Nitrogen For Corn Production

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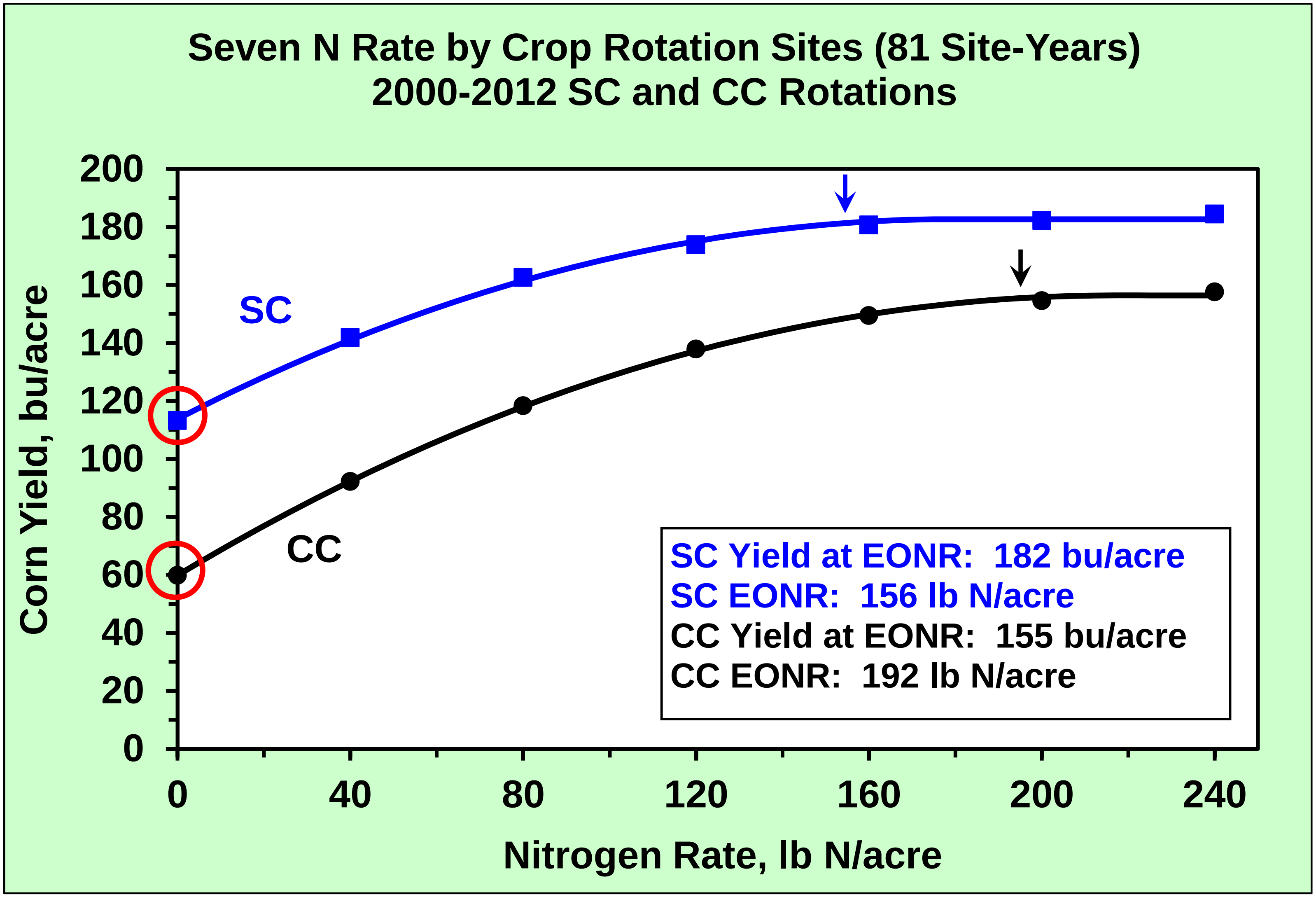
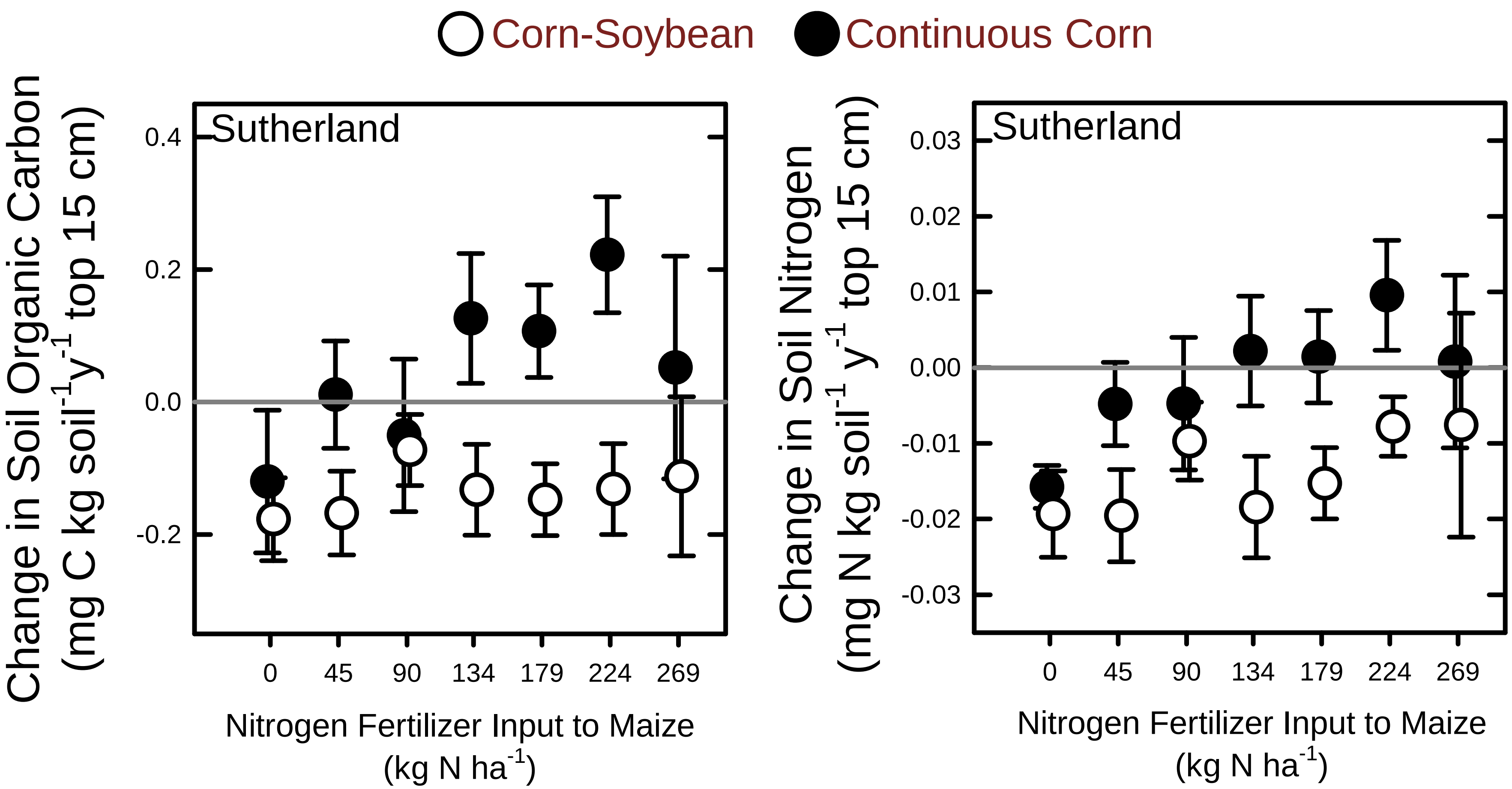
Why Nitrogen Is Applied For Corn

