



Nitrogen Management for Corn Following Alfalfa

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Managing the Rotation from Alfalfa to Corn

Matt A. Yost, Jeffrey A. Coulter, and Michael P. Russelle

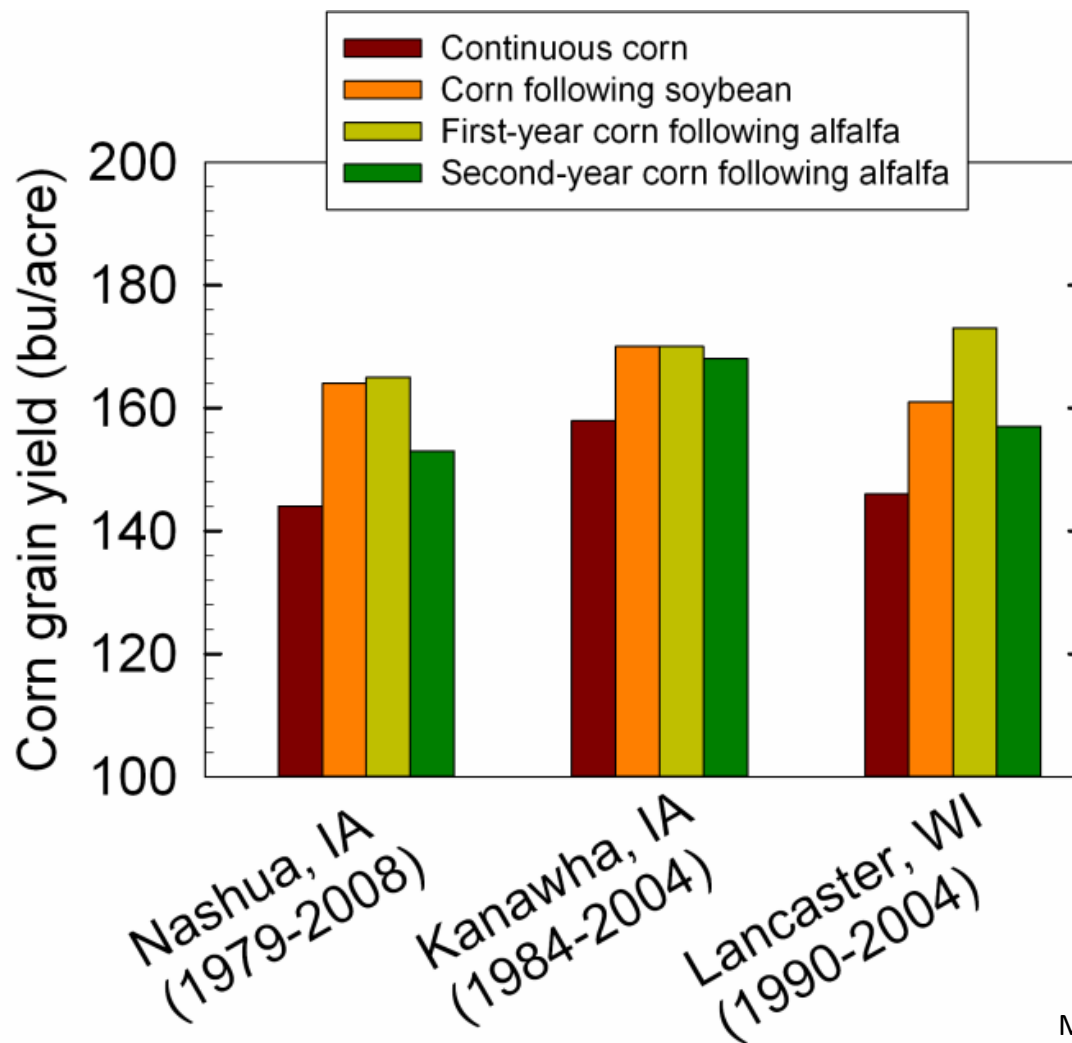


Benefits of alfalfa in crop rotations

- 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

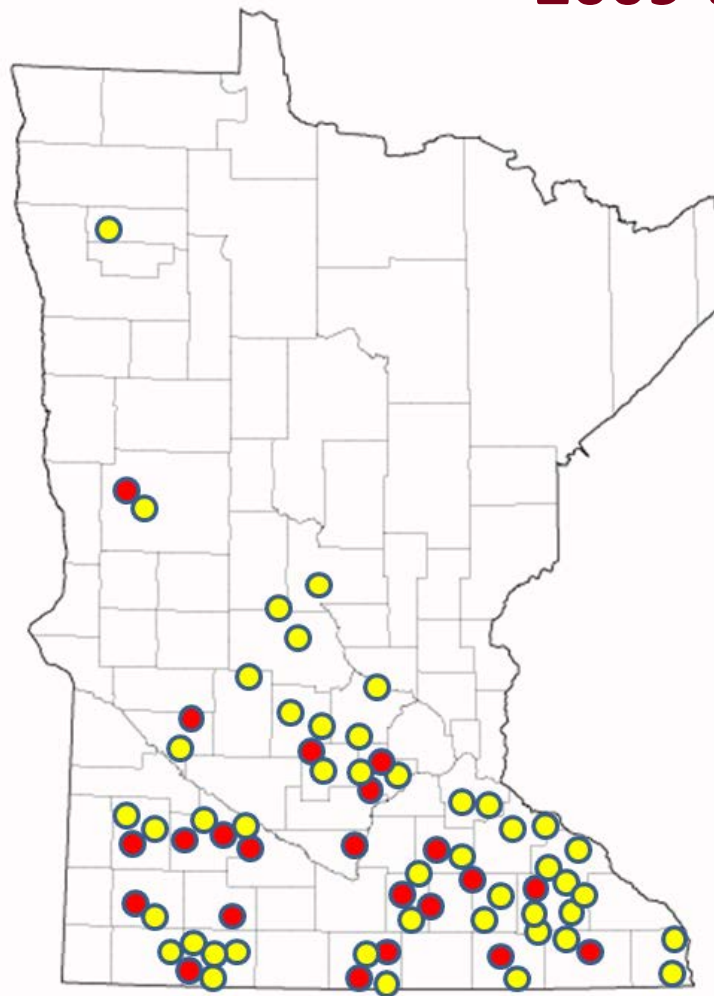
Manure N credit: 40 lb N/ac

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)

