NITROGEN RECALIBRATION FOR SPRING WHEAT AND DURUM IN NORTH DAKOTA

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Abstract

North Dakota will begin using new fertilizer recommendations beginning Dec. 1, 2009. Previous recommendations required a yield guess by growers with no regard to economics of nitrogen application. The new recommendations recognize different N response curves with yield and grain protein within three state agri-climatology zones. The recommendations use the "return to N" method, which vary the N recommendation based on crop price and N costs. The resulting rate is adjusted based on soil test nitrate, previous crop N credit, excessive straw generated the previous season and tillage history. Adjustment due to soil organic matter content is under consideration. The recommendations will be available in print and through the use of an on-line interactive spreadsheet.

Introduction

A brief history of N calibration work and a description of current recommendations were provided by Franzen et al. (2007). Costs for fertilizer N increased nearly 3-fold between fall 2007 and fall 2008 and have now fallen back to about 2007 levels. Interest in site-specific strategies to increase N efficiency and reduce overall N-rates is growing. The purpose of this work is to develop better N recommendation strategies for wheat in North Dakota that are economically responsive, contain site-specific characteristics, and are yield and grain protein response based.

Methods and Materials

The data base for the recommendations is a combination of archived N response experiments from 1970 to 2004 and experiments conducted directly for this effort between 2005 and 2009. All of the data was associated with a soil test nitrate-N analysis. Some of the data was associated with a legume as a previous crop. A legume N credit was added into the available N amount for those sites. Through 2008, a total of about thirty-eight modern N calibration site-years were collected and fifty-eight previously archived site-years for a total of ninety-four site years. A total of about 460 data-points comparing yield/protein and N-rate/credits have been used in recommendation development.

Results

Using archived data and modern data from 2005-2008 (Figure 1), the response of yield to available-N is curvilinear. The zero-N rate does not product zero-yield. A zero-N rate produces about 20 bu/a. The rate of N required to produce additional yield from 20 to 30 bu/a is about 4 lb

N/a, not 2.5 lb N/a as our present formula is written The yield increases between 30 and 40 bu/a are about 5 lb N/bu.

