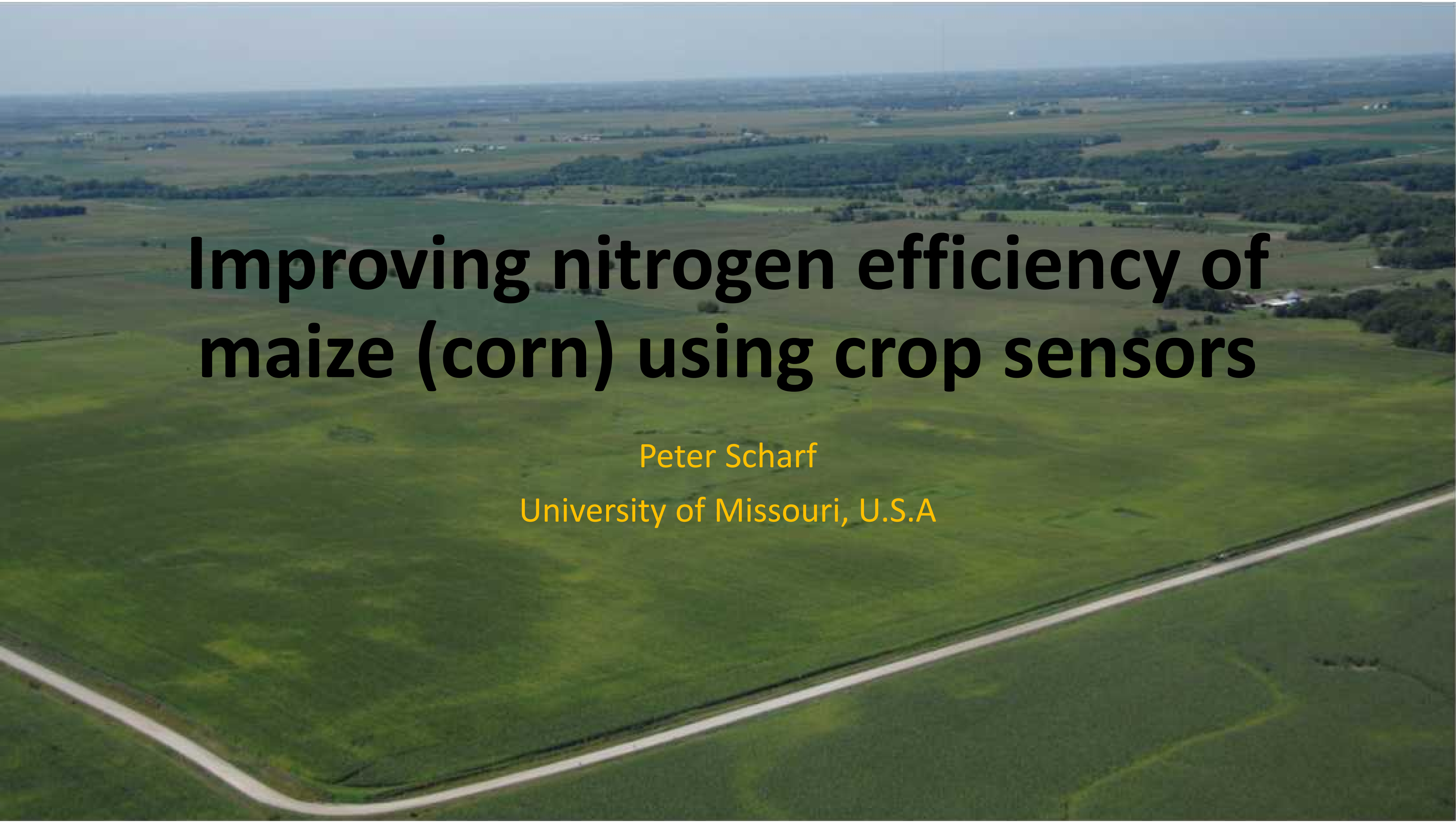

Improving nitrogen efficiency of maize (corn) using crop sensors

Peter Scharf

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