

# Late-season Nitrogen Fertilizer Placement, Timing and Rate Responses in Modern Corn Hybrids

Tony J. Vyn, S. Mueller, K. Chen, R.A. Omonode,  
T.D. West, A. West, Farmers and Other Students  
Purdue University

Presentation to Indiana CCA Conference  
in Indianapolis, IN, on December 14, 2016





# Research Context:

## On-going Experiments with Strip-Till and No-till Corn and Associated Management Options:

1. Nutrient Placement, Rate, Timing, and Source
2. Corn Management (hybrid, plant density, rotation)
3. Greenhouse gas emissions from different N managements





# Cooperative Planting Speed Studies with Deere at Purdue (ExactEmerge) in 2015 and 2016 (Comparison of 5.0, 7.5 and 10 mph)





# 2016 ExactEmerge Trial

## Cooperator: Greg Gilbert, Romney, IN



**24-row 30" ExactEmerge vs. JD 1770 Precision SS 20/20 at 2-3 speeds and 2 populations**

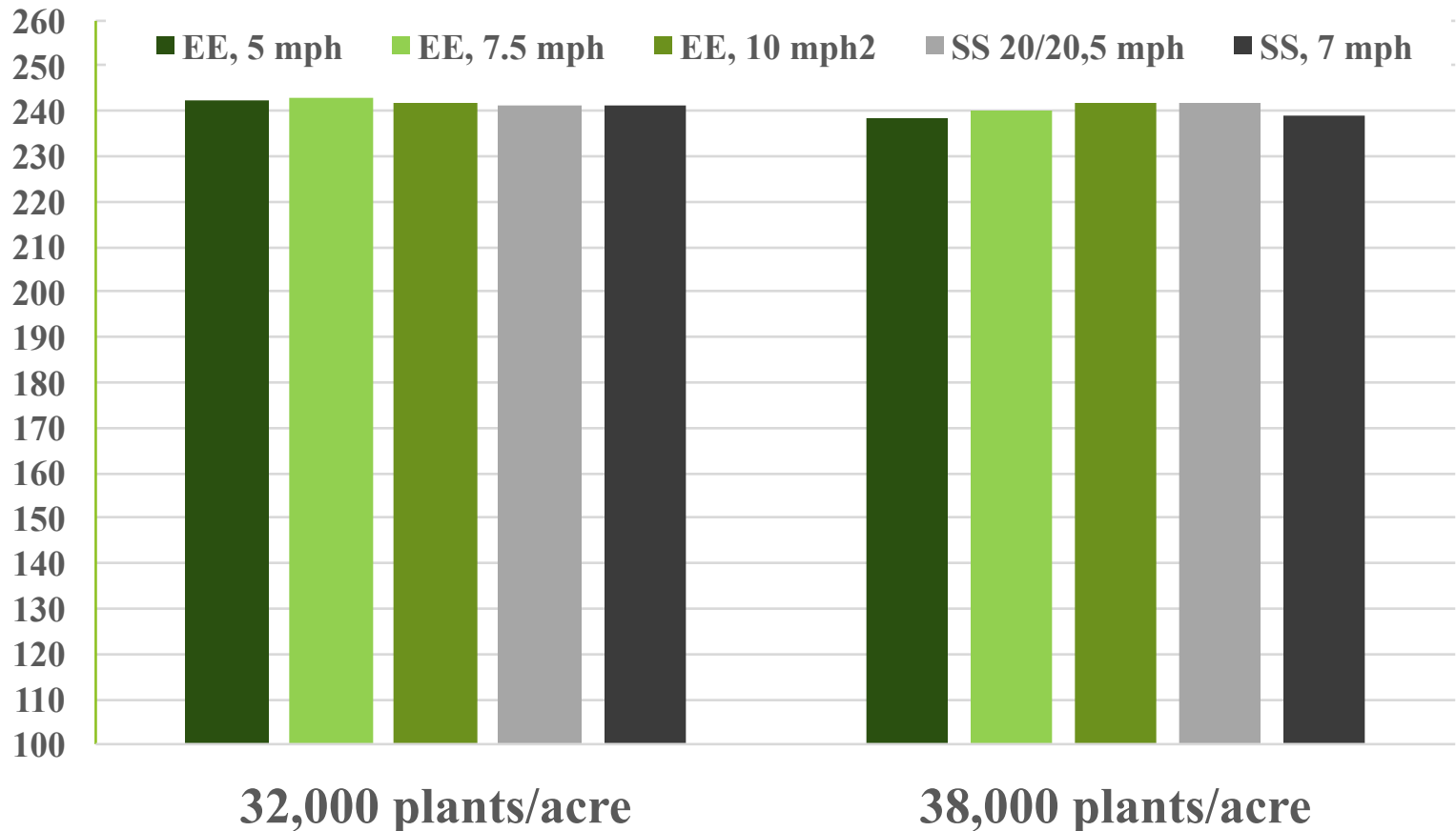




# 2016 ExactEmerge Trial

## Cooperator: Greg Gilbert, Romney, IN

Grain Yields (bu/acre)

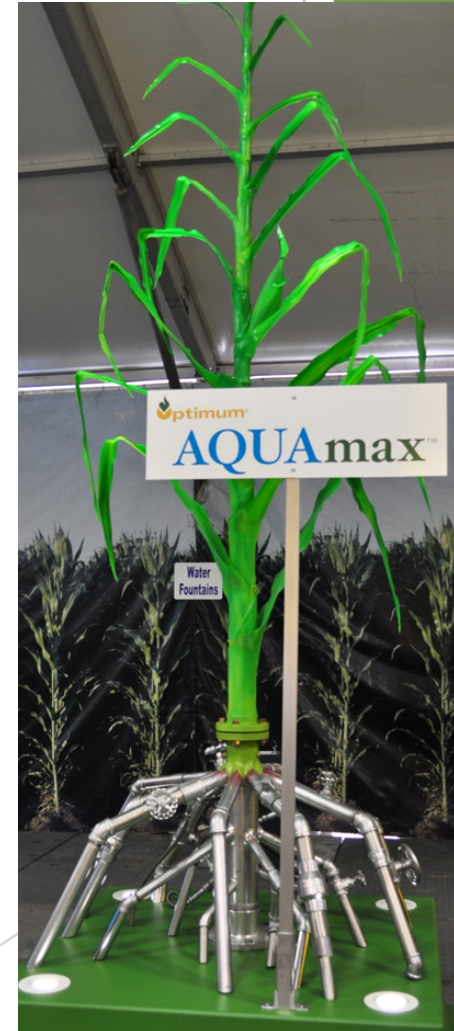


Avg. grain yield = 241.4 bu/acre





# Modern Hybrids, Stress Tolerance and N + H<sub>2</sub>O Management?





# Whole-plant, grain, cob and stover nutrient (macro- and micro-) determination at maturity



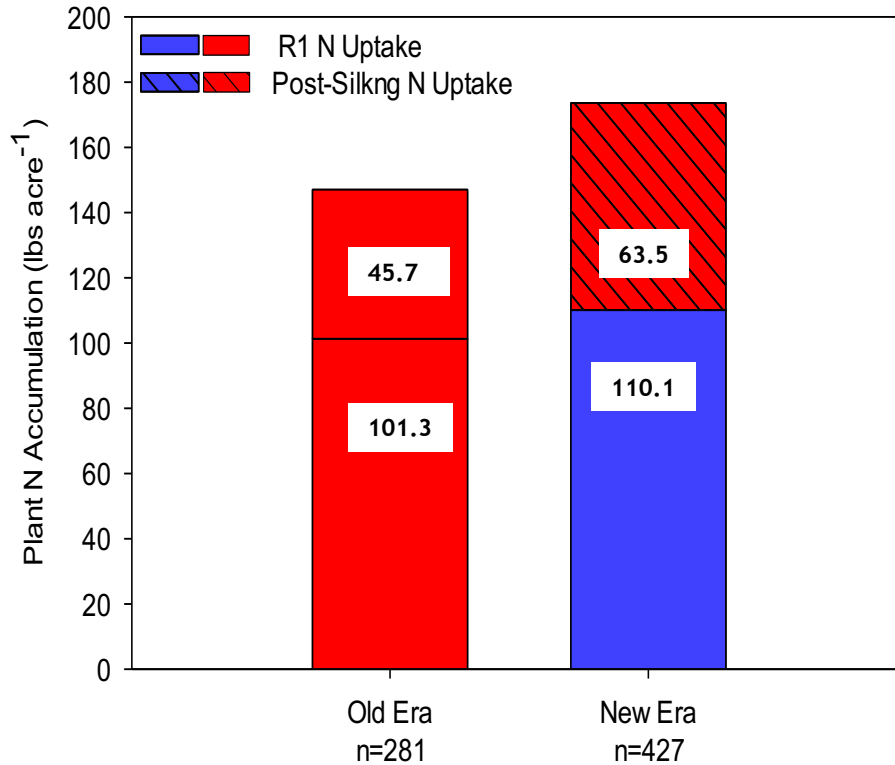


# Summary of Corn Hybrid Changes Over Time

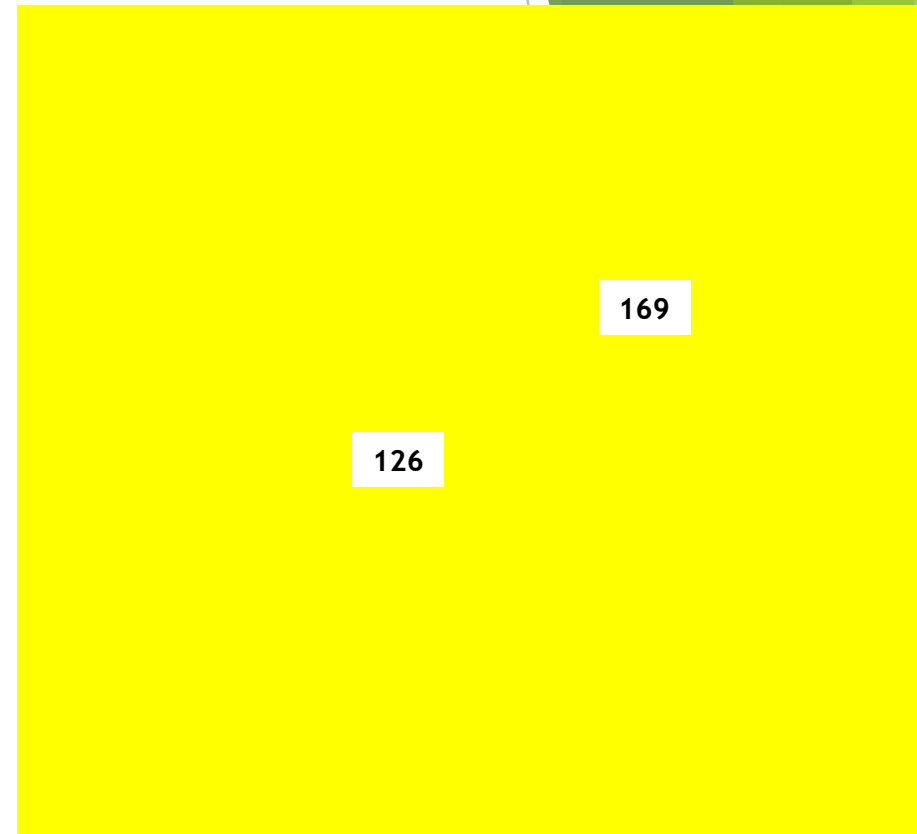
Measured Parameter	Old Era 1942-1990 (mean=1984)	New Era 1991-2011 (mean=2001)
Mean N Rate (lb/Acre)	126	125
Plant Density/Acre	22,800	28,800
Yield (bu/acre)	115	144
N Use Efficiency (PFP)	58	66
N Internal Efficiency (NIE)	49.7	56.0
Grain Harvest Index (HI)	47.6	49.8
N Harvest Index (NHI)	63.1	63.8
Grain N %	1.33	1.20

