Technologies for improved nitrogen use efficiency

Opportunities for crop consultants

Peter Scharf

University of Missouri

Nitrogen management is complex

- Spatial variability in soil N supply to crop
- Potential for loss between application and uptake

Complex + $$$ on the line

↓

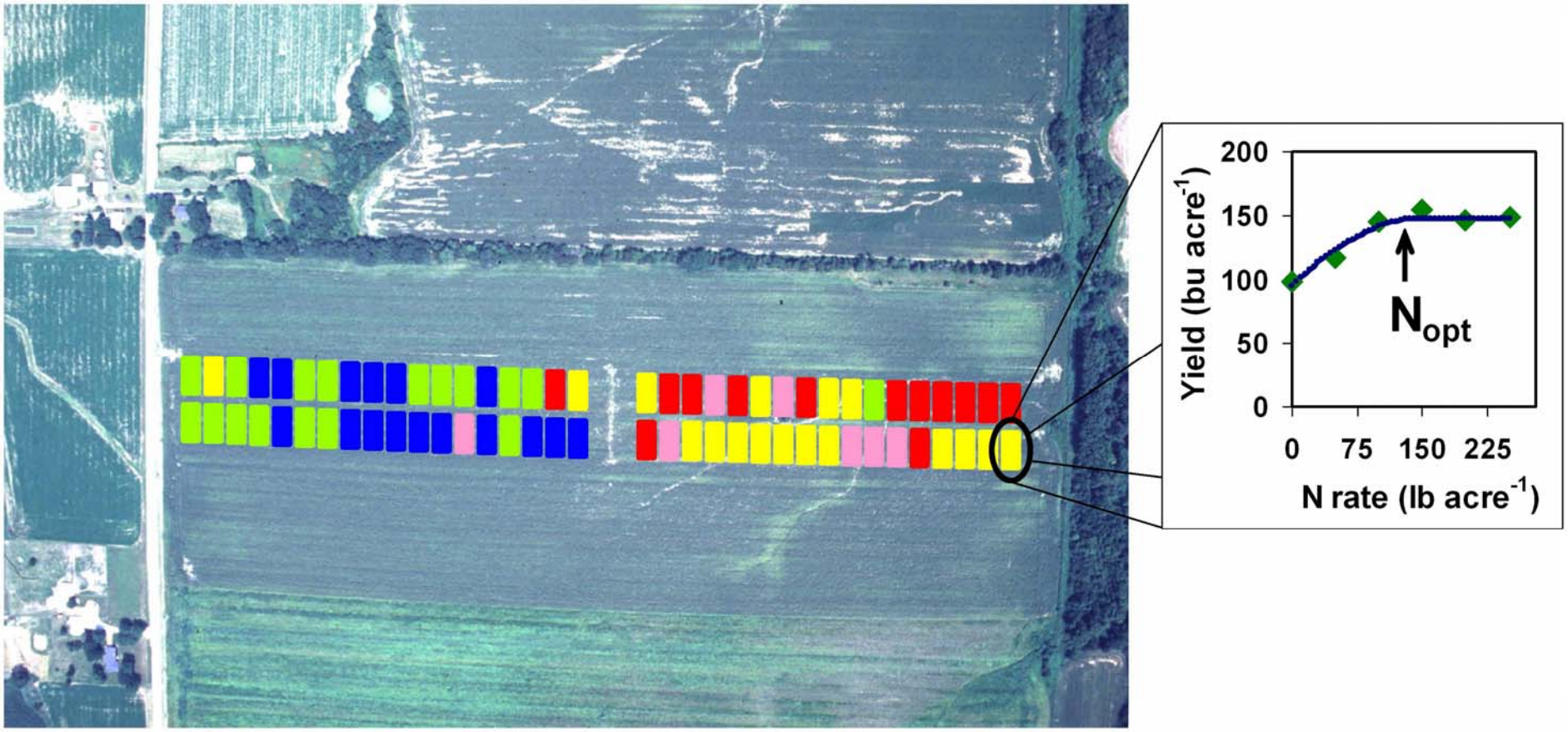
More management

↓

Consultants

Nitrogen efficiency

- Landscape
- Nitrogen sensors
- Nitrogen loss and response
- Nitrogen additives etc.



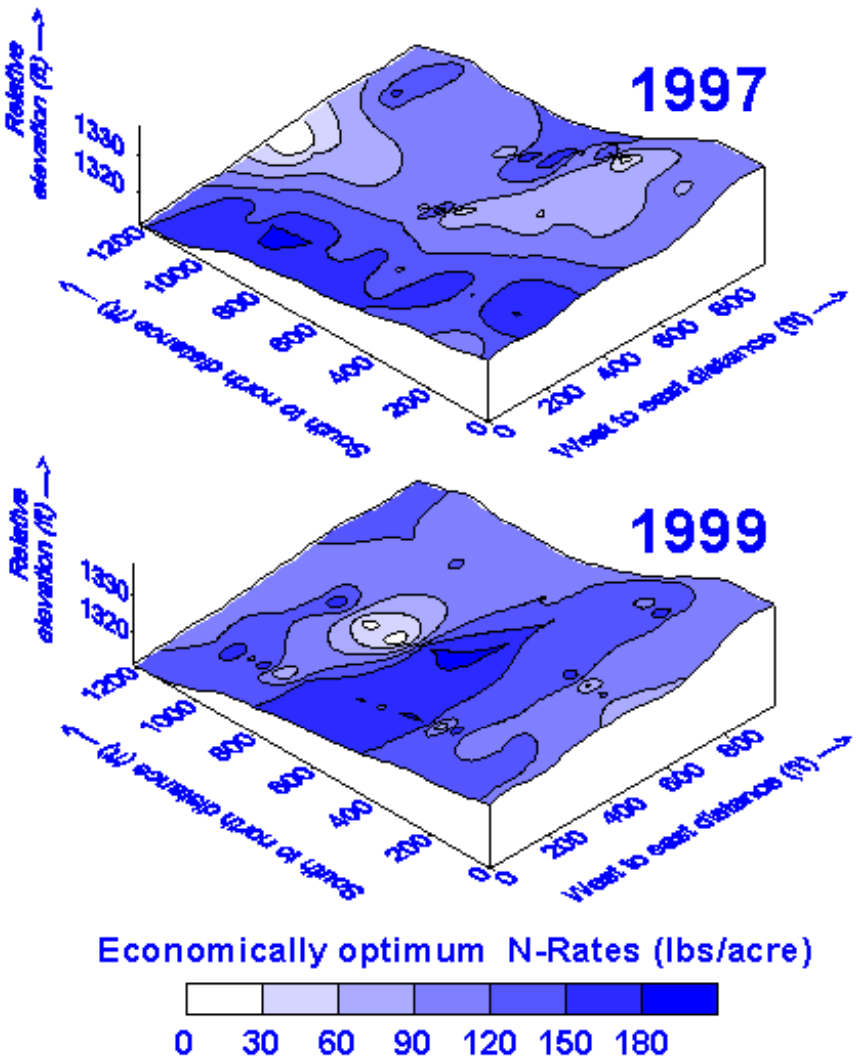
Optimal N rates (lb acre^{-1}) 0 to 80 80 to 120 120 to 160 160 to 200 200 to 250

Landscape affects N availability

- Soil N supply
  - Organic matter
  - Labile organic N
  - Weather effects on release of soil N
- Loss of soil and fertilizer N
  - Weather: excess water?
  - Where does the water go?