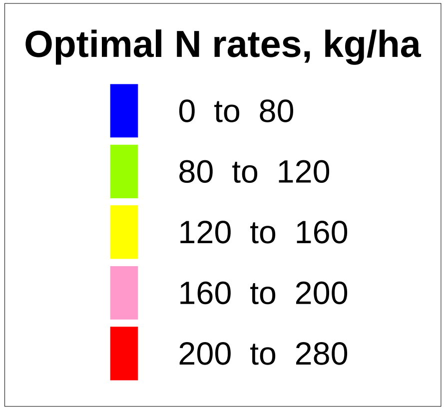
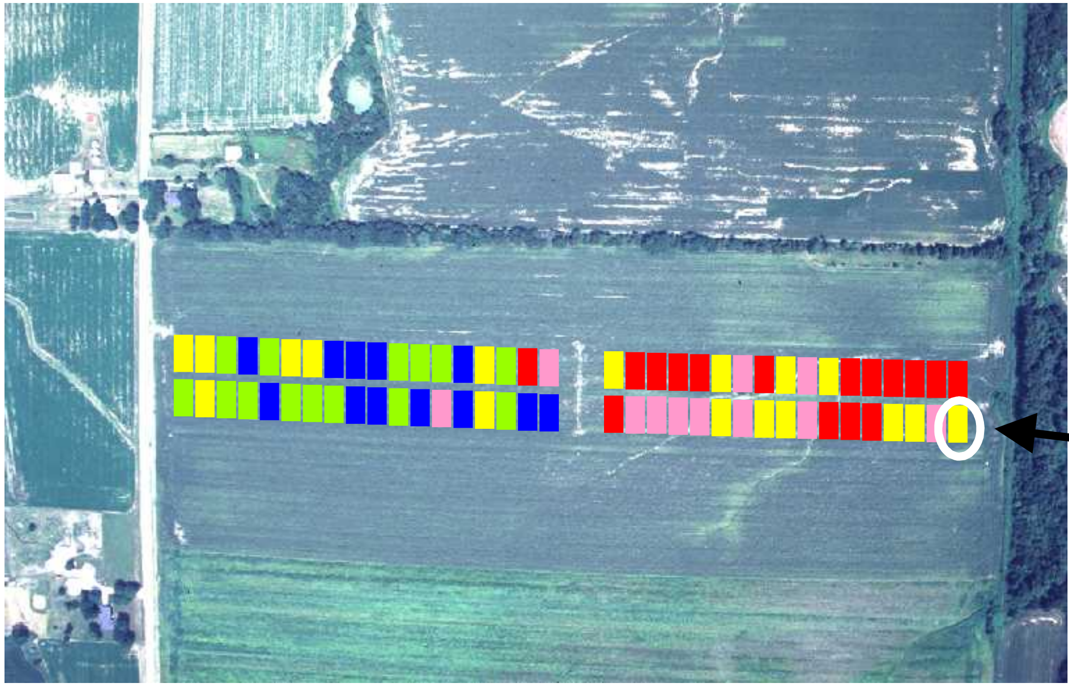
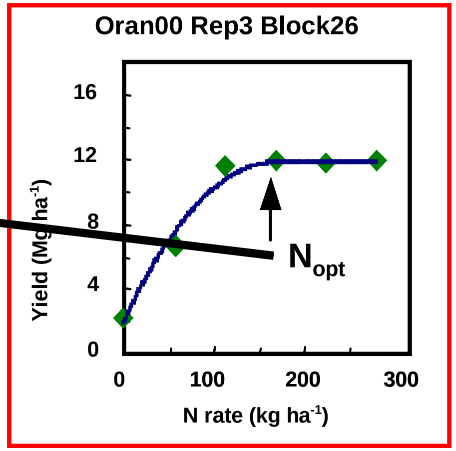
Efficiency

