

The Basics of Profitable Fertilization of Wheat

**Dave Franzen, PhD
Professor Soil Science
NDSU Extension Soil Specialist
Fargo, ND**

Welcome to the North Dakota Wheat Nitrogen Calculator

You will need to know the location of the farm, the general productivity of the soils, the price you contract for wheat, the cost per pound of N, the soil test nitrate-N to a depth of 2-feet, and the previous crop.

Please select the location of the farm. The map of North Dakota on this site will help you determine the region of the farm. *Click on the map for a detailed view.*



- Eastern North Dakota
- Western North Dakota
- Langdon Region

1

Low productivity is defined in Eastern ND as historical yields below 40 bushels per acre

Medium productivity is defined in Eastern ND as historical yields from 41 to 60 bushels per acre

High productivity is defined in Eastern ND as historical yields over 60 bushels per acre

Please select the historical productivity of the farm from the options below.

- Low Productivity
- Medium Productivity
- High Productivity

2

Select Nearest Wheat Price
(\$/bushel)

\$5.00

Please indicate the crop previously planted in the field.

- No Nitrogen-supplying crop
- Soybean, Field Pea, Dry Bean, Lentil, Chickpea, or harvested Sweet Pea
- Sugarbeet with yellow-green leaves
- Sugarbeet with green leaves
- Harvested Alfalfa or unharvested Sweet Clover (> 5 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (3-4 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (1-2 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (< 1 plants/sq-ft)

Nitrogen provided by previous crops:

0

Please indicate the previous tilling method used in the field.

Low Productivity
 Medium Productivity
 High Productivity

Select Nearest Wheat Price (\$/bushel)

3

Select Nearest N Cost (cents/lb)

4

Nitrogen Recommendation Before Credits:

Please indicate the amount of nitrates in the soil. (Enter the analysis result in the box.)

Soil test for Nitrogen analysis (lbs/acre 2-ft depth) Input OK

5

Sugarbeet with green leaves
 Harvested Alfalfa or unharvested Sweet Clover (> 5 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (3-4 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (1-2 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (< 1 plants/sq-ft)

6

Nitrogen provided by previous crops:

Please indicate the previous tilling method used in the field.

Is the field/area conventionally tilled (chisel and/or disc, and/or field cultivator or plow)?
 Has the field/area been in No-till for 1 to 5 years?
 Has the field/area been in No-till for more than 5 years?

7

Nitrogen recommendations assume conventional tillage and no adjustment in N rates are made.

Please indicate the percent of organic matter in the soil. (Enter the percentage in the box.) (If soil organic matter exceeds 5.9%, please type in the soil organic matter value. If 5.9% or less, please leave blank.)

Organic matter % Input OK

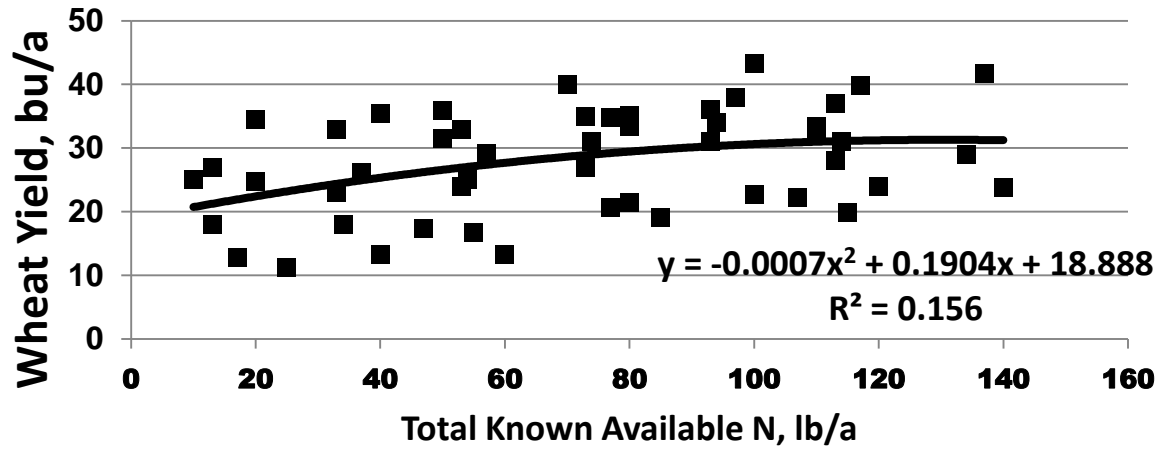
8

Input OK

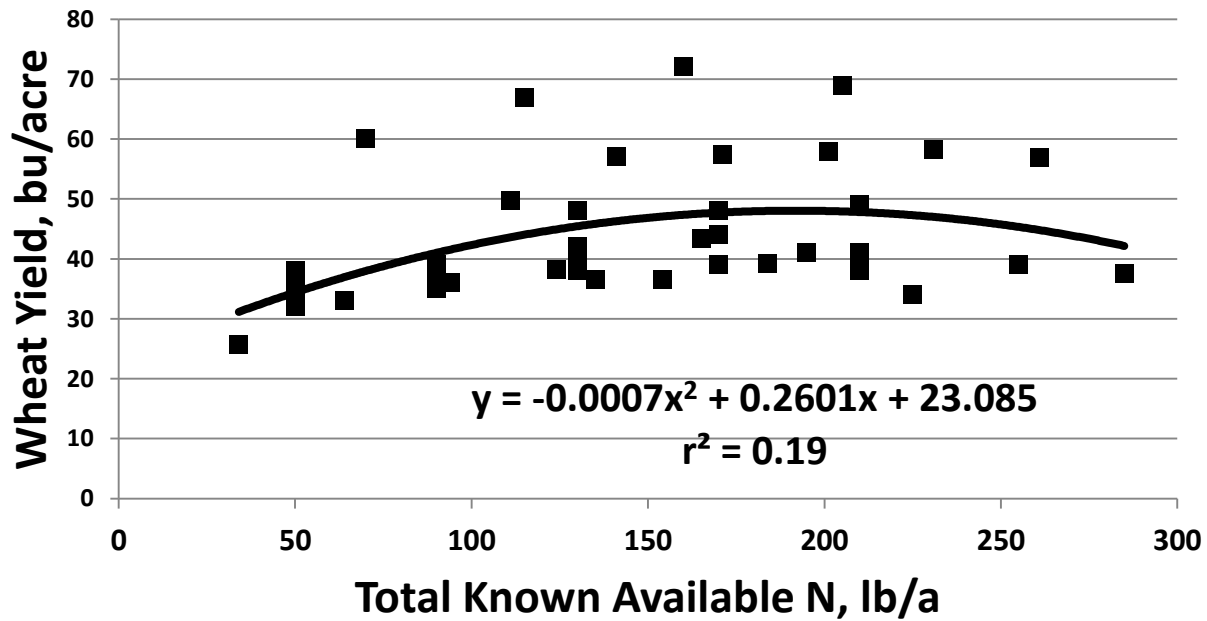
Nitrogen recommendation: plus/minus 30 lbs. N

The final Nitrogen recommendation is the average optimal rate. Growers may choose to apply up to 30 lb N/acre more or less than the calculated N rates due to protein traits of a variety, special soil conditions such as susceptibility to spring denitrification, application techniques that may not be most efficient or historical experiences from the field or part of a field that may influence N uptake and efficiency. For wheat after small grains, we assume about 2,000 lb/acre of straw residue. For every 2,000 lb/acre straw greater than this, add 30 lb N/acre.

