



# Potassium for Last-Year Alfalfa; Nitrogen for First-Year Corn

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# Benefits of Alfalfa in Crop Rotations

- **Supplies nitrogen**
  - About 100% of the N for 1<sup>st</sup> year corn
  - About 50% of the N for 2<sup>nd</sup> year corn
- **Boosts corn yield**
  - Disrupts pest cycles (corn rootworm & weeds)
  - Improves soil structure & tilth
  - Reduces soil erosion
  - Reduces soil organic matter losses



# Potassium (K) for Alfalfa



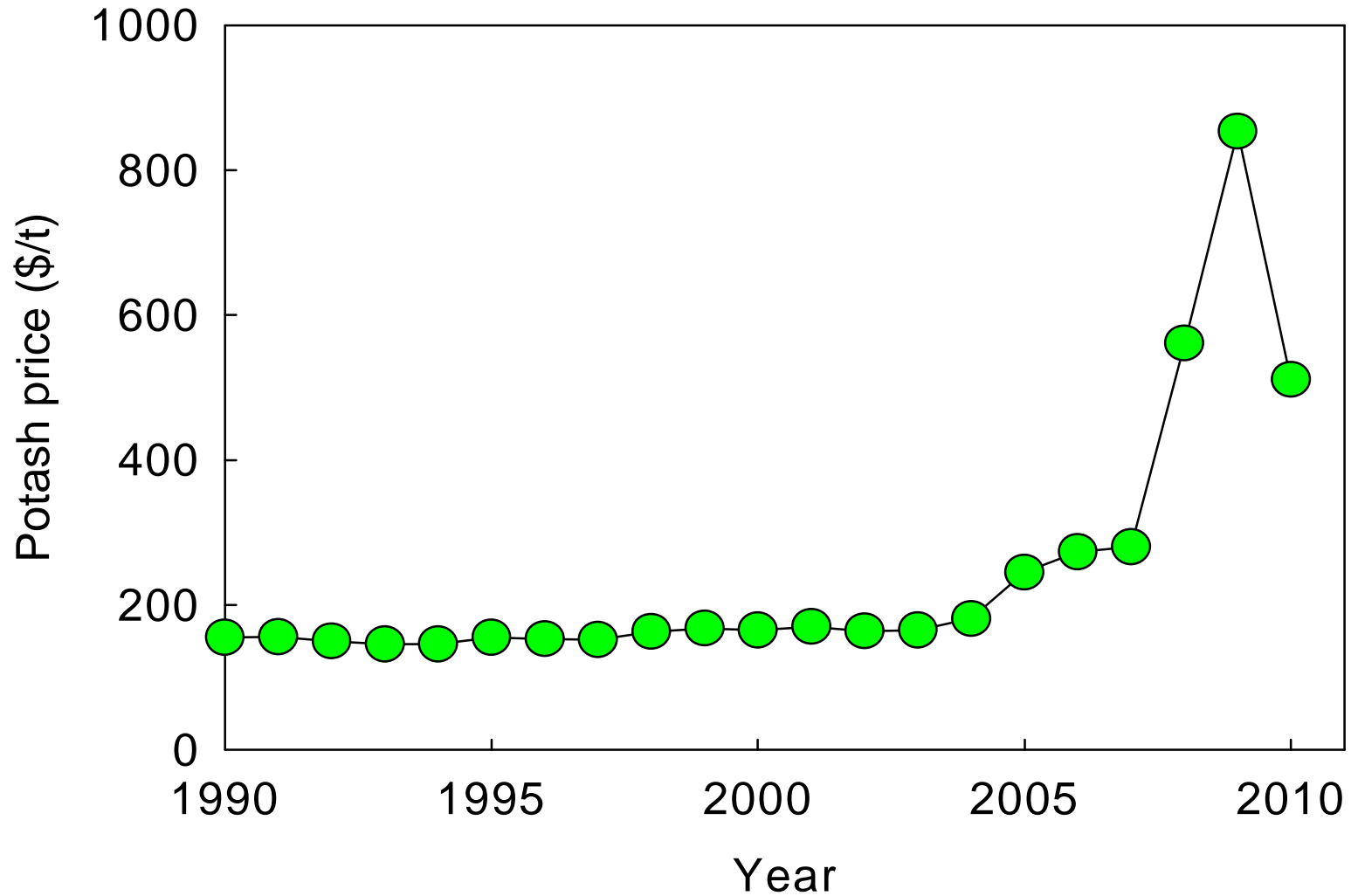
- **K removal is high with alfalfa**
- **Alfalfa is stressed by...**
  - Multiple harvests & field traffic.
  - Poor drainage, drought, overwintering.
- **K is critical for stress tolerance**
  - K helps move sugars from shoots to roots, and then back during regrowth.
  - Univ. of WI recommends increasing K fertilizer rates by 20% if stand life will be greater than 3 years.
  - Alfalfa N credits are based on alfalfa stand density.

# Drawbacks with Excessive K Fertilization in Alfalfa

- Forage with excess K concentration can cause problems as dry cow feed.
- K fertilizers are expensive.

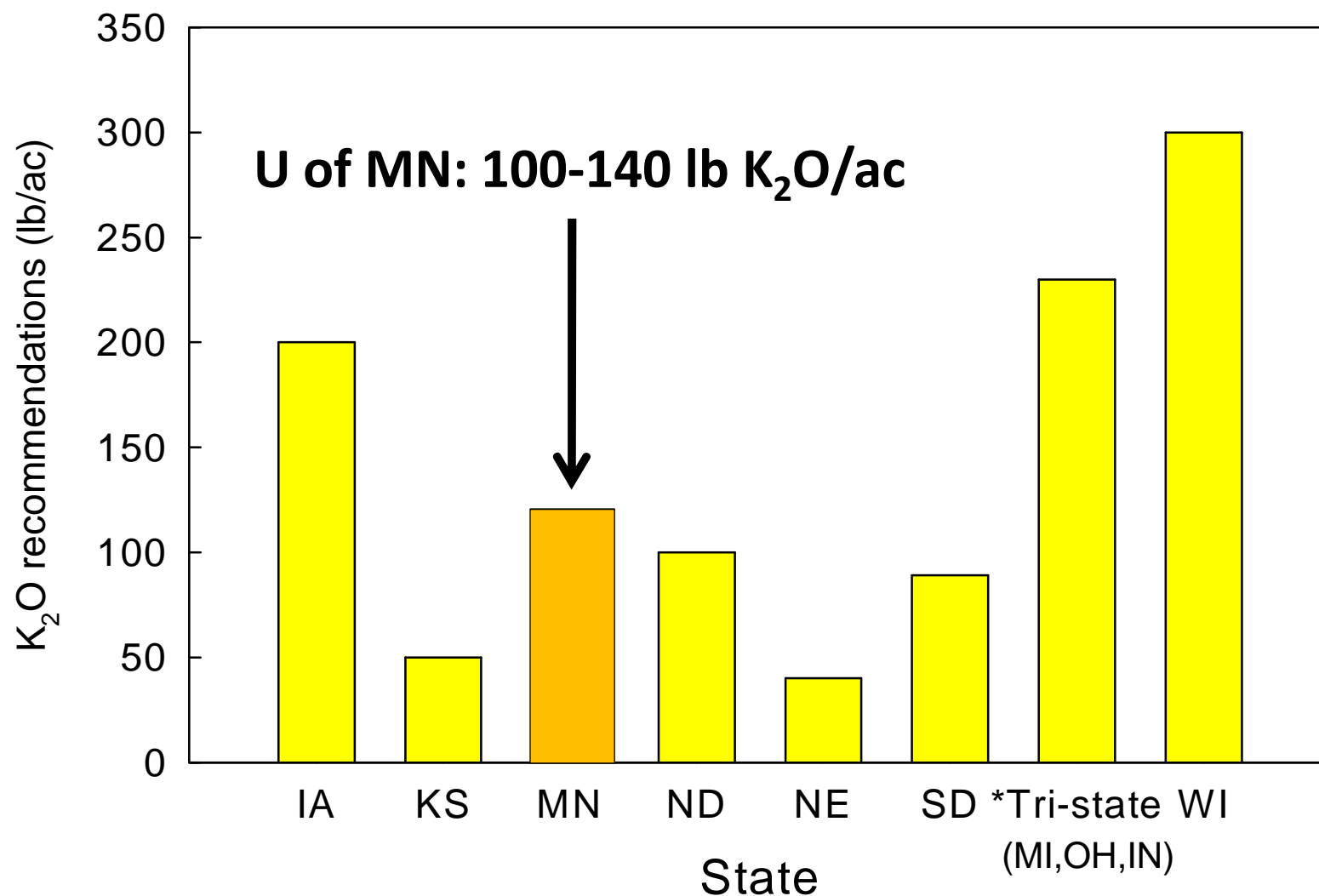


# Is the age of stable fertilizer price over?



**Critical to apply the economically optimum rate.**

## Alfalfa K fertilizer guidelines for soils testing in the medium range (81-120 ppm K for MN)



**Recommendations do not change for last production year.**

# 10 on-farm experiments in southeastern & central MN

- Medium-testing K soils (within 81-120 ppm K)
- Loamy sand to silty clay loam soils