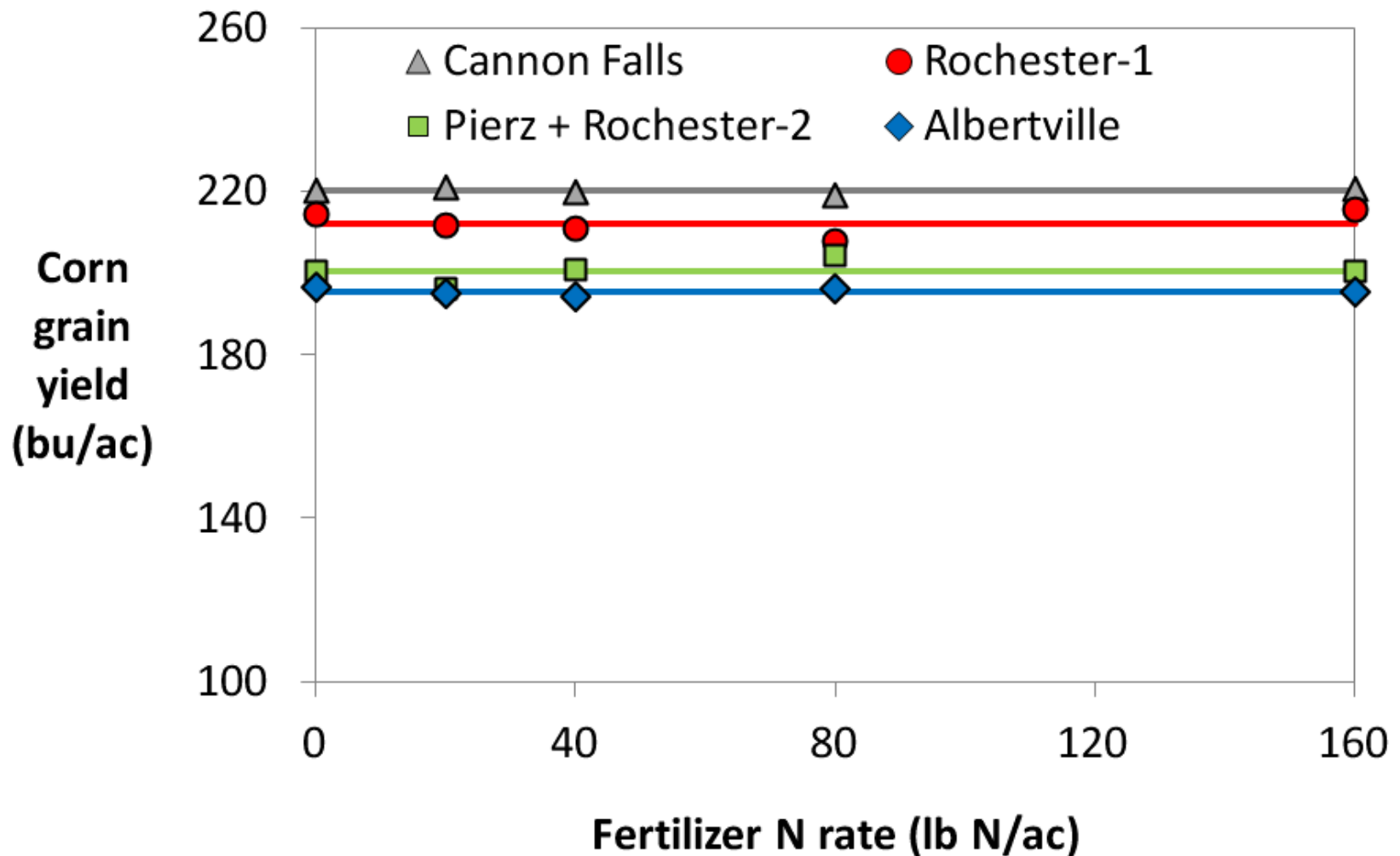
● 2nd-year corn (22 trials)

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

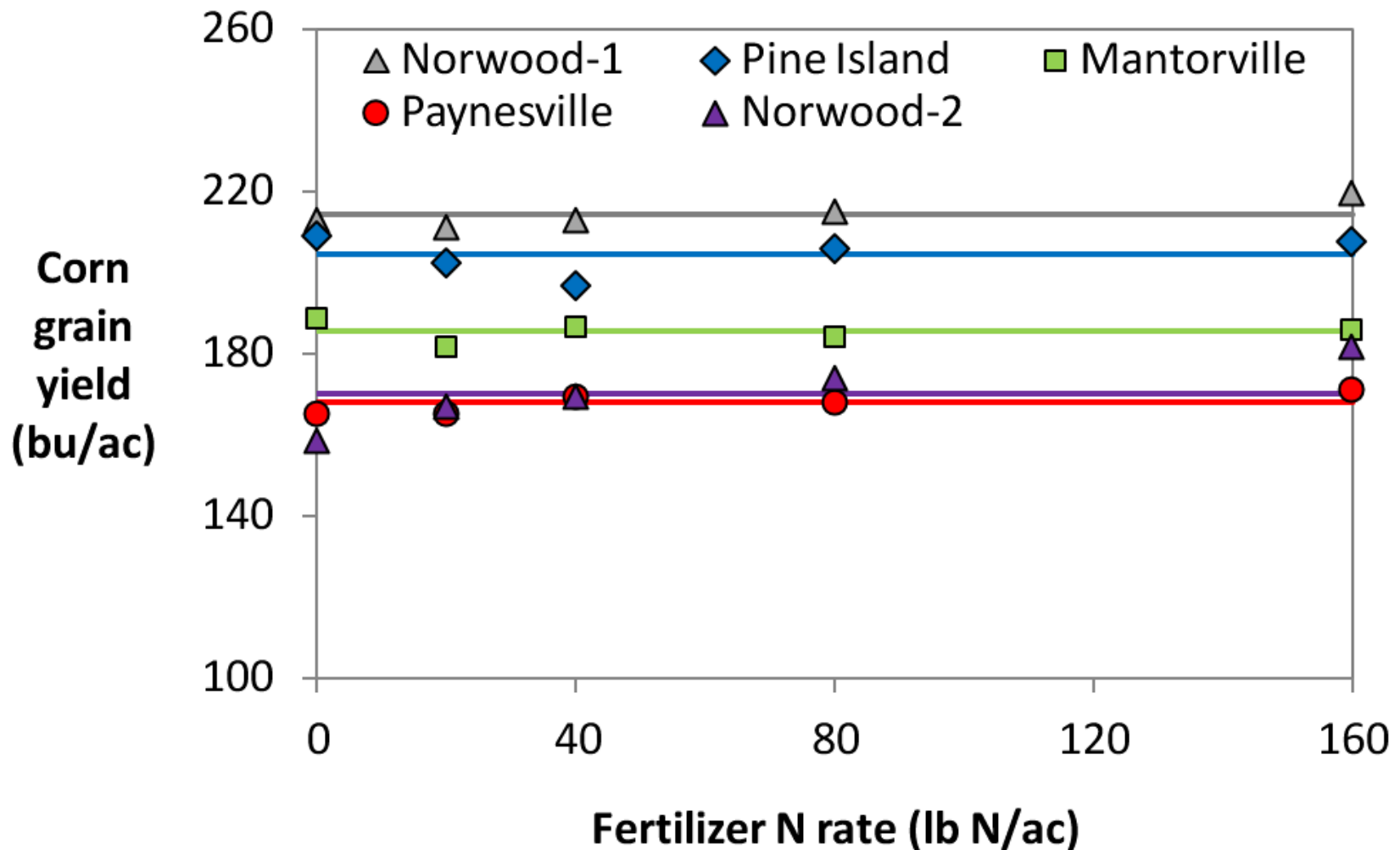
- Evaluated response to fertilizer N in 1st-year corn
- In Dairy Belt of southern & central MN
- No manure during alfalfa
- Alfalfa stands 3–5 years old; 4–10 plants/ft²
- Tillage timing for alfalfa termination varied with farm
- Loam to silty clay loam soils;
1 farm had loamy sand soil