West Wheat Yield Under Conventional Tillage

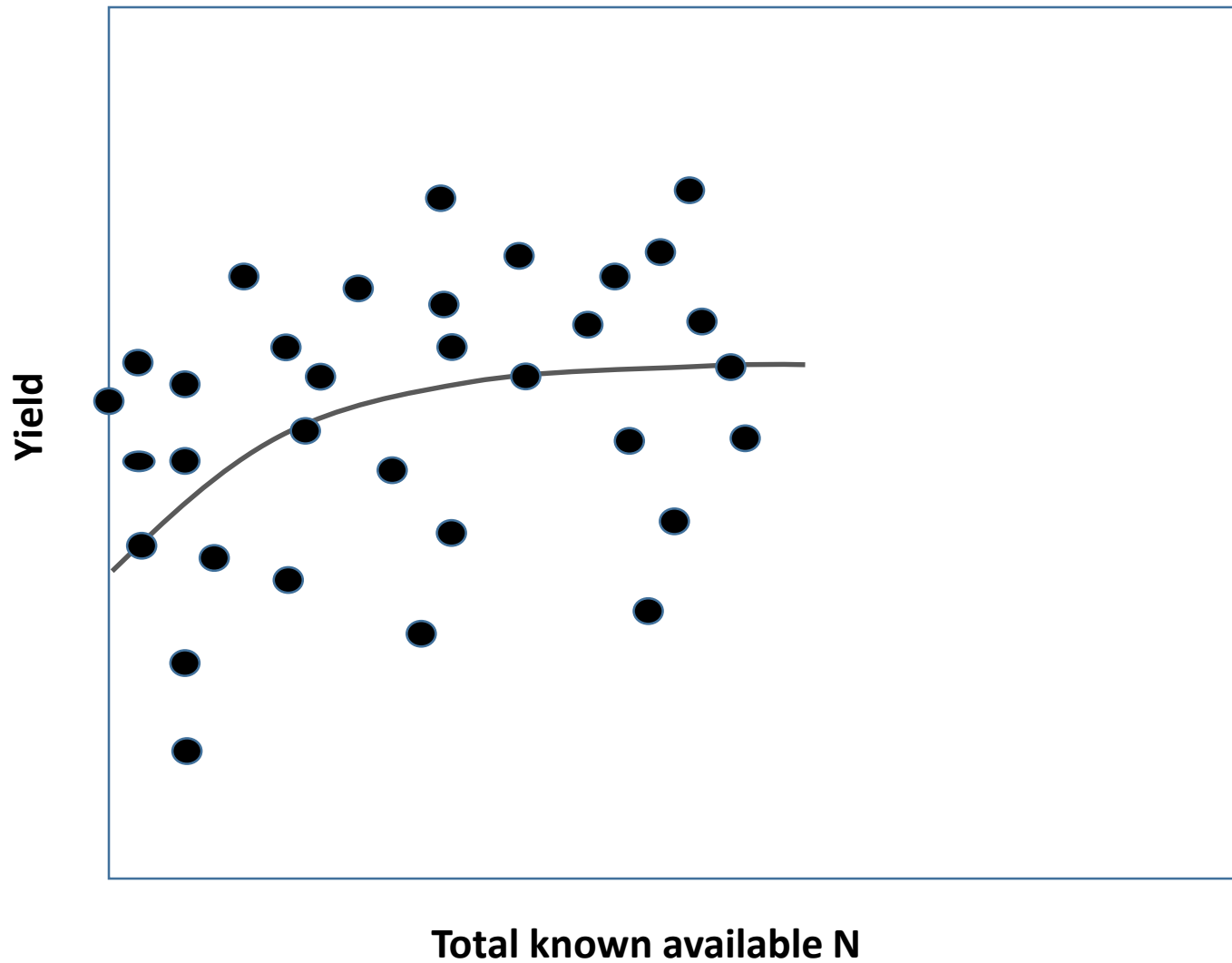


West Wheat Yield Under Long-term No-Till

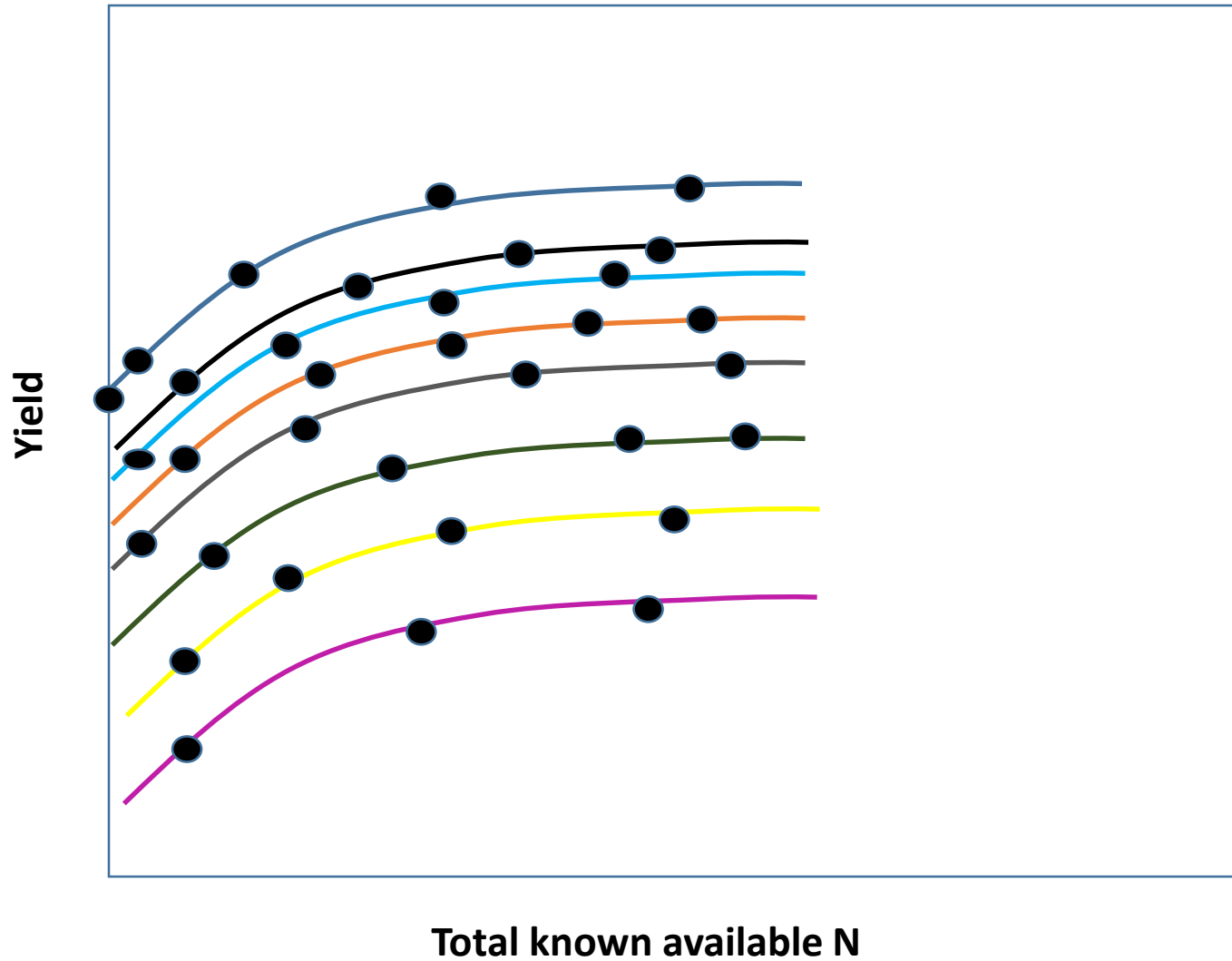


Why is the aggregated relationship of yield and available N so 'diffuse', when the relationships within sites are so highly related?

