Nitrogen Management for Corn Following Alfalfa

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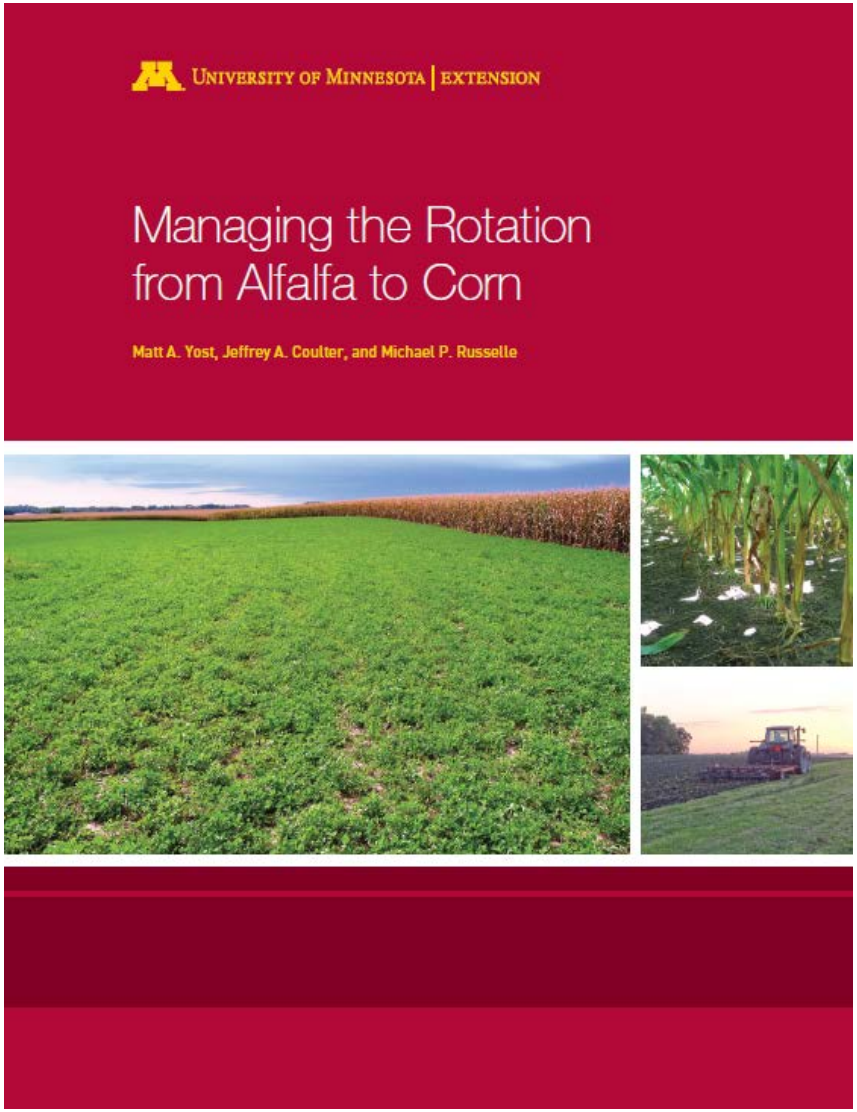
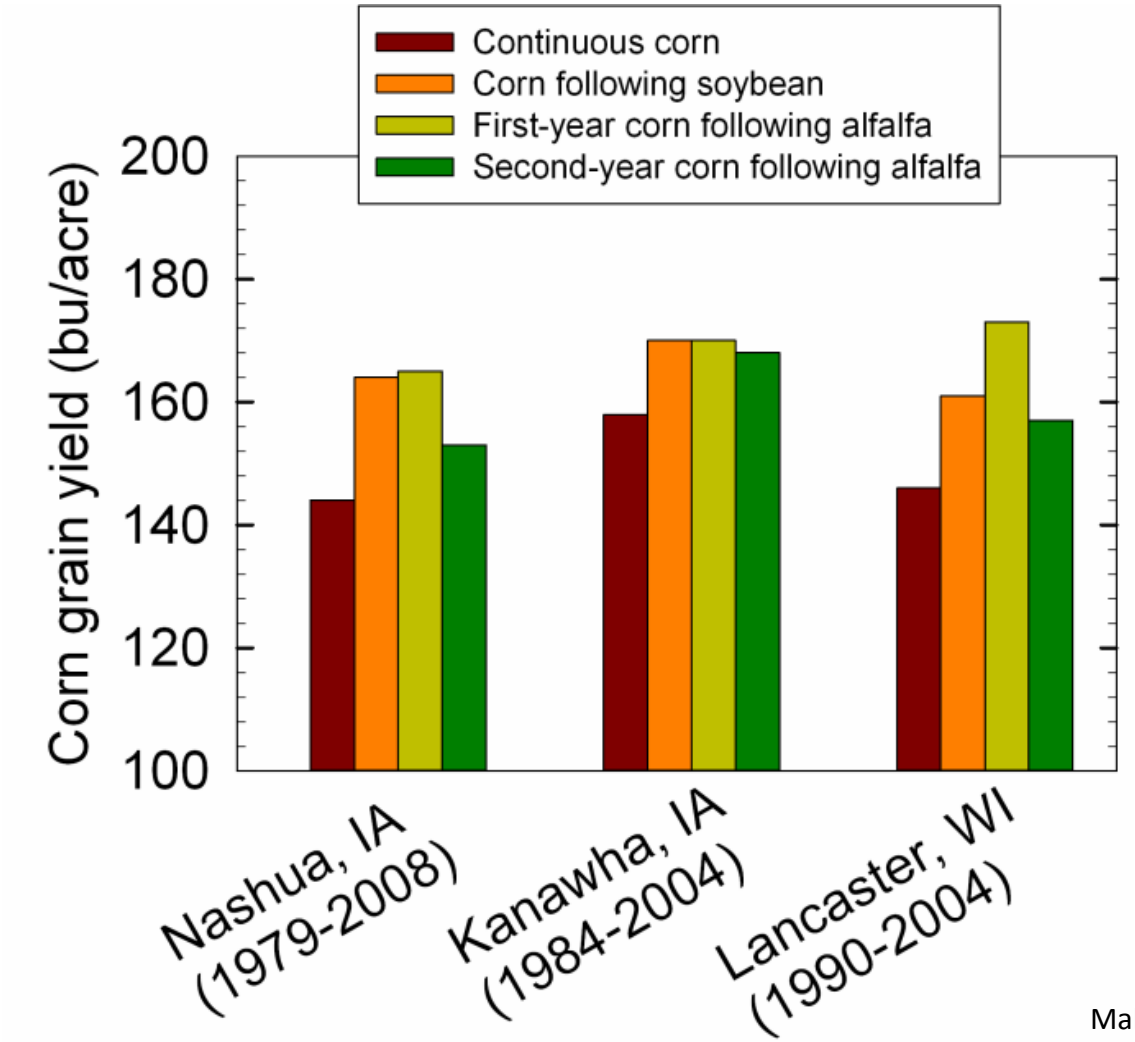
z.umn.edu/rotation



Benefits of alfalfa in crop rotations

- Reduces nitrate leaching potential
- Reduces soil erosion
- Reduces loss of soil organic matter
- Improves soil structure & tilth
- Disrupts pest cycles
- Supplies N to following crops

Alfalfa enhances yield of following corn crops, usually for at least 2 years



Stanger & Lauer (2008)
Mallarino & Ortiz-Torres (2006)

Alfalfa reduces corn N requirements, usually for at least 2 years

- **Recovers soil nitrate**
- **Fixes atmospheric N**
- **Has high N concentration**
- **Adds N to soil organic matter pool**
  (50–150 lb N/acre/year)
  - Harvest losses
  - Stand losses
  - Thin root turnover & root exudation


Photo: Michael Russelle

Improved N management is needed

- Alfalfa grown on 1.4 million acres in MN
- Alfalfa reduces N requirements, often by:
  - 100% for 1st-year corn
  - 50% or more for 2nd-year corn
- The most ***extreme*** cases of excess N fertilization for corn are when it follows alfalfa


