


Agronomic & Fertilizer Management for Corn on Corn

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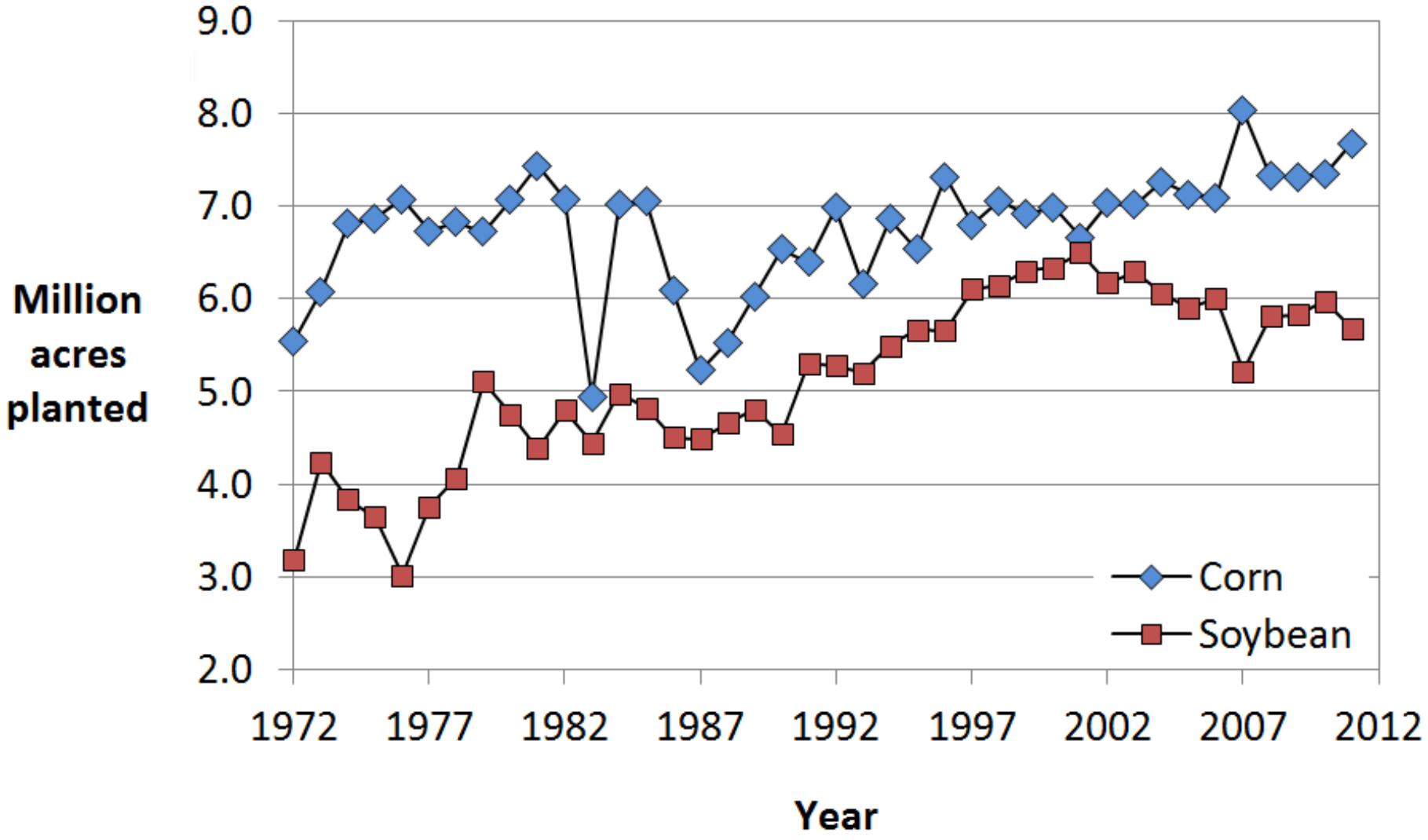
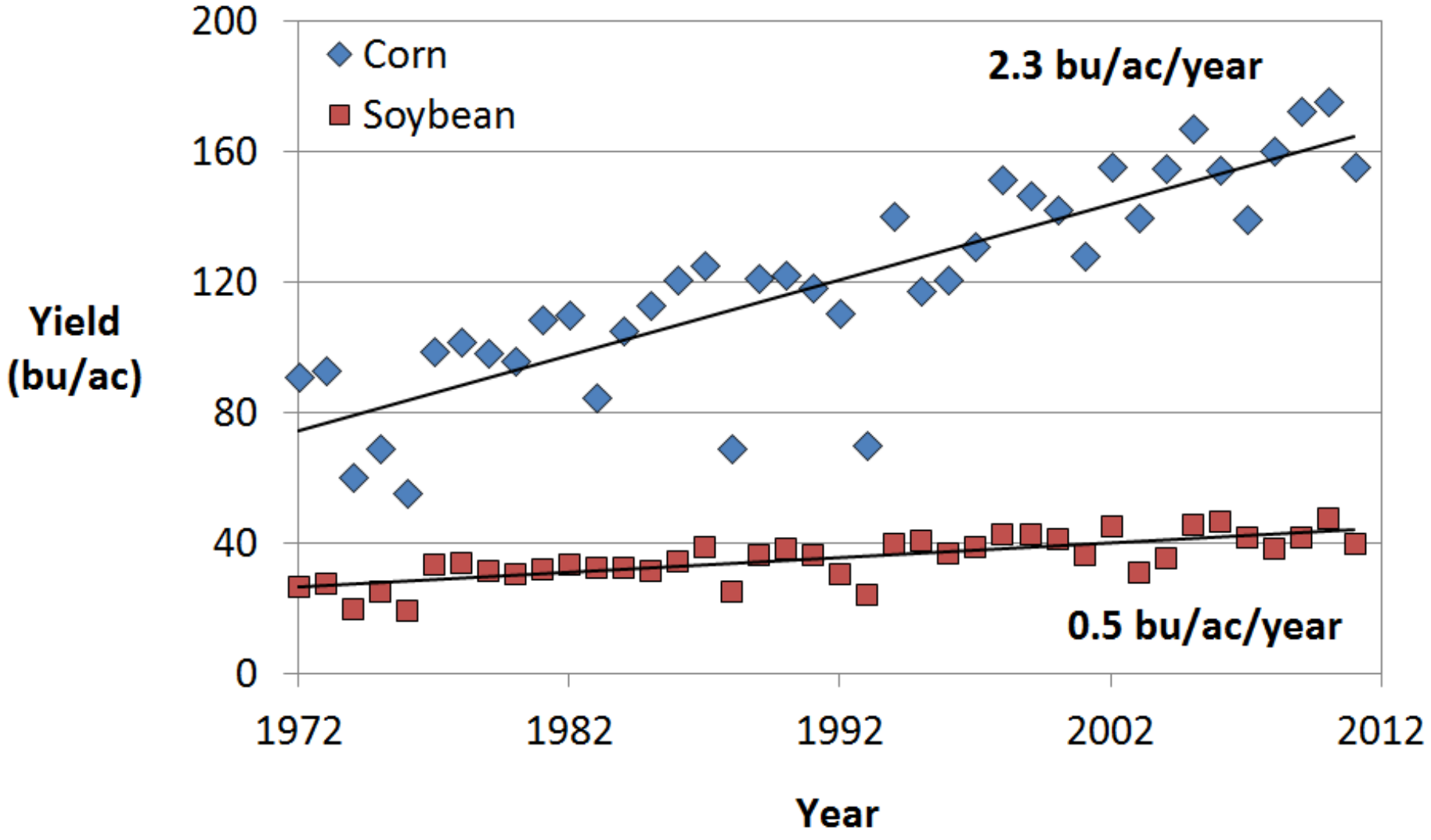
More corn following corn in southern & central MN



Data from USDA-NASS (southern & central MN agricultural districts)

