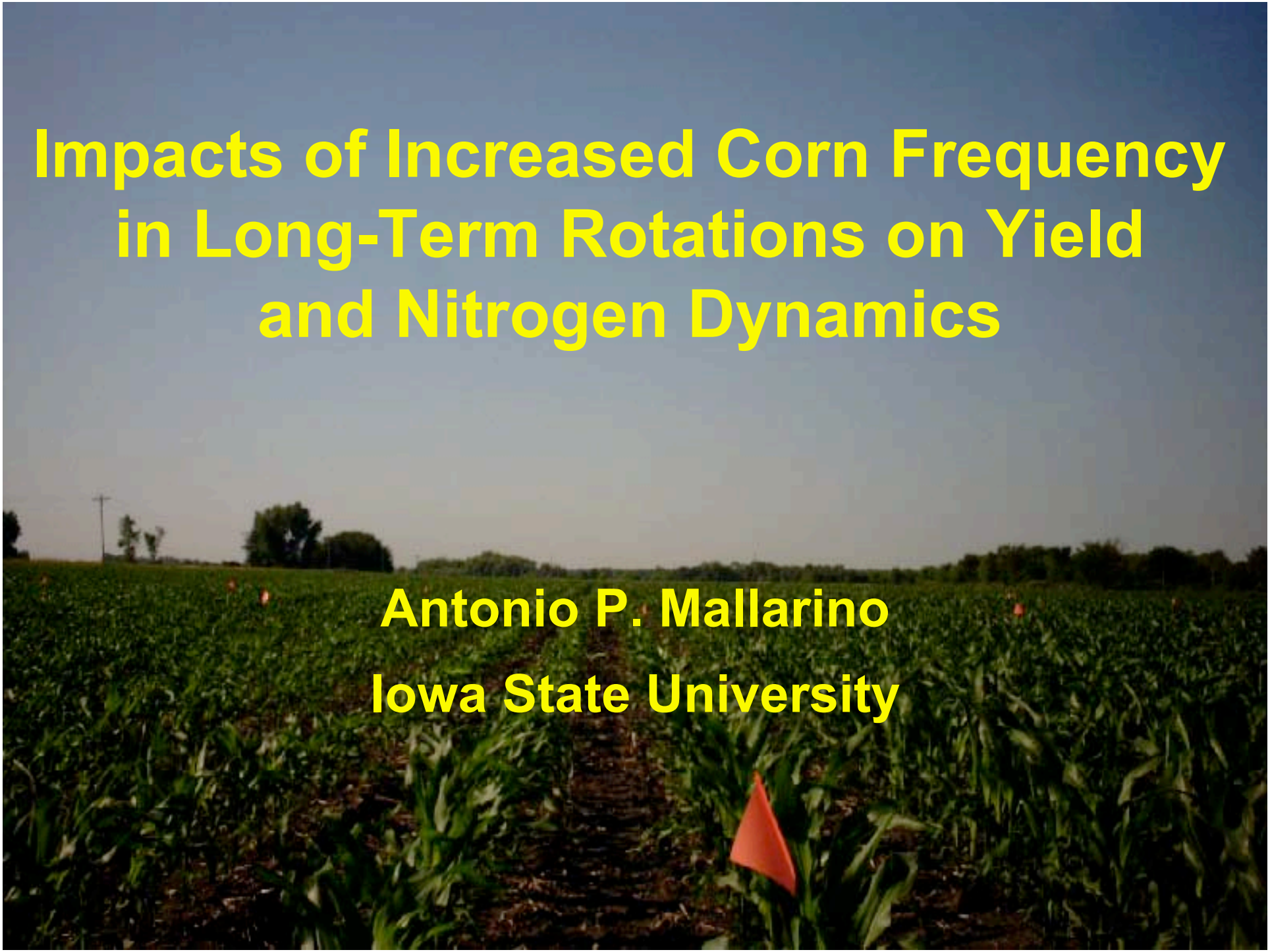

Impacts of Increased Corn Frequency in Long-Term Rotations on Yield and Nitrogen Dynamics

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Iowa State University

N Management in Humid Regions

- Corn acreage in the North Central region is increasing, and the area of corn-corn will also increase.
- N fertilizer costs also are increasing.
- N fertilization of corn is almost always needed to optimize yield and profitability.
- Excessive and inappropriate N fertilization increase the risk of N loss.
- Predicting the N needs of corn is difficult.

Nitrogen in Soils

- N availability highly affected by organic-inorganic N transformations.
- Very mobile nutrient (nitrate).
- Rainfall and temperature greatly affect available soil N before and during the growing season.
  - » mineralization/immobilization processes
  - » nitrification (ammonium to nitrate)
  - » nitrate leaching down the profile
  - » N gas loss (ammonia, denitrification)

Crop Rotation Effects on N

- Significant effect of previous crop on
  - » symbiotic N fixation by legumes, crop N uptake, C-N ratio of roots and residue.
  - » short and long-term effects.
- Organic matter, total N, N mineralization potential, and yield level are poor indices of N availability and N fertilizer needs.
- Soil nitrate testing (preplant or late spring) and in-season crop sensing are not quite ready or accepted yet.

Nitrogen Fertilization Guidelines

- Most N recs in the region include alternative systems or combinations:
  - Empirical, response-based N ranges
    - recognize rotation and manure effects
    - for different regions or conditions
  - Use organic matter and/or potential mineralization
  - Use soil nitrate testing
  - Some beginning to use remote sensing

Iowa Long-Term N-Rotation Studies

- Northeast farm (Nashua), Kenyon loam, 26 years old. Seven rotations: corn grain, corn silage, soybean, oats, alfalfa.
- Northern farm (Kanawha), Webster clay-loam, 60 years old. Seven rotations: continuous corn grain fall N, continuous corn grain spring N, soybean, oats, alfalfa.
- Nitrogen treatments for corn:
  - 0, 80, 160, and 240 lb N/acre
  - granulated urea incorporated into soil

Types of Corn Crops at Nashua

- Summarized corn grain yield 1979-2006

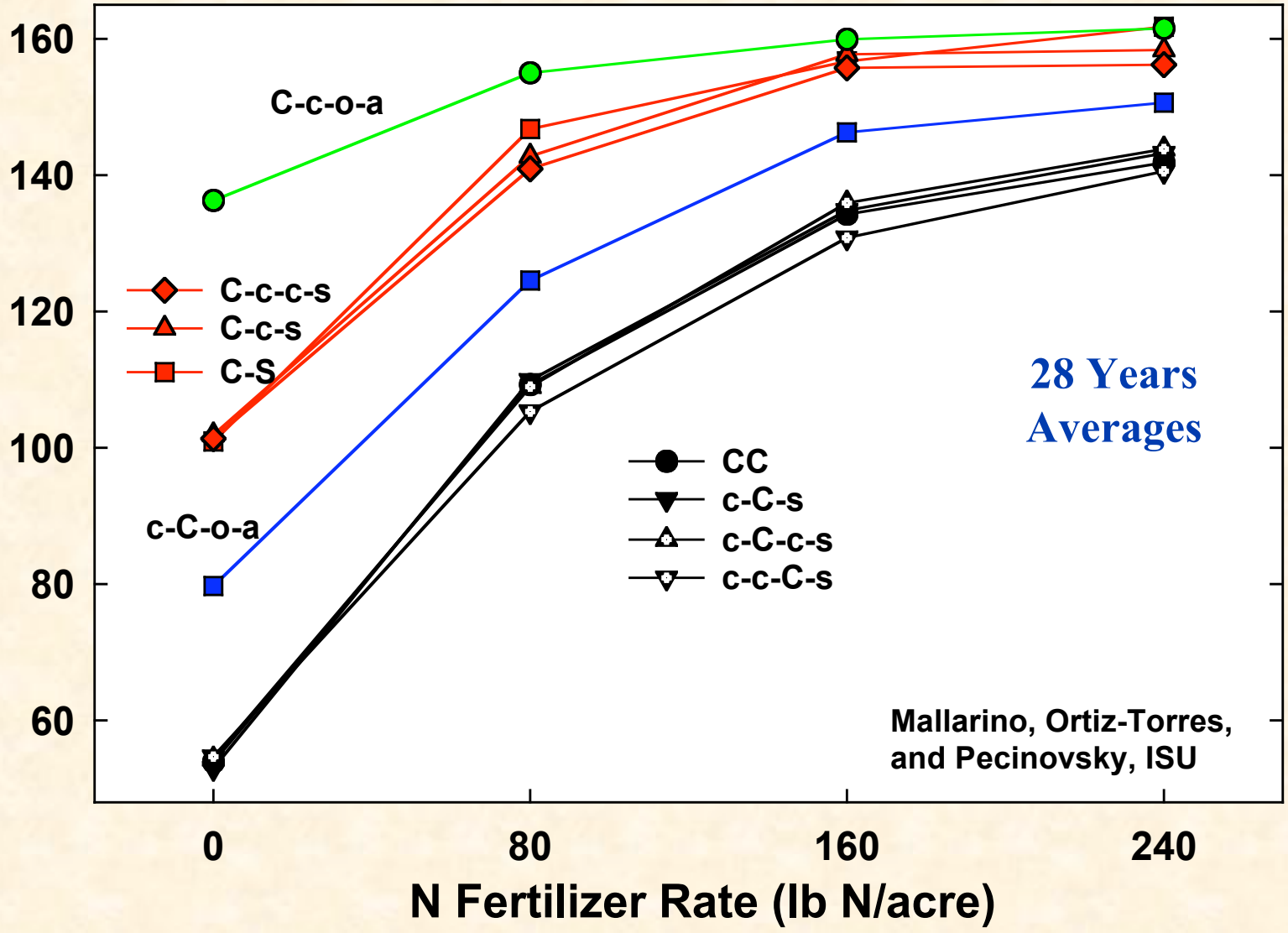
Crop Sequence	Corn Crop Studied	Code
continuous corn	continuous corn	C
corn-soybean	corn after soybe an	Cs
corn-corn-soybean	1st corn after soyb	Ccs
	2nd corn after soyb	cCs
corn-corn-corn-soyb	1st corn after soyb	Cccs
	2nd corn after soyb	cCcs
	3rd corn after soyb	ccCs
corn-corn-oats-alfalfa	1st corn after alfalfa	Ccoa
	2nd corn after alfalfa	cCoa