Tim McCabe, USDA

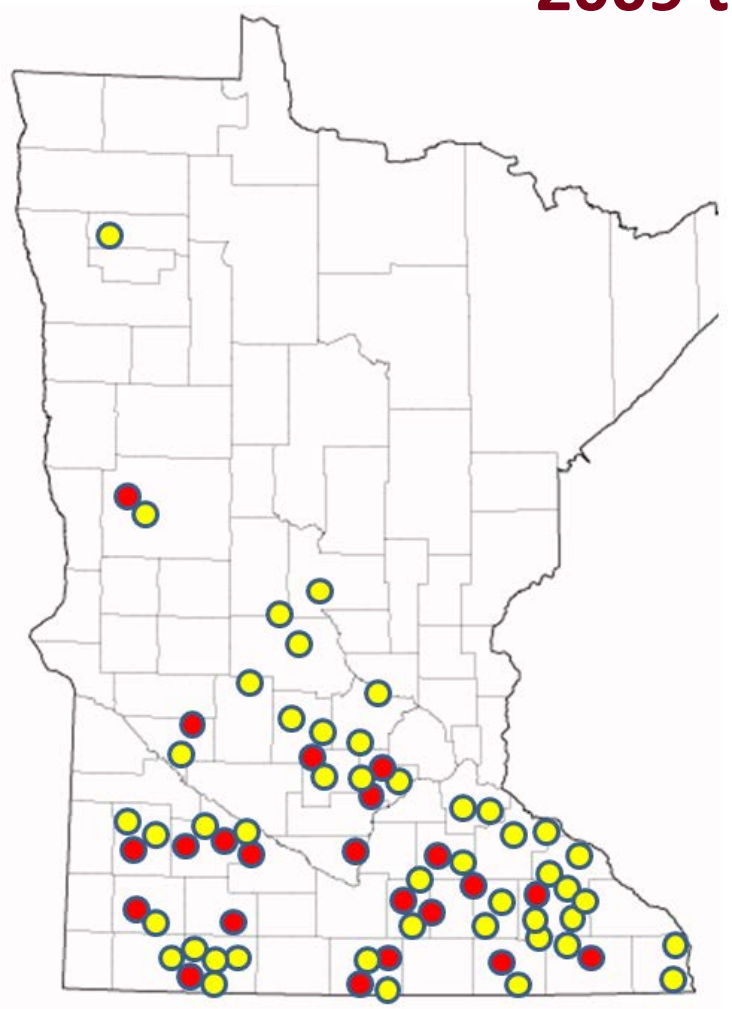
A rotation with high N loading potential

Example for 1st-year corn:

Alfalfa N credit:	150 lb N/ac
Manure N credit:	40 lb N/ac
N fertilizer:	80 lb N/ac
	270 lb N/ac

68 on-farm N rate trials in corn following alfalfa

2009 to 2015



- **1st-year corn** (46 trials)
- **2nd-year corn** (22 trials)

Study #1 = 10 on-farm trials in 2009 & 2010

- Evaluated response to fertilizer N in 1st-year corn
- In Dairy Belt of southern & central MN
- No manure during alfalfa
- Alfalfa stands 3–5 years old; 4–10 plants/ft^2
- Tillage timing for alfalfa termination varied with farm
- Loam to silty clay loam soils;
  1 farm had loamy sand soil