Faster yield gains for corn in southern & central MN

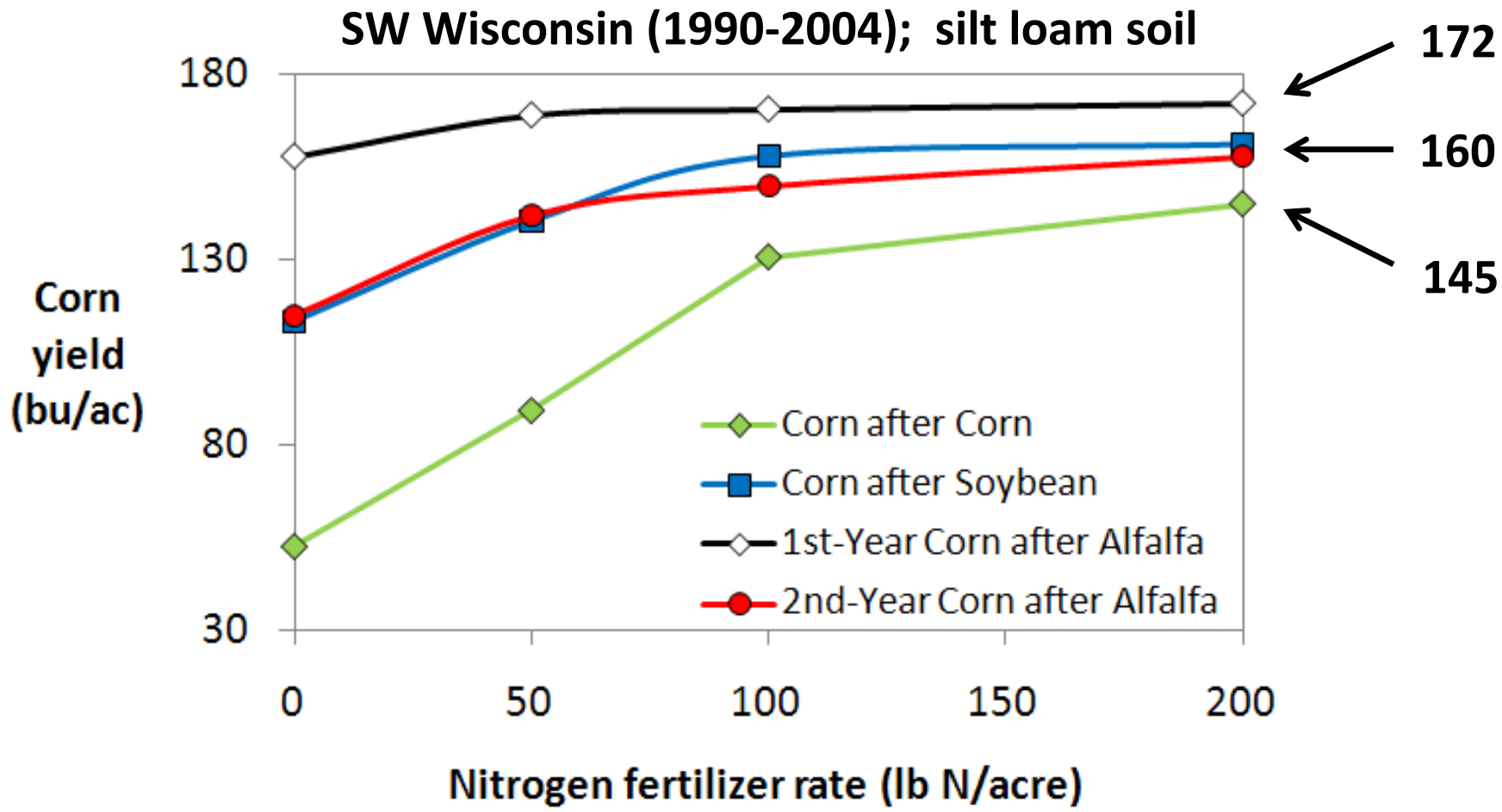


Data from USDA-NASS (southern & central MN agricultural districts)

Crop rotation increases yield & reduces N fertilizer needs for corn

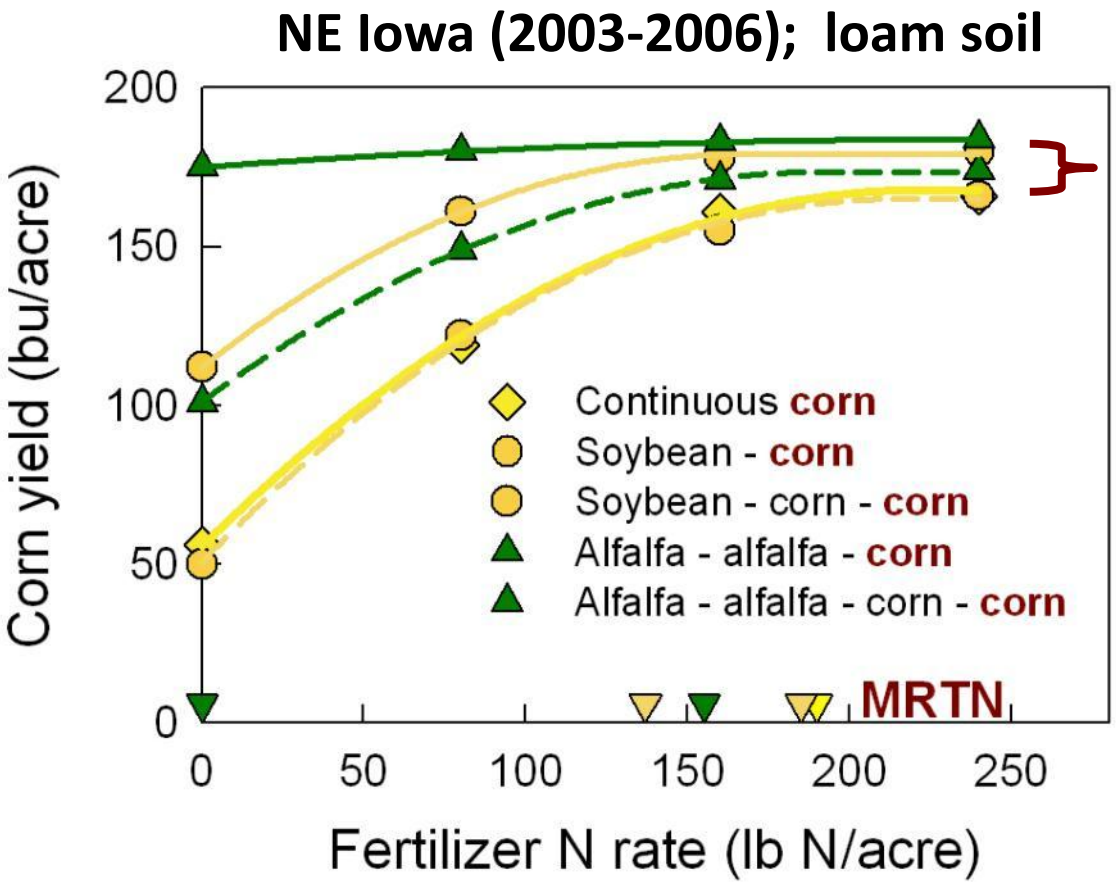
1) Crop rotation increased yield (10-19% at highest N rate)

2) Crop rotation reduced N fertilizer needs for corn



From Stanger et al. (*Agronomy Journal*, 2008)