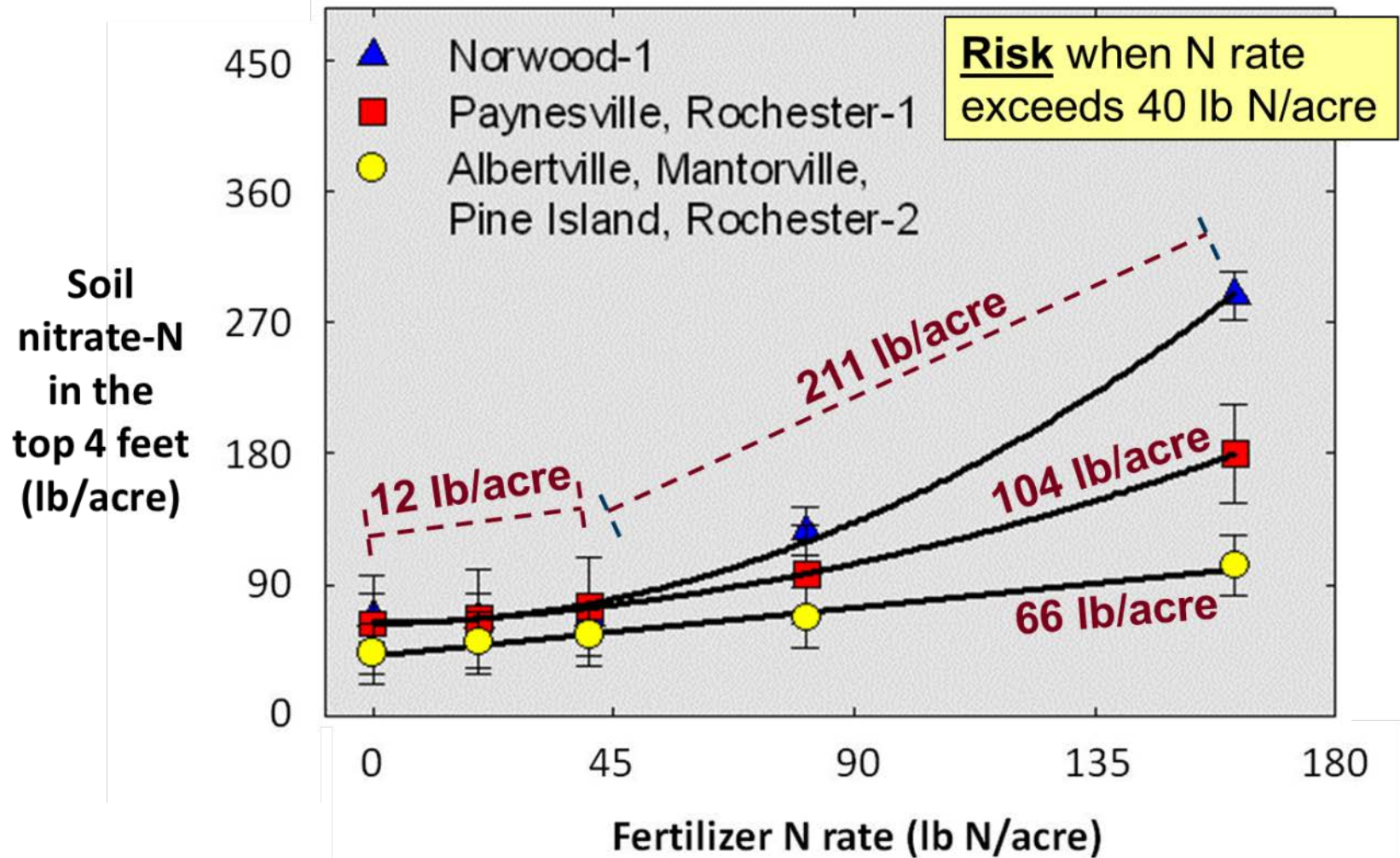
Grain yield was not increased with N on any of the 5 farms in 2009