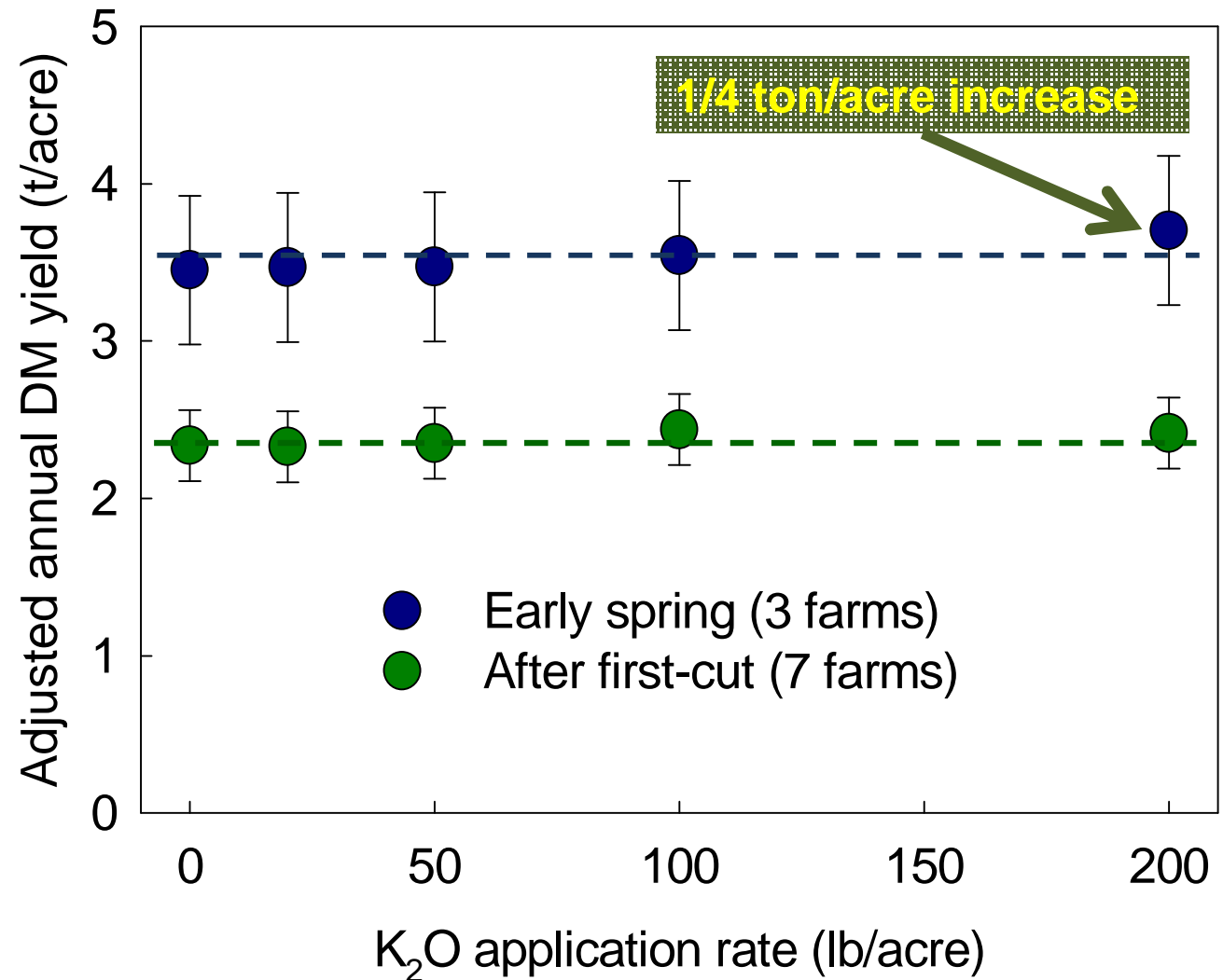
| Year | Location        | Dominant soil type        | Initial<br>STK | Alfalfa variety                       | Stand<br>age<br>(yrs) |
|------|-----------------|---------------------------|----------------|---------------------------------------|-----------------------|
| 2008 | Albertville     | Lester loam               | 111            | Croplan Genetics<br>'TrailBlazer 6.0' | 5                     |
| 2008 | Cannon<br>Falls | Estherville sandy<br>loam | 98             | Geerston Seed Co.<br>'Multi 5301'     | 3                     |
| 2009 | Mantorville     | Marquis silt loam         | 101            | Pioneer '54V46'                       | 3                     |
| 2009 | Norwood         | Sparta loamy sand         | 79             | Mycogen '4A421'                       | 4                     |
| 2009 | Norwood         | Le-Sueur-Lester<br>loams  | 85             | NK Syngenta<br>'Genoa'                | 4                     |
| 2009 | Paynesville     | Tara silt loam            | 92             | Grassland Central<br>'Dynamic'        | 5                     |
| 2008 | Pierz           | Nokay loam                | 89             | Pioneer '54V46'                       | 4                     |
| 2009 | Pine Island     | Downs-Hersey<br>complex   | 95             | Producer's Hybrids<br>'A30-06'        | 4                     |
| 2008 | Rochester       | Port Byron silt loam      | 108            | NK Syngenta<br>'Geneva'               | 4                     |
| 2008 | Rochester       | Garwin silty clay loam    | 110            | Pioneer '53Q60'                       | 5                     |



# Annual Alfalfa Dry Matter Yield

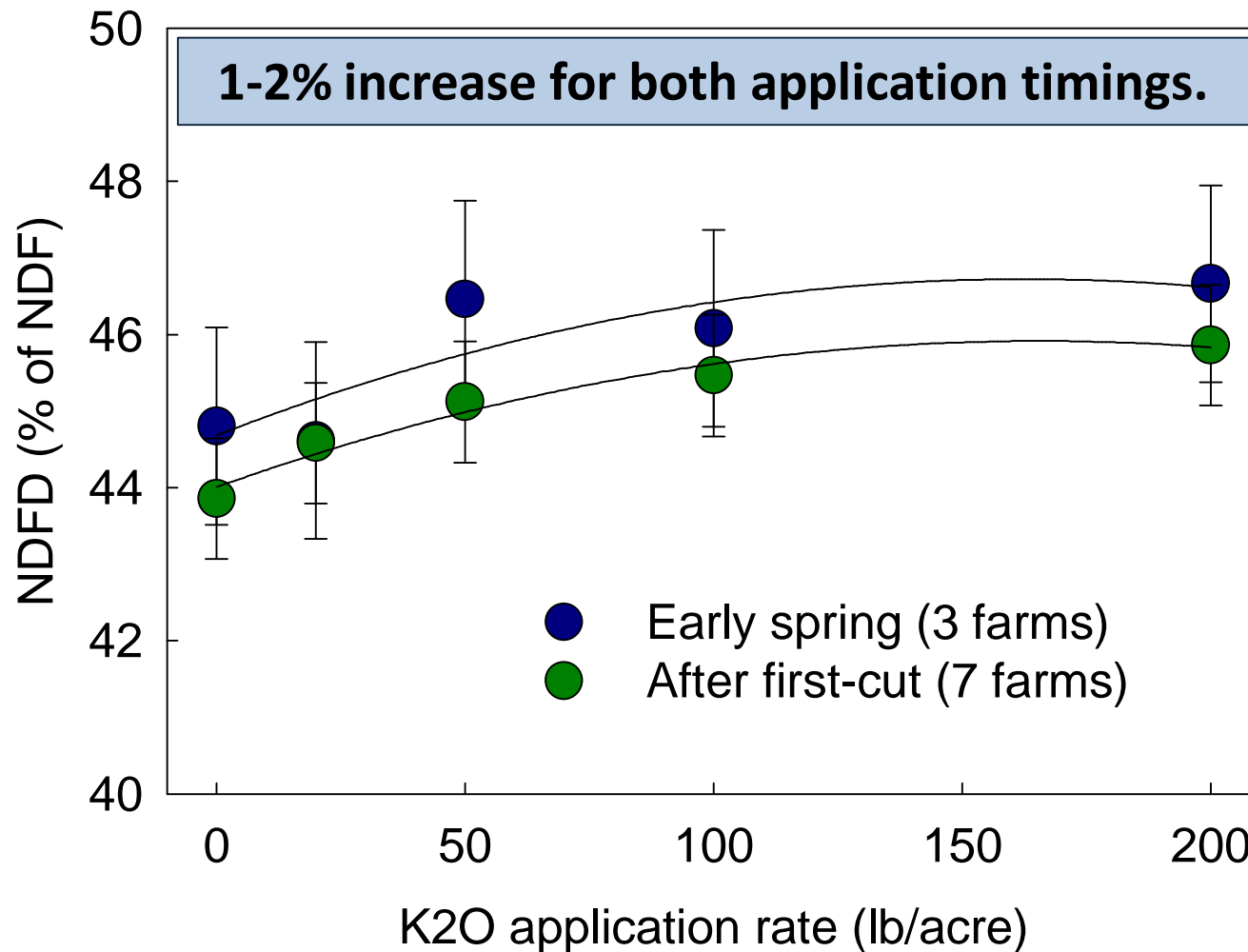
|      | \$ per ton (1990-2010) |       |
|------|------------------------|-------|
|      | KCl                    | Hay   |
| High | \$495                  | \$125 |
| Avg. | \$245                  | \$100 |
| Low  | \$150                  | \$35  |

At avg. potash and hay prices, one needs **2 to 3 times** our observed response to break even.



