Corn Nitrogen Rate Calculator

Impact of Nitrogen Application Timing on Corn Production

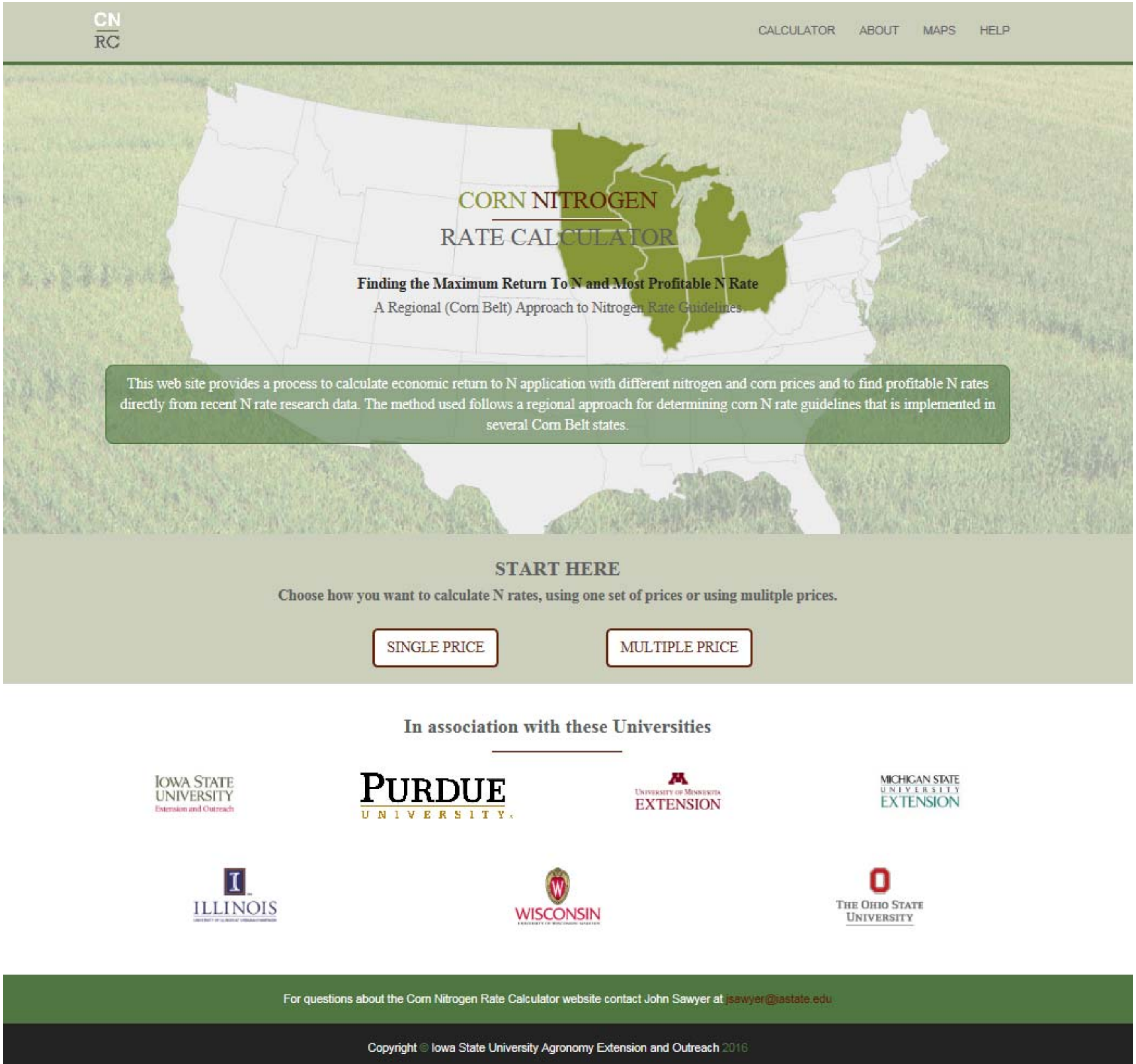
John E. Sawyer

Daniel W. Barker

John P. Lundvall

Department of Agronomy

Iowa State University



IOWA STATE UNIVERSITY
Extension and Outreach

http://cnrc.agron.iastate.edu/

Corn Nitrogen Rate Calculator
Main Iowa Area

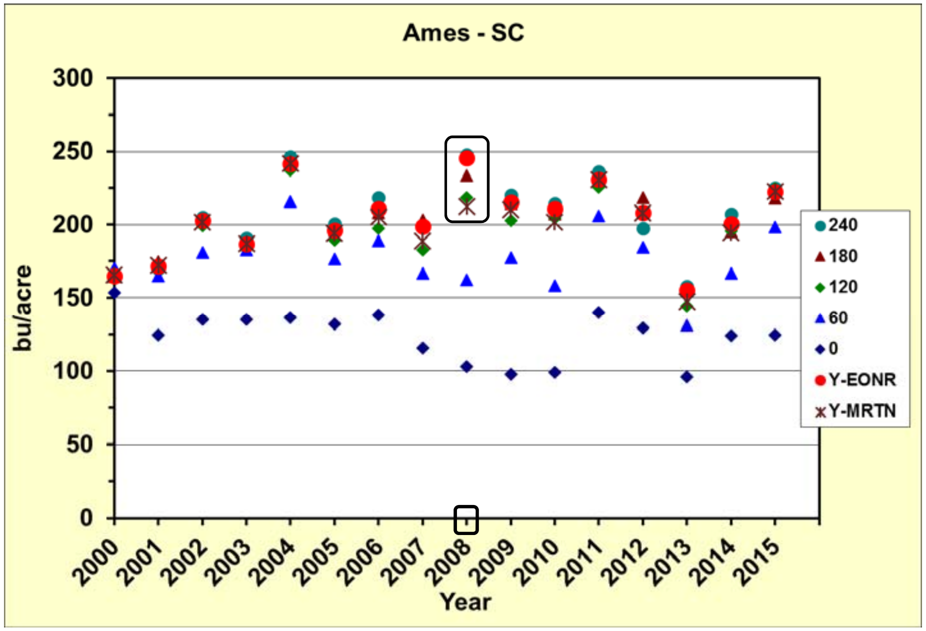
Rates and Charts

State: Iowa
Region: Main
Number of sites: 204
Rotation: Corn Following Soybean

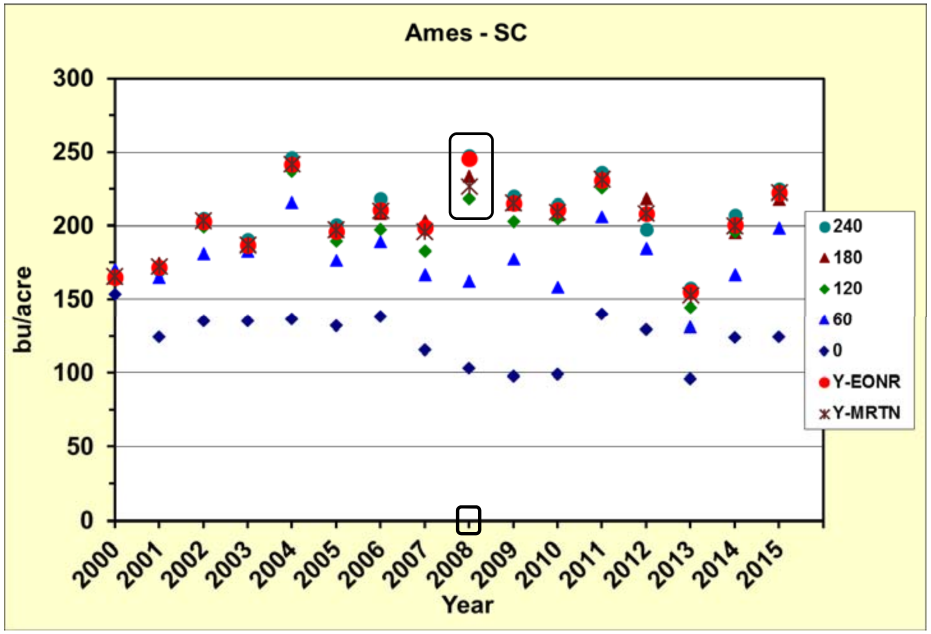
Nitrogen Price ($/lb):	0.35
Corn Price ($/bu):	3.50
Price Ratio:	0.10
MRTN Rate (lb N/acre):	134
Profitable N Rate Range (lb N/acre):	121 - 148
Net Return to N at MRTN Rate ($/acre):	$174.47
Percent of Maximum Yield at MRTN Rate:	99%
