Nitrogen fertilizer additives and "The Domino Theory"

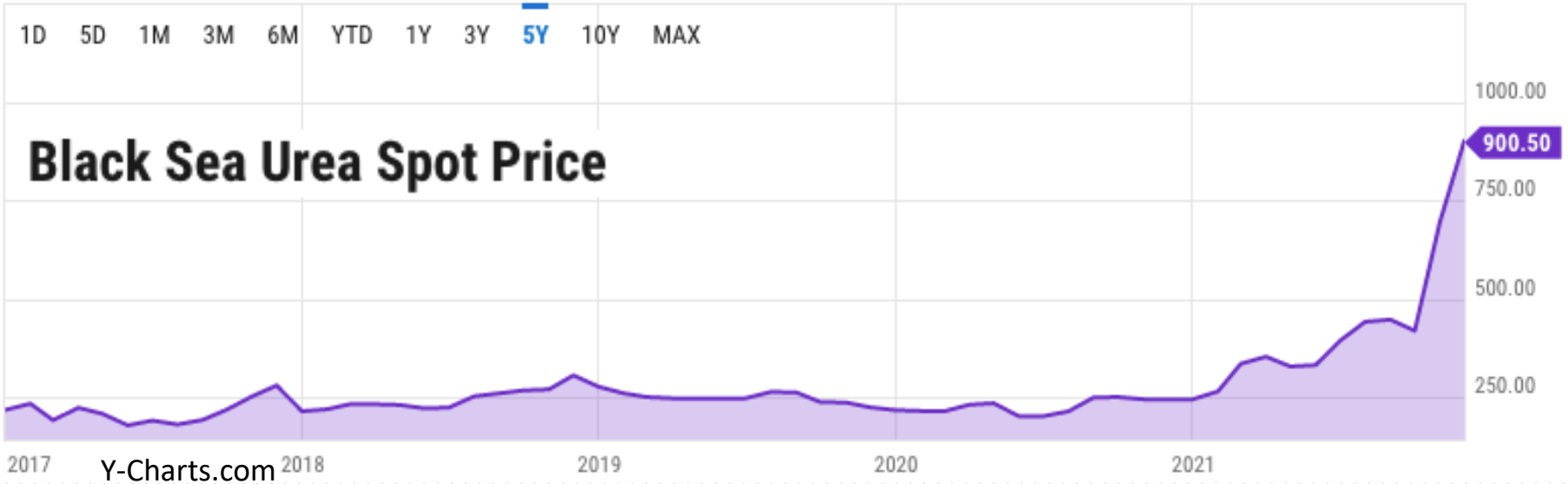
R. Jay Goos

Professor Emeritus, NDSU

- Regarding nitrogen prices, maybe a song is appropriate…

YouTube.com

- At the time this presentation was made….



- With nitrogen prices so high, every aspect of the N program needs to be evaluated
  - Nitrogen rate
    - Residual nitrate
    - Prior crop credits
    - In-season testing, such as PSNT
  - Management to maximize N efficiency
    - Split/delayed application?
    - Nitrogen fertilizer additives, “Nitrogen Loss Inhibitors”?
      - Just one component of a very large decision process

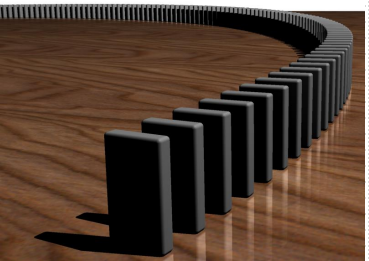
- Nitrogen Loss Inhibitors (NLI)
- Urease inhibitors
  - Slow conversion of urea to ammonia
  - Can reduce ammonia loss after surface application
  - Effectiveness measured in terms of days
- Nitrification inhibitors
  - Slow conversion of ammonium to nitrate
  - Can reduce losses due to leaching and denitrification
  - Effectiveness measured in terms of weeks

- When does the use of a NLI give a yield or quality response?
- When does the use of a NLI provide an economic return?

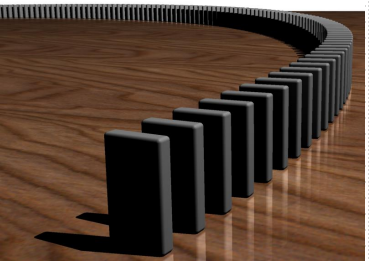
- We have to talk about….Domino Theory
  - Especially with regards to nitrification inhibitors

- For a chain of dominoes to fall, they all have to be there. If one is missing, it doesn't work.