Crop rotation increased yield & reduced N needs



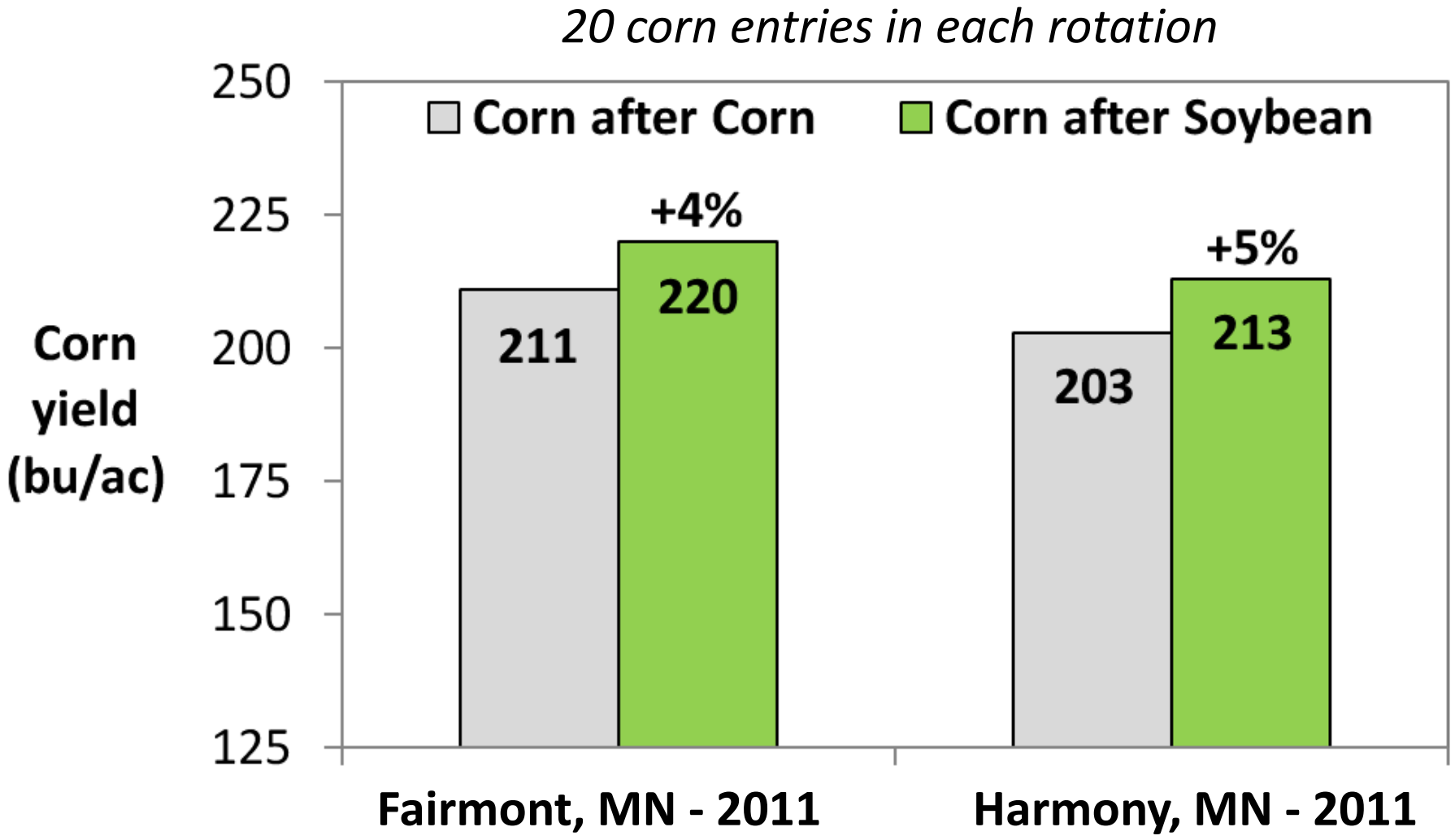
Non-N rotation effects

	N credit (lb N/ac)
1st yr after soybean	53
2nd yr after soybean	5
1st yr after alfalfa	190
2nd yr after alfalfa	34

N Credit = $MRTN_{(continuous\ corn)} - MRTN_{(rotated\ corn)}$

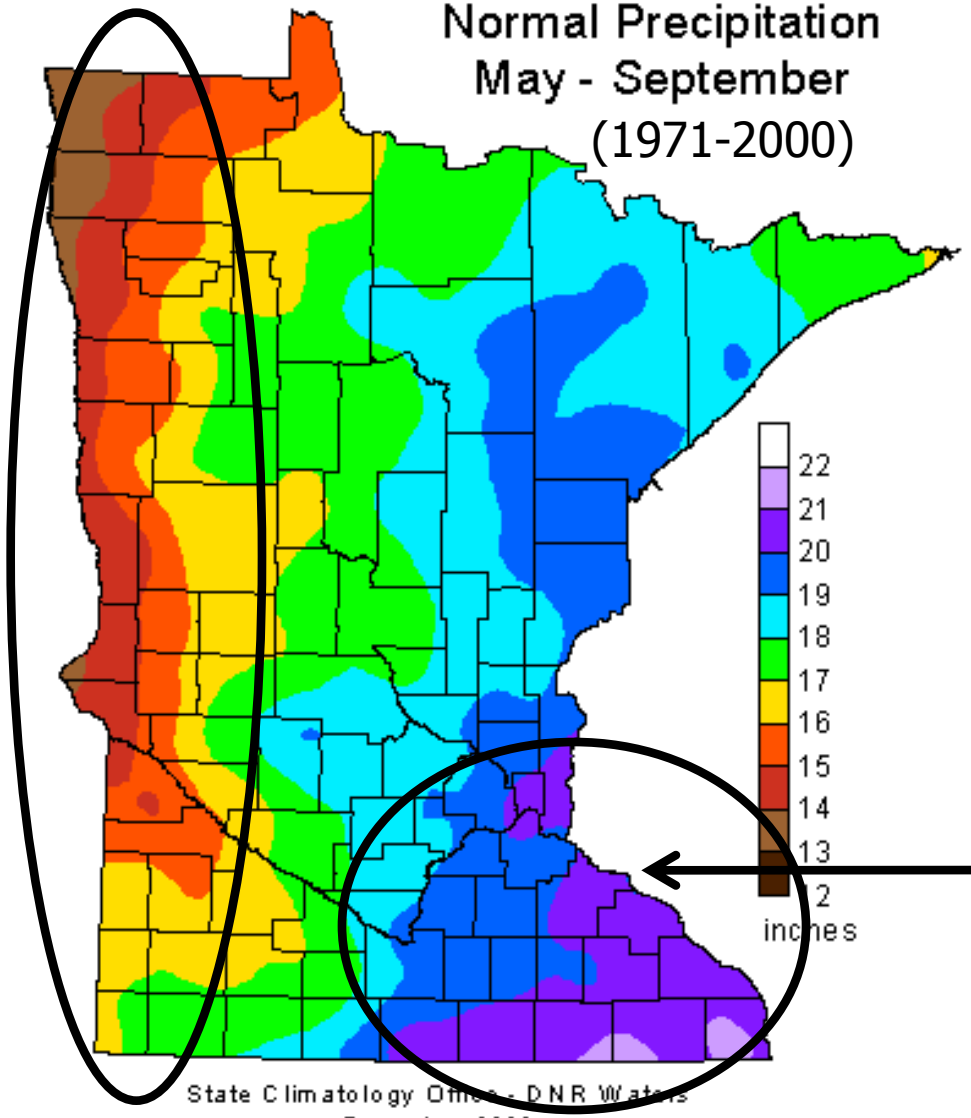
Data from Mallarino & Pecinovsky, 2006; Slide courtesy of Michael Russelle, USDA-ARS

Yield penalty for corn following corn is less in high-yield environments



Data from Crop Production Services

Potential for yield reduction when corn follows corn rather than soybean



Higher risk

Lower risk

The 3-year corn-corn-soybean rotation is a good compromise

12 site-years in northern & central Illinois (2004-2007)

silt loam & silty clay loam soils

Crop and rotation		Yield (bu/ac)
Corn	Corn-soy	197
	1st-year corn in corn-corn-soy	196
	2nd-year corn in corn-corn-soy	184 (-7%)
	Continuous corn	178 (-10%)
Soybean	Corn-soy	54.9
	Corn-corn-soy	58.3 (+6%)

From Emerson Nafziger (*Illinois Agronomy Handbook*, 2009)

Soybean benefits from more corn in the rotation

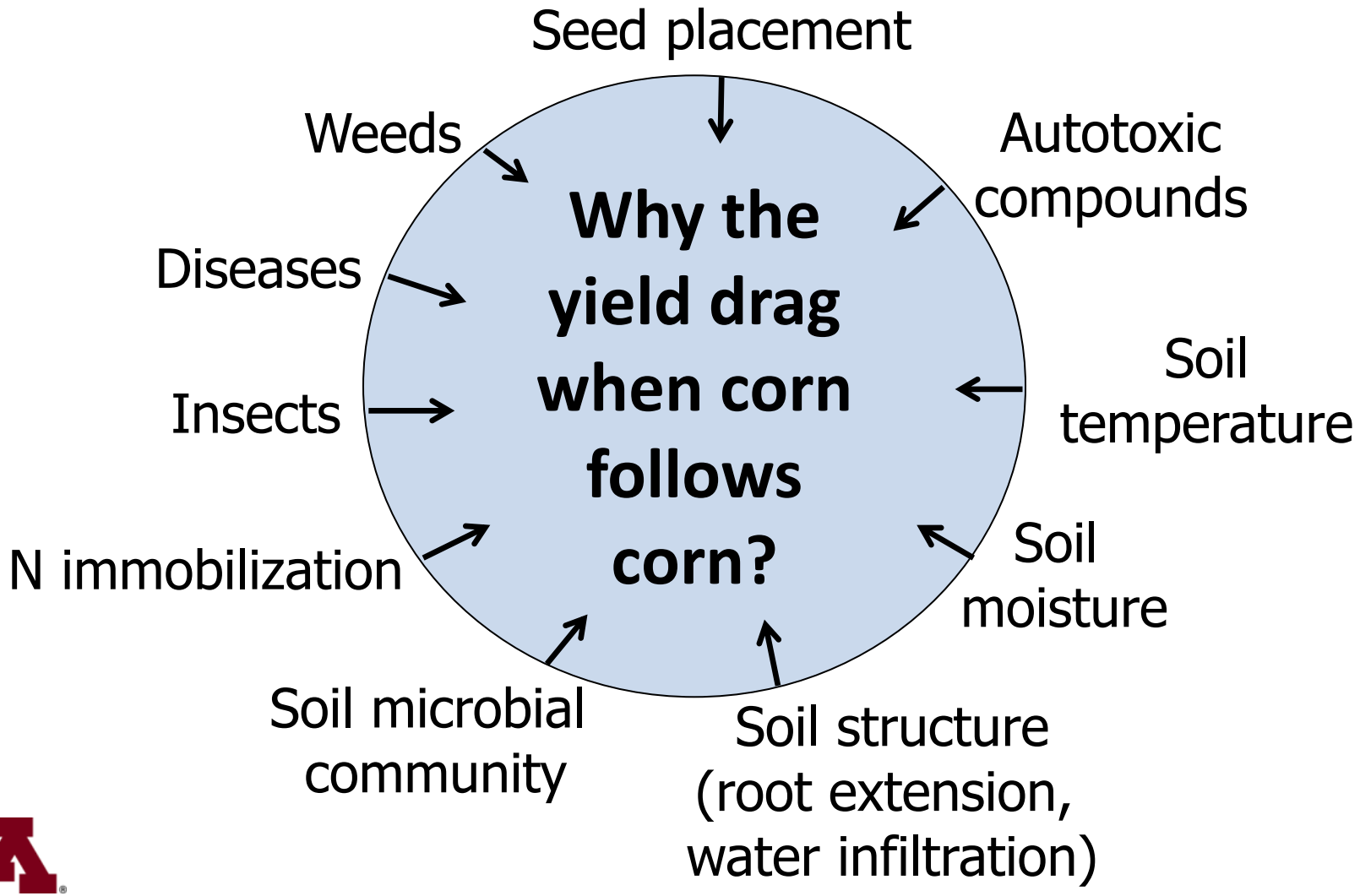
Lamberton MN – loam soil (2010)