Anhydrous Ammonia (82% N) at MRTN Rate (lb product/acre):	163
Anhydrous Ammonia (82% N) Cost at MRTN Rate ($/acre):	$46.90

Comparison of Low and Upper End of Profitable N Rate Range

Ames (Clarion Loam) SC (2000-2015)



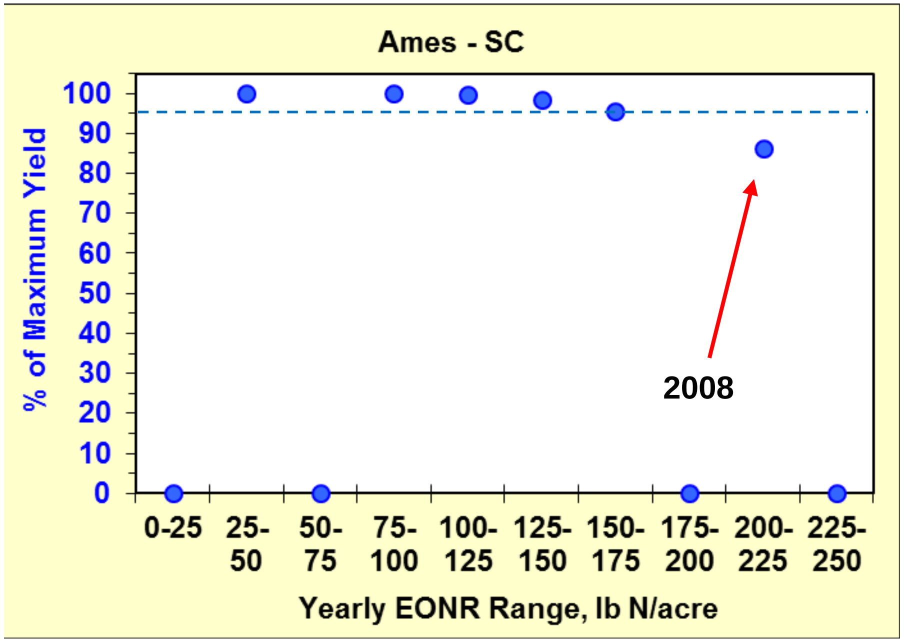
Using Low End of Profitable Range
121 lb N/acre MRTN Rate (0.10 price ratio)



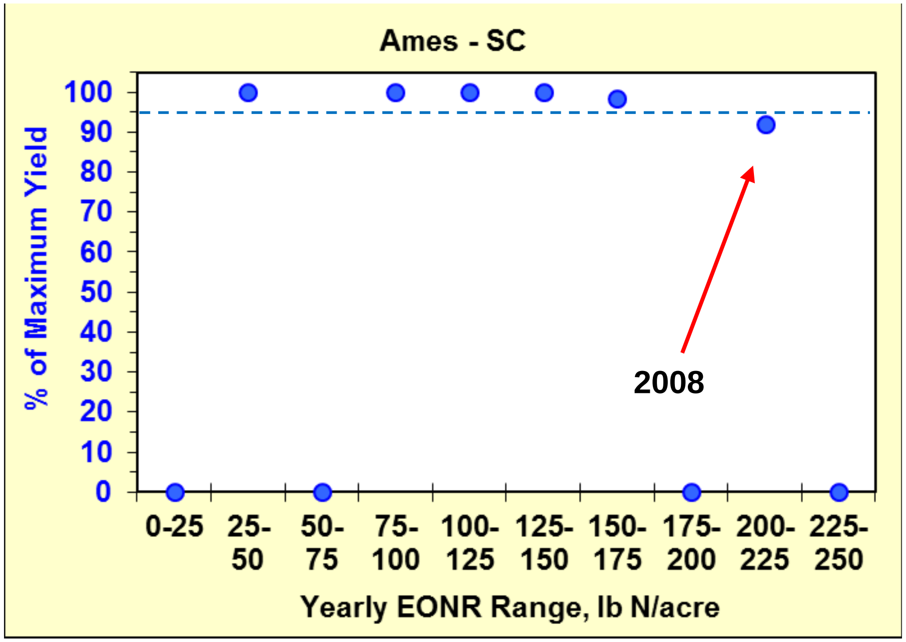
Using Upper End of Profitable Range
148 lb N/acre MRTN Rate (0.10 price ratio)

Comparison of Low and Upper End of Profitable N Rate Range

Ames (Clarion Loam) SC (2000-2015)

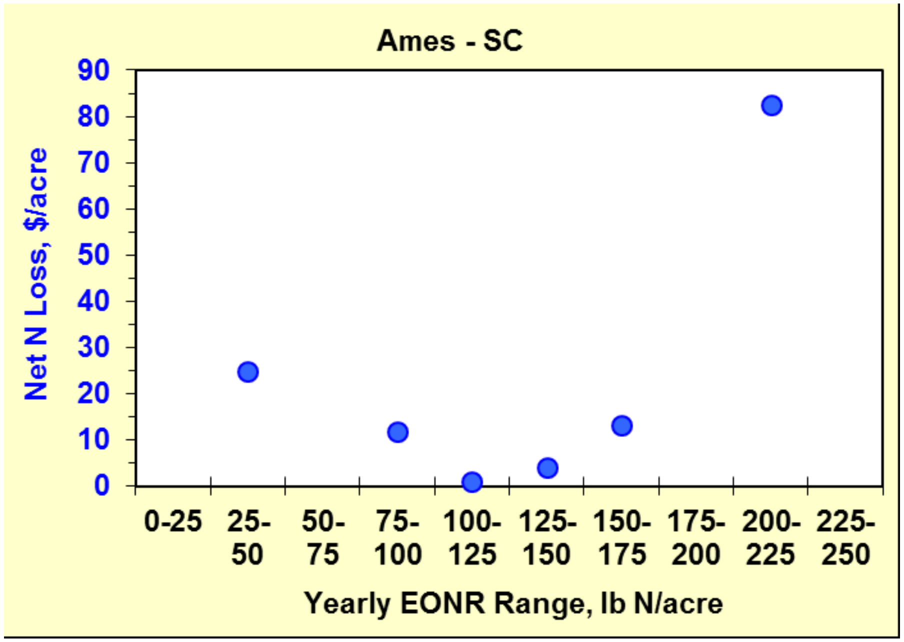


Using Low End of Profitable Range
121 lb N/acre (0.10 price ratio)
$0.35/lb N and $3.50/bu
Potential Increase if Yearly EONR: $13.33/acre