Combining all sites with actual yield at N rate looks like this



When it really looks like this-



To get a better idea of what the data look like without showing all the curves is to 'Normalize' the data- putting it all in the same scale

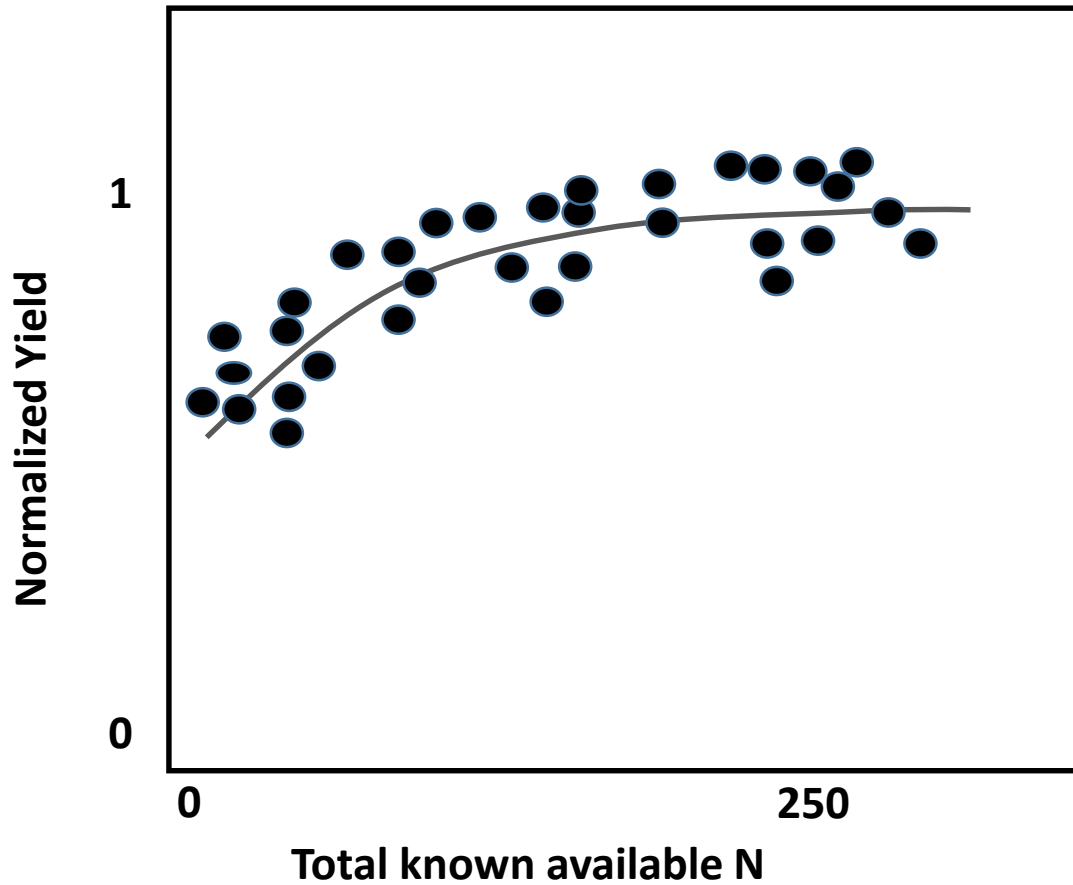
For example-

A wheat site with high yield 80 bu/acre, divide all yields by 80, and we end up with values from 0 to 1

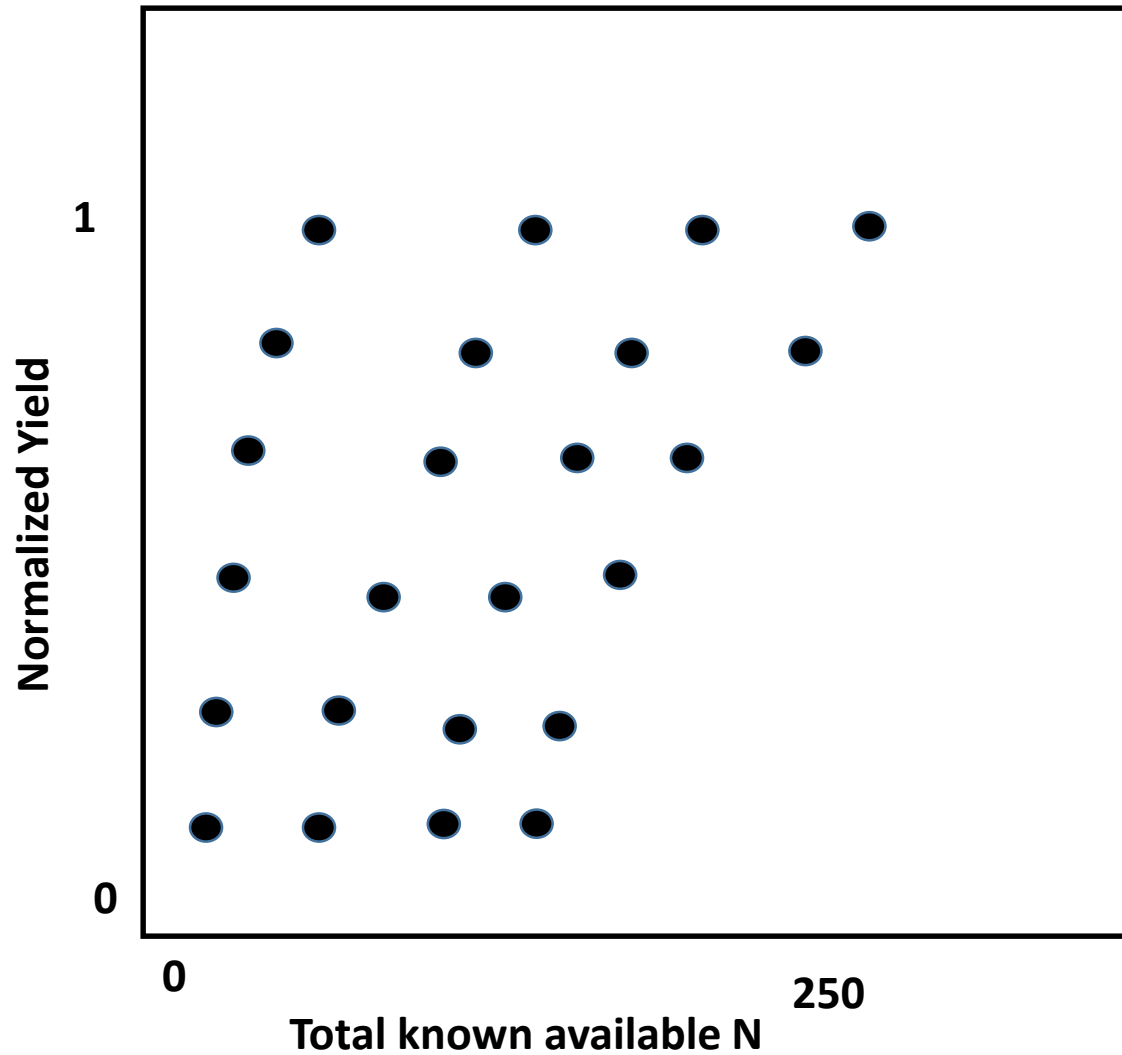
A wheat site with high yield 40 bu/acre, divide all yields by 40, and we end up with values from 0 to 1

A wheat site with high yield 60 bu/acre, divide all yields by 60, and we end up with values from 0 to 1