- Landscape controls water movement
- Water controls N loss
- Weather controls effect of landscape

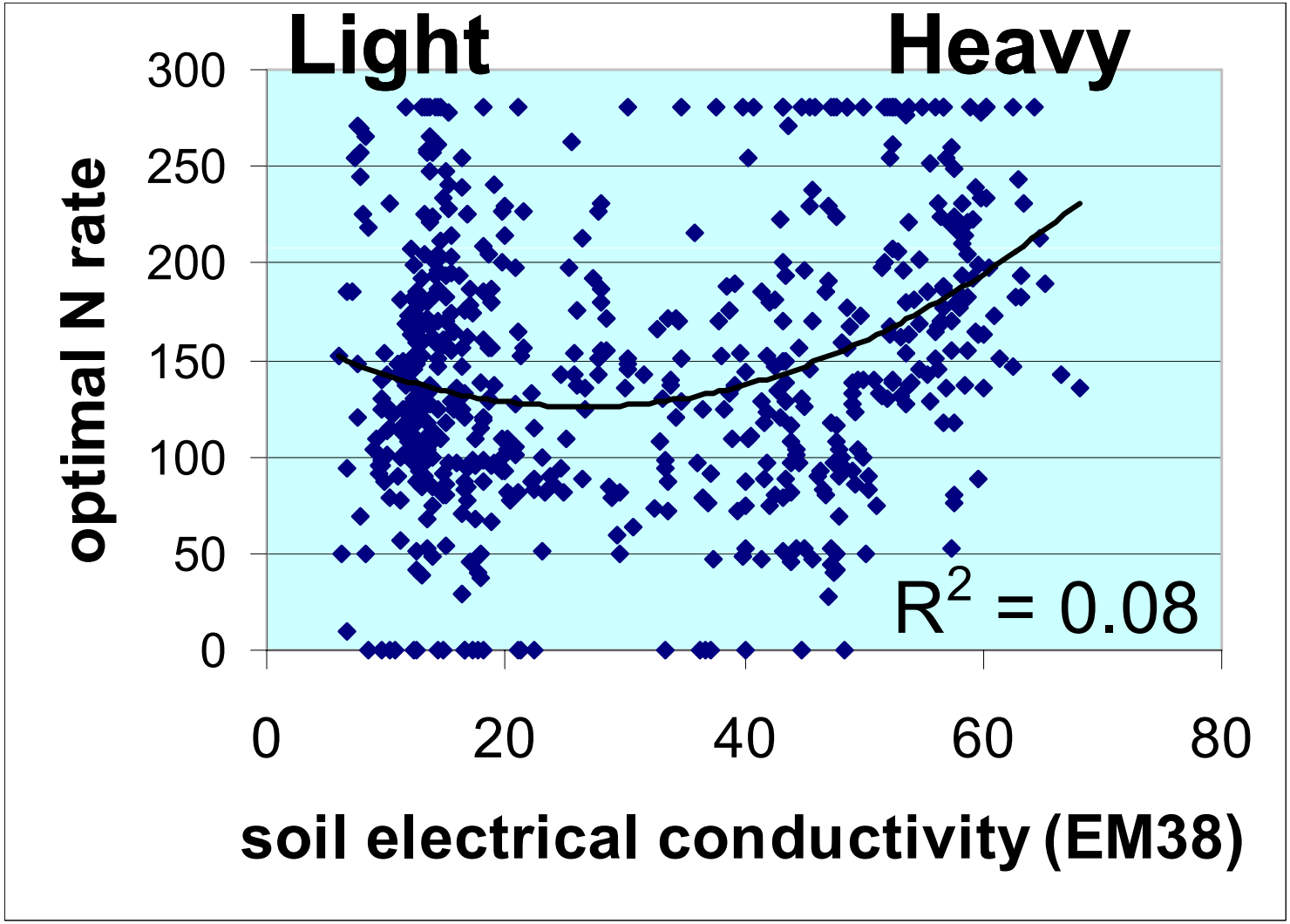
N need: variability from year to year



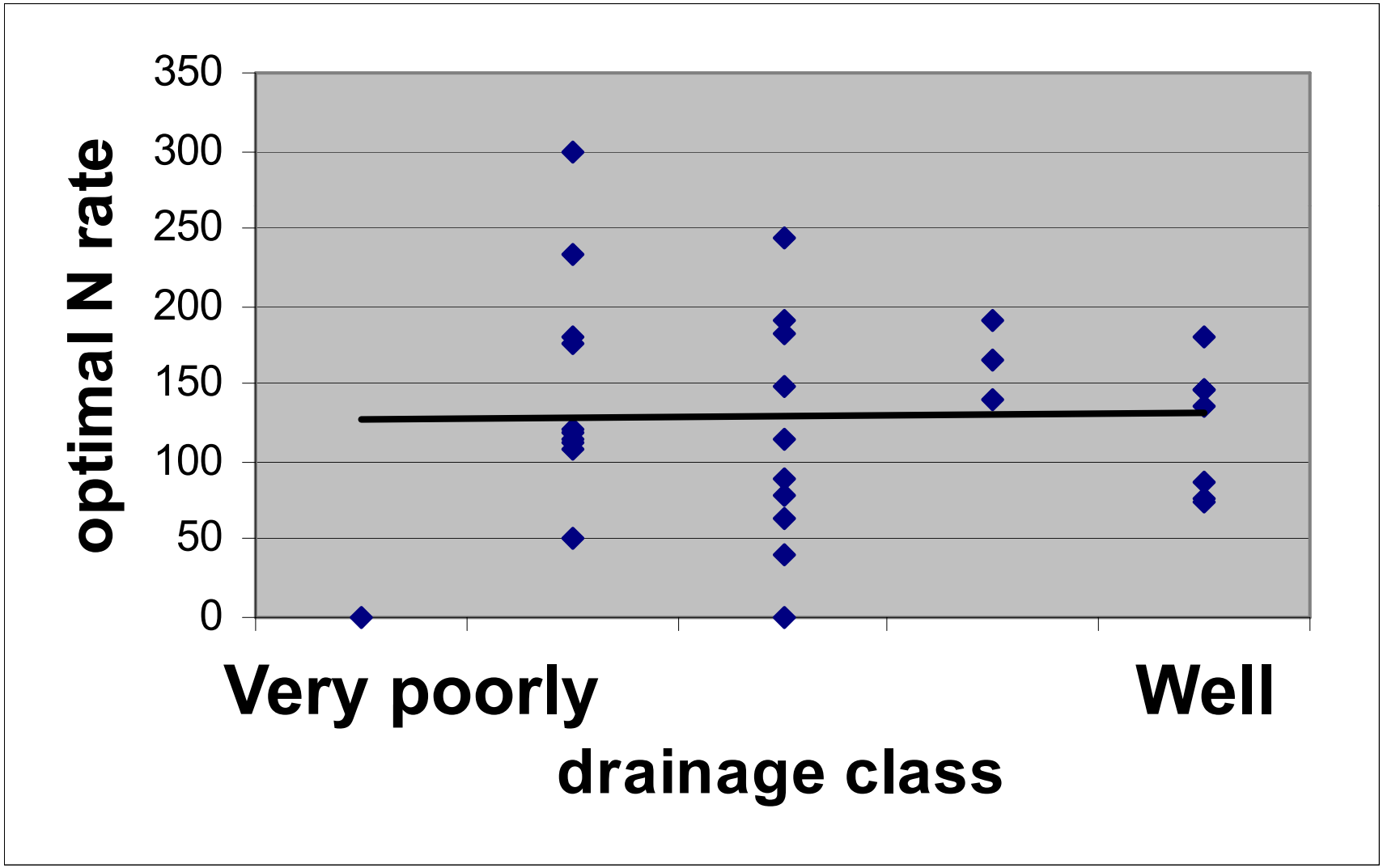
Corn grown in Minnesota: the places that needed the most and least N were not the same in the two years

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

Soil electrical conductivity to predict N need?



