Successful nitrogen management

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University of Missouri
Crop Management Conference
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Central Iowa, August 2008

Improving your game plan for N

- **Timing!**
- Rate
- Sources & additives
- Evenness of applications

Nitrogen timing

- Grain: It's all about risk
  - **Some big losses in recent years: our corn N game plans didn't work**
- Forage: It's all about low-cost weight gain

Nitrogen timing: grain

- Too early: risk of losing N & yield
  - What's 'too early'?—depends on weather
- Too late: risk of losing:
  - Opportunity to get applicator through field
  - Yield potential due to N stress (with corn, less risk than you'd think)

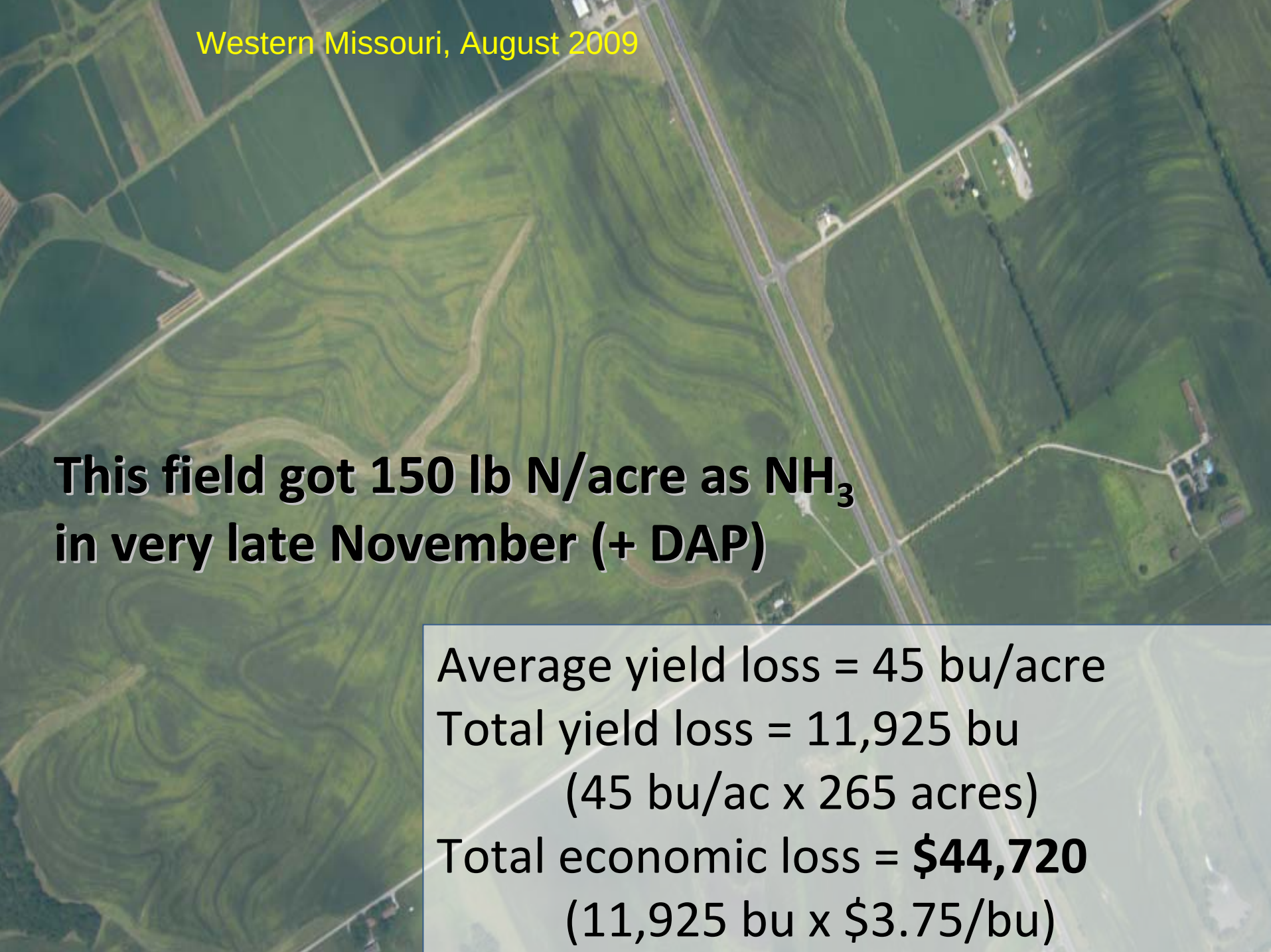
Risk with fall ammonia

1) 8 bushel average yield loss in an average weather year
   a) Average 15 production fields in Missouri
   b) agrees with long-term study in Minnesota
2) Pencil this in when deciding if & how much fall N to use
3) 2 bushel average yield loss in two dry years
4) We're lacking research in wet years, but I've seen plenty of yellow corn that got fall N

Fertilizer source/timing: risk level

Nitrogen source	Date applied	Score
Anhydrous ammonia	before November 1	5
Anhydrous ammonia	Nov. 1 - Dec. 31	4
Anhydrous ammonia	Jan. 1 - Feb. 28	3
Anhydrous ammonia	March 1	2
Anhydrous ammonia		1
Anhydrous	May 1 or later	0
Urea	< 4 days before excess water	4
Urea	4-14 days before excess water	3
Urea	> 14 days before excess water	5
Ammonium nitrate or UAN solution	before April 1	5
Ammonium nitrate or UAN solution	April 1 - 30	4
Ammonium nitrate or UAN solution	May 1 or later	3

N-Serve: drop risk score by 1


Western Missouri, August 2009
This field got 150 lb N/acre as NH_3
in very late November (+ DAP)
Average yield loss = 45 bu/acre
Total yield loss = 11,925 bu
(45 bu/ac x 265 acres)
Total economic loss = **$44,720**
(11,925 bu x $3.75/bu)

Corn: applying dry N early

- Four Missouri experiments with applying dry N (ammonium nitrate, urea) in March
- Average yield penalty: 35 bu/acre
  - Compared to same N source applied day of planting
  - Two experiments in 1995 (flood year), lots of rain, corn planted late
  - Two experiments in 1994

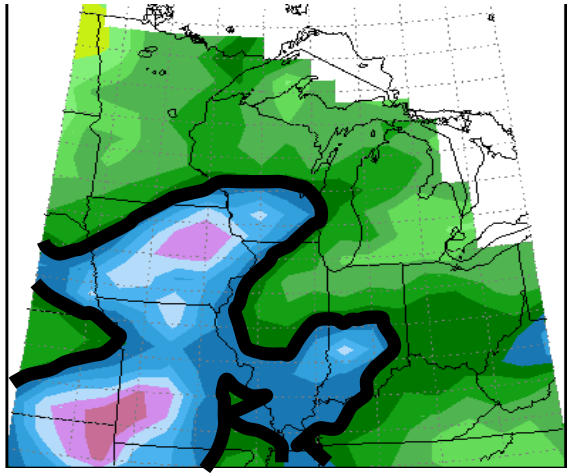
Nitrogen timing in the corn belt

- All-preplant is normal
- Massive failure over the past four years
- Wet spring weather leading to N loss and yield loss
- My current estimate: **2 billion bushels**