Cropping history (year)							% of soybean stem length with BSR symptoms	Soybean yield (bu/ac)
04	05	06	07	08	09	10		
C	C	C	C	C	C	S	6 d	68 a
C	S	C	C	S	C	S	21 c	62 b
S	C	S	C	S	C	S	42 b	63 b
C	S	C	S	C	S	S	55 a	55 c

Data from Bruce Potter

LSD (0.10)

Due to several factors, many of which are influenced by old corn residue



Yield drag for corn on corn is partially due to the residue

2 years in central Illinois; silty clay loam soil; 200 lb N/ac

Cropping system	Yield (bu/ac)
Corn after soybean	200
Corn after soy (corn residue added)	188 (-6%)
Corn after corn (residue removed)	176 (-12%)
Corn after corn	167 (-17%)

From Emerson Nafziger (*Illinois Agronomy Handbook*, 2009)

Corn residue over the row reduces soil temperature, which can…

- Cause delayed & uneven emergence
- Slow early root & shoot growth
- Slow nutrient uptake
  - Especially important for nutrients that are primarily taken up through diffusion (P, K, micronutrients)
- **Early growth & nutrient uptake can affect yield**

Corn residue in the row can cause autotoxicity

- Autotoxic compounds are released from corn residue
- Autotoxic compounds slow early growth & nutrient uptake by corn seedlings

Corn residue in the row can cause immobilization of N, leading to N deficiency

- Soil microbial populations increase as they feed on carbon-rich corn residue
- Due to limited N in corn residue, these growing microbial populations utilize N from the soil
- Less N is then available to corn

Minimize within-row residue problems when corn follows corn

- Distribute residue evenly behind the swath of combine
- If a full-width tillage system is used, ***shred stalks*** & ***till early*** in the ***fall***
- Have good row cleaners & make sure they are working
- Monitor wear on double disc openers

Corn-on-corn residue management study

- 2011 & 2012 at Lamberton & Waseca, MN
- Clay loam soil (4-6% OM)
- All 4 trials were 2nd-year corn following soybean
- Fall disk-rip tillage system
- Soil fertility (excluding N & S) managed for 250+ bu/ac
- 30-inch rows; 35,000 seeds/ac

(Year 1-Soybean; Year 2-Corn; Year 3-Corn)

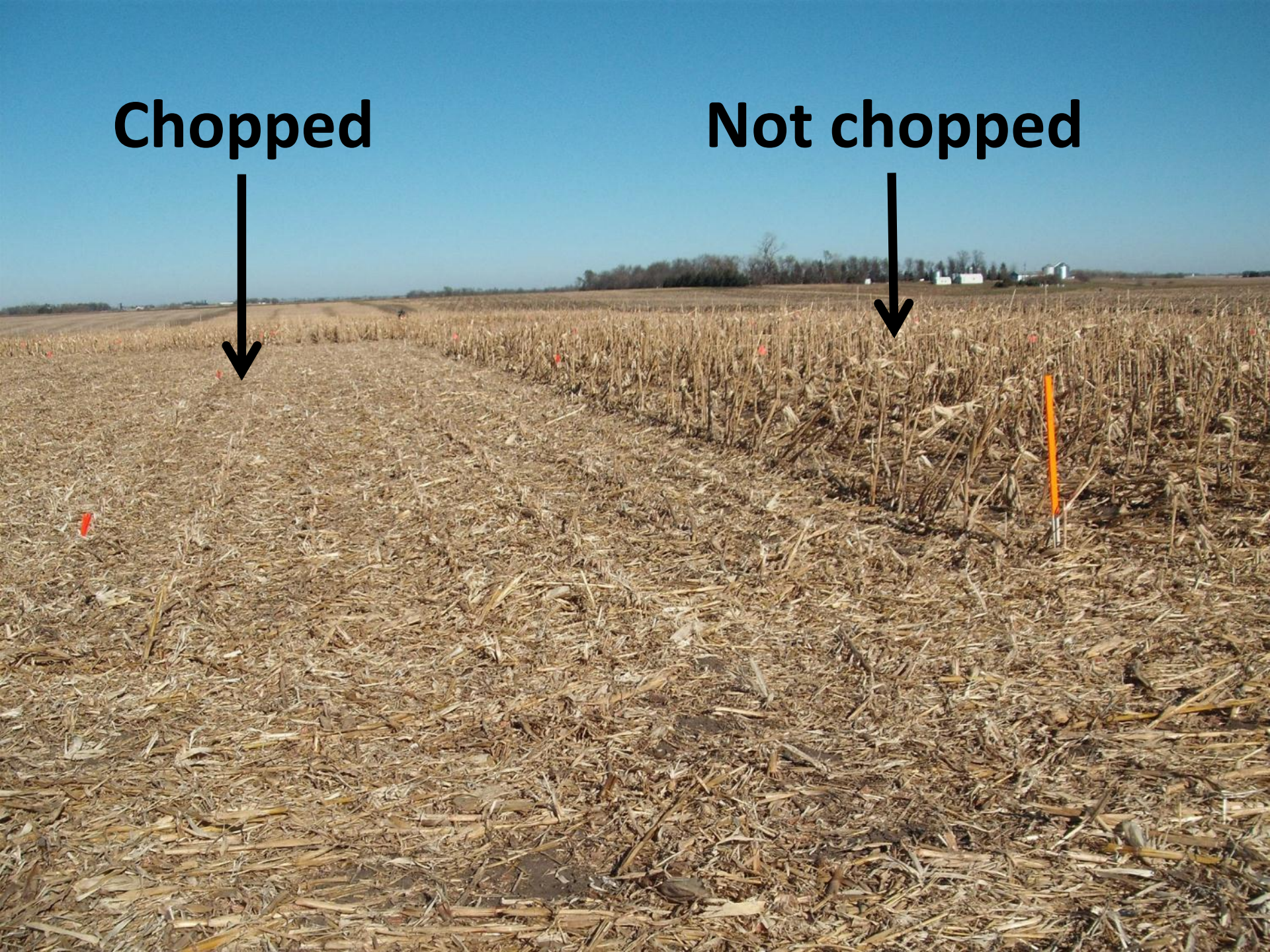
Corn residue treatments imposed in year 2

- **Residue chopped before fall tillage**
- **Residue not chopped before fall tillage**

9 combinations of N & S for 2nd-year corn

(in addition to 170 lb N/ac in spring)

1	2	3
4	5	6
7	8	9


Chopped
Not chopped

- 2 main plot treatments (stalks chopped vs. not before fall tillage)
- 9 subplot treatments - in addition to 170 lb N/ac in spring

1)	Control
2)	30 lb N/ac in fall
3)	30 lb N/ac in spring
4)	15 lb S/ac in fall
5)	15 lb S/ac in spring
6)	30 lb N/ac in fall + 15 lb S/ac in fall
7)	30 lb N/ac in fall + 15 lb S/ac in spring
8)	30 lb N/ac in spring + 15 lb S/ac in fall
9)	30 lb N/ac in spring + 15 lb S/ac in spring

- Fall N = UAN Spring N = urea S = potassium thiosulfate (liquid)
- K applied to plots not receiving S – to maintain similar K levels

Results

- Emergence & plant population not affected by residue or fertilizer treatments
- Stalk chopping increased yield by 12 bu/ac (+8%) in 1 of 4 trials
- No yield response to N rates above 170 lb N/ac
- Sulfur (fall or spring) increased yield in 1 of 4 trials

Manage corn residue by removing it?