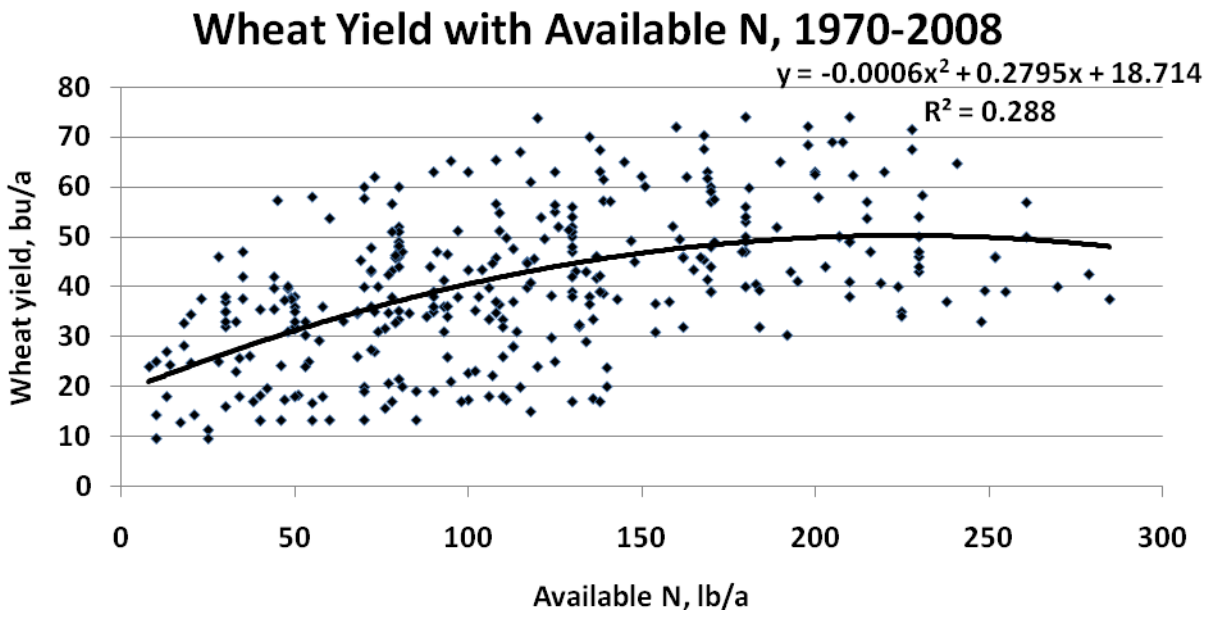

Figure 1. Wheat yield compared with N rate (total known available-N), 1970-2008.

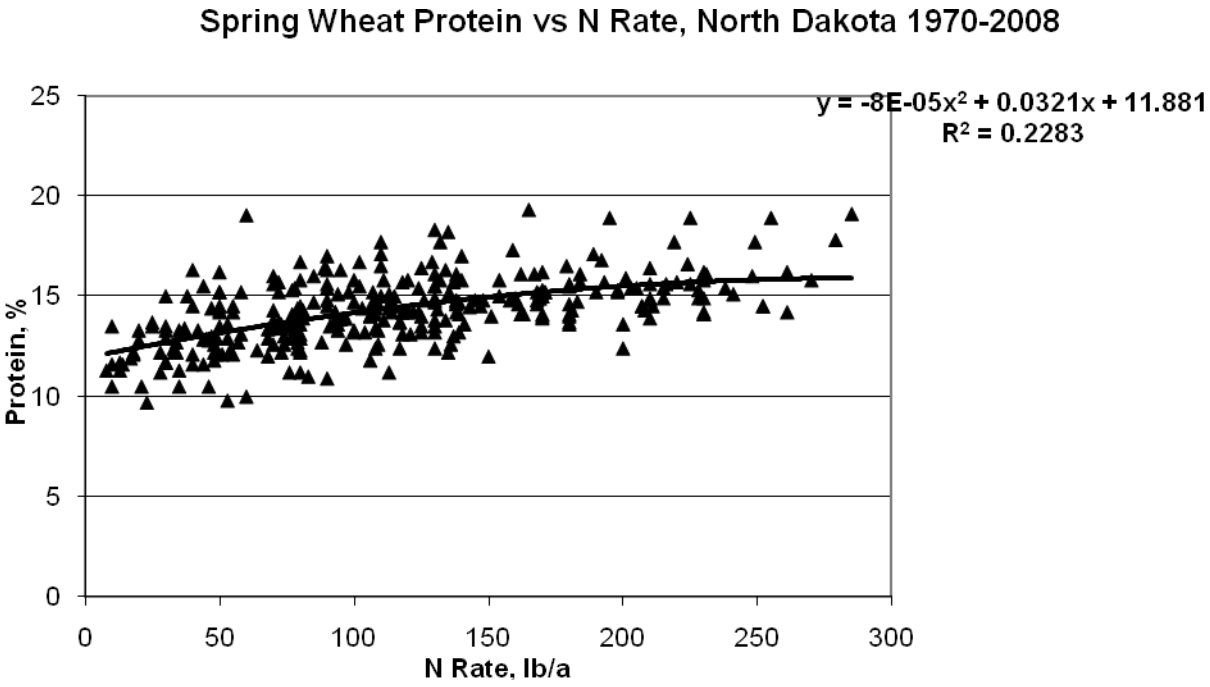

Figure 2. Wheat protein response with N-rate (total known available-N).