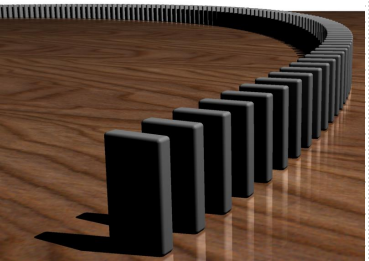
- When does the use of a NLI lead to a crop yield/quality increase????
- All the"dominoes" need to line up:
  - 1. The N rate cannot be excessive
    - If a farmer applies 160 lb of N/A, and the crop really only needed 120, a loss of 25% of the applied N won't be noticed



- When does the use of a NLI lead to a crop yield/quality increase????
- All the "dominoes" need to line up:
  - 1. The N rate cannot be excessive
  - 2. Significant nitrogen loss has to occur
    - Obviously, no significant N loss, no benefit from the NLI
  - The next “domino” is really important….

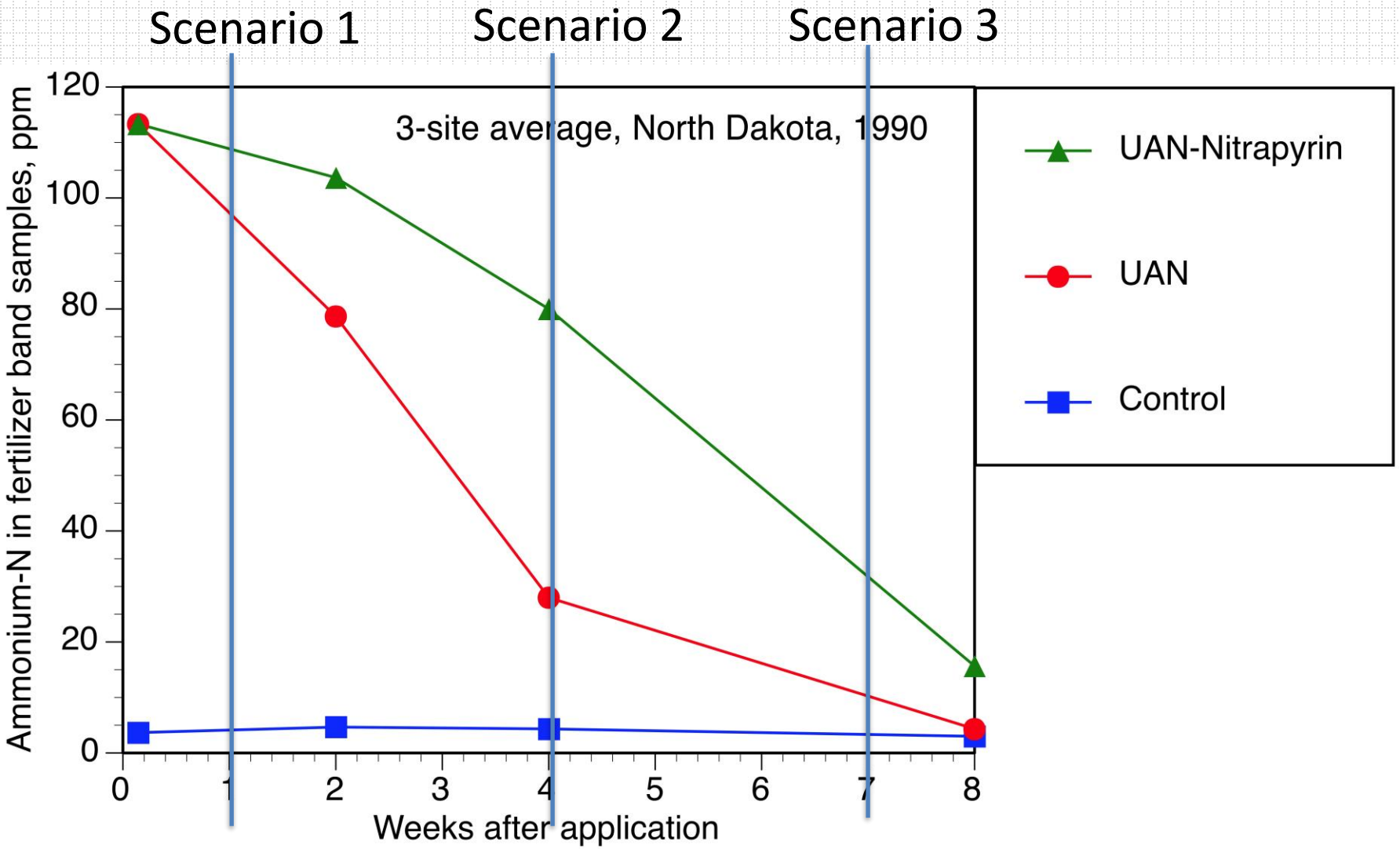


- When does the use of a NLI lead to a crop yield/quality increase????
- All the "dominoes" need to line up:
  - 1. The N rate cannot be excessive
  - 2. Significant nitrogen loss has to occur