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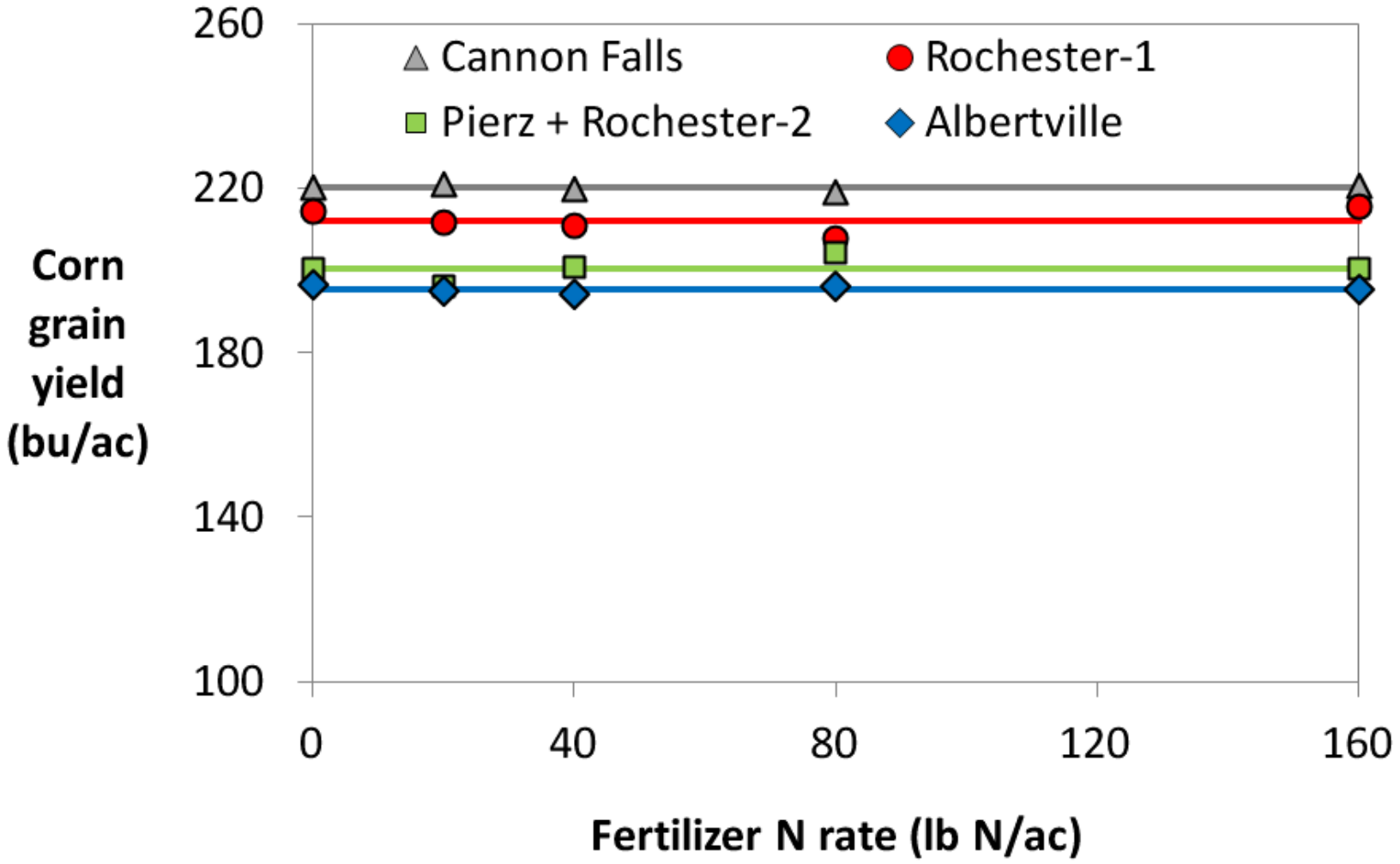
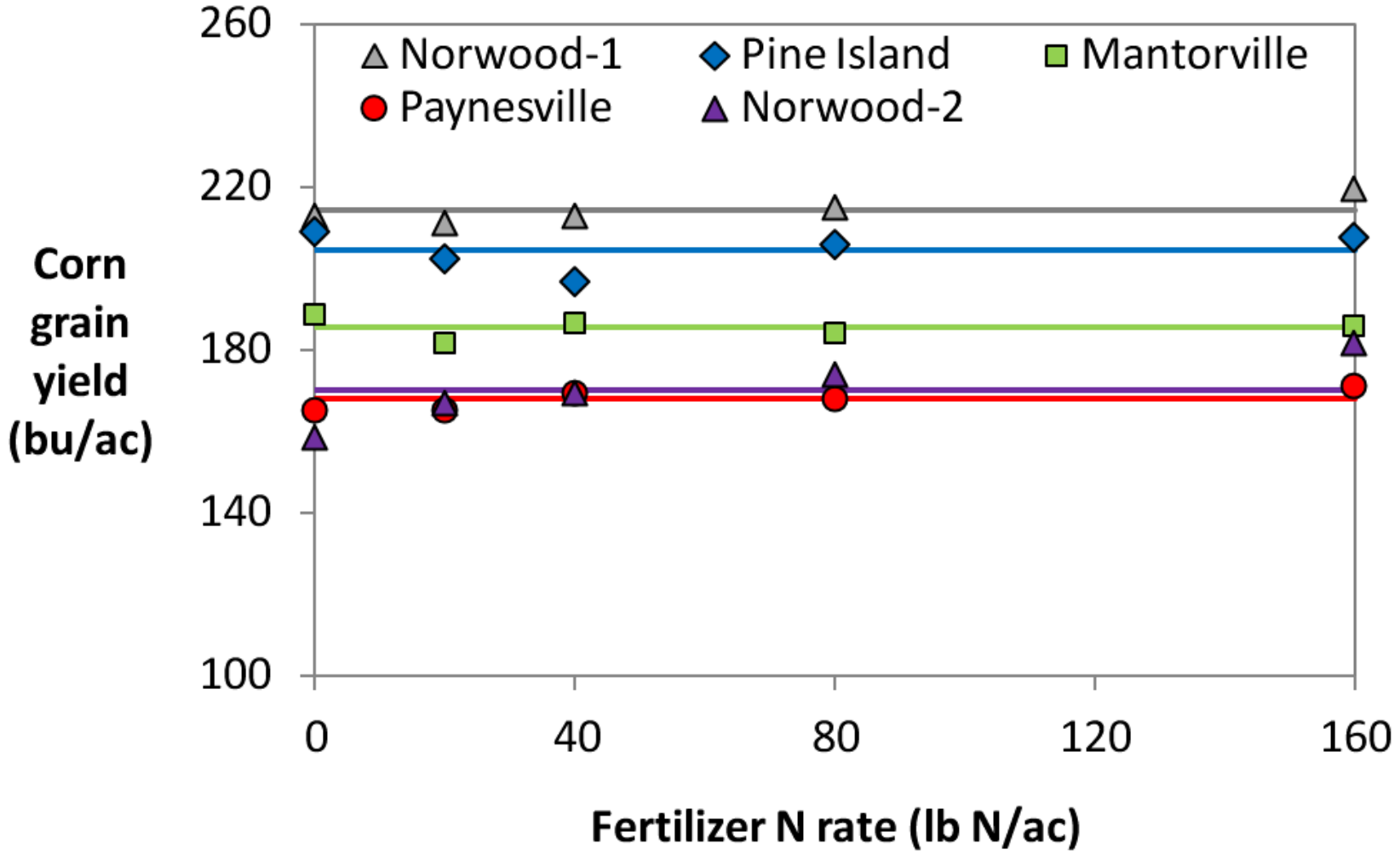
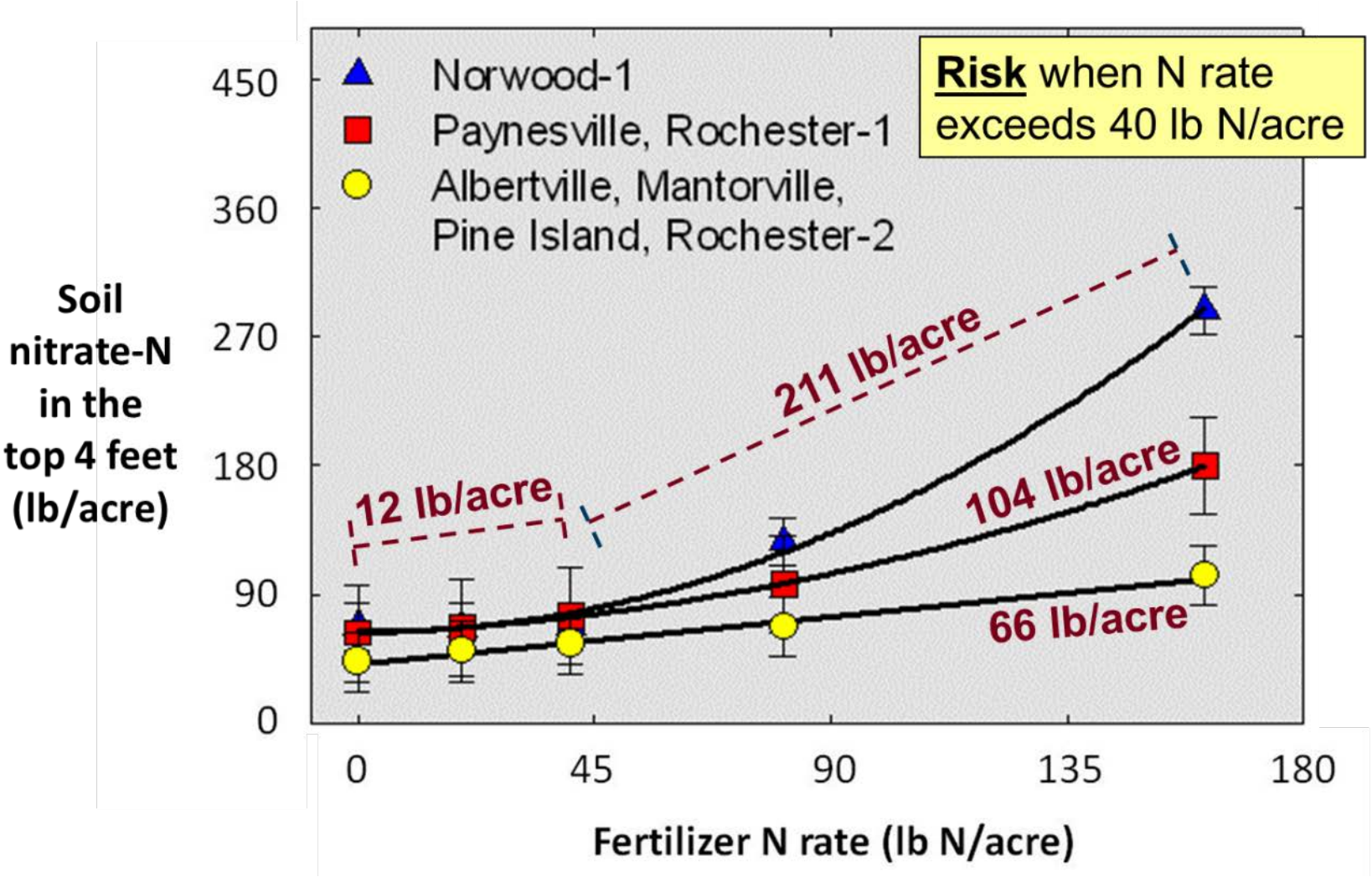
Grain yield was not increased with N on any of the 5 farms in 2009



Grain yield was not increased with N on any of the 5 farms in 2010



Soil nitrate-N after harvest in the top 4 feet at 7 farms in 2009–2010



Study #2 = 6 on-farm trials in 2010

- Evaluated 1st-year corn response to fertilizer N based on alfalfa regrowth & tillage timing for alfalfa termination
- In southern & west-central MN
- Loam, silt loam, & clay loam soils