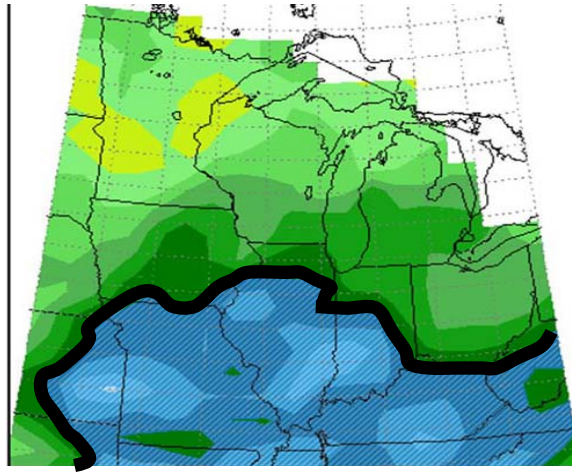
Four wet springs

Outlined areas > 16 inches rain April-June

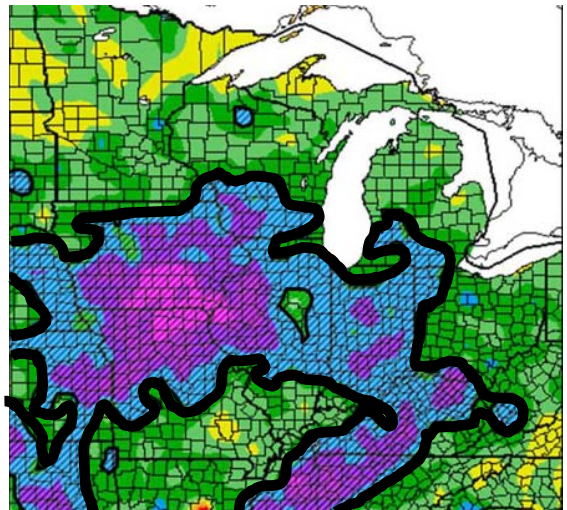
2008



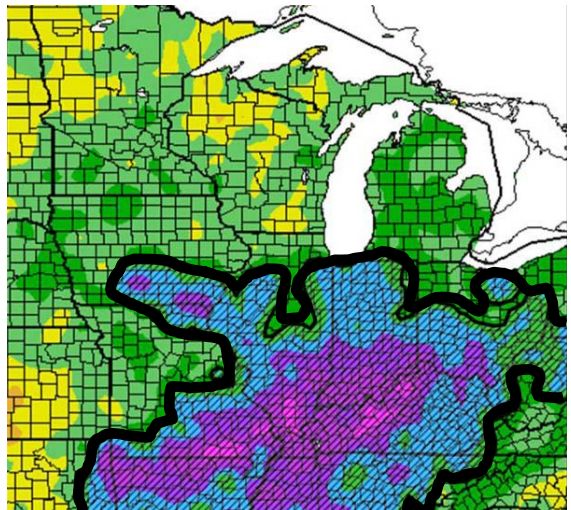
2009



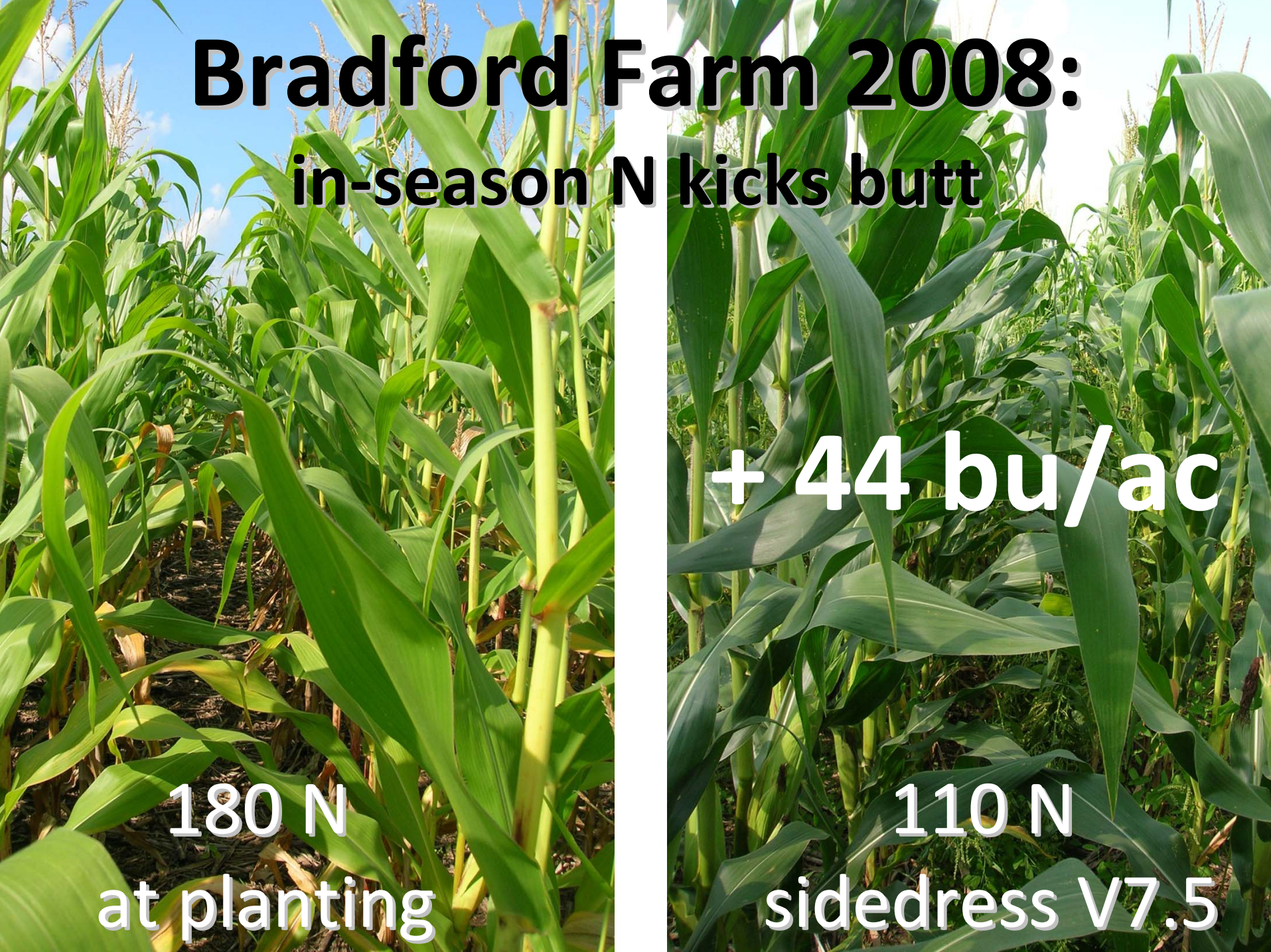
2010



2011



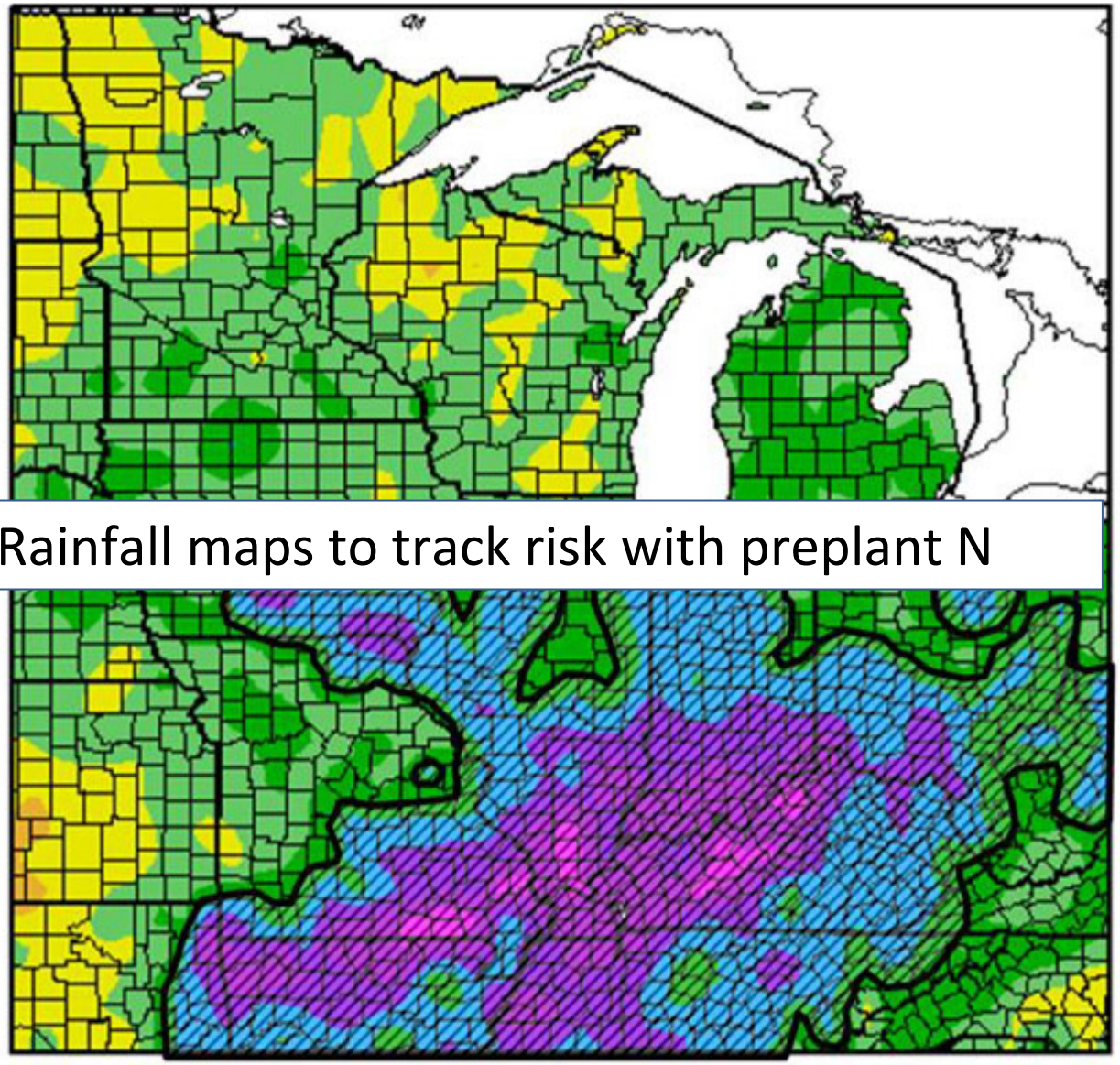
Widespread deficiency symptoms


Bradford Farm 2008:
in-season N kicks butt
+ 44 bu/ac
180 N
at planting
110 N
sidedress V7.5

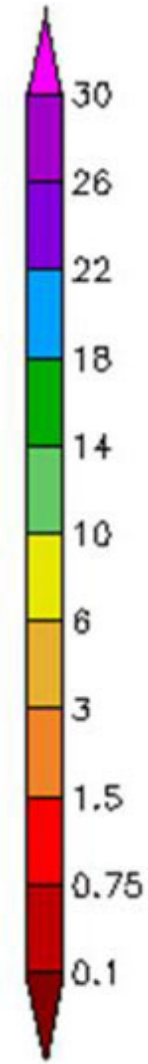

