ac
149 bu/ac

High-N reference area

115

175

175

Sensor Benefits:

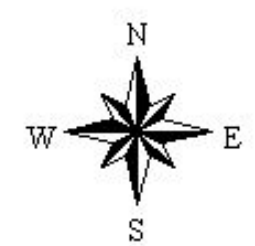
- Make sure enough N is applied
- Avoid unneeded N application



**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



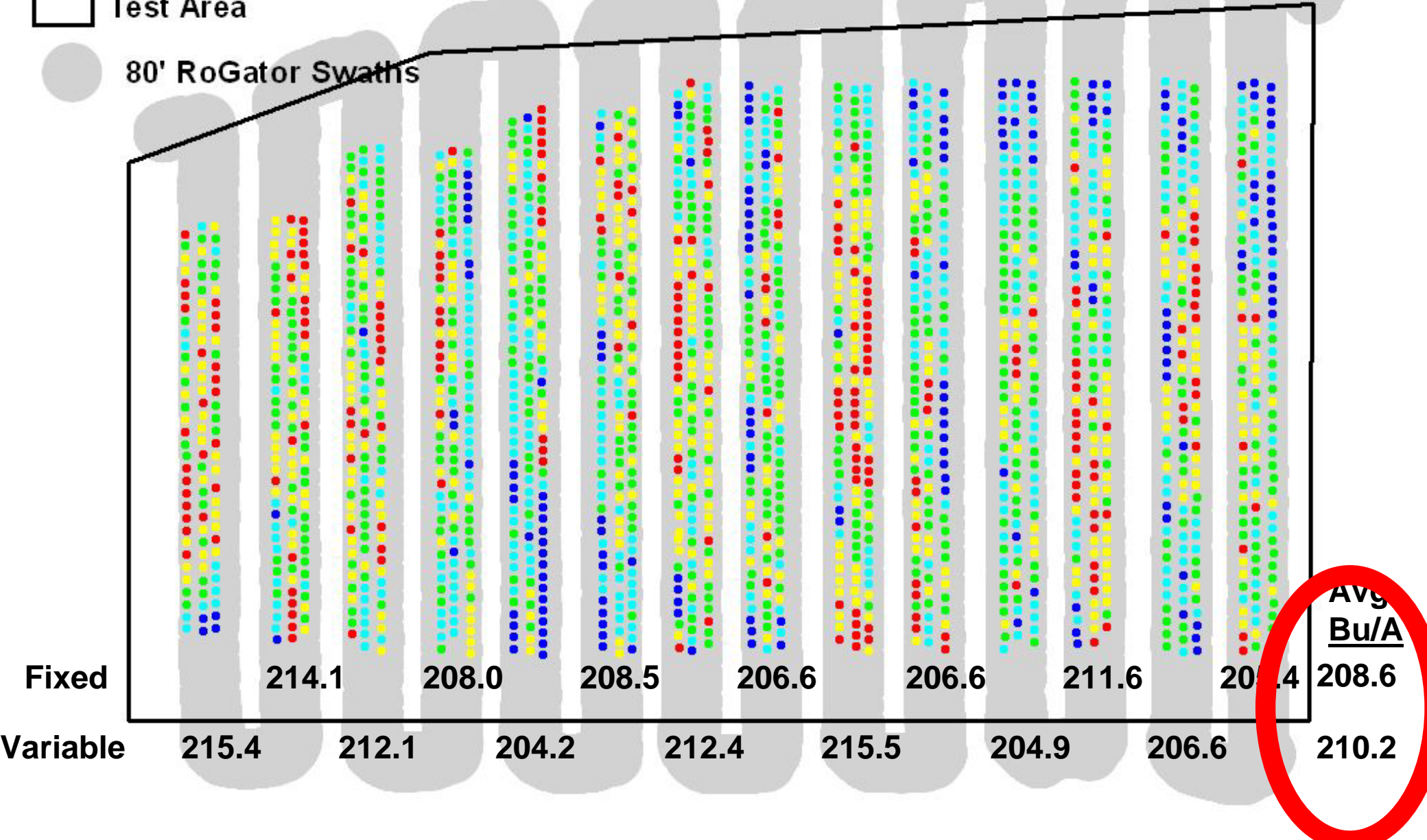
August 1 Aerial Photo after the June 13 UAN Application



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

- Bu/A**
- 156 - 192
 - 192 - 204
 - 204 - 213
 - 213 - 222
 - 222 - 247
- Test Area

● 80' RoGator Swaths



AVG Bu/A
208.6

210.2