Regrowth treatments

Tillage timing teatments

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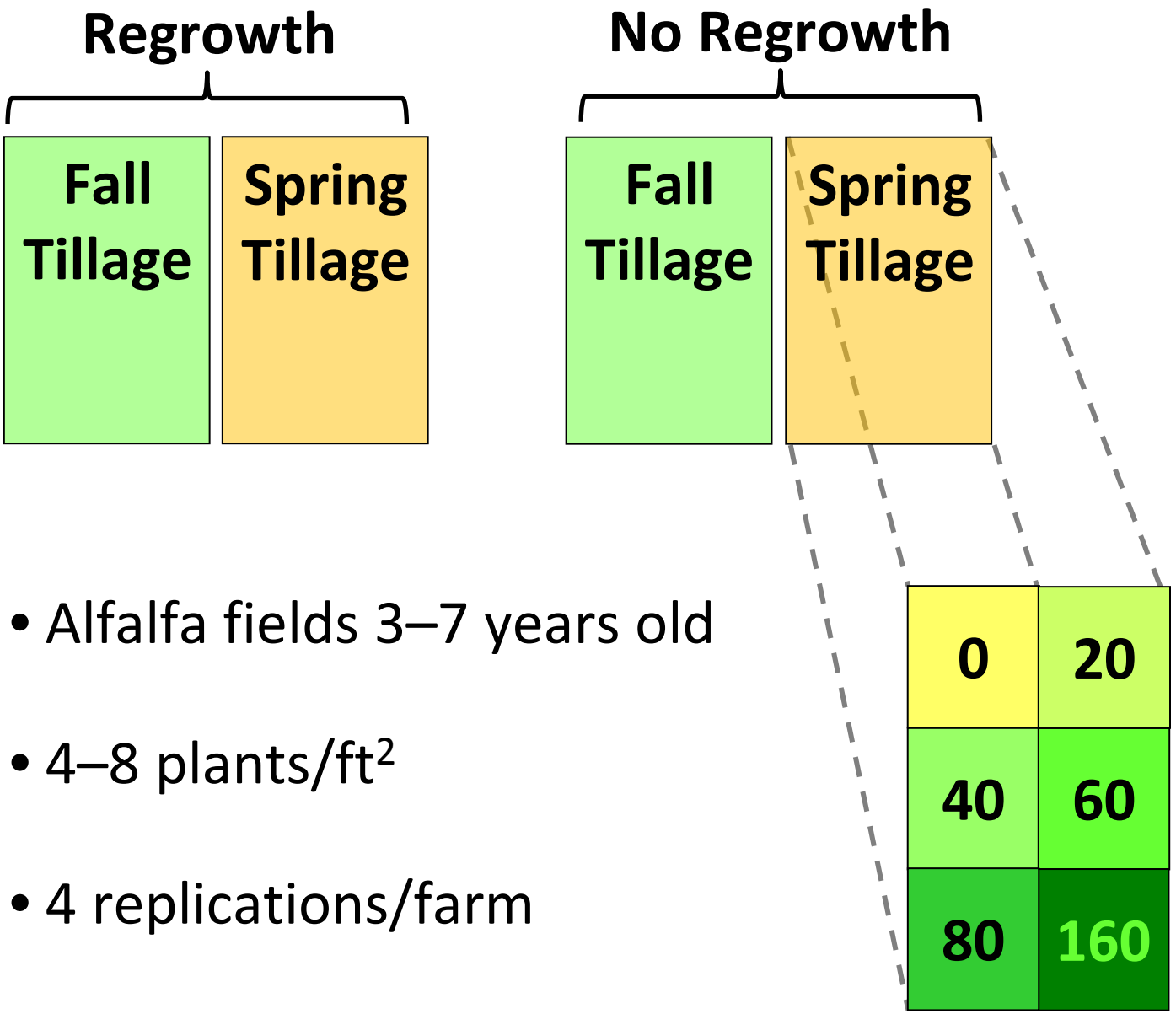


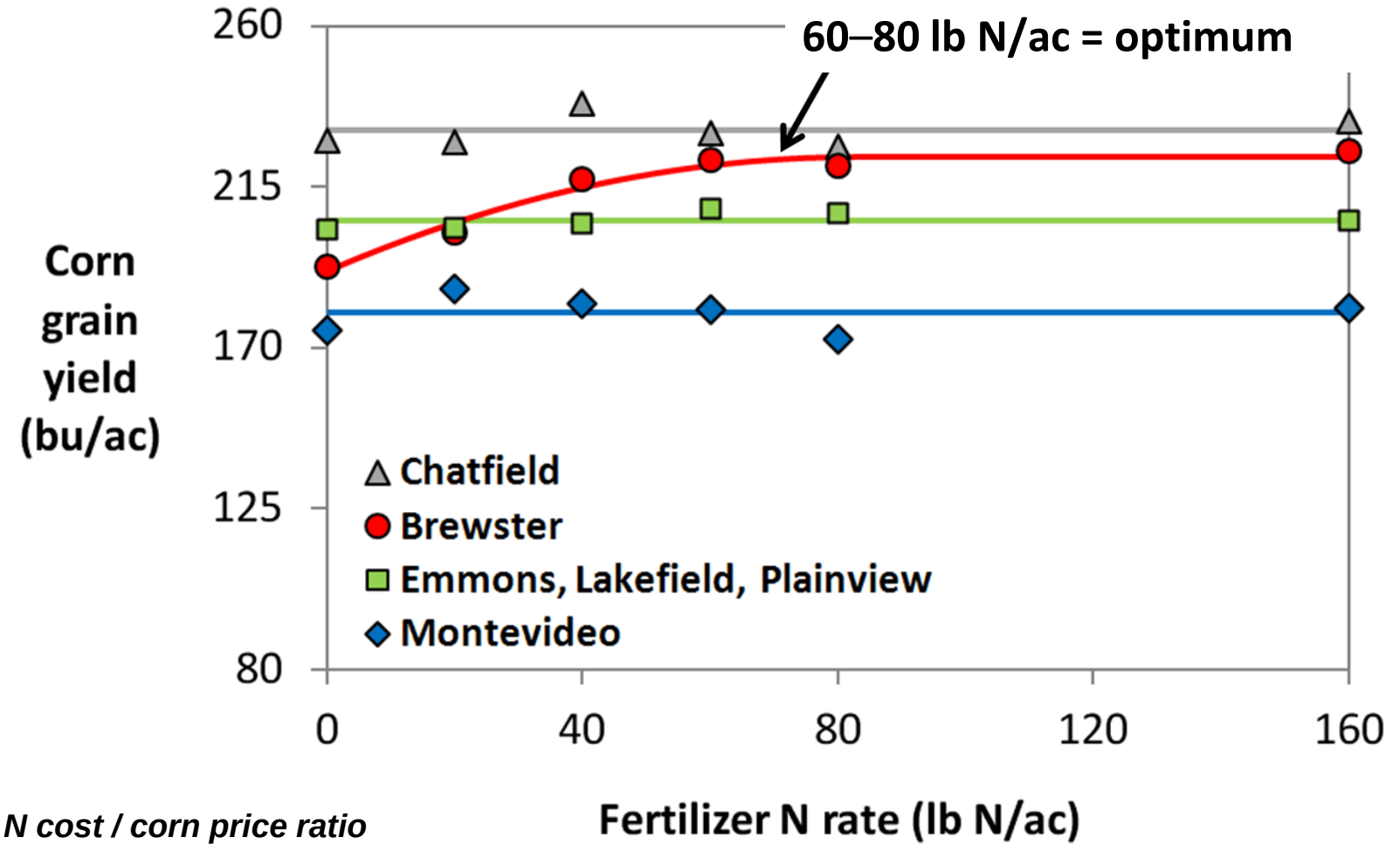
- Alfalfa fields 3–7 years old
- 4–8 plants/ft^2
- 4 replications/farm

No effect of fall alfalfa regrowth or tillage timing on grain or silage yield, or their response to N

Location in Minnesota	Fall alfalfa regrowth where it was not harvested		
	Height of regrowth	Dry matter yield	N content
	-- inches --	-------- lb/acre --------	
Emmons	4	300	9
Brewster	6	400	17
Plainview	10	700	33
Chatfield	13	900	38
Lakefield	15	1,400	47
Montevideo	18	1,500	52

5 of 6 farms had no response to N in 2010

Responsive field had fine-textured soil & abundant rainfall in spring



0.10 N cost / corn price ratio

Study #3 = 7 on-farm trials in 2010 & 2011

- Evaluated response to fertilizer N in 1st-year **no-till** corn after alfalfa
- In southern MN
- No manure during alfalfa
- Alfalfa stands 2–7 years old; 4–8 plants/ft^2
- Loam, silt loam, & clay loam soils
- 3–20 lb N/ac as starter fertilizer

Grain and silage yields were not increased with N on any of these 7 no-till farms

		Average yield across N rates (0, 20, 40, 80, 160 lb N/ac)	
Location	Soil type	Grain	Silage
		--- bu/ac ---	--- tons/ac ---
Cashton	Silt loam	199	27.9
Goodhue	Silt loam	203	21.1
Lake City	Silt loam	220	---
Lakefield	Loam	212	24.5
Norwalk	Silt loam	211	30.3
Okabena	Clay loam	209	---
Plainview	Silt loam	211	---

Study #4 = 8 on-farm trials in 2011

- Evaluated response to fertilizer N in 1st-year corn after alfalfa; used fall tillage
- In Dairy Belt of southern & central MN
- No manure during alfalfa
- Alfalfa stands 2–5 years old; 3–7 plants/ft^2
- Loam, silt loam, silty clay loam, & clay loam soils
- 0–15 lb N/ac as starter fertilizer