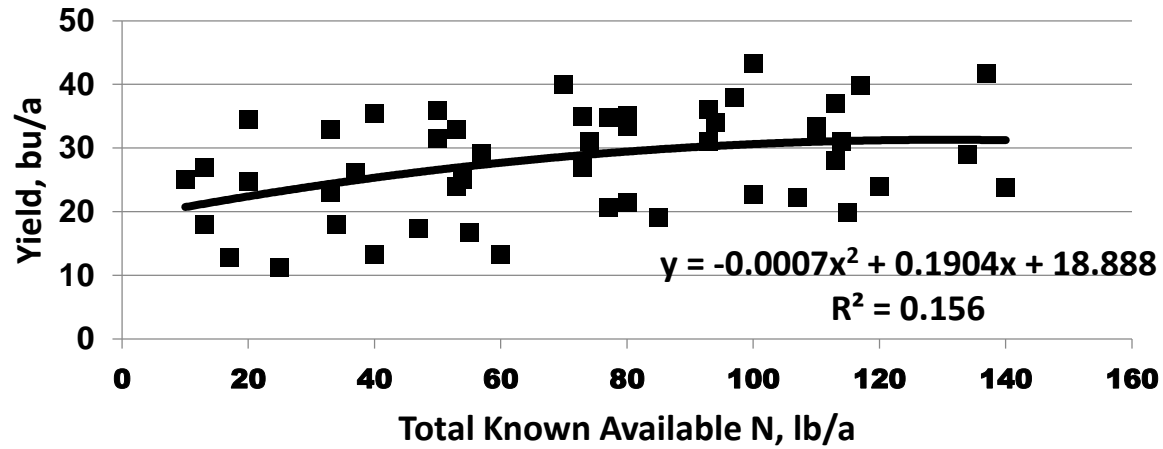
Normalizing yields at all sites ends up looking like this-



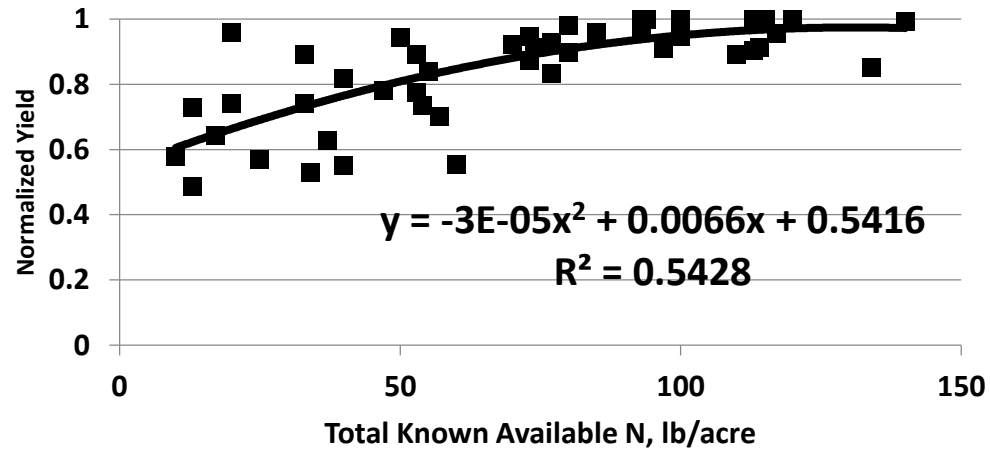
If N rate and Yield were related between sites, the graphs would look like this after they were normalized

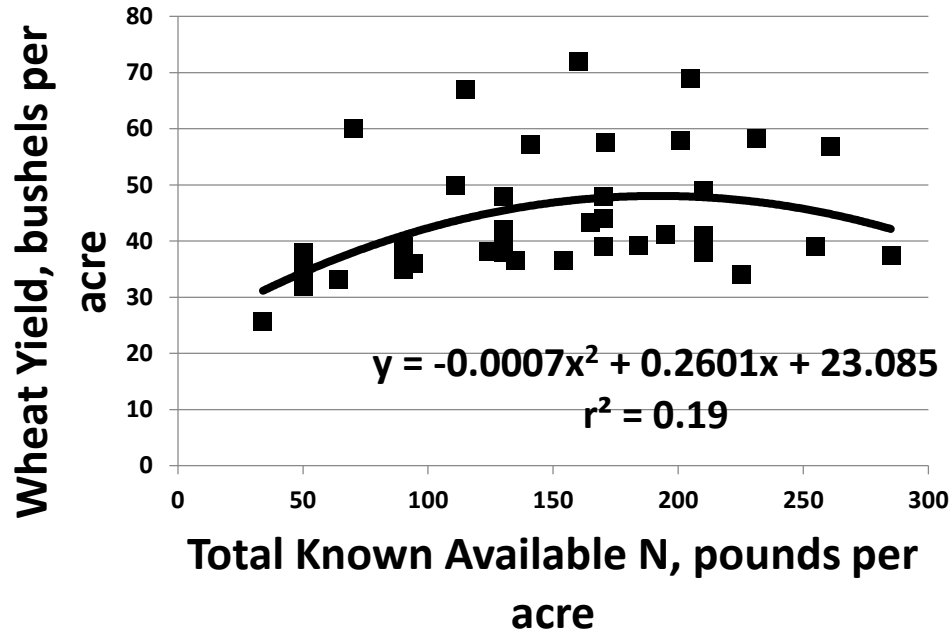


West Wheat Yield Under Conventional Tillage

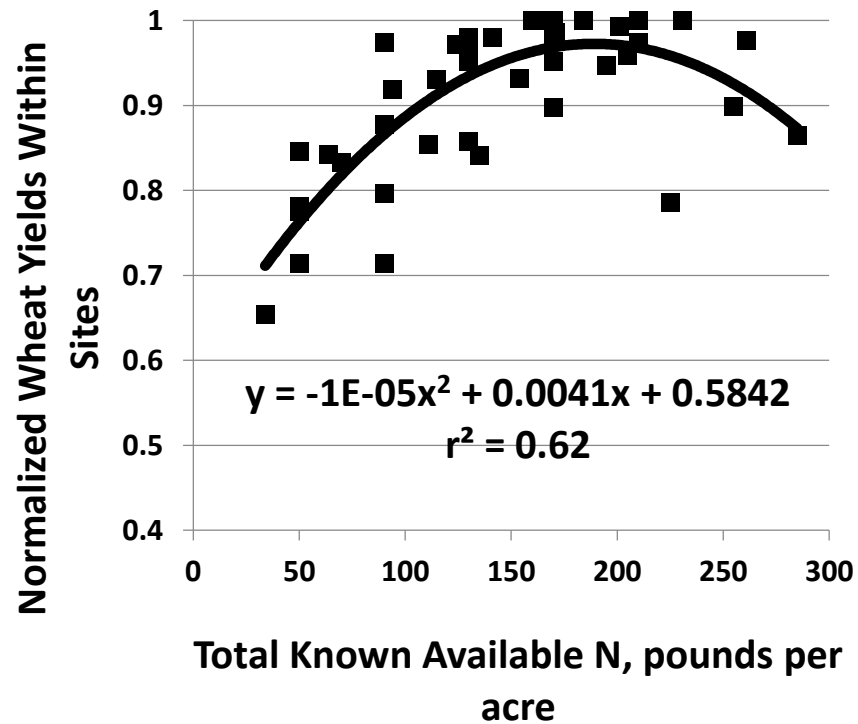


West Normalized Wheat Yield Conventional Tillage





Western ND No-Till wheat sites normalized yields



Low yield environment-
usually drier (sometimes excessive wetness)
Lower N use efficiency and crop uptake
Less N mineralization

High yield environment-
Moisture near ideal- not too wet or too dry
Higher N use efficiency and crop uptake
Greater N mineralization

**Net result is that rate to produce economic max yield
is similar in both environments.**

Welcome to the North Dakota Wheat Nitrogen Calculator

You will need to know the location of the farm, the general productivity of the soils, the price you contract for wheat, the cost per pound of N, the soil test nitrate-N to a depth of 2-feet, and the previous crop.