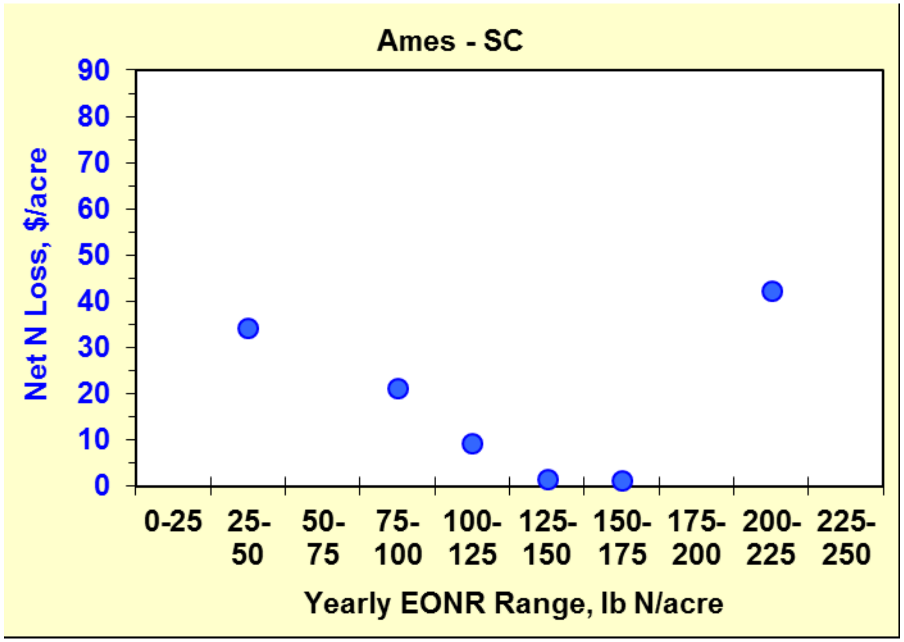


Using Upper End of Profitable Range
148 lb N/acre (0.10 price ratio)
$0.35/lb N and $3.50/bu
Potential Increase if Yearly EONR: $10.56/acre

Comparison of Low and Upper End of Profitable N Rate Range (and Dealing with Extremes)
Ames (Clarion Loam) SC (2000-2015)

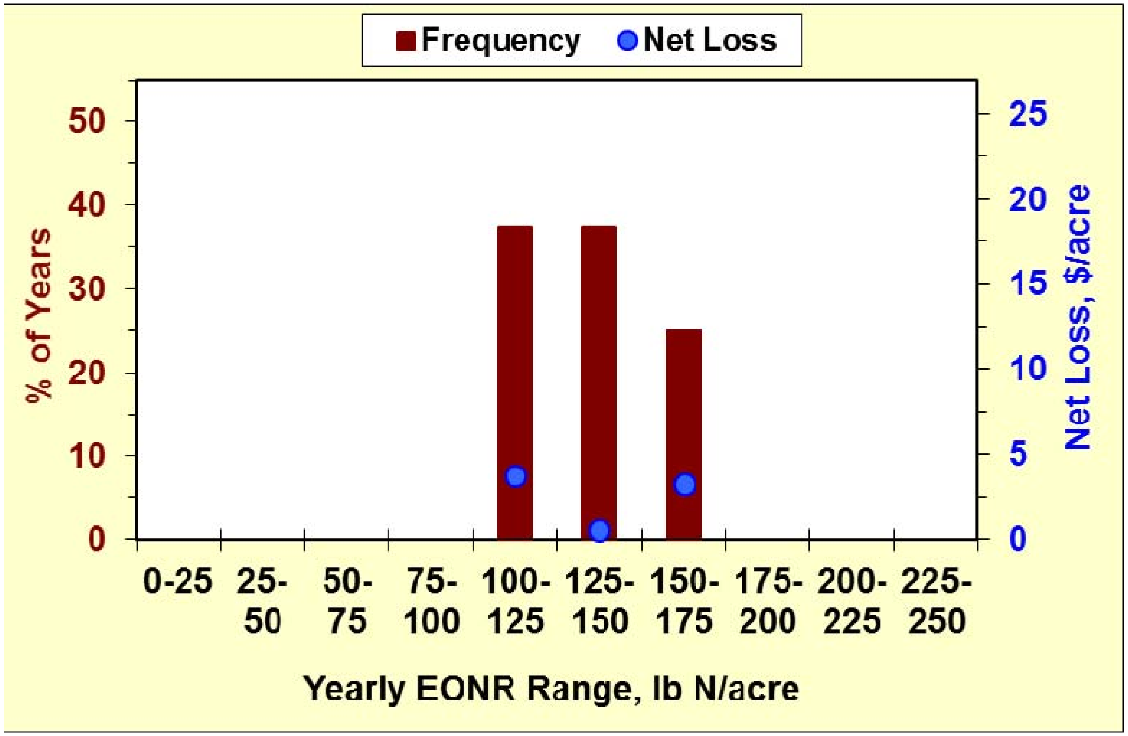


Using Low End of Profitable Range
121 lb N/acre (0.10 price ratio)
$0.35/lb N and $3.50/bu
Potential Increase if Yearly EONR: $13.33/acre



Using Upper End of Profitable Range
148 lb N/acre (0.10 price ratio)
$0.35/lb N and $3.50/bu
Potential Increase if Yearly EONR: $10.56/acre

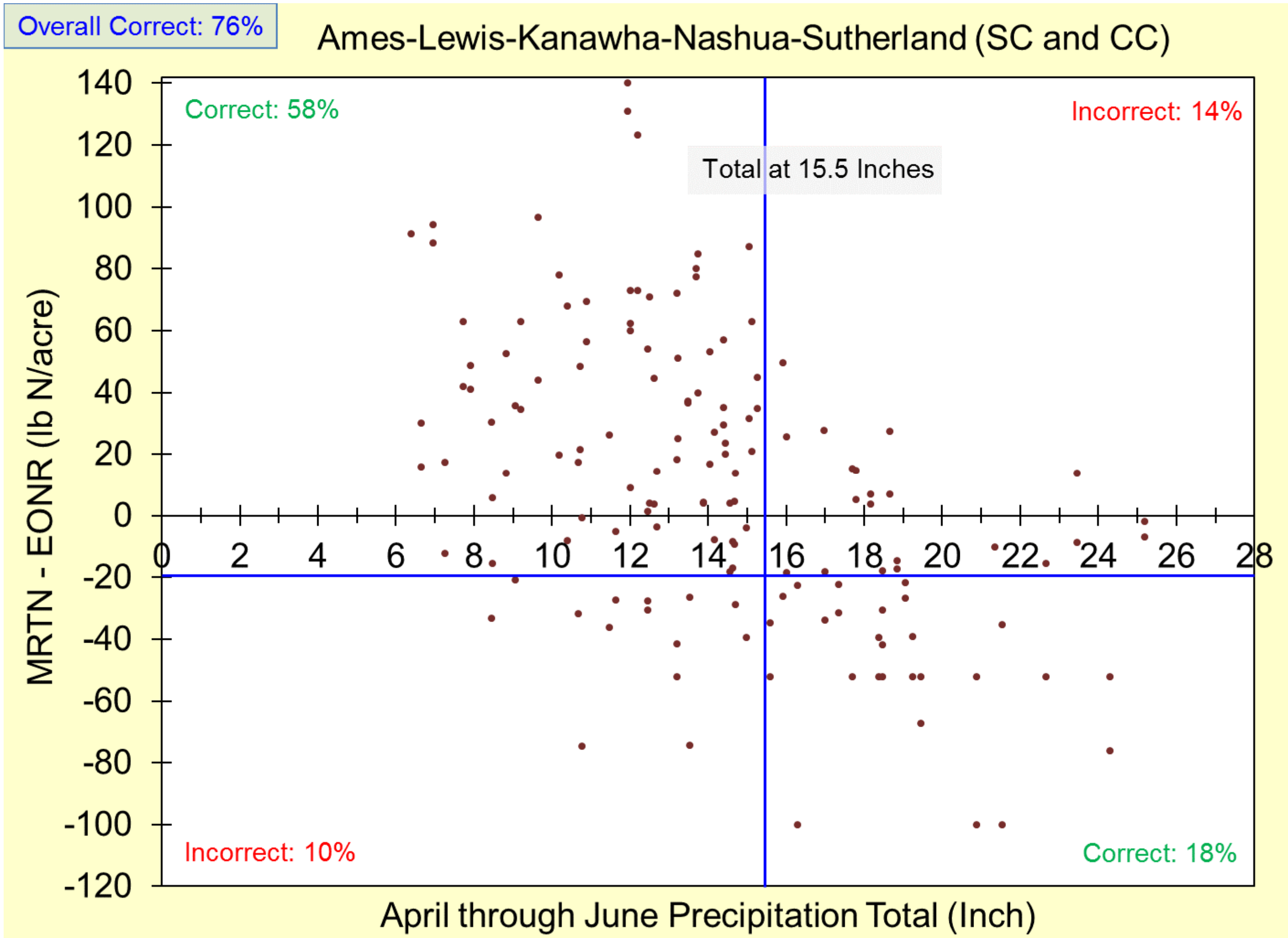
Extremes in Nitrogen Response are Important
Ames (Clarion Loam) SC (2000-2015)