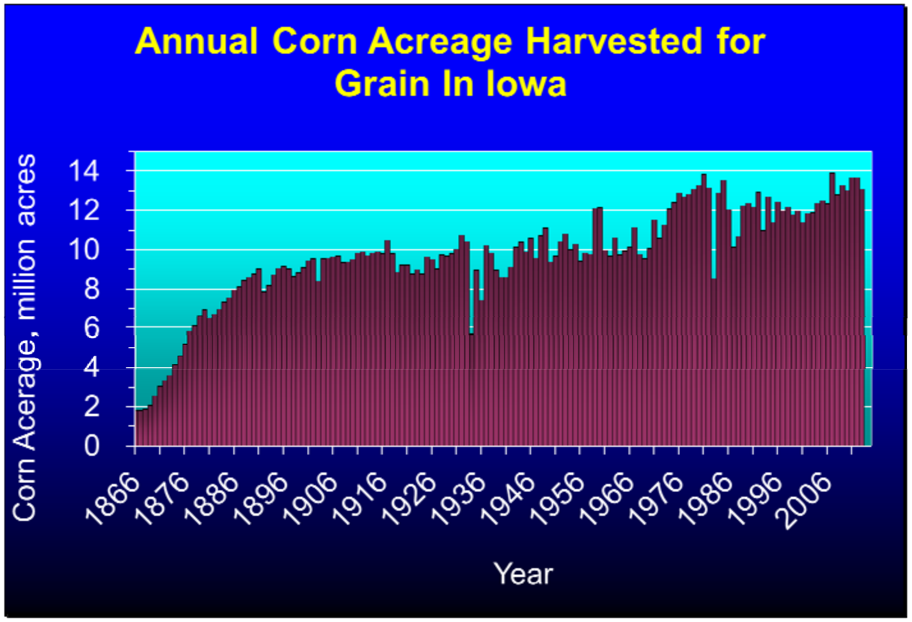
Corn Yield Response

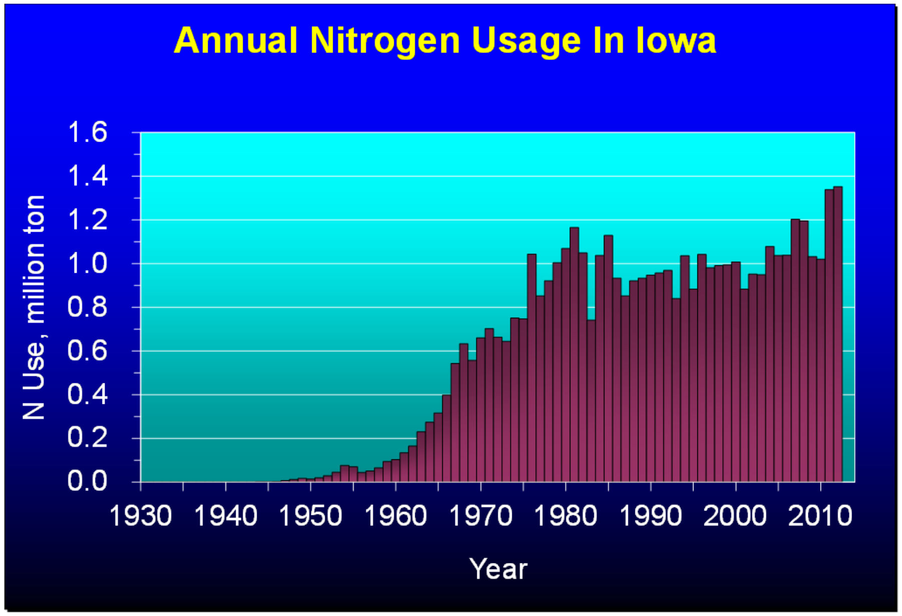


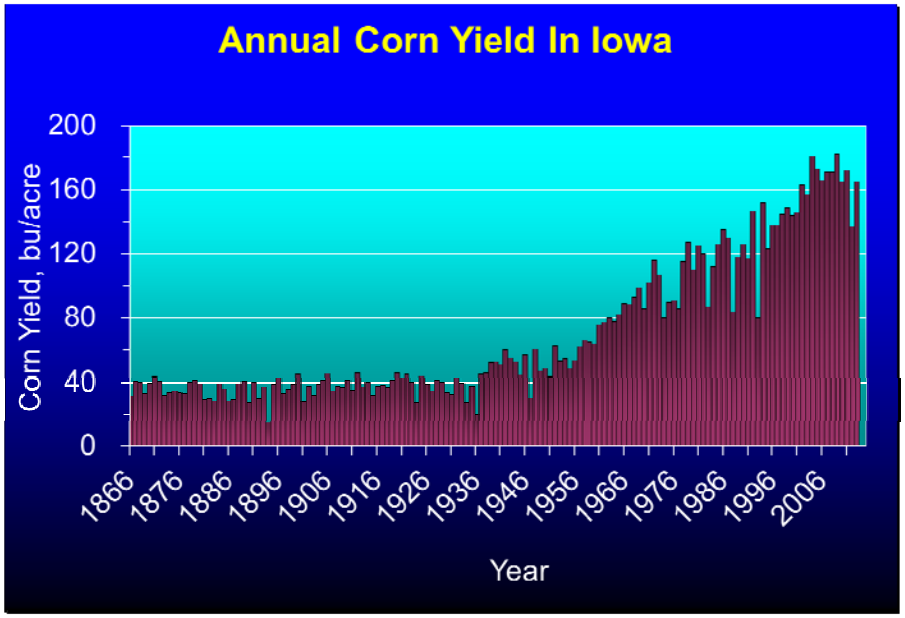
Soil Carbon and Nitrogen Response



Nitrogen Use Efficiency





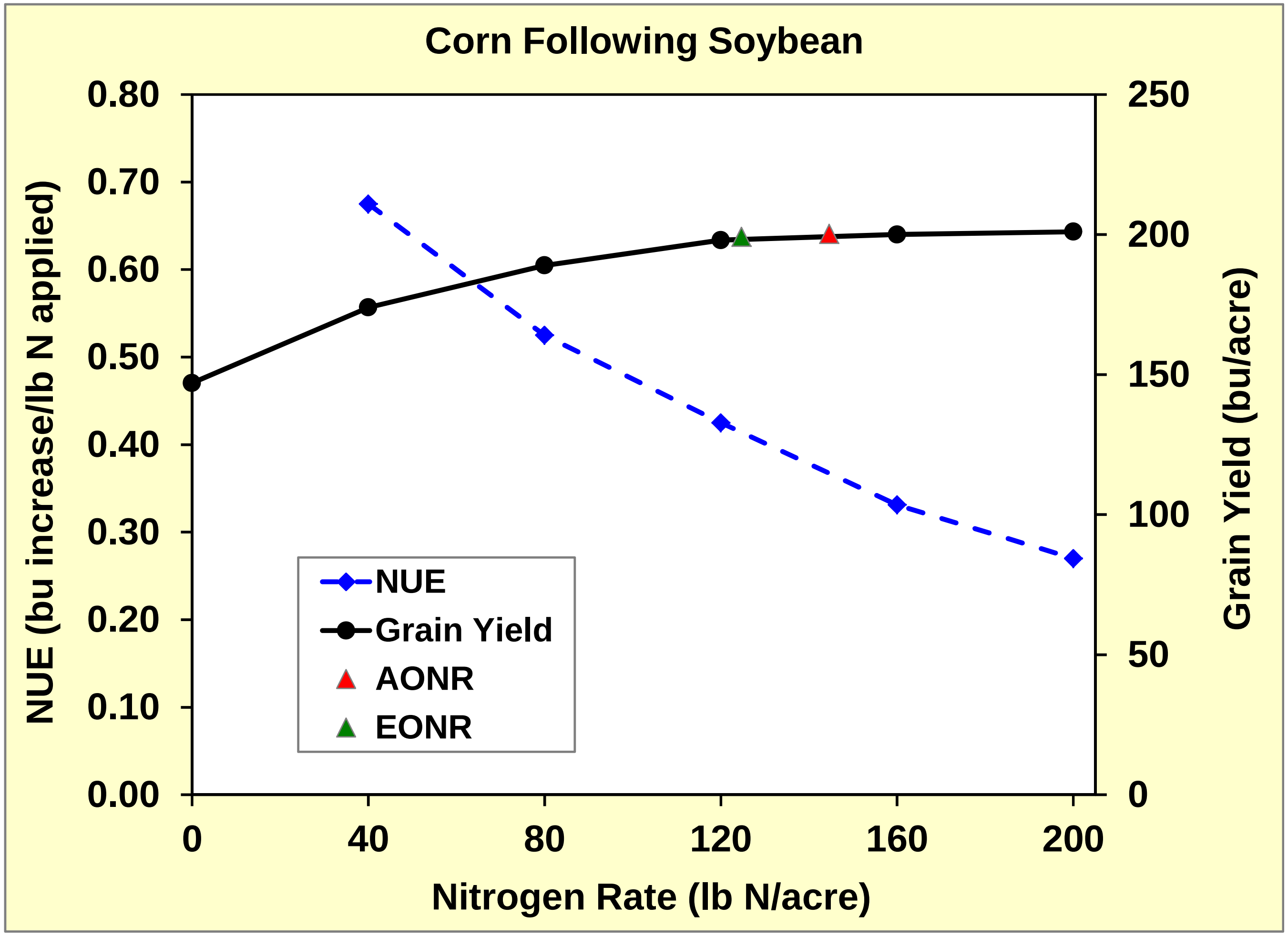


Data Source: USDA-NASS, TVA, AAPFCO

Corn Grain N Removal vs. N Application

