Rawat N, Sehgal SK, Joshi A, Rothe N, Li W, and Gill BS. 2011. Dissecting the ligno-cellulose pathway in *Triticum monococcum* using TILLING. PAG XVIII Abstract P726.

Sehgal SK, Gupta S, Kaur S, Sharma A, and Bains NS. 2011. A direct hybridization approach for gene transfer from *Aegilops tauschii* Coss. to *Triticum aestivum* L. Plant Breed 130(1):98-100.

Sehgal SK, Aknunov E, Li W, Kaur G, Catana V, Pillamari J, Faris J, Reddy L, Devos KM, Rabinowicz PD, Chan A, Maiti R, Dolezel J, Simkova H, Safar J, Luo MC, Ma Y, You FM, and Gill BS. 2011. Towards a physical and genetic framework map of chromosome 3A of bread wheat (*Triticum aestivum* L.). PAG XVIII Abstract P019. Zhang W, Friebe B, Gill BS, and Jiang J. 2011. Centromere inactivation and epigenetic modifications of a plant cromosome with three functional centromeres. Chromosoma 119:553-563.

NEBRASKA

UNIVERSITY OF NEBRASKA AND THE USDA–ARS GRAIN, FORAGES AND BIOENERGY UNIT.
Lincoln, NE, USA.

In 2010, 1,600,000 acres of wheat were planted in Nebraska and 1,490,000 were harvested with an average yield of 43 bu/acre for a total production of 64,070,000 bu. This crop would be considered a small crop. Autumn rains in 2009 prevented much of eastern Nebraska from harvesting corn and soybeans in time to plant wheat after the summer crop. In 2009, 1,700,000 acres of wheat were planted in Nebraska and 1,600,000 were harvested with an average yield of 48 bu/acre for a total production of 76,800,000 bu. In 2008, 1,750,000 acres of wheat were planted in Nebraska and 1,670,000 were harvested with an average yield of 44 bu/acre for a total production of 73,500,000 bu.

New cultivars.

In 2010, two new wheat cultivars were formally released. **NE01481**, to be marketed as **Husker Genetics Brand McGill**, in honor of a legendary professor of genetics at the University of Nebraska, was selected from the cross 'NE92458/Ike'. The pedigree of NE92458 is 'OK83201/Redland' and the pedigree of OK83201, an experimental line developed by Oklahoma State University is 'Vona//Chisholm/Plainsman V'. McGill was recommended for release primarily due to its superior adaptation to rainfed wheat production systems in eastern and west central Nebraska and its excellent resistance to wheat soil borne mosaic virus (WSBMV). McGill is moderately resistant to moderately susceptible to stem rust (caused by *Puccinia graminis Pers.: Pers. f. sp. tritici* Eriks & E. Henn.) in field nursery tests inoculated with a composite of stem rust races (RCRS, QFCS, QTHJ, RKQQ, and TPMK). In greenhouse tests, it is resistant to races TPMK, QFCS, and RCRS, but susceptible to race TTTT and RKQQ. It is moderately resistant to moderately susceptible to leaf rust (caused by *P. triticina* Eriks), and moderately susceptible to susceptible to stripe rust (caused by *P. striiformis* Westendorp f. sp. t*ritici*). McGill is susceptible to Hessian fly (*Mayetiola destructor* Say) and to wheat streak mosaic virus (field observations in NE). McGill has acceptable milling and baking end-use quality.

The second line is **NI04421**, which will be marketed as **Husker Genetics Brand Robidoux** in honor of a pioneer French trapper who had a trading post between Nebraska and Wyoming. Robidoux was selected from the cross 'NE96644/Wahoo (sib)' where the pedigree of NE96644 is 'Odesskaya P/Cody//Pavon 76/3*Scout 66'. Robidoux was released primarily for its superior performance under irrigation and rainfed conditions in western Nebraska (west of North Platte, where drought is common) and irrigated production sites in western Nebraska and eastern Wyoming. This cultivar seems to have good drought tolerance and does best in irrigated environments in the drier areas (eastern WY). Robidoux is moderately resistant to stripe rust (caused by *P. striiformis* Westendorp f. sp. t*ritici*), moderately resistant to moderately susceptible to stem rust (caused by *P. graminis Pers.: Pers. f. sp. tritici* Eriks & E. Henn.) in field nursery tests inoculated with a composite of stem rust races, moderately susceptible to leaf rust (caused by *P. triticina* Eriks). Robidoux is susceptible to Hessian fly (*M. destructor* Say) and to wheat streak mosaic virus. Robidoux is susceptible to common bunt (syn. stinking smut, caused by *Tilletia spp.*) and seed treatments are recommended. Where common bunt was present, Robidoux was the only line with the tell-tale odor and diseased kernels. The overall end-use quality characteristics for

Robidoux are acceptable and similar to many commonly grown wheat cultivars which are well received by the milling and baking industries.