The protein response is also curvilinear (Figure 2). Maximum protein is achieved statewide with about 175-200 lb N/acre. Protein is an important component of economic analysis of wheat. When protein is less than 14%, there is a substantial dock. When protein is greater than 14%, up to a level of 15%, there is often, but not always a protein premium paid to growers. Beyond 15%, there are no additional incentives for protein. In some years, this premium is very large, but in most years it is about 1/3 the amount deducted as dockage for low protein.

Using the technique introduced by Nafziger and Sawyer (2005), the return to N for wheat was developed. For each region (Figure 3) the N response curve for yield and protein were independently determined. Inserting an N cost, yield return and protein return for each increment of N, the response to N curve was developed. (Figures 4-6). Within the protein return, N rates that returned protein below 14% was subject to a dockage of 50 cents per %, while protein above 14% was given a premium of 50 cents per % up to a protein of 15%, where no further premium was provided. The 15% protein cut-off is the reason why the curves especially in Figure 4 for western ND have a kink in the curve.

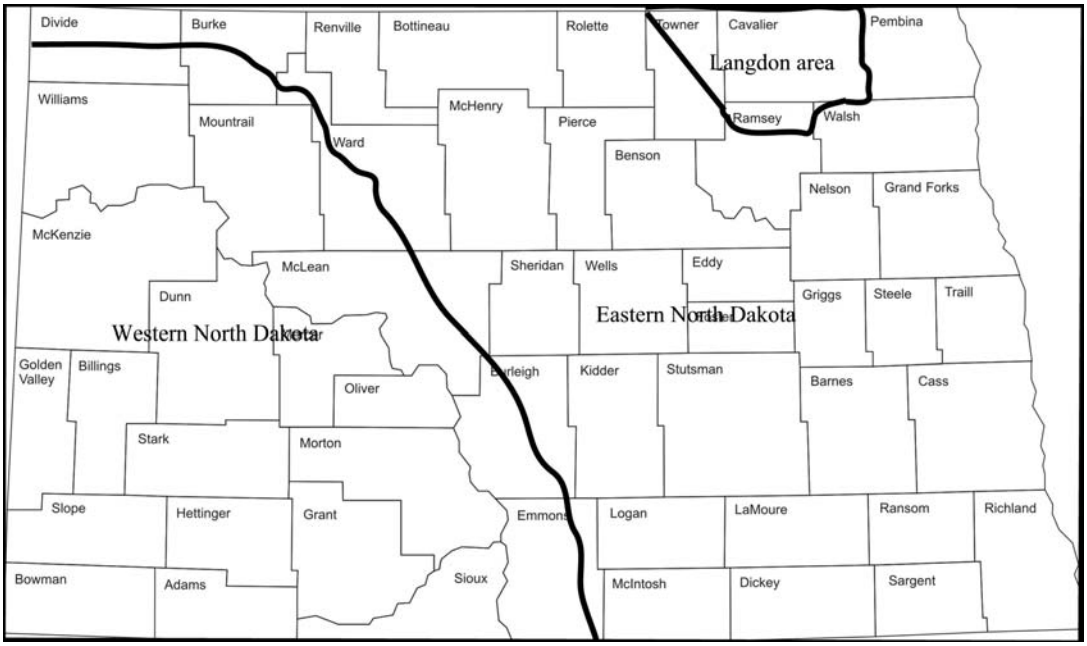

Figure 3. Location of Eastern North Dakota, Western North Dakota and Langdon Region agri-climatology zones.

Sites in the east and west were also segregated by tillage systems. Sites with a conventional tillage history required higher rates than sites that had been in no-till greater than 5 years. Adjustments are included for growers to consider in determining final N rates.