Years within ± 25 lb N/acre range (109-159 lb N/acre) of the MRTN at 134 lb N/acre (0.10 price ratio)
$0.35/lb N and $3.50/bu
Potential Increase if Used Yearly EONR Instead of MRTN: $2.44/acre

10 of 16 years within 109-159 lb N/acre range.

Spring Precipitation as a Tool for Decisions About Additional Nitrogen Application (Main Iowa)



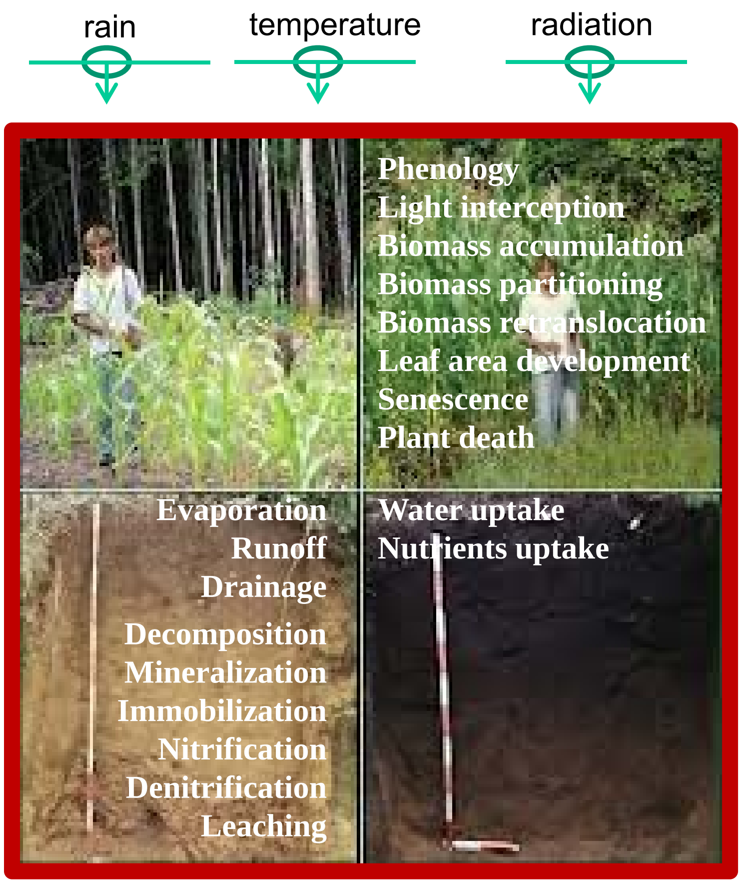
J.E. Sawyer, ISU

The APSIM Model
Agricultural Production Systems sIMulator

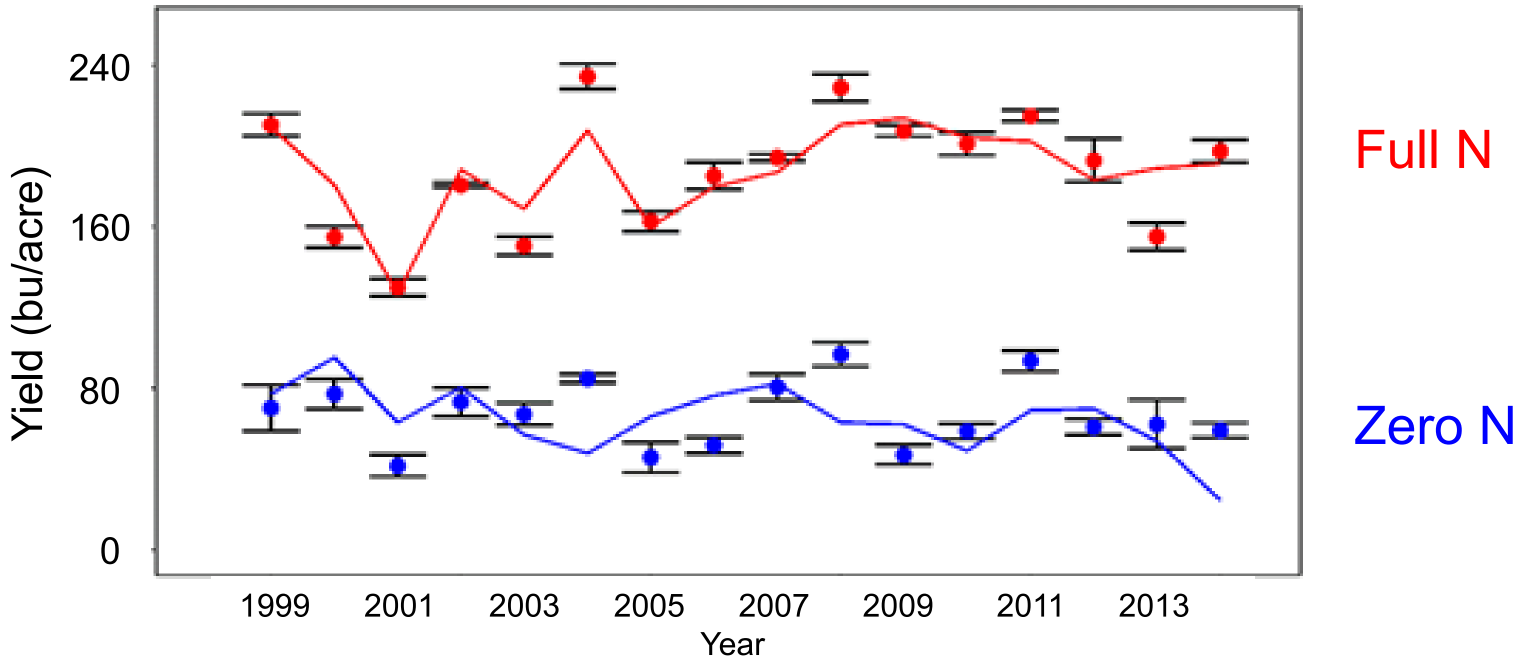
A model is a computer program that integrates scientific knowledge in the form of mathematical equations and attempts to represent a real world system.