Ciampitti and Vyn (2012, Review Paper, Field Crops Research 133: 48-67)

# Higher and Later N Uptake in Modern Corn Hybrids



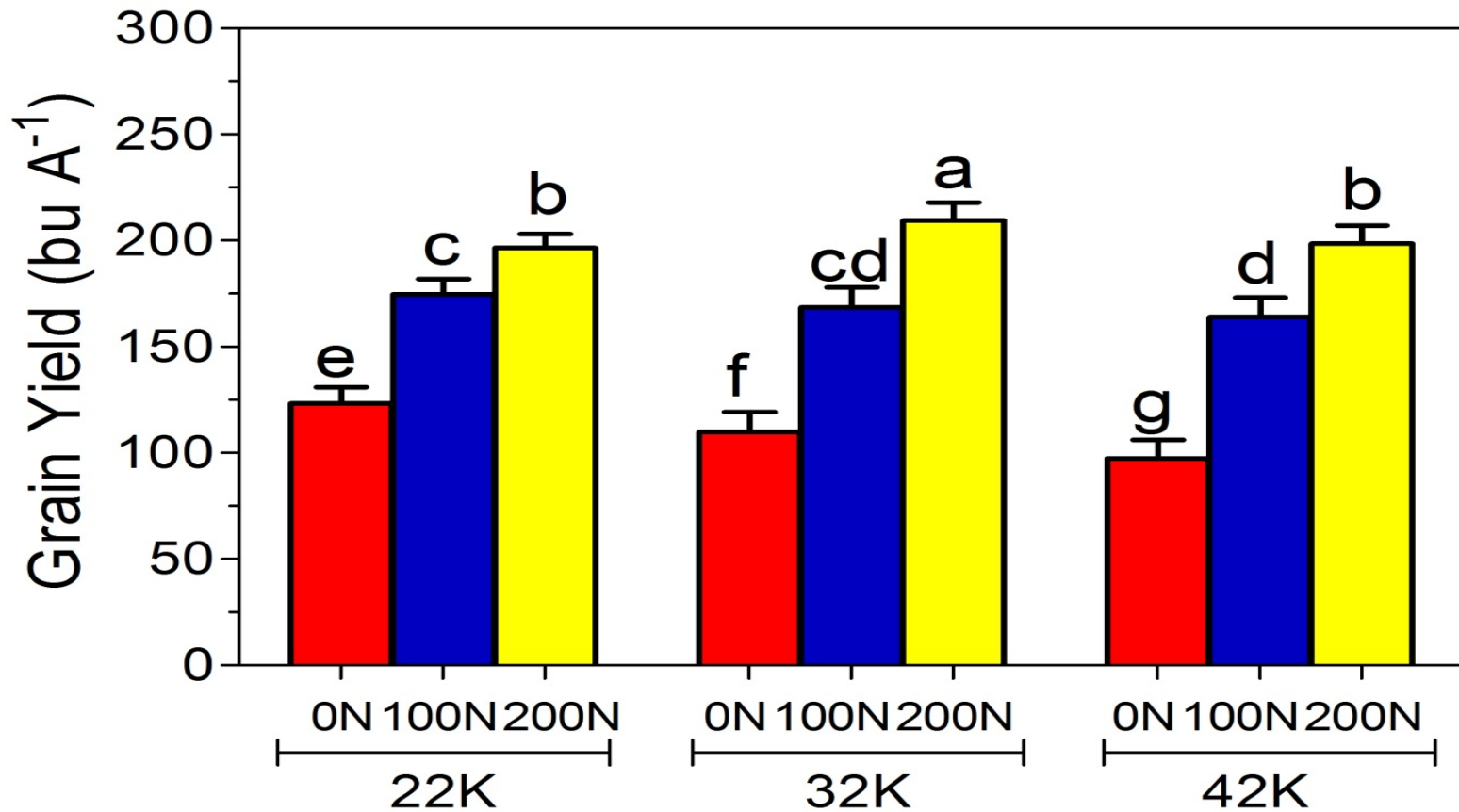
Mean N rates in lbs N acre<sup>-1</sup>:  
**151**                      **153**



Source: S. M. Mueller and T.J. Vyn 2016 (Frontiers in Plant Science)



# Plant Density and N Rate Impacts on Grain Yield (average of 2 hybrids, 2 locations and 2010-2011)

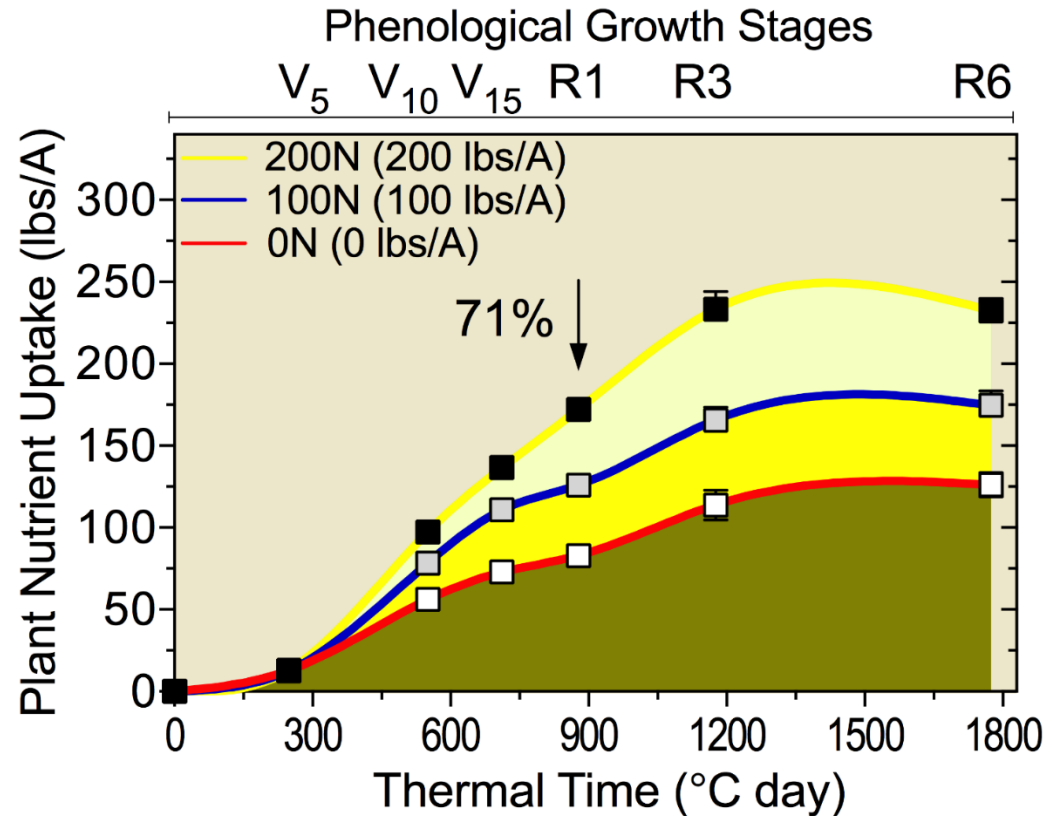
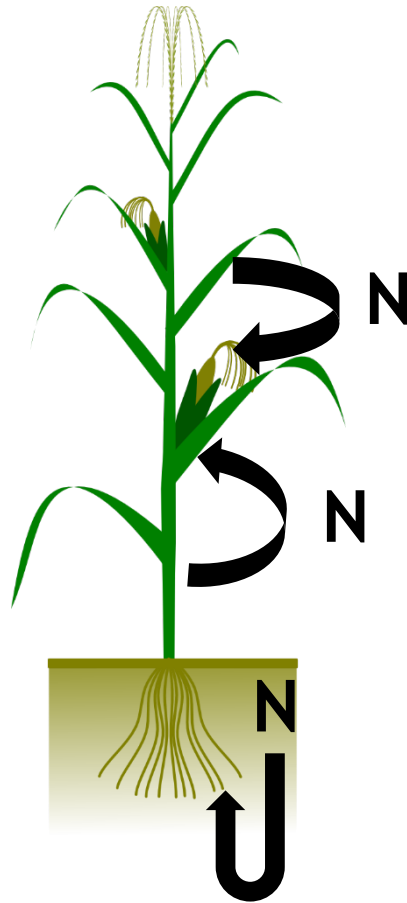


Ciampitti & Vyn, 2011



Dow AgroSciences

# Timing and Source of N Uptake by Plants and Grain



Ciampitti et al., 2013 Agronomy Journal

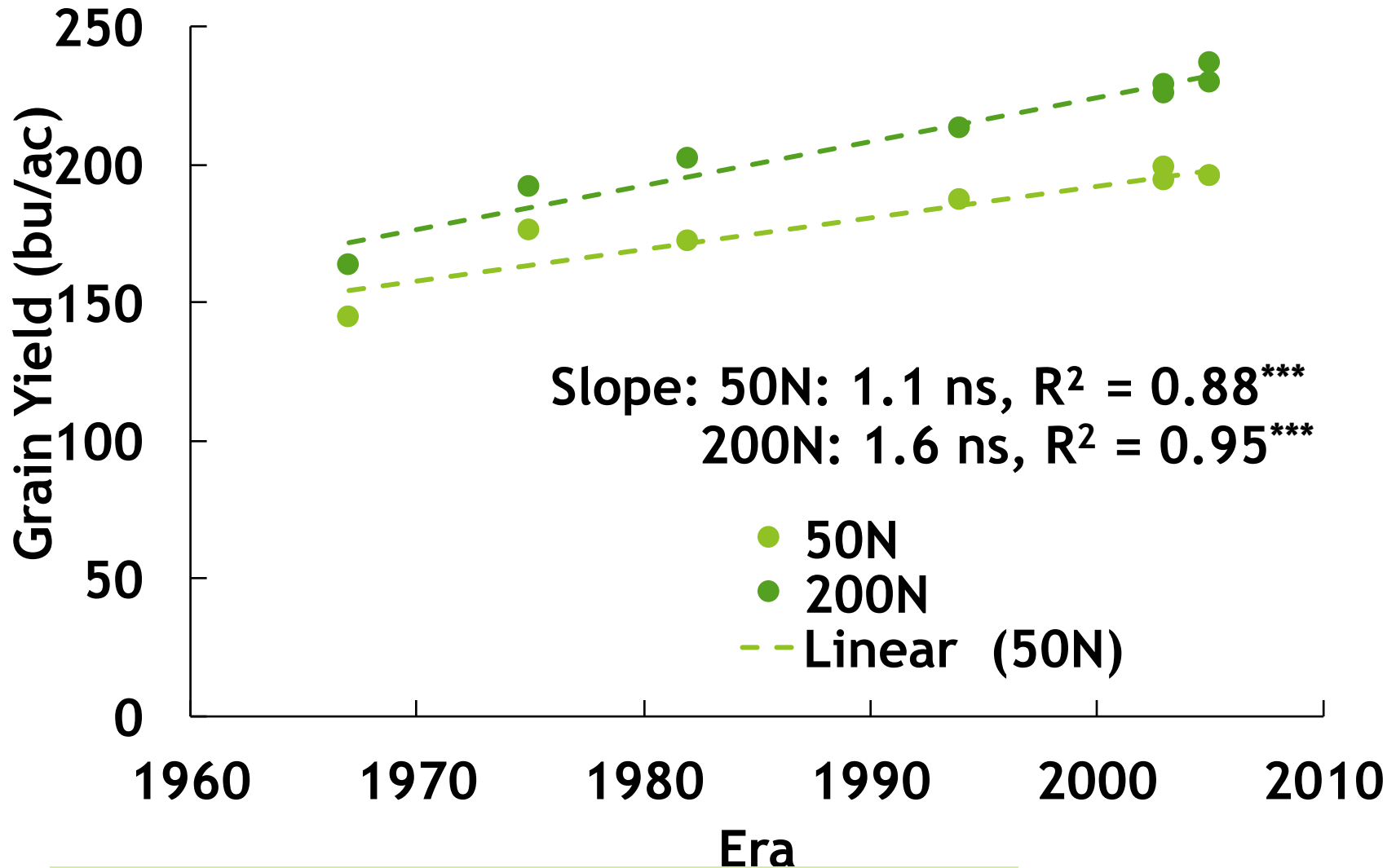


**Study of Dekalb Hybrids from 1967 to 2005 and Their  
Response Changes to Nitrogen and Plant Density Management  
(2012-2014)**