Drainage class: Effect on best N rate?

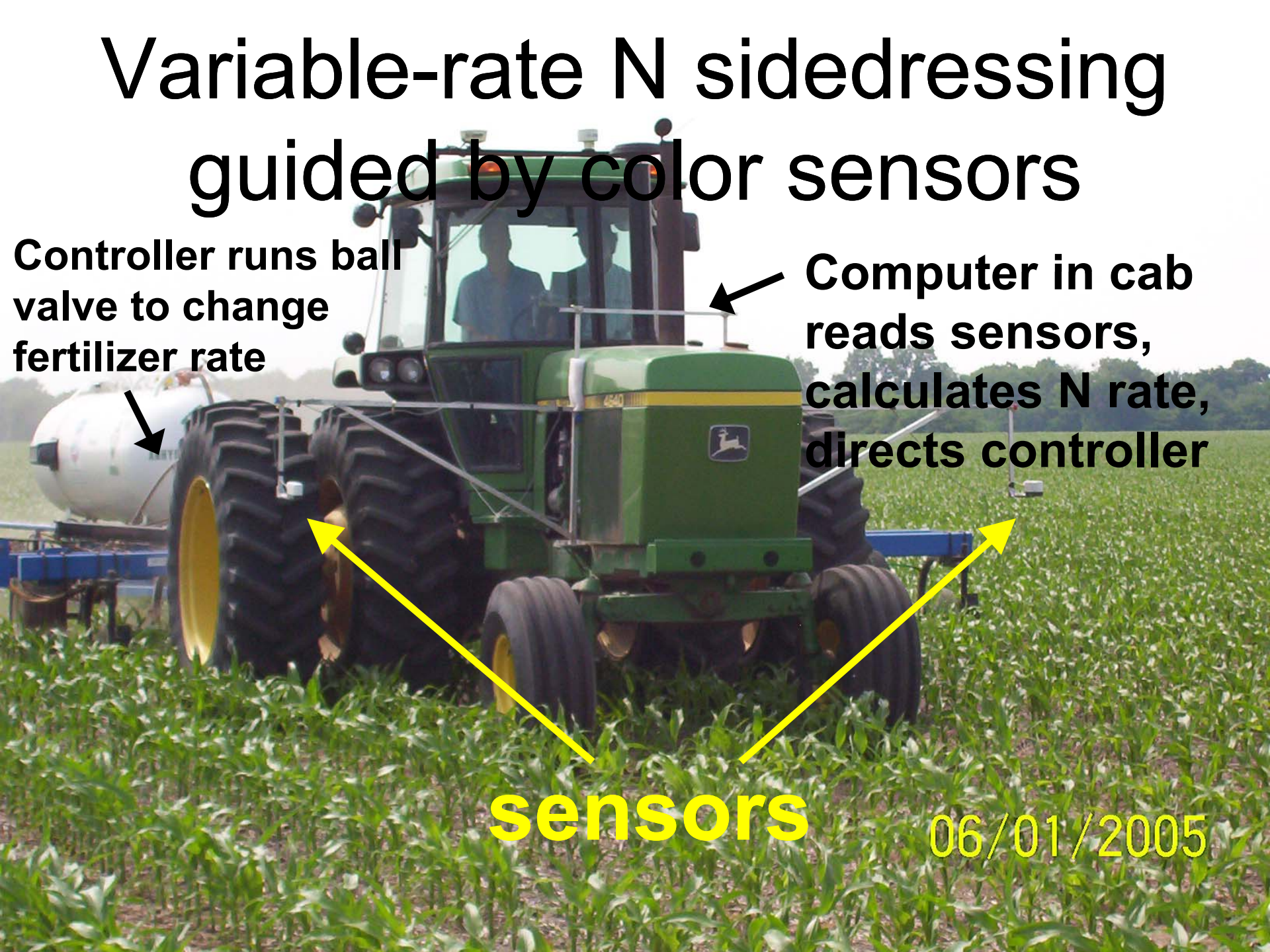


Sensing crop N status

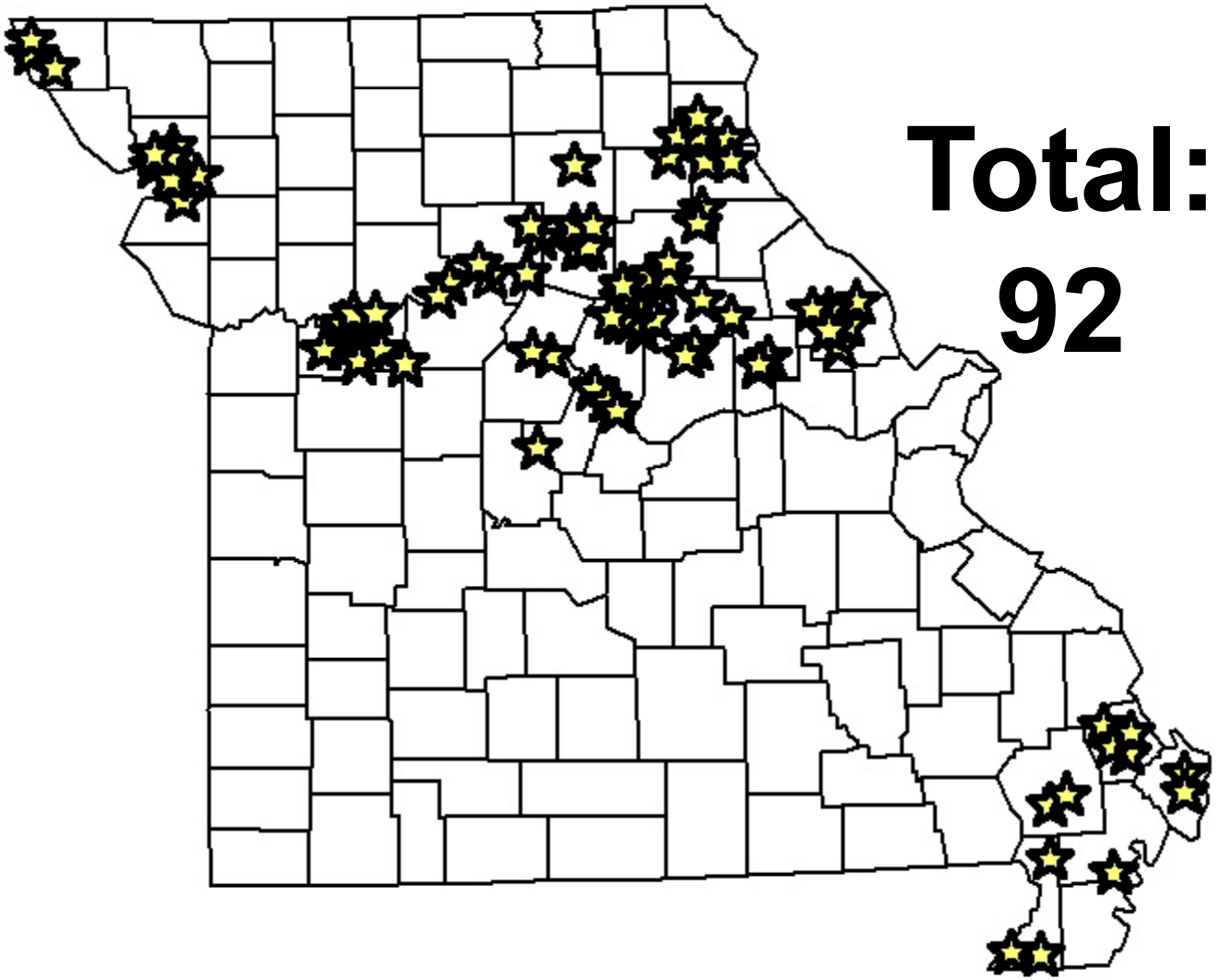
- Integrates landscape and weather influence and interaction
- How?
- Chlorophyll meter
  - Can predict N rate needed
  - Can predict yield response to additional N
  - Niche: troubleshooting 1 field at a time
- Too limited--think bigger and faster

