Minnesota Wheat Research and Promotion Council
CROP YEAR 2013 RESEARCH REPORTING FORM

1. PROJECT TITLE:

Verifying the Need for Post Anthesis N Based on Crop Measurements

2. PRINCIPAL INVESTITAGATOR (S)

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4. REPORT DATE

November 15, 2013

5. REPORTING PERIOD

January 2011 to December 2012

6. TERMINAL REPORT ____X_____ **PROGRESS REPORT** _____

7. AMOUNT OF GRANT: $10,000

8. PUBLICATIONS

9: EXECUTIVE SUMMARY

Research Question:

Can grain protein reliably be predicted from plant measurements made prior to flowering? What is the relationship between plant N content prior to flowering and grain protein at harvest in a wide range of genotypes?

Results:

In-season measurements were made on plots in a number of experiments to determine if the protein content at harvest could be predicted with these measurements. The in-season measurements included: leaf N tissue content at 6 lf and flag leaf stages, stalk N at flag leaf stage, and Greenseeker readings, chlorophyll content, leaf color chart readings at the 6 lf and flag leaf stages. Tissue samples have not yet been analyzed, so those data could not be used in the correlation analysis reported here. Based on a preliminary analysis of the available data, in-season measurements did not adequately predict grain protein across a range of genotypes (see Figure 1 as an example). This might be due to the narrow range of proteins that was found within the variety trial we used in this experiment. This result might partially be explained by the fact that leaf color characteristics of varieties can vary independently of nitrogen content. Though the relationship between in-season measurements and protein across varieties needs additional verification, these data suggest that it is unlikely that an absolute NDVI reading can be established for all cultivars to predict protein. An NDVI reading of 0.8 might mean that the cultivar being "sensed" will reach 14% protein, but it does not mean that an adjacent cultivar with a similar reading will also reach 14% protein. This also means that NDVI cannot be used for selecting protein characteristics of genotypes at least under high N levels. We also note, however, that the protein levels were generally very high in this particular study (the vast majority above 14%) and NDVI readings exceeded 0.8 in almost all cases. It might be useful to have these same genotypes sensed under lower fertility levels to see if this relationship holds up when NDVI readings and protein levels are on average much lower.

Data from the other experiments analyzed also indicated that in general the later measurements were more effective in predicting protein content than the earlier ones. This supports the results of our previous work. In several studies, correlations between protein and chlorophyll content, NDVI, and the leaf color chart when measure at the flag leaf stage were similar. This suggests that any technique that can accurately measure the greenness of the leaf might be able to predict protein content. The data this year also supports the work done previously that varieties with different protein characteristic will also likely have different "sensed verse protein content" curves (see the 2nd figure attached). Though the regression lines for the three varieties have similar slopes, Glenn, which genetically produces higher grain protein than the other two varieties, has a much higher protein level for a given NDVI reading than the other two. Finally, these data suggest that the Greenseeker does not have adequate precision; at least as we used it, to separate protein differences within the range of proteins that are most interesting (i.e. 12-14 percent range). The technology seems to work well in separating protein values less than 12% and lower and higher values. This is demonstrated in the final two graphs that are attached, where there is a relatively heavy grouping of values in the 13 to 15% protein range with very similar NDVI values.

Application/Use:

It appears that our research has created more questions than it has answered. It does show the value of late in-season plant measurements on predicting protein content especially if these values fall on the lower end of the protein spectrum. These techniques, however, need to be further refined and tested before they can be applied.

Materials and Methods:

The experiments included in this project were grown at five locations. These experiments varied in their treatments and objectives. Some were varieties trials with no differences in N fertilization within the experiment, two were fertilizer based studies and two had both fertilizer and varieties as treatments. In addition to yield and protein at the end of the season, the following in-season measurements made were: Greenseeker readings, leaf and stalk tissue nitrogen content, and leaf chlorimeter readings all at the 6 lf and flag leaf stages. Regression analysis was used to determine the relationship between the measured values and protein at harvest.

Economic Benefit to a Typical 500 Acre Wheat Enterprise:

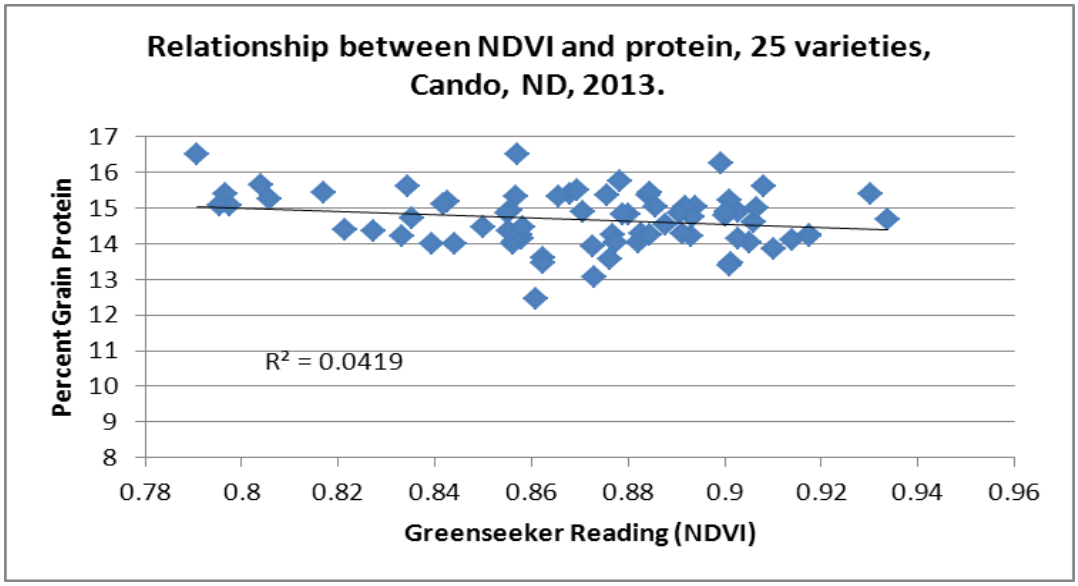
I do not believe that the application of this research has any direct benefit to farmers at the present time. However, this research does have the potential for helping farmers manage for higher protein content. This could have substantial benefit to farmers when protein discounts are high. Additional refinement of this technology is needed, however, before it can effectively and profitably be applied.