Please select the location of the farm. The map of North Dakota on this site will help you determine the region of the farm. *Click on the map for a detailed view.*



- Eastern North Dakota
- Western North Dakota
- Langdon Region

1

Low productivity is defined in Eastern ND as historical yields below 40 bushels per acre

Medium productivity is defined in Eastern ND as historical yields from 41 to 60 bushels per acre

High productivity is defined in Eastern ND as historical yields over 60 bushels per acre

Please select the historical productivity of the farm from the options below.

- Low Productivity
- Medium Productivity
- High Productivity

2

Select Nearest Wheat Price (\$/bushel) \$5.00

Please indicate the crop previously planted in the field.

- No Nitrogen-supplying crop
- Soybean, Field Pea, Dry Bean, Lentil, Chickpea, or harvested Sweet Pea
- Sugarbeet with yellow-green leaves
- Sugarbeet with green leaves
- Harvested Alfalfa or unharvested Sweet Clover (> 5 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (3-4 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (1-2 plants/sq-ft)
- Harvested Alfalfa or unharvested Sweet Clover (< 1 plants/sq-ft)

Nitrogen provided by previous crops: 0

Please indicate the previous tilling method used in the field.

Low Productivity
 Medium Productivity
 High Productivity

Select Nearest Wheat Price (\$/bushel)

3

Select Nearest N Cost (cents/lb)

4

Nitrogen Recommendation Before Credits:

Please indicate the amount of nitrates in the soil. (Enter the analysis result in the box.)

Soil test for Nitrogen analysis (lbs/acre 2-ft depth) Input OK

5

Sugarbeet with green leaves
 Harvested Alfalfa or unharvested Sweet Clover (> 5 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (3-4 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (1-2 plants/sq-ft)
 Harvested Alfalfa or unharvested Sweet Clover (< 1 plants/sq-ft)

6

Nitrogen provided by previous crops:

Please indicate the previous tilling method used in the field.

Is the field/area conventionally tilled (chisel and/or disc, and/or field cultivator or plow)?
 Has the field/area been in No-till for 1 to 5 years?
 Has the field/area been in No-till for more than 5 years?

7

Nitrogen recommendations assume conventional tillage and no adjustment in N rates are made.

Please indicate the percent of organic matter in the soil. (Enter the percentage in the box.) (If soil organic matter exceeds 5.9%, please type in the soil organic matter value. If 5.9% or less, please leave blank.)

Organic matter % Input OK

8

Input OK

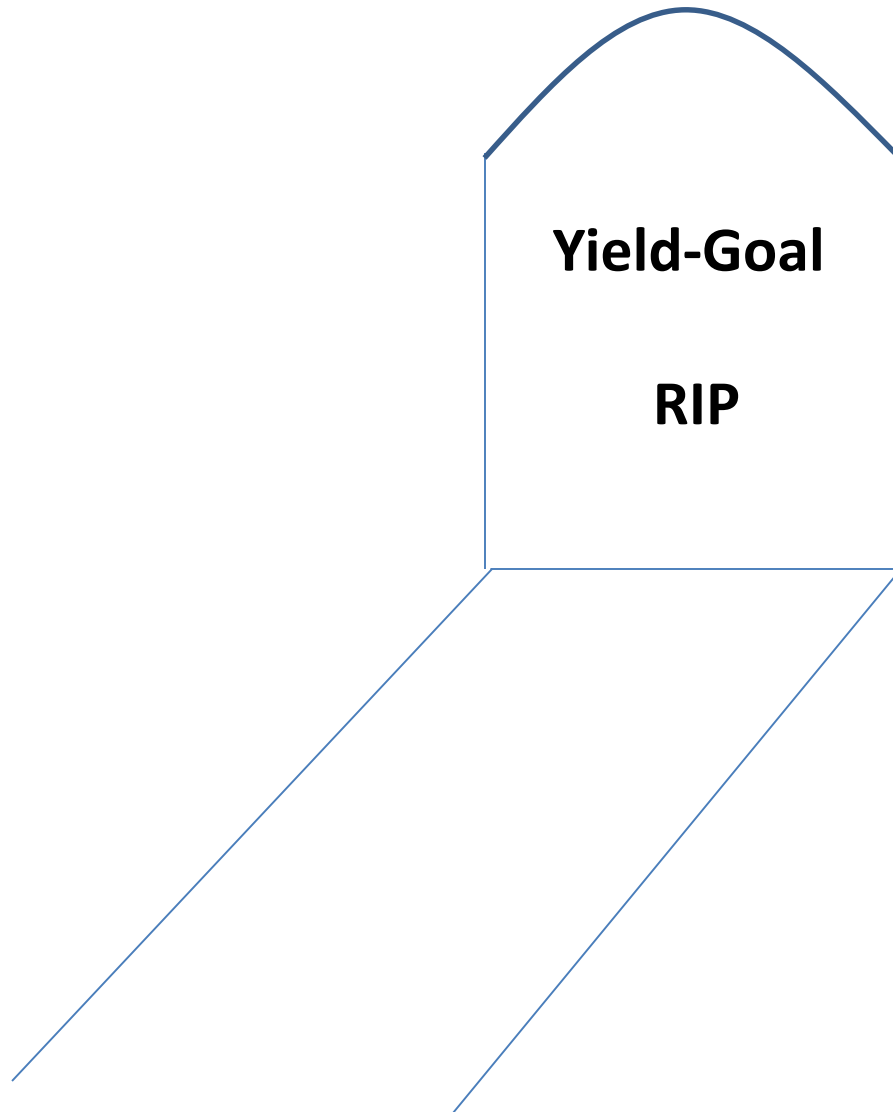
Nitrogen recommendation: plus/minus 30 lbs. N

The final Nitrogen recommendation is the average optimal rate. Growers may choose to apply up to 30 lb N/acre more or less than the calculated N rates due to protein traits of a variety, special soil conditions such as susceptibility to spring denitrification, application techniques that may not be most efficient or historical experiences from the field or part of a field that may influence N uptake and efficiency. For wheat after small grains, we assume about 2,000 lb/acre of straw residue. For every 2,000 lb/acre straw greater than this, add 30 lb N/acre.

There is a new phone app for Android and Iphones for the 3 N calculators, including wheat.

Go to app store and search for North Dakota Crop Nitrogen Calculator follow the instructions.

It's free to download.