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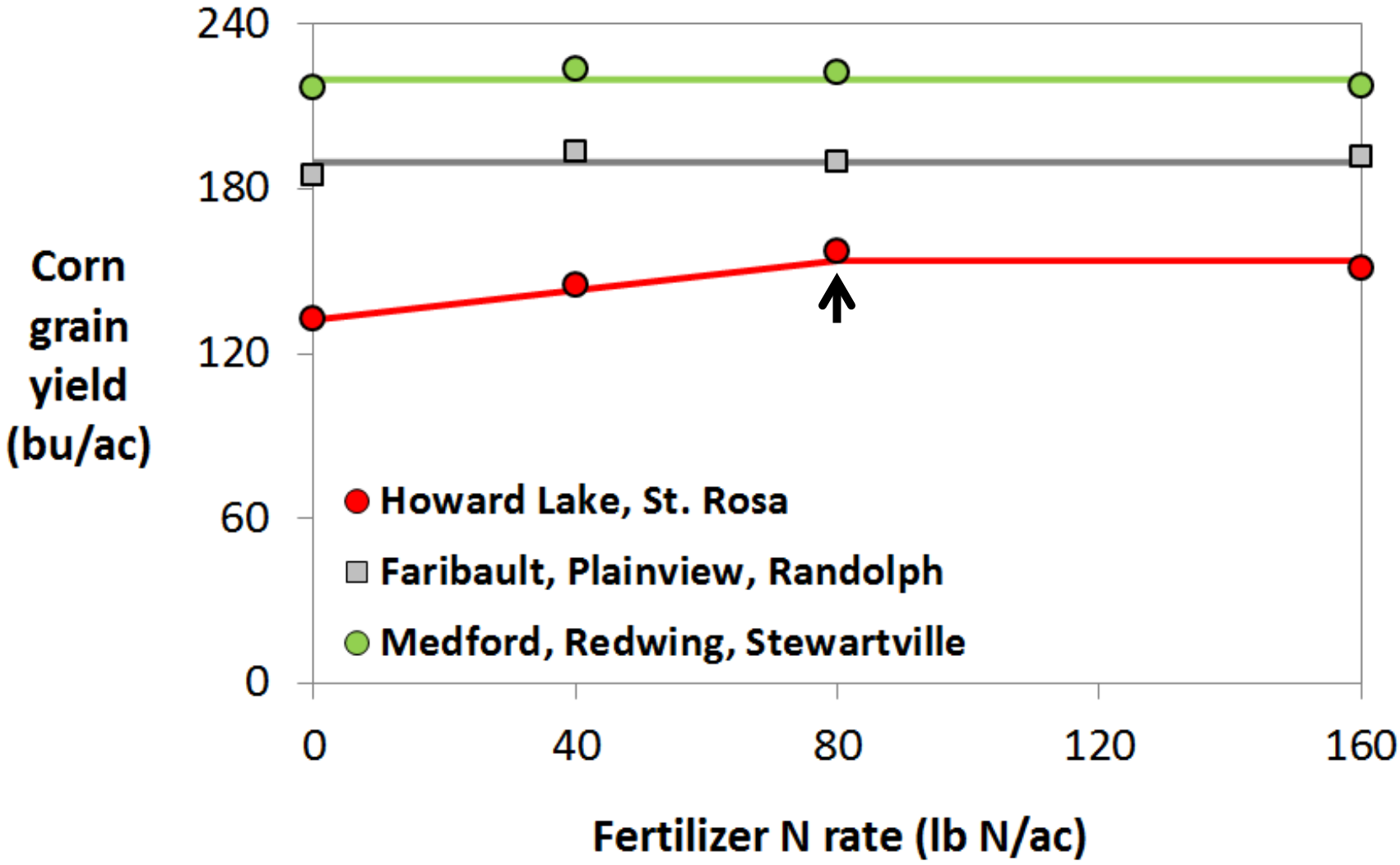
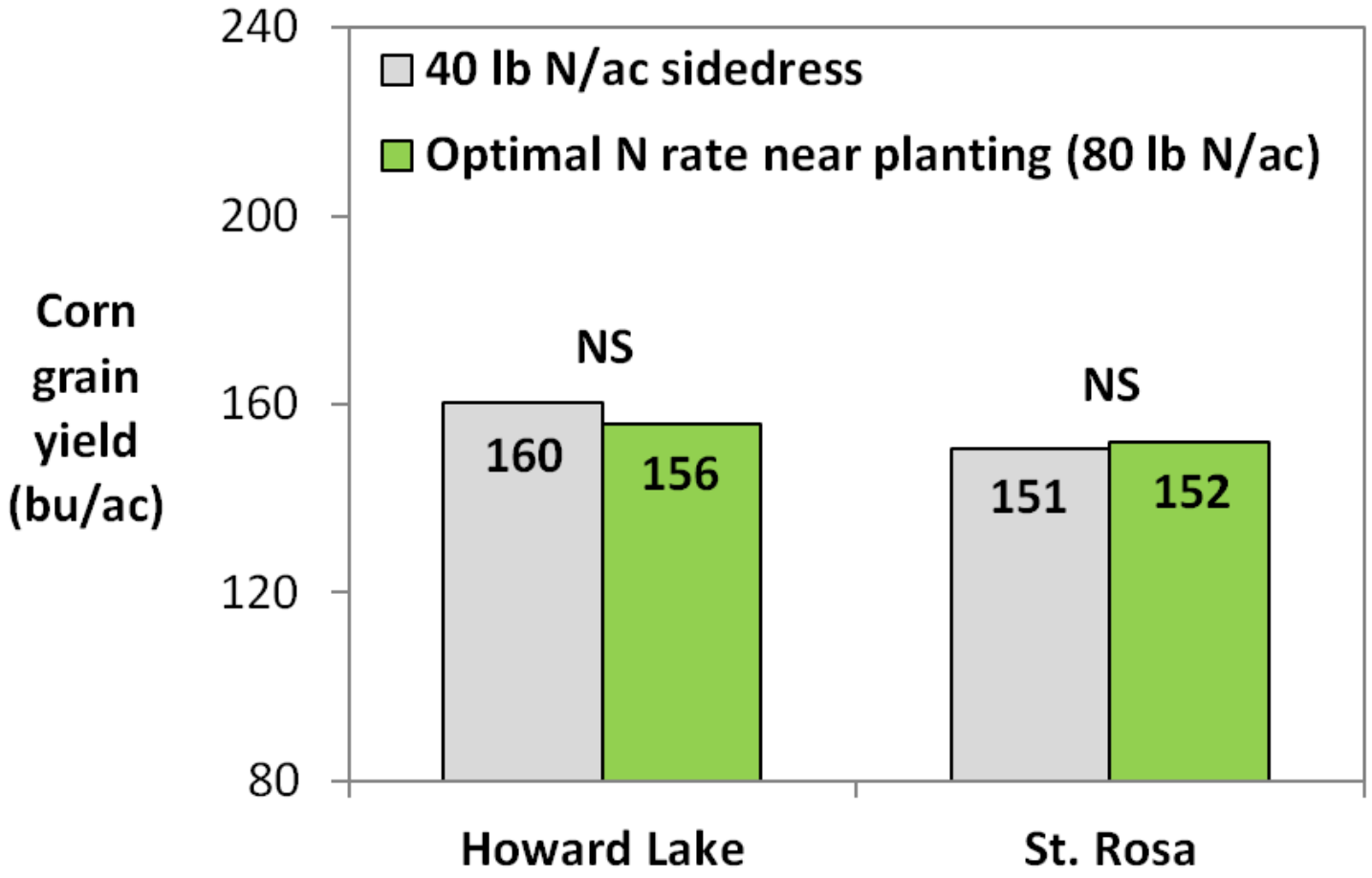
MAWRC MINNESOTA AGRICULTURAL WATER RESOURCE CENTER