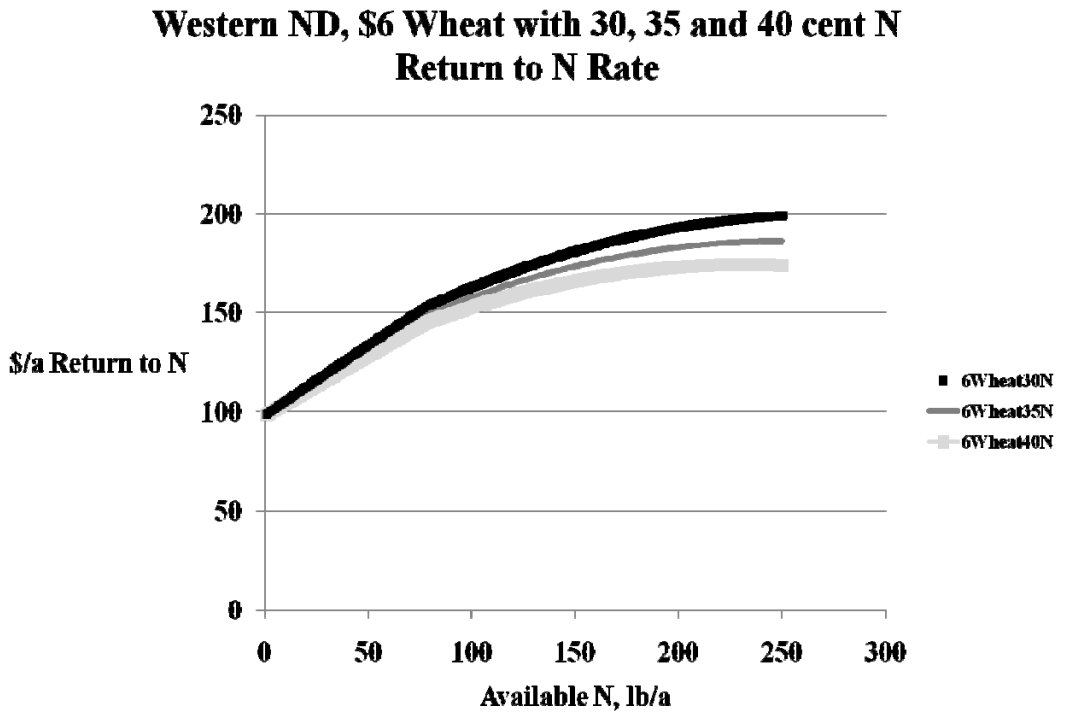

Figure 4. Return to N for western ND, 1970-2008 database, $6/bu wheat with 30-40 cent/lb N costs.