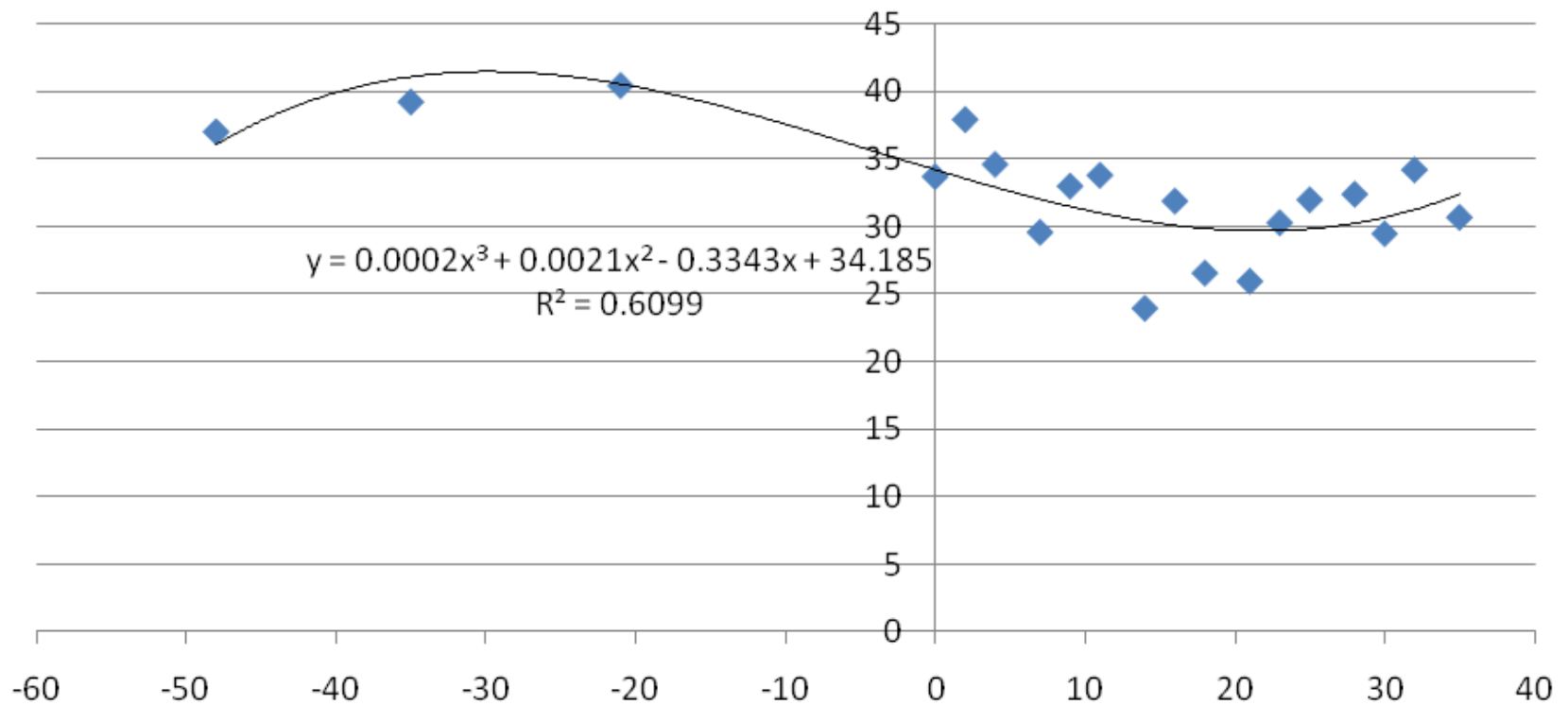


Questions-

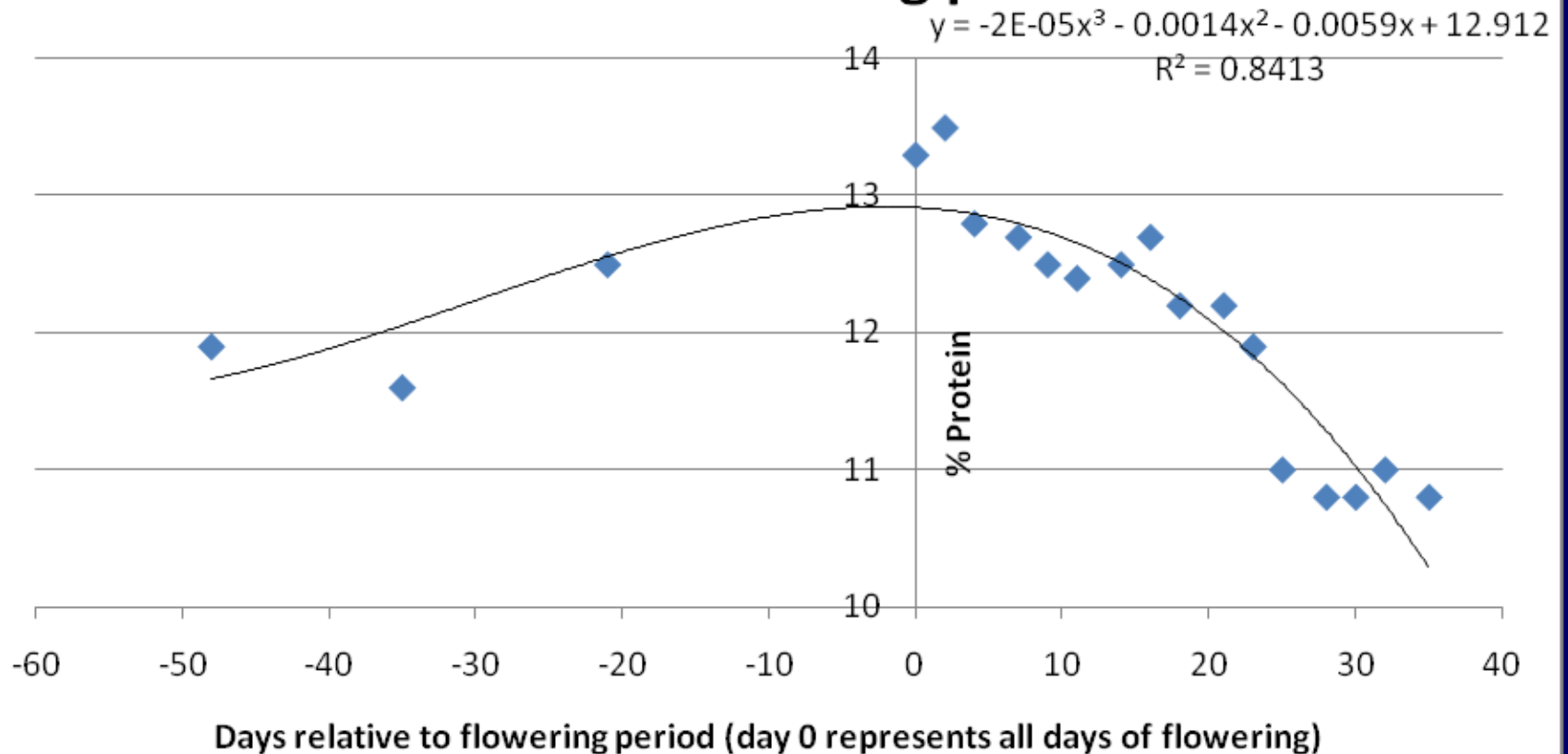
Is the protein increase with the recipe real?

Are N applications after the water-ripe stage real?