Types of Corn Crops at Kanawha

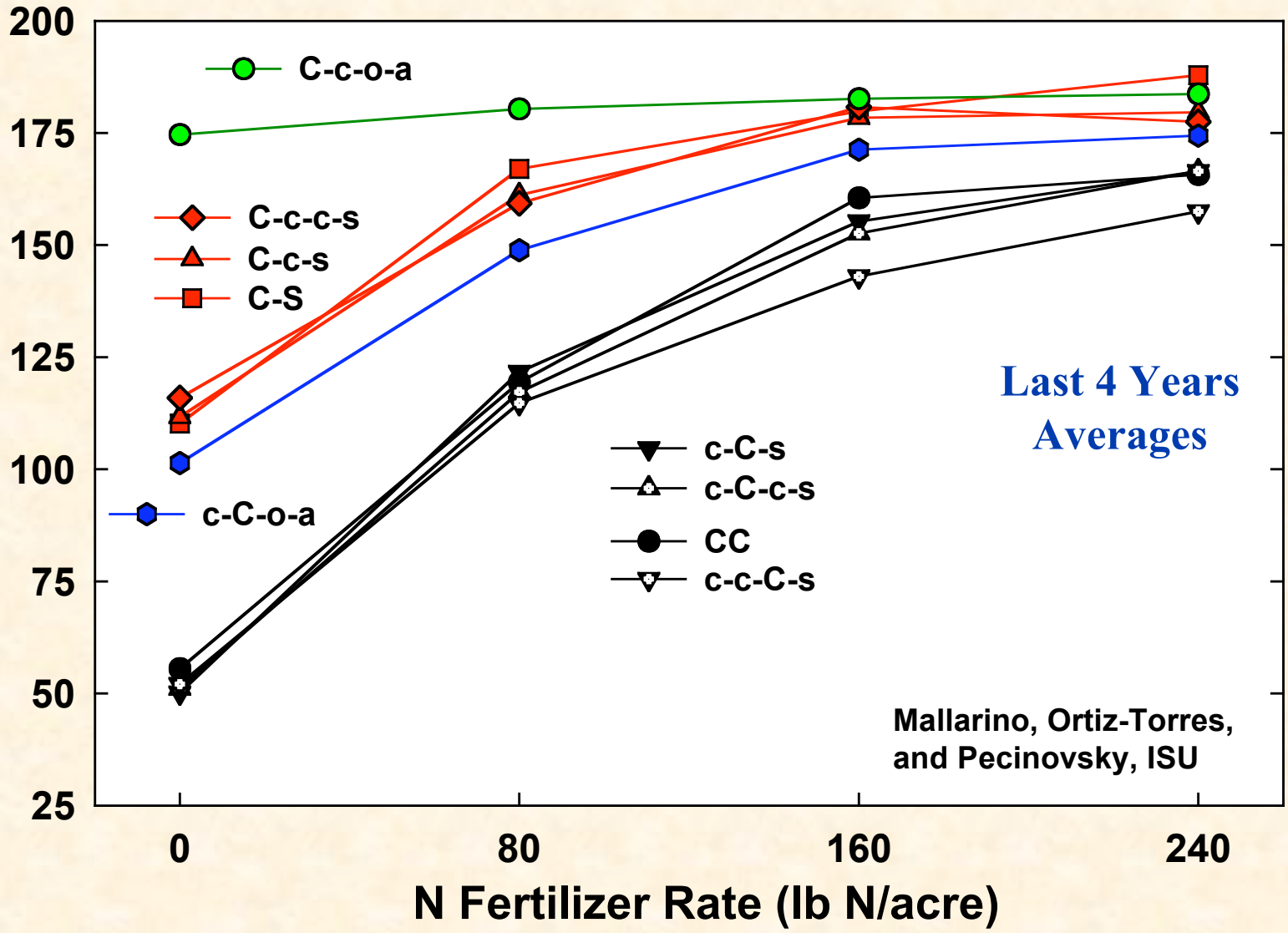
- Summarize 1985 through 2004 (20 years)

Crop Sequence	Corn Crop Studied	Code
continuous corn	continuous corn	C
corn-corn-corn-oats	1st corn after oats	Ccco
	2nd corn after oats	cCco
	3rd corn after oats	ccCo
corn-soybean	corn after soyb	Cs
corn-soyb-corn-oats	corn after oats	Csco
	corn after soyb	csCo
corn-corn-oats-alf	1st corn after 1 yr of alf	Ccoa
	2nd corn after 1 yr of alf	cCoa
corn-oats-alf-alf	corn after 2 yr of alfalfa	Coaa