**Photo: ACRE, 2014**

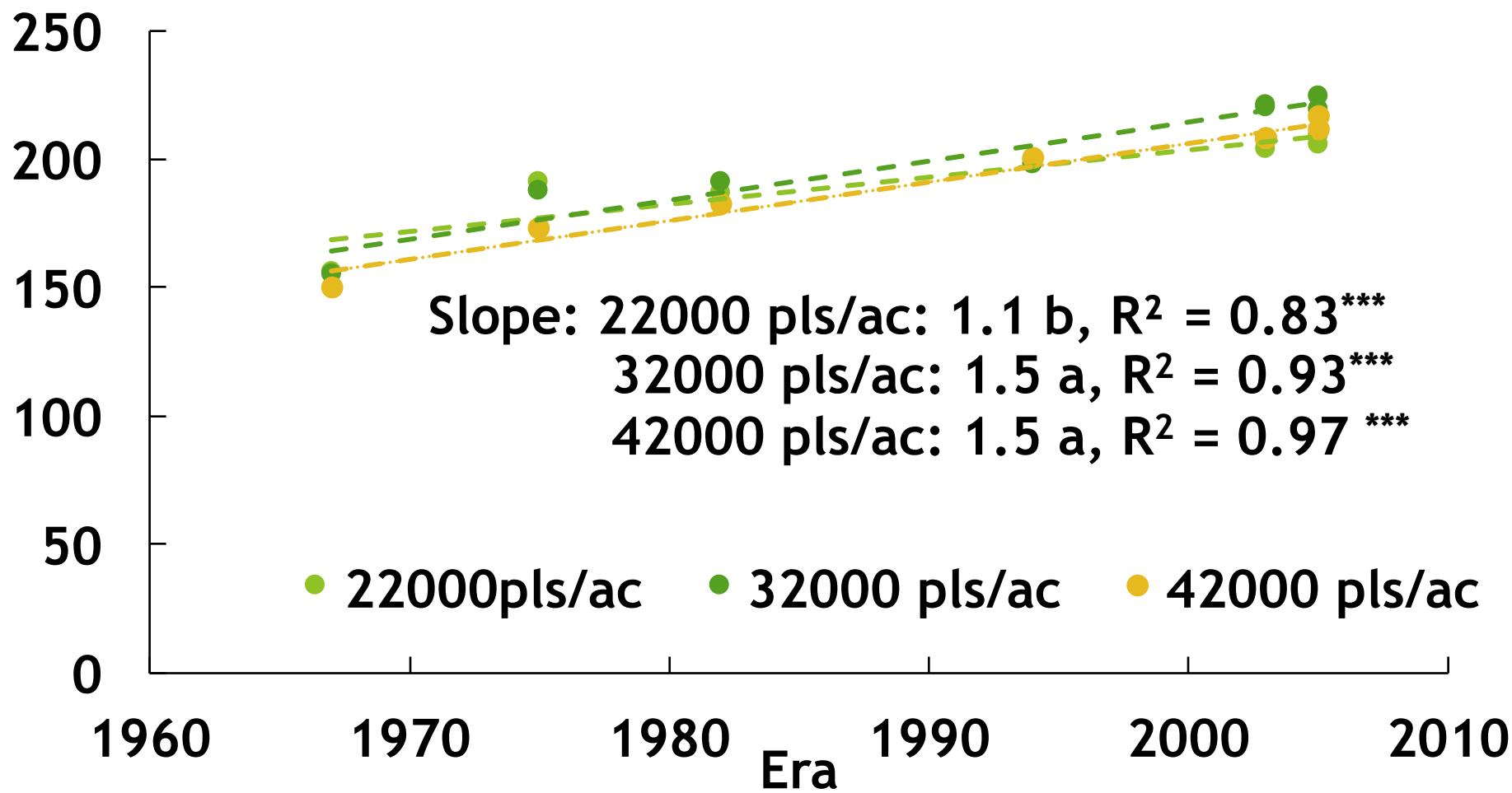
# West Lafayette, IN, N rate effect on Dekalb hybrid yield gains with year of commercial release (2013-2014)



Source: Keru Chen et al., Field Crops Research, 2016



# West Lafayette, IN, density effect on grain yield response to Dekalb hybrid era (2013-2014)



Source: Keru Chen et al., Field Crops Research, 2016

# Effects of two “modern” hybrids (2005) versus a common older hybrid (1975) on corn grain yield, total N uptake, and post-flowering stage N uptake when N rate = 200 pounds N/acre

(mean of 3 plant populations from 22,000 to 42,000/acre and 3 site-years in NW + NC Indiana in 2012-2013).

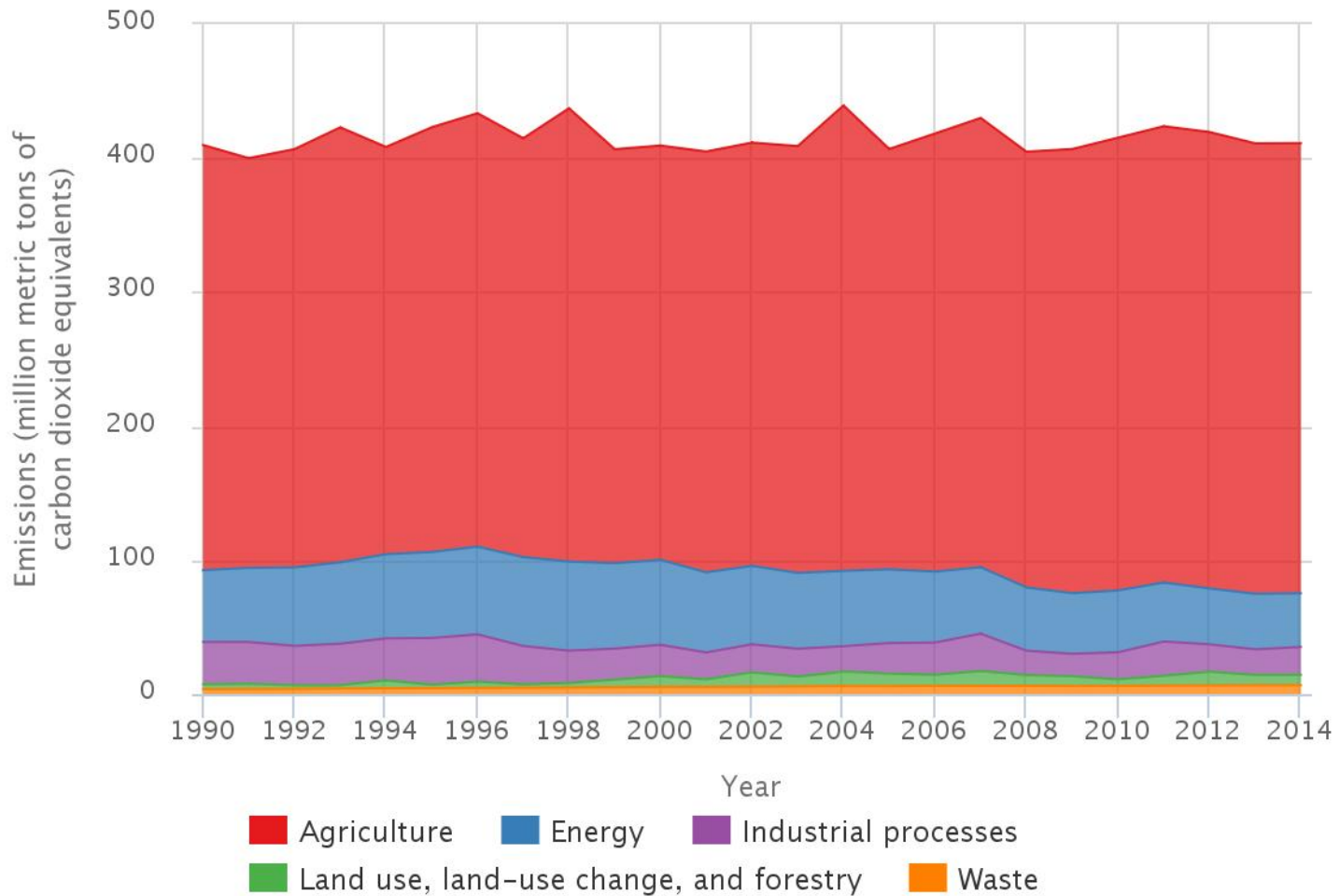
Data Source: K. Chen (Ph.D. Student) & T.J. Vyn

Hybrid (commercial release year)	Grain Yield (bushels/acre)	Total Plant N Uptake (pounds/ac)	Post-silk Plant N Uptake (% of final total uptake)
DKC61-69VT3 (2005)	226	240	37
DKC61-72RR (2005)	225	244	38
DKC XL72AA (1975)	189	203	30



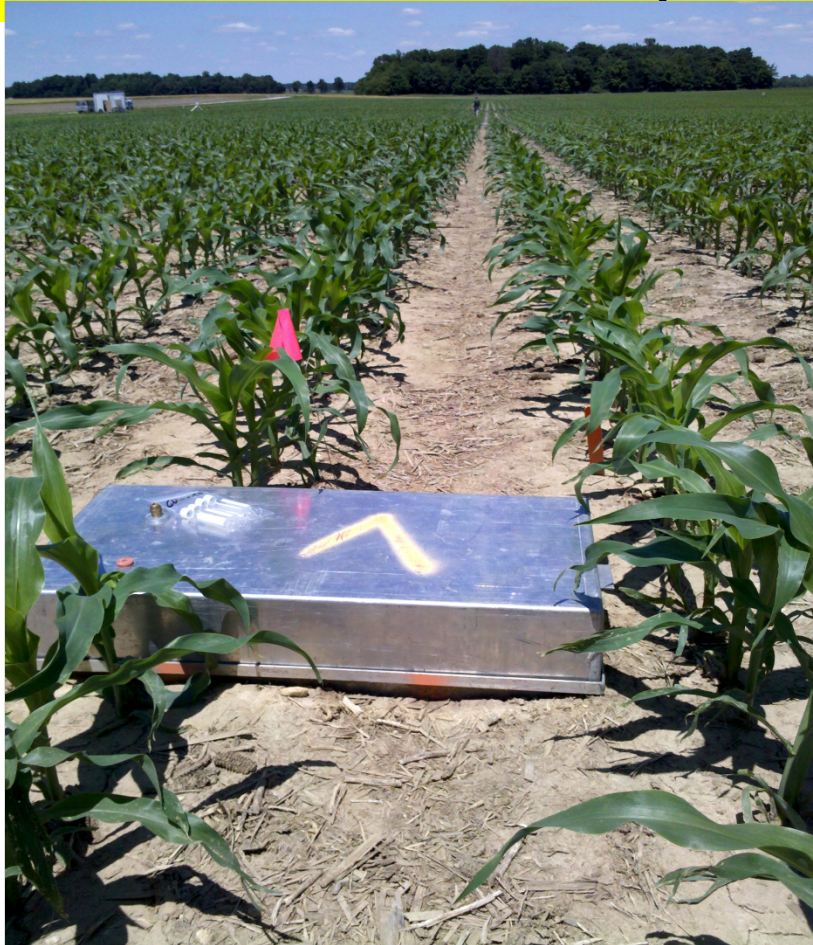


# U.S. Emissions of Nitrous Oxide by Inventory Sector, 1990-2014

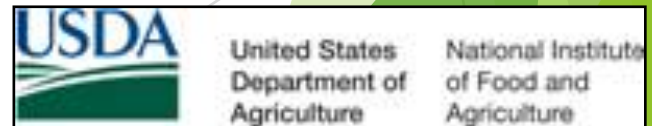


Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014.  
<http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html>