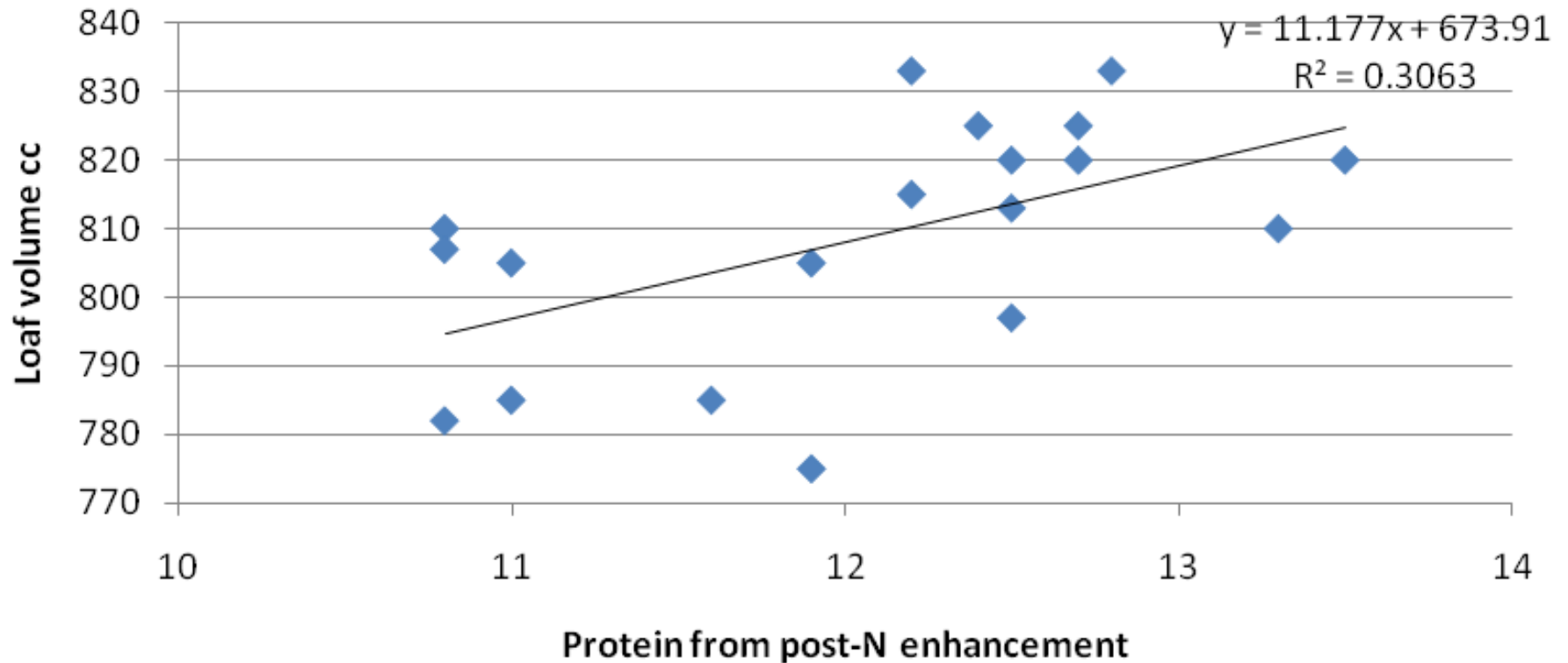
Wheat yield with 30 lb N timing relative to flowering period, from Finney et al., 1957



Real Bread Protein % with post-N timing relative to flowering period



Relationship of Loaf Volume with Grain Protein from Post-N



The bottom-line of this research, and follow-up work conducted at Carrington, Minot, Langdon during the late 1990's is

- Protein increase is maximized when N is applied **immediately post-anthesis** (watery-ripe stage).
- Profitable protein enhancement is maximized with a rate of **30 lb N/acre (UAN or urea solution if biuret content is low)**

'The Recipe' is:

10 gallon UAN with 10 gallon water

Apply immediately post-anthesis

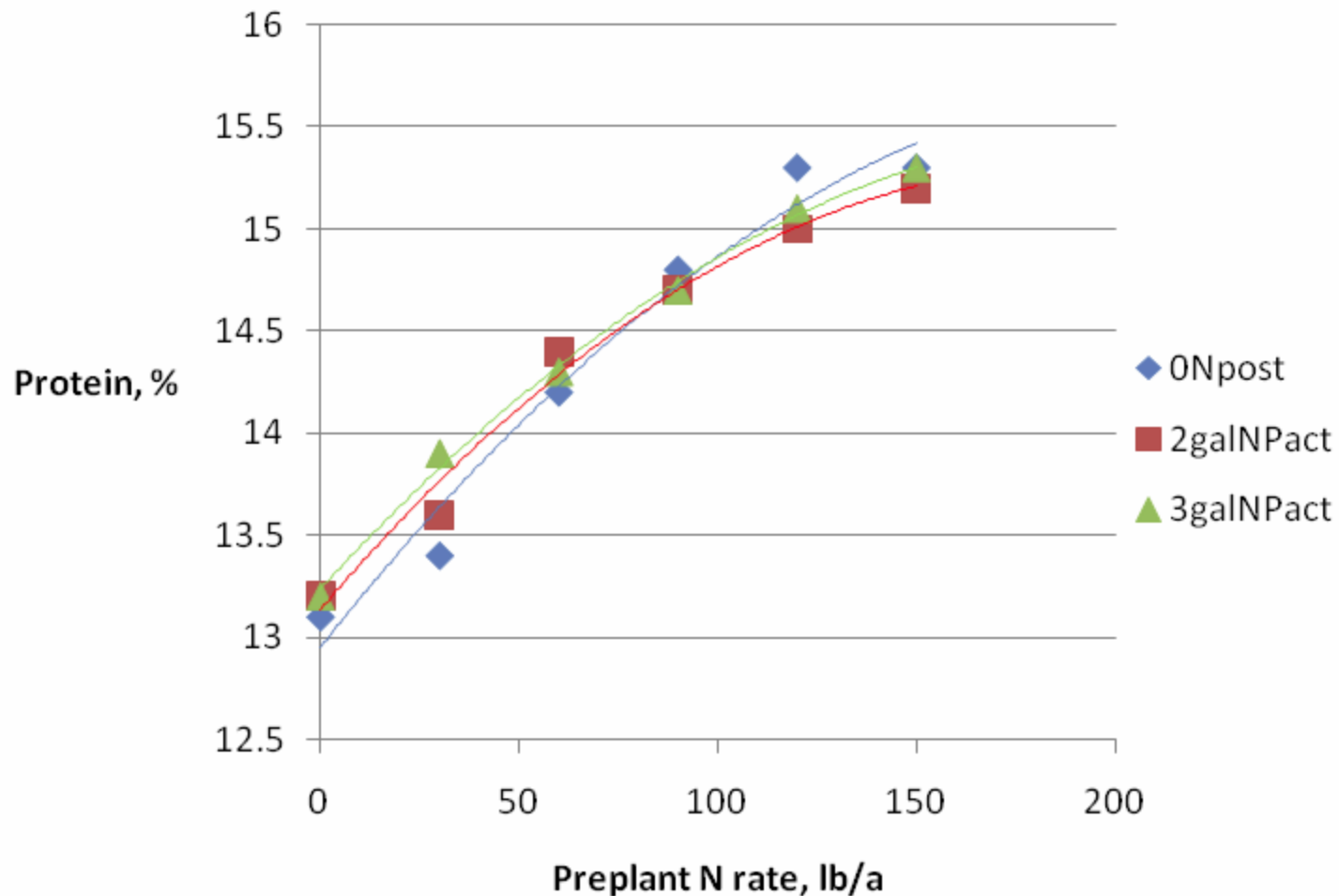
Apply cool of the day (mornings preferably to evenings)