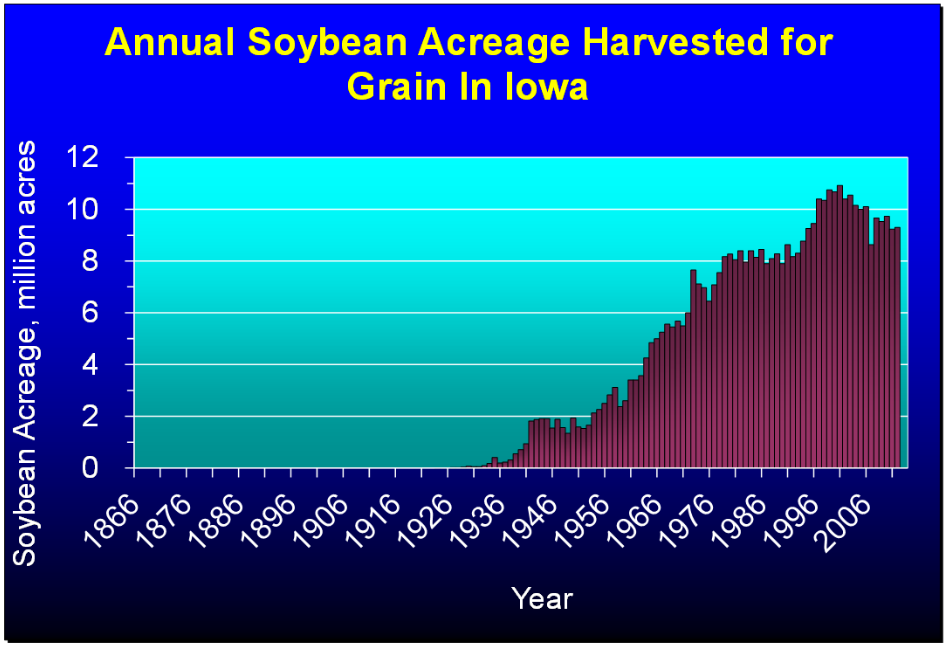
- Iowa example
  - 1976-1980 vs. 2006-2010
  - 107 bu/acre vs. 171 bu/acre yield
  - 87 lb N/acre vs. 91 lb N/acre in grain harvest
  - 120 lb N/acre vs. 139 lb N/acre application
  - 0.73 ratio vs. 0.65 ratio
    (grain N to applied N ratio)
