

Quality, Cultural, and Climatic Interactions

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Introduction:

There have been numerous studies that have investigated the relationships between climate, yield, and nitrogen (N) rate. The work has shown that in dryland situations a delicate balance exists between applying too much N and applying too little N. In some situations applying too much N can reduce yields, because the N fertilizer stimulates tiller production and water use, which in turn reduces the water availability during the critical grain filling stages. In contrast, little work has been conducted investigating how interactions between these factors impacts wheat quality. The concept behind this proposal is that producers of high quality wheat will obtain better prices by managing cultural practices that improve quality characteristics.

Quality refers to the desirability of the product and depends on the intended purpose. Typical quality measurements include weight per unit volume, kernel weight, kernel size and shape, kernel texture, color, damaged kernels, impurities, milling and baking properties, moisture content, protein content, protein quality, alpha amylase activity, ash content, taste, color, appeal, starchiness, and texture when grain is prepared for food. Starting with high quality wheat is a prerequisite to produce high quality bread, cakes, pizza dough, bagels, cookies, and pastries. Quality is strongly influenced by consumer preferences. The quality of the wheat influences its price in the marketplace.

Different end users require wheat of different qualities. Wholesale bakers often value mixing tolerance, texture, loaf volume, and adsorption, while pizza crust makers may consider consistency, protein, and absorption as most important. South Dakota producers should be able to produce high quality wheat by understanding how cultural practices, varieties, and climate interact to impact quality. Souza et al. (2004) reported that responses to N management and location were not cultivar specific, and that grain protein had more value than test weight or grain hardness for predicting bread or noodle quality. Research conducted in South Dakota had different results and showed that N had different impacts on wheat quality in Brigg and Russ. In Russ, protein, farinograph stability, and aleograph values increased with N rate, while in Briggs protein was not related to aleograph and farinograph stability.

Research on quality has been and will continue to be conducted by a variety of different groups in South Dakota. Research has shown that: 1) wheat quality is influenced by variety selection and that N and water stress interact to influence wheat quality, 2) the

amount of ^{13}C discrimination that occurs in the plant can be used to characterize and quantify how N and water stress interact to influence wheat characteristics, and 3) Se content of wheat is influenced by interactions among genetics, soil, and climate. The concept behind this project is that by combine historical with current projects it will be possible to assess how interactions among cultural practices, climate, and varieties influence wheat quality. This information will be used to develop guidelines for developing corrective solutions and for the successful marketing of wheat.

Objectives:

1. Develop a central data base where historical, current, and future wheat quality data will be stored. This data base will consist of location, precipitation, temperature, variety, climatic conditions, yield, wheat quality, pests, and soil nutrient status of popular spring and winter wheat varieties.
2. Analyze data base using geostatistical, data mining, and multivariate approaches to identify relationship between cultural and environmental factors.
3. Use the data base to develop guidelines for producing wheat grown under different climatic conditions with specific characteristics for targeted markets.

Locations and Varieties at CPT sites

Winter Wheat

Locations: Brookings, Dakota Lakes, Wall, Winner, Onida (2007), Kennebec
Varieties: 11 varieties as suggested by the Wheat Commission

Spring wheat

Locations: Brookings, Northeast Research Station (Watertown), Warner, Selby, Bison and Ralph.
Varieties: 11 varieties as suggested by the Wheat Commission

The CPT trials will generate a total of 132 samples of which 66 will be winter wheat and 66 will be spring wheat. At these fields, rainfall will be measured and pre-season soil test values will be determined.

Farmer Sites

The farmer study will be expanded from 143 samples submitted for analysis in 2007 to over 200 samples submitted this year. This expansion is needed to fill gaps in the data base. County extension agents and certified seed growers are being contacted to assist in locating additional sites. Cultural information from these sites will also be collected. These samples will be analyzed for Selenium (Se), protein, allograph, $\delta^{13}\text{C}$, and test weight. Cultural information that will be collected includes variety, location, tillage, fertilizer, rainfall, yields, and soil test values. Soil test values will be recorded if soil samples were collected.

Update on Wheat Quality 2007

CPT Trials:

During the past year a total of 210 CPT samples from 2006 and 2007 were analyzed. This data has been entered into a spread sheet that will be combined with subsequent years. The sample analysis from 2006 has been completed. This data is summarized in the tables below.

Variety	Grain Selenium	Farinograph Stability	$\delta^{13}\text{C}$	Grain Protein	Yield
	ug/g (ppm)	Minutes		%	bu/A
Briggs	0.828	9	-24.29	15.5	50.9
Forge	0.699	17	-24.52	14.8	49.9
Freyr	0.928	12	-24.29	15.4	50.2
Granger	0.771	16	-24.70	15.2	51.6
Kelby	0.750	13	-24.38	16.3	47.5
Oxen	1.109	21	-24.53	15.4	52.3
Reeder	0.766	16	-24.45	15.1	49.7
SD3851	0.699	31	-24.73	15.3	48.3
SD3868	0.786	19	-24.69	14.6	52.3
Traverse	0.865	5	-24.74	14.7	54.3

Table 1. Wheat quality tests (selenium, farinograph stability, ^{13}C , grain protein) and yield for South Dakota State University Crop Performance Trials. Values represent average by location for spring wheat samples from 2006 CPT trial locations. Sites averaged were Brookings, South Shore (NE Farm), Warner, Selby, Bison and Ralph for all values reported in the table.