- It's a nitrogen-limited world
- We have 7.4 billion to feed, and growing
- **Without nitrogen fertilizer, we can't feed everyone**
- What limits N efficiency?
  - Loss between application and uptake (wet weather; NH_3 volatilization)
  - Applying more than is needed
- Crop sensors address both in U.S. maize
- The right amount of N varies widely—year to year, field to field, and place to place within a field; how can we manage this?
- **I define efficiency = N removed in grain / N applied (fertilizer + manure)**

N need: Varies widely within fields







We studied 8 fields this way; 7 were as variable as this one

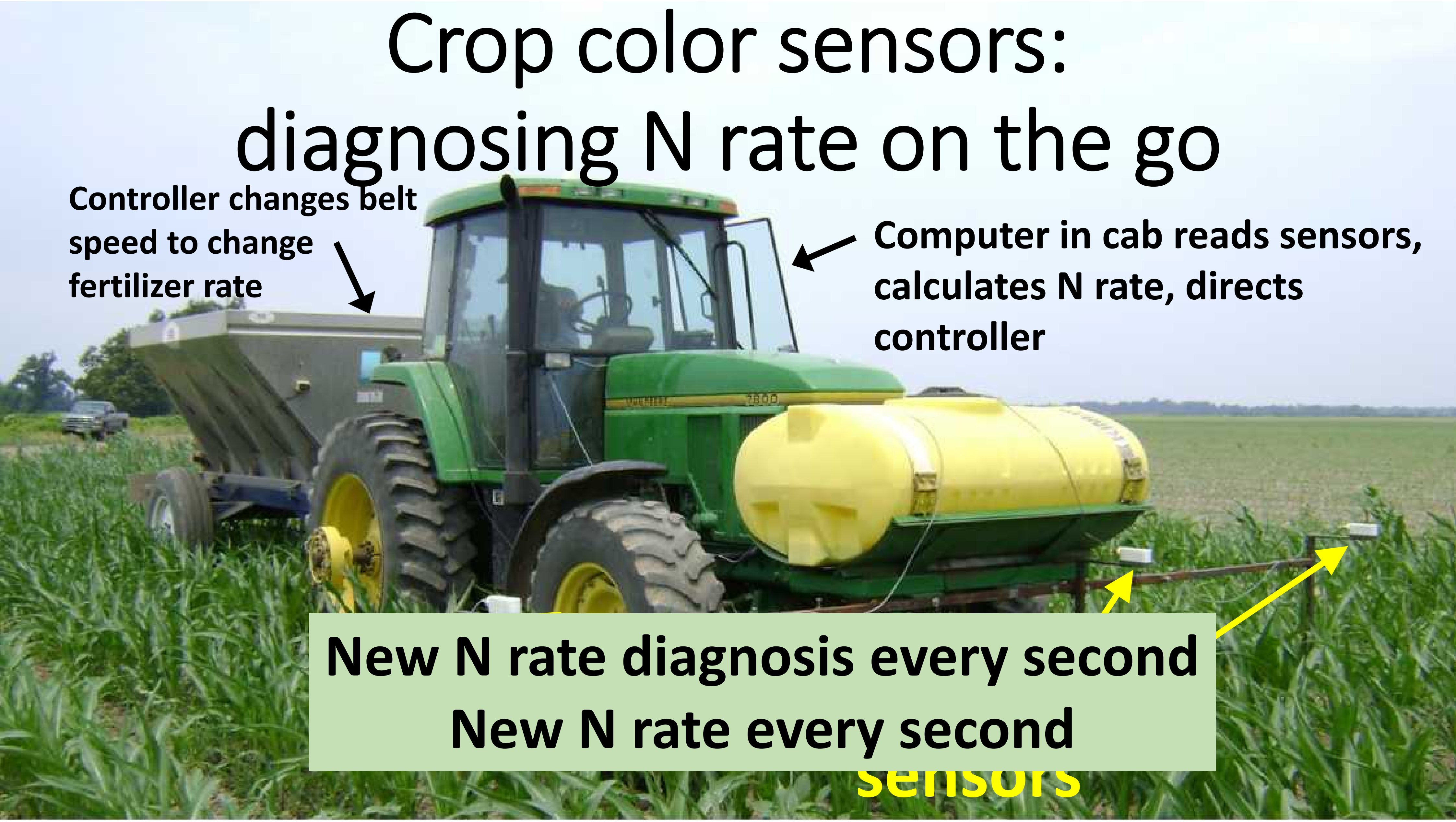
Scharf et al., 2005, Agron. J. 97:452

Crop color is the most accurate way I’ve found to predict how much N is needed

I’ll report N efficiency with sensor-based variable-rate N in 3 experiments

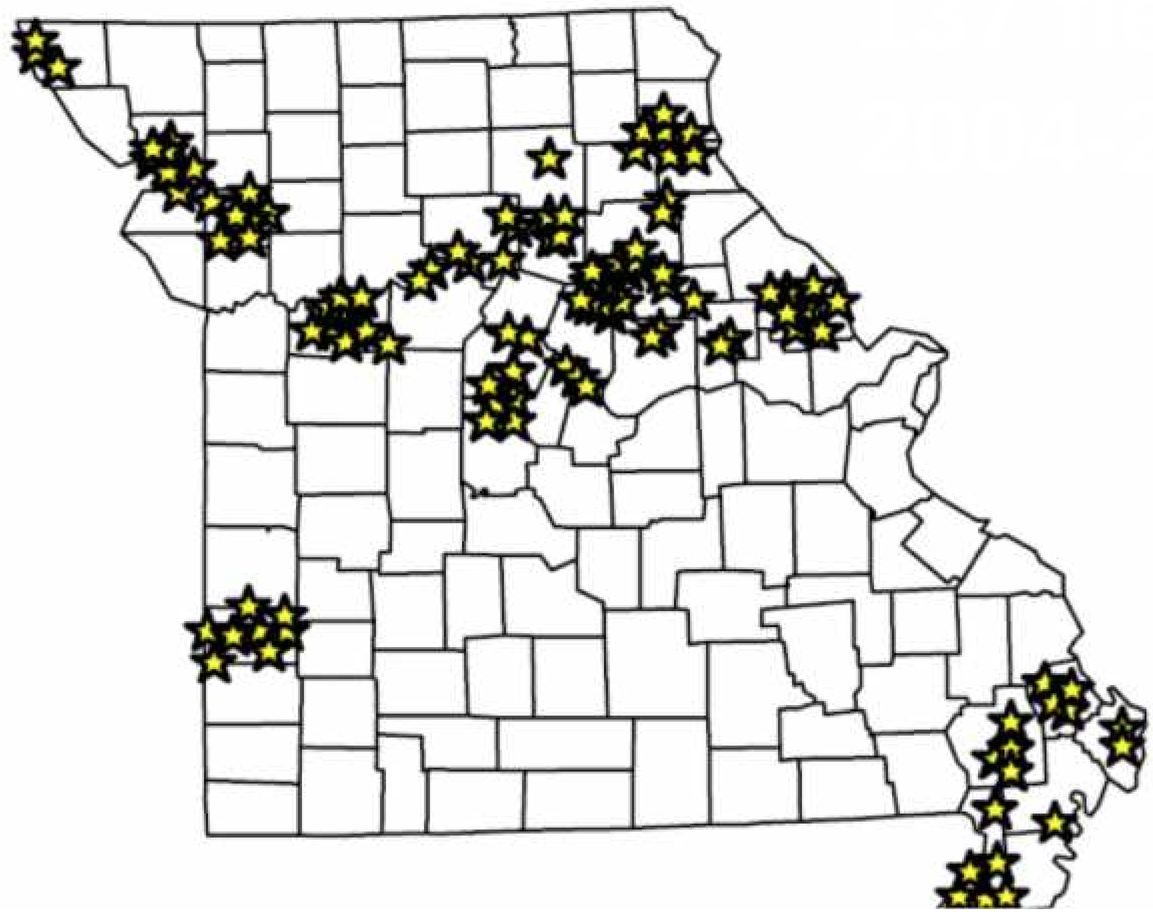
- On-farm comparison of farmer-chosen N rate with sensor-based N rate
- Long-term N systems experiment
- 3-year N management and drainage