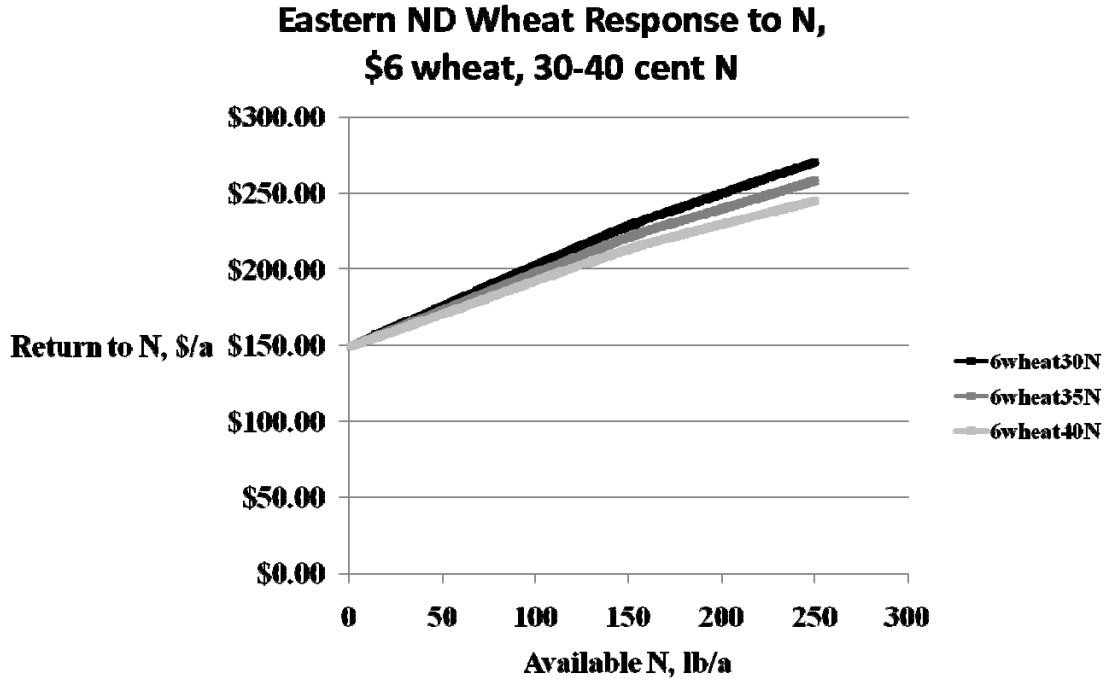

Figure 5. Return to N for eastern ND, 1970-2008 database, $6/bu wheat with 30-40 cent/lb N costs.

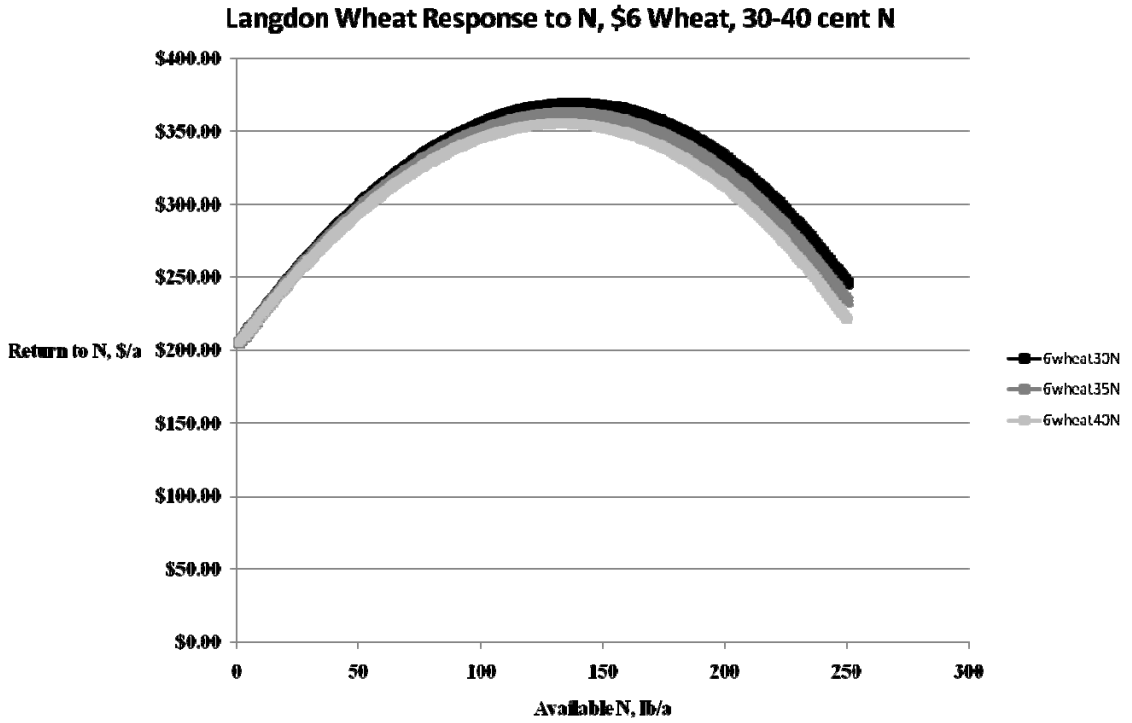

Figure 6. Return to N for Langdon region, 1970-2008 database, $6/bu wheat with 30-40 cent/lb N costs.