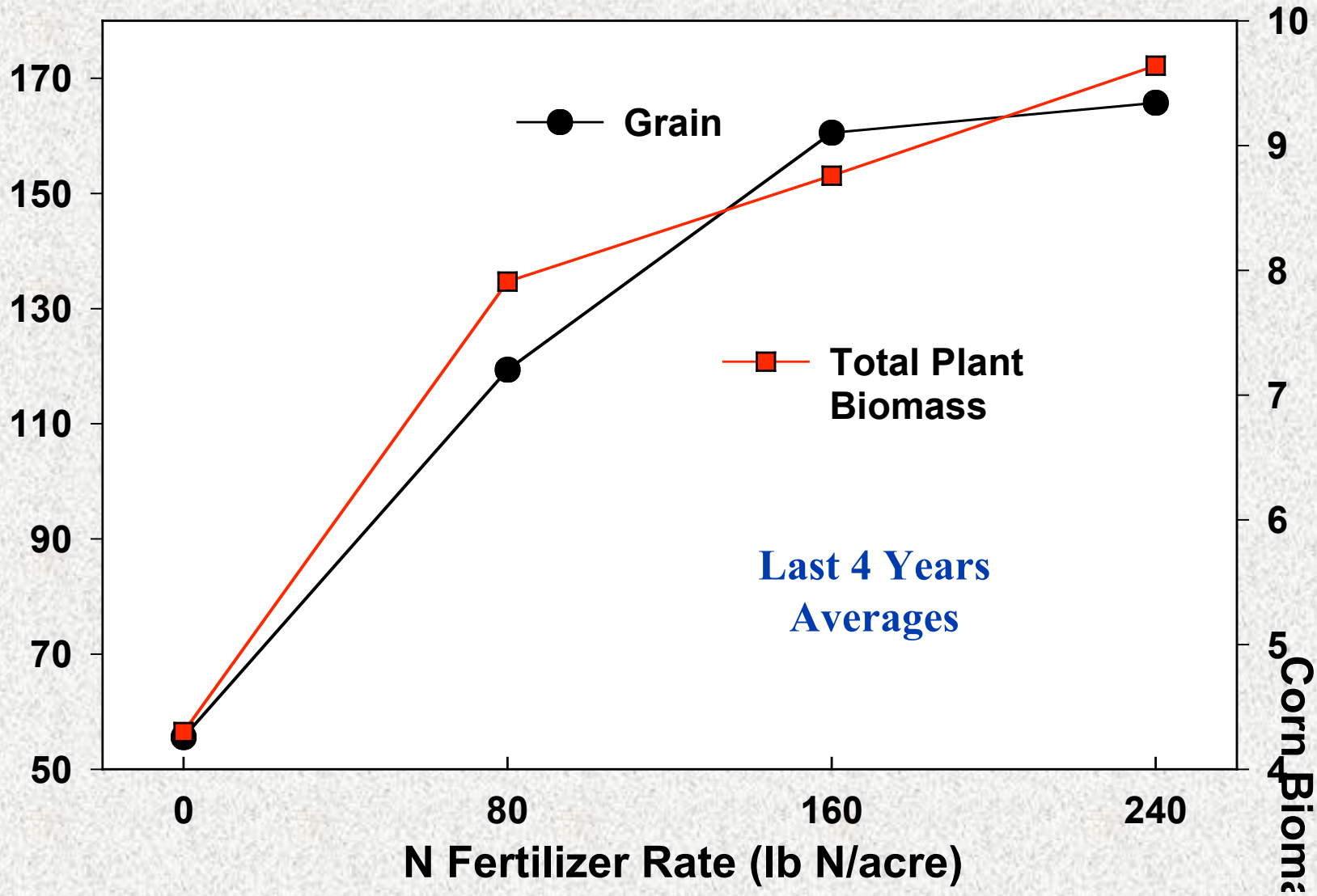
Rotation and N Effects: Nashua



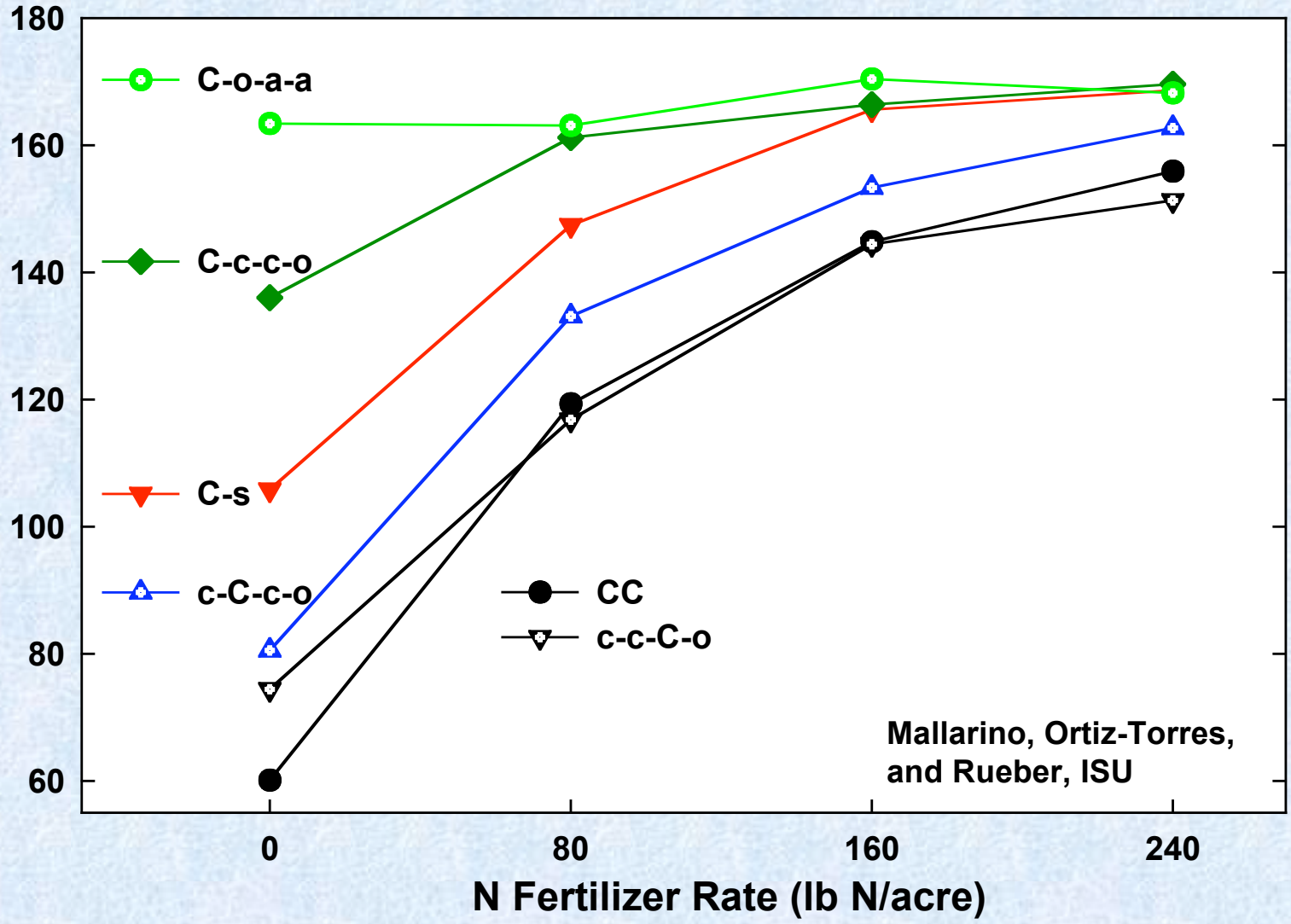
Rotation and N Effects: Nashua



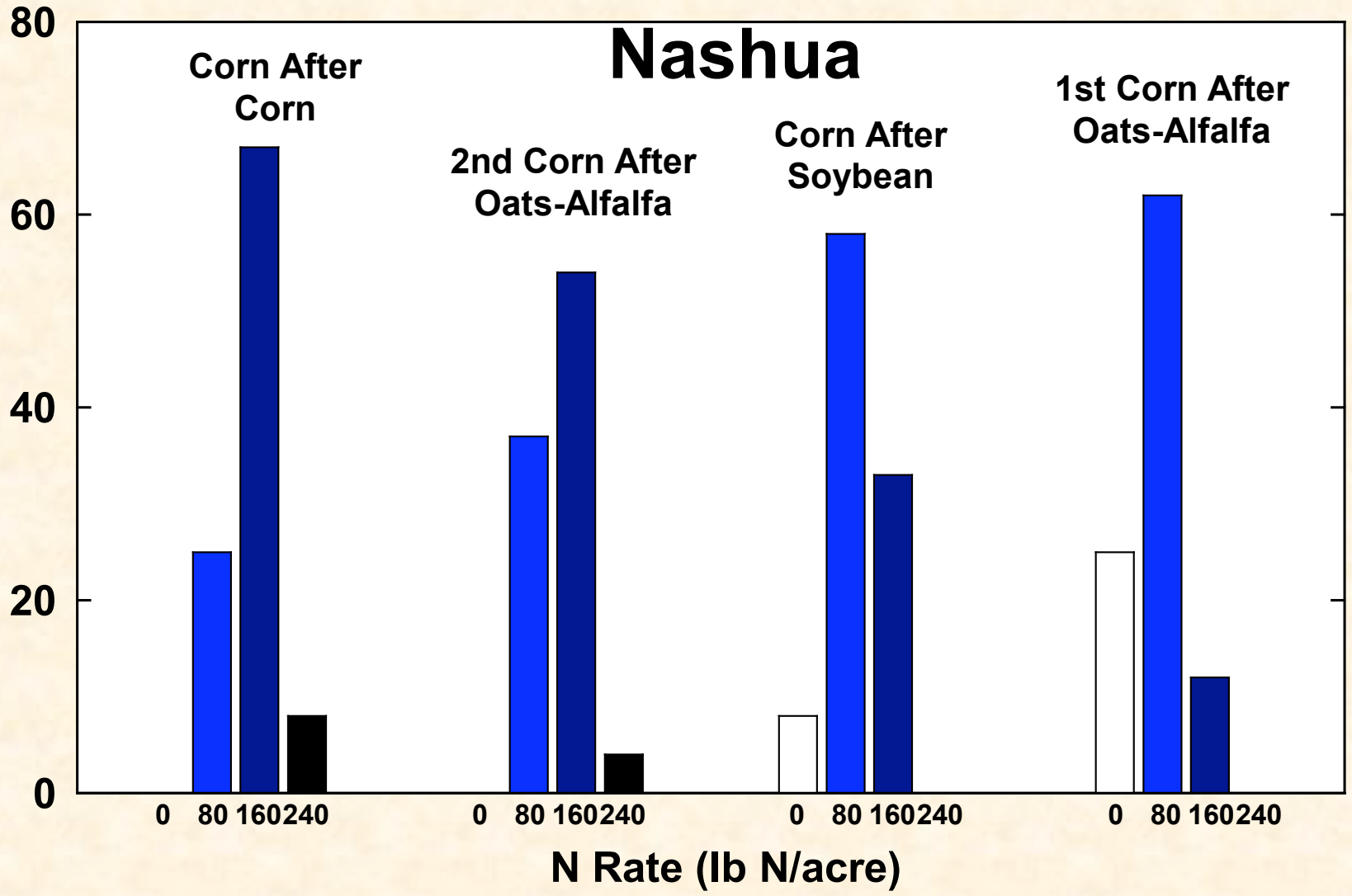
N Rates for Grain or Total Biomass Continuous Corn (Nashua)



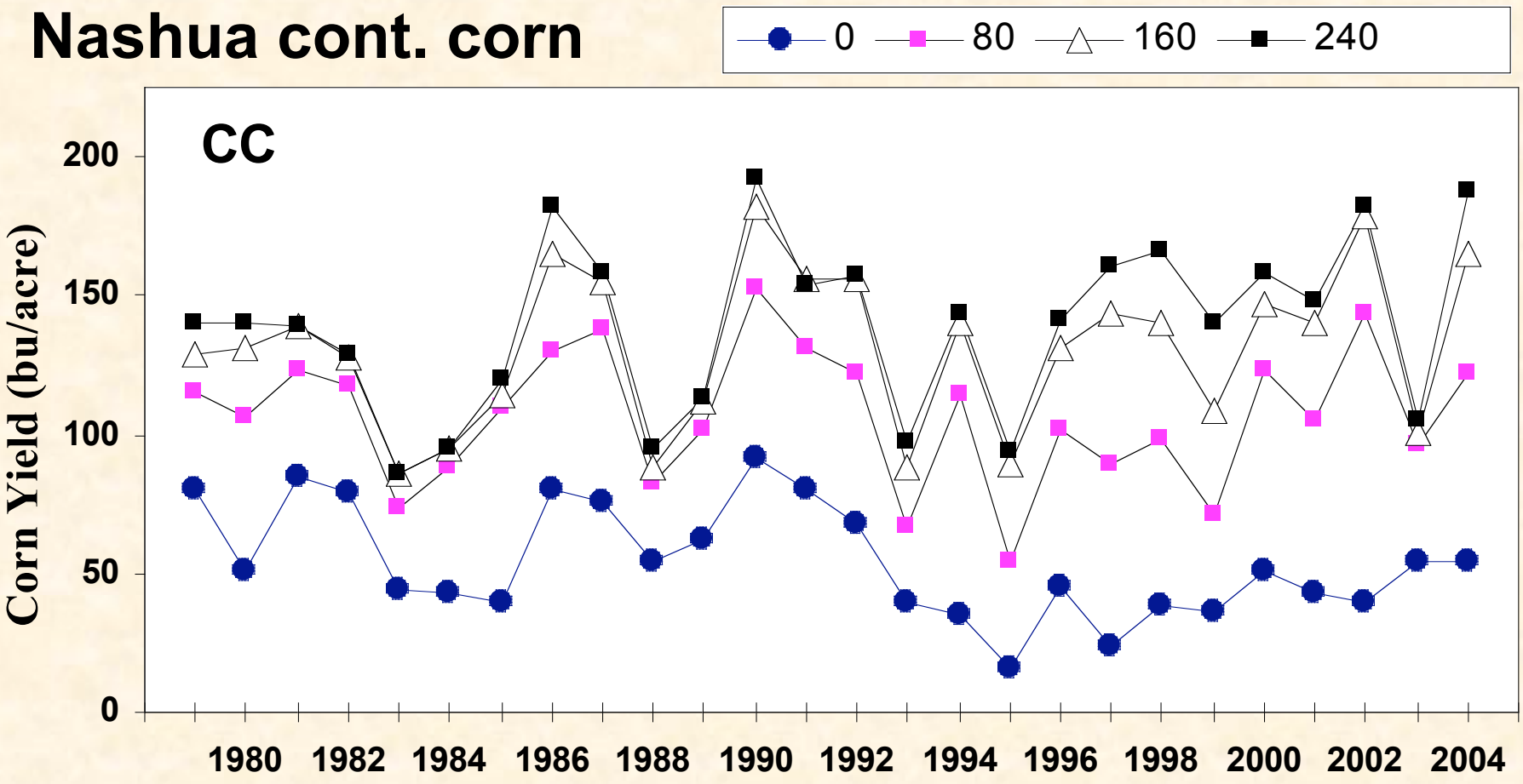
Rotation and N Effects: Kanawha



Frequency of Response to N Rates



Variation in Response to N Over Time



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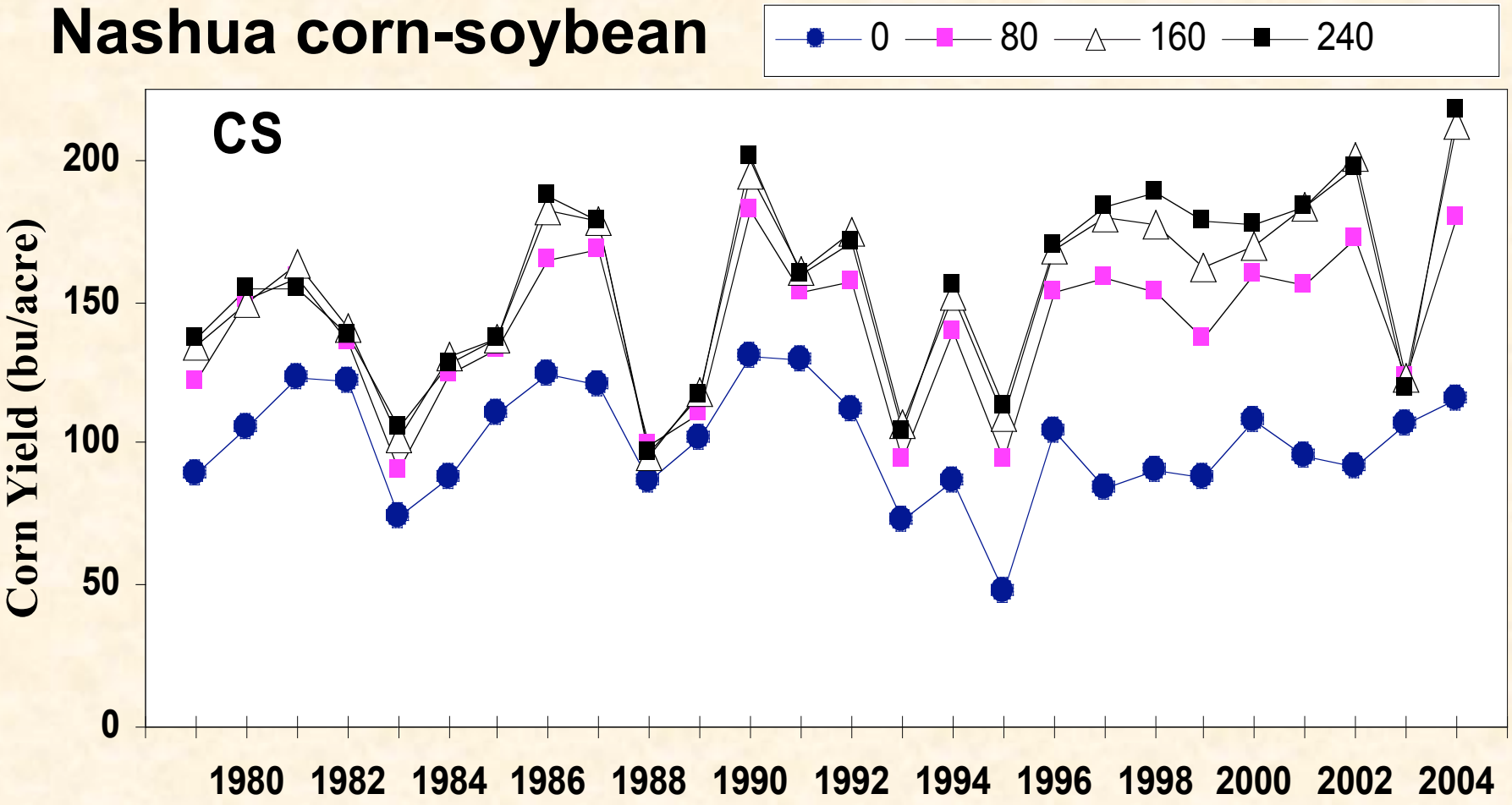