APSIM is a modular process-based model for simulating agricultural systems.

ISU development/evaluation for optimal N-rate prediction in corn.

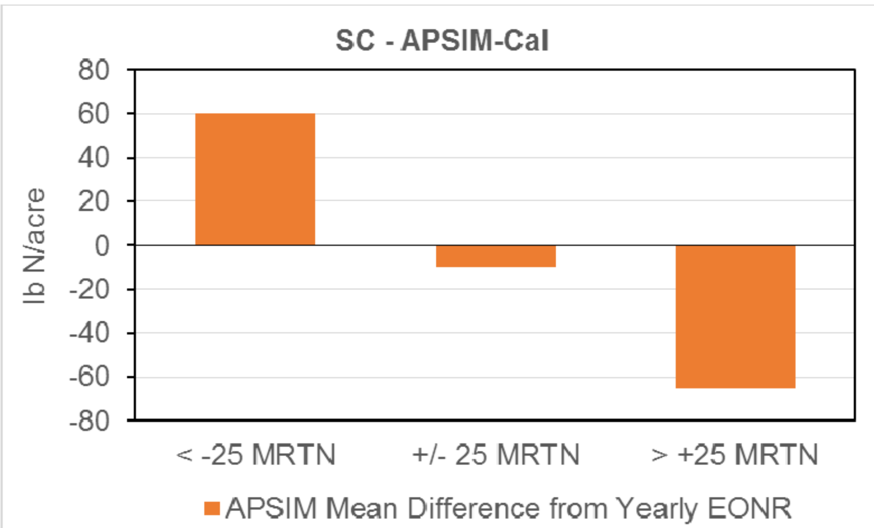


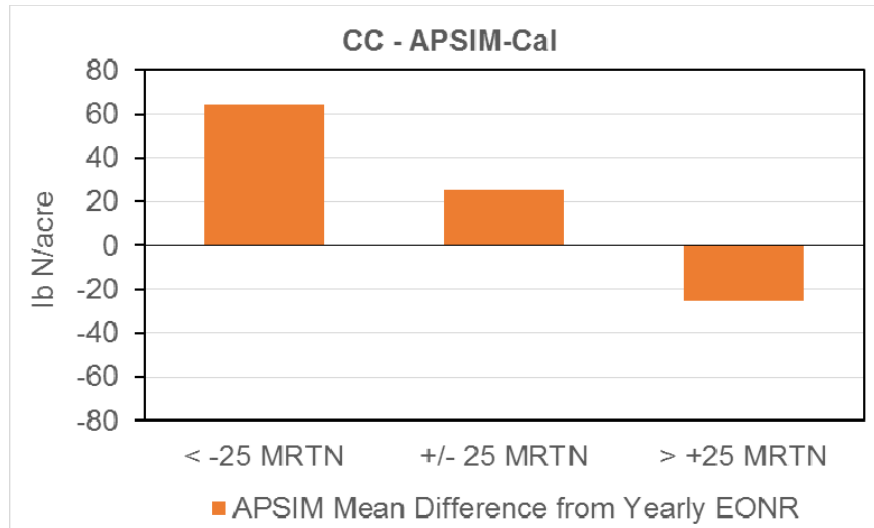
APSIM Modelling Corn Yield Across N Rates
Initial Evaluation of Model Performance
(Ames Site CC)



Puntel et al., 2016
Frontier Plant Science

APSIM Modelling Optimal N Rate
Initial Evaluation (Ames Site SC and CC)





When Yearly EONR Is Within One of these Three N Rate Categories

How Well Does APSIM Hit the Yearly EONR Extremes?

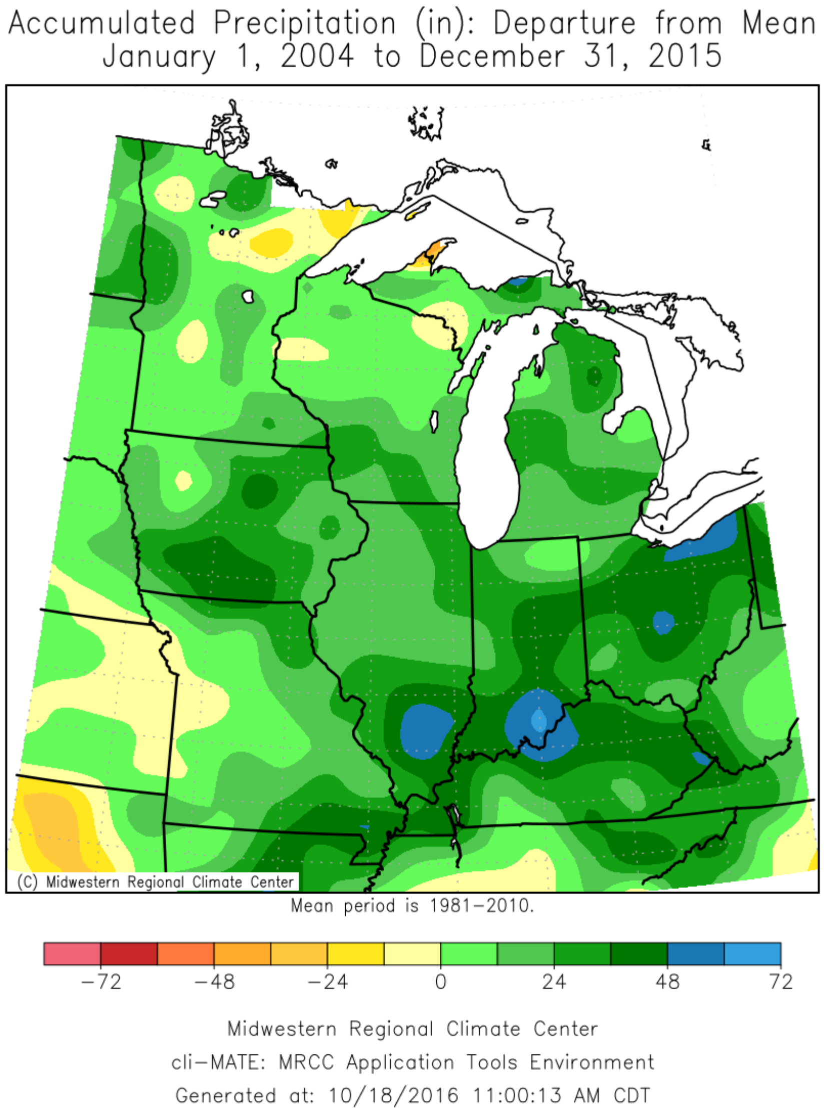
Impact of Nitrogen Application Timing on Corn Production

John E. Sawyer
Daniel W. Barker
John P. Lundvall
Department of Agronomy
Iowa State University

Nitrogen Application Timing Studies

- Nine studies in 2004-2016
- Seventy one site-years
- Nitrogen application timings
  - Fall, spring preplant, at planting, split/sidedress, mid-vegetative, late-vegetative
- Question?
  - Nutrient reduction strategy and 4R management
  - 4% yield increase fall to spring preplant
  - 0% yield increase spring preplant to sidedress