Two additional lines are under increase for possible release in 2011 (NE03490 and NE04490), however, NE03490 is adapted to the same environments as Robidoux and NE04490 is adapted to the same environments as McGill. Hence, it is difficult to predict if these lines will have sufficient merit to be released.

Use of wheat synthetics to expand our genepool.

K. Onweller, R. Ward, P.S. Baenziger, Y. Jin, R. Bowden, S. Wegulo, C. Baker, R. Graybosch, and P. Byrne.

A collaborative effort with Colorado State University to use CIMMYT-developed wheat synthetic lines as sources for drought tolerance led us to further characterize six synthetic CIMMYT wheat lines. In our these studies, we discovered some lines were resistant to *P. graminis, P. striiformis*, and *Schizaphis graminum*. Two of the six lines possessed resistance to stem rust races in the Ug99 family. Studies to determine the identity of the genes are underway. Based on phenotyping of the synthetic parental lines at the Cereal Disease Laboratory in Minnesota, it has been hypothesized that the resistance in the synthetic parental lines may be from *Sr33*. *Sr45* will be tested for as well, as *Sr33* and *Sr45* are both derived from *Ae. tauschii* and are located on chromosome 1DS. Both genes have been shown to confer resistance to numerous races of stem rust, including Ug99. All synthetic lines exhibited seedling resistance and five exhibited adult resistance to *P. striiformis* race PST-100. Two different synthetic lines conferred excellent resistance to greenbug biotypes E, I, and K. A detailed inheritance study was undertaken with the assistance of Cheryl Baker (USDA–ARS, OK) to identify the genetic constitution of the resistance. Preliminary data suggest that single, dominant genes are acting in each synthetic line. In addition to resistance, the synthetic lines were assayed for high-molecular-weight glutenin and gliadin composition. The work revealed protein subunit compositions not commonly found in the Great Plains wheat cultivars.

Understanding the stem rust resistance in Gage wheat.

T. Kumsa, P.S. Baenziger, S. Wegulo, M. Rouse, and Y. Jin.

With the advent of stem rust race Ug99, understanding and developing better stem rust resistance is again in the attention of wheat community. In this project, we are interested in understanding the *Sr2* complex in Gage (a Nebraska cultivar released in 1965), which historically was superior to Scout 66 (a wheat cultivar that also carried the *Sr2* gene). Our goal is to understand the nature of Gage's superior resistance to stem when compared to that found in many other *Sr2* cultivars. With a newly developed marker csSr2, we confirmed the presence of *Sr2* in this cultivar. We are advancing generation to obtain $F_{2:3}$ families from crosses made between Bill Brown (susceptible cultivar) and Gage. These families will be used for phenotyping and genotyped to understand the *Sr2* complex. As part of this research, we also are collecting additional sources of resistance and pyramiding effort these genes. For example, using molecular markers it is hypothesized that some of the Nebraska lines contain both *Sr2* and *Sr24*. Crossing these lines to lines with *Sr36* and *Sr26* sources have been made to pyramid the resistance genes. We have collected useful germplasm for *Sr39*, *Sr40*, and *SrR*. Molecular markers and phenotyping will be used for selection and backcrossing.

Association mapping for important biotic and abiotic related traits in a structured wheat breeding population.

I. Salah, D. Wang, K. Eskridge, J. Crossa, and P.S. Baenziger.

The main objectives of this research are to apply association mapping and whole genome selection approaches to identify DArT and SSR markers associated with important traits in structured wheat breeding population and determine a marker-based kinship matrix and study the impact of selection (decreasing the number of lines as is commonly done in breeding programs) on genetic diversity. We grew 280 genotypes of hexaploid winter wheat plus two check cultivars in our preliminary nursery and harvested in nine environments during the 2009–10 season. Based on the phenotypic and molecular marker data, we clustered these lines into three groups. Then, we selected the best 57 genotypes from the 280 lines for advancement to the intermediate nursery (Nebraska Triplicate Nursery, year 2). We will evaluate the

57 genotypes using the same molecular markers and obtain new phenotypic data at similar locations throughout NE, but in replicated experiments. In the following year, approximately 25 lines will be advanced to the Nebraska Intrastate Nursery (year 3). We will also repeat this process for an additional 280 new genotypes in year 2, which will be advanced to 57 genotypes in year 3.

Preharvest sprouting derived from red/white wheat mating populations.

Juthamas Fakthongphan, R. Graybosch, and P.S. Baenziger.