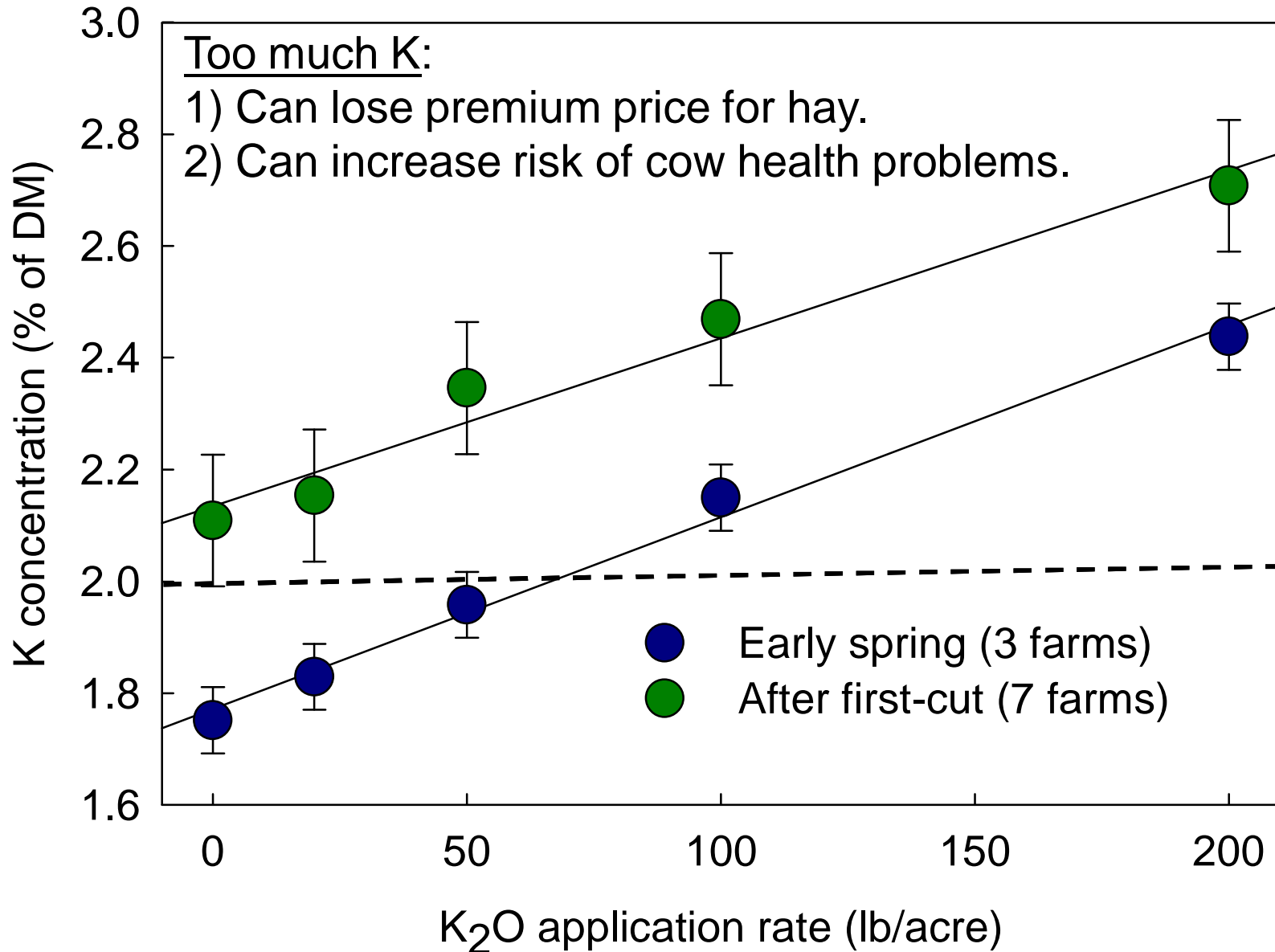
Adding K to alfalfa during the last production year **likely** will reduce profitability.

# No potash effect on any forage quality parameter except NDF digestibility



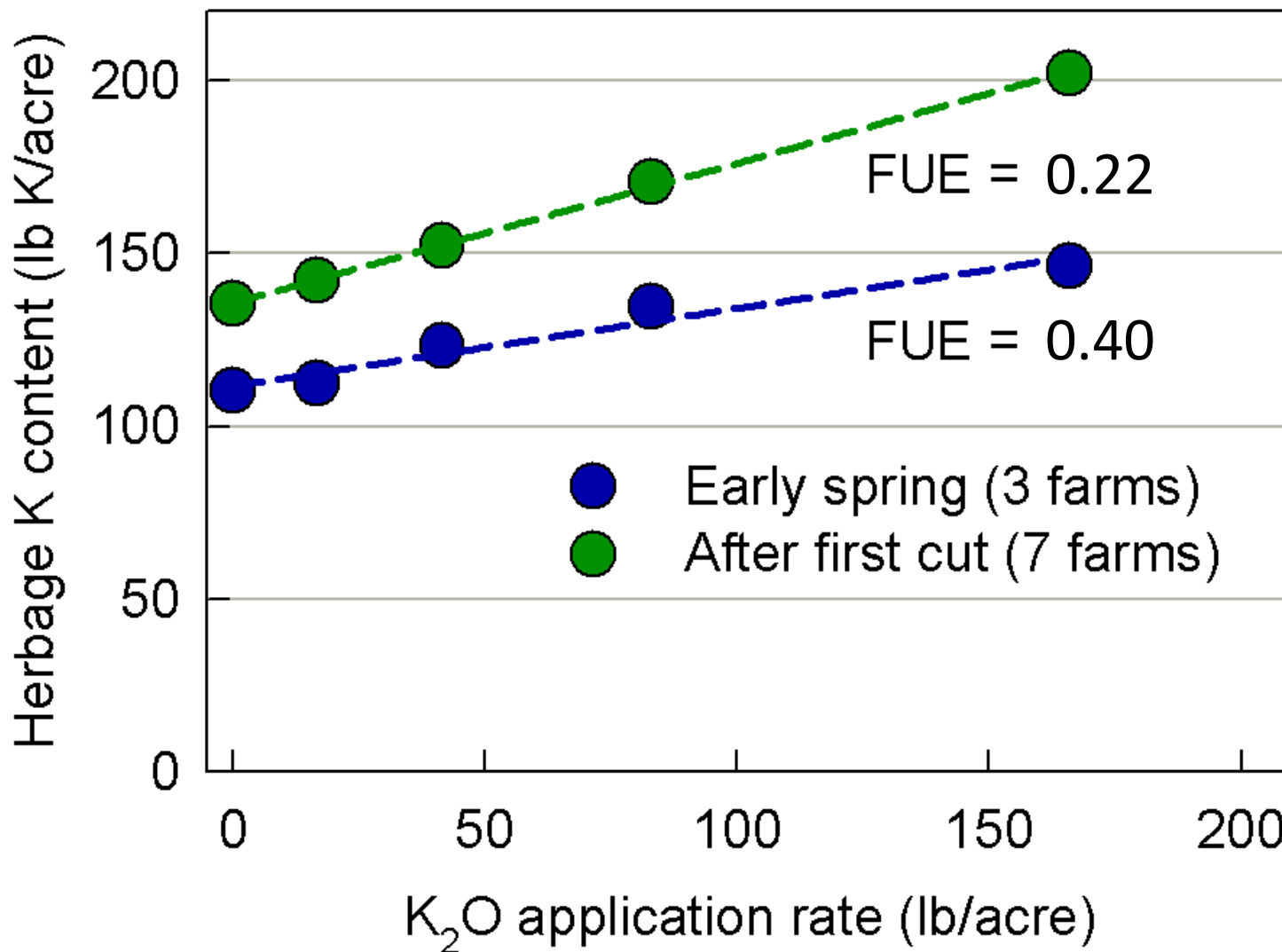
**But, this change did not improve overall forage quality  
--- or it's value in the market.**