6 of 8 farms with tillage had no response to N in 2011

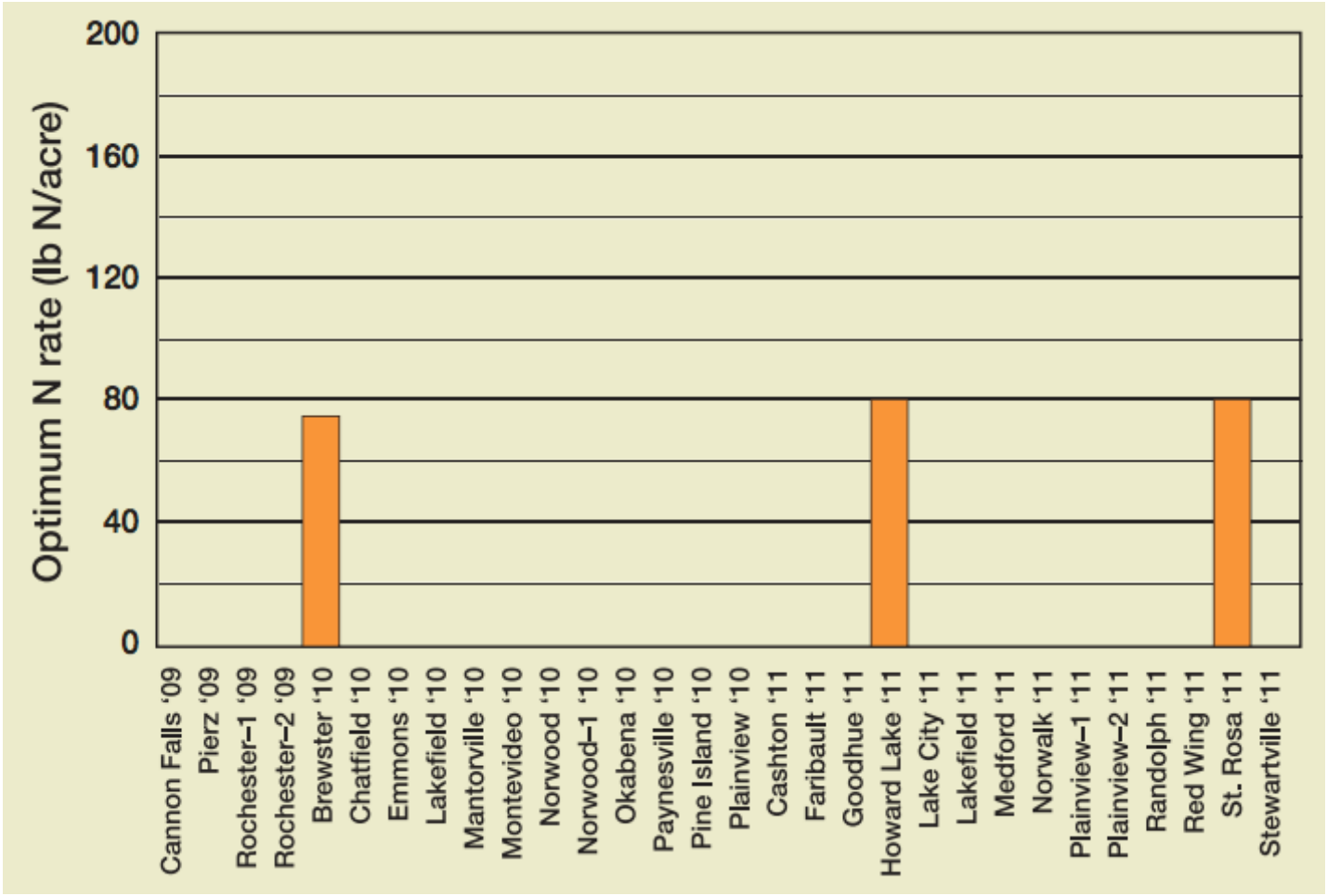


A sidedress of 40 lb N/ac was evaluated on these 8 farms in 2011

Equivalent yield with 40 lb N/ac sidedressed at V6 or 80 lb N/ac near planting on the 2 farms where corn responded to N



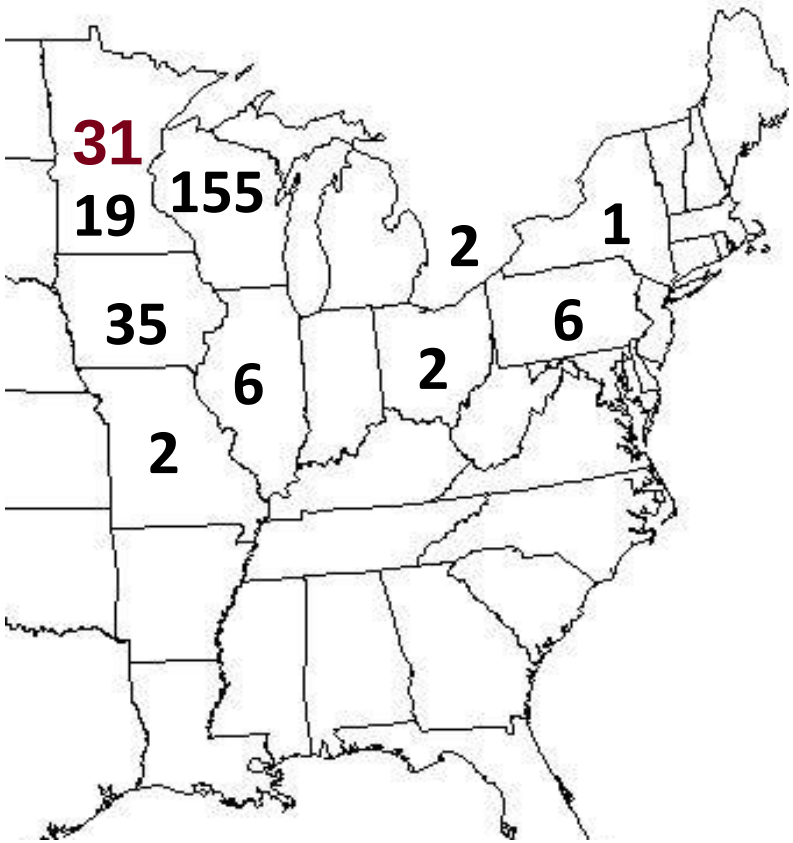
1st-year corn responded to N on 3 of 31 farms from 2009 to 2011



0.10 N cost / corn price ratio

Summary of N rate trials in 1st-year corn

- N rates to 1st-year corn following alfalfa
- No manure during alfalfa
- 31 recent MN trials + 228 previous trials



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Summary of N rate trials in 1st-year corn

Soil texture	Termination timing	Alfalfa age, years	Alfalfa seeding method	Sites responsive to fertilizer N	Total sites
Coarse				96%	11
Medium	Fall	1	Direct	56%	16
Medium	Fall	2	With oats	35%	54
Medium	Fall	2	Direct	8%	25
Medium	Fall	3+		5%	86
Medium	Spring	3+		17%	48
Fine				53%	19

Take home points for 1st-year corn

- Frequency & level of yield response to N is closely associated with:
  - Soil texture
  - Age of alfalfa at termination
  - Weather conditions

1st-year corn rarely responds to N except:

- On coarse-textured soils
- When following very young alfalfa stands
- In some cases when following spring-terminated alfalfa on medium- & fine-textured soils
- On fine-textured soils when prolonged wet early-season soil conditions