Considerations for harvest of corn residue

- Residue harvest best suited to continuous corn
- Sustainable harvest rates – soil organic matter & erosion
- Nutrient removal
- Soil compaction
- Effect on subsequent crop yields
- Effect on optimum tillage & fertilizer rates

Sustainable harvest rates for corn residue

- **Continuous corn:**
  - 40% with disk-rip tillage systems
  - Up to 50% with less intensive tillage systems
- **Corn-soybean rotation:**
  - 27% or less (about 15% of residue is cobs)
- **<u>Alternative</u>: harvest a larger quantity of residue, but…**
  - Only every other year in continuous corn
  - Only every 4th year in a corn-soybean rotation
  - Leave enough residue to protect against erosion

Nutrient replacement costs with 40% residue harvest in 200 bu/ac corn

Nutrients removed with 40% residue removal (lb/ac)*	Nutrient price**	Nutrient replacement cost ($/ac)
28 lb N	$0.46/lb N	$12.88
11 lb P_2O_5	$0.66/lb P_2O_5	$7.26
48 lb K_2O	$0.50/lb K_2O	$24.00
		$44.14

*From Sawyer & Mallarino (2007).

**Nutrient sources were anhydrous ammonia, DAP, & potash. Cost of N in DAP was removed.

- If residue is harvested in continuous corn, what is the optimum tillage system?

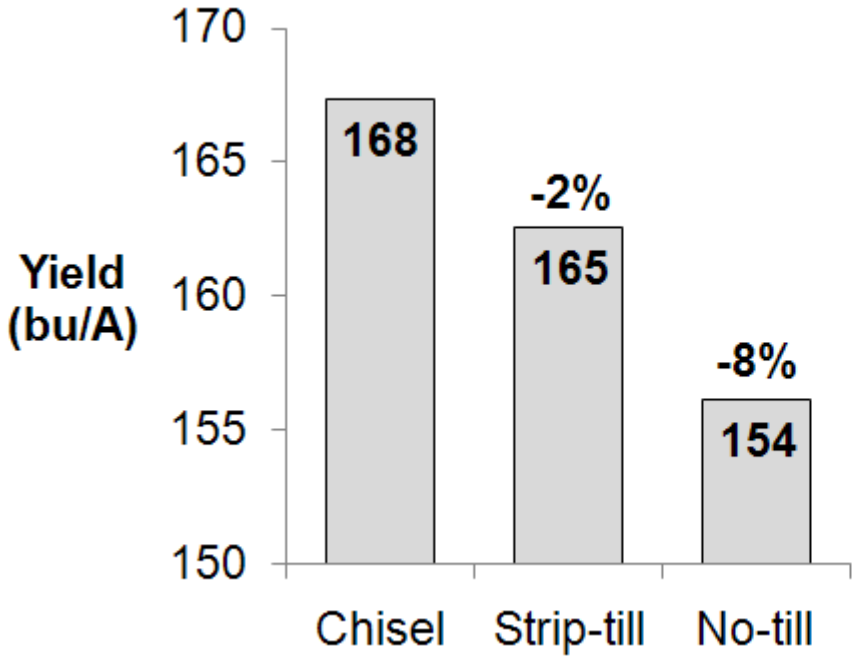
- Do optimum N fertilizer rates differ with residue removal and tillage system?

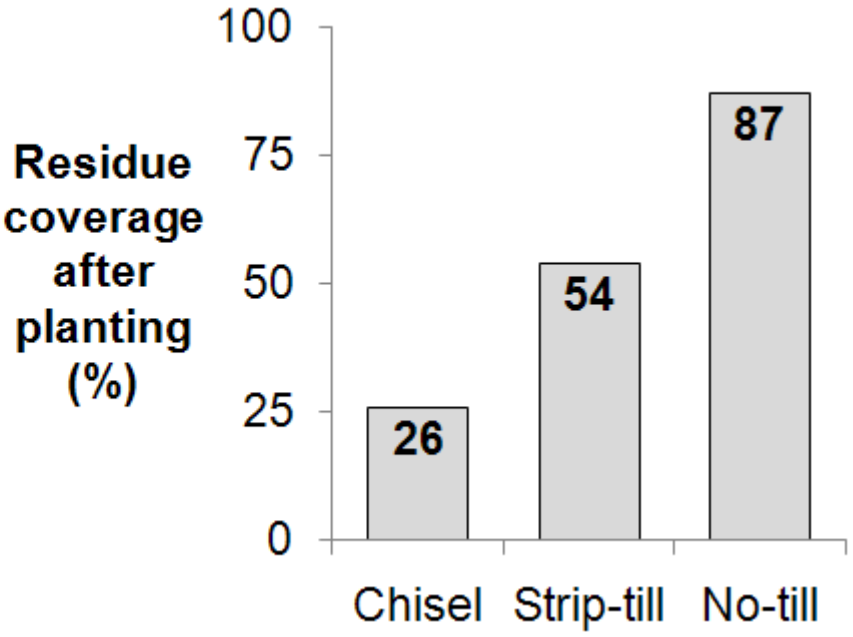
1) Yield of continuous corn was lower with less tillage

2) Correlation between yield & surface residue coverage

Continuous corn - Rochester, MN (1997-2000)

Port Byron silt loam soil





Vetsch & Randall (2002, *Agronomy Journal*)

Continuous corn residue removal study

- Established following corn in fall 2008 at Lamberton & Waseca, MN, yields measured from 2009 to 2012
- Treatments applied to the same plots each year
- Loam & clay loam soils
- Soil fertility (excluding N) managed for 250+ bu/ac
- Starter (5 gal/ac 10-34-0 in furrow)
- 102-day hybrid, 35,000 seeds/acre

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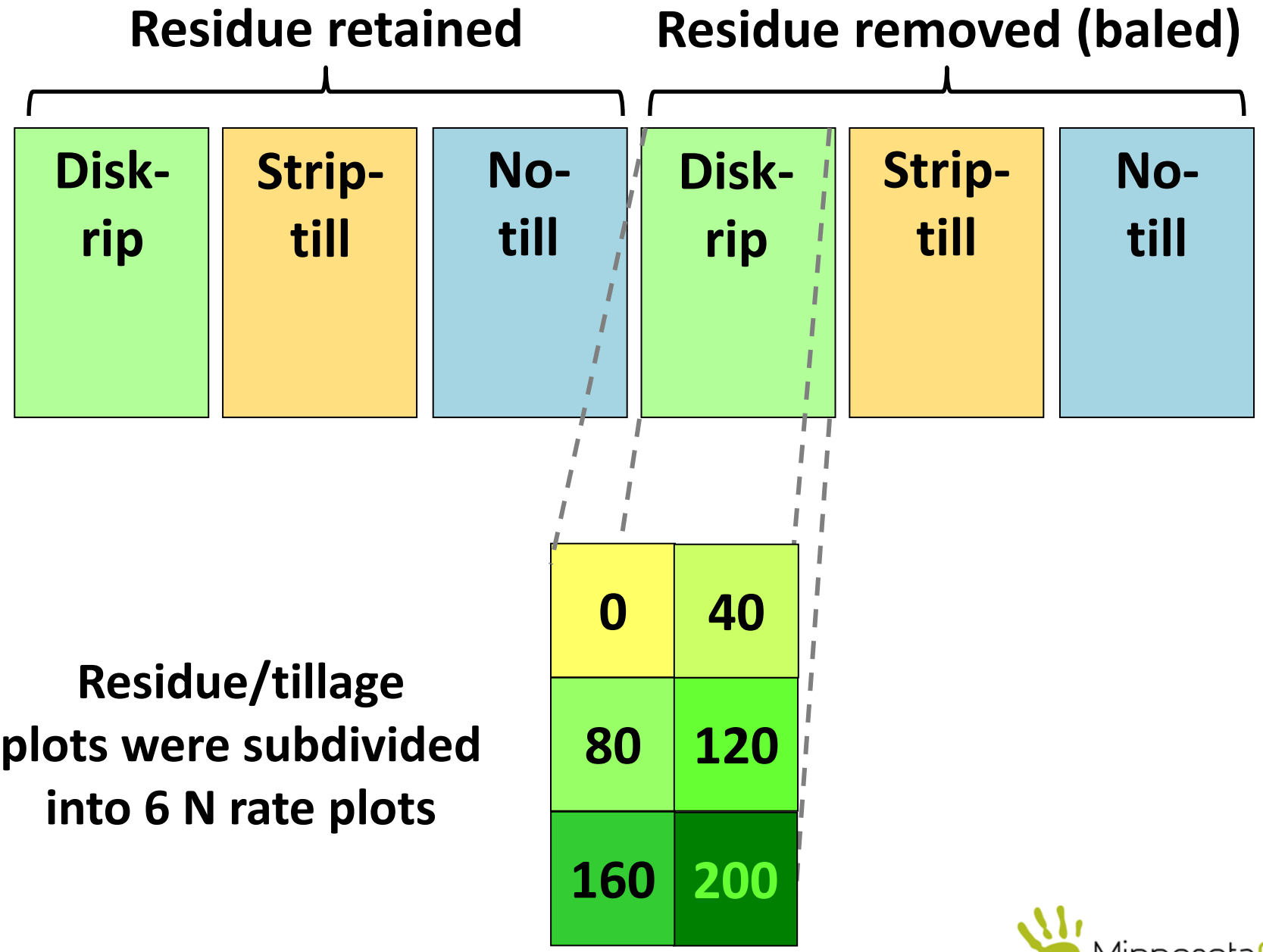