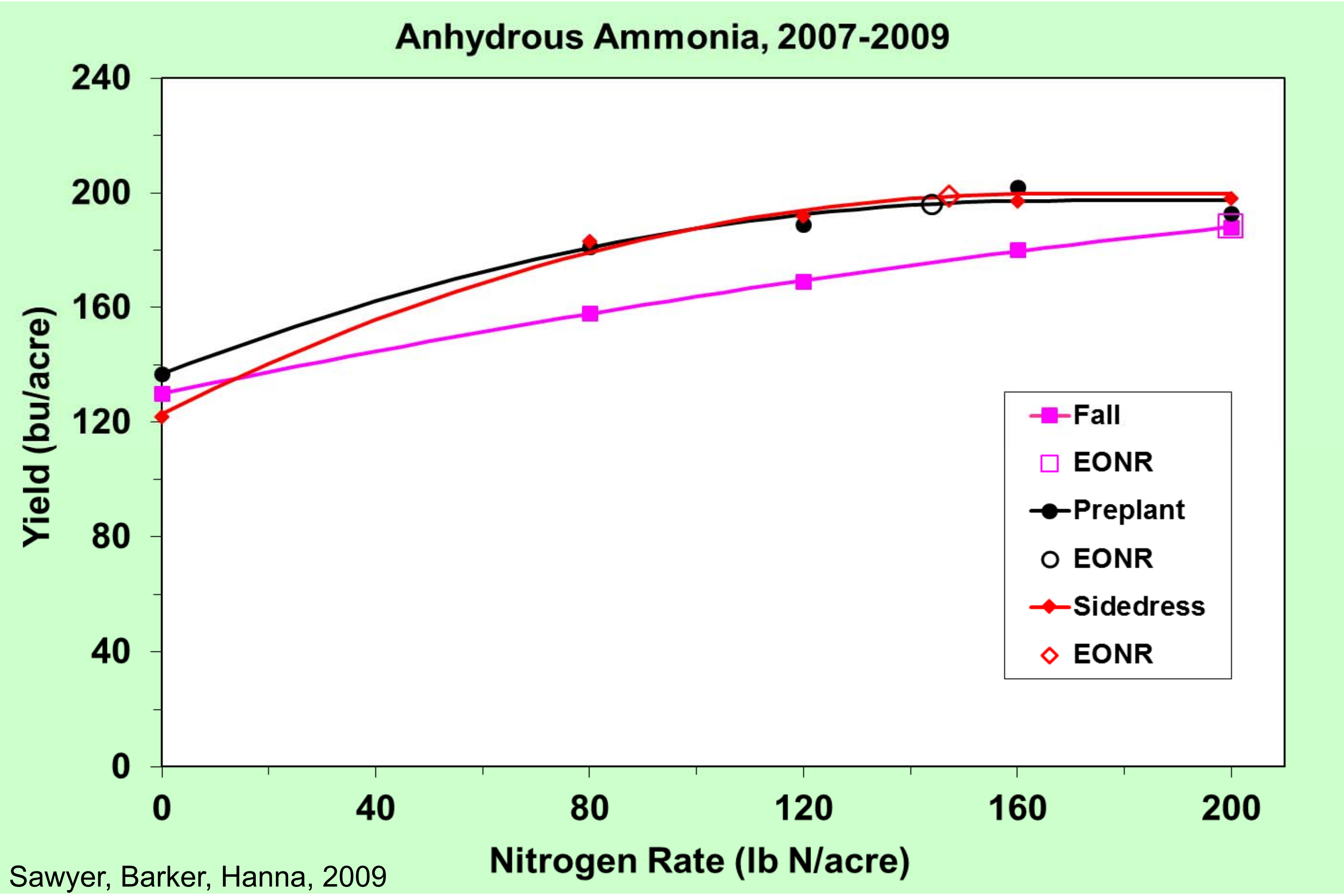
2004-2015 High Precipitation Period



Anhydrous Ammonia Timing Study

- Late fall (< 50°F), spring preplant (mid-April to mid-May) & split/sidedress (V2-V4 corn stage, early-mid June)
- Five N rates
- No nitrification inhibitor
- Corn following soybean
- Three years (2007-2009)
- Ames

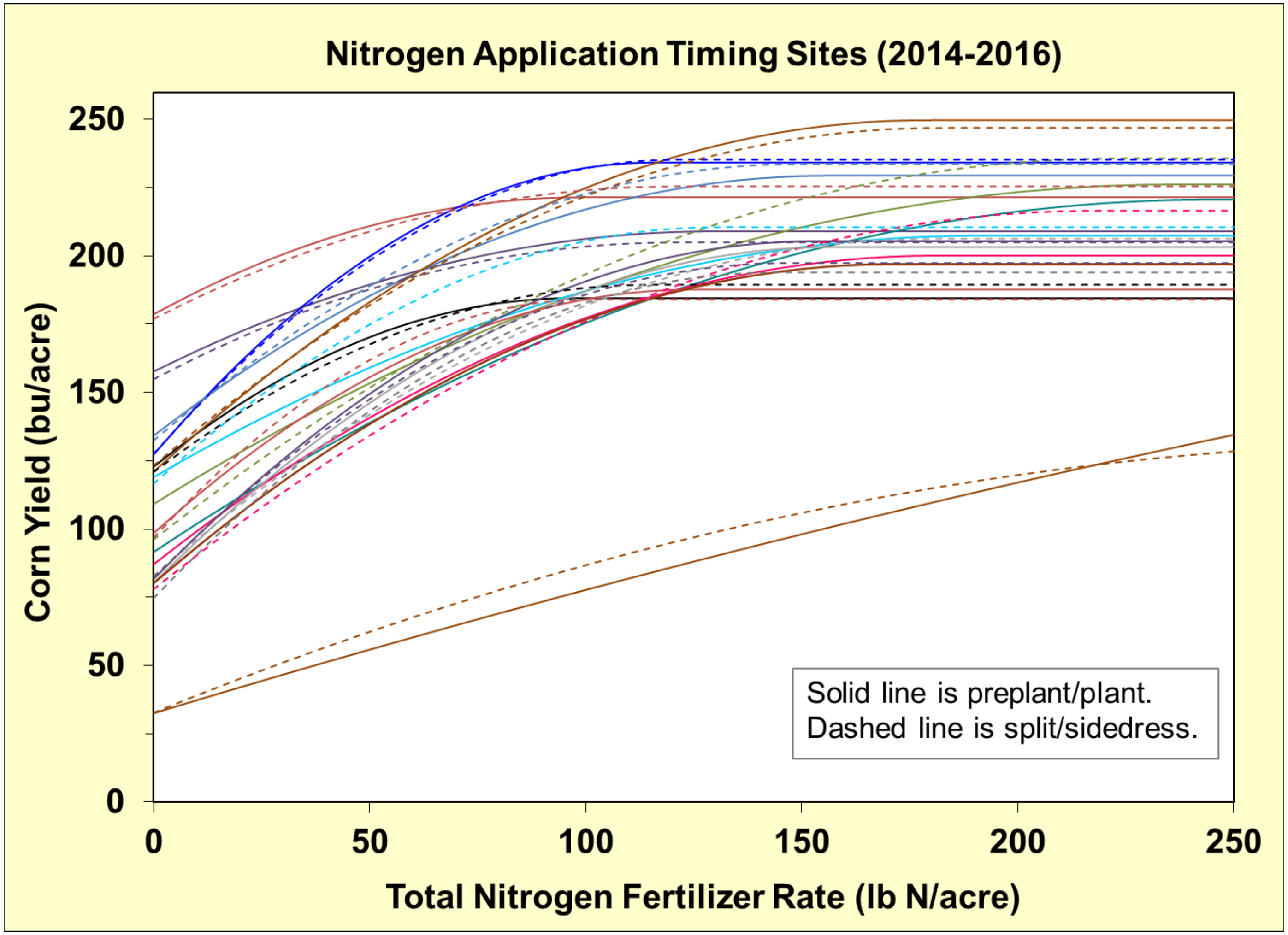
Preplant and Split/Sidedress Anhydrous Ammonia



Springtime Timing Studies

- Spring preplant or at-planting & split/sidedress
- Sidedress at V4 – V9 corn growth stage
- Six to eight N rates
- UAN, urea, ammonium nitrate
- Corn following soybean
- Three years (2014-2016)
- Fourteen site-years across Iowa

Preplant or At-Planting and Split/Sidedress



Sawyer, Lundvall, Hall, Barker 2014-2016.