Crop color sensors: diagnosing N rate on the go



New N rate diagnosis every second
New N rate every second

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




Melbourne Cricket Grounds
Farmer N rate
Variable-rate N
based on sensors
450 m
10.7 m
Average size of the 55 field experiments

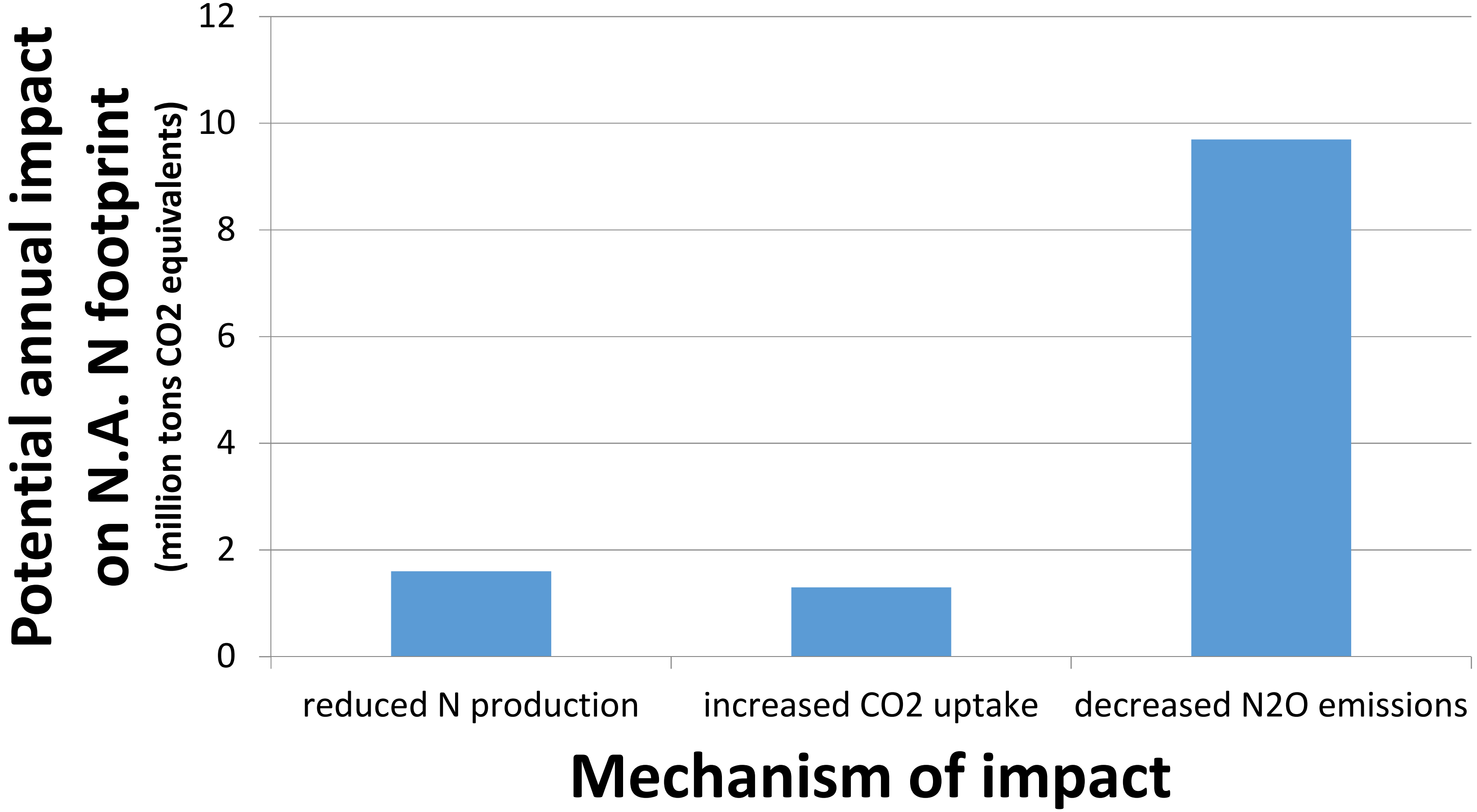
On-farm sensor N outcomes

N rate system	Yield	N removed in grain	N applied	N efficiency
Farmer choice	9.8	115	194	**0.68*** (0.67)
Sensor-based variable	9.9	117	179	**0.78*** (0.73)

*Average of efficiencies at the 55 individual locations; (average N removed 55 locs/average N applied 55 locs)