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

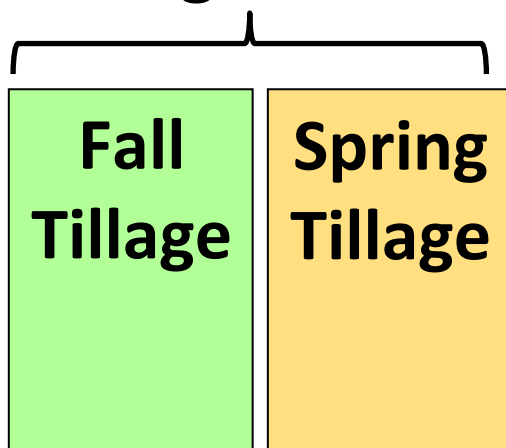
Regrowth treatments



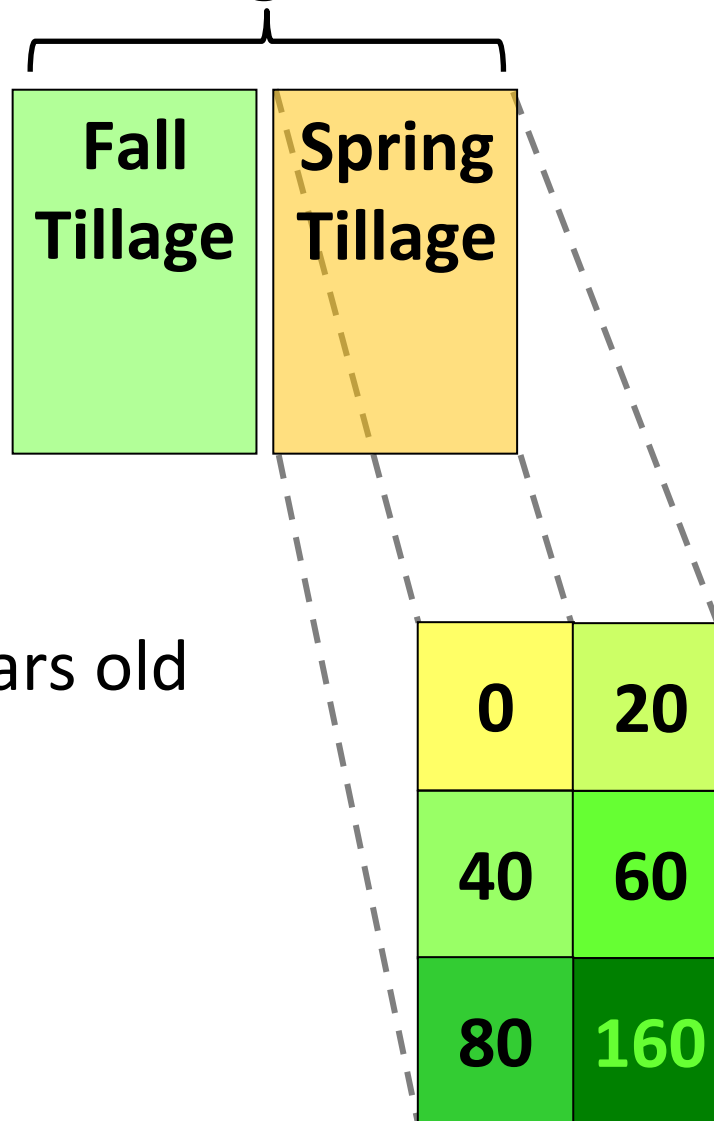
Tillage timing treatments



Regrowth



No Regrowth



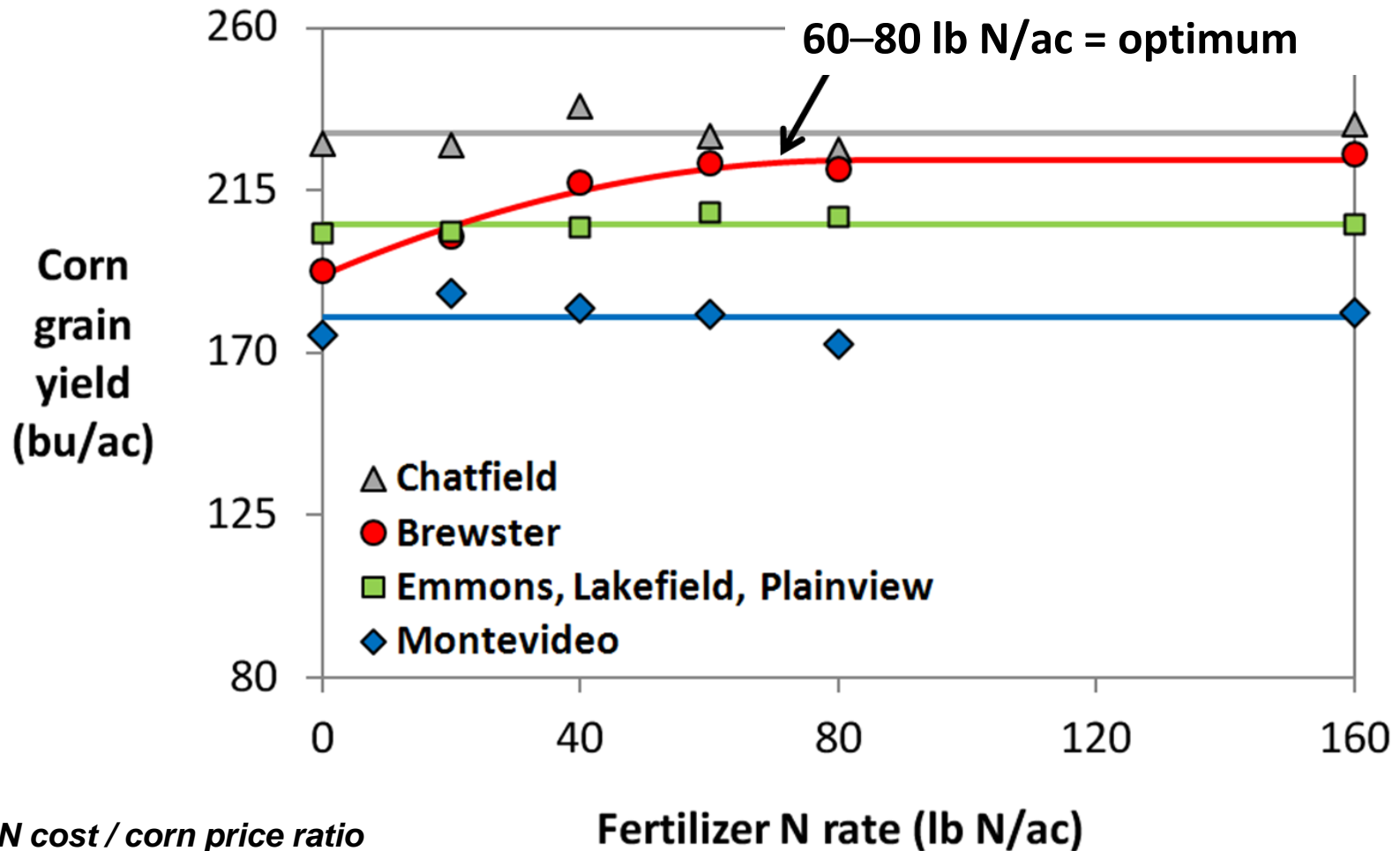
- Alfalfa fields 3–7 years old
- 4–8 plants/ft²
- 4 replications/farm

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



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/ft²
- 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	---