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Residue removed + Disk-rip

Residue removed + Strip-till

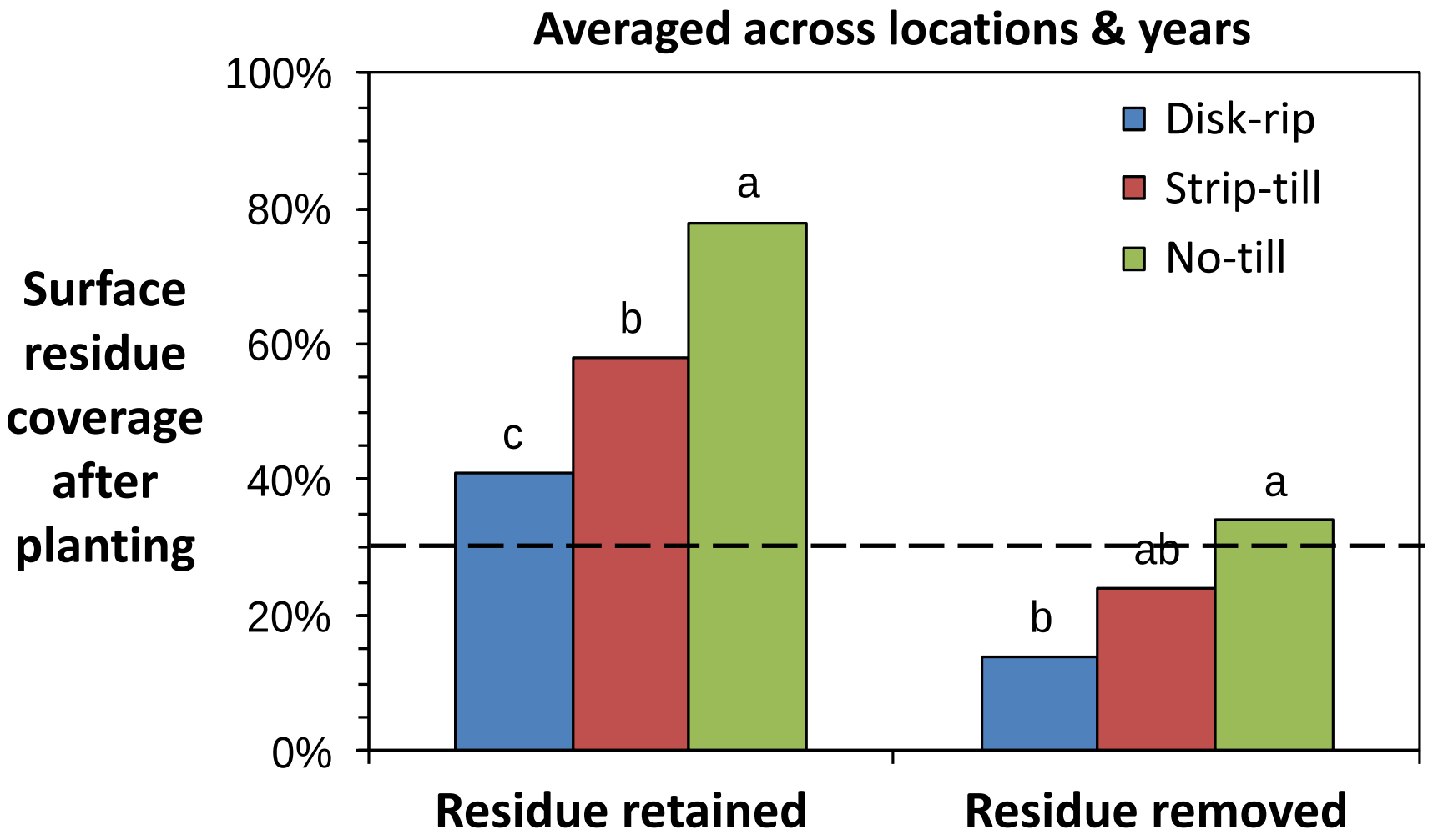
Residue removed + No-till

Residue retained + Disk-rip

Residue retained + Strip-till

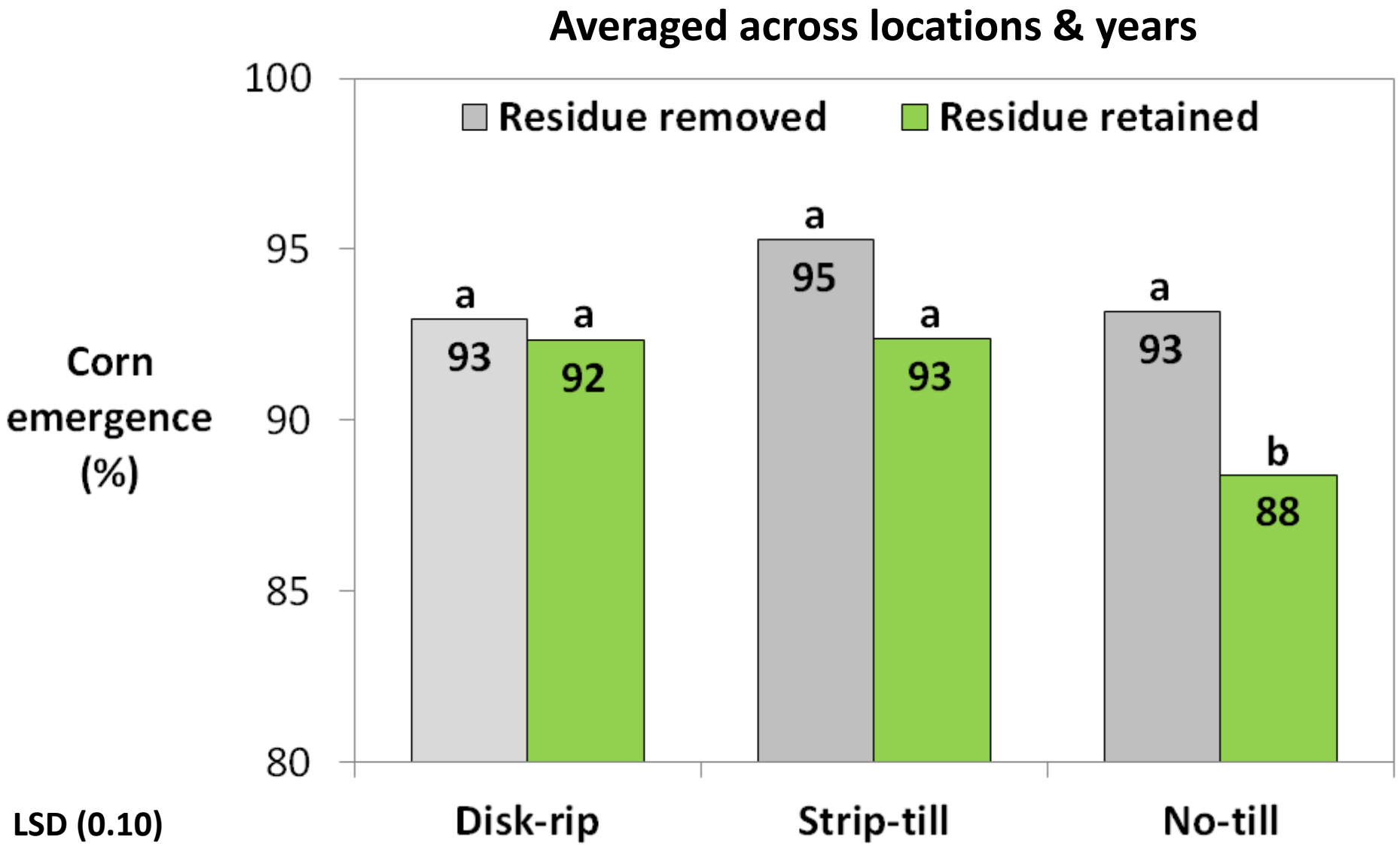
Residue retained + No-till

- When residue was removed, only no-till had at least 30% surface residue coverage, but strip-till was close



LSD (0.10)

- 92 to 95% emergence across all tillage & residue treatments except for no-till with residue retained