    - 0.82 lb N/bu vs. 0.53 lb N/bu
    - 85% N to planted corn acres per ground water protection act reporting method

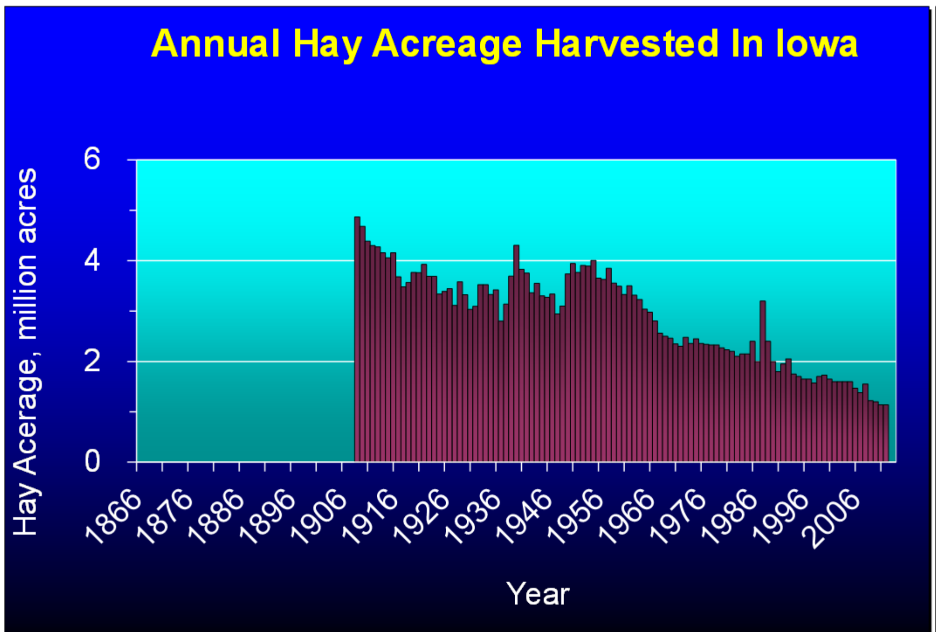
Nitrogen Use Efficiency (NUE) and Yield With Increasing N Rate

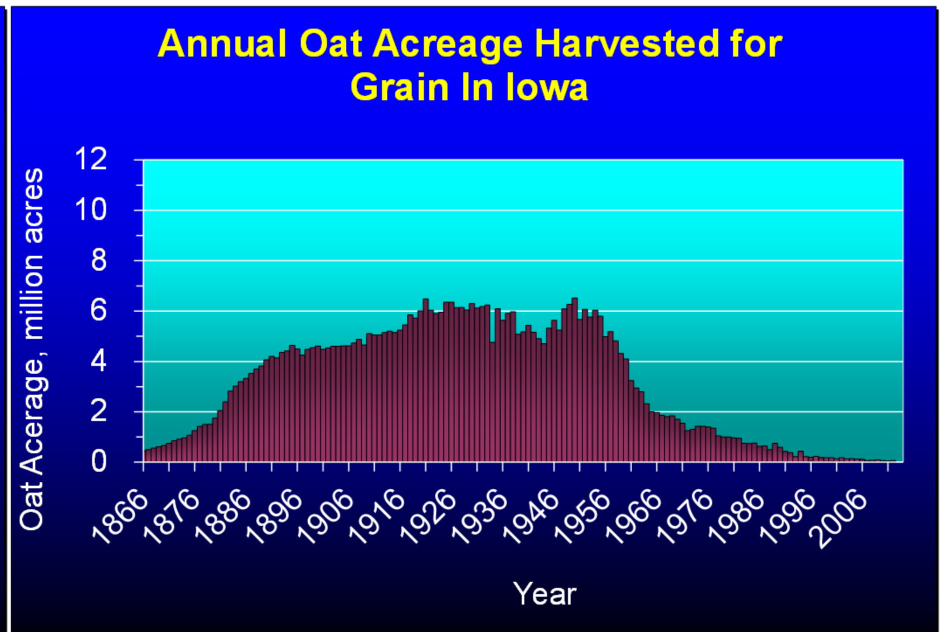


2006-2007 - 14 Iowa Sites. Yield/Agronomic Efficiency.