Variety	Grain Selenium	Farinograph Stability	$\delta^{13}\text{C}$	Grain Protein	Yield
	Ug/g (ppm)	Minutes		%	bu/A
Alice (White)	0.529	17	-24.92	12.8	52
Arapahoe	0.549	10	-24.74	13.1	55
Expedition	0.476	40	-24.97	12.8	57
Harding	0.580	16	-25.33	13.4	51
Jagalene	0.549	17	-25.29	12.4	50
Tandem	0.569	23	-24.68	13.2	51
Wendy (White)	0.500	9	-24.83	12.9	55
Wesley	0.556	30	-24.79	13.4	53

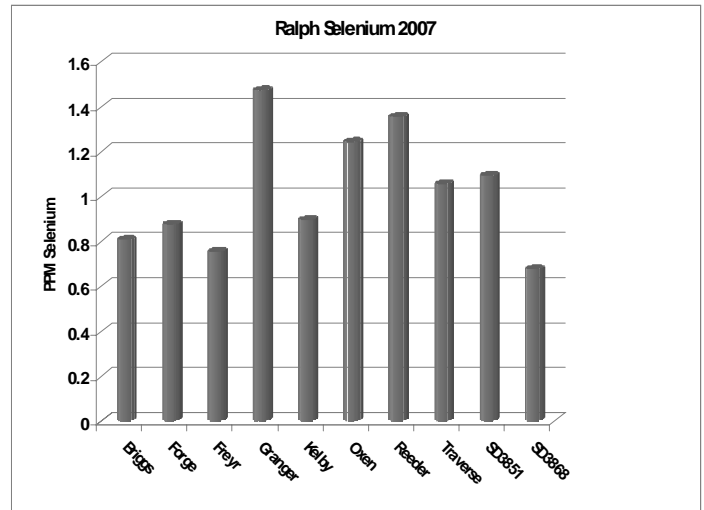
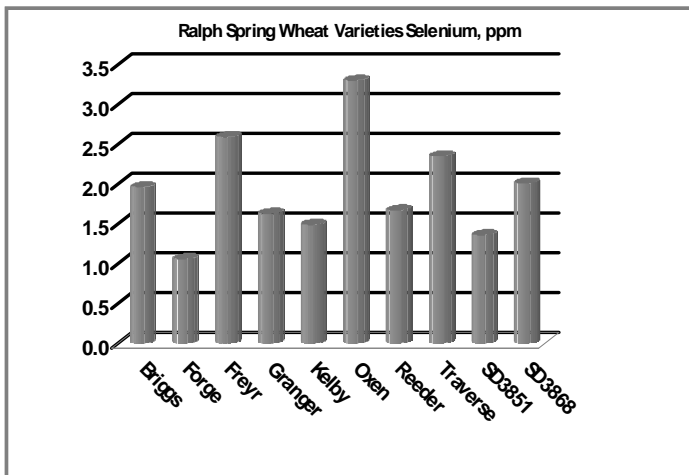
Table 2. Winter wheat quality tests (selenium, farinograph stability, C^{13} , grain protein) and yield for South Dakota State University Crop Performance Trials. Values represent average by location for the 2006 CPT trial locations. Sites averaged were Brookings, Dakota Lakes, Wall and Winner for grain selenium, farinograph stability and ^{13}C . Yield and grain protein not reported for Dakota Lakes due to severe drought and lack of enough replicates at each site to produce an accurate yield or protein value.

Varietal differences in grain Se, farinograph stability, $\delta^{13}\text{C}$, grain protein, and yield were detected. In general Se was higher in the spring than the winter wheat varieties and Oxen had the highest Se contents. The $\delta^{13}\text{C}$ value is used to assess drought tolerance. In wheat, $\delta^{13}\text{C}$ values become less negative as the plants close the stomata in response to water stress. Preliminary analysis of this data suggests that farinograph stability and Se content are impacted by yield potential and drought tolerance ($\delta^{13}\text{C}$). When the 2007 samples are added to the data base, these relationships will be more fully explored.

In 2006, Se contents were higher than 2007. Annual differences most likely are the result of climatic variability.