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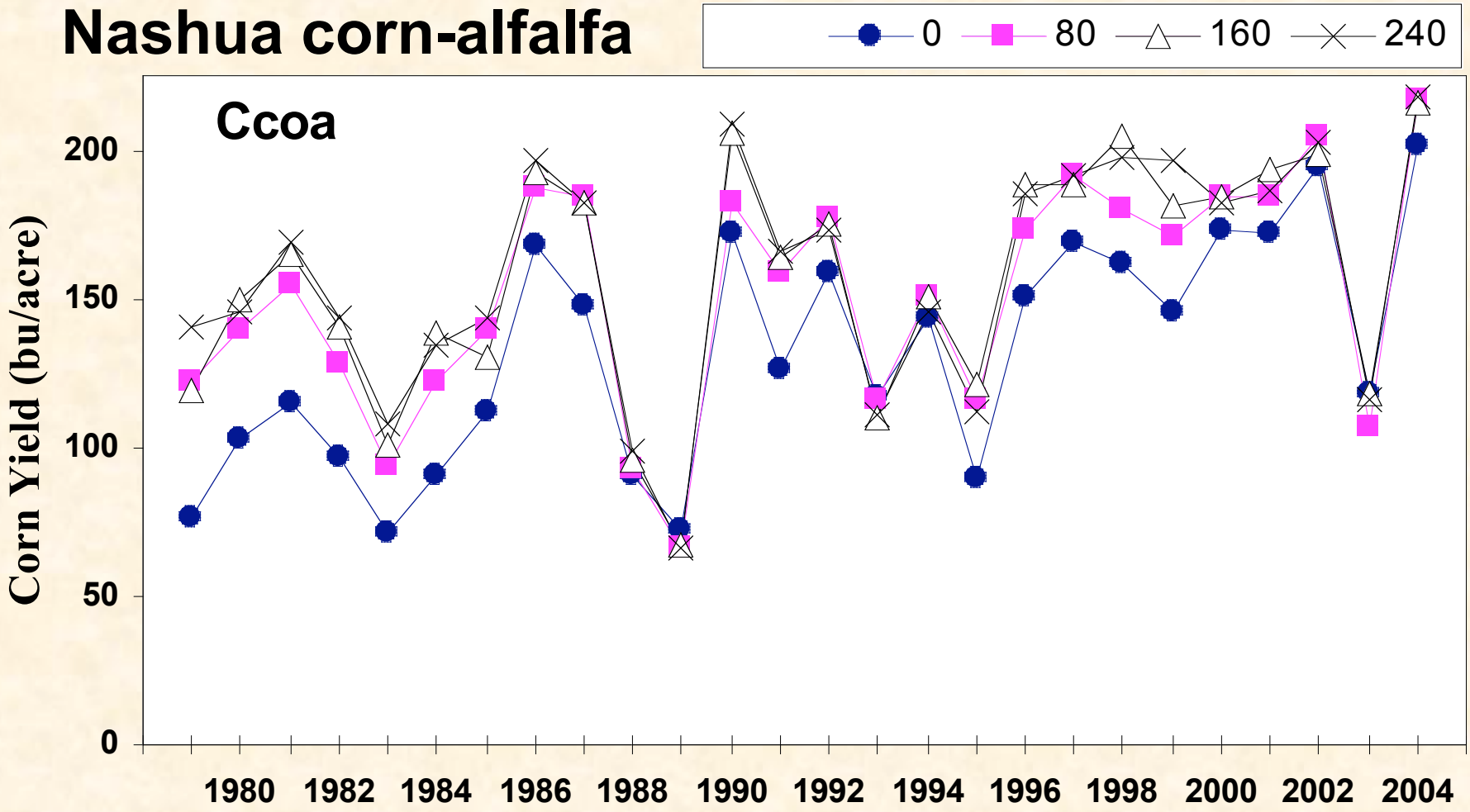

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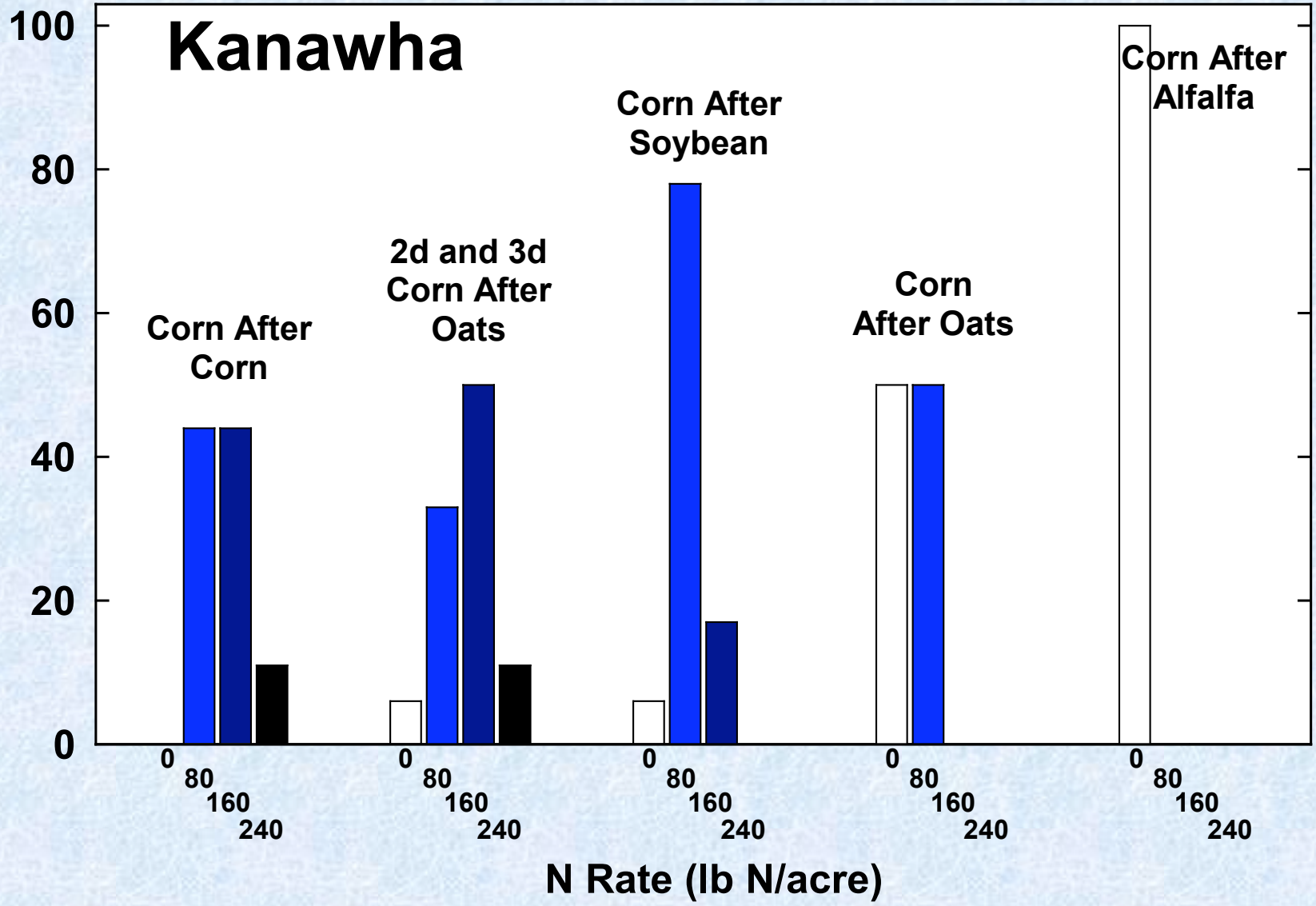