North Dakota has at least three agriclimatology zones within the state. The plateau in the Langdon area is usually 5 degrees F cooler than other parts of the state, with less growing season evapotranspiration. The east is more humid and has more rainfall than the west. Therefore, data was divided into these regions and analyzed separately for return to N characteristics. From the results shown in Figures 4-6, the segregation appears justified.

The western ND dataset for $6/bu wheat (Figure 4) shows profitable N returns for N costs between 30-40 cents/lb N. The eastern ND dataset for $6/bu wheat shows profitable returns between 30-40 cents/lb N. Comparing eastern ND to western ND return to N, western ND return to N becomes limited at about 200 lb N/acre, while return to N in eastern ND continues at higher N rates. The response to N in western ND is greater than eastern ND at lower N rates, but becomes less as N rates increase.

The Langdon return to N for $6/bu spring wheat maximized return with $0.30 N was about 145 lb/acre, while increasing N costs to $0.40 decreased optimal N rate to about 125 lb/acre (Figure 6). In contrast to both western and eastern ND, excessive rates decrease profitability. Reduced profit is likely the result of pre-anthesis lodging due to excessive N in this region. Mineralization rates are high in the Langdon region according to N rate study results. Note the high return to N associated with the zero-N rate compared with zero-N rates in the east and the west, with the west being the lowest.

For a grower or consultant to develop a suitable N rate requires following a series of steps.

1. Locate the farm on the agriclimatology map (Figure 3).
2. Choose a productivity level. The productivity level forces the grower to consider the history of the farm or soil. There are three productivity levels for each region, low, medium and high.

Each is defined as:

Eastern North Dakota

Low productivity = yields < 40 bu/acre
Medium productivity = yields between 40-60 bu/acre
High productivity = yields > 60 bu/acre

Western North Dakota

Low productivity = yields < 30 bu/acre
Medium productivity = yields between 30-50 bu/acre
High productivity = yields > 50 bu/acre

Langdon Region

Low productivity = yields < 40 bu/acre
Medium productivity = yields between 40-60 bu/acre
High productivity = yields > 60 bu/acre

3. Choose a wheat price
4. Choose an N cost
5. Look up the gross available N for those criteria in a table or on-line. An example appears in Table 1.

Table 1. Eastern North Dakota Medium Productivity

	N Costs cents per pound N								
Wheat price	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
	Total available N for optimum return, lb/acre								
$3.00	125	115	105	90	60	30	0	0	0
$4.00	150	140	130	120	110	100	80	50	0
$5.00	160	150	140	130	120	110	100	90	80
$6.00	170	160	150	140	130	120	110	100	90
$7.00	180	170	160	150	140	130	120	110	100
$8.00	185	175	170	165	160	140	140	130	120
$9.00	190	180	175	170	165	160	150	140	130
$10.00	200	190	185	180	170	165	160	150	140

6. Subtract adjustments
   - Subtract the soil test nitrate from the 0-2 foot depth
   - Subtract any previous crop N credits
   - Add 20 lb N/acre if the field has been in No-Till for 1-5 years
   - Subtract 50 lb N/acre if the field has been in No-Till greater than 5 years
   - Add 30 lb N/acre for each ton of straw above 2,000 lb/acre generated the previous year
7. The final result will be plus or minus 30 lb N/acre for considerations attributed to soil, variety, grower experiences or other grower/consultant designated factors.

An interactive spreadsheet will be available on-line after December 1, 2009. The draft site is shown in Figures 7 and 8, and contains the steps previously described. Growers can choose different scenarios for each field/soil to investigate the implications of N cost and wheat price on their final decision.