Chlorophyll meter

Variable-rate N sidedressing guided by color sensors



Locations of sensor demonstration fields 2004-2008



Total: 92

Sensor outcomes

- 2004-2007: +$15/ac on corn
  - Broke even on yield
  - Saved 24 lb N/acre
- 2008: +$26/ac
  - 8 bu yield increase
  - Used 15 lb extra N
  - **Adjusted for wet weather and N loss!**

What kind of N applicator can you use sensors with?

Injecting anhydrous ammonia

injecting solution (tractor)

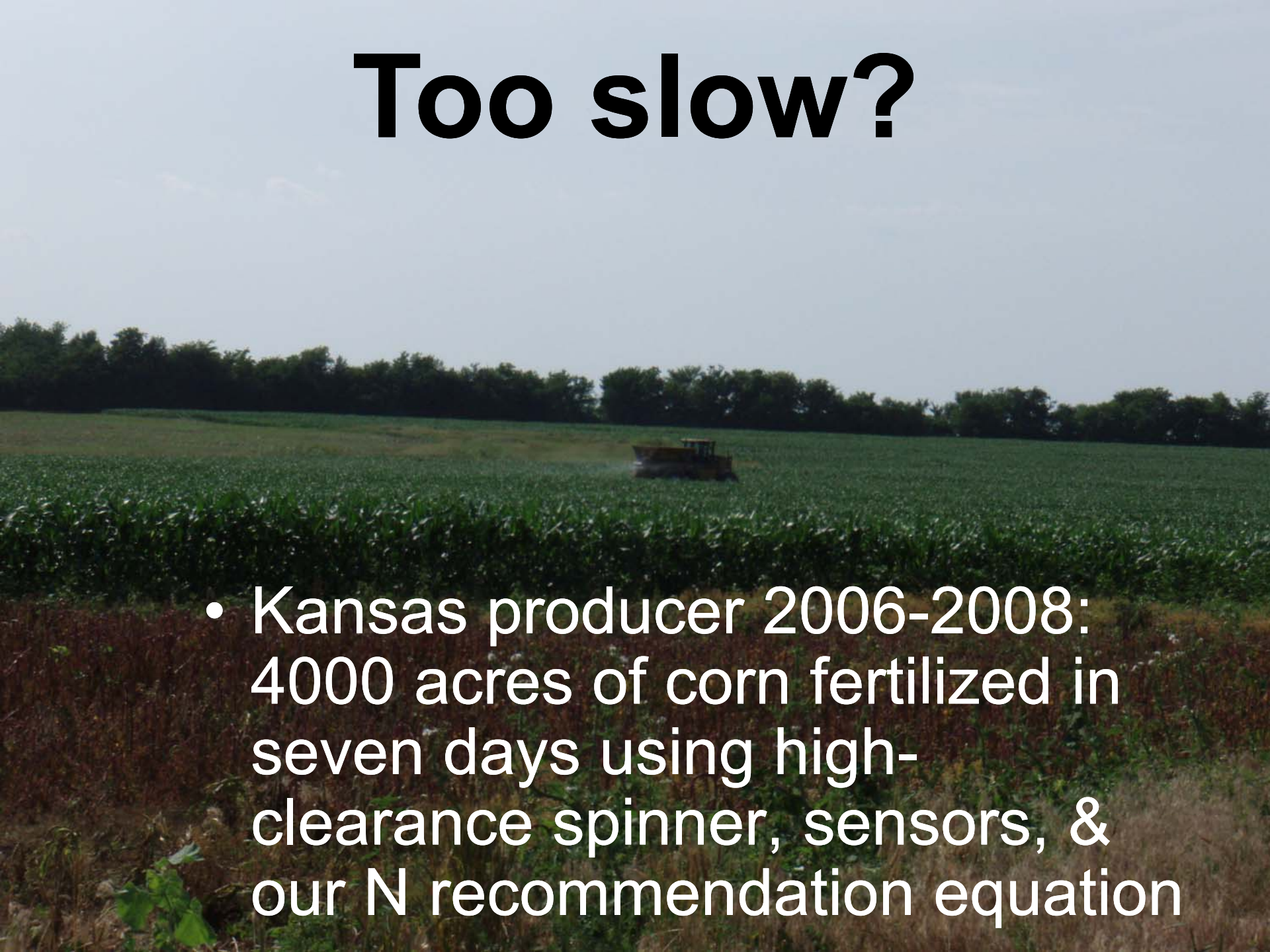
injecting solution (high-clearance)

Dribbling solution

Spinning on dry N

(easier to get a wide range of rates)

Too slow?



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

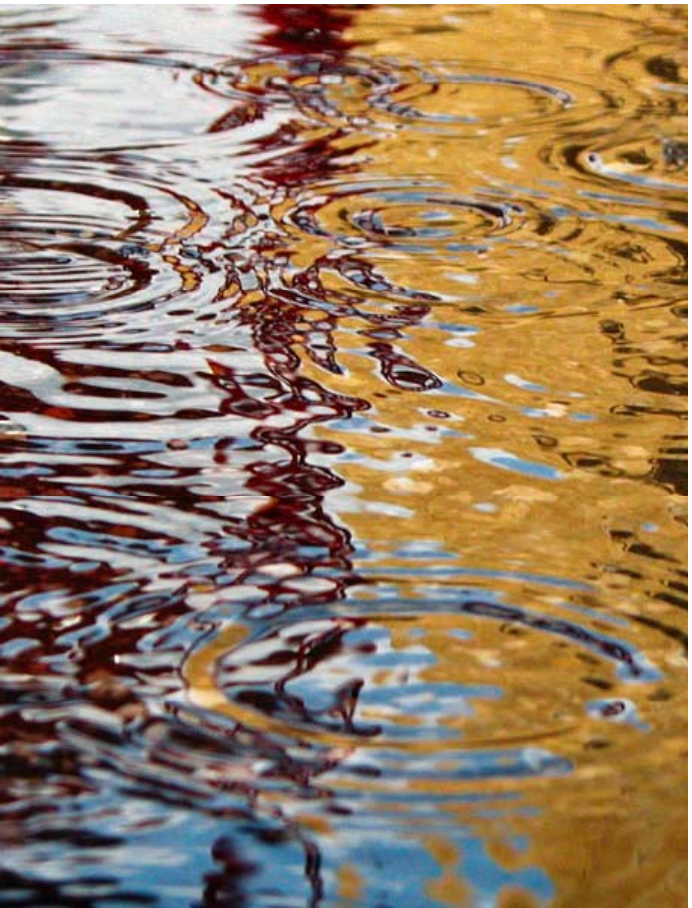
Opportunity?