Do not apply with fungicide

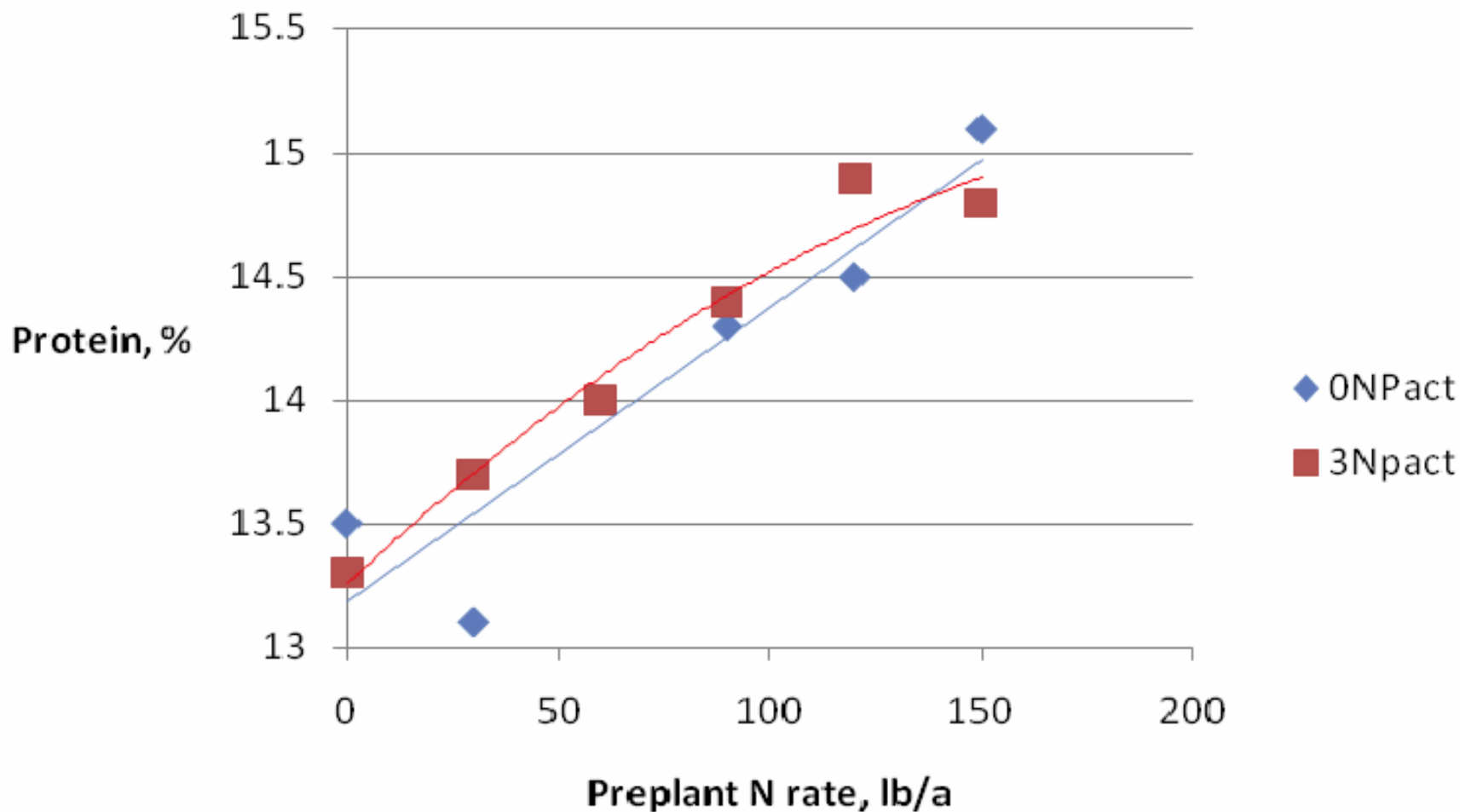
Use flat-fan nozzles, broadcast

Expect leaf burn, but it's not important

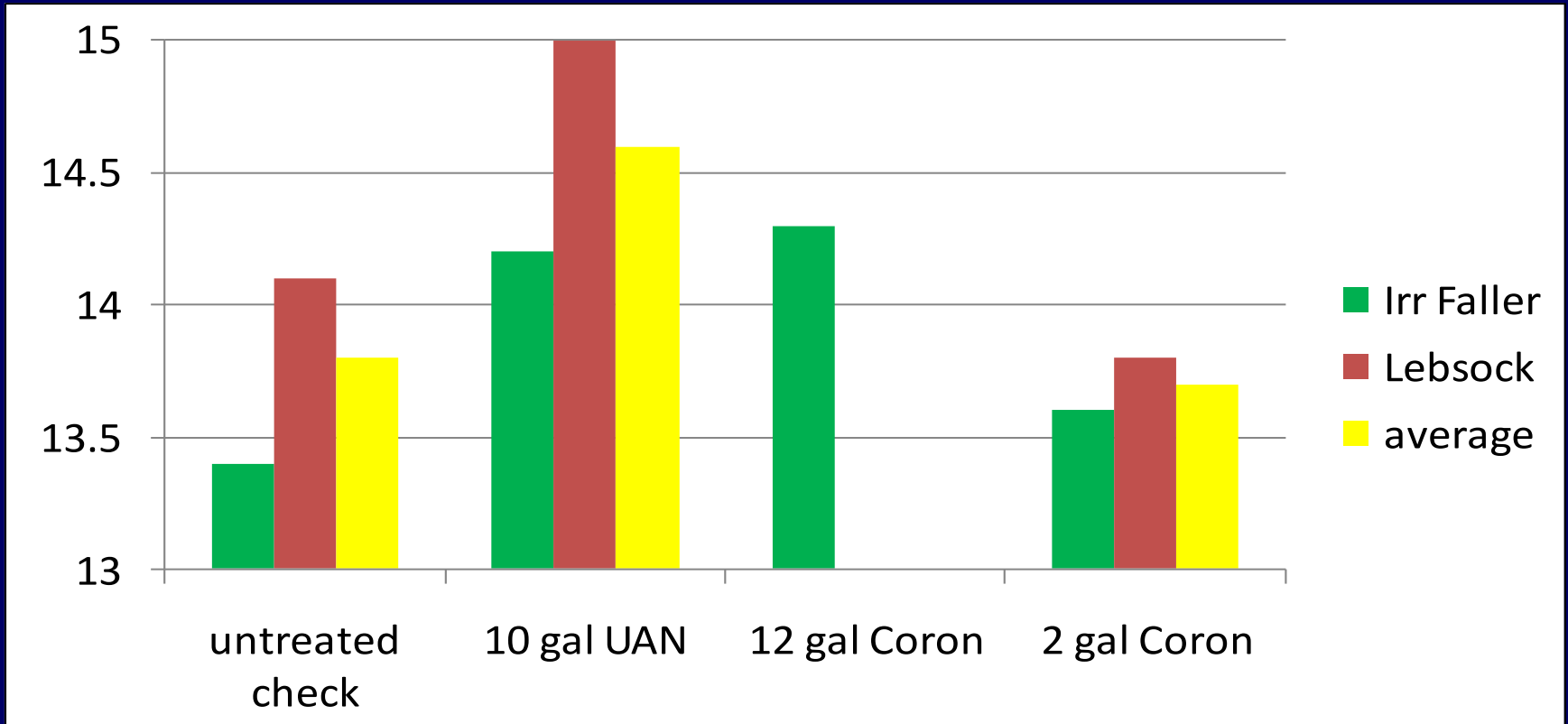
Valley City protein response to 5-leaf N-Pact application over preplant urea rates, 2008.



Protein response of post-anthesis N-Pact application, 3 gal/acre. Valley City, 2008



2009 Carrington, ave. 2 sites, post-anthesis application for protein enhancement. Schatz



Faller yields over 100 bu/acre

Slide courtesy of Greg
Endres, NDSU, Carrington REC

Don't skimp on starter P for wheat and barley

Apply chloride for malting barley especially if soil test is low.

Increases plump and helps to reduce effect of lower barley yield due to reduced kernel size.

Wheat yield increase from broadcast or Banded P. Average of six sites, Zubriski,

P ₂ O ₅ applied, lb/a			
Banded with seed			Broadcast
12	24	48	48
3.8	5.0	5.5	3.3

Banded P vs Broadcast in Wheat, Rasc, MB

Rate of P ₂ O ₅ , lb/a				
0	25 banded	25 brdcst	50 banded	50 brdcst
Wheat yield, bu/a				
35	40	39	43	40

**Similar in size of response (2-4 bu/acre)
higher than broadcast in SD, ND.
(about 10% yield increases, consistently)**

Summary-

- Use of the N calculator for wheat for most profitable N rates. Use common sense to determine the rate best suited to your farm and variety.**
- Yield goal is not a factor in N rate**
- Protein enhancement is possible with the proper rate and timing of in-season N**
- Use of slow-release liquids at reduced rates are no more efficient than UAN**
- Band apply P**