Take home points for 1st-year corn

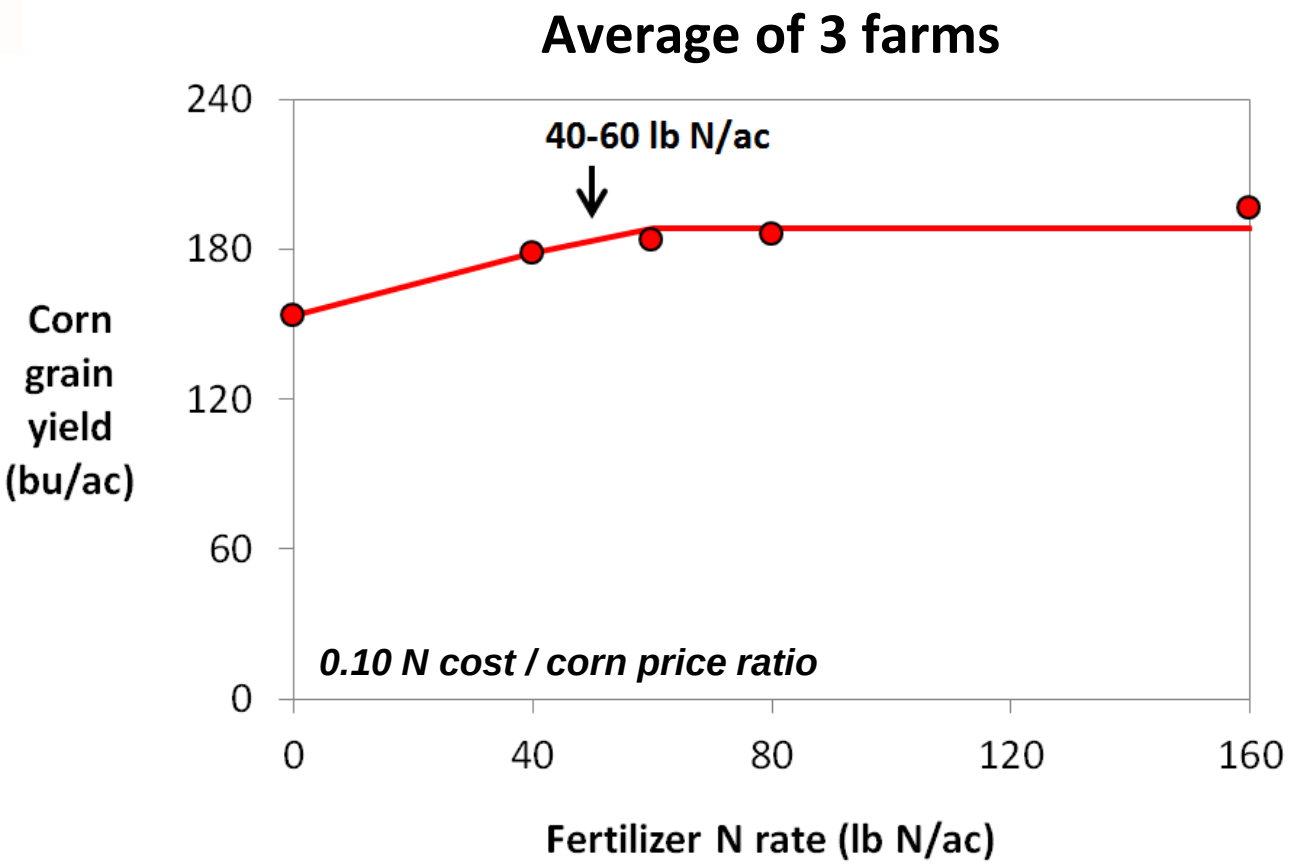
- If one expects N may be needed for 1st-year corn on medium- & fine-textured soils, consider…

  - Limiting the amount of N from fertilizer & manure applied before & near planting

  - Applying additional N in-season if necessary based on weather, soil, & crop conditions

N management for 2nd-year corn following alfalfa

40–60 lb N/ac optimized yield of 2nd-year corn on 3 farms in 2011



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8 trials in 2nd-year corn after alfalfa in 2012

- In southern MN
- No manure during alfalfa
- Alfalfa stands 2–7 years old with at least 4 plants/ft^2
- Alfalfa termination method varied with farm
- 0–6 lb N/ac as starter fertilizer
- Loam, silt loam, & clay loam soils

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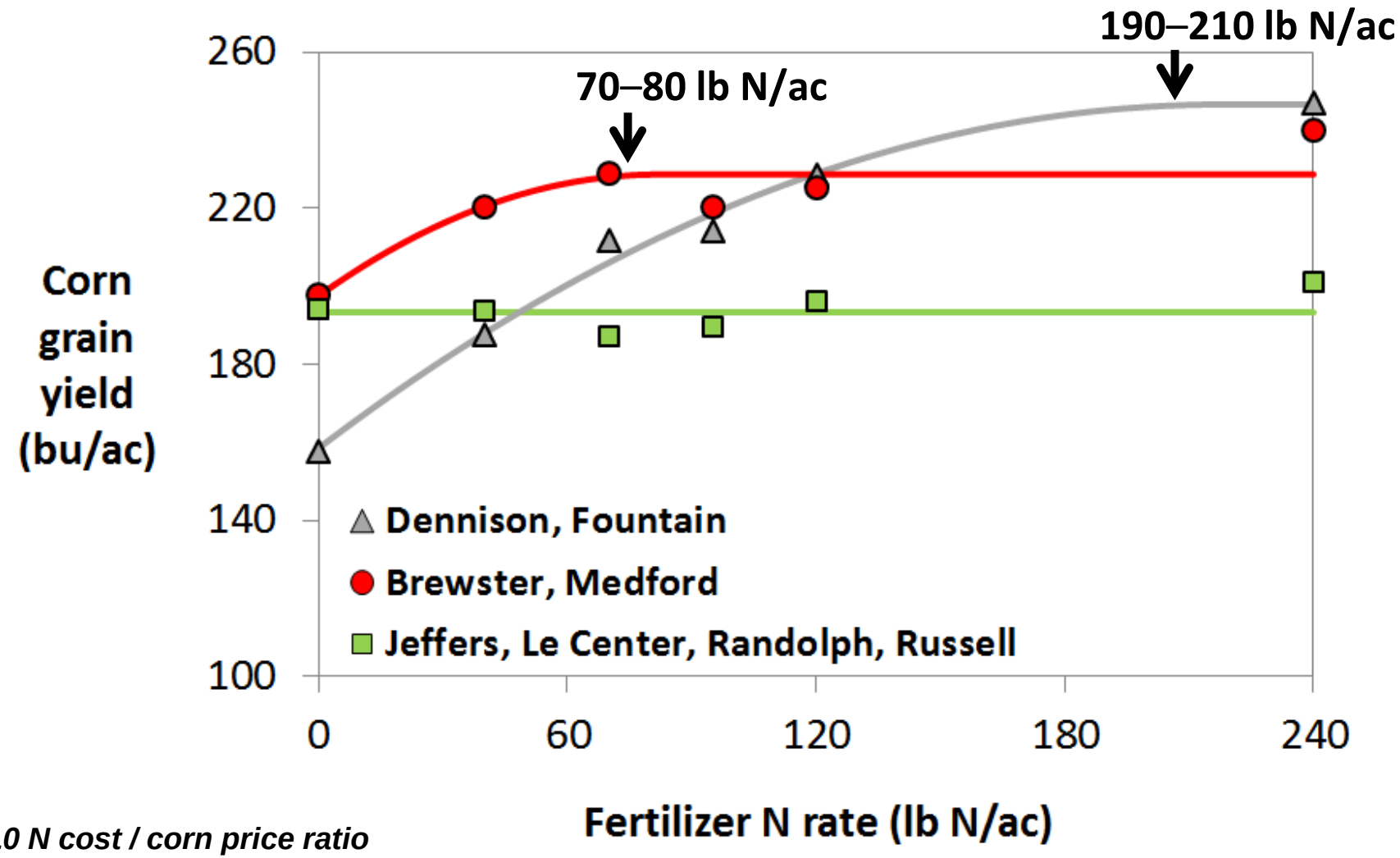
2nd-year corn grain yield was not increased with N on 4 of 8 farms in 2012