  - 3. This nitrogen loss has to occur during a "sweet spot" of time when the inhibitor is functioning
    - Really important for nitrification inhibitors



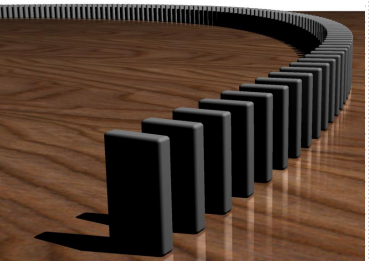
- The "sweet spot" of time, an example using N-Serve…
- Consider three loss scenarios with regards to a nitrification inhibitor
  - Scenario 1....N loss event happens shortly after N application
  - Scenario 2....N loss event happens during the period of time that the inhibitor is effective
  - Scenario 3....N loss event happens after nitrification is largely complete, with or without an inhibitor

- Spring application, at planting time



Goos and Johnson, 1992

- When does the use of a NLI lead to a crop yield/quality increase????
- All the "dominoes" need to line up:
  - 1. The N rate cannot be excessive
  - 2. Significant nitrogen loss has to occur
  - 3. This nitrogen loss has to occur during a "sweet spot" of time when the inhibitor is functioning
  - 4. The amount of N saved by the use of an inhibitor has to be large enough to lead to a measurable difference in yield or quality



- An example where all the “dominoes lined up”
- Fall of 1996. Dow Chemical needed some soil data for a registration update for N-Serve
- We knifed in 75 lb N/A as aqua ammonia alone in early October with:
  - Nothing
  - 1 X labeled N-Serve rate
  - 3 X labeled N-Serve rate
  - 15 lb S/A as ammonium thiosulfate (ATS)
  - Then, what happened….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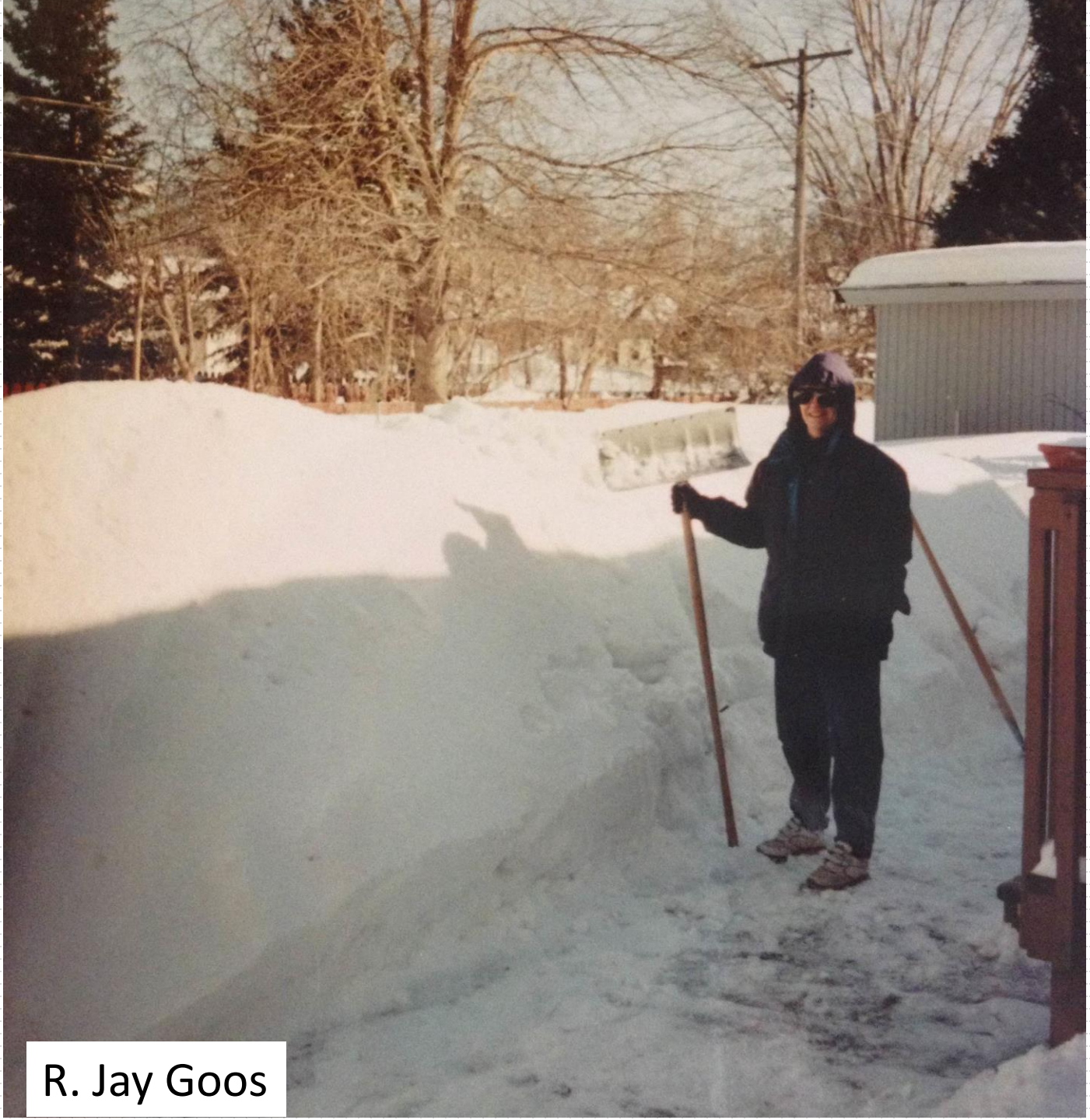
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- Band samples taken in the spring, how much mineral N (ammonium + nitrate-N) made it through such an awful winter?????