Bradford Farm 2009:
in-season N kicks butt again
+ 68 bu/acre
153 N
sidedress V7.5
180 N
at planting


140
PRE
180
PRE
147
SIDE
100
PRE
80 bu difference
Bradford Farm 2010:
Can you believe a 3-peat?
0
197
SIDE
124
PRE
202
SIDE

Nitrogen Watch: A tool to assess risk of N loss

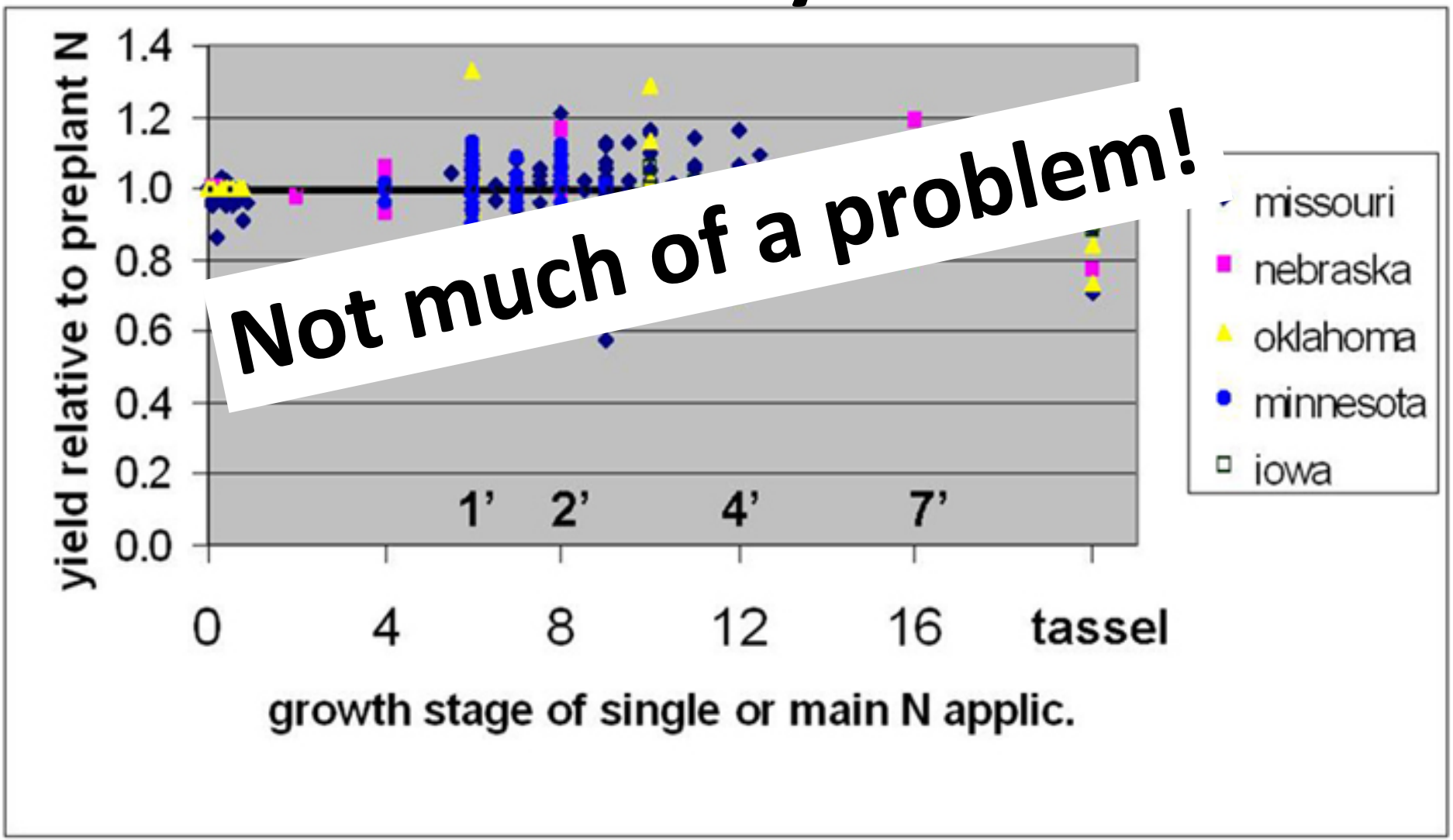


Rainfall maps to track risk with preplant N



Inches of rain, April 1 to July 3

What about risk of yield loss with delayed N?