# Sidedress UAN and Instinct™ Application (2010-2016)



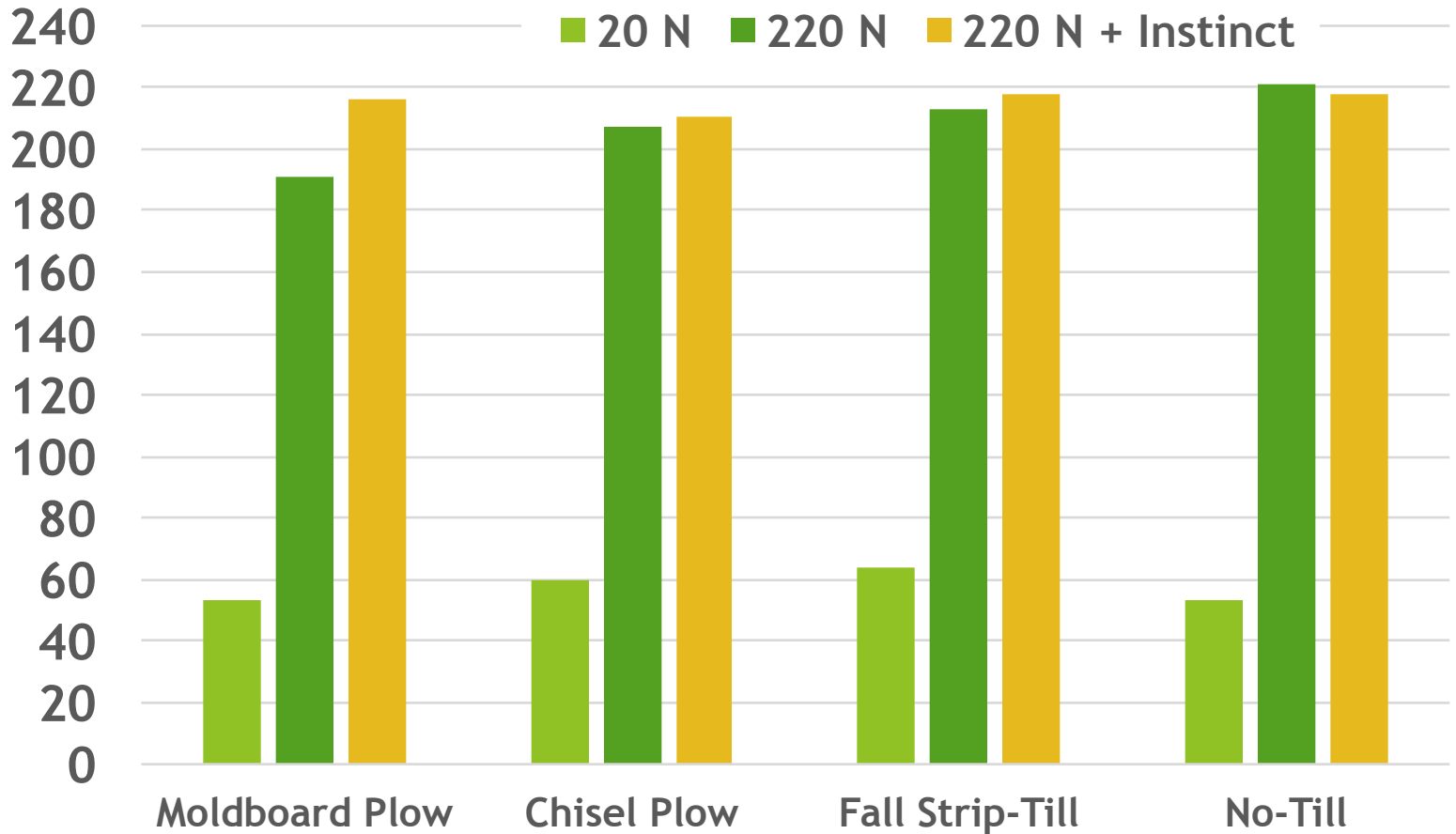
Dow AgroSciences





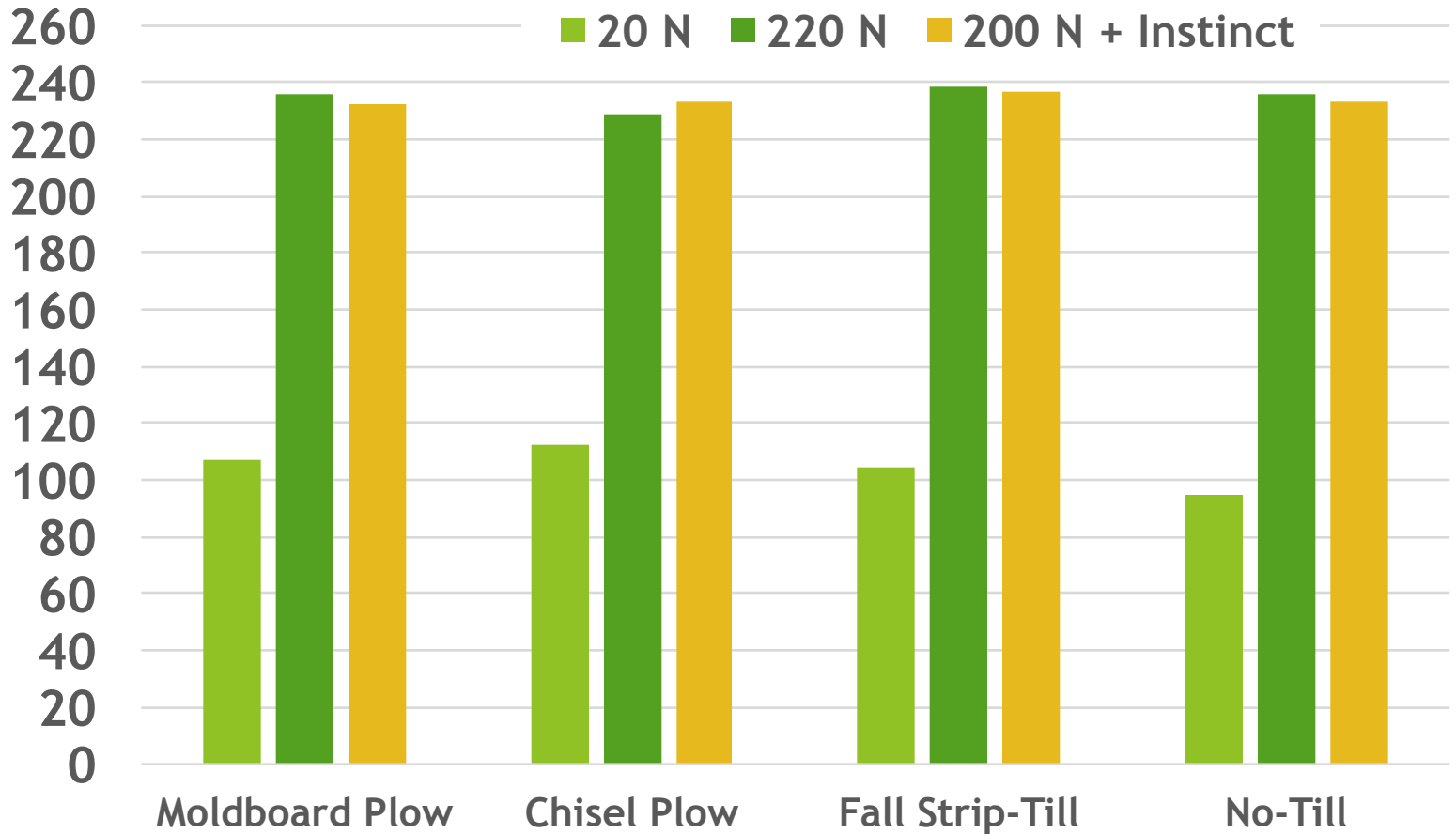
# 2015 Corn Yield Response to N Rate and Nitrification Inhibitor in 42<sup>nd</sup> Year of Tillage Systems for a Corn-soybean Rotation (West Lafayette, IN)

Corn Yield  
(bu/acre)

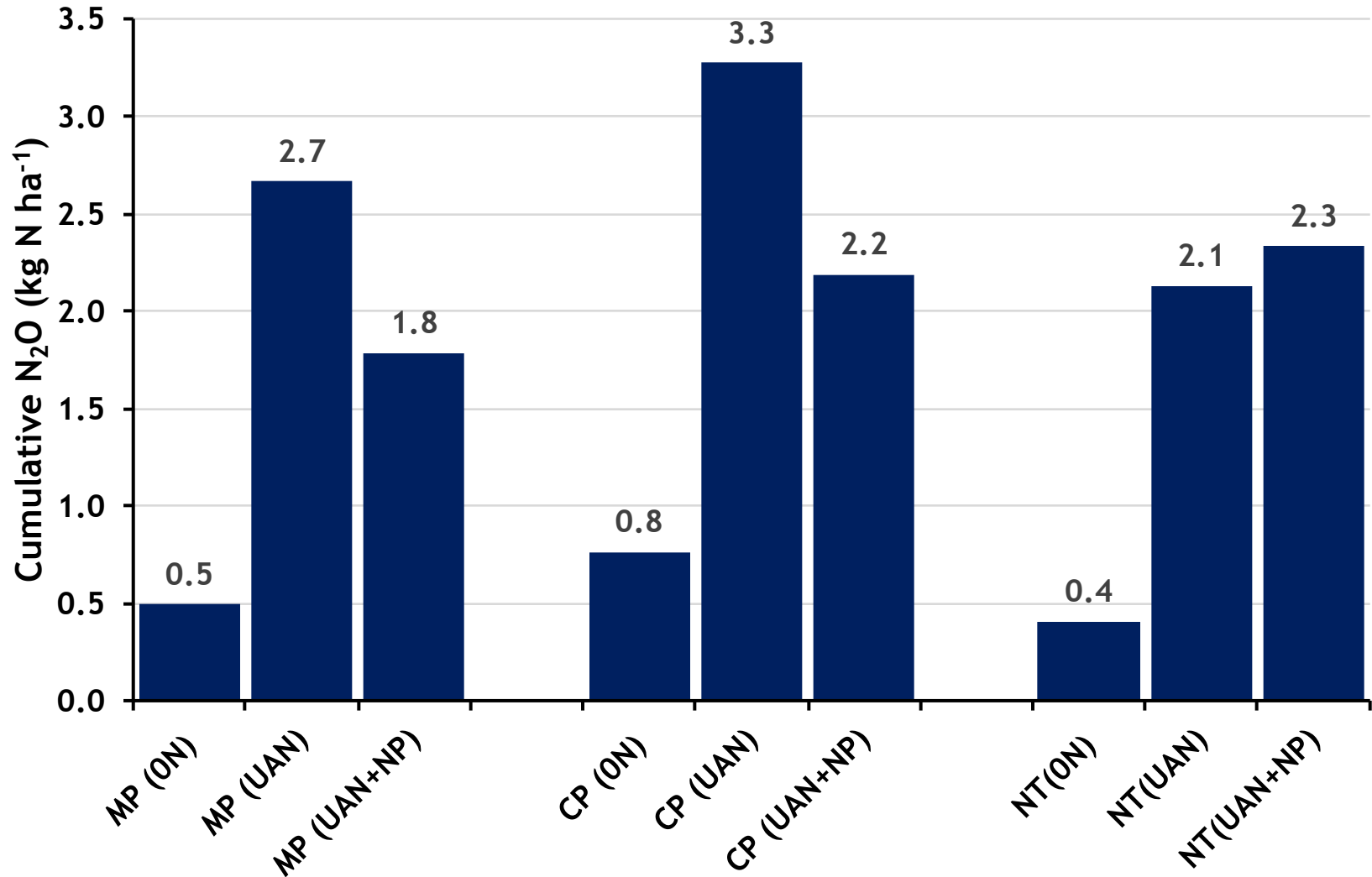


# 2016 Corn Yield Response to N Rate and Nitrification Inhibitor in 43<sup>rd</sup> Year of Tillage Systems for a Corn-soybean Rotation (West Lafayette, IN)