Residue removed + Disk-rip

Residue removed + Strip-till

Residue removed + No-till

Residue retained + Disk-rip

Residue retained + Strip-till

Residue retained + No-till

- Stover removal enhanced early-season growth, especially with reduced tillage systems

Stover removed **Stover retained**

No-till, 200 lb N/ac, V7 to V8 stage

- N deficiency was easily observed at the V7 to V8 stage

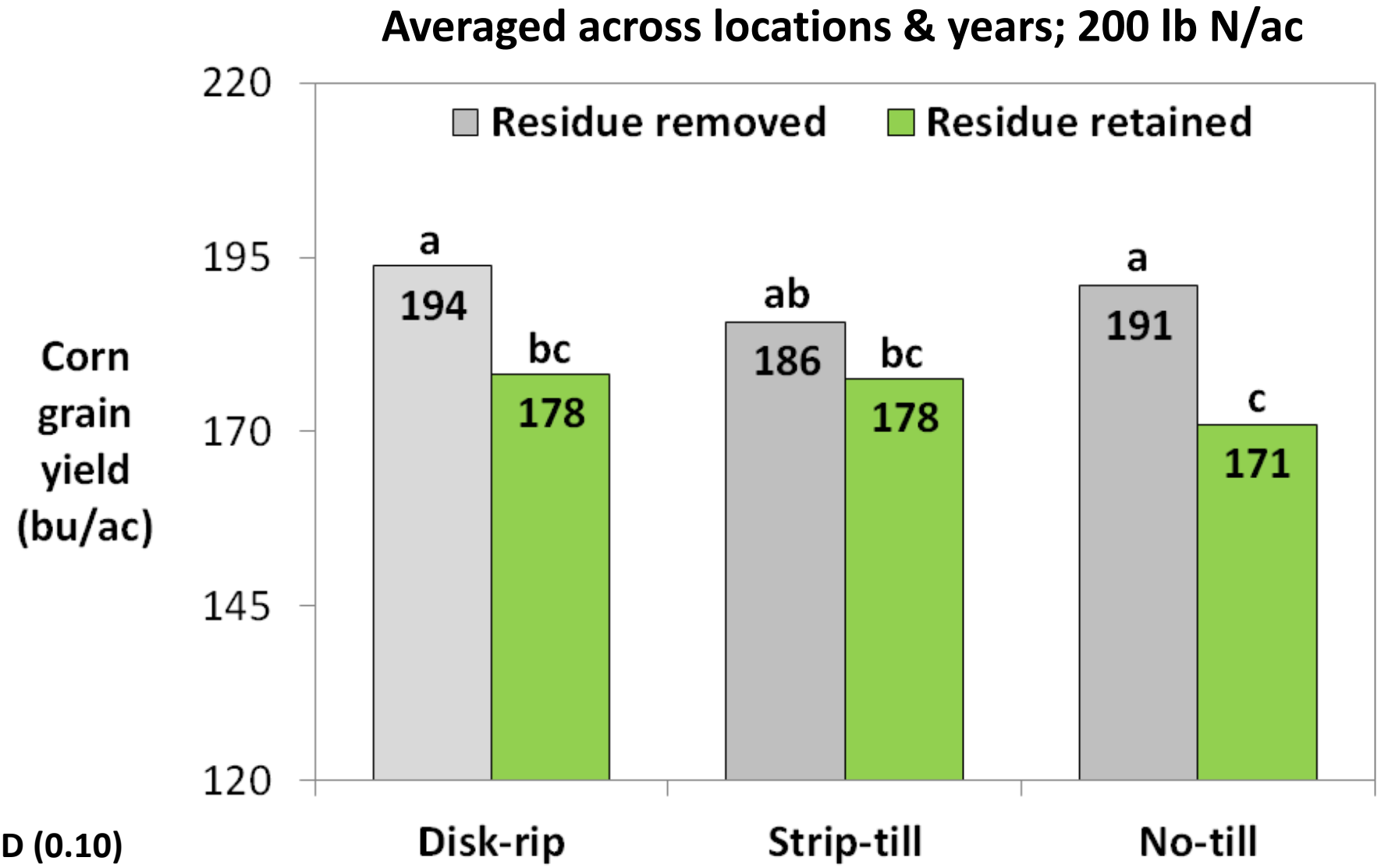
40 vs. 200 lb N/ac

40 vs. 200 lb N/ac

Strip-till, Stover retained

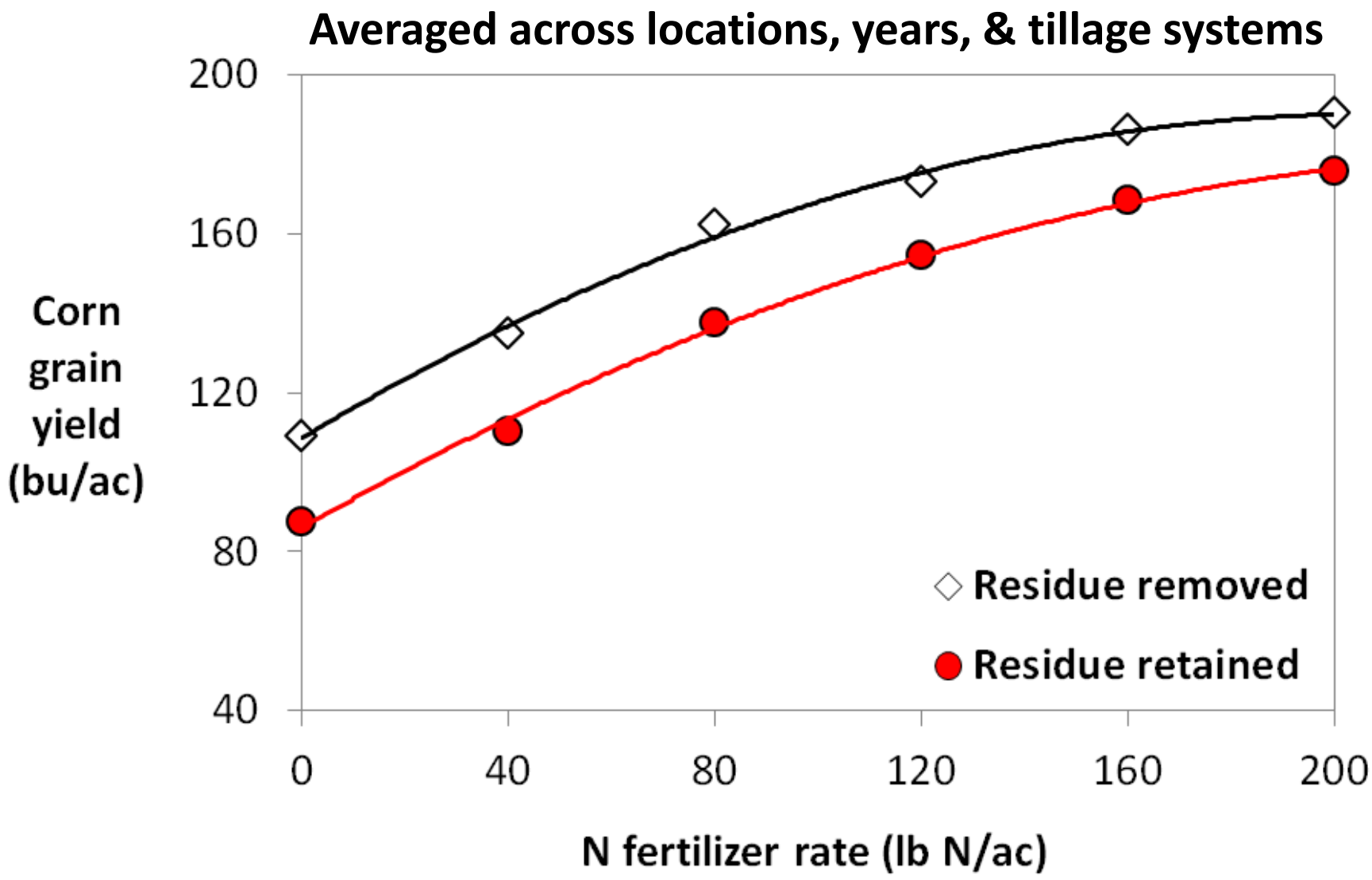
- Residue removal increased yield by 4 to 12%