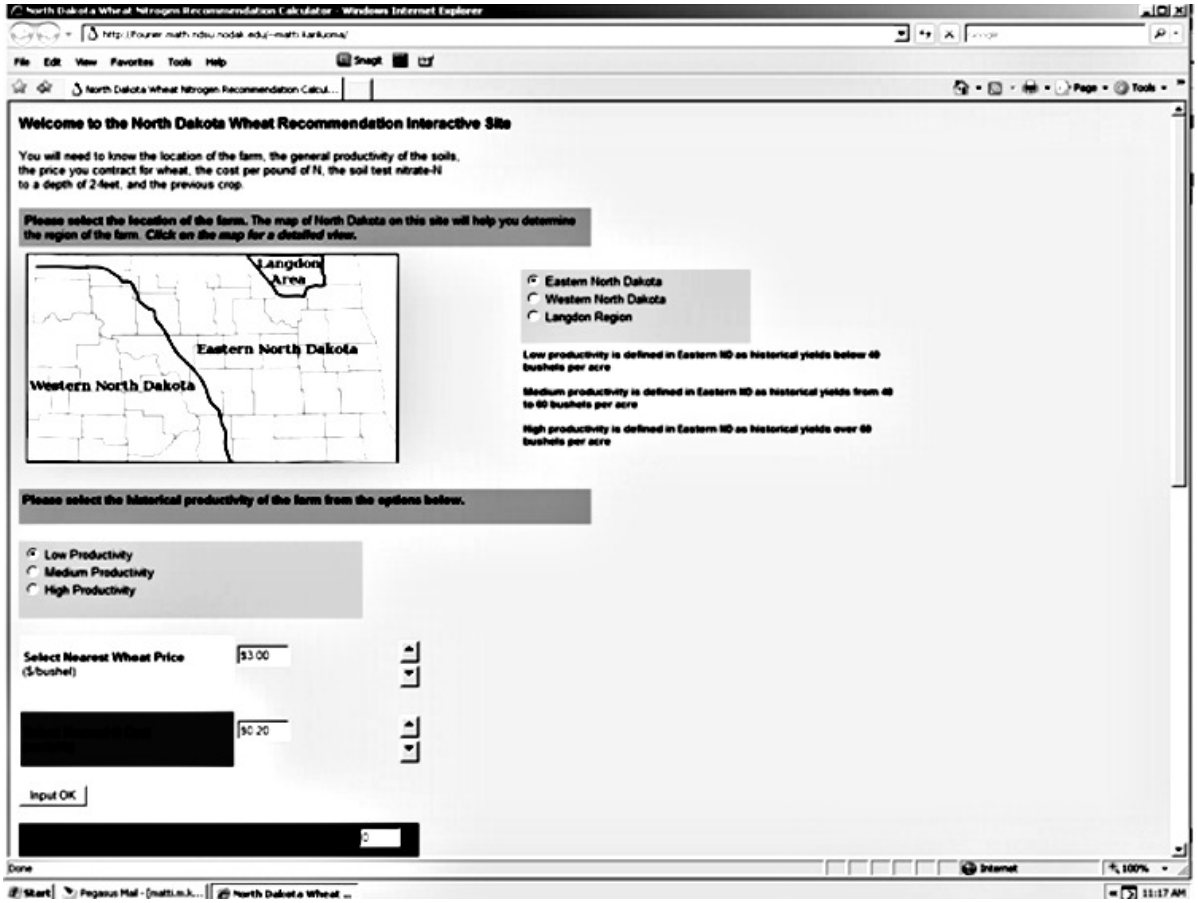

Figure 7. Draft of the beginning of the North Dakota wheat recommendation interactive website.