Preplant or At-Planting and Split/Sidedress

		Mean EONR		Mean YEONR	
Category	Sites	Pre	Split	Pre	Split
		- - lb N/acre - -		- - bu/acre - -	
Split EONR at least 10 lb N/acre lower than Preplant	4	167	138	202	201
Preplant EONR at least 10 lb N/acre lower than Split	3	108	126	203	206
Preplant and Split EONR within 10 lb N/acre	7	151	147	221	221
Overall Mean	**14**	**146**	**140**	**212**	**212**
Chariton (2015)	1	250*	250*	134	129

Based on N response equations and 0.10 N:corn price ratio.

Sawyer, Lundvall, Hall, and Barker, 2014-2016.

In-Season Sensor-Based Project

- Spring preplant or early sidedress (Pre-N)
- In-season mid- to late-vegetative SPAD meter-based high clearance (Post-sensing N)
- Four Pre-N rates plus sensor-based N
- UAN Post-sensing N product
- Corn following soybean
- Three years (2004-2006)
- Thirty on-farm sites across Iowa with field-length strips

N Applied Pre and Post-Sensing

N Application Treatment	Mean Total N Applied†	Number of Sites with Post-Sensing N Applied	Relative CM Value	Mean Yield‡
	lb N/acre	n		bu/acre
0	0	--	0.82	141d
60	60	--	0.93	177c
60+	115	28	---	185b
120	120	--	0.97	192a
120+	131	9	---	193a
240	240	--	1.00	197a

† Sum of Pre-N and Post-sensing N rate, averaged across all 30 SC sites.

‡ Mean yields are not significantly different when followed by the same letter ($P \leq 0.10$).

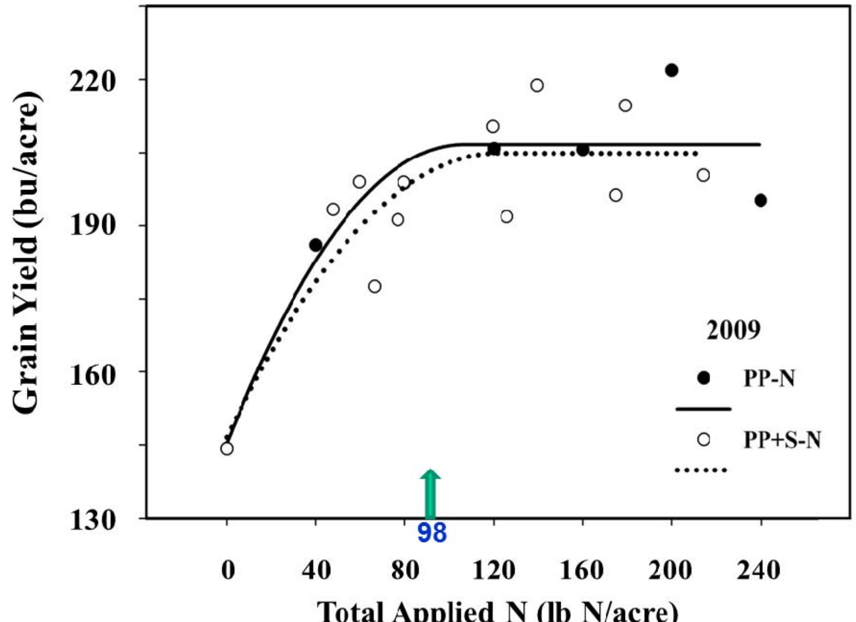
Hawkins, Lundvall, Sawyer, 2006

EONR(0.10) for Pre-N rates = 132 lb N/acre

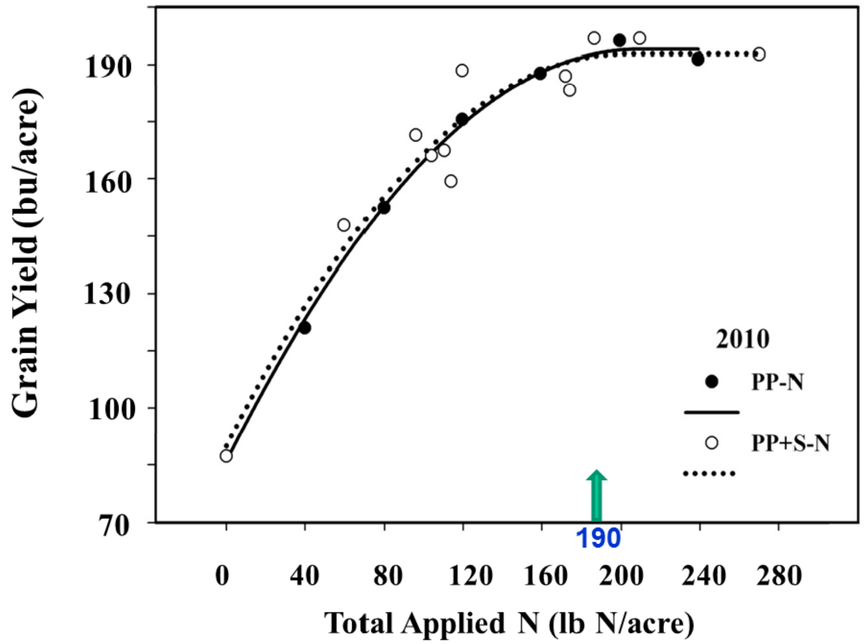
Mid-Vegetative Sensor-Based Timing Study

- Spring preplant urea (PP-N)
- Mid-vegetative (V10 stage) active canopy sensor-based application (PP+S-N)
- Seven PP-N rates plus sensor-based N
- UAN Post-sensing N product
- Corn following soybean
- Two years (2009-2010)
- Central Iowa, new site each year

N Applied Preplant and Mid-Vegetative Based on Canopy Sensing



Barker and Sawyer, 2012



Mid-Vegetative Sensor-Based Demonstration

- Preplant N Rate (PP-N)
  - Farmer rate and product (Fall, Sp, Split, NH_3, NS, UAN)
- Preplant + In-Season Fixed Rate (PP+F-N)
  - Farmer rate + 100 lb urea/acre (46 lb N)
- Preplant + In-Season Sensor Rate (PP+S-N)
  - Farmer rate + 3 potential sensor-based rates
  - Un-calibrated NDVI (no relative index)
    - *1)* ≥0.85 no N; *2)* 0.85-0.50 100 lb urea/acre (46 lb N); *3)* <0.50 150 lb urea/acre (70 lb N)
  - Sensor-based N applied June 28–30, 2011
- Multiple fields