Corn Yield  
(bu/acre)

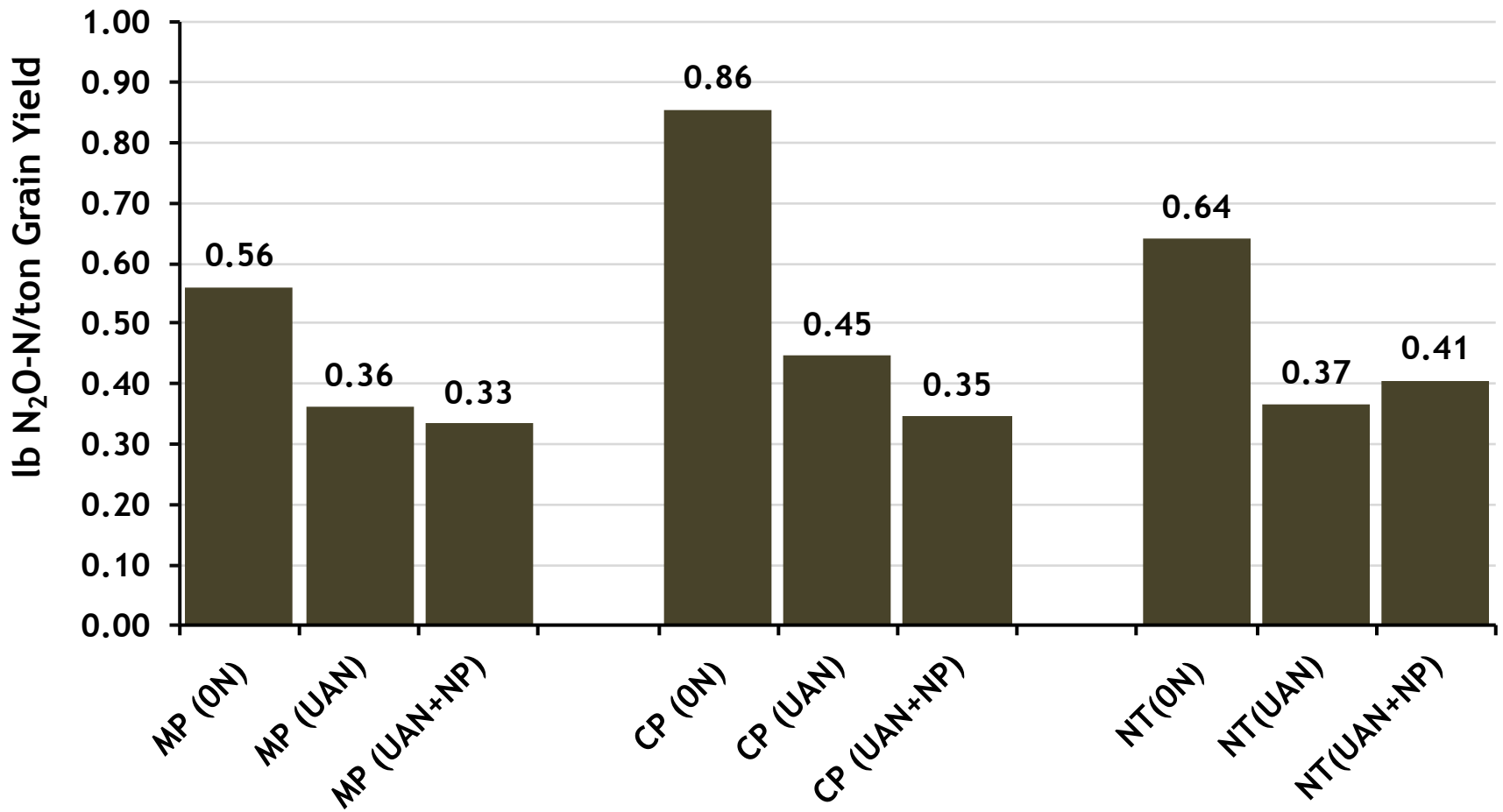


## Seasonal Cumulative N<sub>2</sub>O Under Long-term Tillage Systems at ACRE, West Lafayette (2016).





**Nitrous Oxide Emission Relative to Corn Grain (Yield-Scaled  $N_2O$ ) Under Long-term Tillage Systems at ACRE, West Lafayette (Average of 2015 & 2016).**



Source: Omonode and Vyn, 2016, unpublished

# What About Late-Season N?





**Are there greater yield and economic benefits from “late” nutrient applications with modern hybrids and higher plant densities?**





# **“Rescue N” versus “Late-Split N”**

- **Rescue N means adding more N fertilizer after the entire N rate has already been applied because of excessive N loss**



- **Late-split N means intentionally delaying application of the last 20-30% of total N until after the V10 stage, but usually before R1 stage. It may be variable rate applied.**

# Late-Split N Applications with Older versus “Modern” Pioneer Hybrids (2014-2016)



# Methodology

Main Treatment: N rates

Treat. Name	Lbs N V3-V4	Lbs N V12-V14
0	0	
140	140	
180	180	
220	220	
180S	140	40
220S	180	40

Sub-Treatment:  
Hybrid (Release year)