Cropping System







Data Source: USDA-NASS, TVA, AAPFCO

Influence of Cropping System On Nitrate-N Concentration In Tile Drainage

System	1990	1991	1992	1993
	mg NO_3^- N/L (flow weighted)			
Cont. Corn	30	39	40	20
Corn – Sb	22	29	26	14
Sb – Corn	26	38	27	13
Alfalfa	--	4	4	1
CRP	--	4	1	0.3

Gyles Randall, Univ. of Minnesota, Lamberton

Influence of Cropping System and N Management On Nitrate-N In Tile Drainage

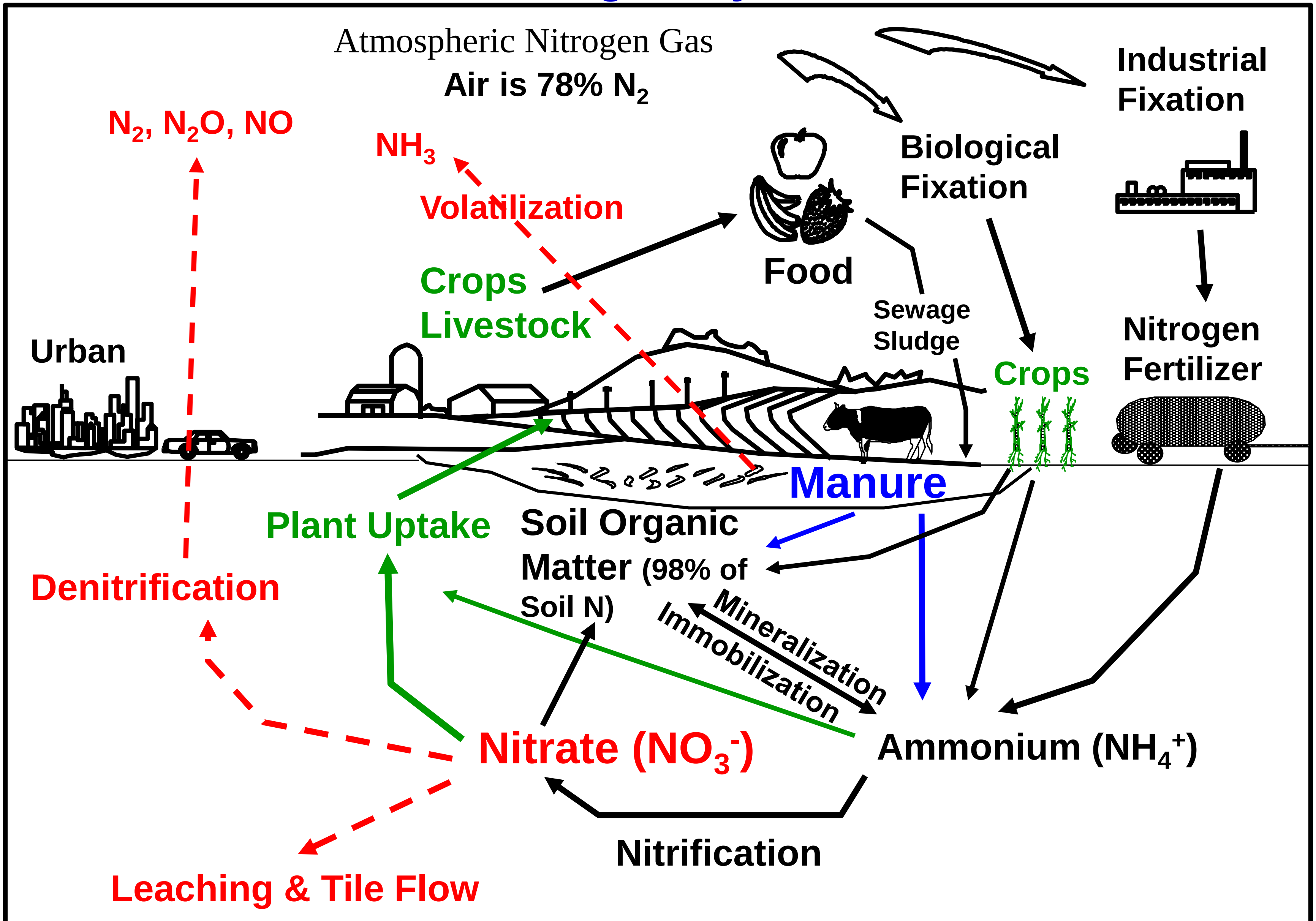
Year	Crop	Fall	Fall + NS	Spring	40/60 Split
		- - - - - - lb NO_3 Leached - - - - - -			
1989	Corn	0	0	0	0
1990	Soybean	52	62	70	65
1990	Corn	109	69	60	74
1991	Soybean	65	53	50	57
1991	Corn	75	72	56	57
1992	Soybean	10	11	15	15
1992	Corn	21	17	17	17
1993	Soybean	20	17	22	20
1993	Corn	31	29	26	22
	Total	383	330	316	327
	Soybean Total	147	143	157	157
	Corn Total	236	187	159	170