Preharvest prouting (PHS) of wheat, the premature germination of wheat heads, takes place in a field under conditions of delayed harvest, high humidity, or wet conditions. This problem has a high economic impact on farmers and end-users. Wheat breeders have tried to diversify the wheat production system in Nebraska by introducing hard white winter wheat cultivars. T he grain yield potential and disease resistance have been increased but the current germ plasm of hard white winter wheat lacks some essential quality traits such as low levels of grain enzyme polyphenol oxidase, and resistance to PHS. Both traits will be important issues once the U.S. exports white wheat to the world markets. This research will focus on identifying red wheat parents capable of donating genes for tolerance to PHS, mapping or confirming which markers are applicable for the Great Plains hard white wheat gene pool, and analyzing the ABA sensitivity in these materials to correlate the misting assay for PHS to ABA response.

Modified food starches from waxy and partial waxy durum wheats.

L.E. Hansen, R. Graybosch, D. Jackson, and R. Wehling.

Partial waxy (reduced-amylose) and fully waxy (amylose-free) tetraploid wheats were developed by introgression of null alleles at the *Wx-A1* and *Wx-B1* loci from common hexaploid wheat. Purified starches were obtained from each genotype, and chemically modified by cross-linking with phosphorus (V) oxychloride, substitution with propylene oxide, and sequential cross-linking with phosphorus (V) oxychloride followed by substitution with propylene oxide. Functional properties were compared to blends of tetraploid waxy and wild-type starches of known amylose contents. Significant differences in functionality were observed amongst the genotypes and blends after each modification. Waxy (0% amylose) and wild-type (30% amylose) were very often at the extremes of the observed ranges of functional properties. In general, the functional properties of the chemically modified starches were dependent upon amylose content. Starches from *Wx-B1* null lines (24% amylose), were an exception. After substitution, such starches had the significantly highest value for RVA final viscosity, and generally performed in a manner similar to starch blends of 12–18% amylose.

Genetic improvement in U.S. hard winter wheats.

R. Graybosch and C.J. Peterson.

Data from USDA-coördinated winter wheat regional performance nurseries collected over the time period 1959–2008 were used to estimate genetic gain (loss) in grain yield, grain volume weight, days to heading, and plant height in winter wheats adapted to the Great Plains. In both the Southern Regional (SRPN) and Northern Regional Performance Nurseries (NRPN), linear regression revealed significant positive relationships between relative grain yields of advanced breeding lines and calendar year of the nursery trial. The estimated genetic gain in grain yield potential since 1959 was approximately 1.1% (of the control cultivar Kharkof)/yr for all entries in the SRPN, and 1.3%/yr if only the most productive entry was considered. For the NRPN, the estimates of genetic gain in grain yield were 0.79%/yr for all entries and 0.79%/yr for the most productive entry. Relative grain volume weights and days to heading have remained fundamentally unchanged since 1959, but relative plant heights have declined at rates of approximately 0.43%/yr in the SRPN and 0.32%/y in the NRPN. Linear regressions of relative grain yields versus year over the time period 1984–2008, however, showed no significant trend in the SRPN, and a very weak positive slope in the NRPN. Relative grain yields of Great Plains hard winter wheats may have peaked in the early to mid-1990s, and further improvement in the genetic potential for grain yield awaits some new technological or biological advance.

Fun with transgenic glutenins.

R. Graybosch, A. Blechl, B. Seabourne, and Y.R. Chen.

Quality and agronomic effects of three transgenic high-molecular-weight glutenin subunit (HMW-GS) events were characterized in advanced-generation breeding lines of hard winter wheat in three Nebraska crop years. Two of the transgenic events studied, Dy10-E and B52a-6, over-express HMW-GS 1Dy10, and the third event, Dx5+Dy10-H, over-expresses HMW-GS 1Dx5 and, to a much lesser extent, 1Dy10. In addition, novel proteins, possessing solubility characteristics defining them as HMW-GS, were present in Dx5+Dy10-H and B52a-6. Average grain yield of lines derived from the three transgenic events was statistically lower than that of a group of control cultivars and advanced breeding lines, but not lower than the mean of their respective non-transgenic sibs. Grain hardness was influenced by one of the events. Dx5+Dy10-H produced harder kernels than controls, its non-transgenic sister lines, and the two additional transgenic events. All three events produced doughs with unusual mixing properties, likely not directly useful in commercial applications. As a consequence, loaf volumes were depressed, but to variable degrees by the three events. The results indicated that over-expression of HMW-GS could eventually lead to improved bread-making quality by optimizing the level of over-expression or by development and characterization of additional events.

Breeding hopeful monsters (waxy wheats).