1. Pioneer 3394 (1991)
2. Pioneer 3335 (1995)
3. Pioneer 1498 HR (2012)
4. Pioneer 1360 HR (2014)

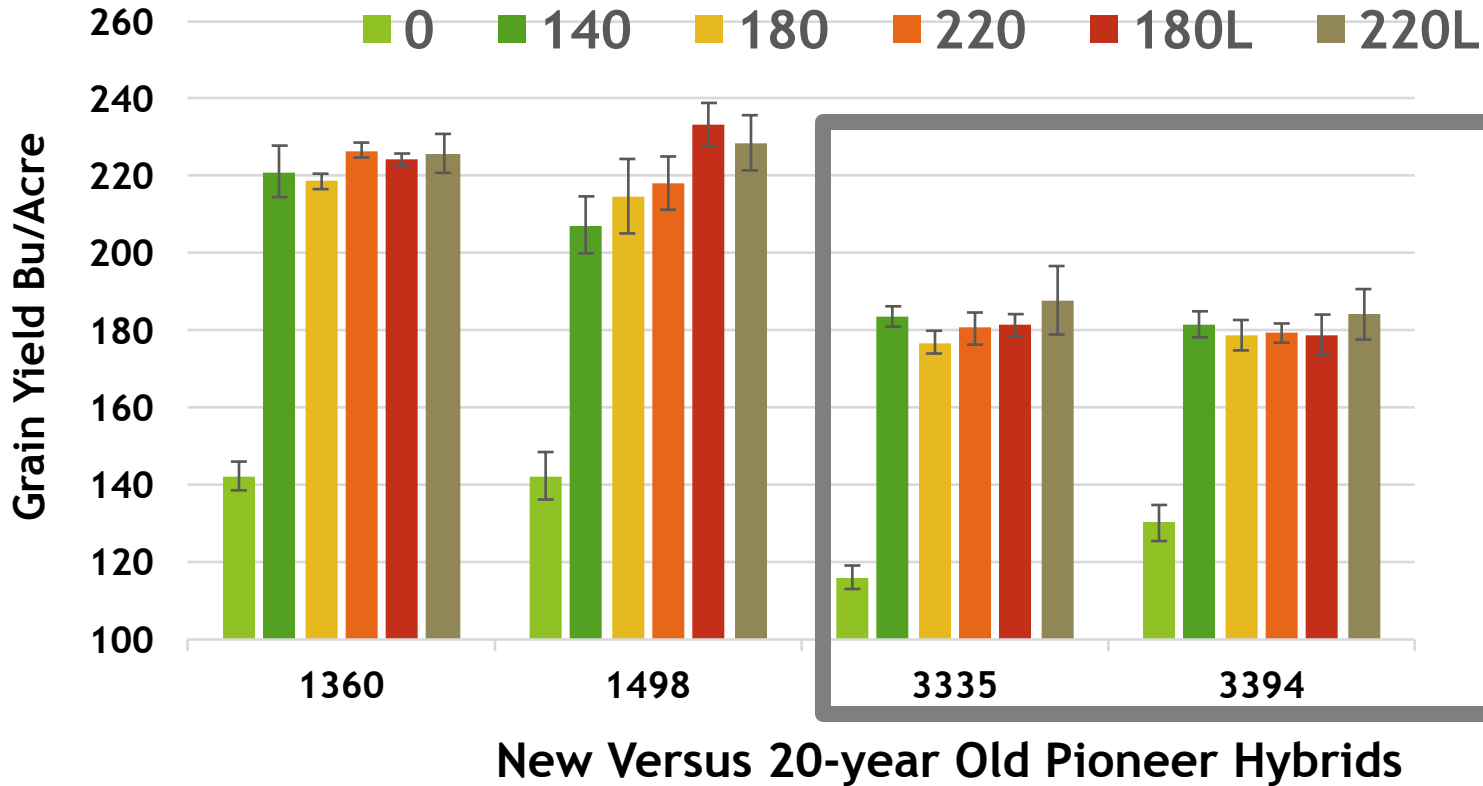






# Corn Yield Response to N Rate and Late-Split N in 2014 (Wanatah, IN)

Grain Yield Response to N Rate and Late-split N



32,500 plants/acre



# N Rate and Timing effects on Earshoot Growth, N Concentrations and N Uptake During the Critical Period

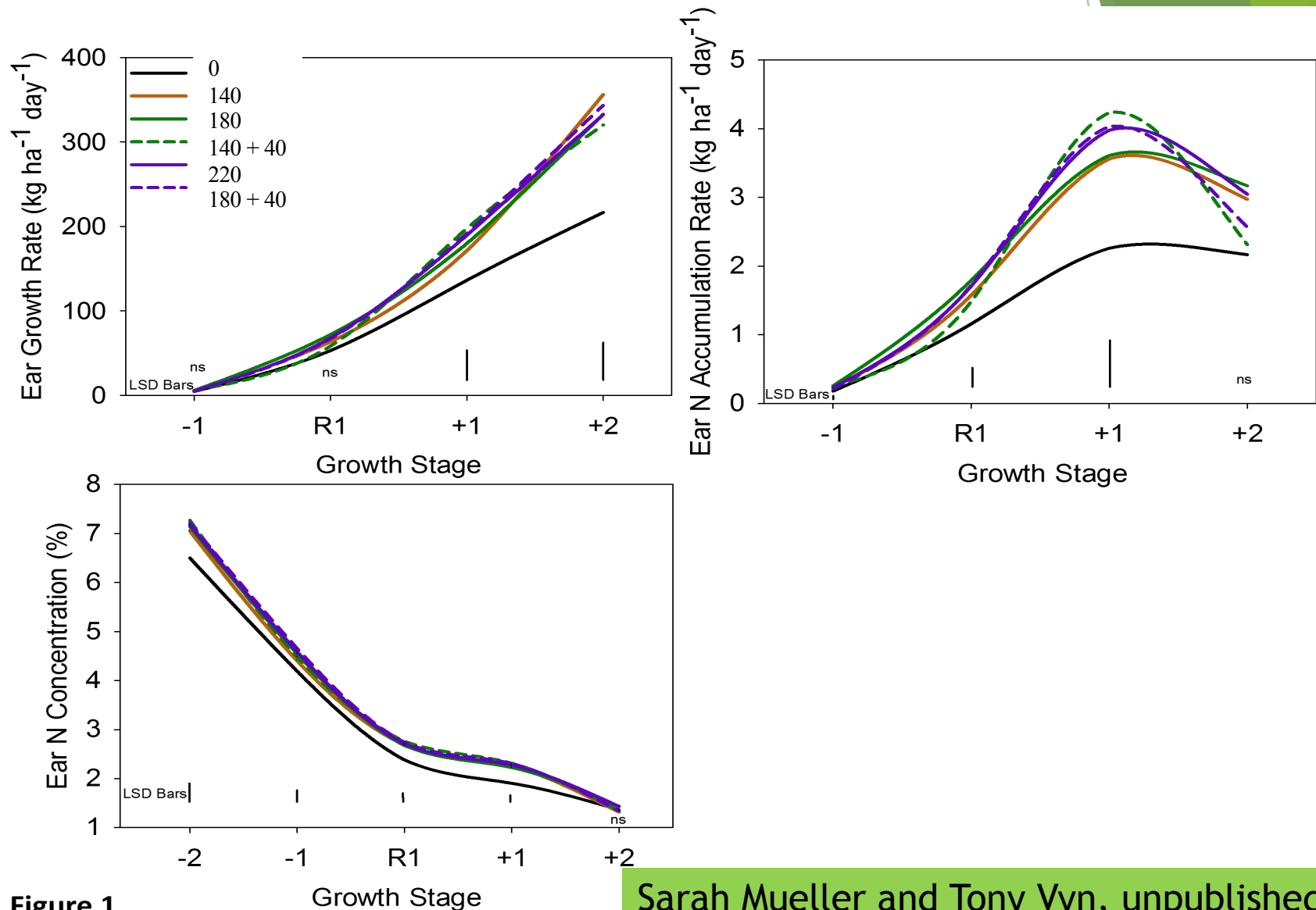


Figure 1

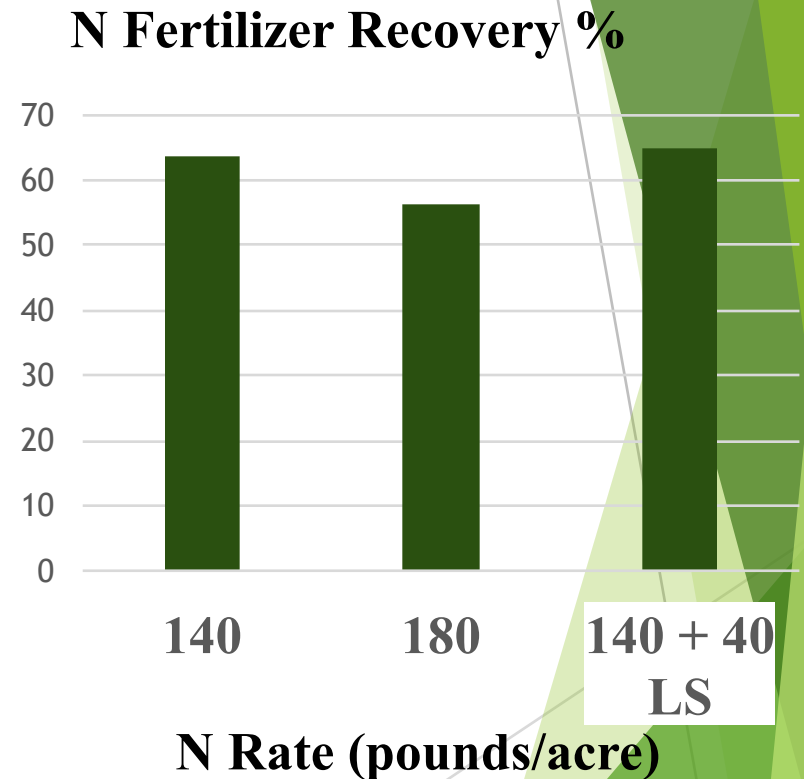
(a) Change in earshoot growth rate (b) change in

Sarah Mueller and Tony Vyn, unpublished





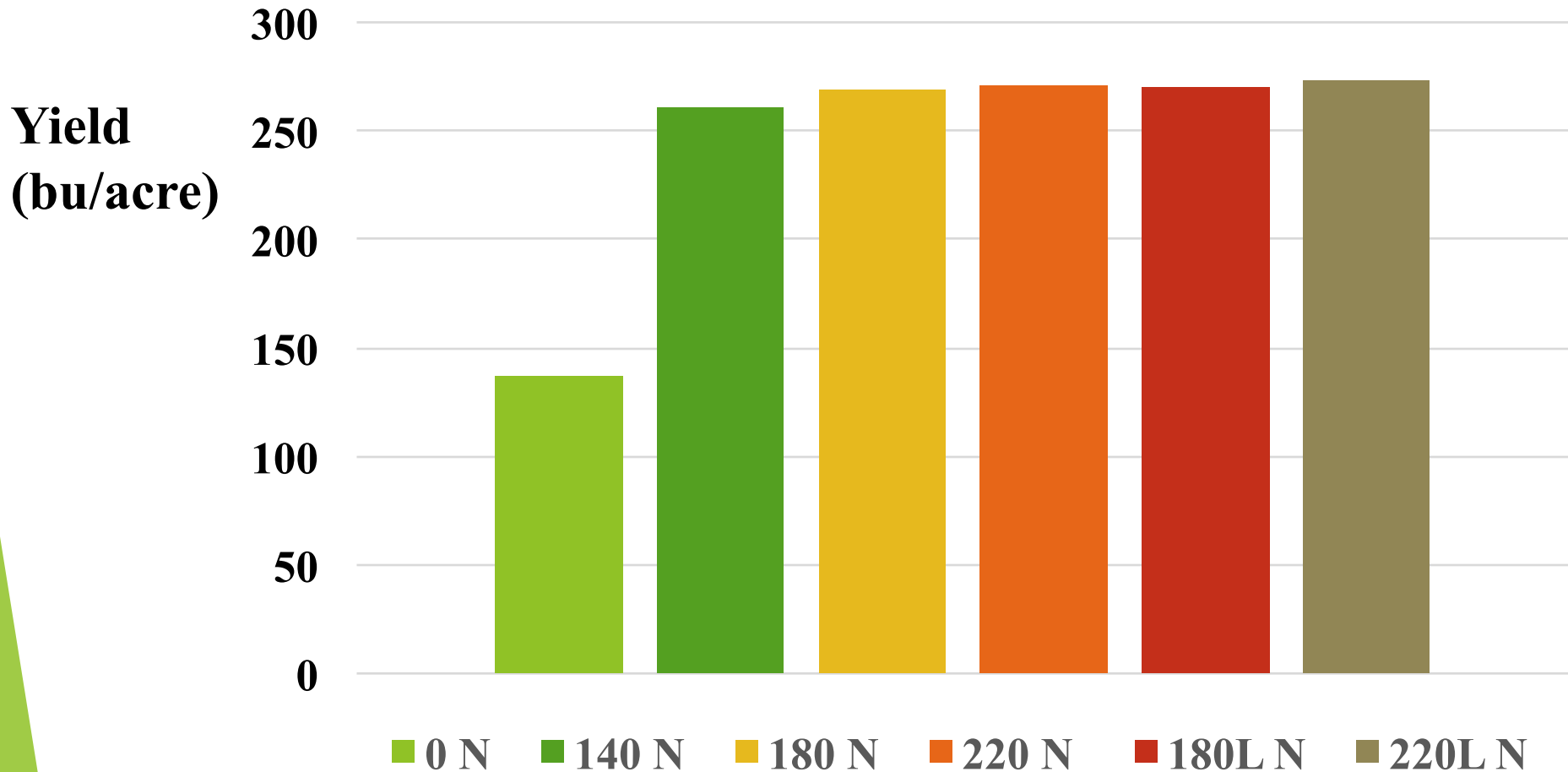
# Preliminary Corn Yield and N Uptake Responses to Late-Split N in 2014-2015