135 lb N/acre as NH_3; Total N applied 1,080 lb since 1987

Waseca, MN, Webster cl

The Open System and Natural Nitrogen Processing

Nitrogen Cycle

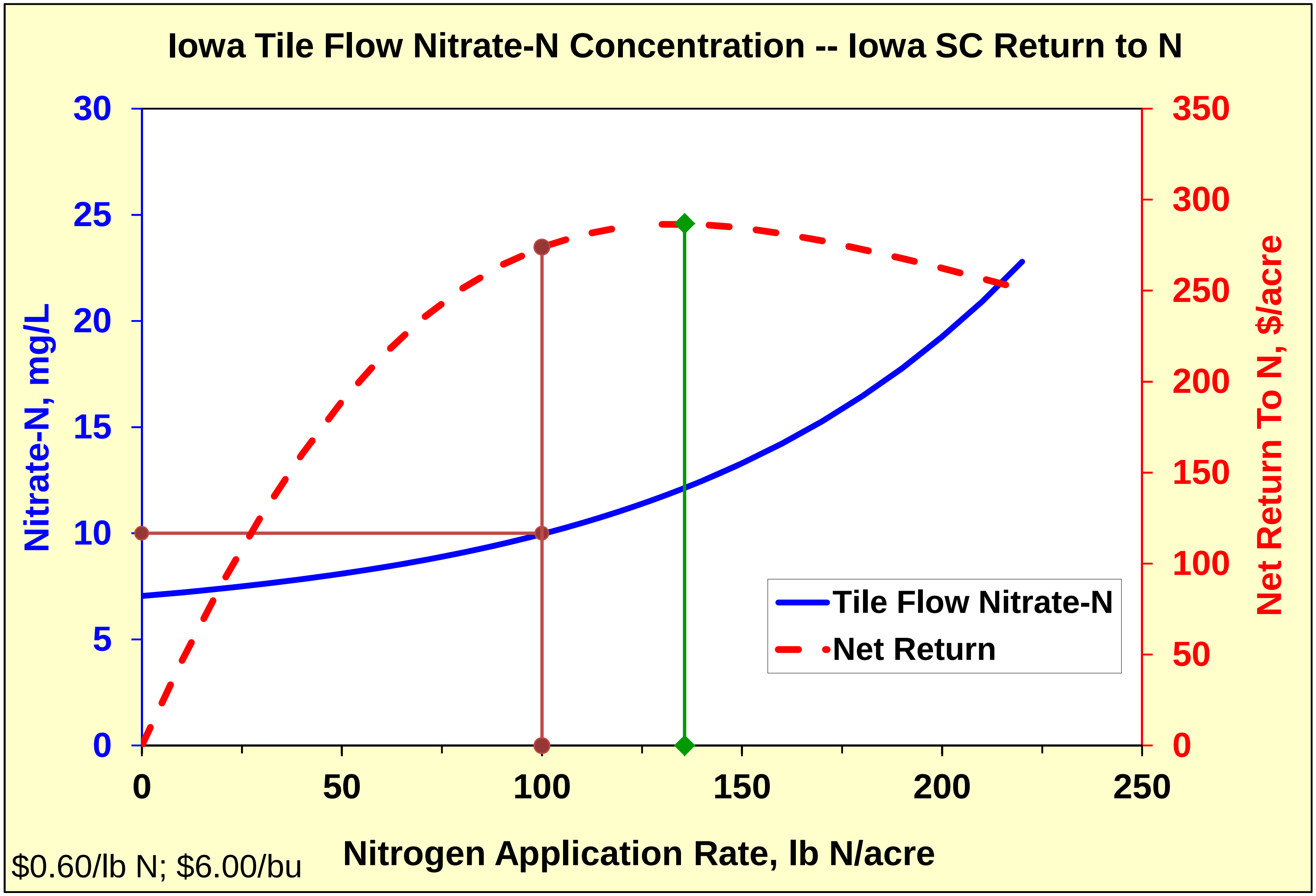


Influence of Precipitation on Nitrate-N In Tile Drainage (180 lb N/acre/yr)

Year	Apr. – Oct. Rainfall	Drainage	Conc.	Flux
	Inches		mg/L	lb/acre
1985	24.3	5.6	13	15
1986	31.3	15.8	14	49
1987	23.1	1.6	9	4
1988	16.8	1.8	15	5
1989	16.3	1.0	12	2
1990	31.1	19.1	24	100
1991	37.8	24.3	24	124
1992	28.6	16.4	14	49

Normal = 25.2 in.   Gyles Randall, Univ. of Minnesota, Waseca

Nitrogen Rate Reduction Potential to Reduce Nitrate Losses in Tile Drainage



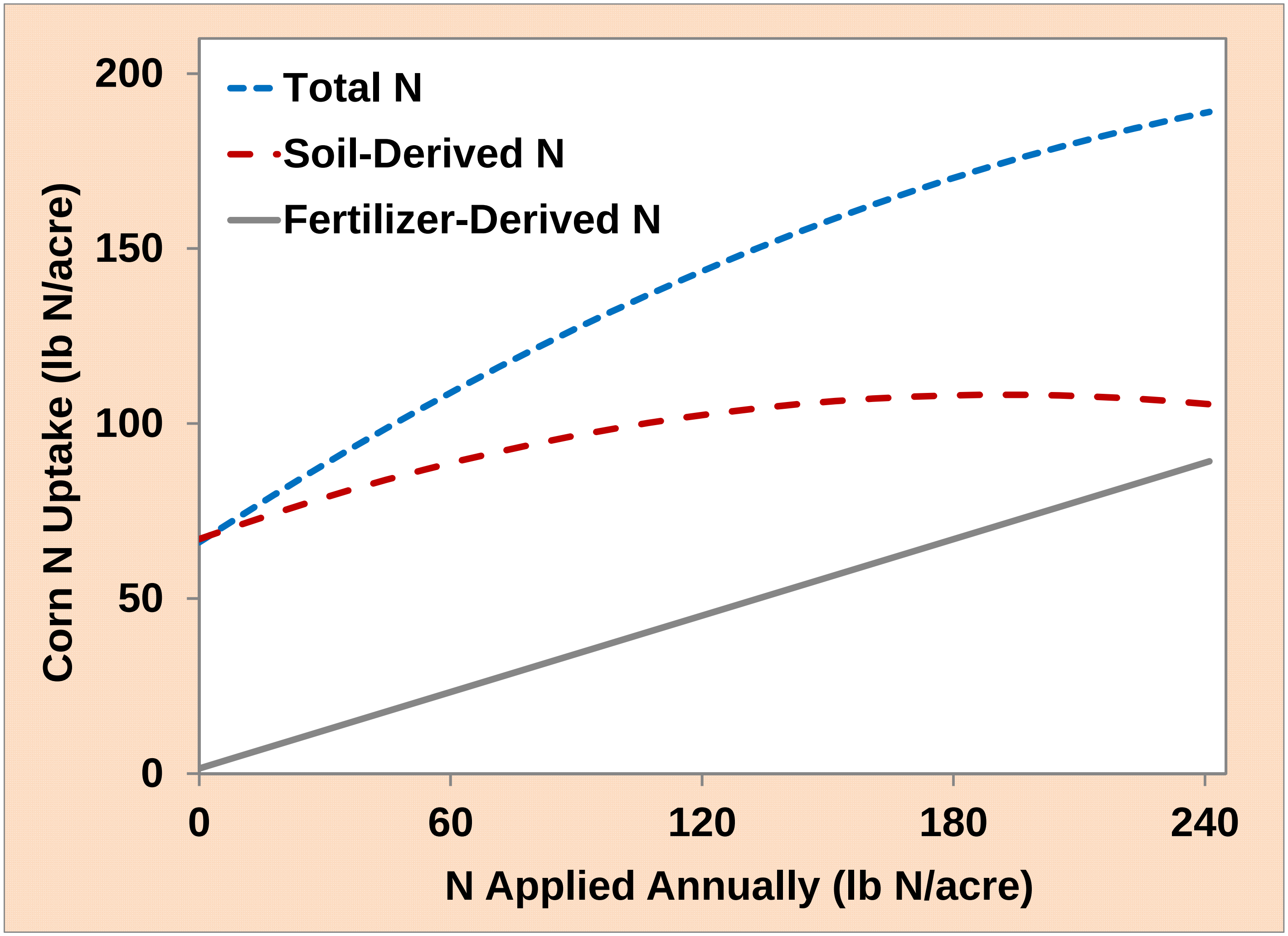
Fertilizer Derived N Recovered After Corn Harvest – Long Term Continuous Corn