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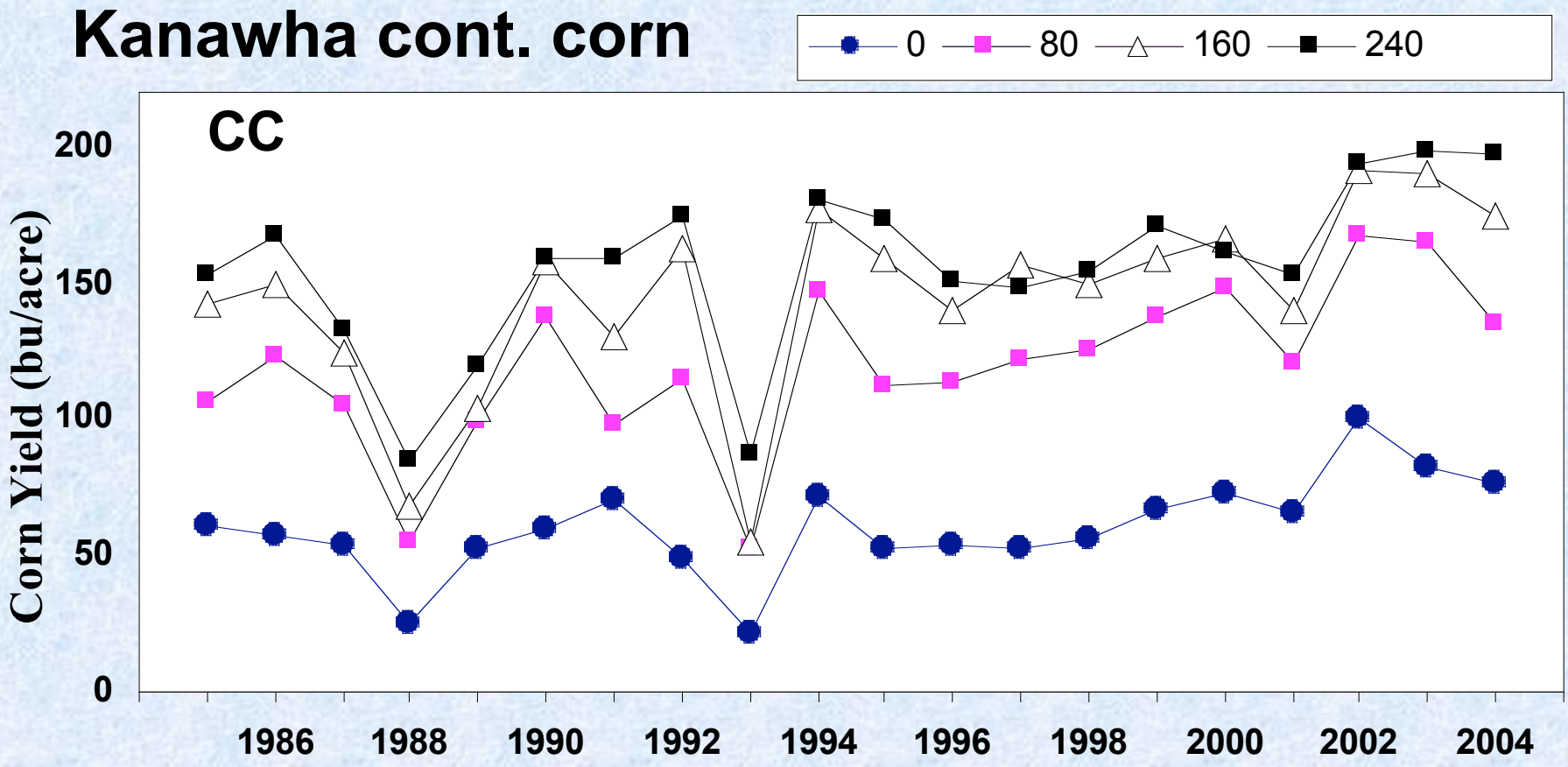

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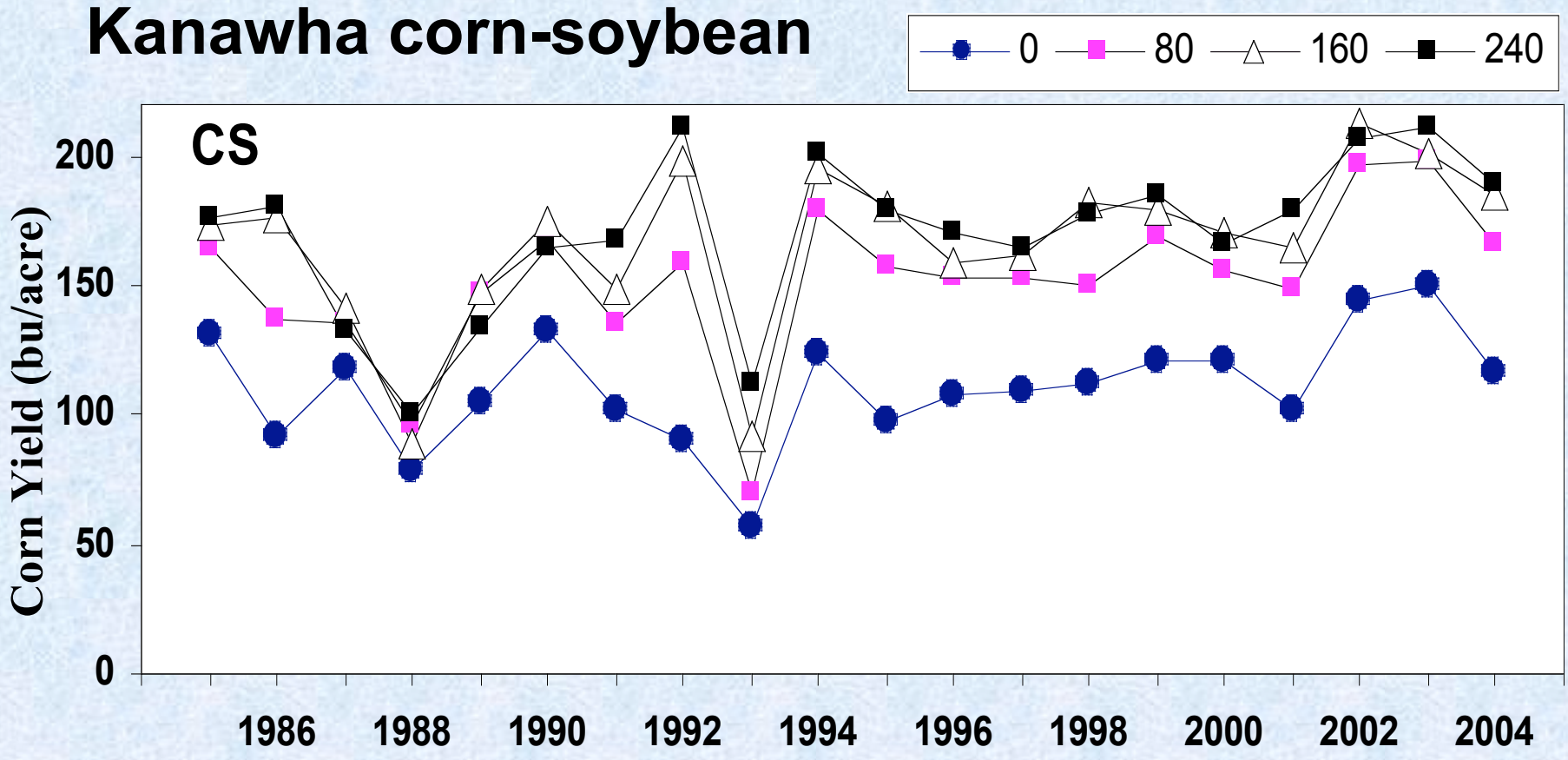

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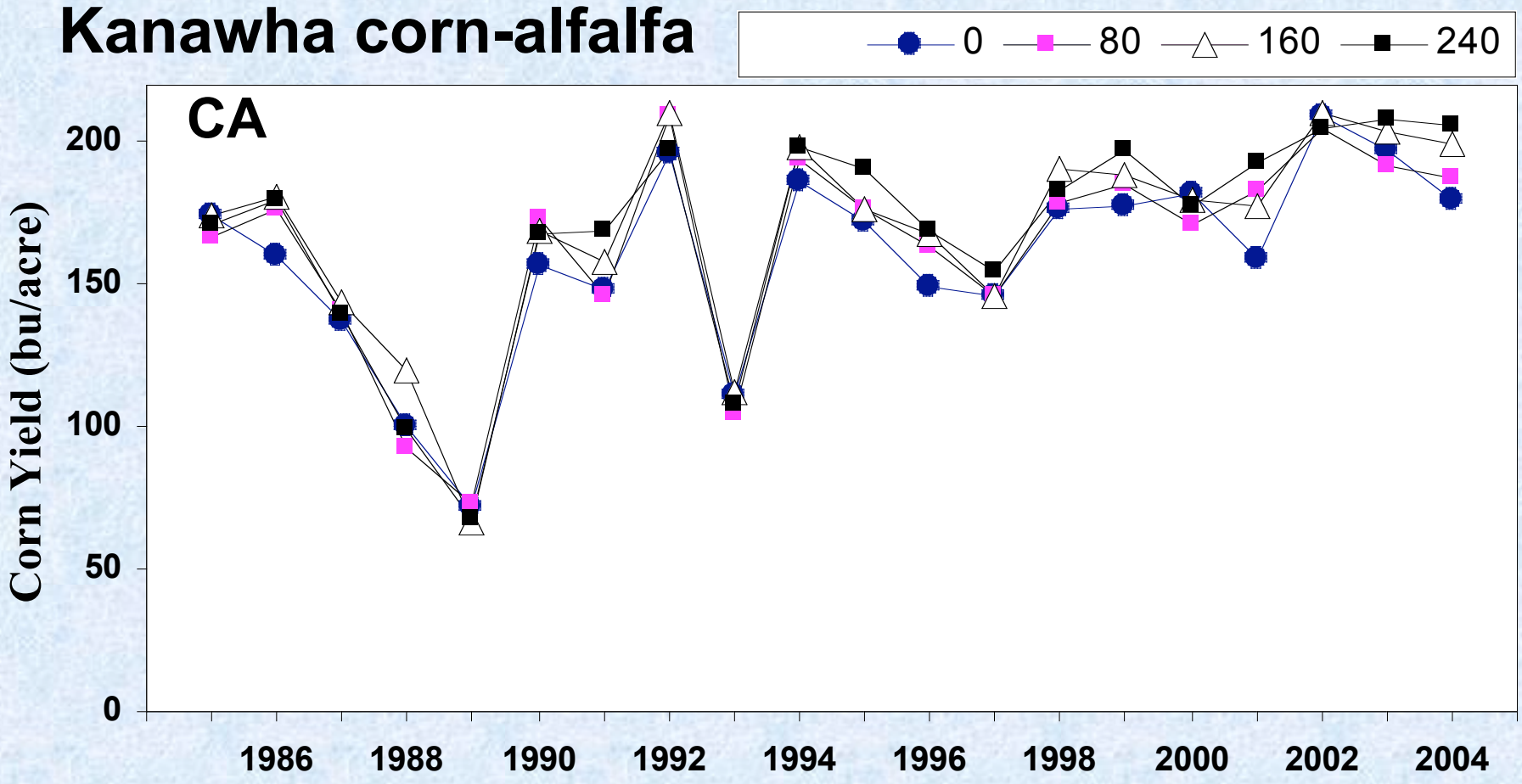