Scharf et al., 2011, Agron. J. 103:1683

Sensor-based N and the C footprint



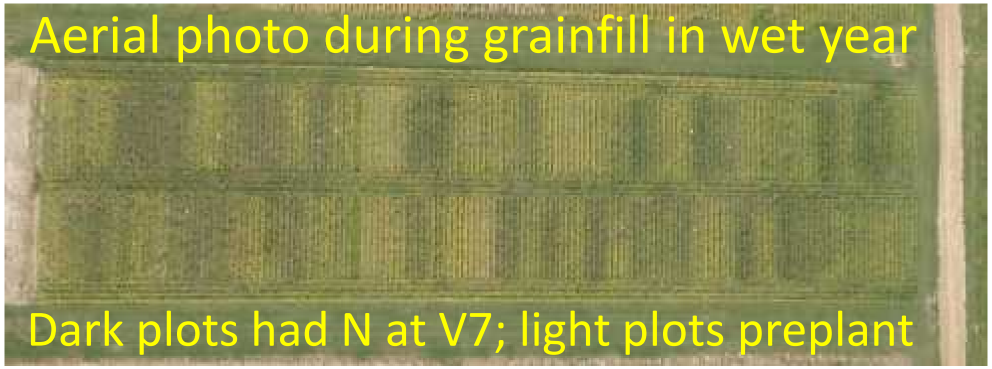
Long-term N systems experiment

- Small plots (3 m x 12 m) at research station
- Continuous no-till maize, 2007-2014
- Eight N rate/timing treatments, six replications
  - Four fixed rates at planting (0, 110, 155, 200)
  - Preplant soil nitrate test
  - Early-season soil nitrate test
  - Chlorophyll meter
  - Canopy sensor

N applied when plants are knee-high (V7)

Long-term N system outcomes

N rate system	Yield	N applied	N efficiency
200 kg N/ha preplant	6.6	200	**0.43**
Sensor-based variable-rate N	9.0	161	**0.74**