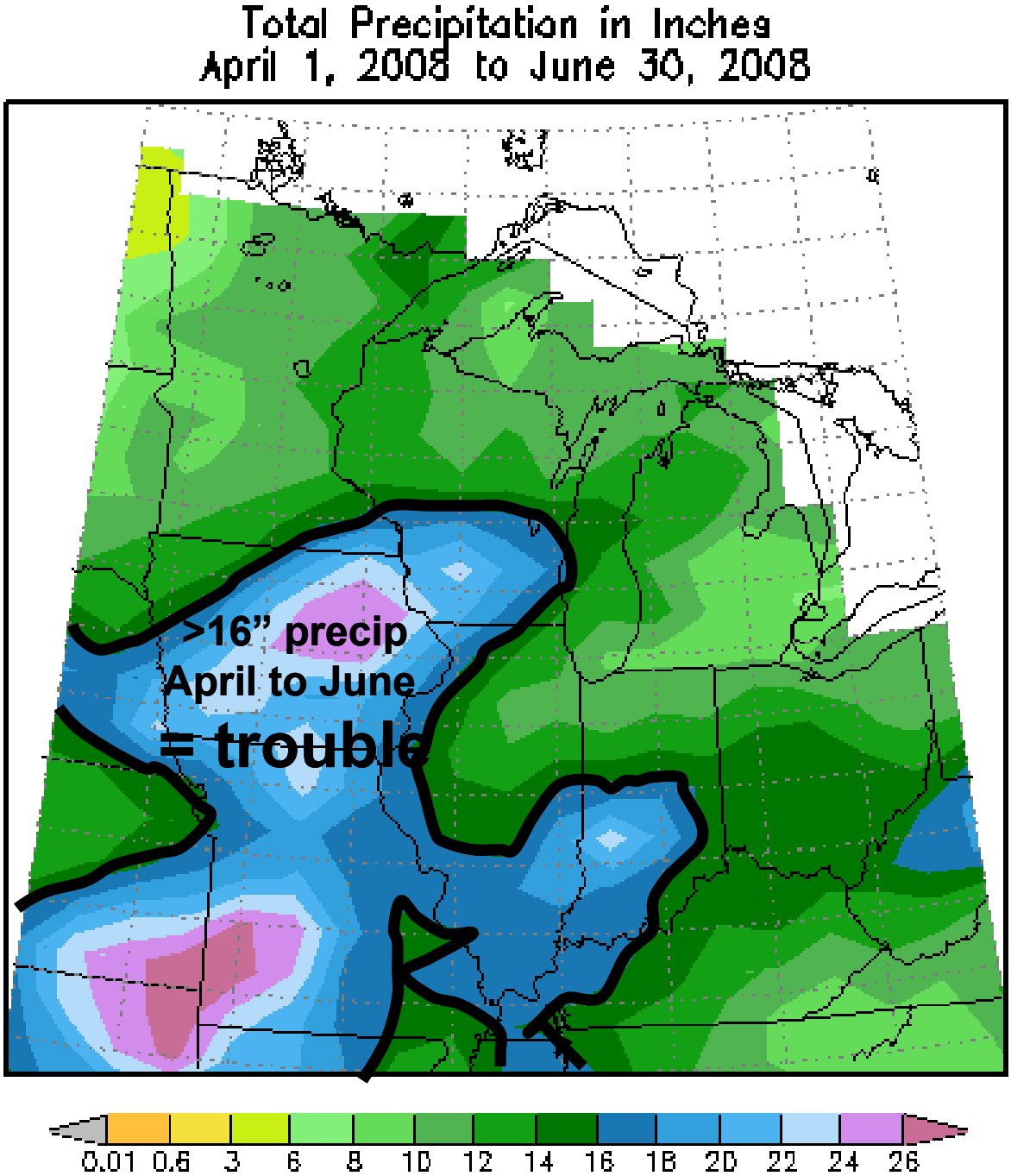
- I believe that nitrogen sensors are the wave of the future
- Producers will need help with getting started and doing it right

Losing nitrogen = losing yield

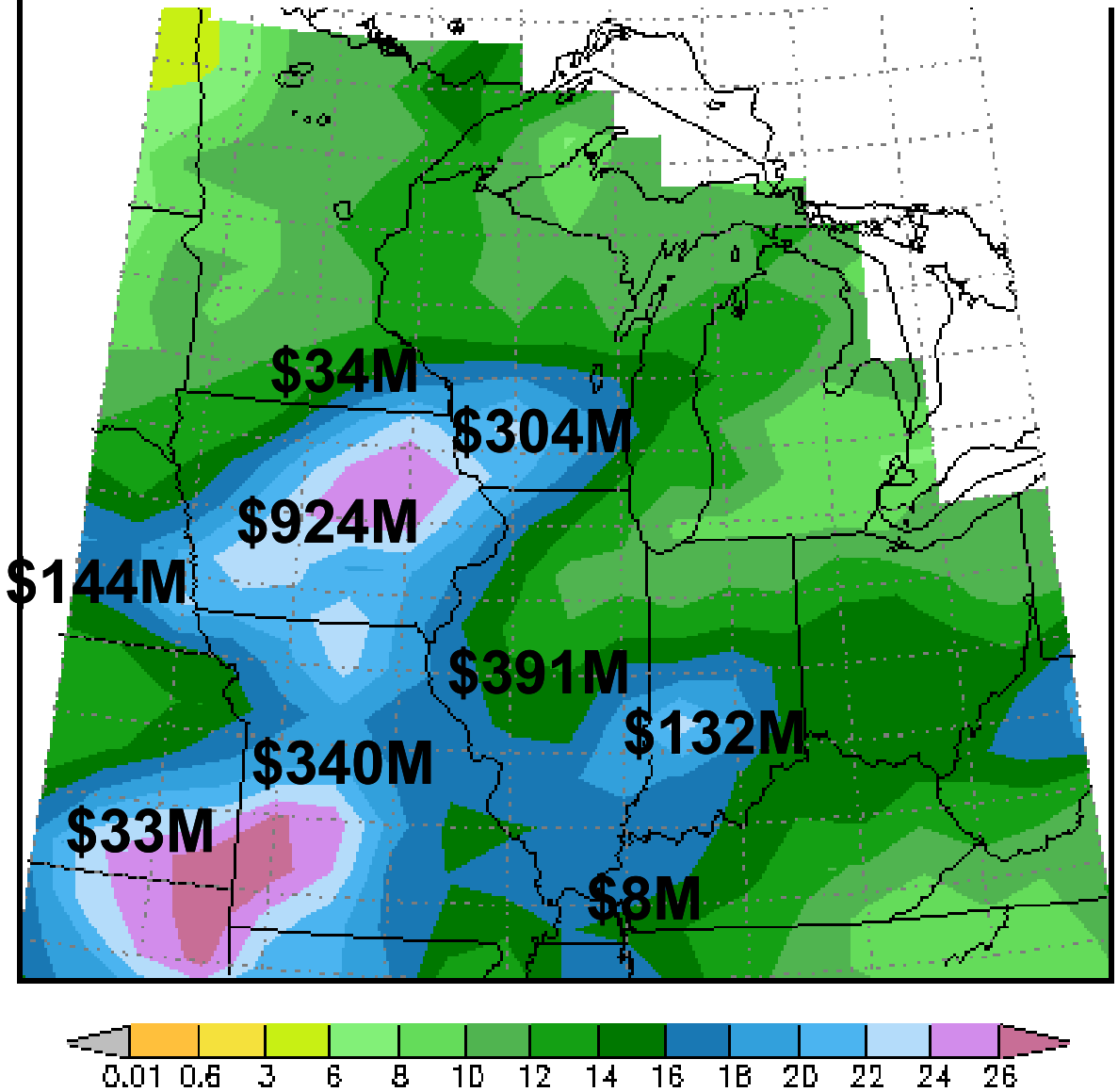
My estimate: 460 million bushels of potential corn yield lost in 2008