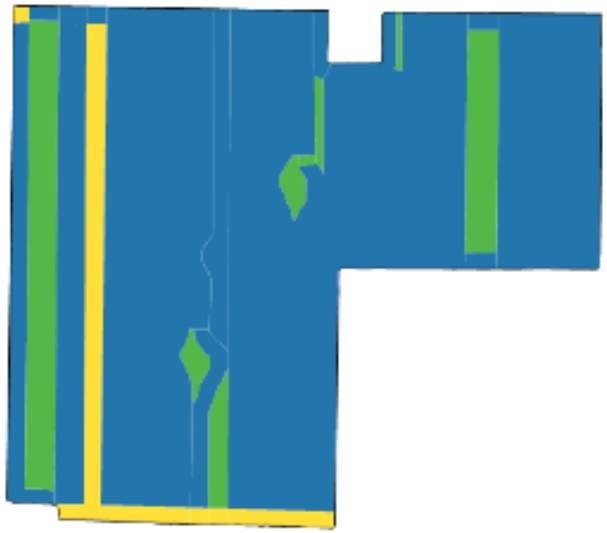


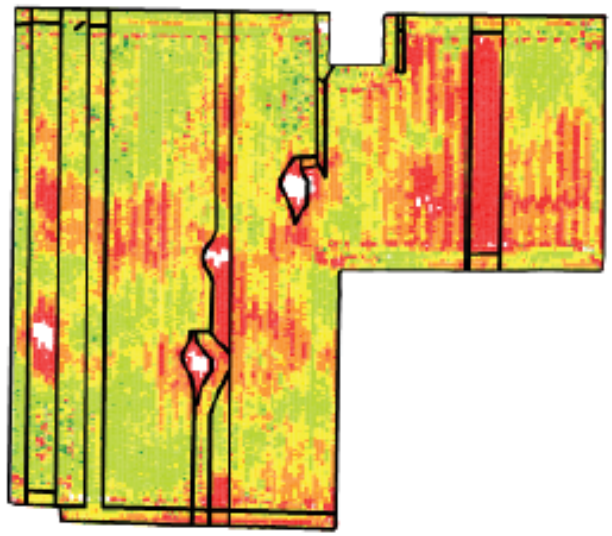
My rescue N outcomes

- **11 tests, average yield response 34 bu/acre**
- **Yield response depended on visible stress**
  - High stress: 57 bushels (2 tests)
  - Medium stress: 41 bushels (5 tests)
  - Low stress: 14 bushels (4 tests)
- **How late is too late?**
  - Six tests in 2010, all applied at tassel, ave 34 bu
  - Give up by 2 weeks after tassel (?)

Rescue N in Illinois: 37 bu

Corn Yield by Fertilizer Treatment





Client: Illini FS_Heritage Family Farms
Farm: Heritage Family Farms
Field: MCCOLL 137
Area: 136.59 ac
Event Date: 7/7/2009
Save Name: Urea 09

Dry Yield - Corn - 2009
12 - 113.51 (19.48 ac)
113.51 - 162.49 (32.78 ac)
162.49 - 199.31 (39.47 ac)
199.33 - 253.25 (40.93 ac)
253.33 - 300 (1.66 ac)

Legend	Treatment	Dry Yield Avg.	Dry Yield Min.	Dry Yield Max.	Avg. Moisture	Total Bushels	Acres
	46-0-0 Urea (160 lb/ac)	174.19	12.21	300.00	23.70	1,400.51	8.04
	46-0-0 Urea (150 lb/ac)	172.88	12.04	300.00	23.25	19,386.0	112.13
	None	135.89	12.00	300.00	22.72	1,923.48	14.15

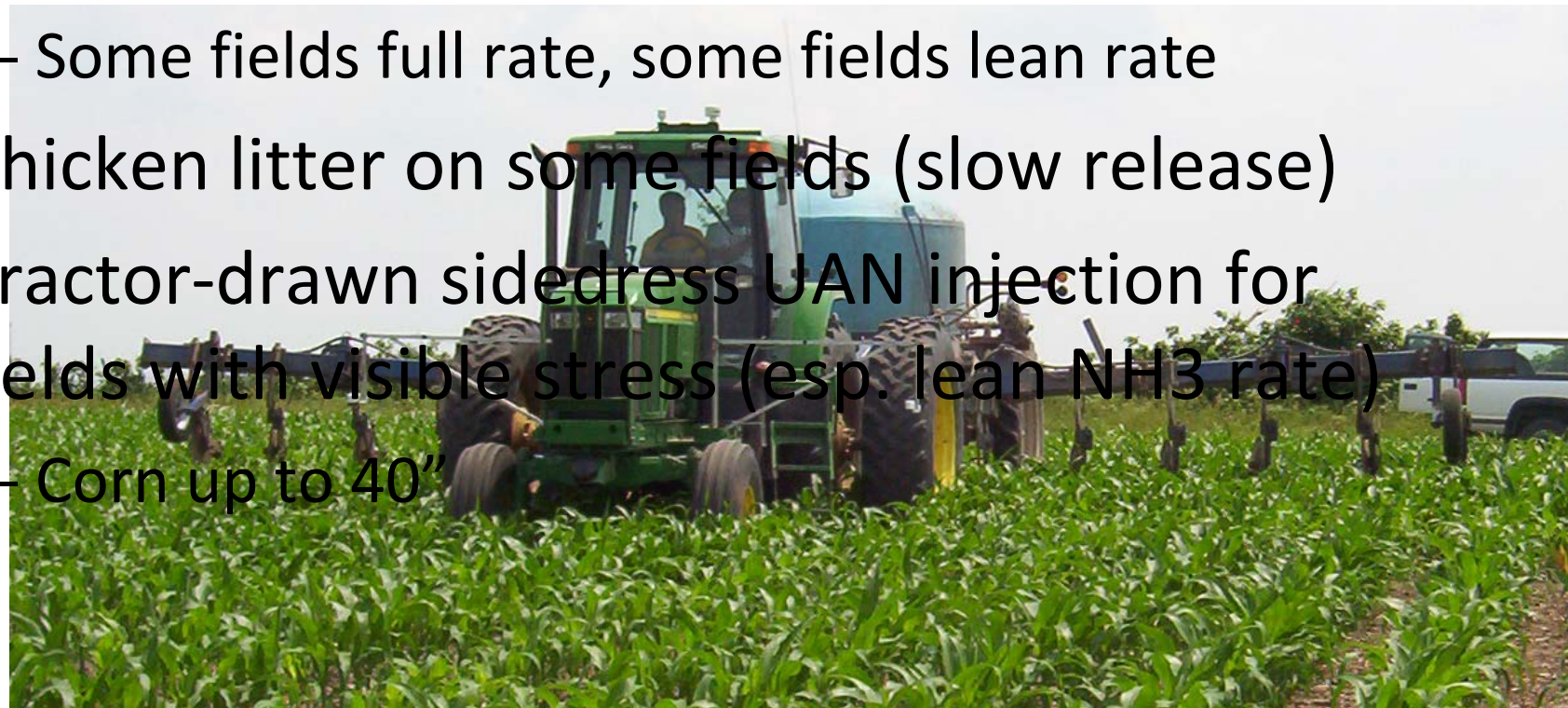
How do you balance all these N timing risks?

Winning game plans: Sander

- Ted Sander, producer, Randolph County
- About 70 lb N/acre preplant
  - In DAP
  - With herbicide
- Sidedress with Hagie UAN injector guided by crop sensors