Sensor-Based Demonstration SC

Application	1	2	3	4	5	6	
	- bu/acre -						
PP-N	218	213	211	212	212	198	
PP+F-N	217	214	199	194	223	193	
PP+S-N	219	206	209	222	205	198	
Sign. (0.05)	NS	NS	NS	NS	NS	NS	
	- - - - - - - - - - - - - - - - - - - lb N/acre - - - - - - - - - - - - - - - - - - -						
PP-N	159	161	160	160	160	160	
PP+F-N	205	206	205	205	205	205	
PP+S-N	209	212	208	209	206	210	
NDVI	0.699	0.674	0.691	0.693	0.703	0.682	
						Barker and Sawyer, 2011	

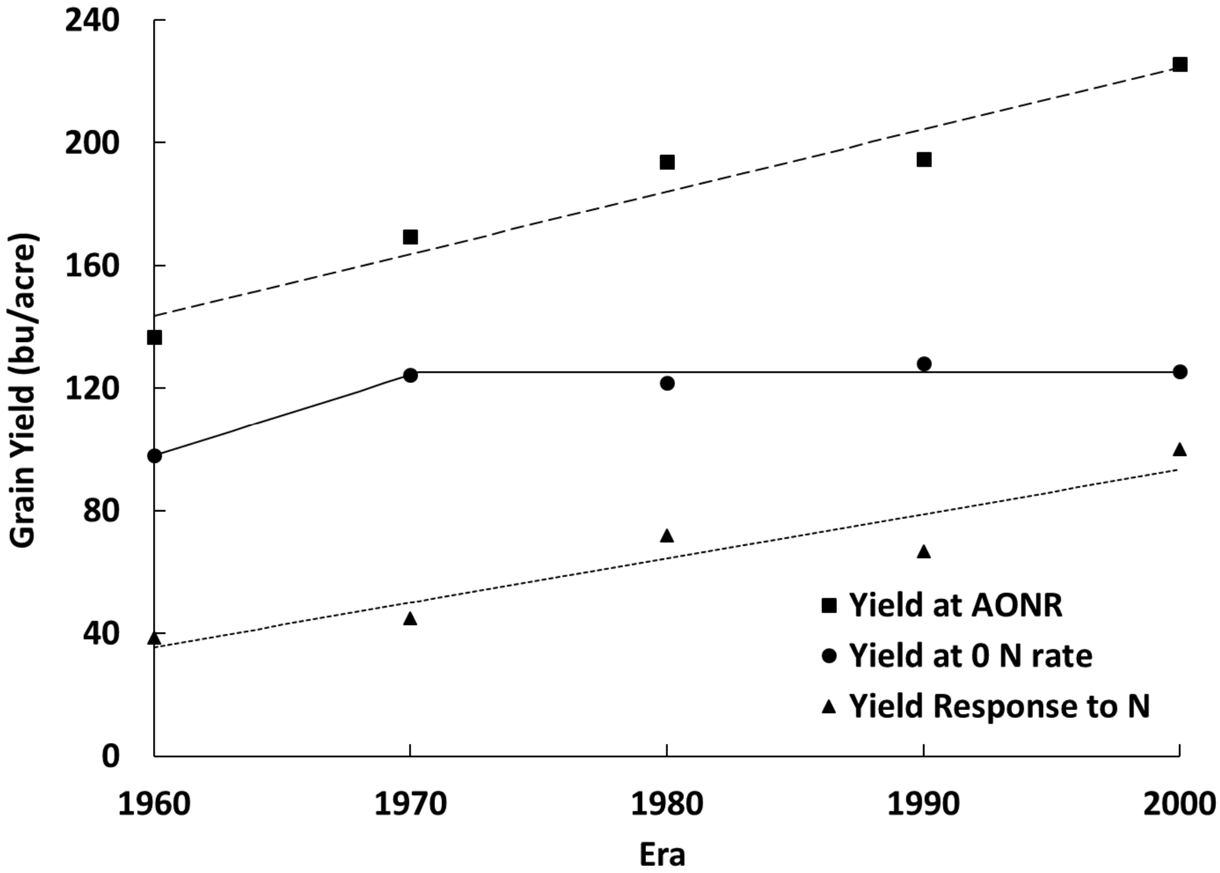
Time of Nitrogen Application Summary

- Fall anhydrous ammonia less efficient than spring or split/sidedress
- Generally, little difference in corn yield or EONR between springtime N application timing; preplant, split/sidedress, or mid-vegetative
- If a springtime timing difference, not consistent between preplant and sidedress
- Even in extremely wet and N responsive conditions, similar corn yield and EONR
- Split applications are okay / application options

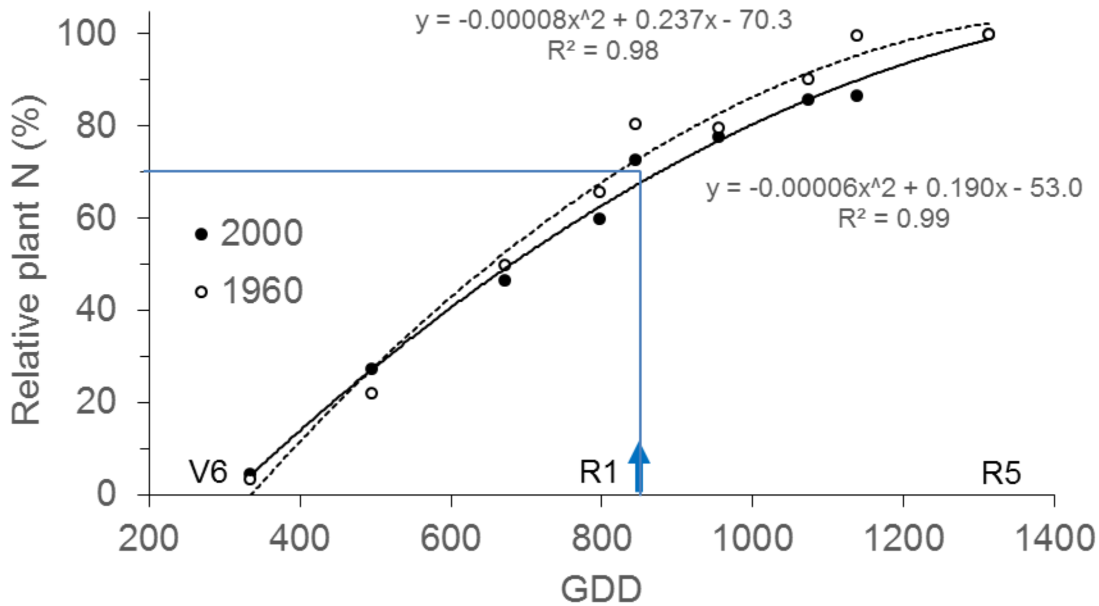
Why Little Spring Timing Difference?

- Not sandy (coarse textured) soils
- Soil organic matter mineralization
- Soil inorganic-N loss in wet springs makes sites more N responsive
- Applied N (fertilizer) loss if applied preplant, at-planting, or sidedress
  - Late spring or summer wet periods
- Less corn response to late applied N
- Corn N uptake timing has not changed

Why No Spring Timing Difference?
Era Hybrid Comparison Study (2007-2008)



Why No Spring Timing Difference?
Era Hybrid Comparison Study (2007-2008)



	Era	
	1960	2000
GY (bu/acre)	134b	224a
Total N uptake at R6 (lb/acre)	159b	190a
Grain N (lb/acre)	113b	138a
Grain (bu/lb N)	1.03b	1.42a
Grain N Concentration (%)	1.61a	1.23b