Four-Foot Post-Harvest Soil N.					
	Fertilizer Derived				Soil Derived
N Rate	Mineral	Organic	Mineral	Organic	Mineral
lb N/acre	lb N/acre		% of applied N		lb N/acre
60	3	24	4	41	43
120	3	37	2	31	51
180	12	41	6	23	85
240	28	47	12	20	108

Stevens et al. (2005). Univ. of Illinois. 1994-1996

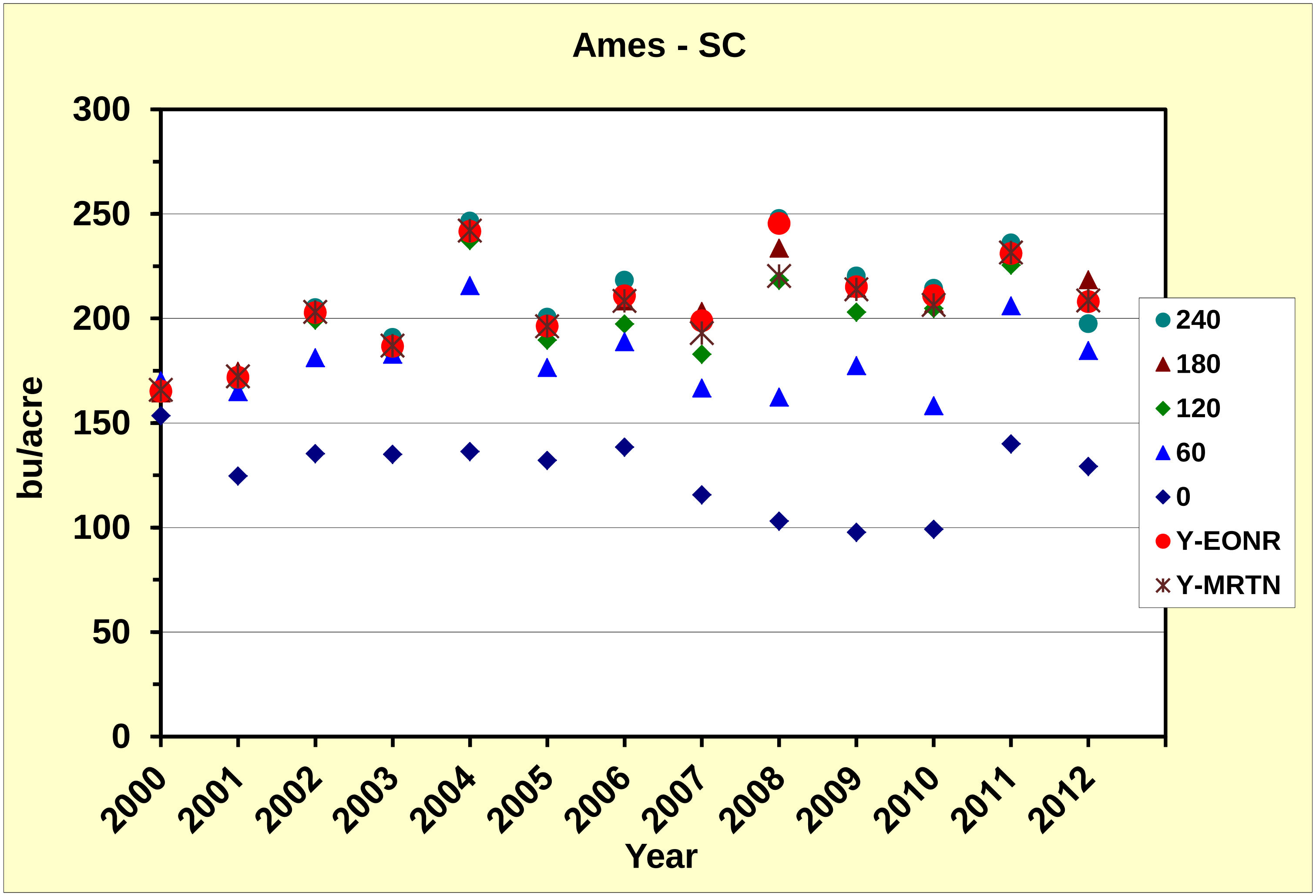
Corn N Uptake

Stevens et al. (2005) Univ. of Illinois

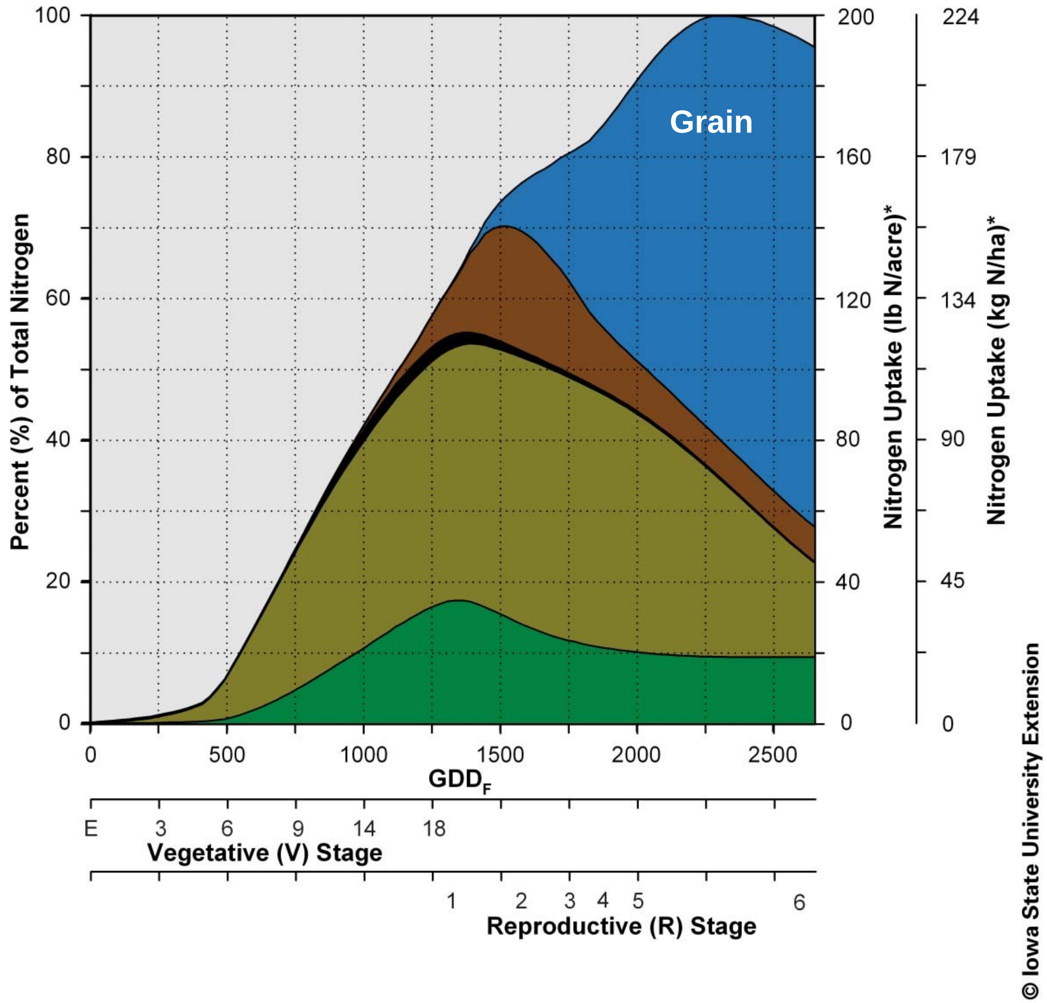


Corn Productivity and Nitrogen Response

Yield and Response to Nitrogen Vary Across Years



Corn Nitrogen Uptake and Composition



PMR 1009; Abendroth et al., 2011

Management to Change Nitrate-N Losses

Nitrogen Reduction Practices

	Practice	% Nitrate-N Reduction [Average (Std. Dev.)]	% Corn Yield Change
Nitrogen Management	Timing (Fall to spring)	6 (25)	4 (16)
	Nitrogen Application Rate	Depends on starting point	
	Nitrification Inhibitor	9 (19)	6 (22)
	Cover Crops (Rye)	31 (29)	-6 (7)
Land Use	Perennial – Land retirement	85 (9)	
	Perennial – Energy Crops	72 (23)	
	Extended Rotations	42 (12)	7 (7)
Edge-of-Field	Drainage Water Mgmt.	33 (32)*	
	Shallow Drainage	32 (15)*	
	Wetlands	52	
	Bioreactors	43 (21)	
	Buffers	91 (20)**	

*Load reduction not concentration reduction