S.M. Brooks and T. J. Vyn, 2014, unpublished  
1 hybrid (P1498), 1 location

S.M. Brooks and T. J. Vyn, 2016, unpublished  
Average of 4 hybrids

# “Late-split N” Response with Pioneer 1360 in 2015



# Hybrid Recovery of Late-Season N Applications?

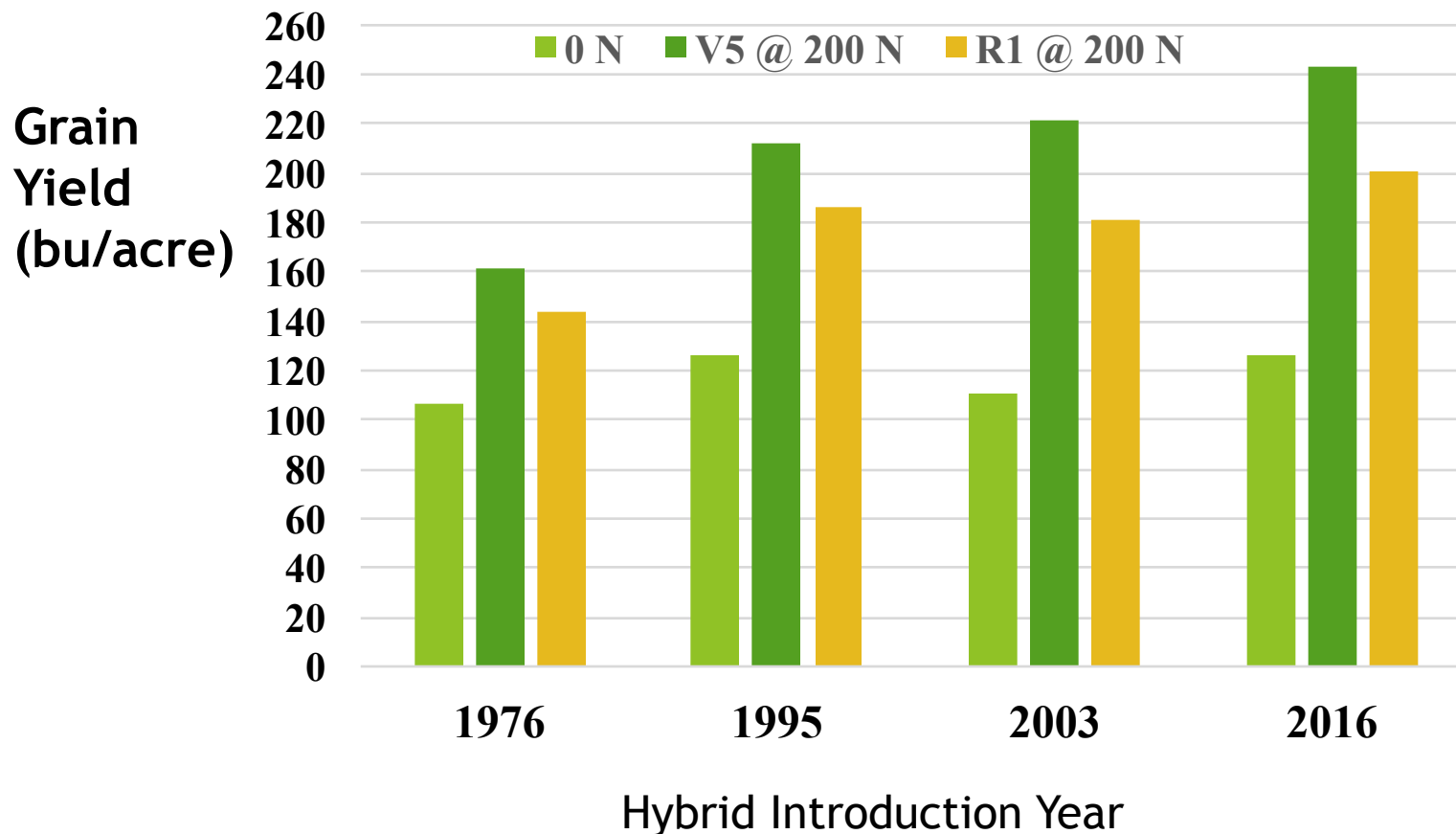


**PIONEER**<sup>®</sup>  
A DUPONT COMPANY





# Pioneer Hybrid Yield Resiliency in Response to UAN applied at the R1 stage versus the V5 stage (West Lafayette, 2016)



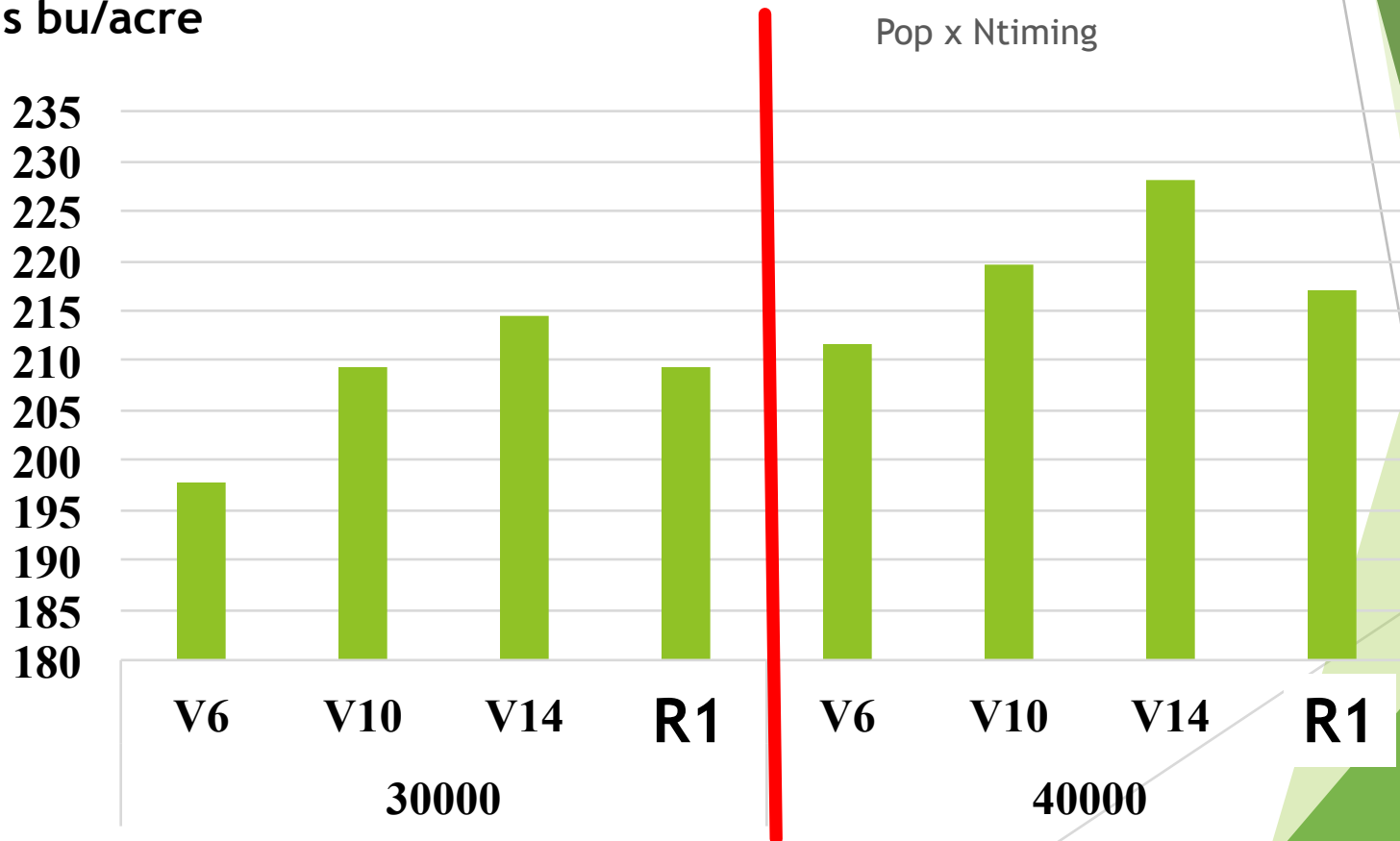
Source: Mueller and Vyn, unpublished, 2016

# Fertigation N Opportunities?



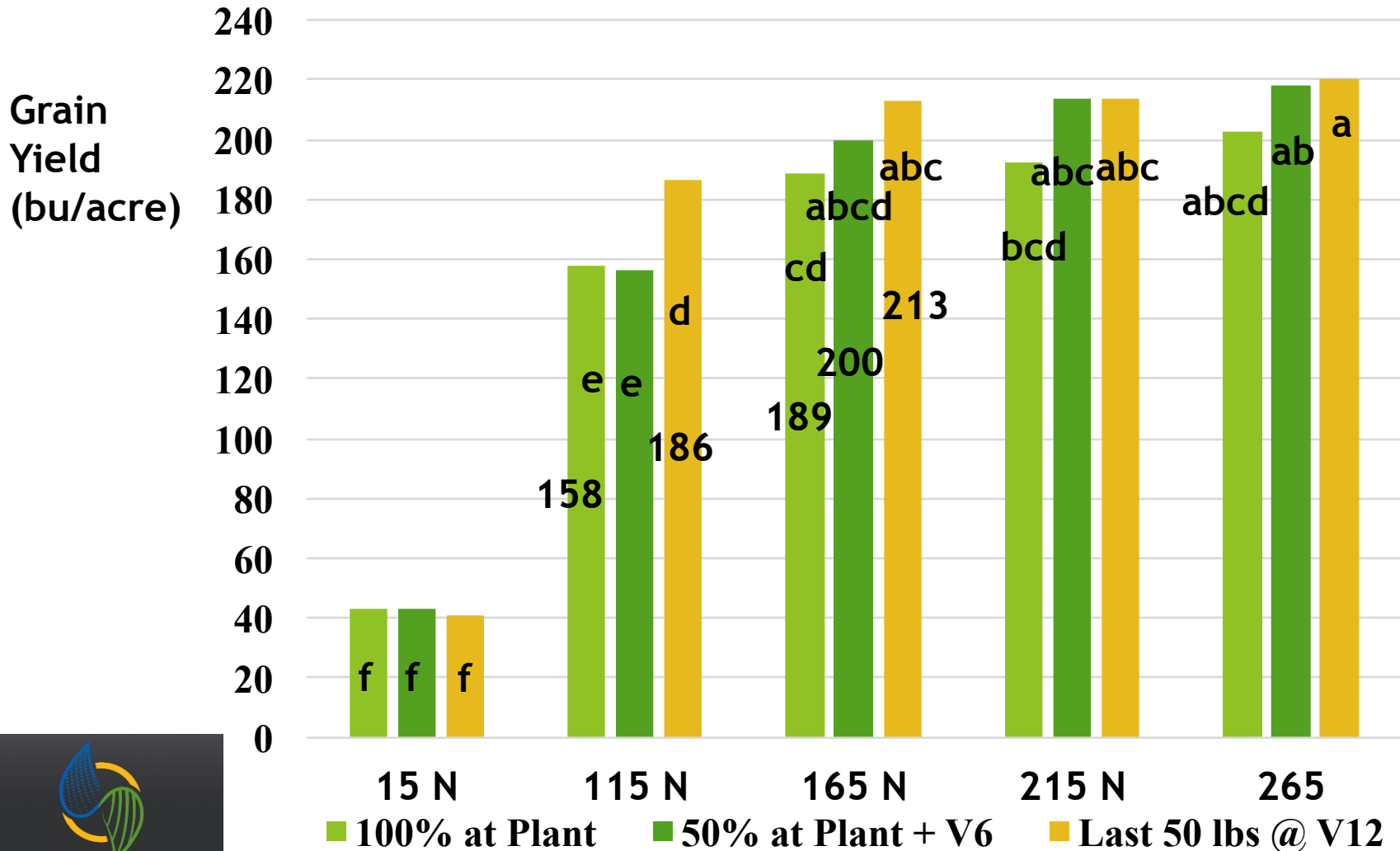
# Timing of last N application (50 pounds/acre) in Irrigated Corn (mean of P1498 and P1360 at 2 populations in 2015)

Yields bu/acre

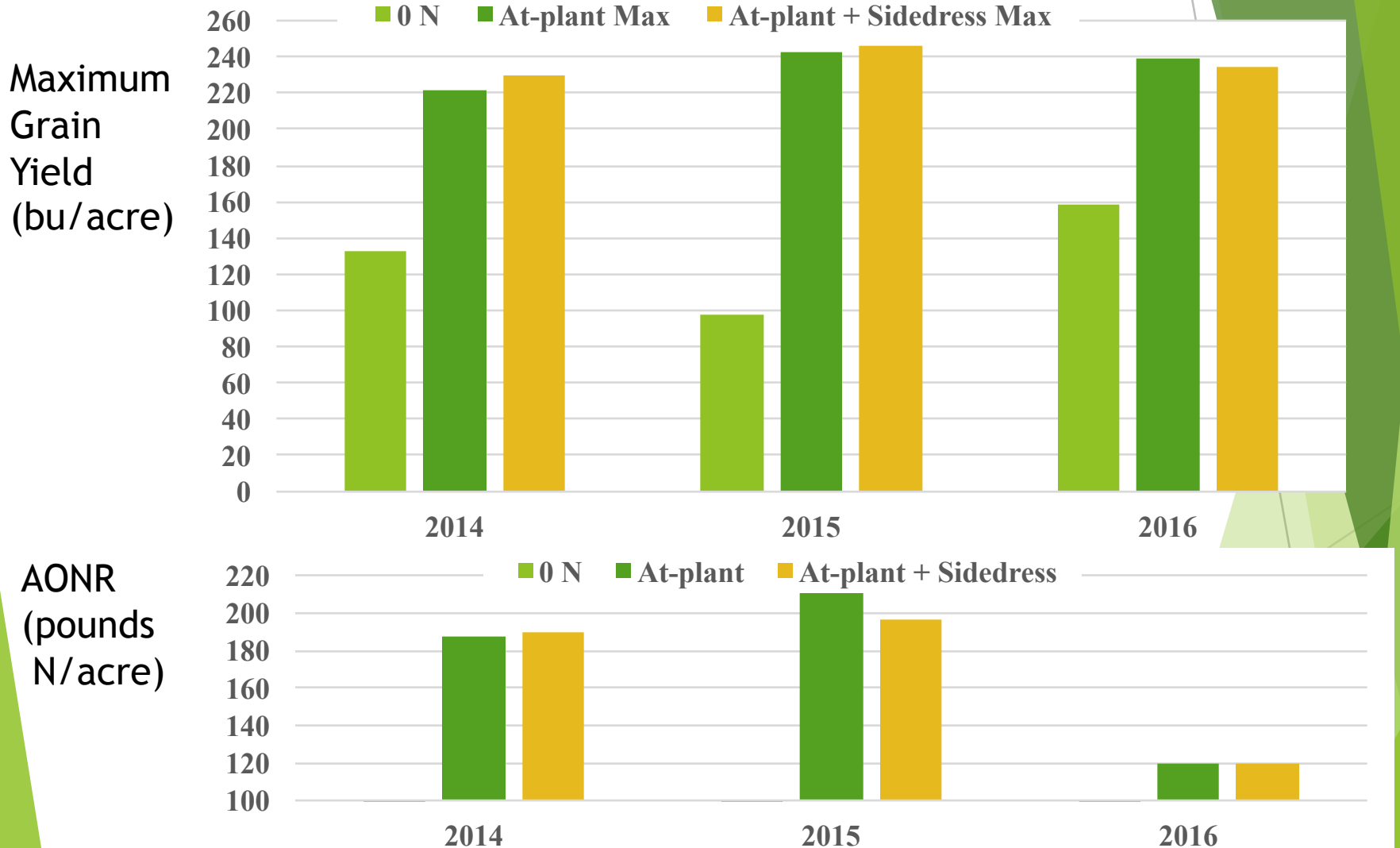




# Nitrogen Timing in Continuous Corn on Irrigated Sandy Soil (LaCrosse, IN) with DKC66-42 in 2016



**Pioneer Study Results from Dr. J. Camberato and Matt Schafer  
for Wanatah, IN, sandy soils; 2014-2015 (P0987) and 2016 (P1197)  
with 8 N rates from 0 to 280 pounds of N as NH<sub>4</sub>NO<sub>3</sub> and  
either 100% applied at-plant or 50% at-plant plus 50% at V9-10.**