Winning game plans: Riekhof

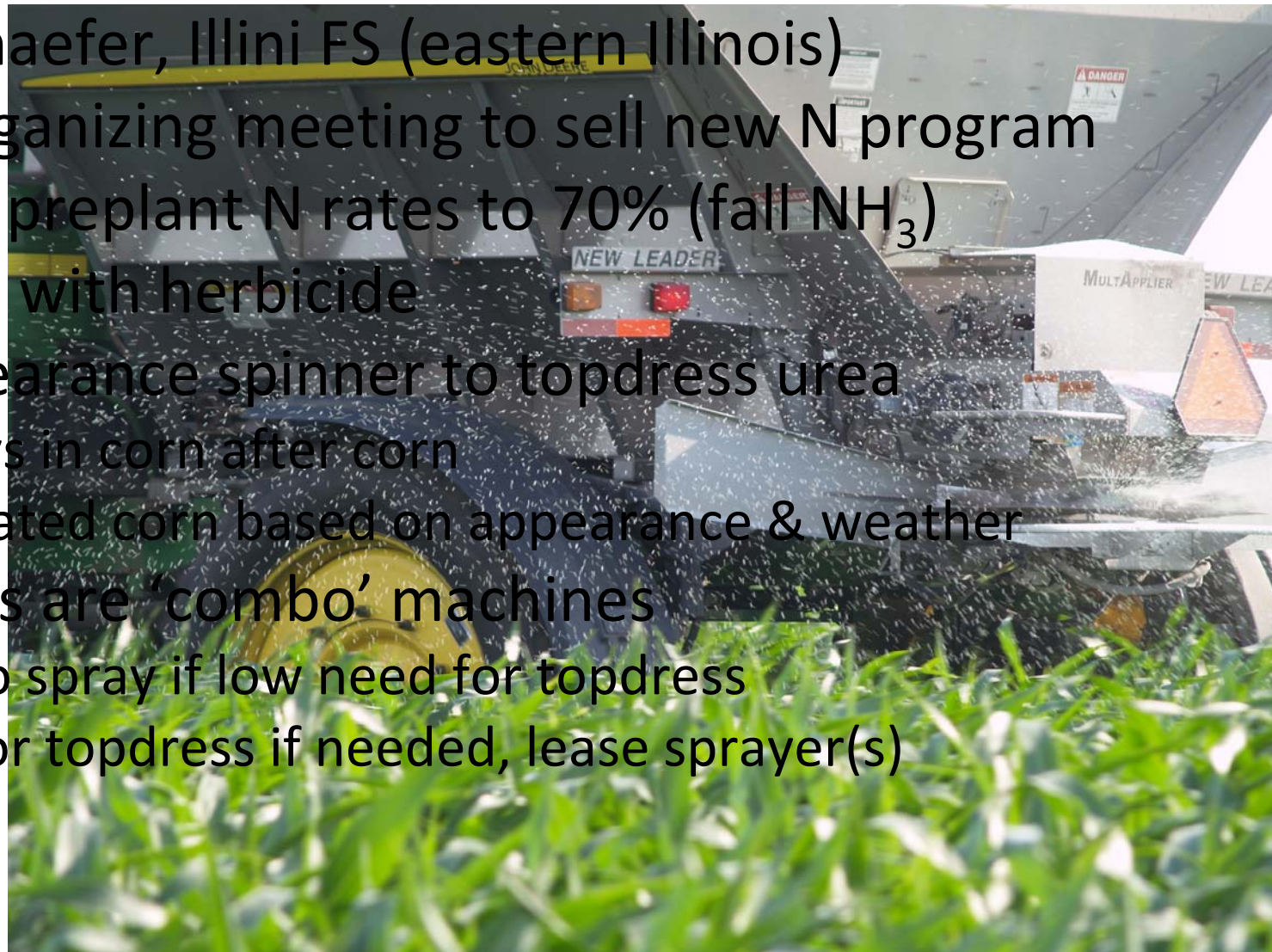
- Gary & Garret Riekhof, producers, Lafayette County
- Fall or spring NH_3
  - Some fields full rate, some fields lean rate
- Chicken litter on some fields (slow release)
- Tractor-drawn sidedress UAN injection for fields with visible stress (esp. lean NH3 rate)
  - Corn up to 40”



Winning game plans: Ramsey

- Gabe Ramsey, Central Missouri Agri-Services (Marshall)
- Producers follow their normal N program
  - Suggest 130-150 lb N/ac as NH_3 + N-Serve
- Spinner with crop sensors
  - **Help producers who experience N loss**

Winning game plans: Schaefer



- Dan Schaefer, Illini FS (eastern Illinois)
- Held organizing meeting to sell new N program
- Reduce preplant N rates to 70% (fall NH_3)
- Apply N with herbicide
- High-clearance spinner to topdress urea
  - Always in corn after corn
  - In rotated corn based on appearance & weather
- Spinners are 'combo' machines
  - Use to spray if low need for topdress
  - Use for topdress if needed, lease sprayer(s)

Winning game plans: Brown

- Steve Brown, Macon MFA
- Organized rescue N airplane in 2010
- 2011 started planned in-season N program with some customers, either:
  - Tractor-drawn UAN injection (contractor) OR
  - Plane broadcasting SuperU
  - Choice based on customer preference
  - Reduced preplant N rates

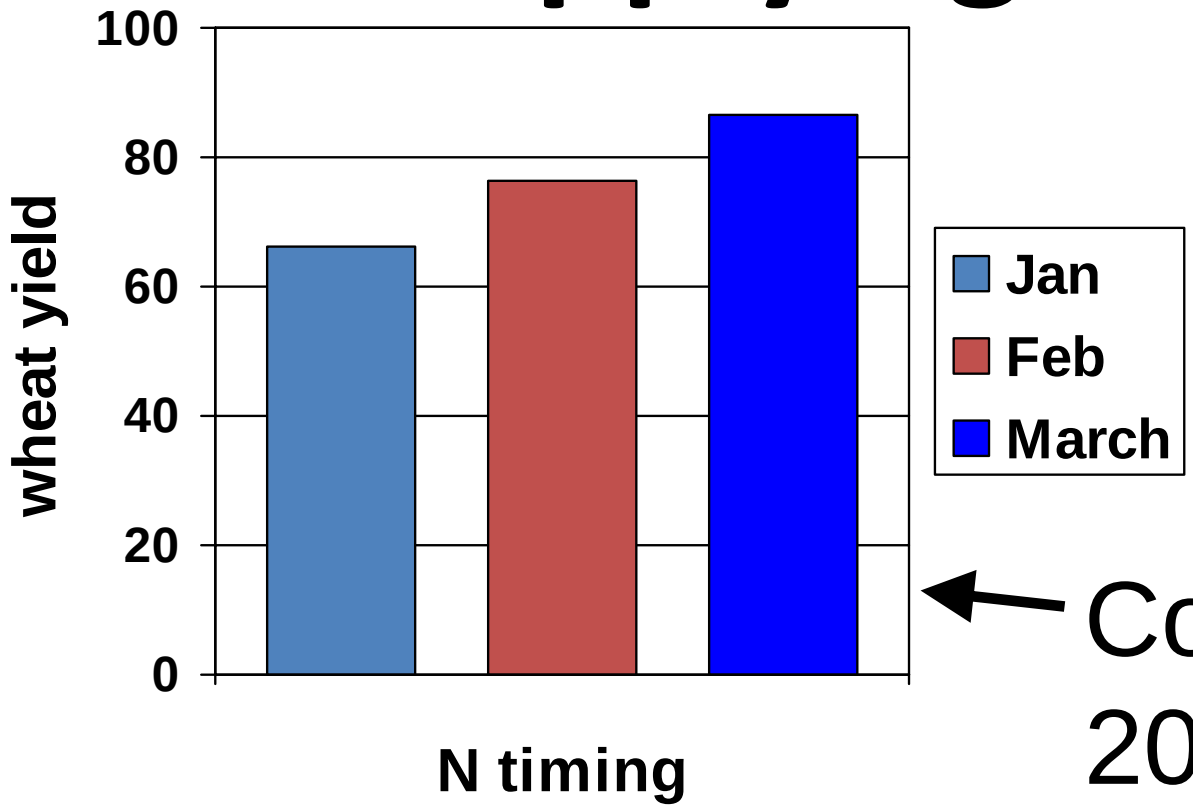
Your New Game Plan

- If you're not sidedressing, you MUST be ready to apply in-season N when preplant N is lost
- Planned low-rate sidedress N is catching on
  - Flexible to allow increased in-season N in seasons with N loss

Nitrogen timing in wheat

N Timing	Function
Preplant	Stimulate tiller development
Greenup	Stimulate tiller development
Prejointing	Support rapid crop growth