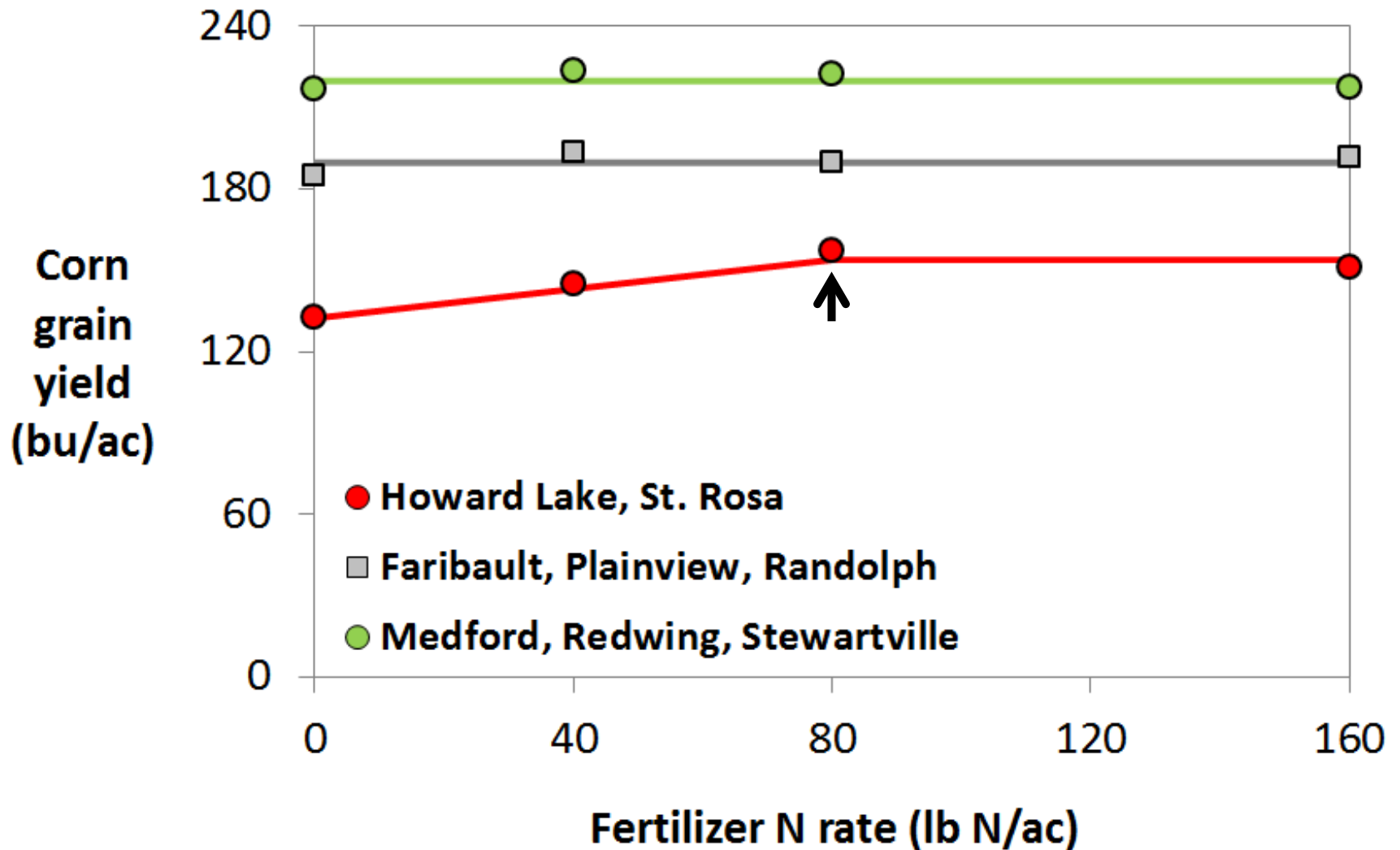


Study #4 = 8 on-farm trials in 2011

- 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/ft²
- Loam, silt loam, silty clay loam, & clay loam soils
- 0–15 lb N/ac as starter fertilizer



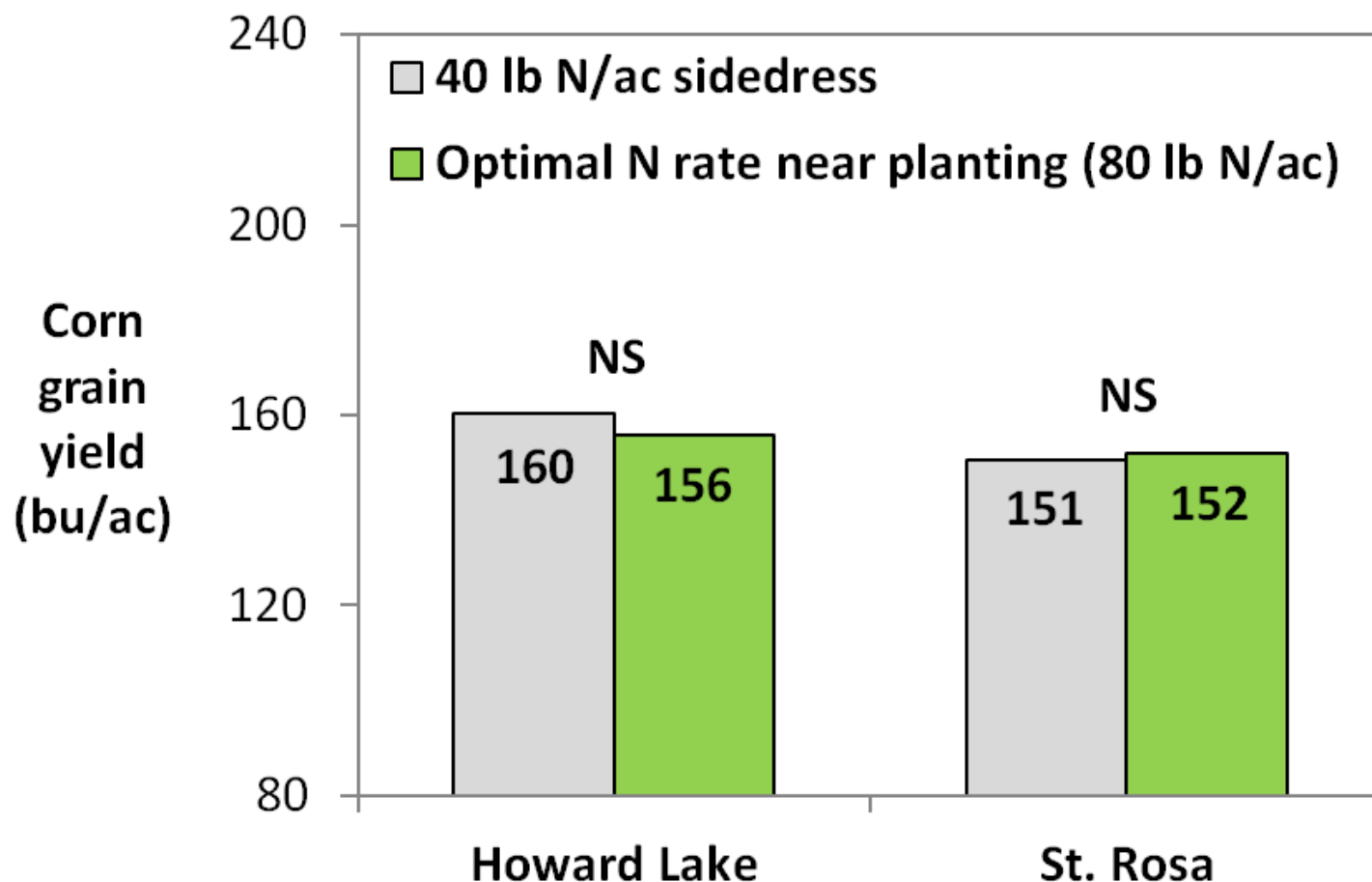
6 of 8 farms with tillage had no response to N in 2011