The Cause




Total Precipitation in Inches
April 1, 2008 to June 30, 2008
>16" precip
April to June
= trouble
0.01 0.6 3 6 8 10 12 14 16 18 20 22 24 26

Dollars lost in 2008 due to N deficiency: My estimates by state

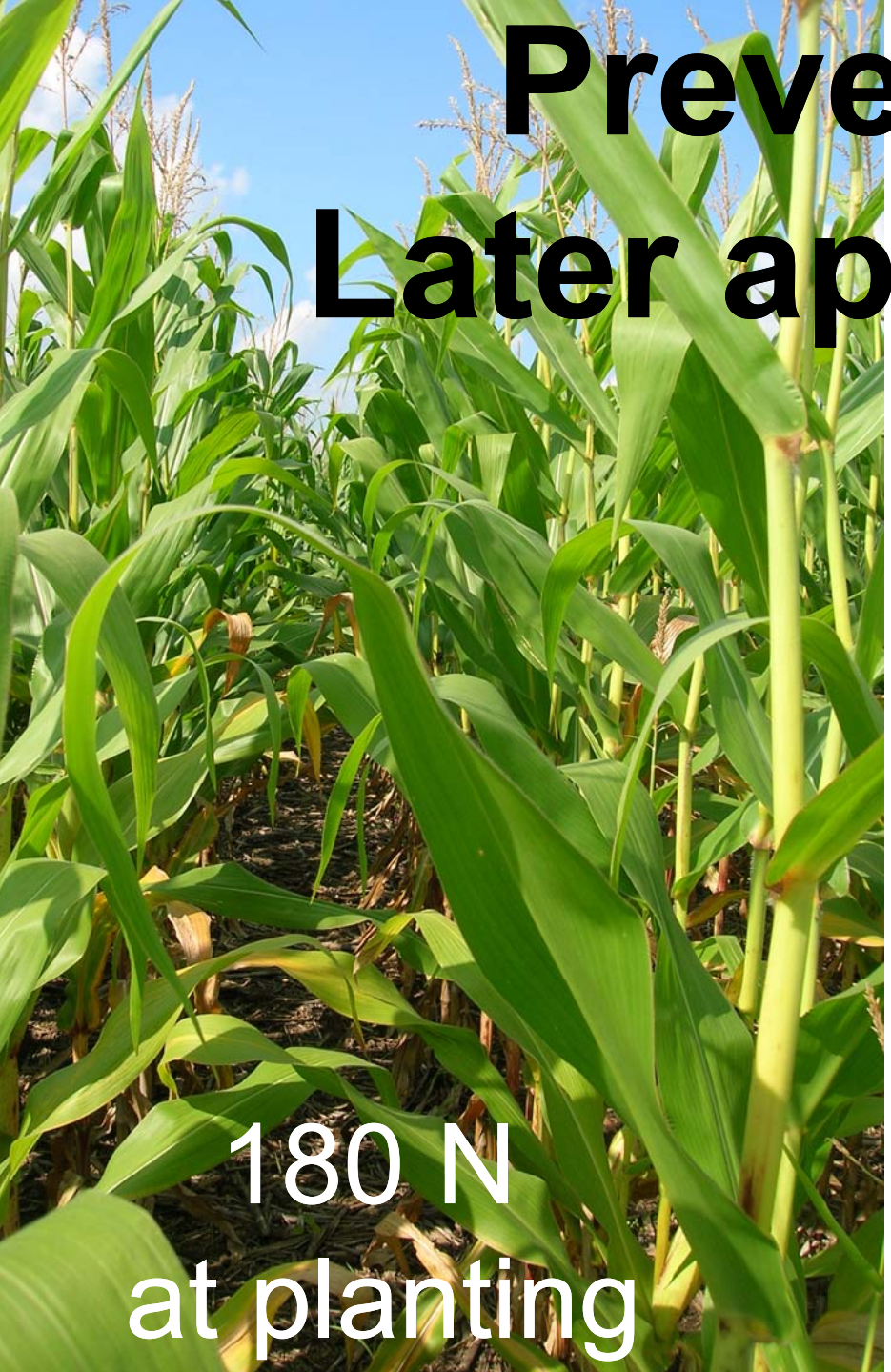


Total 9 states:

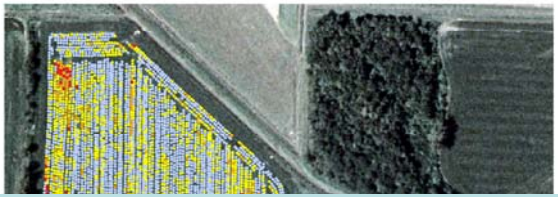
$2.3B

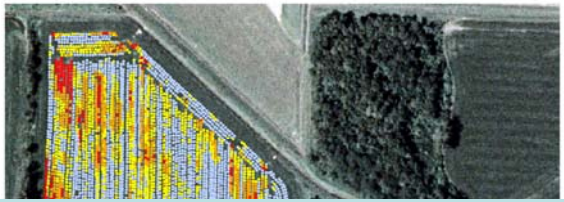
- Some yields are very good anyway
- Many could have been better