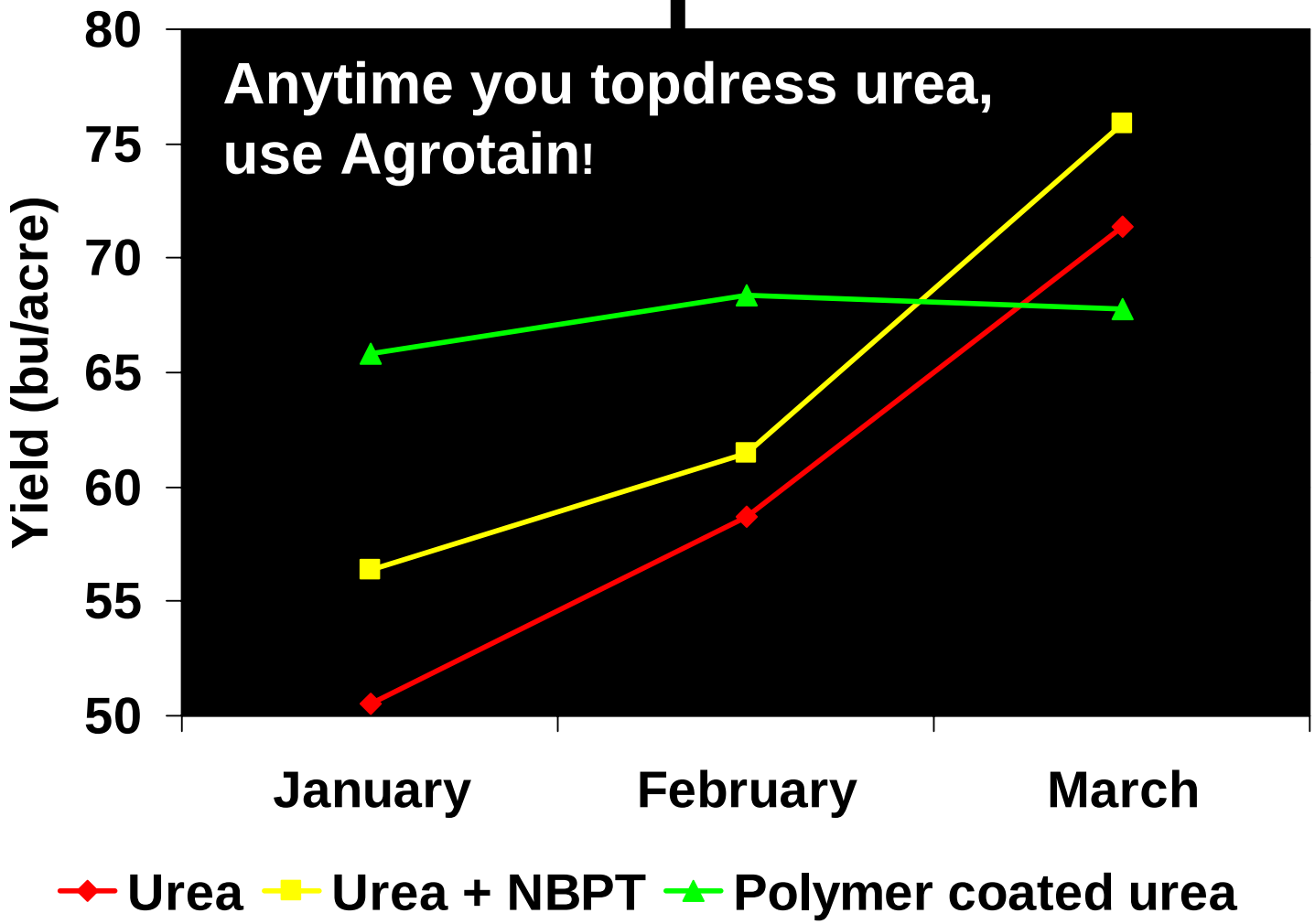
Wheat: applying N early



Columbia 2005

- On average over 9 tests in Missouri, March N beats Feb. N by 3 bu/acre
- For four tests with yield > 70, March N beats Feb N by 8 bu/acre

If you must topdress early, use ESN!



Columbia 2005, 2006

Late N applications for wheat

- Two experiments in Missouri
- Yield potential starts to drop if N is delayed until the two-joint stage
- By boot stage, there are only two reasons to apply N:
  - Extreme deficiency
  - You're getting a high-protein premium
- Wheat is less forgiving than corn with late N

Nitrogen timing in grass

N Timing	Function
March	Hay—maximum tons
May	Increase summer grazing
August	Increase fall & winter grazing

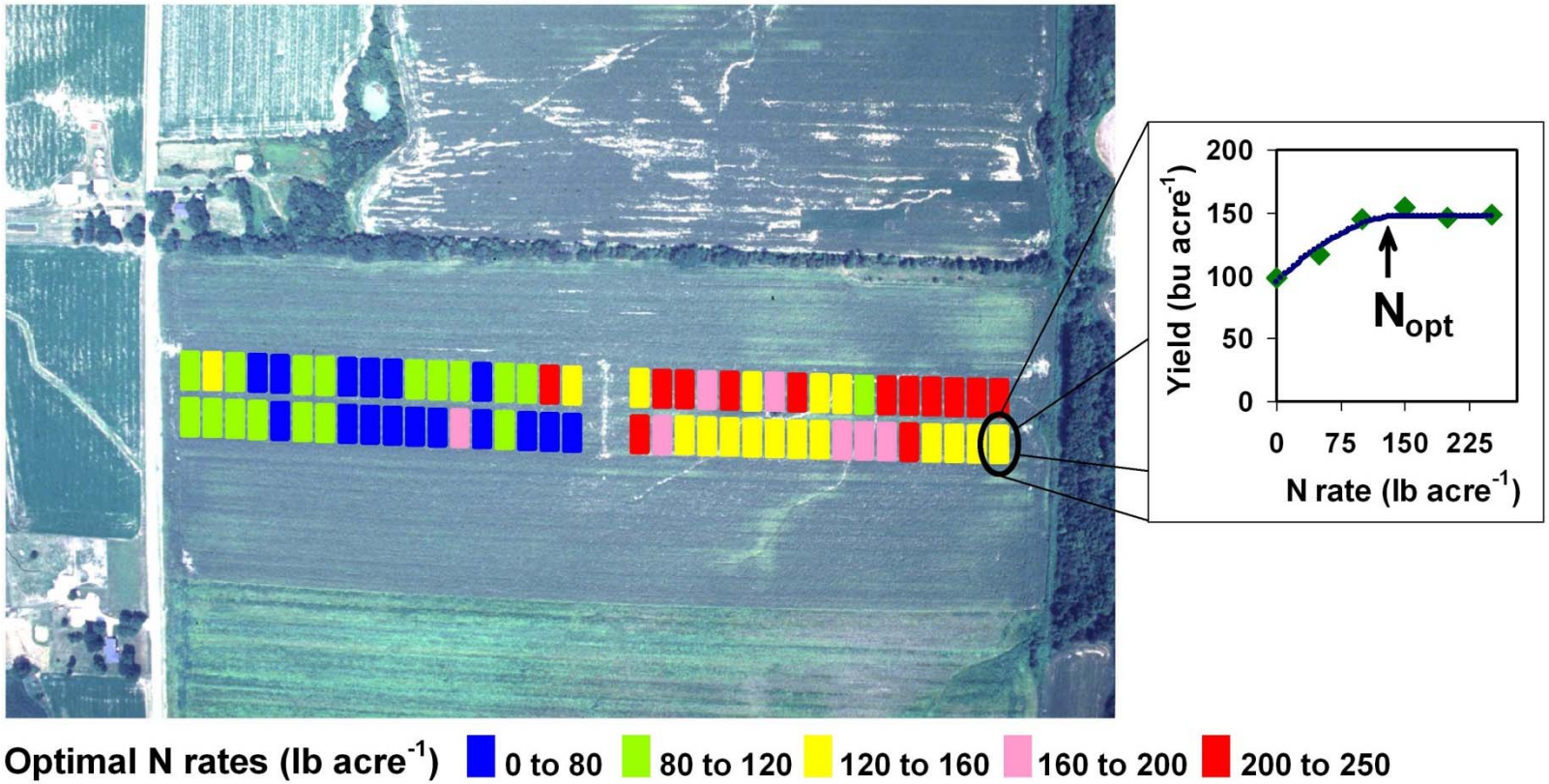
In pasture, N timing is about extending the grazing season!