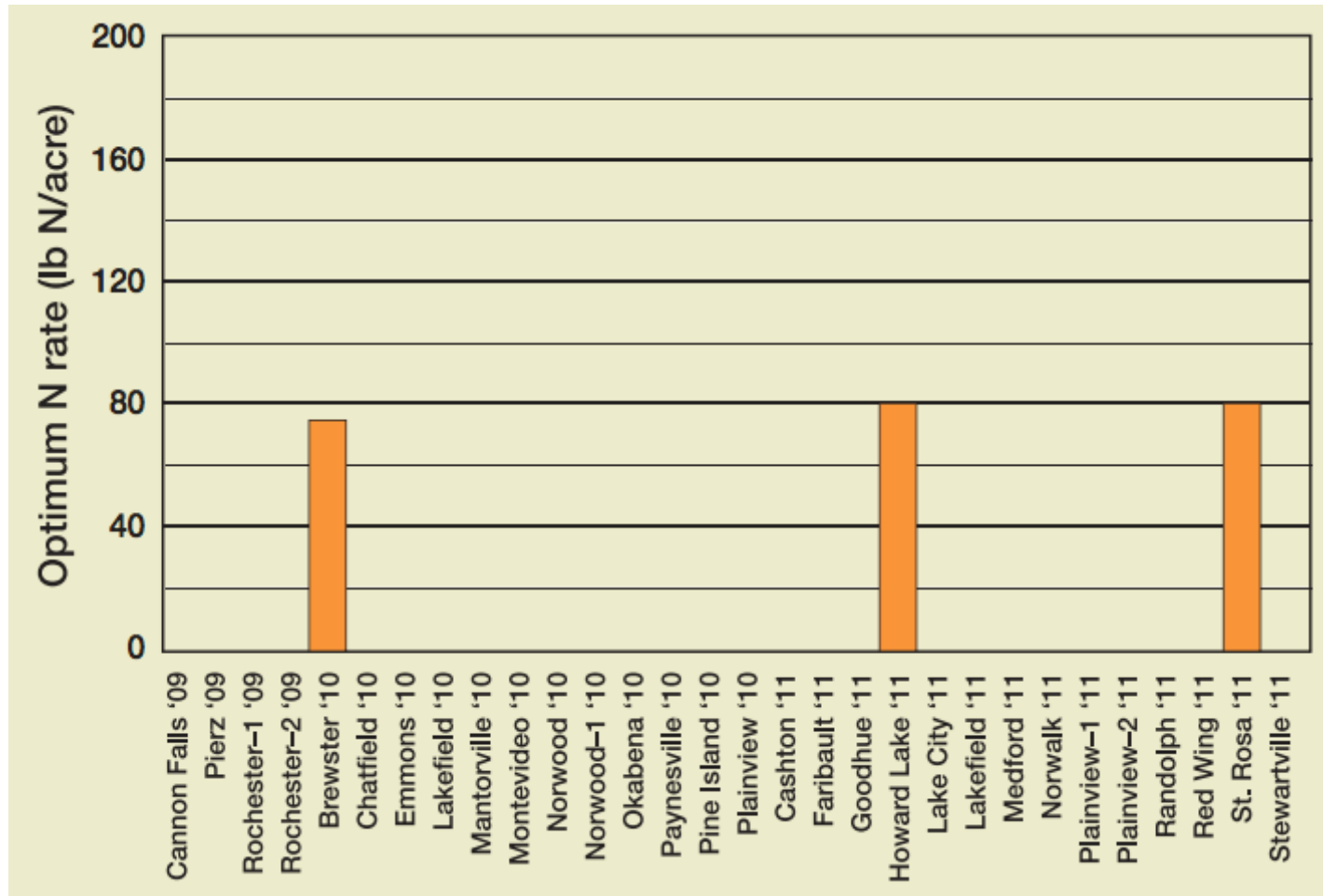
A sidedress of 40 lb N/ac was evaluated on these 8 farms in 2011



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

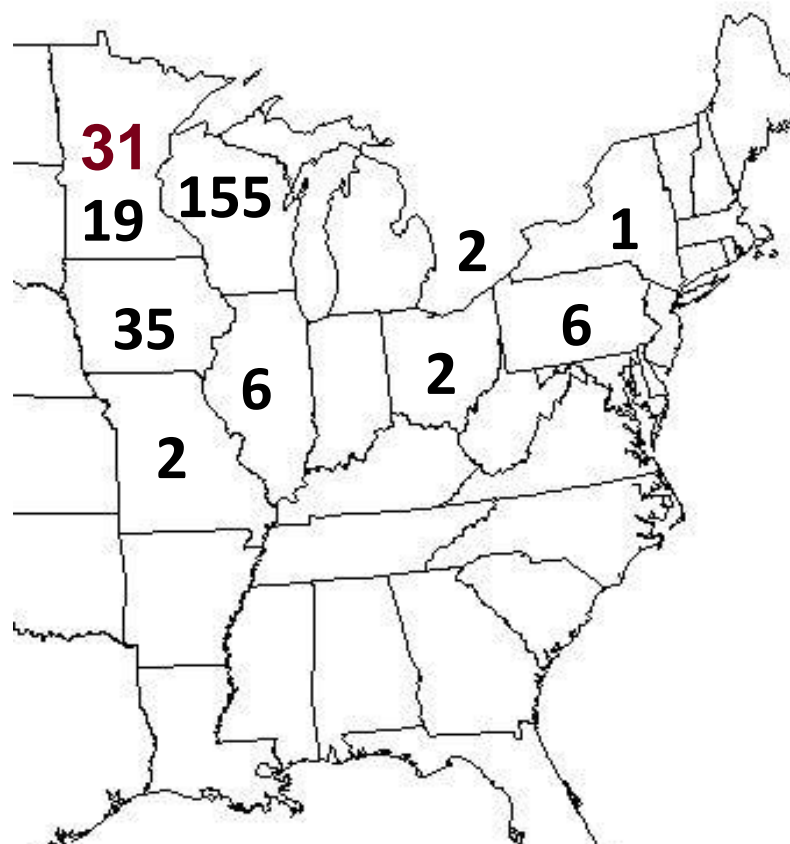


0.10 N cost / corn price ratio



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



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

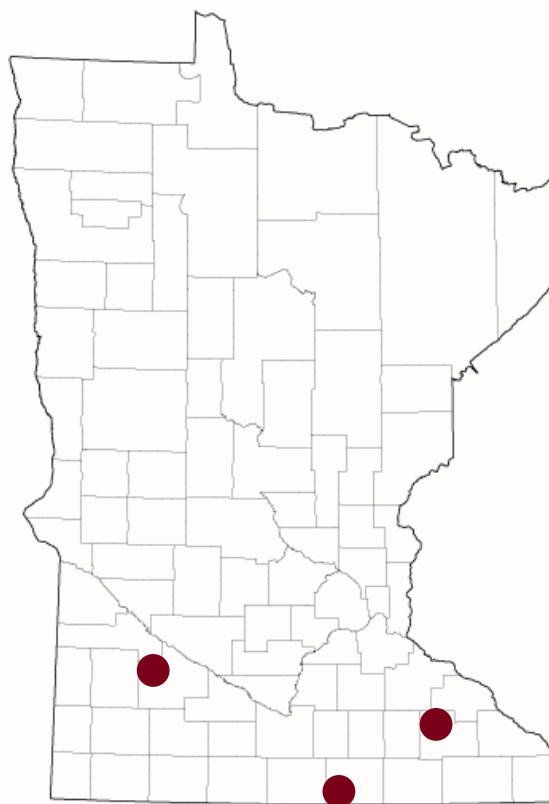
- If one expects N may be needed for 1st-year corn on medium- & fine-textured soils, consider...
 - Limiting the amount of N from fertilizer & manure applied before & near planting
 - Applying additional N in-season if necessary based on weather, soil, & crop conditions