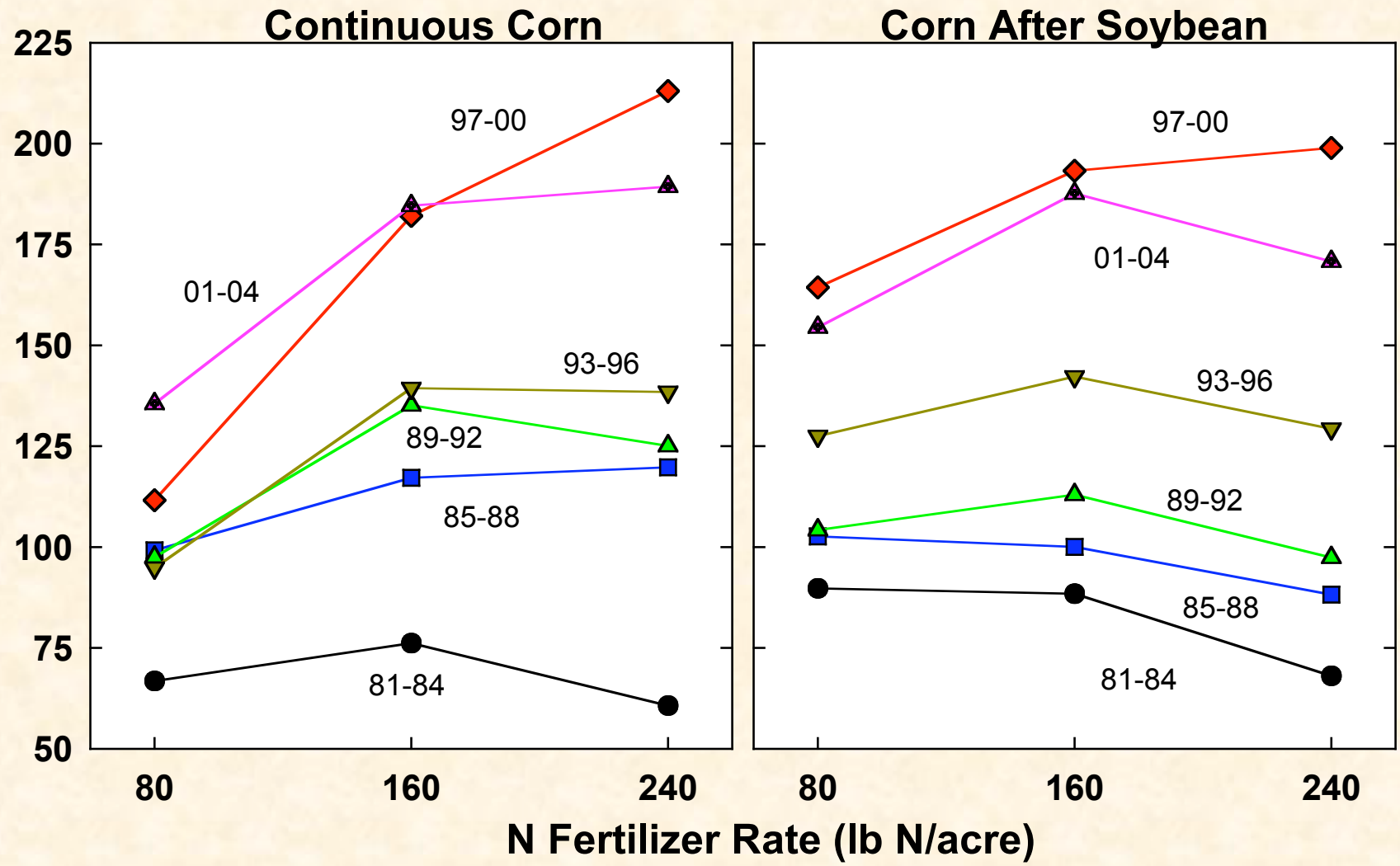
Yield Increase Over Time with Nitrogen

Corn crop	N rate	Rate of Increase	Statistical Significance
Corn after corn	0	-87x	0.01
	80	-11x	ns
	160	65x	0.01
	240	100x	0.01
Corn after soybean	0	-37x	0.01
	80	68x	0.01
	160	128x	0.01
	240	143x	0.01
Corn after alfalfa	0	241x	0.01
	80	181x	0.01
	160	175x	0.01
	240	155x	0.01

Yield Stability Over Time at Nashua

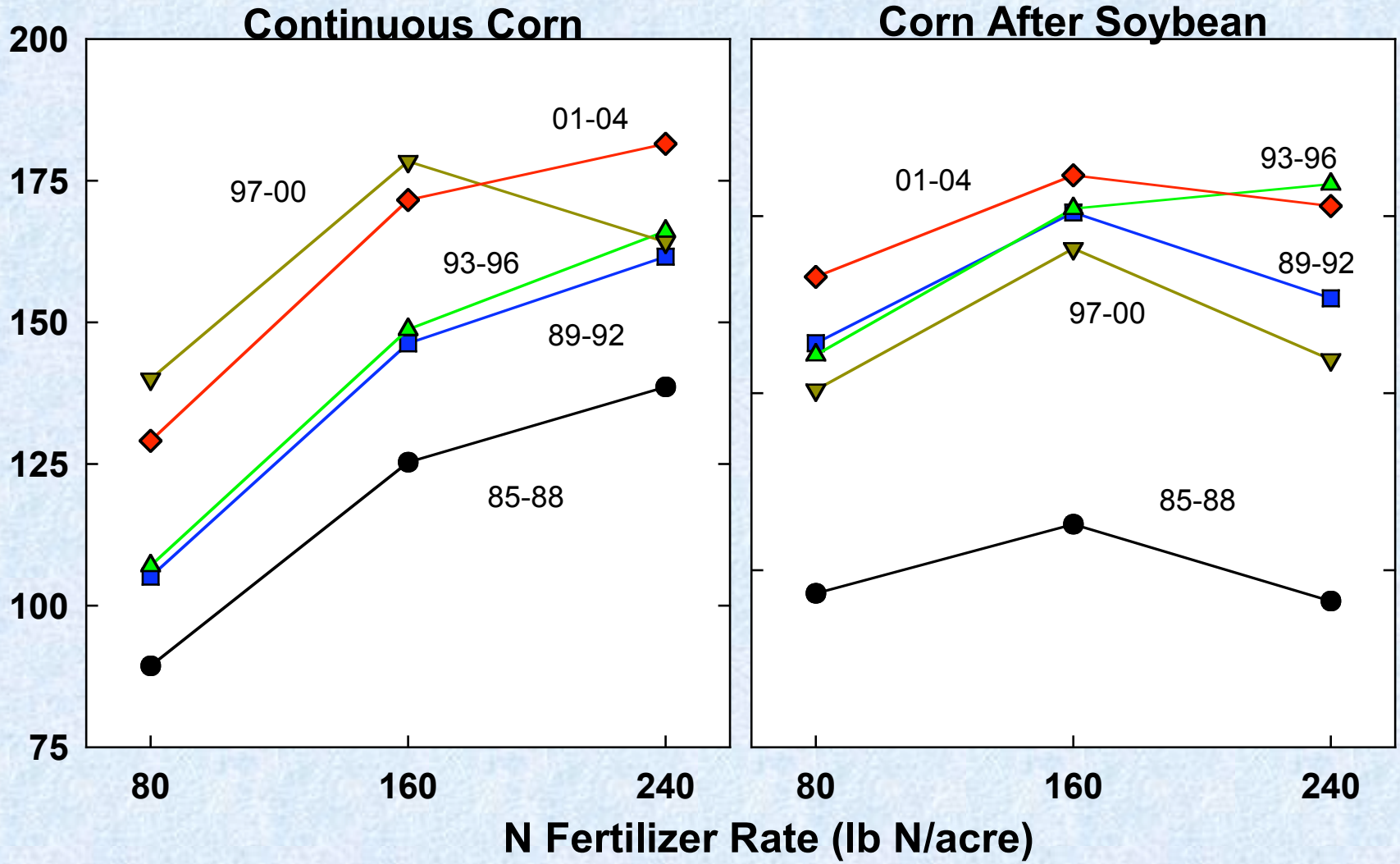
Corn crop	N rate	Stability index	Corn Yield	
			Mean	Difference
C	0	0.4	54	-71
C-soyb	0	0.5	100	-24
C-alf	0	1.3	132	8
C	80	0.9	54	-17
C-soyb	80	1.0	100	17
C-alf	80	1.3	132	27
C	160	1.0	54	6
C-soyb	160	1.2	100	30
C-alf	160	1.4	132	33
C	240	1.2	54	14
C-soyb	240	1.2	100	32
C-alf	240	1.4	132	34