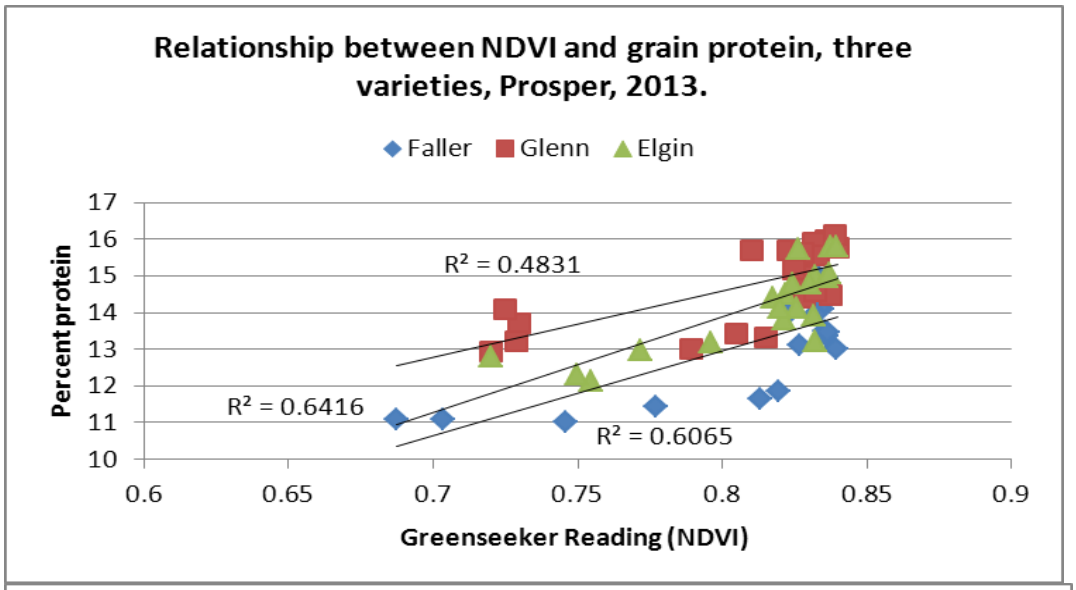
10: RELATED RESEARCH None

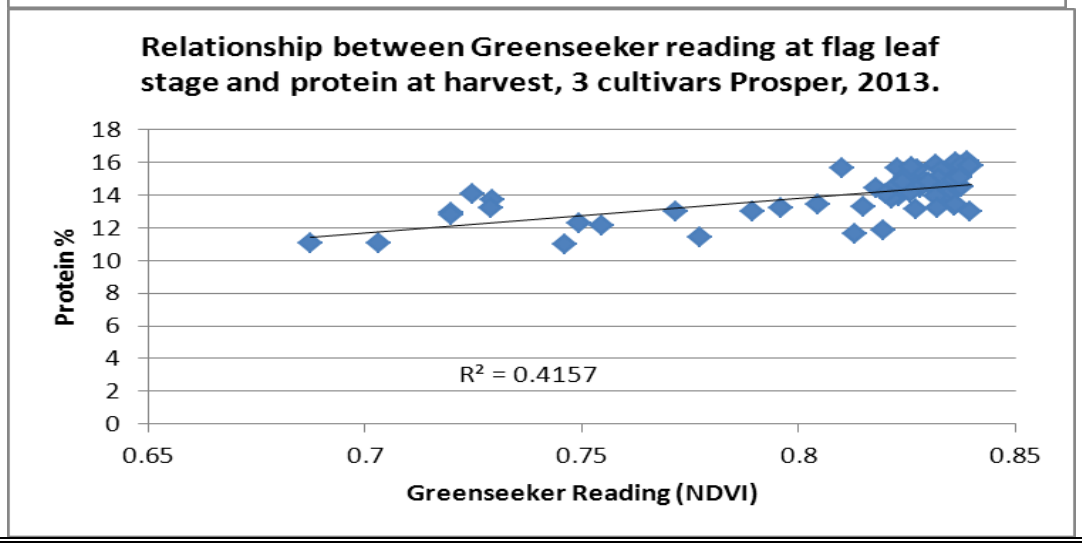
11: RECOMMENDED FUTURE RESEARCH

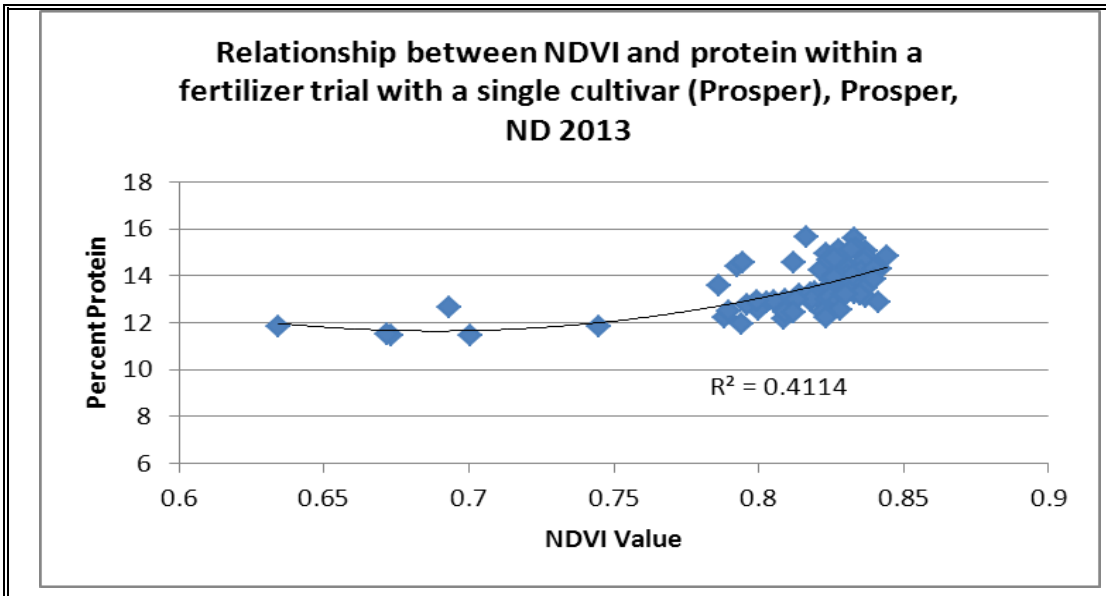
Research is needed to determine the most precise way to predict protein across cultivars within the 12 to 15% range of proteins. Research to determine if varietal difference in protein content can be predicted when grown in an N deficient environment would be useful and may have an application in breeding programs.

12: APPENDIX


Relationship between NDVI and protein, 25 varieties, Cando, ND, 2013.
Percent Grain Protein
17
16
15
14
13
12
11
10
9
8
R² = 0.0419
0.78
0.8
0.82
0.84
0.86
0.88
0.9
0.92
0.94
0.96
Greenseeker Reading (NDVI)


Relationship between NDVI and grain protein, three varieties, Prosper, 2013.
Faller
Glenn
Elgin
Percent protein
17
16
15
14
13
12
11
10
R² = 0.4831
R² = 0.6416
R² = 0.6065
0.6
0.65
0.7
0.75
0.8
0.85
0.9
Greenseeker Reading (NDVI)


Relationship between Greenseeker reading at flag leaf stage and protein at harvest, 3 cultivars Prosper, 2013.
Protein %
18
16
14
12
10
8
6
4
2
0
R² = 0.4157
0.65
0.7
0.75
0.8
0.85
Greenseeker Reading (NDVI)


Relationship between NDVI and protein within a fertilizer trial with a single cultivar (Prosper), Prosper, ND 2013
Percent Protein
18
16
14
12
10
8
6
0.6
0.65
0.7
0.75
0.8
0.85
0.9
NDVI Value
R² = 0.4114