N management for 2nd-year corn following alfalfa

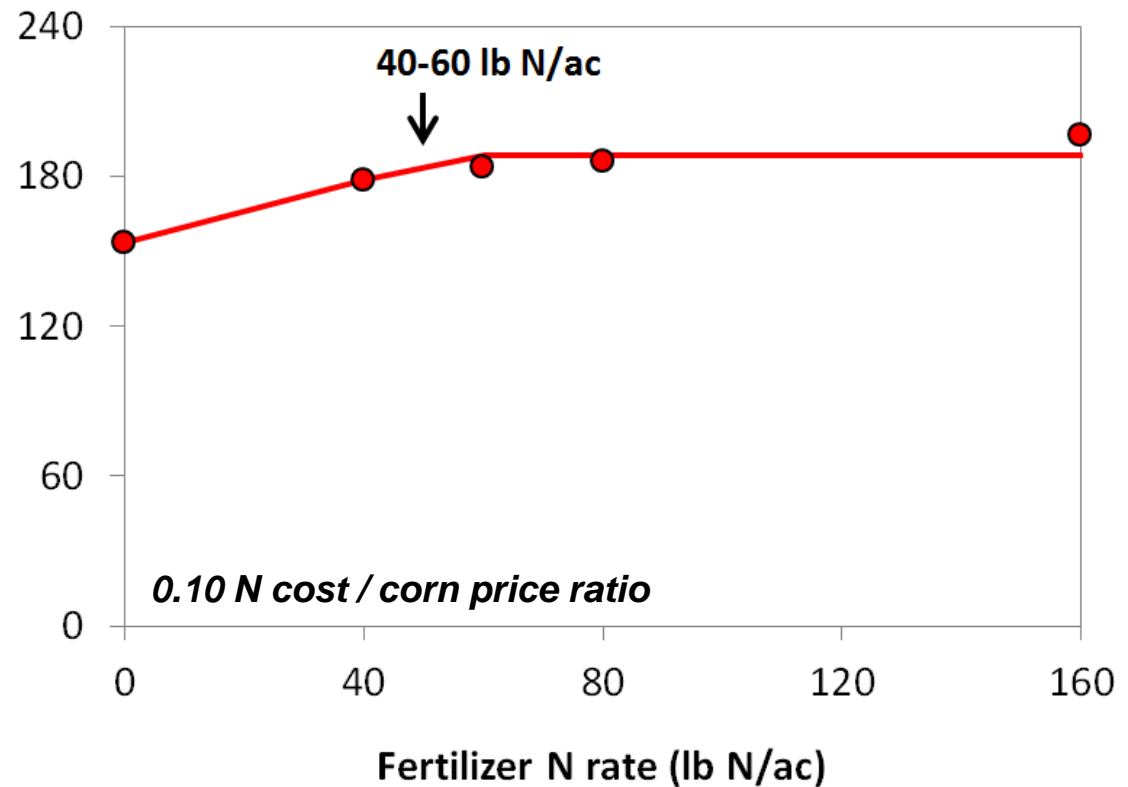
40–60 lb N/ac optimized yield of 2nd-year corn on 3 farms in 2011



Corn
grain
yield
(bu/ac)



Average of 3 farms

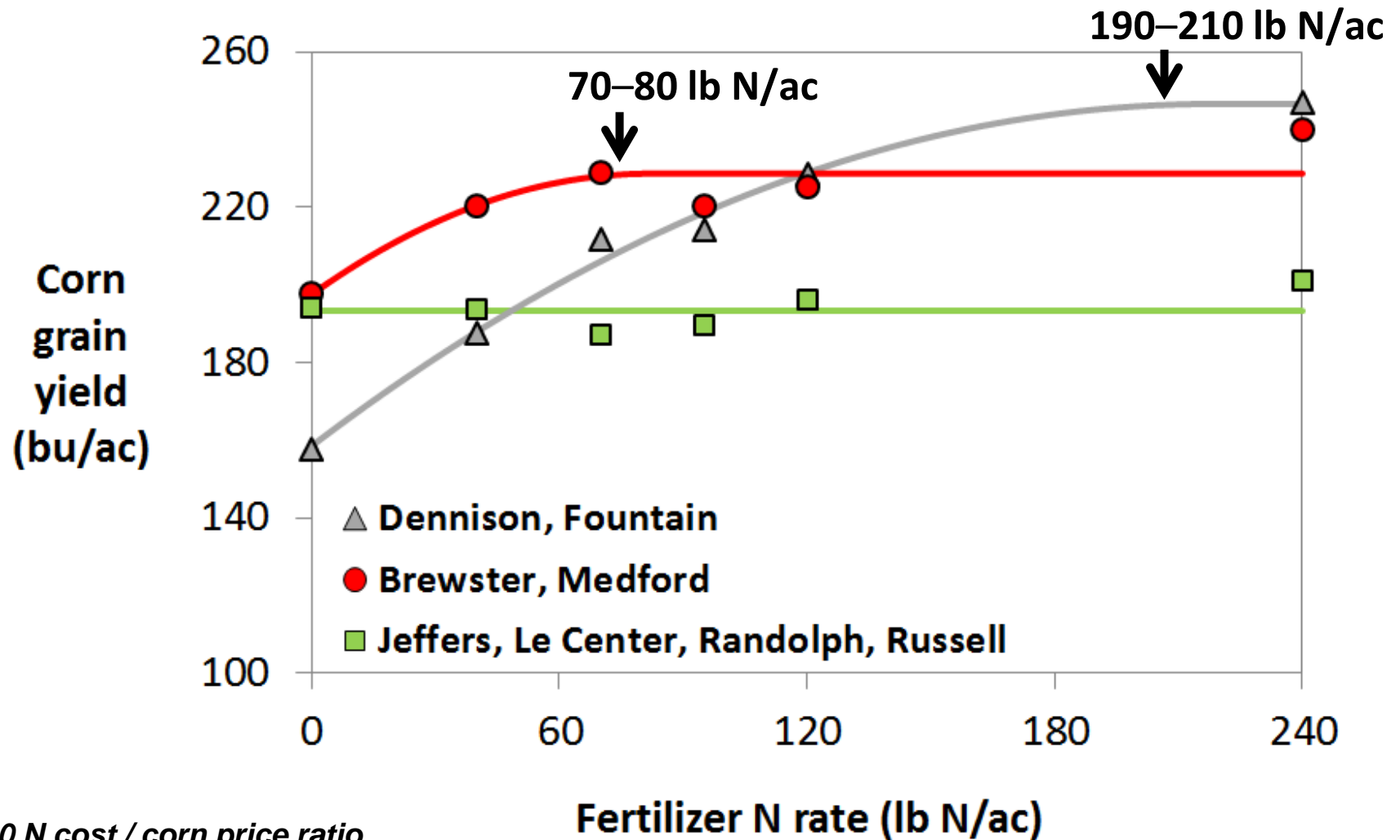


8 trials in 2nd-year corn after alfalfa in 2012

- In southern MN
- No manure during alfalfa
- Alfalfa stands 2–7 years old with at least 4 plants/ft²
- Alfalfa termination method varied with farm
- 0–6 lb N/ac as starter fertilizer
- Loam, silt loam, & clay loam soils