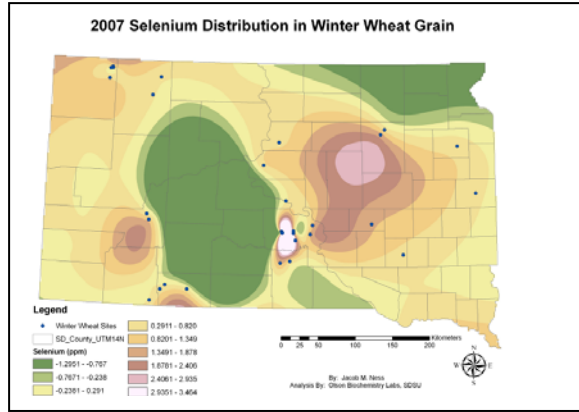
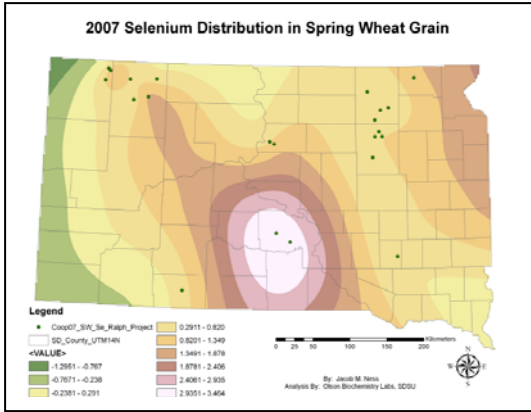
	2006	2007
Se	1.94 ppm	1.02 ppm

Each of the sites had unique results. For example, at Ralph, spring wheat variety, Oxen had relatively high Se contents in both 2006 and 2007. In 2006 and 2007, Oxen had the highest and third highest Se content, respectively. As the quality analysis of the 2007 CPT are completed, they will be added to the data base.

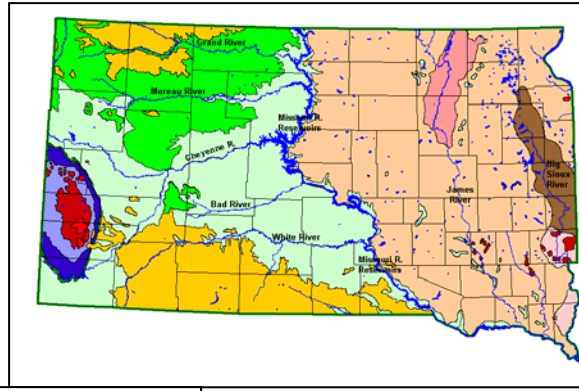
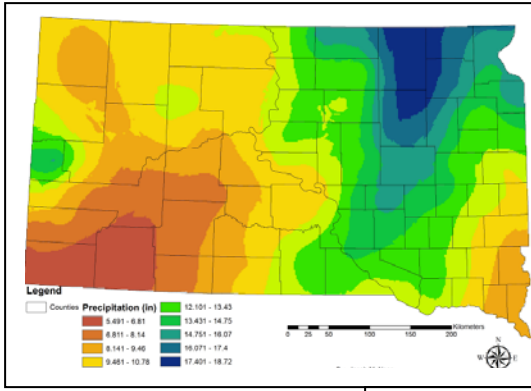


Producer samples:

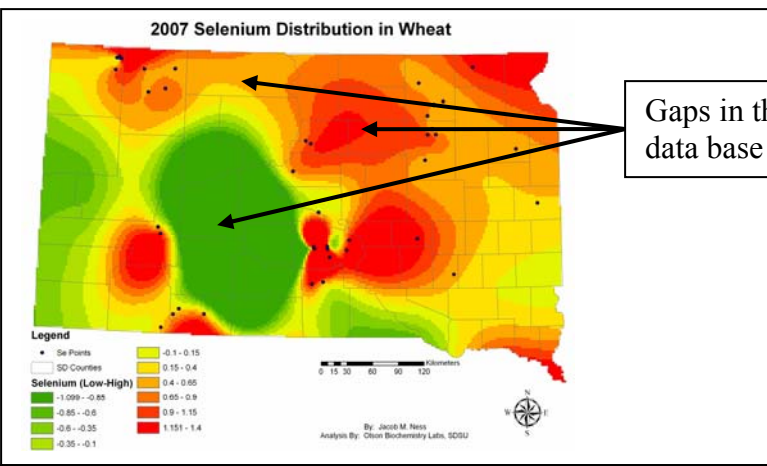
To expand the data base and provide information needed for individual decision a producer sampling program was initiated in 2007. These samples were analyzed for Se, protein, total N, and Farinograph. Quality analysis of these samples continues. Study site locations are shown in the chart below. Based on this chart, areas for additional samples were identified. To fill this need the number of sampling locations will be increased in 2008. The data base will be created by identifying the geological characteristics, soils, and climatic conditions at each site. Based on data from the CPT trial characteristics of the individual varieties will be considered in the analysis. Portions of this data base are shown below. This map shows that there are gaps in the data base as well as their being areas with relatively high and low Se contents.



Se content in spring and winter wheat



Rainfall and geologic maps



Gaps in the data base

Combined spring and winter Se wheat maps

Following sample analysis, the laboratory results will be provided to the collaborating producers. During the next year, analysis will be conducted with the goal of building a geospatial model that can identify areas with targeted attributes. Samples will then be collected from these areas to validate the model.