What about N rate?

Optimal fertilizer N rate varies widely among fields

- 20 on-farm experiments in Missouri with corn after soybean, no manure
- Optimal 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
- Does anybody see a pattern?
- There is a lot of confusion about how much N to apply, and how to make the decision

Optimal N rate varies widely within fields, too



What happens when you apply 150 lb N/acre to the whole field?

Yes: Minnesota, Kansas, Missouri, Pennsylvania

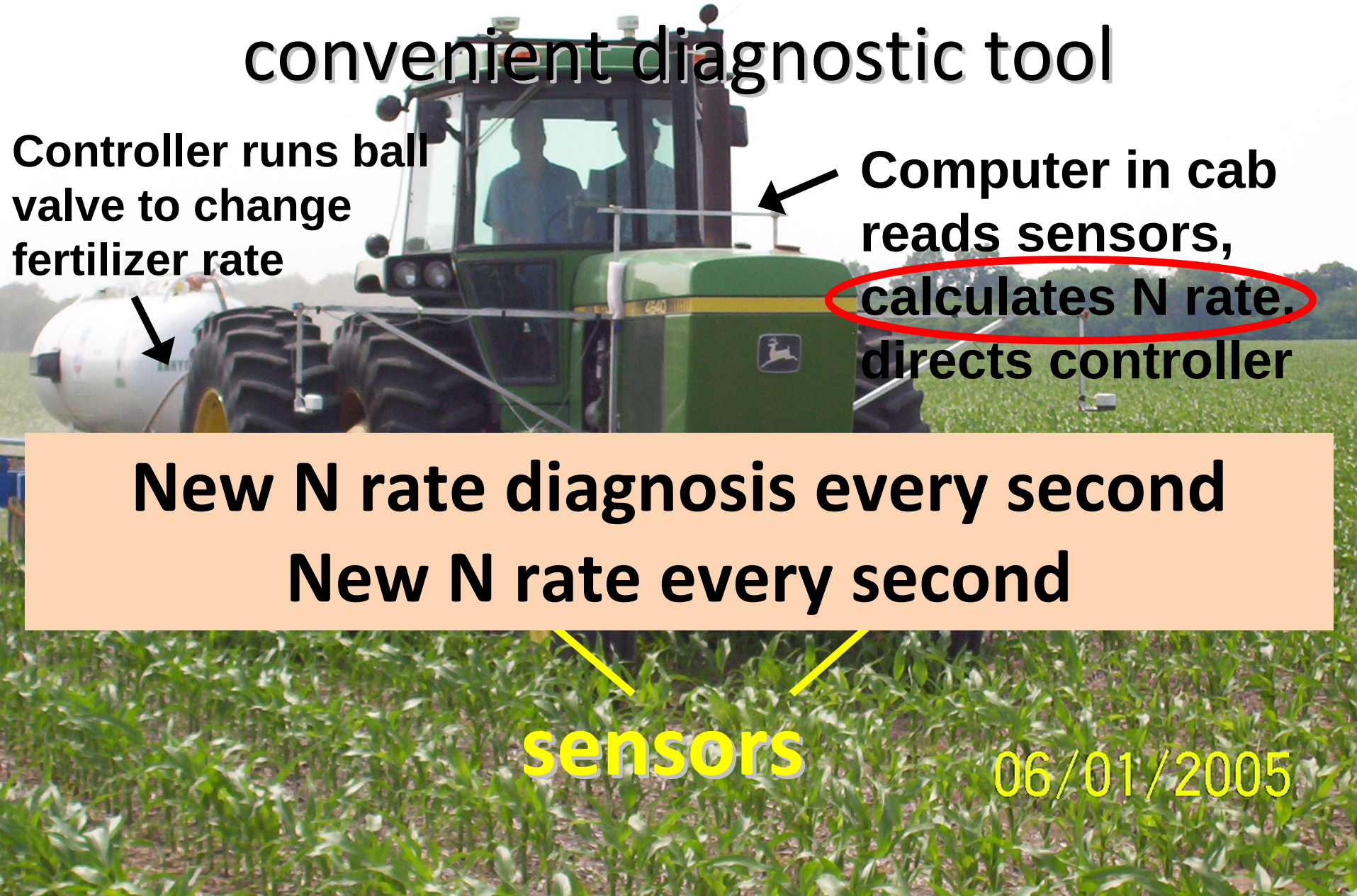
No: Wisconsin

So how can we improve N rate decisions?

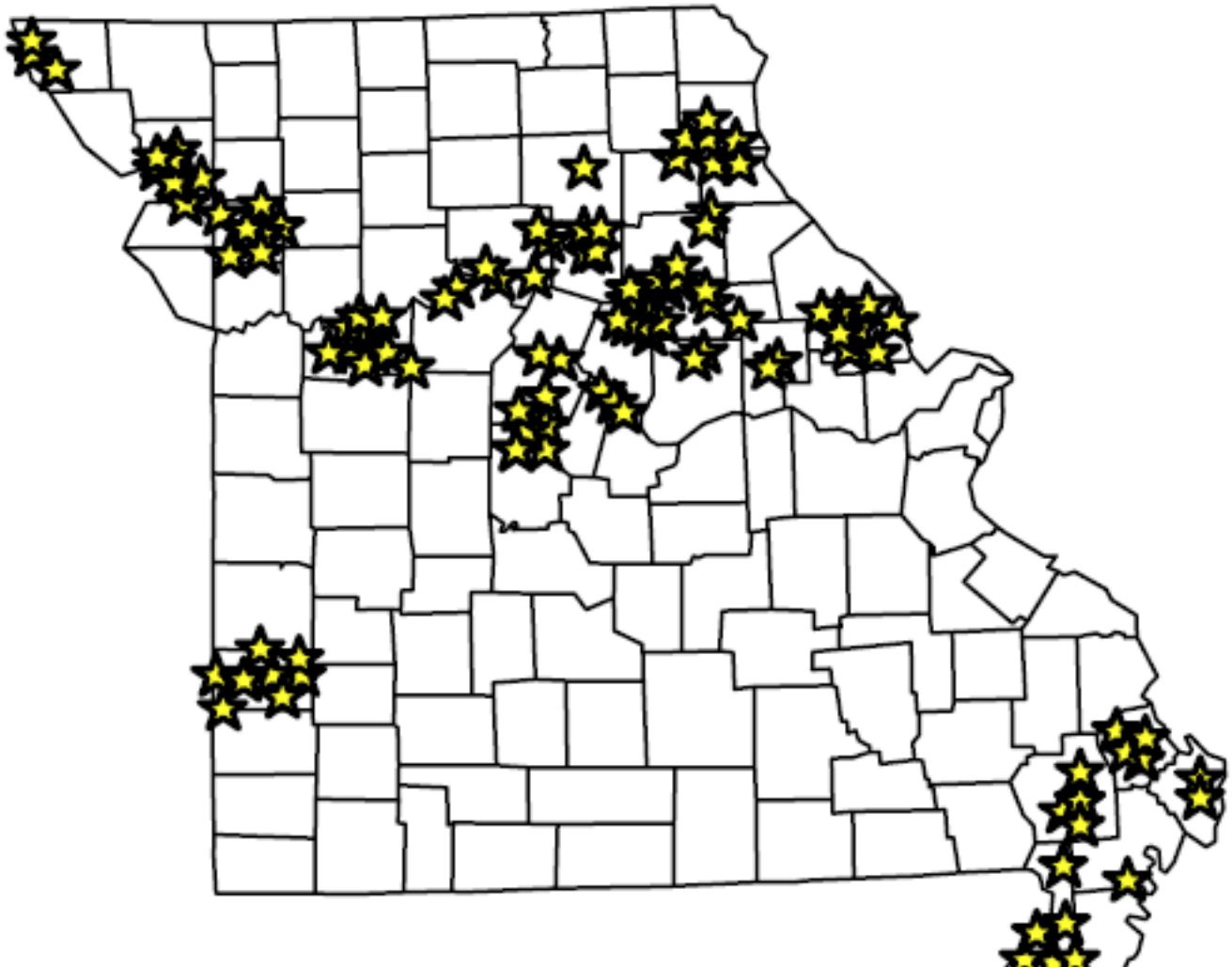
How can we decide where to put more N? Where to put less?