	Site 1	Site 2	Average
Control	3	4	4
Aqua	7	9	8
Aqua + NP	22	31	27
Aqua + 3X NP	37	41	39
Aqua + ATS	29	36	33

- Site 2 was planted to wheat.

Goos and Johnson, 1999

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- Yield and NUE data...

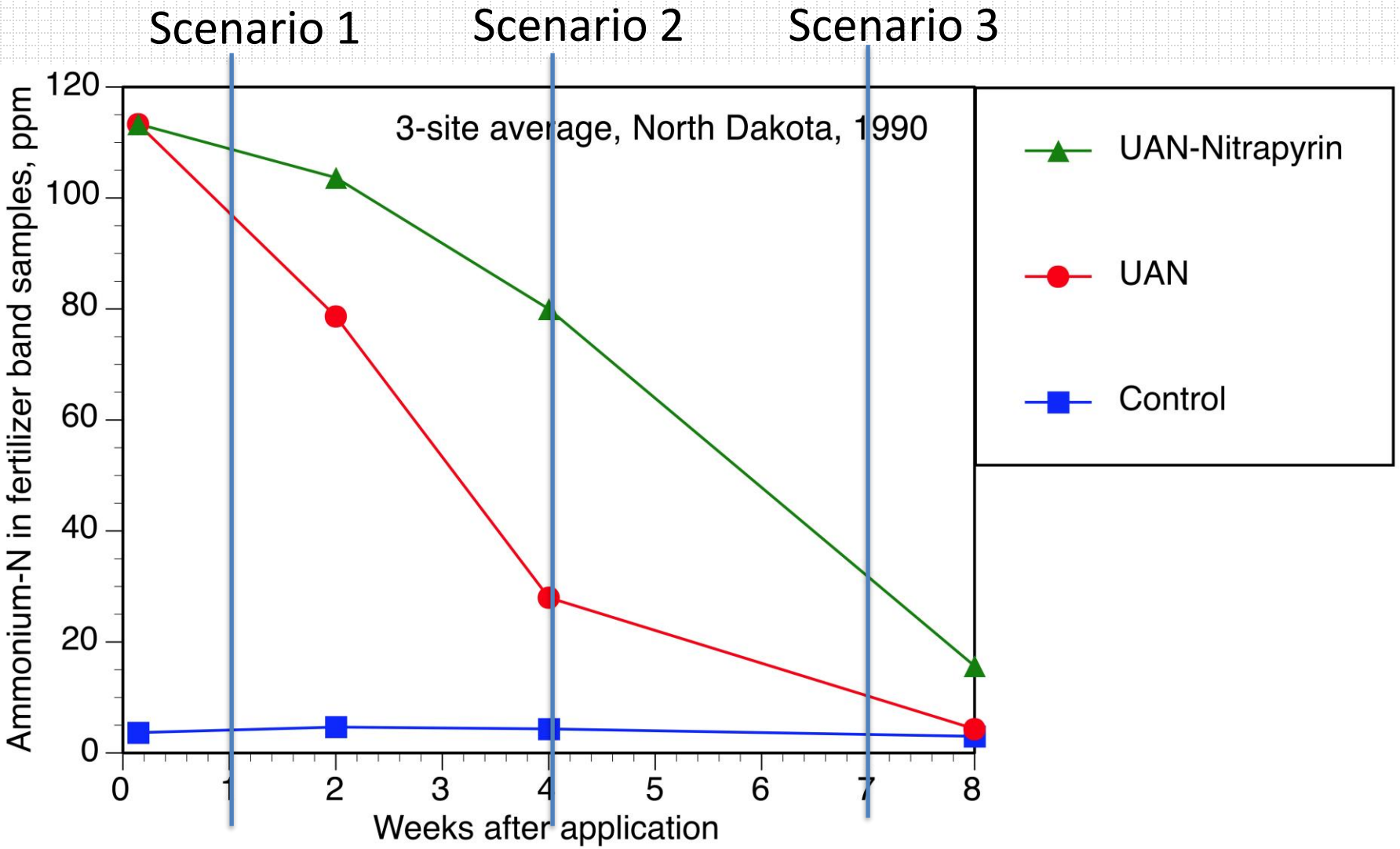
Treatment	Grain yield	Total N uptake in grain + straw	Nitrogen fert. use efficiency
	bu/A	lb/A	%
Control	23.4	34.6	--
Aqua	37.0	52.9	24
Aqua + NP	45.0	72.2	50
Aqua + 3X NP	45.9	72.5	50
Aqua + ATS	47.3	77.0	56

Goos and Johnson, 1999

- So, all of the dominoes lined up
  - The N rate was not excessive
  - Nitrogen loss occurred
  - Nitrogen loss occurred during the “sweet spot of time” that the N-Serve and ATS were slowing nitrification (soil froze before nitrification was complete)
  - A yield and quality response occurred

- For nitrification inhibitors, the most common use has been with fall N application
  - Soil freezes during “sweet spot”
  - Only protects through spring thaw
- For spring N application, the “sweet spot of time” may not get you very far into the corn growing season
- Split application better for corn

- Again, spring-banded N with nitrapyrin



Goos and Johnson, 1992

% nitrification of spring broadcast and incorporated urea granules 4 weeks after application. 3 sites per year. Adapted from Goos, et al. 1999.