# Was the potash available?



**Yes, topdressed K was available to the crop.**

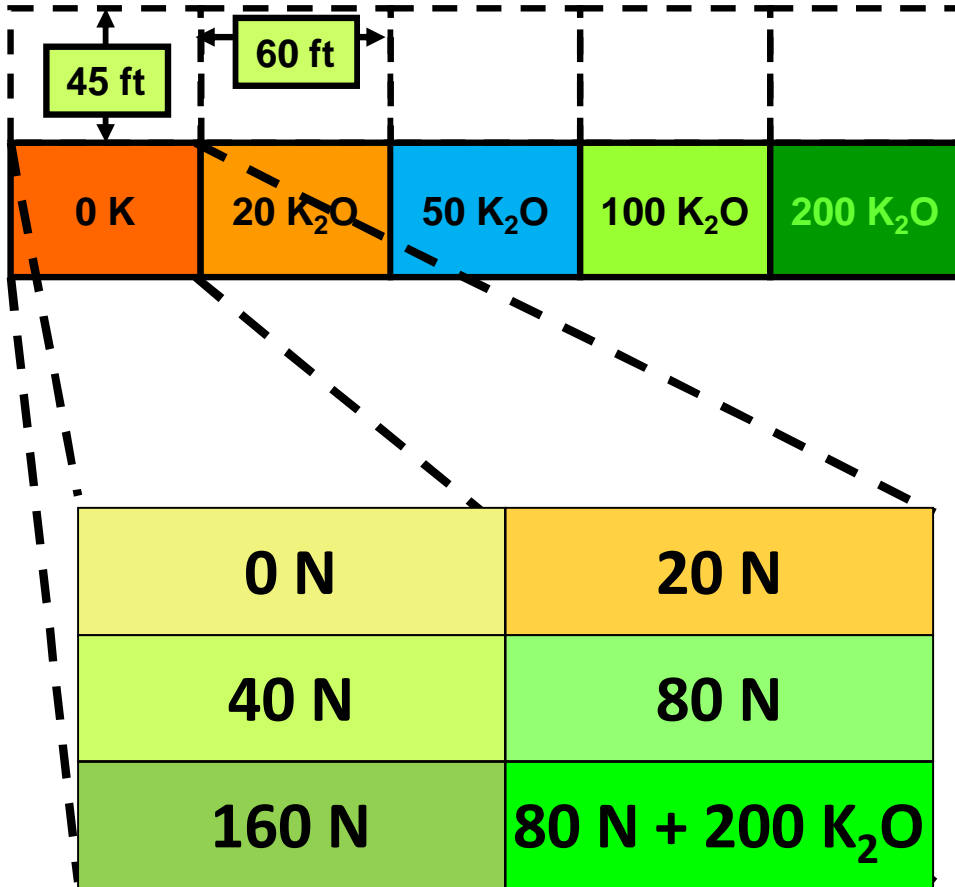
# How much of the potash was taken up?



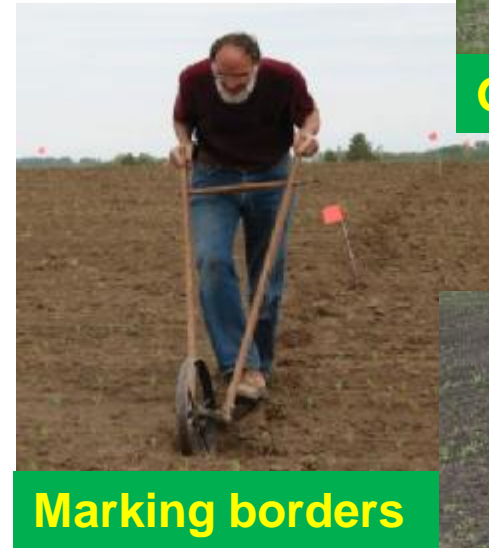
**22 to 40% of the potash was removed in forage.**

# Corn Phase

Every K plot subdivided for N rate treatments.

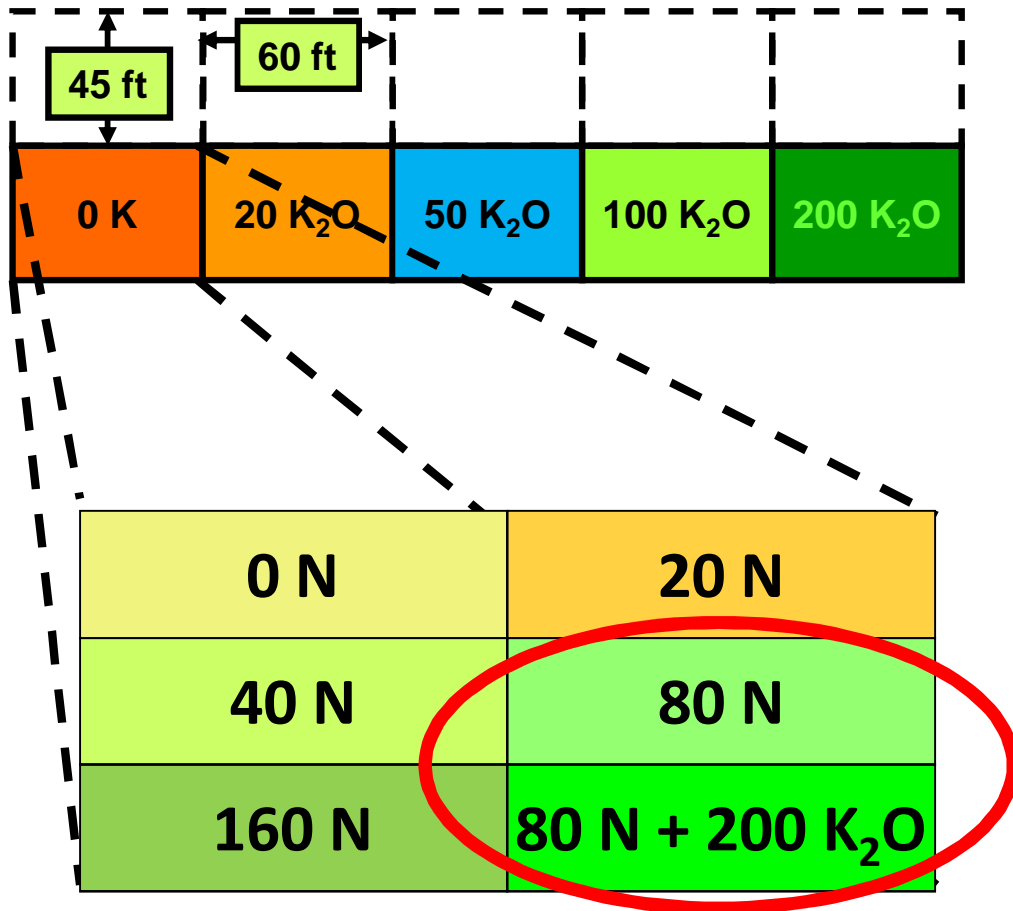


Phosphorus and sulfur fertilization according to U of MN recommendations.