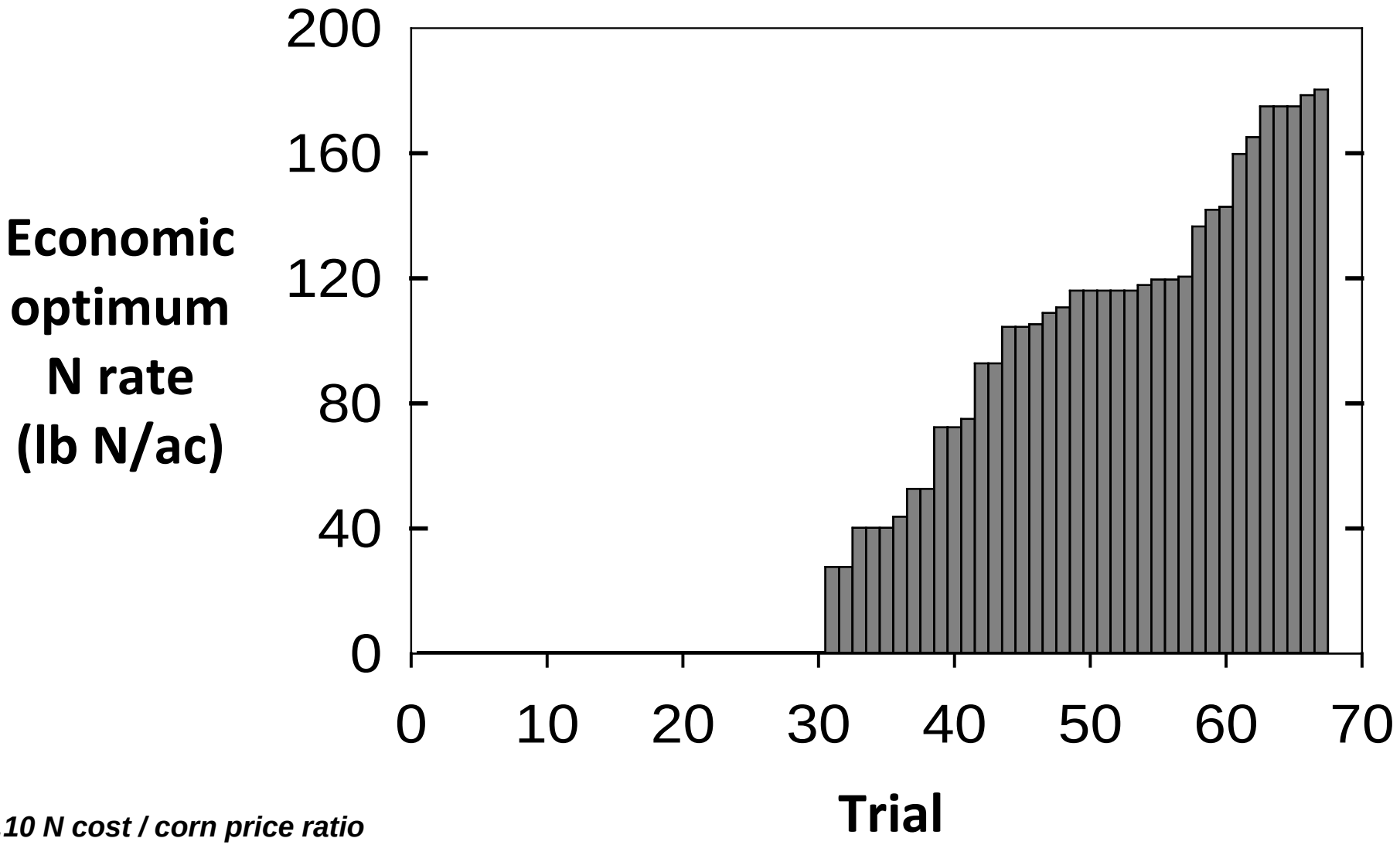


0.10 N cost / corn price ratio

Enhanced efficiency when N was sidedressed at V6 in 2nd-year corn

- At the 4 farms where corn responded to N in 2012:
  - Sidedressed N was more efficient
  - 100 lb N/ac sidedressed = 118 lb N/ac near planting

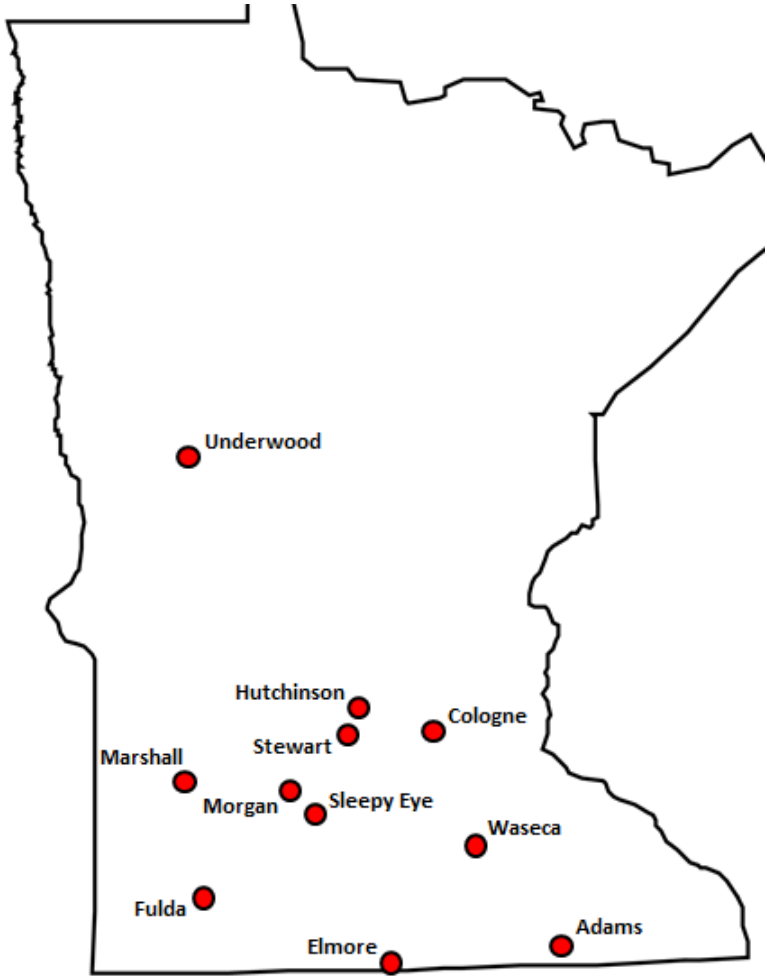
No response to N in one-half of 2nd-year corn trials



0.10 N cost / corn price ratio

11 trials in 2nd-year corn after alfalfa in 2015

- Clay loam soils
- No manure during alfalfa
- Alfalfa stands 3–7 years old with at least 4 plants/ft^2
- Alfalfa terminated with fall tillage
- 0–10 lb N/ac as starter fertilizer



11 trials in 2nd-year corn after alfalfa in 2015

- Maximum yield in trials ranged from 200–254 bu/ac
- Grain yield was not increased with N on 5 of 11 farms
- Optimum N rate was:
  - 30–40 lb N/ac on 2 farms
  - 100–110 lb N/ac on 2 farms
  - 180–200 lb N/ac on 2 farms
- Sidedressed N was more efficient on 1 farm
  - 100 lb N/ac sidedressed = 151 lb N/ac near planting

Take home points for 2nd-year corn

- Frequency & level of yield response to N is closely associated with:
  - Soil texture
  - Age of alfalfa at termination
  - Weather conditions

Take home points for 2nd-year corn

- Grow 2 years of corn after alfalfa to capture N benefits
- Yield of 2nd-year corn was not increased with N in one-half of trials
- Optimal N rates can vary greatly due to weather-related variability in soil N mineralization
- Applying N as a sidedress can enhance N use efficiency

Take home points for 2nd-year corn

- If one expects N may be needed for 2nd-year corn on medium- & fine-textured soils, consider…

  - Limiting the amount of N from fertilizer & manure applied before & near planting

  - Applying additional N in-season if necessary based on weather, soil, & crop conditions


Lynn Betts, USDA

New N management guidelines for corn following alfalfa

Table 4. Nitrogen suggestions for first- and second-year corn following alfalfa.[a]					
Soil texture[b]	Irrigated or non-irrigated	Alfalfa age[c]	Alfalfa termination time	First-year corn following alfalfa	Second-year corn following alfalfa
		years		lb N/acre	lb N/acre
Coarse	Irrigated	1	Fall or spring	140-170	140-170[d]
Coarse	Irrigated	2 or more	Fall or spring	70-150	70-150
Coarse	Non-irrigated	1	Fall or spring	40-80[d]	80-120[d]
Coarse	Non-irrigated	2 or more	Fall or spring	0-20	0-80
Medium	Both	1	Fall or spring	40-80[d]	80-120[d]
Medium	Both	2 or more	Fall	0-20	0-80
Medium	Both	2 or more	Spring	0-40	0-80
Fine	Both	1	Fall or spring	40-80[d]	80-120[d]
Fine	Both	2 or more	Fall	0-20[d]	0-80[d]
Fine	Both	2 or more	Spring	0-40[d]	0-80[d]

[a] Includes pure stands of alfalfa and alfalfa-grass mixtures with at least 50% alfalfa in the stand.

[b] Coarse = sands and sandy loams; medium = loams and silt loams; fine = clays, clay loams, and silty clay loams.

[c] Alfalfa age at termination, including the establishment year if alfalfa was direct seeded without a small grain companion crop.

[d] An additional 30 to 40 lb N/acre can be applied to corn during the growing season if necessary based on the University of Minnesota supplemental N worksheet, available at: http://z.umn.edu/ncalculator

Thank you!