**Concentration reduction of that water interacts with active zone below the buffer

Nitrogen Reduction Scenarios

	Practice/Scenario	Statewide Nitrate-N Reduction % (from baseline)
Nitrogen Management	Baseline	
	Cover crops (rye) on all CS and CC acres	28
	Reducing nitrogen application rate from background to the MRTN 133 lb N/acre on CB and to 190 lb N/acre on CC (in MLRAs where rates are higher than this)	9
	Sidedress all spring applied N	4
	Using a nitrification inhibitor with all fall applied anhydrous ammonia fertilizer	1
	Moving fall anhydrous ammonia fertilizer application to spring preplant	0.1

Nitrogen Management is a Challenge

- Corn has a high N demand
- Need N fertilization for profitable production
- Crops are grown in an open soil system
- Need to maintain soil N and C resource
- Corn and soybean are in high demand
- Corn and soybean are annual crops
- Perennial crops can significantly reduce nitrate-N losses; but need market for profitability

Nitrogen Management is a Challenge

- Meeting EPA drinking water standard, Gulf hypoxia size, **and/or** nutrient criteria
  - Different goals and scales
  - Different timelines
  - Different expectations
- What combination of agronomic, edge-of-field, and land use practices can be implemented to meet these goals
- Water vs. air quality effects