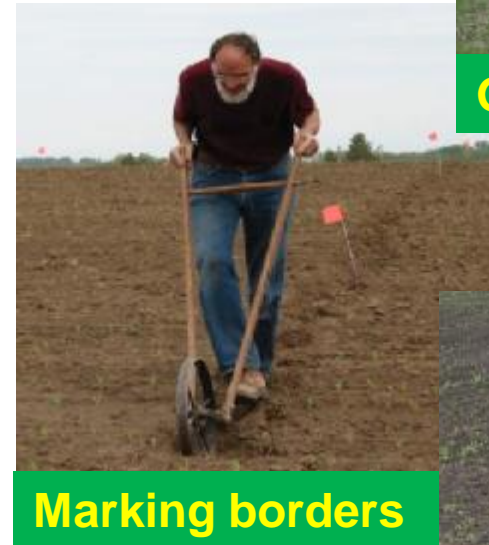


Every K plot subdivided for N rate treatments

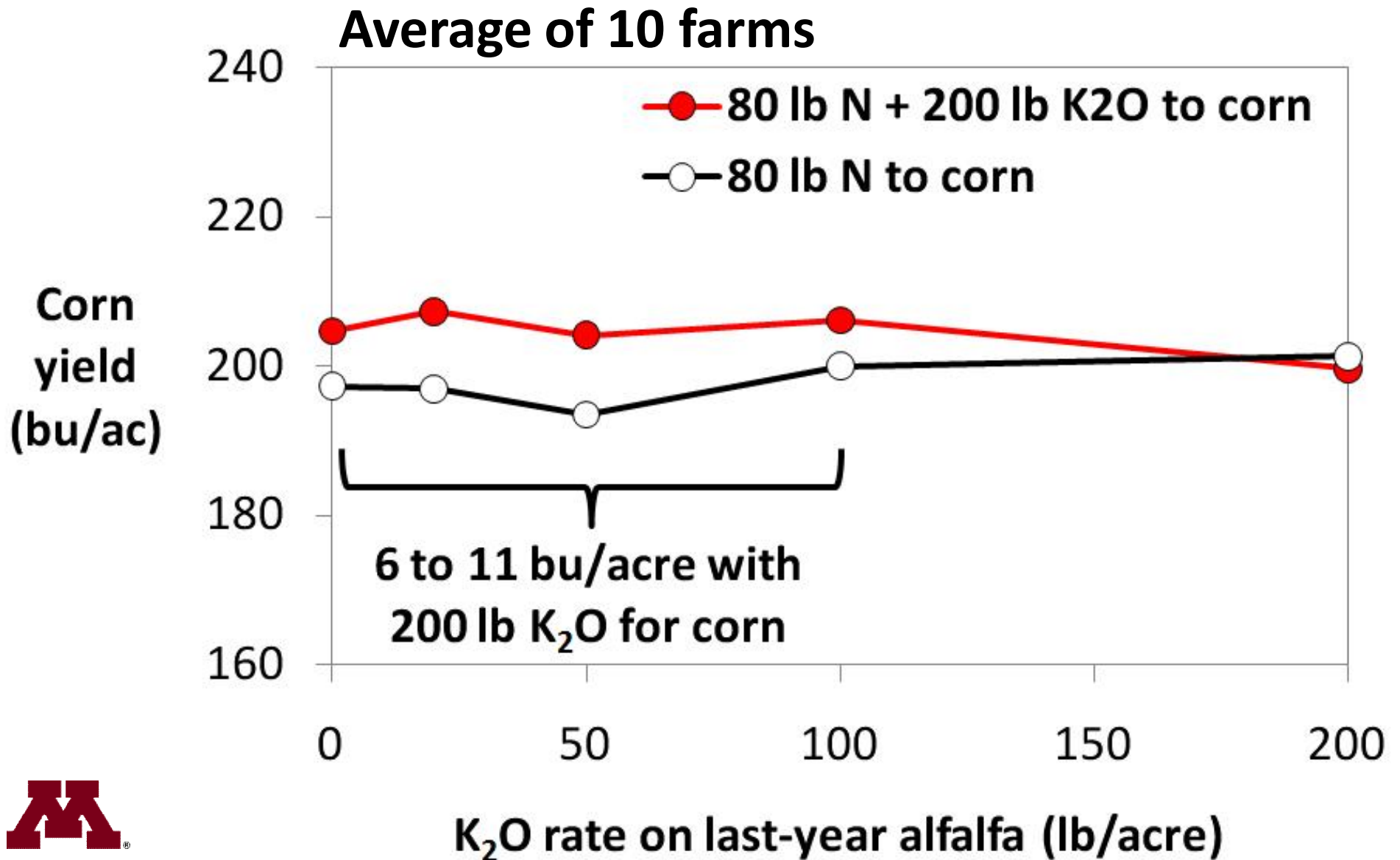
# Corn Phase



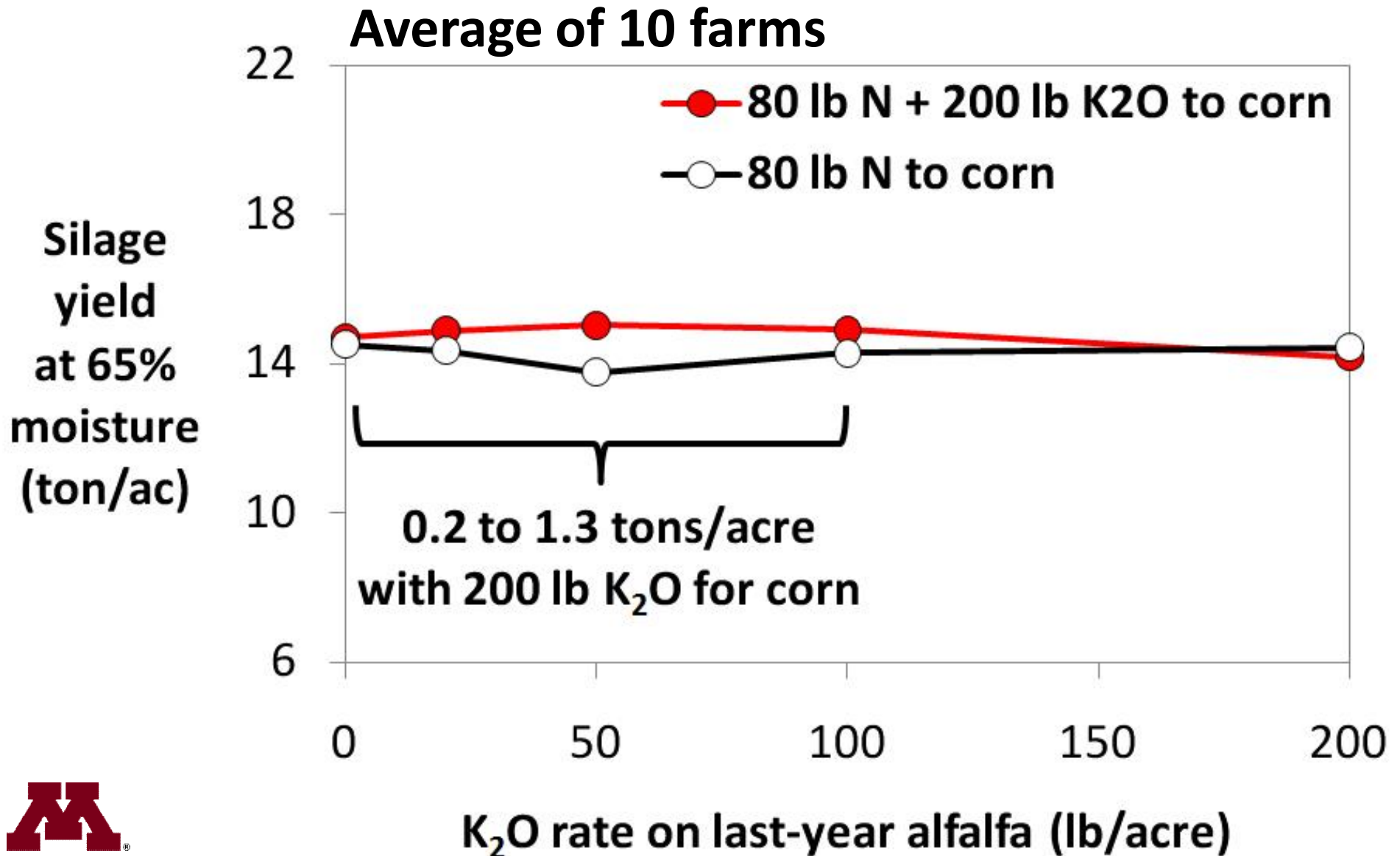
Phosphorus and sulfur fertilization according to U of MN recommendations.



# Some yield response to $K_2O$ in corn when $\leq 100$ lb $K_2O$ /acre applied to last-year alfalfa.



# Some yield response to $K_2O$ in corn when $\leq 100$ lb $K_2O$ /acre applied to last-year alfalfa.



## Summary for medium-testing K soils

- Potash recommendations may be too high for *final-year* alfalfa on medium-testing soils.

***Potash did not pay for itself on 10 farms.***

- Alfalfa removed 22 to 40% of the applied potash.
- Some yield increase with potash applied to 1<sup>st</sup> year corn (when  $\leq 100$  lb  $K_2O$  applied in final-year alfalfa).

***Apply K to the crop that needs it.***

- 1<sup>st</sup> year corn response to N fertilizer was not affected by K rate applied to final-year alfalfa.

# Minnesota N Fertilizer Guidelines

(Corn: \$6.00/bu; N fertilizer: \$0.45/lb N)

- Corn following corn: 146 to 162 lb N/acre
- Corn following soybean: 107 to 127 lb N/acre
- N credit for 1<sup>st</sup> year corn after alfalfa:
  - 150 lb N/acre for  $\geq 4$  plants/sq. ft
  - 100 lb N/acre for 2 to 3 plants/sq. ft
  - 40 lb N/acre for  $\leq 1$  plant/sq. ft



# How does alfalfa provide N credits to corn?

- **Recovers excess soil nitrate**
- **Fixes atmospheric N**  
*(100 to 500 lb N/acre/year)*
- **Maintains high N concentration**  
*(>2% N in roots and residue)*
- **Adds N to soil organic matter pool**  
*(50 to 150 lb N/acre/year)*
  - Harvest losses
  - Stand losses
  - Thin root turnover
  - Root exudation



Slide from  
Michael Russelle  
(USDA-ARS)