Predictor	% of variability in N need explained
Yield	13 to 20
Soil nitrate	17
Soil conductivity	8
Corn color	53 to 77

Color sensors: the most accurate & convenient diagnostic tool



Demonstration program: started in 2004 to help farmers try this technology



Sensor demo outcomes

- 55 replicated on-farm trials
- Increased corn yield by 2 bushels/acre
- Reduced N use by 14 pounds/acre
- Increased partial profit by $17/acre
- Reduced ‘surplus N’ by 27%
- Based on Missouri interpretations for sensors
- Works with all N forms, placements

Sensors also work to guide rate decisions for cotton, probably wheat

N rate: summary

- Optimal N rate varies widely
  - From field to field
  - From place to place within a field
- Difficult to predict
  - Influenced by many factors—fertilizer N loss, soil N supply
  - Many failed attempts to develop prediction systems
- Crop color is by far the most accurate
  - But doesn't fit most N management systems in MO

N sources

- All N sources are good N sources
- All can succeed
- All can fail

Two things NOT to do

- Don’t surface-apply untreated urea and leave it on top
- Don’t broadcast UAN solution on high-residue fields

Urea on the surface

- Will generate ammonia gas, escape to air
- Average 25% loss
  - Range 0 to 50%
  - Depends on weather after application
- Effectively prevented by:
  - Coating with Agrotain
  - Incorporating with tillage (within 3 days)
  - Incorporating with irrigation (within 3 days)

Surface urea and yield loss: How much?

- Missouri research
- Broadcast and left on surface
  - mostly no-till
- Corn: 14 bu/acre
  - Average of 38 tests in Missouri
  - (Yield with ammonium nitrate) – (yield with urea)
- Wheat: 5 bu/acre
  - Average of 9 tests, same comparison

UAN broadcast on residue

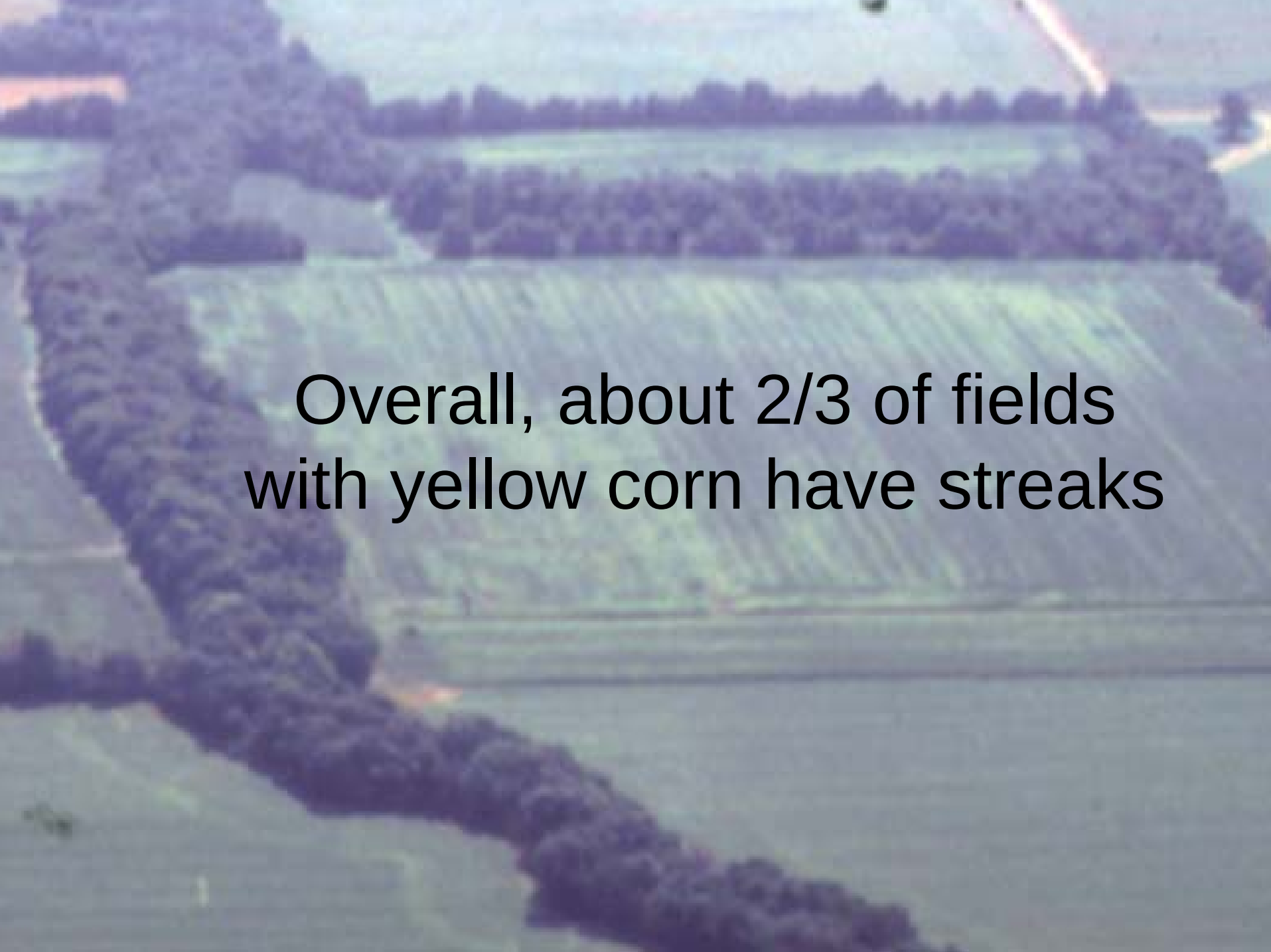
- Will get tied up on residue (even soybean)
- Not lost but not available to the crop
- Minimize contact between N and residue
  - Inject below surface residue (best)
  - Dribble on surface residue (OK)
- Broadcast UAN on low-residue fields is OK

UAN and yield loss: How much?

- Missouri research
- Broadcast in no-till
- Corn: 25 bu/acre
  - Average of 20 tests in Missouri
  - (Yield with ammonium nitrate) – (yield with broadcast UAN solution)

Even N application

- Aren’t we doing that already?
- My aerial photos say NO


Overall, about 2/3 of fields
with yellow corn have streaks

Why??

- Most common streak widths:
  - 30
  - 40
  - 60
  - 80
- Spinners & anhydrous bars

Spinners

- I think it's mostly a material problem
- Increasing imports of dry N
  - Through more augers
  - More fines than in the past
- You can't throw dust
- Also probably some failure to set spinners correctly

Anhydrous bars

- Mainly due to uneven distribution at manifold
- Two main solutions:
- Use a new, ‘better’ manifold!
- Randomize hoses so that low rates aren’t applied through adjacent knives

Nitrogen: summary

- Timing affects risk:
  - Loss
  - Logistics
  - Corn: more risk early than late
- Optimal rate varies widely, hard to predict
- Crop color is by far the most reliable predictor
  - Inconvenient for most producers

Nitrogen: summary

- N sources all good but avoid:
  - Untreated urea left on the surface
  - UAN broadcast onto a high-residue surface
- Problems with streaky applications are widespread
- Poor-quality dry N (lots of dust)
- Low-performing anhydrous manifolds


Thanks for your time & attention—comments or questions?
Central Iowa, August 2008