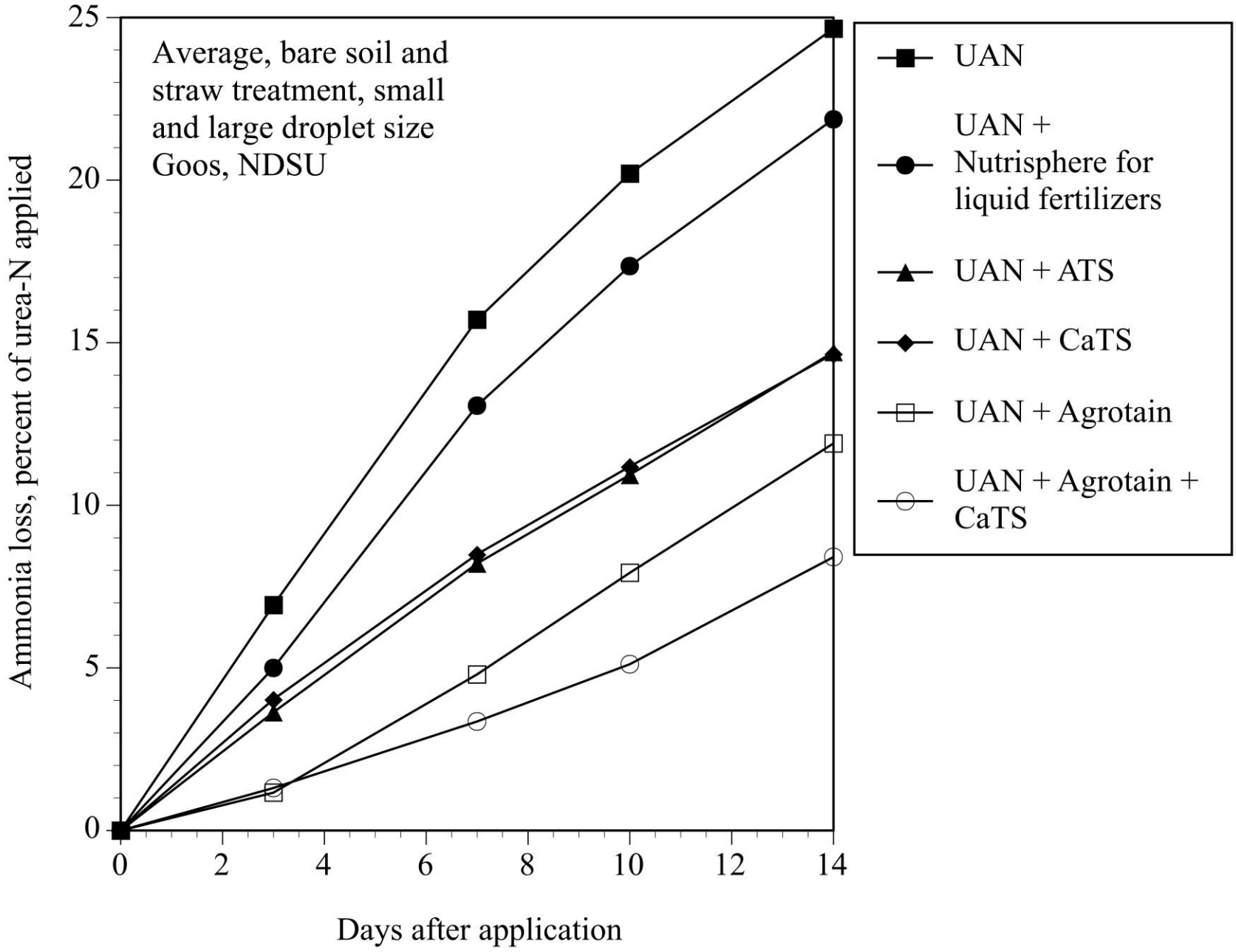
Fertilizer	1992	1993	Average
Urea	82	79	81
Urea-DCD	38	58	47

Urea-DCD granules contained about 1.4% DCD by weight

- Spring or fall, don't use bogus nitrification inhibitors
  - Nitrapyrin is the industry standard
  - DCD works, ***IF THE RATE IS HIGH ENOUGH***
- Surface-applied DCD products….the rate is probably too low
  - SuperU, 0.85% DCD by weight
  - A typical surface-applied DCD product:
    - 28% DCD, 9.71 lb/gal, 4 quarts/ton of urea
    - 0.14% DCD by weight
    - Some products even lower amounts of DCD

- So, what about urease inhibitors??
  - This is a much easier call
  - Kinetics measured in terms of days, not weeks
  - Urease inhibitor is most active when it is needed, right after application
- For urea applied to no-till, left on the surface, use an effective urease inhibitor if forecast for rain for the next 1-2 days is less than 0.5” or so

- Don’t use an ineffective urease “inhibitor”, or one that does not give the exact concentration of active ingredient
  - ~26-27% NBPT has been the industry standard
- For UAN, surface-banding slows volatilization, adding ATS (if you need S) slows volatilization, too.



Adapted from Goos, 2013

- In summary
- Crop yield response to a urease or nitrification inhibitor depends on several factors that have to happen in sequence
  - Important concept for nitrification inhibitors, as leaching or denitrification can happen weeks or months after N application
  - An easier call for urease inhibitors, as ammonia loss typically happens in the first week or two after application

- Alternatives exist for nitrification inhibitors
  - Split/delayed application
- Alternatives exist for urease inhibitors
  - Timing before rain, shallow injection
  - Surface band UAN
- Use proven products