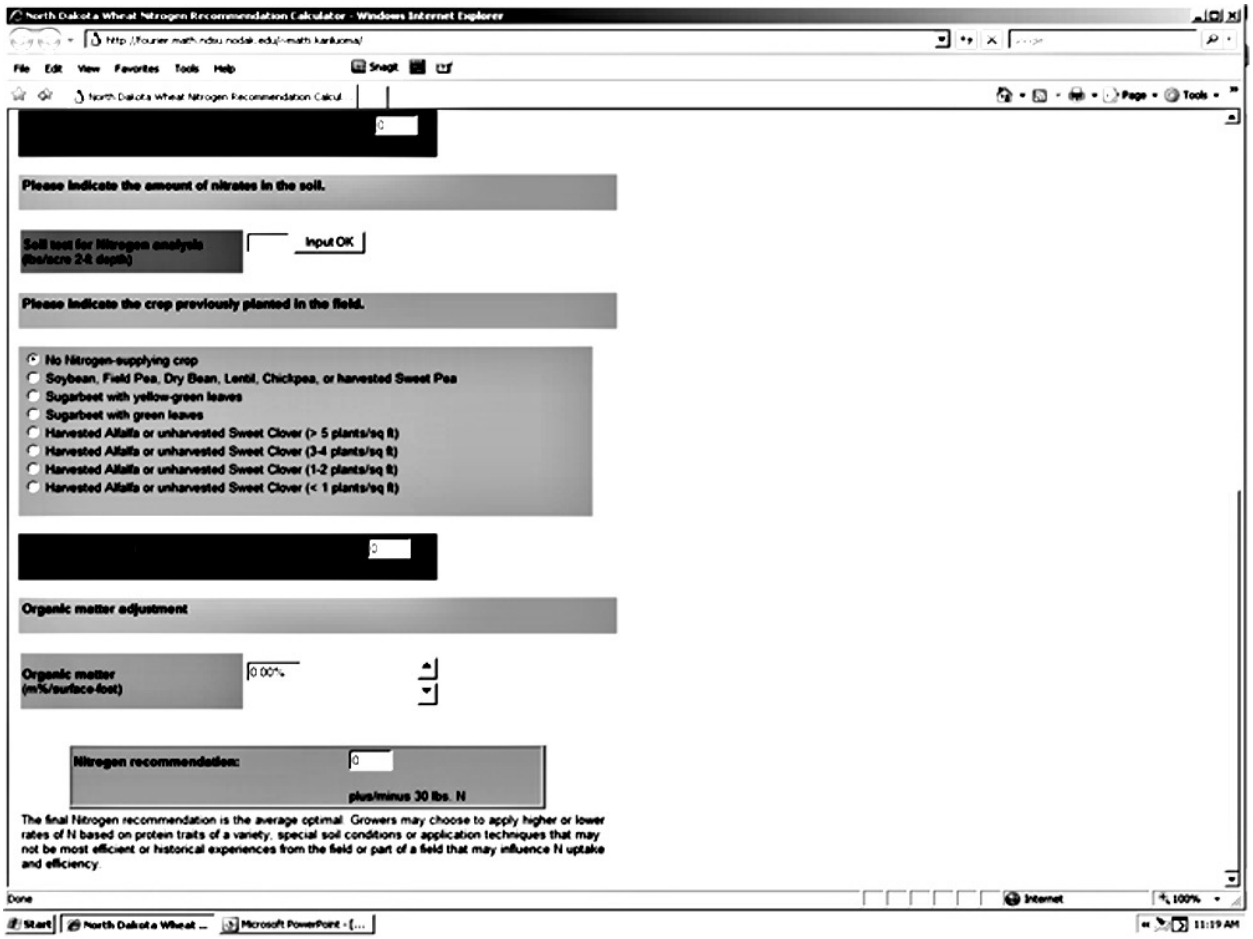

Figure 8. Draft of the conclusion of the North Dakota wheat N recommendation interactive website.

Summary

Archived N calibration data from spring wheat/durum trials from 1970 to present were gathered, along with recent field N rate experiments since 2005. There appear to be good reasons for segregating North Dakota into agriclimatology zones. Response curves are different in different areas of the state. The recommendations use response data as well as wheat price and N costs to extract gross N recommendations from return to N response curves. Adjustments to rate are soil test nitrate to 2-feet in depth, previous crop N credits, tillage history and excessive straw from the previous season. Adjustments with respect to organic matter are under consideration. Recommendations will be available in print and on-line.

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