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

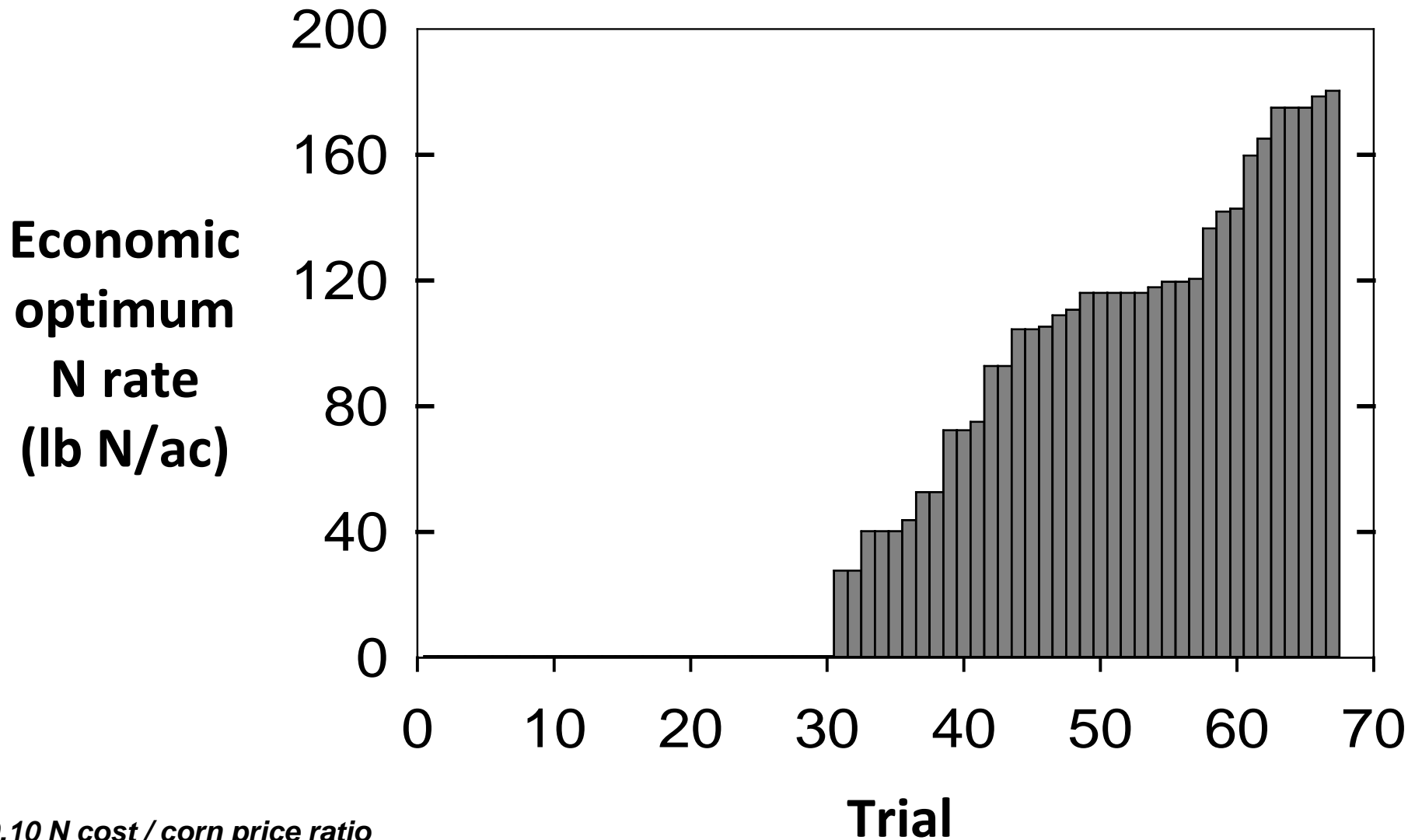


Enhanced efficiency when N was sidedressed at V6 in 2nd-year corn

- 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



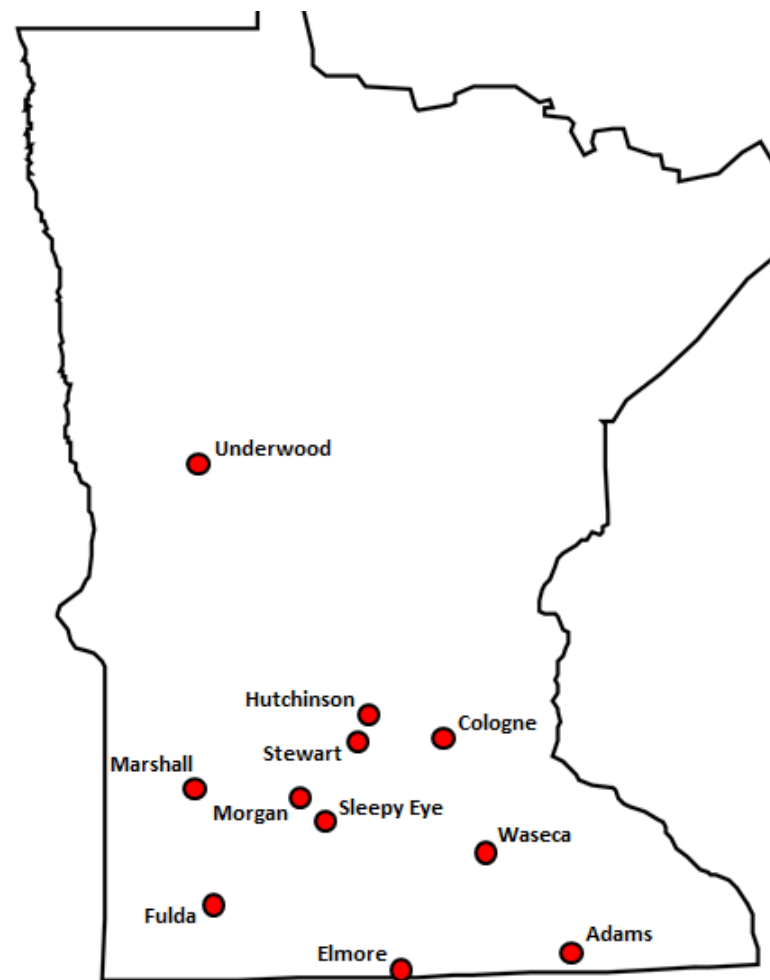
No response to N in one-half of 2nd-year corn trials



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/ft²
- 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



New N management guidelines for corn following alfalfa

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Fertilizing Corn in Minnesota

By Daniel E. Kaiser, Fabian Fernandez, and John A. Lamb, Extension Specialists — Nutrient Management; Jeffrey A. Coulter, Extension Corn Agronomist; and Brian Barber, Director — University of Minnesota Soil Testing Laboratory

2016

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In Minnesota, corn is grown on more acres than any other crop. Nationally, Minnesota ranks among the top five states in corn production. Average corn yields have improved steadily over the past several decades. While general fertilizer use contributed substantially to yield increases in the past, total fertilizer management which optimizes nutrient efficiency will be needed to increase future production and profitability.



Nitrogen Guidelines

Minnesota corn growers receive substantial return for money invested in nitrogen (N) fertilizers. For many situations, the most profitable yield cannot be achieved unless N fertilizers are used.

There are many management decisions involved in the use of N fertilizers. The most important, however, is the selection of a N rate that will produce maximum profit while limiting the potential for environmental degradation. The choice of an appropriate rate of fertilizer N is not easy because of the transient nature of N in soils.

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>





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