Prevention: Later application



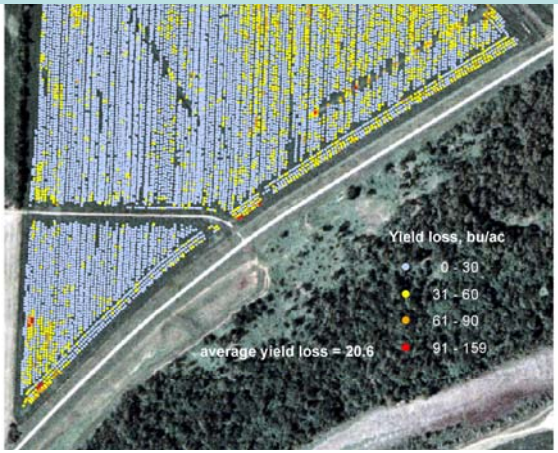
Diagnosis and decision: an example



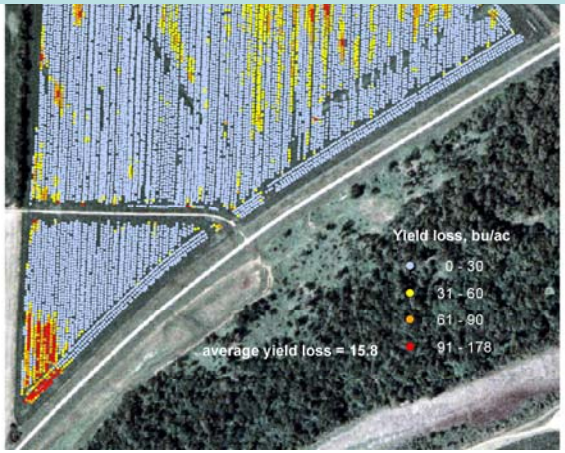


Another opportunity for consultants!

June 24 aerial photo



Yield loss map predicted from June 24 aerial photo

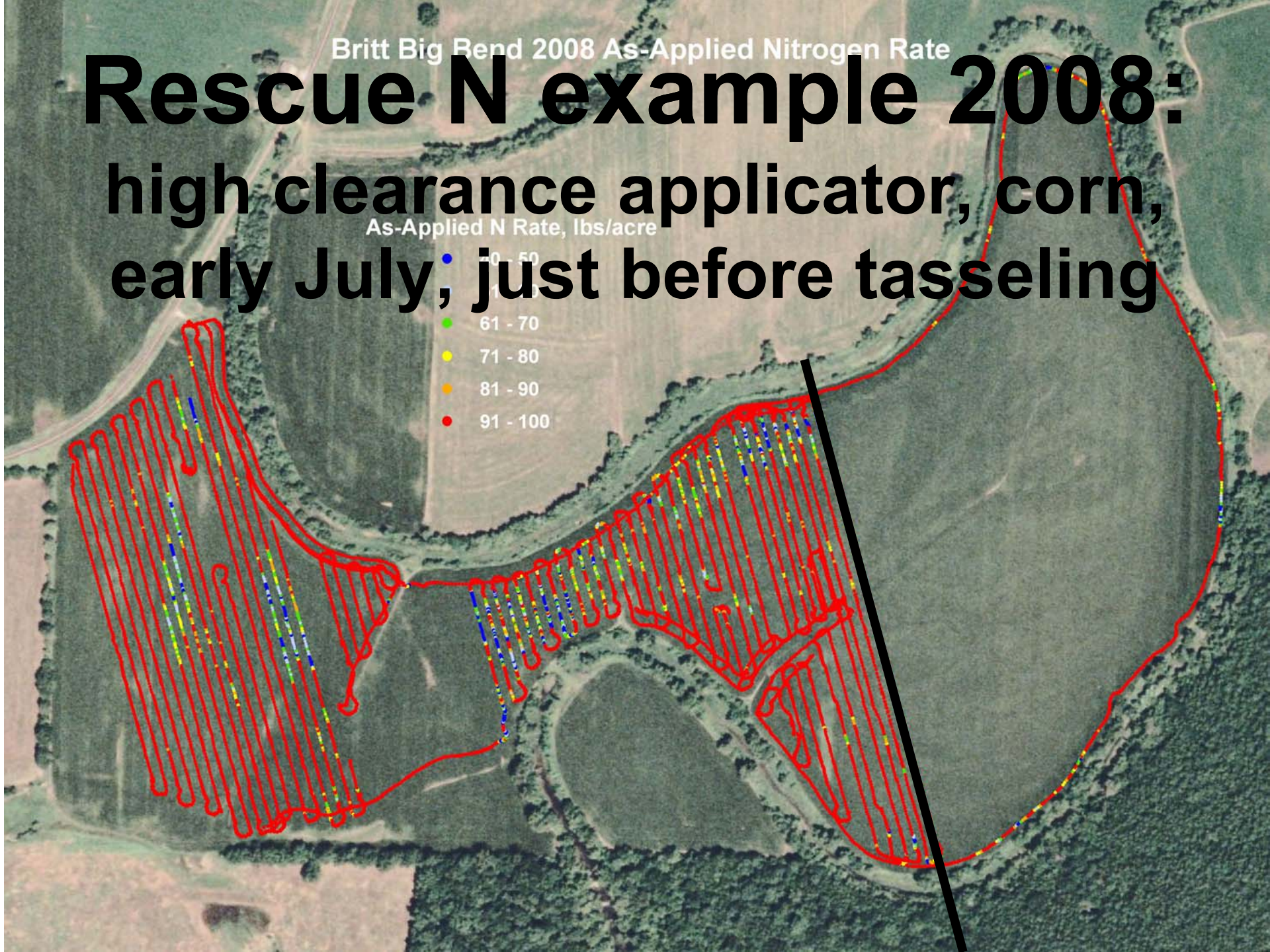


Yield loss map based on yield monitor data (September 30)

The Cure

Rescue N example 2008:

high clearance applicator, corn, early July, just before tasseling



Aerial photo August 3

Plan B

- What will I do if we get enough rain to cause N loss?
  - Diagnosis & decision
  - Application
- Every producer should have a plan!
- Consultants are a natural fit

Nitrogen source technologies

- Agrotain
  - Volatilization inhibitor for urea
  - Cost $0.05/lb N
- ESN
  - Plastic-coated urea
  - Cost $0.10/lb N