# Response of 1<sup>st</sup> Year Corn to N Fertilizer

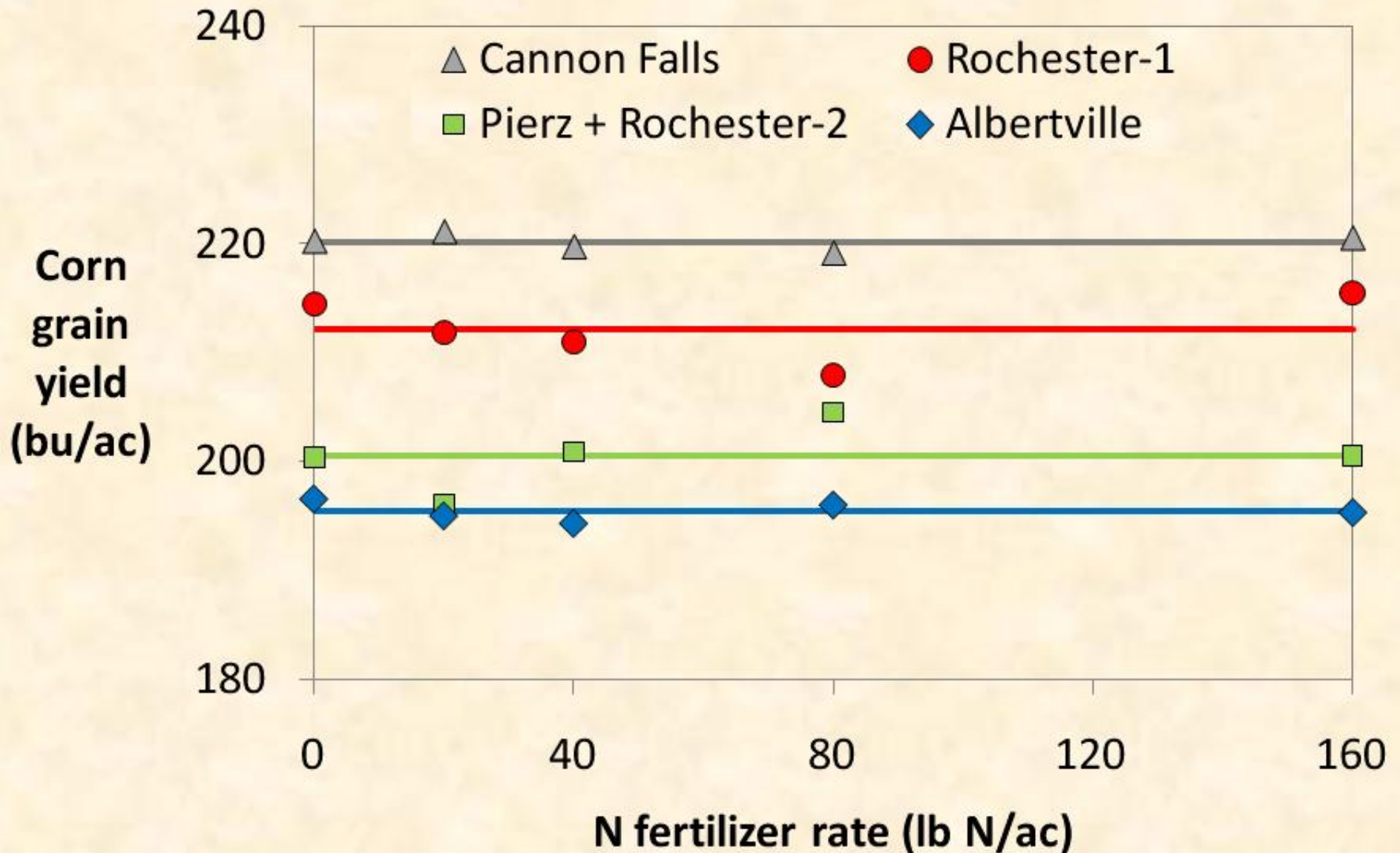
- Loamy sand to silty clay loam soils (SE & central MN).
- Alfalfa stands at termination: 4-10 plants/sq. ft.
- Alfalfa stands were 3-5 years old.
- Alfalfa termination varied by farm.
- 1<sup>st</sup> year corn response to N fertilizer was not affected by K rate applied to final-year alfalfa.



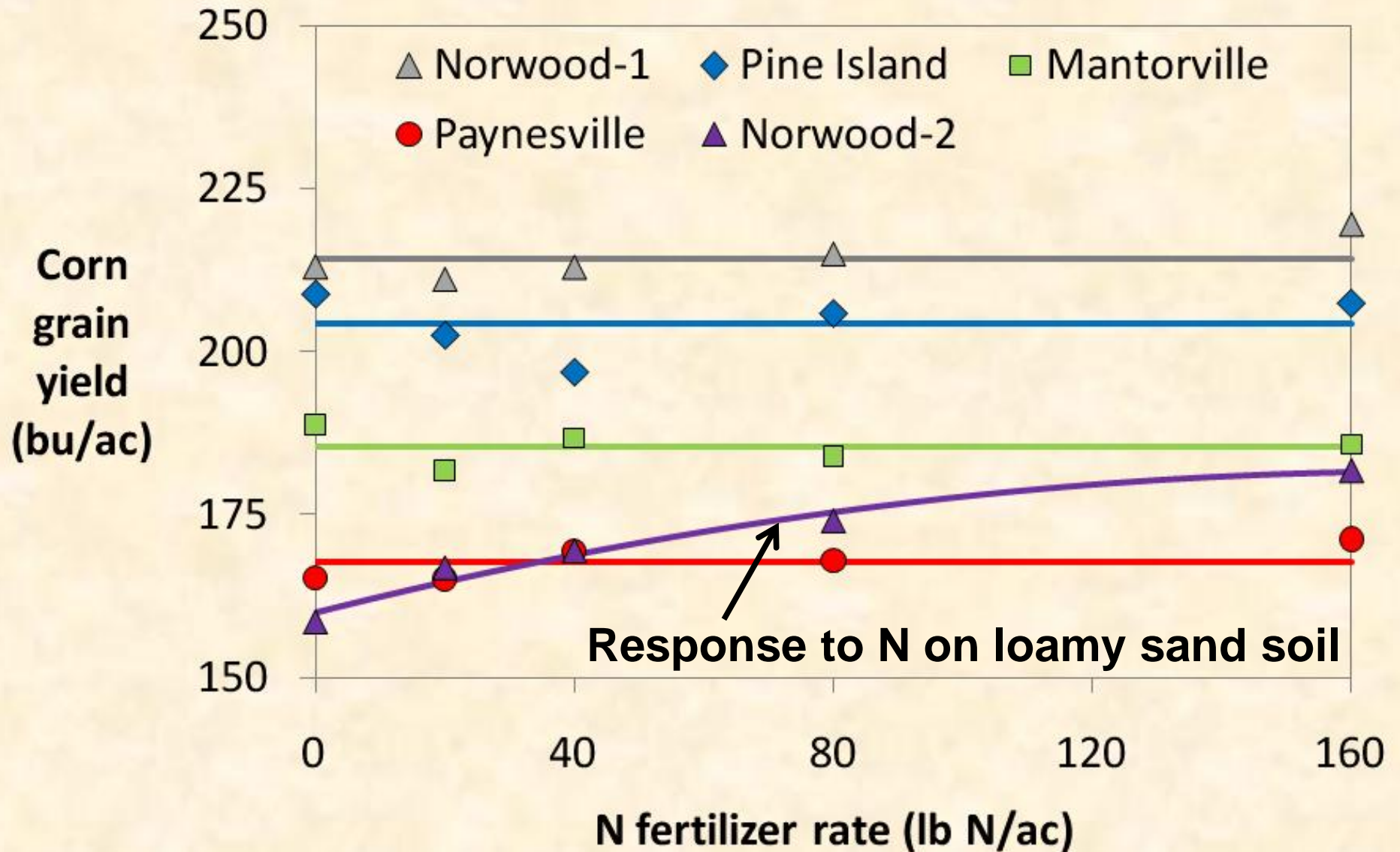
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# All 5 sites had no grain response to N in 2009