Why? 5 wet years (of 8), N applied pre-plant lost before rapid N uptake period

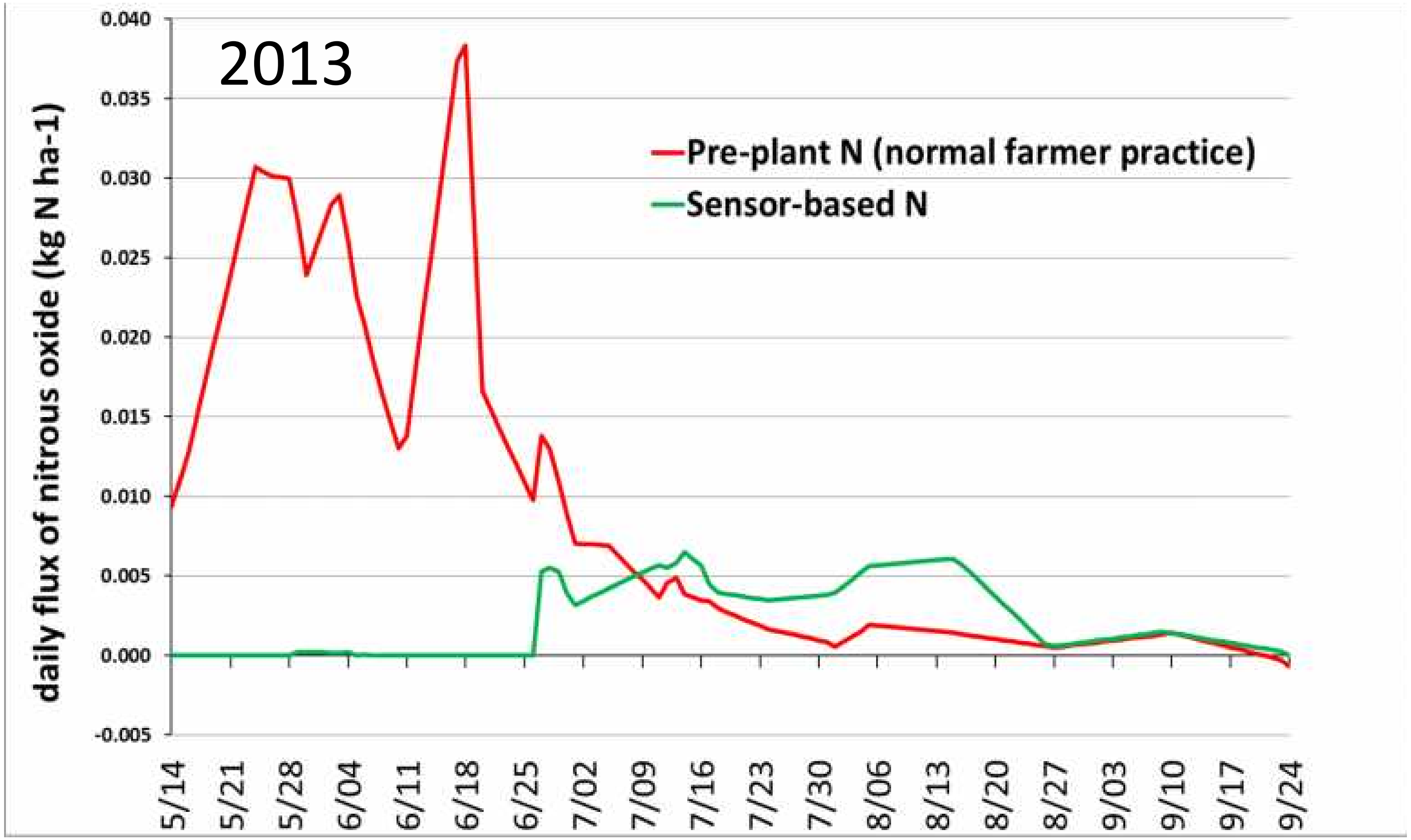
N management & drainage experiment

- Medium-sized plots (12 m x 60 m) at research station
- Continuous no-till maize, 2012-2014
- Two N treatments, four replications
  - 155 kg N/ha at planting
  - Canopy sensor-based real-time variable rate N when plants are knee-high (V7)
- I will only report results of N treatments

N management & drainage outcomes

N rate system	Yield	N applied	N efficiency
155 kg N/ha preplant	6.0	157	**0.51**
Sensor-based variable-rate N	6.8	155	**0.57**

Sensor-based N is also reducing N_2O flux



- The dominant flux period is often prior to application of sensor-based N
- Fertilizer-derived N dominates flux in our environment

Sensor-based N efficiency: Summary

- Optimal N rate varies widely year to year, field to field, and place to place within a field
- Crop sensors provide a mechanism for dealing with this variability
  - Rate is matched more closely to need
  - Timing is also optimized—just before maximum uptake period

Experiment	# of site-years	N efficiency with:	
		Constant-rate N	Sensor-based variable-rate N
On-farm trials	55	0.68	0.78
Long-term N systems	7	0.43	0.74
N system & drainage	3	0.51	0.57


Questions or comments
are welcome