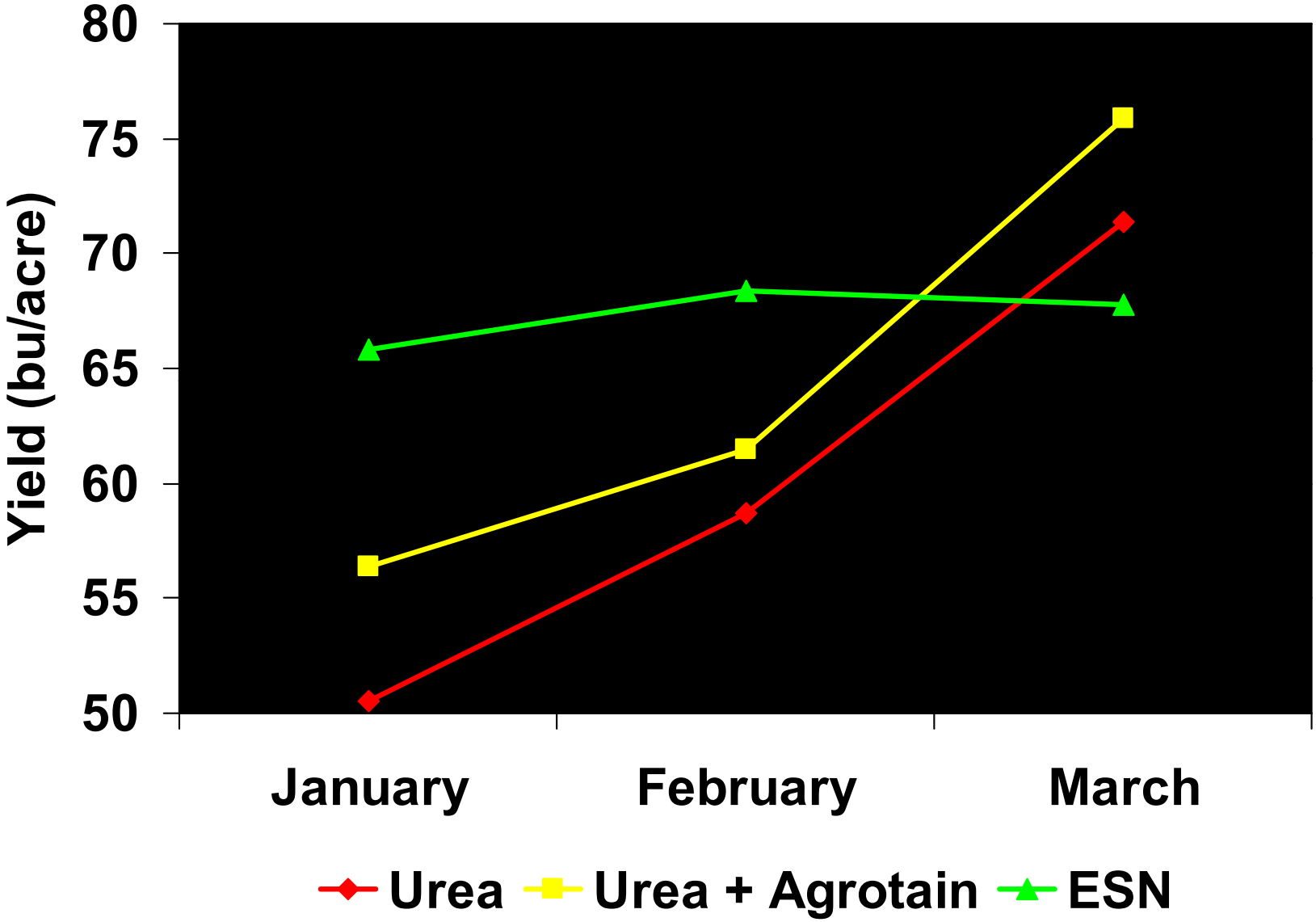
Agrotain

- Average yield response in Missouri:
  - Corn 7 bushels (16 tests)
  - Wheat 4 bushels (9 tests)
    - Independent of topdress timing
  - Grass 330 lb/acre (6 tests)

ESN

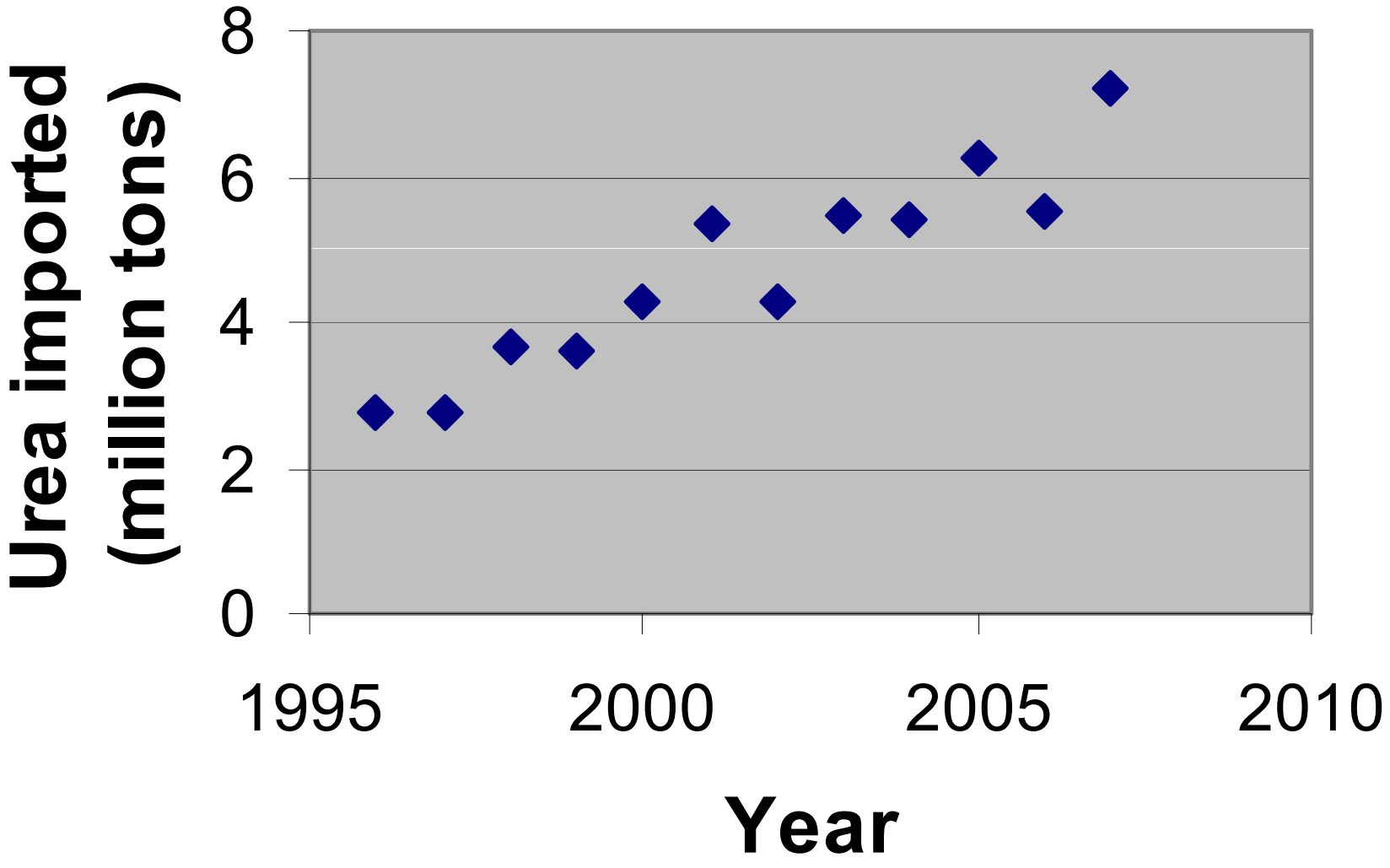
- No advantage in at-planting applications to corn
- Advantage over urea in:
  - Early preplant N applications
  - Early wheat topdress
  - Low spots in the field
    - Dual-bin machine, urea & ESN?
    - Need zones: consultant opportunity

Wheat Response to N Application Timing



Columbia 2005, 2006.

Increasing urea imports



Help producers avoid this: Problems with dry N quality

Summary

- Nitrogen management is complex
  - Producers need help
  - Lots of money on the line
- Top opportunities:
  - Sensors to diagnose correct N rate
  - Aerial photos to detect N deficiency
  - Plan B to respond to N loss
  - Decisions about N source technology


Thanks!
Questions?
06/08/2006

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

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