Net Returns To Nitrogen: Nashua



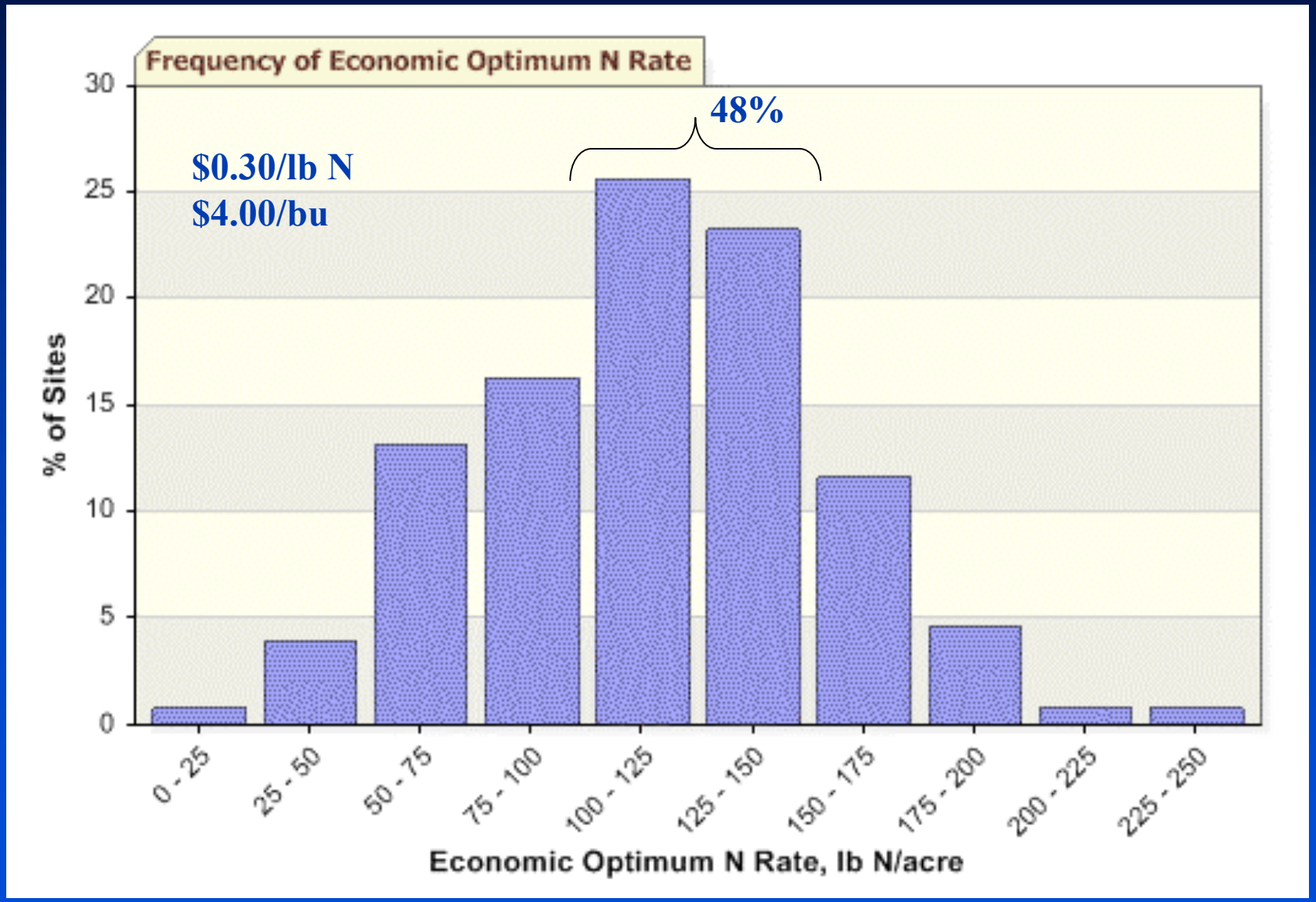
Assumed $2.20/bu corn and $0.20/lb N

Net Returns To Nitrogen: Kanawha

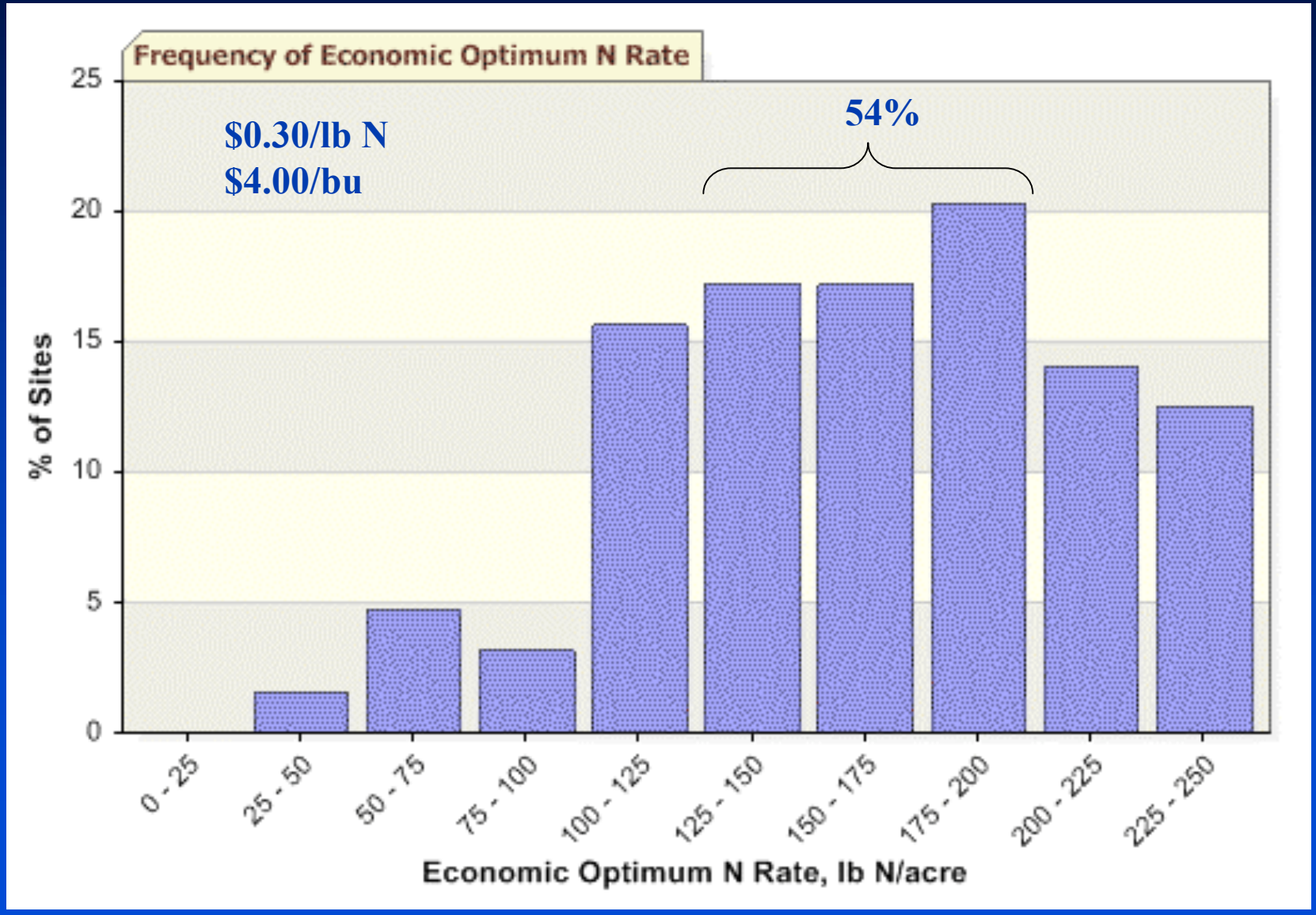


Assumed $2.20/bu corn and $0.20/lb N

N Rate Calculator Corn after Soybean



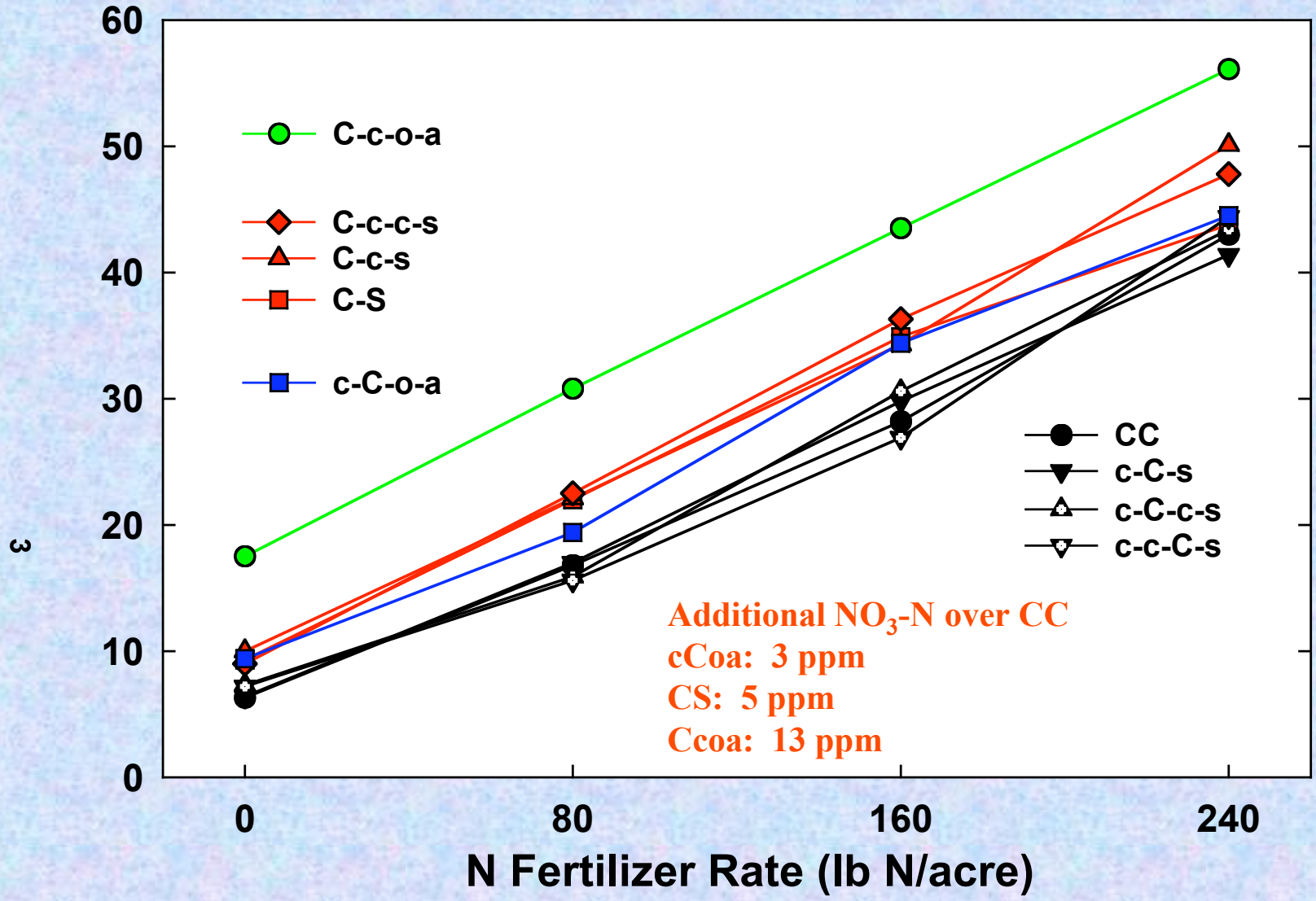
N Rate Calculator Corn after Corn



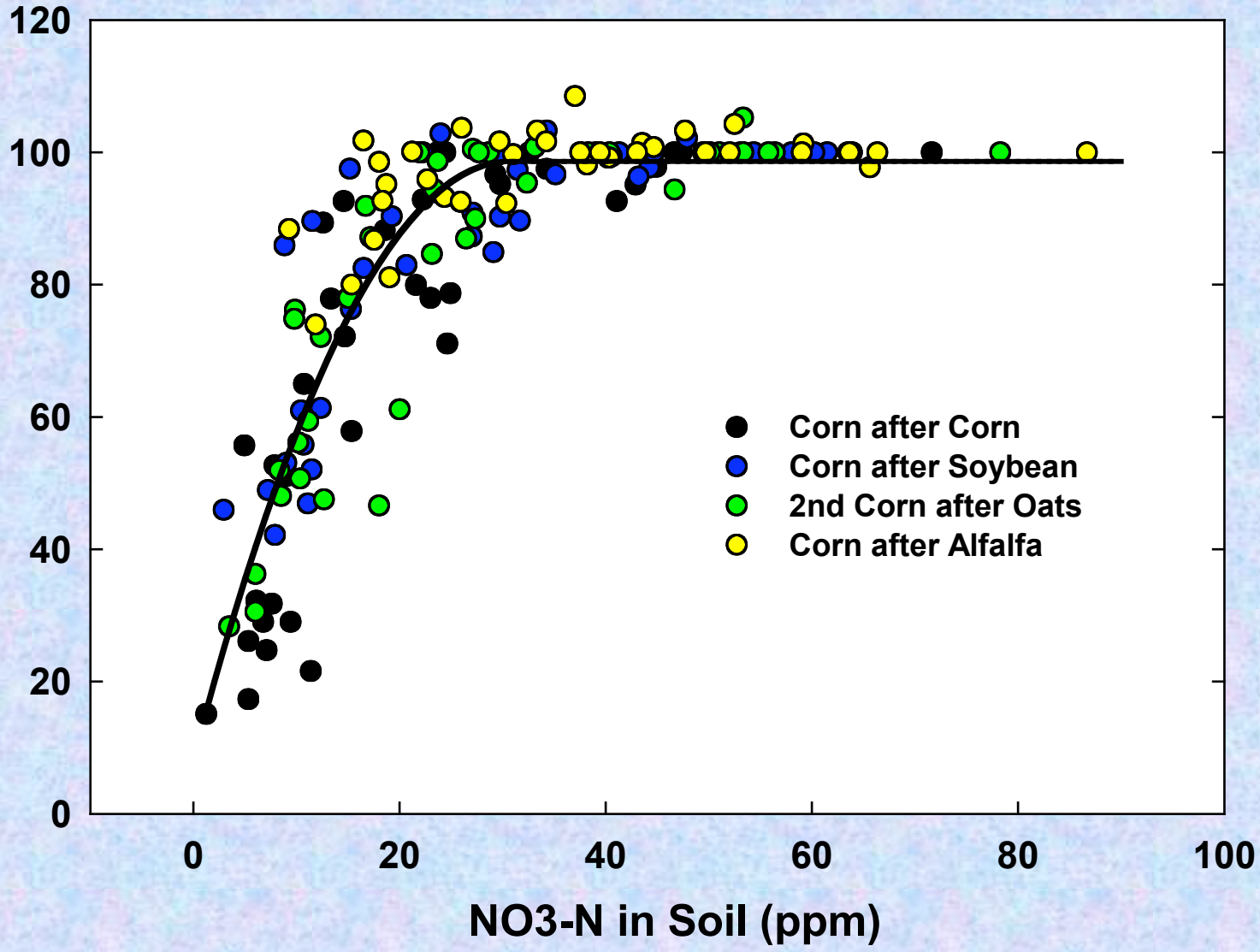
Long-Term Effect on Soil Properties

- Organic matter:
  - highest for corn after alfalfa, intermediate for corn after corn, lowest for corn after soybean.
  - increased by N fertilization only with continuous corn
- Potential N mineralization:
  - affected only by rotation, highest for corn after alfalfa but similar for others

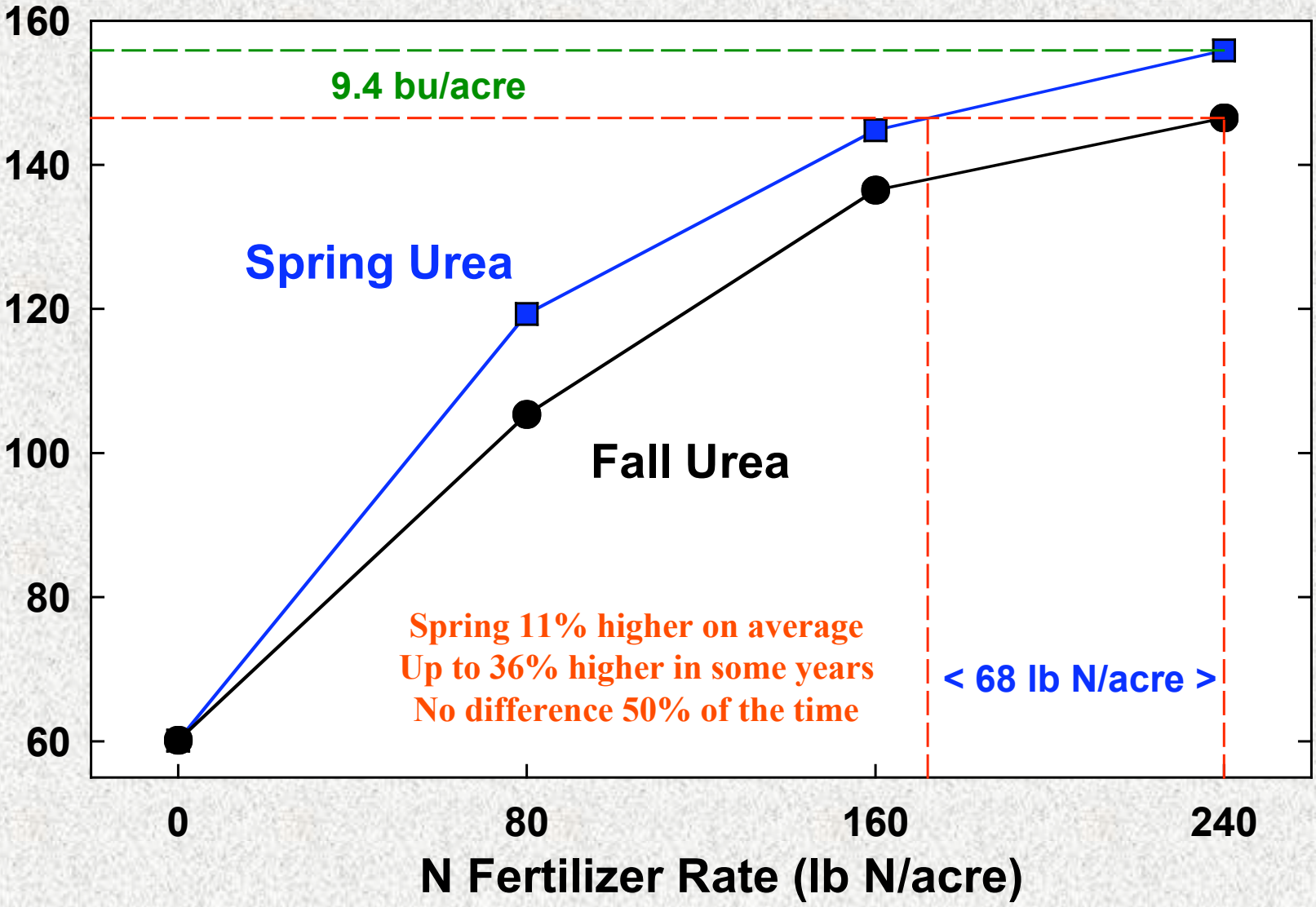
N Rate, Rotation, and Soil Nitrate



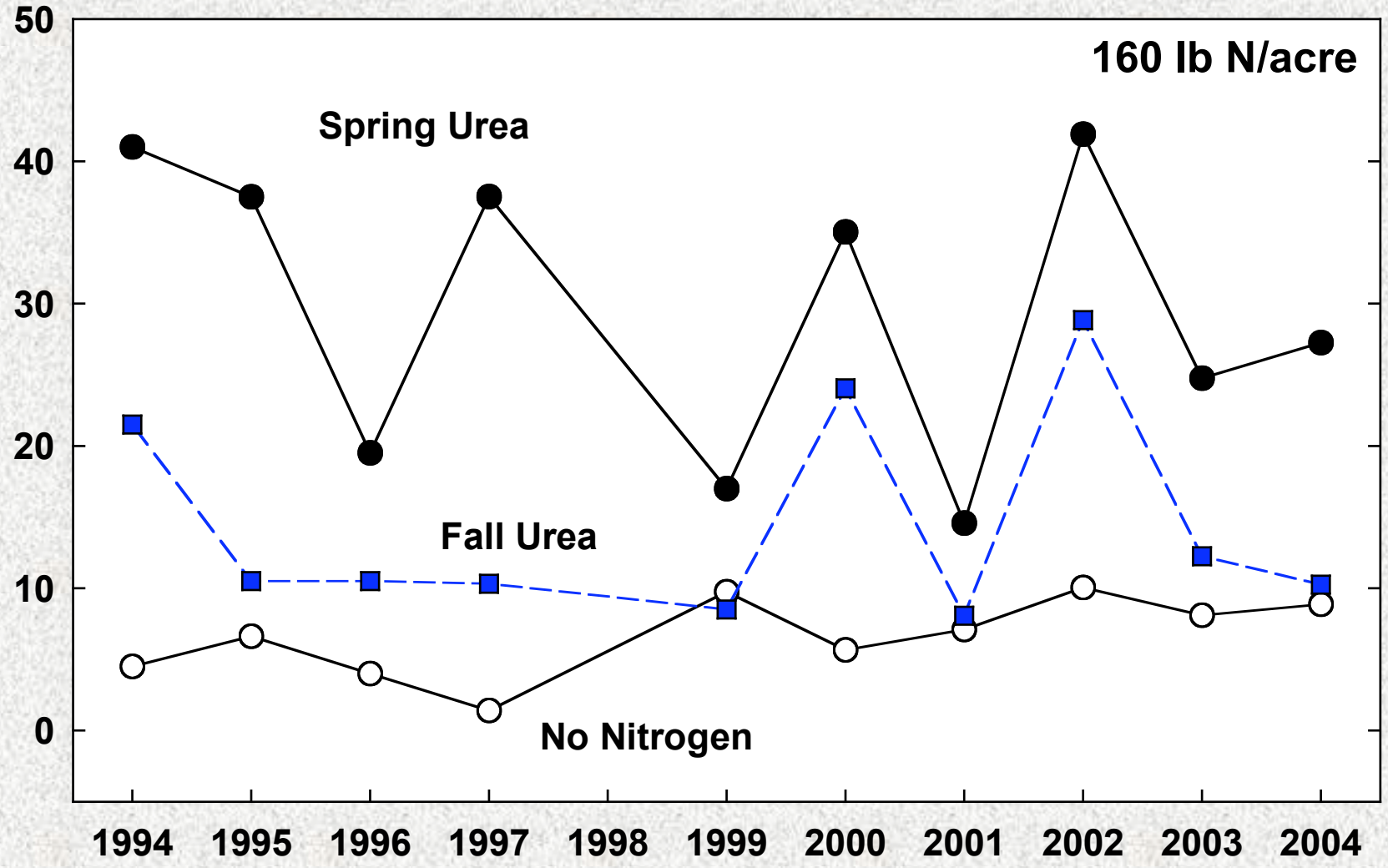
Corn Yield and Soil Nitrate



Fall-Spring Urea for Continuous Corn
20-Year Yield Averages from Kanawha



Fall-Spring Urea for CC: Soil N Trends



Summary: Rotations and N for Corn

- Rotation effects other than N over yield of continuous corn:
  - 13% for corn-alfalfa
  - 10% for corn-soybean.
- Continuous corn and 2nd or 3rd year corn after soybean have had similar yield levels and N fertilizer requirements.
- N rates to attain maximum yield or returns have not changed consistently over time.

Summary: Rotations and N for Corn

- Near-optimum or higher N rates allowed for expression of yield level increases over time and for better yield stability.
- On average, spring N produced 11% more yield than fall N on average, was up to 36% higher in individual years, but did not differ 50% of the time.
- Soil nitrate in late spring reflected well increased N availability for rotated corn and N loss from fall N application.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