- Tillage system did not affect yield much



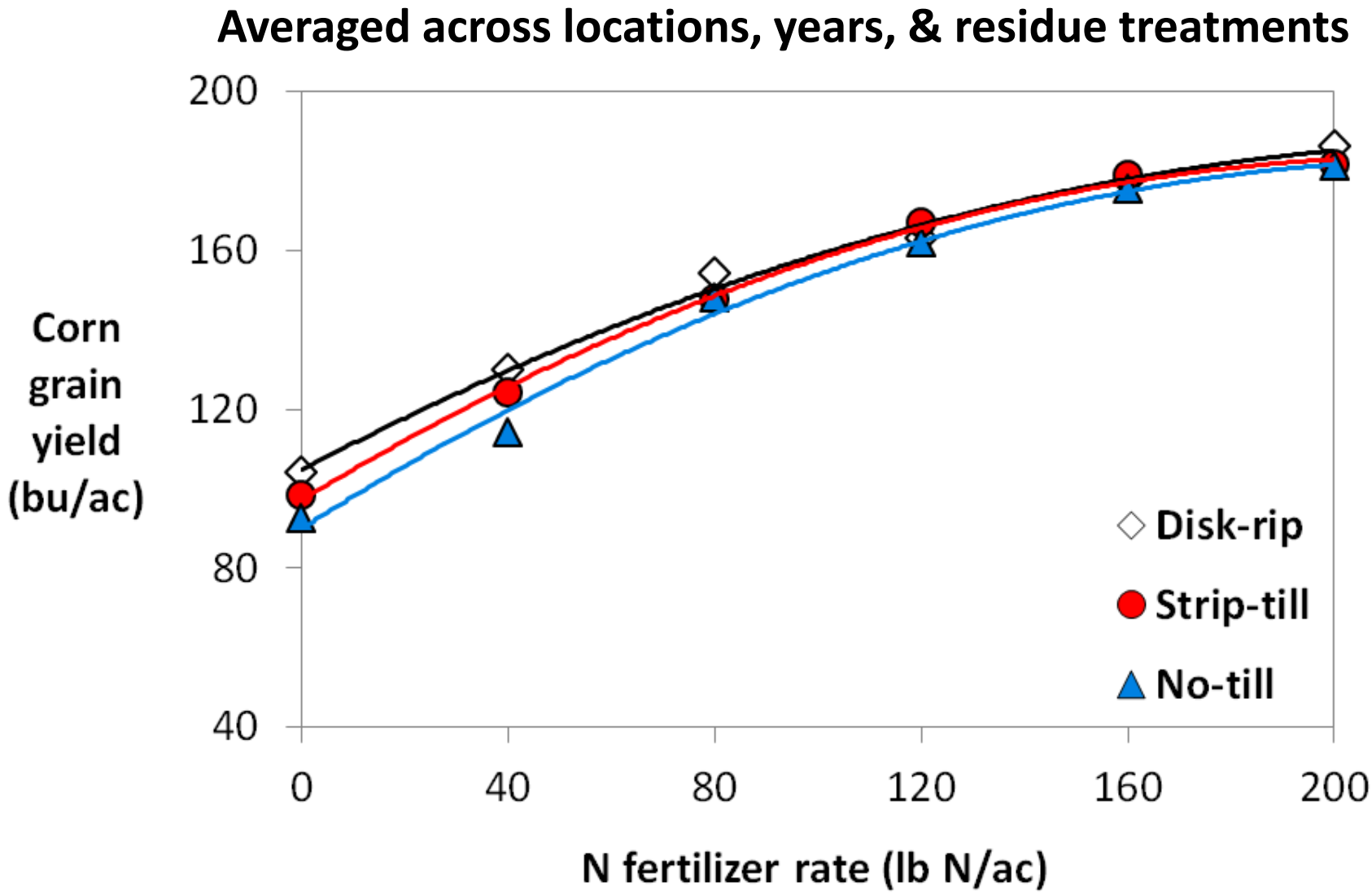
- On average, residue removal increased yield by 13%

- Response to N did not differ among residue treatments



- On average, little difference among tillage systems

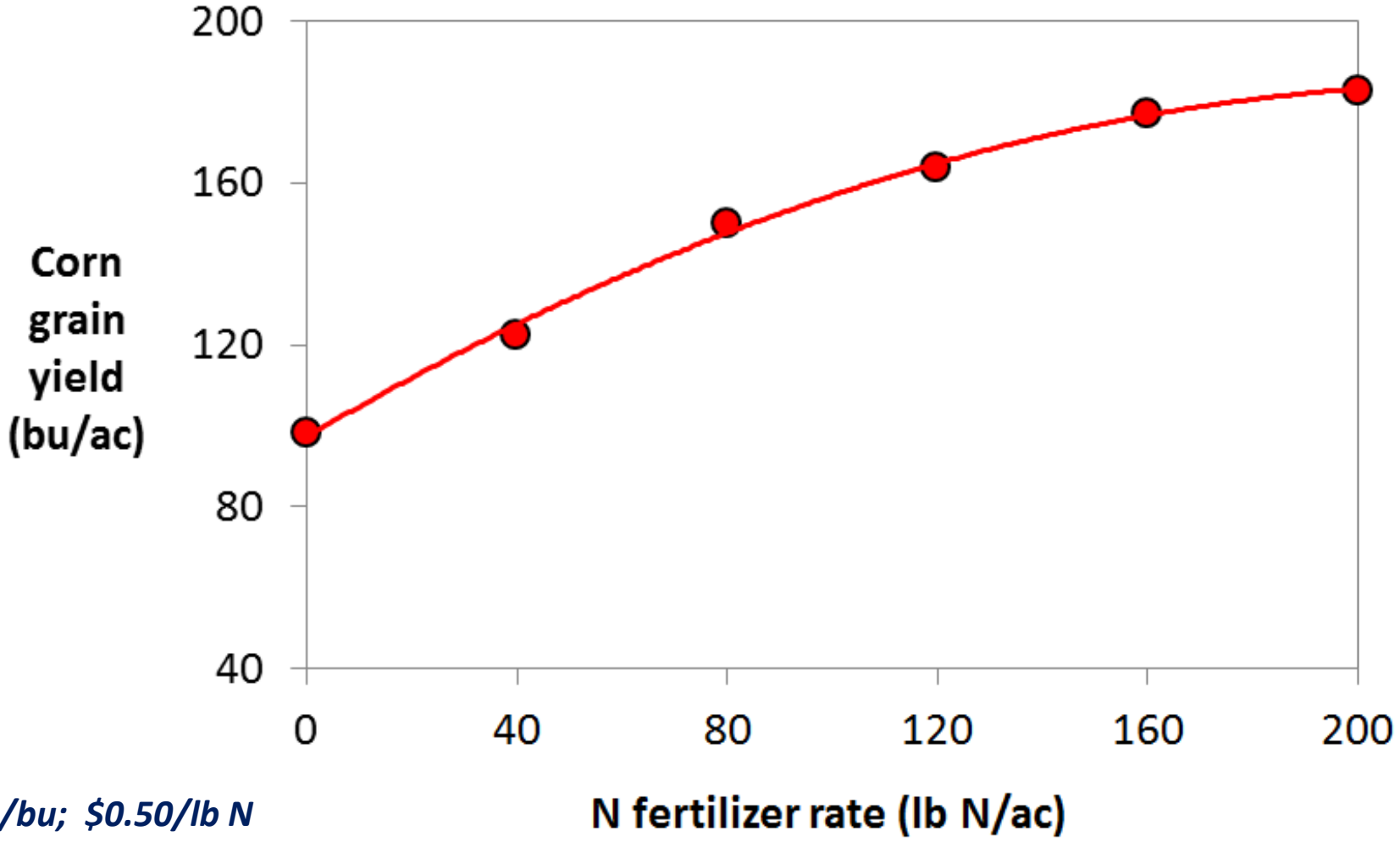
- Response to N did not differ among tillage systems



- Optimum N rates were higher than expected

- Net return within $1/ac of maximum with 194 to >200 lb N/ac

Averaged across locations, years, residue treatments, & tillage systems



$6.50/bu; $0.50/lb N

Take home points – continuous corn

- Continuous corn yields less
- Consider a 3-year corn-corn-soybean rotation as an alternative to continuous corn
- High-input systems for managing crop residue in continuous corn do not guarantee high yields & they can be expensive

Take home points – residue management

- Yield reductions for corn on corn are due in part to residue, especially if it is not cleared out of the seed row
- If full-width tillage is used for corn on corn, shredding stalks and tilling early in the fall should help, but research data does not strongly support
- Applying N or S in the fall to stimulate residue decomposition is rarely effective
- Focus on moving residue out of the row during planting & achieving excellent seed-to-soil contact

Take home points – corn residue harvest

- ***Partial*** residue harvest appears sustainable on productive soils in the Corn Belt
- Avoid residue harvest in drought-prone fields
- Residue harvest is best suited to continuous corn
- Reduce tillage following residue harvest
- Optimum N rates do not differ much if residue is harvested

Take home points – tillage for corn on corn

- In general, yield of corn on corn has been greater with more aggressive tillage on poorly-drained fine-textured soils
- Conservation tillage for corn on corn can work well on:
  - medium- to coarse-textured soils
  - tile-drained fine-textured soils
  - fields where corn residue is harvested
- Optimum N rates do not differ much among tillage systems




Thanks!

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