# **In-season Soil Sampling for NO<sub>3</sub> and NH<sub>4</sub> after banded N applications virtually impossible!**

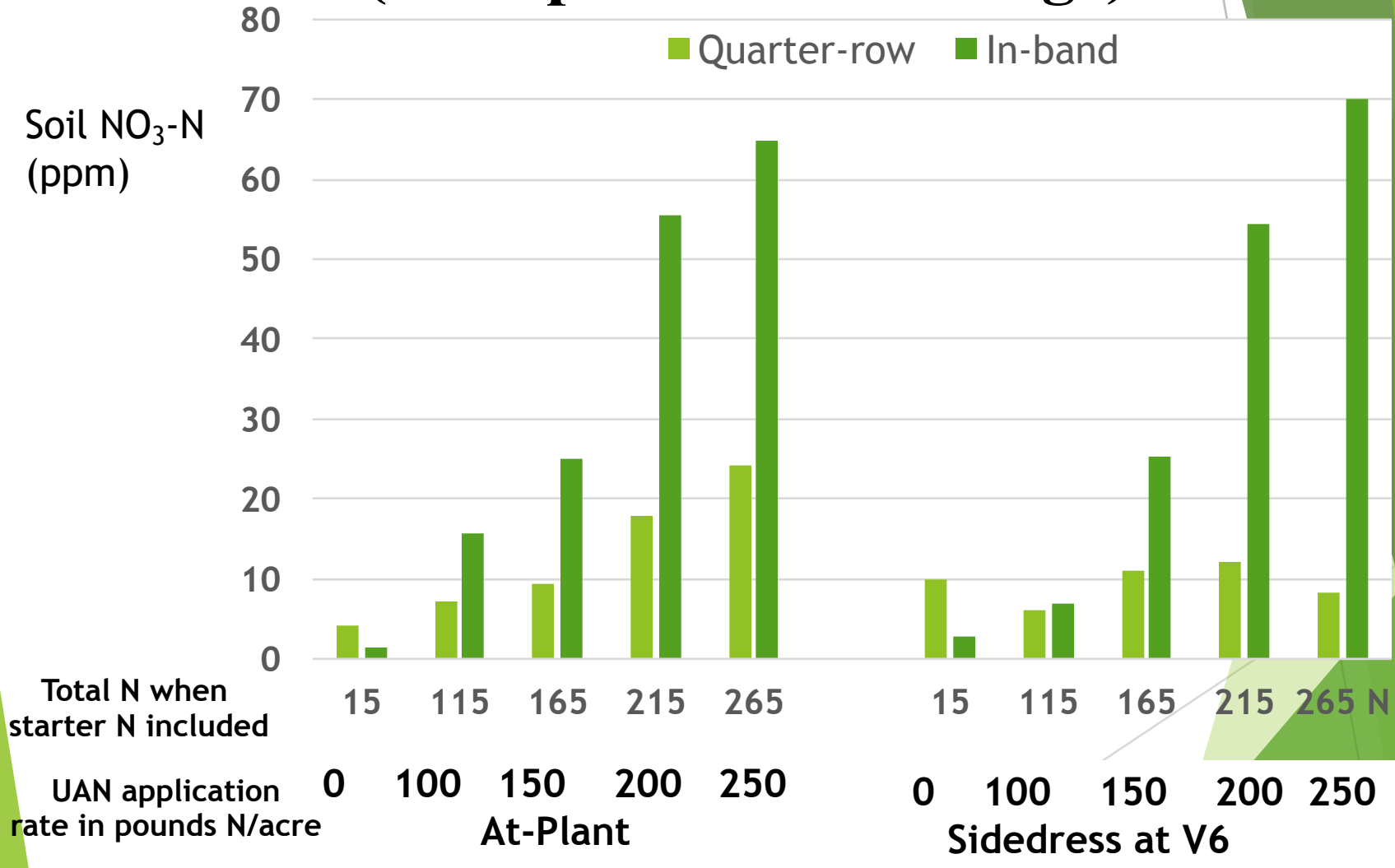
## **Recommended Sampling Positions (Depths of 0-12” plus 12-24”):**

- 1. Iowa State (1997) A. Blackmer and R. Voss. PM-1714**  
24 cores per composite sample drawn from 8 positions from the center of row in 1/8<sup>th</sup> width increments until you get to 7/8 of the distance between any 2 corn rows.
- 2. Illinois N Watch: sampling using a board with 11 holes across a single interrow, and then replicated for different field positions (Dan Schaefer’s presentation on 12-13-16).**
- 3. Nitrogen Advisor (sampling in row and between rows, but always at least 6” from the N band).**

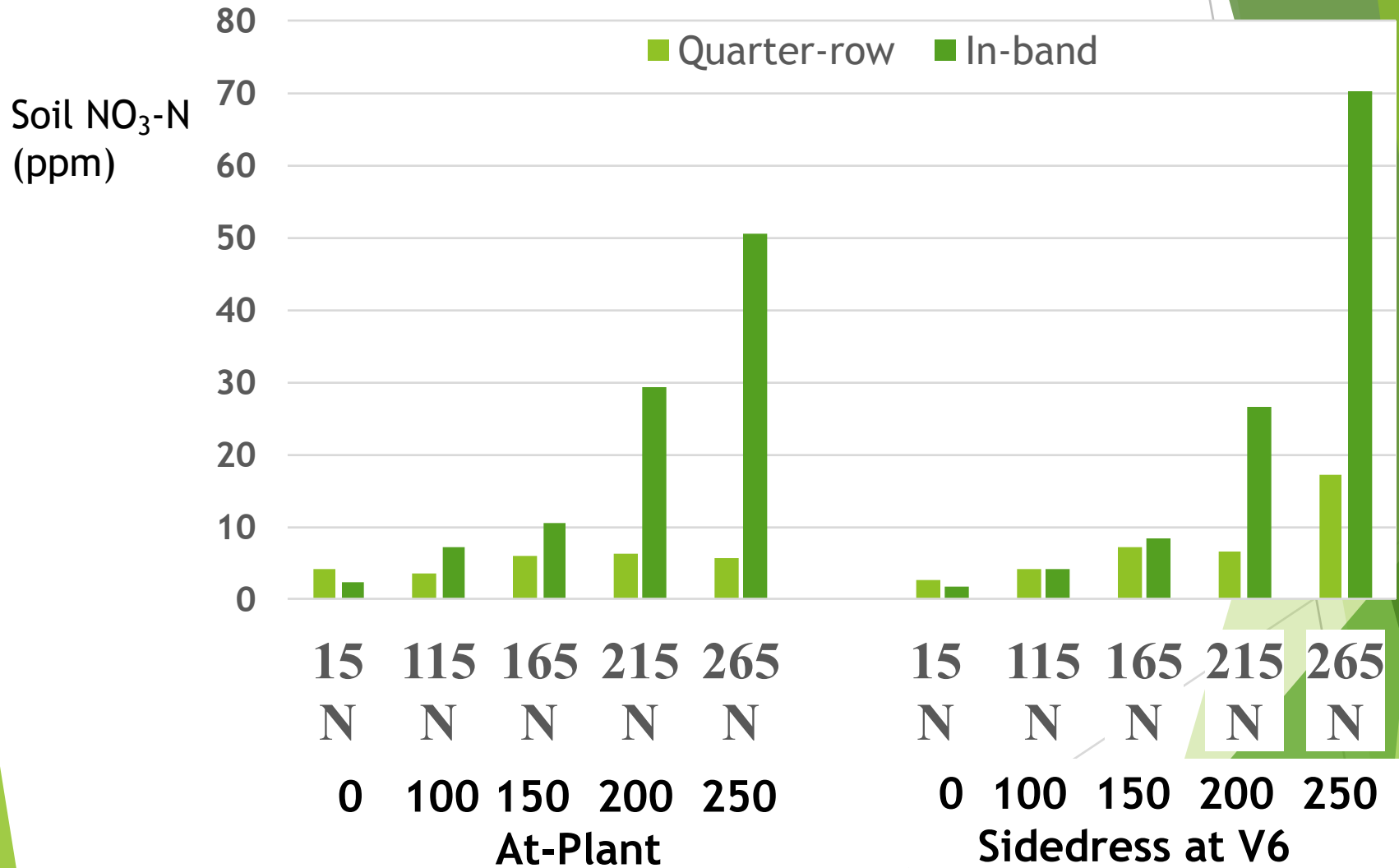


# In-season Soil Sampling for $\text{NO}_3$ and $\text{NH}_4$ after banded N applications virtually impossible!

(example from V12 stage)



# In-season Soil Sampling for $\text{NO}_3$ and $\text{NH}_4$ after banded N applications virtually impossible! (example from VT stage)



# On-farm Studies with Intentional Late-Season N applications of 30 to 50 pounds





# Conclusions

- **Modern hybrids take up more total N at the same N rates, and more post-silking than old hybrids, so there could be more yield and N efficiencies to gain with late-split N.**
- **The yield response to late-split N isn't consistent; it varies with hybrid (and sometimes by year/environment for the same hybrid), but is more likely to be positive at low to moderate total N rates, and may be more positive in continuous corn, low soil OM, and in irrigated environments.**
- **Late-split N may not change earshoot N much during the critical period, but may have more impact on functional stay-green during grain fill.**
- **Determination of the N rate still needed for late-split N is complicated (soil vs. plant based?).**
- **We need more research focus on plant nutrient availability in soil to late season corn growth (nutrient rate, efficiencies, timing, ...).**

# Acknowledgments

## Funding:

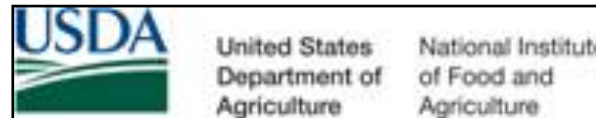
**Indiana Corn Marketing Council**  
**Dupont-Pioneer**  
**Dow AgroSciences (2009- )**  
**4R Nutrient Stewardship**  
**The Mosaic Company**  
**Monsanto Company**



MONSANTO



Research  
Fund



## Equipment:

**John Deere Cropping Systems Unit**



## Seed:

Pioneer Hi-Bred, Int'l.  
Monsanto  
Dow AgroSciences





Questions?