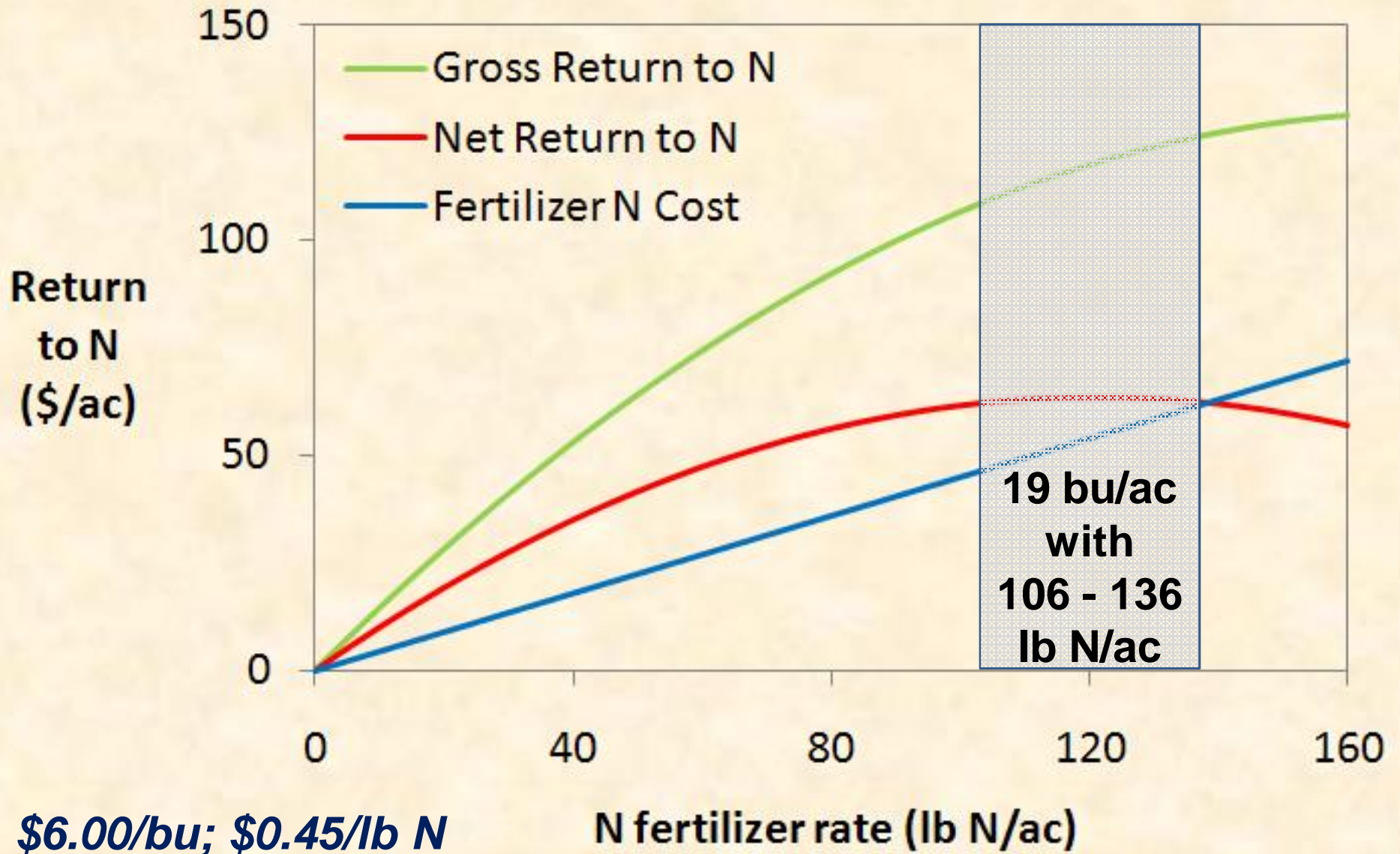


# 4 of 5 sites had no grain response to N in 2010



# Economics for the 1 site of 5 that responded in 2010

*(loamy sand soil; 8 plants/sq ft; 9" regrowth;  
4 yr-old stand; spring tillage; abundant rainfall in 2010)*



**\$6.00/bu; \$0.45/lb N**

**N fertilizer rate (lb N/ac)**

# 6 Additional On-Farm Trials Conducted in 2010

- In final-year alfalfa on cash grain farms in southern & central MN.
- Loam to clay loam soils.
- Evaluated the response of 1<sup>st</sup> year corn after alfalfa to N fertilizer.
- Alfalfa stands at termination:
  - 4 to 8 plants/sq. ft
  - 3 or more years old



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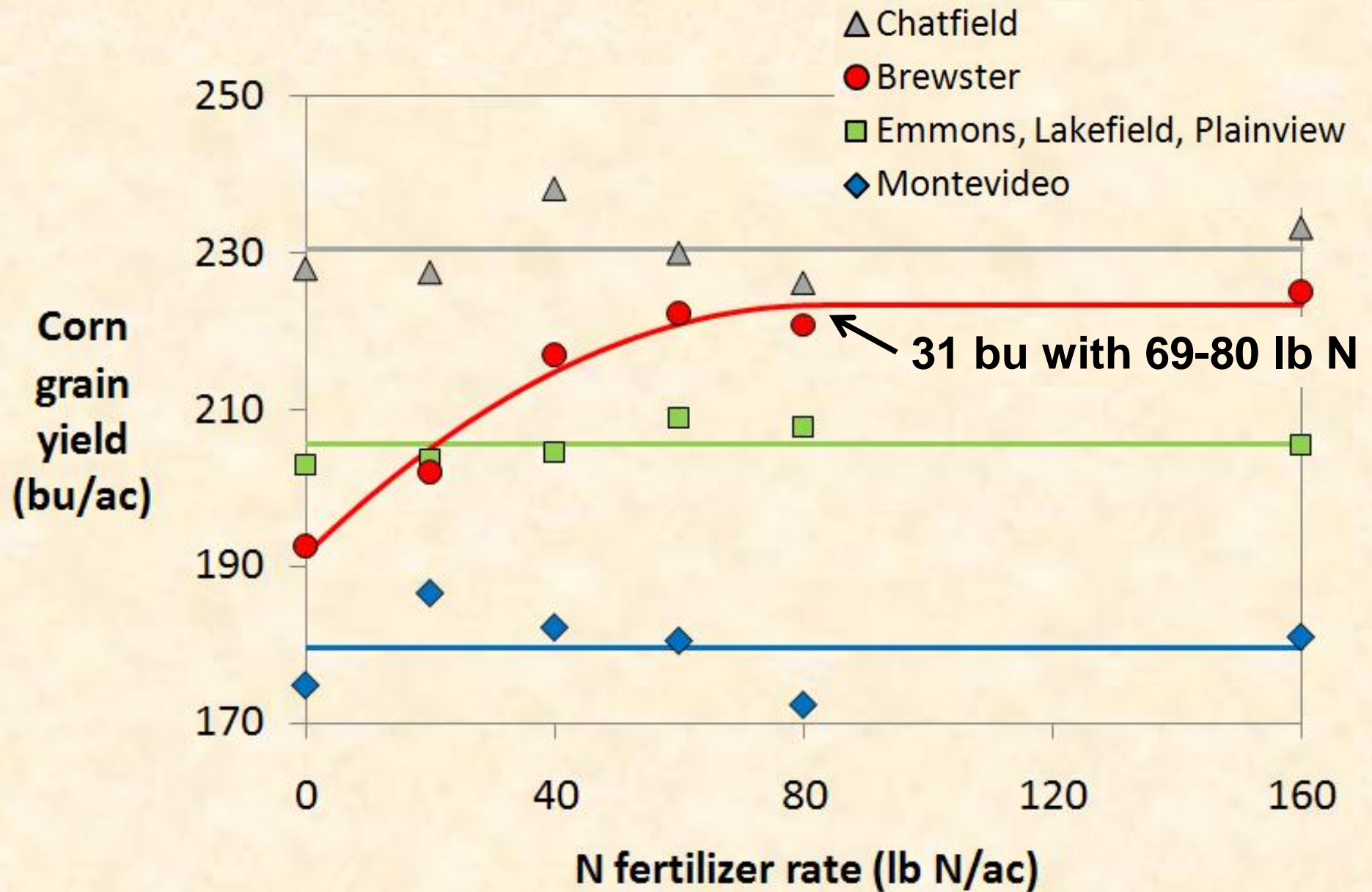


## 2010 Provided a Good Test for Alfalfa N Credits

| Location in MN | Oct.-Sept. precip (inches) |                        | # of years wetter than 2009-2010 |
|----------------|----------------------------|------------------------|----------------------------------|
|                | 2009-2010                  | 30-yr avg. (1979-2009) |                                  |
| Brewster       | 45.7                       | 29.1                   | 1 of 30                          |
| Chatfield      | 47.8                       | 32.8                   | 0 of 30                          |
| Emmons         | 40.9                       | 34.2                   | 3 of 30                          |
| Lakefield      | 44.3                       | 28.7                   | 1 of 30                          |
| Montevideo     | 42.0                       | 29.0                   | 1 of 30                          |
| Plainview      | 42.1                       | 33.9                   | 4 of 30                          |



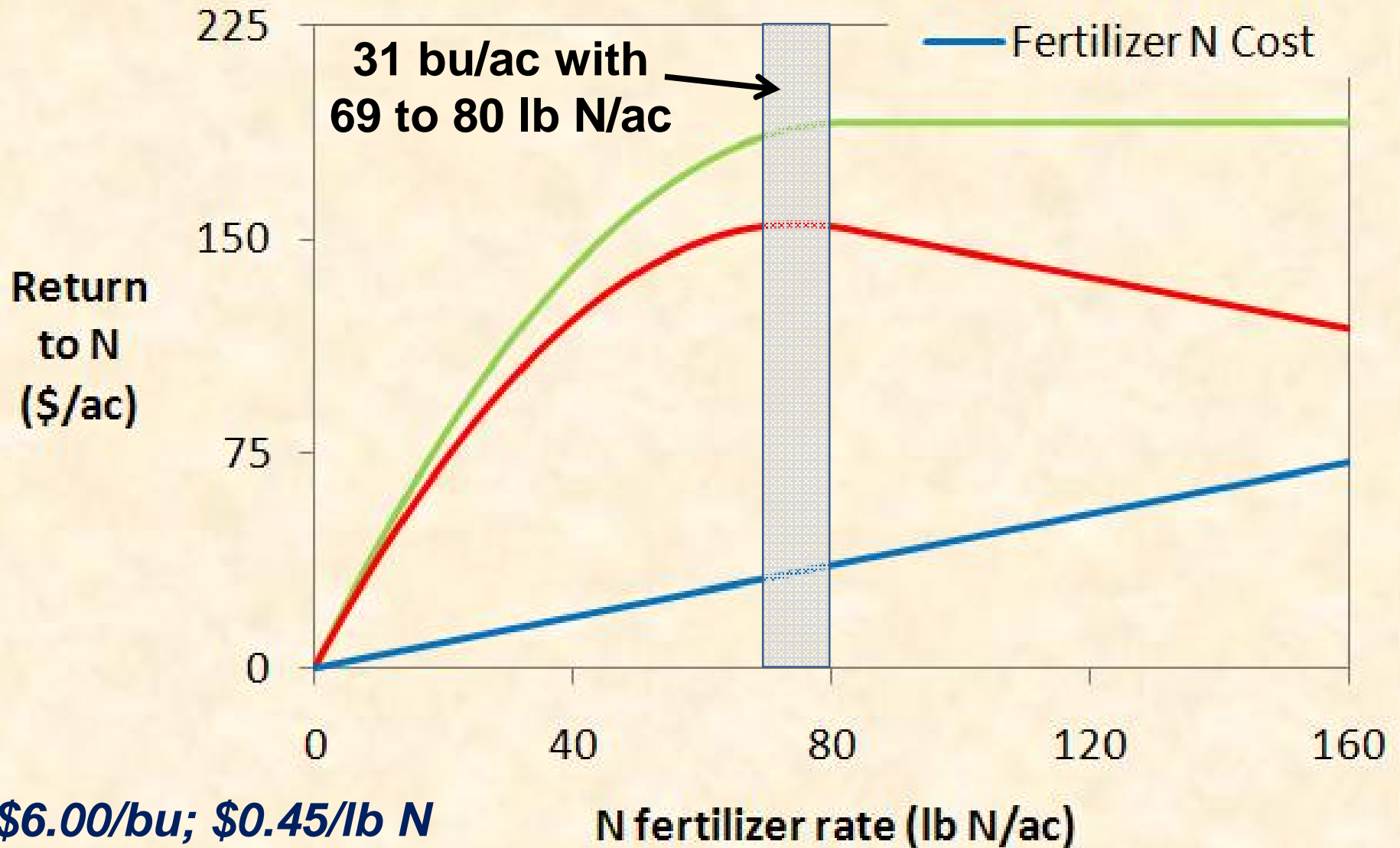
# 5 of 6 sites had no grain response to N in 2010



# Economics for the 1 site of 6 that responded in 2010

*(silty clay loam; 6 plants/sq ft; 6" regrowth;  
4-yr old stand; no manure history)*

— Gross Return to N  
— Net Return to N  
— Fertilizer N Cost



# Economic Risk vs. Reward

- In 1 of 15 trials on sandy loam to clay loam soils with good alfalfa stands, there was a grain yield increase in 1<sup>st</sup> year corn with N fertilizer.
  - 11 of these 15 trials were in 2010, with above normal rainfall and high potential for N loss.
- On 1 loamy sand site in 2010:
  - 19 bu/ac with 106 to 136 lb N/ac



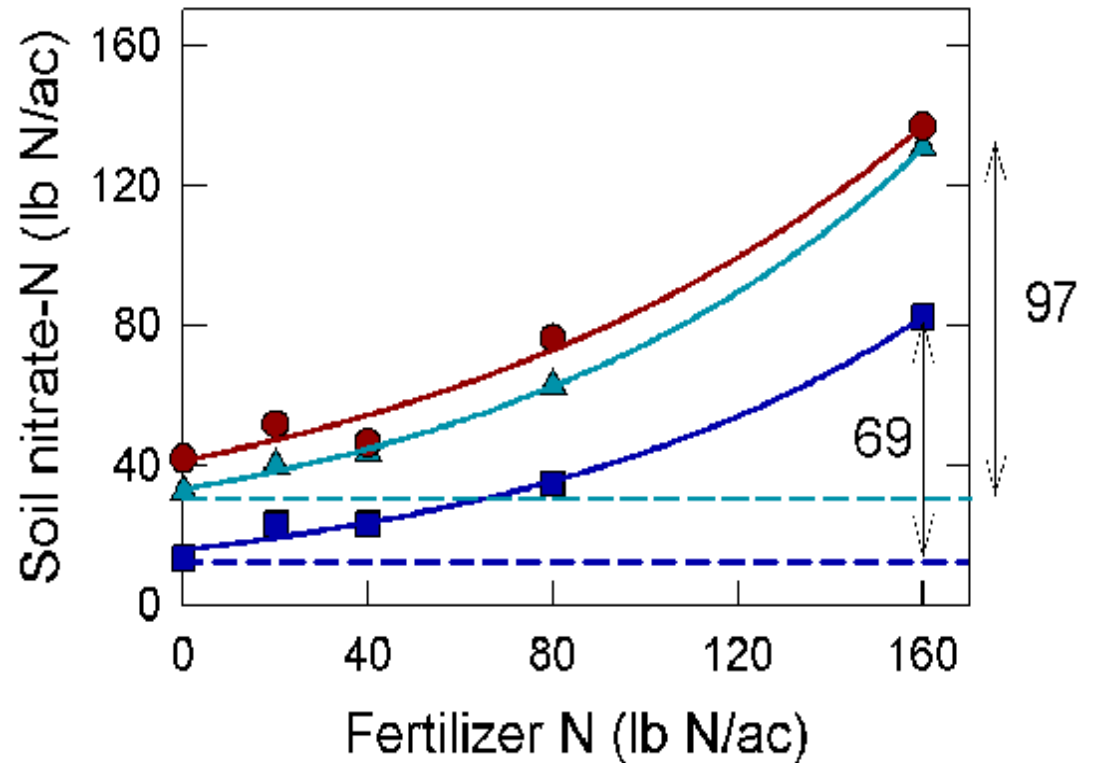
# Insurance applications of N for 1<sup>st</sup> year corn on medium and fine textured soils with good alfalfa stands are hard to justify.

| Annual N rate<br>for 1st-yr corn | N cost       | Our measured<br>response for a<br>given N rate in<br>1 of 15 site-yr | Break-even yield increase needed<br>in 1 yr based on the probability<br>of our measured response |            |
|----------------------------------|--------------|--|--|------------|
|                                  |              |  | 1 in 15 yr   | 1 in 20 yr |
| -- lb N/ac --                    | - \$/ac/yr - | ---- bu/ac ----  | ----- bu/ac -----  |            |
| 70                               | 31.50        | 31   | 79   | 105        |
| 40                               | 18.00        | 23   | 45   | 60         |
| 20                               | 9.00         | 14   | 23   | 30         |
| 10                               | 4.50         | 7  | 11   | 15         |
| 5                                | 2.25         | 4  | 6  | 8          |

*Assumes \$0.45/lb N and \$6.00/bu*



# Residual soil nitrate in the top 4 feet at 3 farms in 2009 with no response of corn yield to N



**Risk** increases with high N fertilizer rates.

## Take full advantage of N credits with 2 years of corn

Alfalfa N credit guidelines for good stands ( $\geq 4$  plants/ft sq) on medium and fine textured soils.

| State     | 1st year<br>N credit | 2nd year<br>N credit |
|-----------|----------------------|----------------------|
|           | ----- lb N/ac -----  |                      |
| Iowa      | 120 - 180            | 90 - 150             |
| Illinois  | 150 - 180            | 20 - 50              |
| Wisconsin | 150                  | 50                   |
| Minnesota | 150                  | 75                   |

# Summary - 1<sup>st</sup> Year Corn

- On sandy loam to clay loam soils with good alfalfa stands...
  - Grain yield increased with N in 1 of 15 trials (11 of the 15 trials were in 2010).
  - Insurance applications of N for grain based on this measured response in 1 of 15 trials would not pay.
- This supports current recommendations that no to little N is needed for 1<sup>st</sup> year corn after alfalfa on medium- to fine-textured soils, even with high yields.



# Summary

- Residual soil nitrate after 1<sup>st</sup> year corn increased rapidly as N rate increased over 40 lb N/ac.
- 2<sup>nd</sup> year N credits are real, and can supply half or more of the N needed for 2<sup>nd</sup> year corn.
- 2<sup>nd</sup> year N credits are more variable than 1<sup>st</sup> year N credits, & likely depend on environmental conditions in the 1<sup>st</sup> year of corn.





# Thanks!



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