R. Graybosch, P.S. Baenziger, and F. Dowell.

Seed of the waxy wheat line NX04Y2107 was increased by UNL Foundation Seed and entered in the 2011 NE State Variety Trials. A second waxy line, NX05MD4180-6, was tested in both the 2010 NRPN and Uniform Eastern Soft Wheat Trial and advanced to state yield trials in NE and NY. Twenty-five waxy wheat lines of diverse parentage were selected for inclusion in advanced yield trials to be seeded in NE and OH. An additional 50 lines from 2010 field trials were advanced to a preliminary yield trial. Automated NIR-based seed sorting technology at the USDA–ARS Center for Grain and Animal Health Research has proven an invaluable aid in the breeding of waxy wheat. The technology allows automated segregation and recovery of waxy seed from segregating F_3 bulk populations.

Public private (University of Nebraska) collaborations.

In 2009, the University of Nebraska decided to sustain the wheat breeding project via enhanced collaborations with commercial companies spanning the value chain. The University of Nebraska–Lincoln (UNL) has had a long standing arrangement with BASF, providing access to the Clearfield technology. In 2009, UNL began a collaboration with ConAgra. In 2010, UNL developed a collaboration with Bayer Crop Science that allows nonexclusive access to UNL germ plasm and is in accordance with the principles for collaboration approved by the National Association of Wheat Growers and with the U.S. Wheat Associates Joint Biotechnology Committee. USDA–ARS projects at the University of Nebraska are not party to these agreements.

Personnel.

Anyamanee Auvachanon (currently a lecturer in Thailand), Neway Mengistu (currently a corn breeder with Pioneer Hibred), and Nicholas Crowley (currently a corn breeder with Pioneer Hibred) successfully completed their Ph.D. Juthamas Fakthongphan and Santosh Rajput began their Ph.D. program. Russell Ward and Sumardi bin Haji Abdul Hamid began their M.S. program. Dr. Devin Rose was hired with a joint appointment in the Food Science and Agronomy and Horticulture Departments as a cereal chemist who will oversee our wheat quality laboratory.

Publications.

Ali ML, Baenziger PS, Al Ajlouni Z, Campbell BT, Gill KS, Eskridge KM, Mujeeb-Kazi A, and Dweikat I. 2011. Mapping QTLs for yield and agronomic traits on wheat chromosome 3A and a comparison of recombinant inbred chromosome line populations. Crop Sci (accepted).

Baenziger PS, Dweikat I, Gill K, Eskridge K, Berke T, Shah M, Campbell BT, Ali ML, Mengistu N, Mahmood A, Auvuchanon A, Yen Y, Rustgi S, Moreno-Sevilla B, Mujeeb-Kazi A, and Morris RM. 2010. Understanding grain yield: It is a journey, not a destination. *In:* Proc 8th Internat Wheat Conf, St. Petersburg, Russia, 1-4 June, 2010.

Baenziger PS, Graybosch RA, Nelson LA, Regassa T, Klein RN, Baltensperger DD, Santra DK, Ibrahim AMH, Berzonsky W, Krall JM, Xu L, Wegulo SN, Bernards ML, Jin Y, Kolmer J, Hatchett JH, Chen MS, and Bai G. 2011. Registration of 'NH03614 CL' wheat. J Plant Regist 5:75-80.

Bockus WW, Baenziger PS, and Berzonsky W. 2010. Reaction of Kansas, Nebraska, and South Dakota winter wheat accessions to Fusarium head blight (FHB), 2009. Plant Dis Manage Rep (online), Report 4:CF013. DOI:10.1094/PDMR04.

Chao S, Dubcovsky J, Dvorak J, Luo MC, Baenziger PS, Matnyazov R, Clark DR, Talbert LE, Anderson JA, Dreisigacker S, Glover K, Chen J, Campbell K, Bruckner PL, Rudd JC, Haley S, Carver BF, Perry S, Sorrells ME, and Akhunov ED. 2011. Population- and genome-specific patterns of linkage disequilibrium and SNP variation in spring and winter wheat (*Triticum aestivum* L.). BMC Genomics (In press).

Delwiche SR, Graybosch RA, St Amand P, and Bai G. 2011. Discrimination of waxy, partial waxy and wild-type starch in hexaploid wheat by near-infrared reflectance. J Agric Food Chem (In press).

Graybosch RA and Peterson CJ. 2010. Genetic improvement in winter wheat yields in the Great Plains of North America, 1959-2008. Crop Sci 50:1882-1890.

Graybosch RA, Seabourn B, Chen YR, and Blechl AE. 2010. Quality and agronomic effects of three high-molecular-weight glutenin subunit transgenic events in winter wheat. Cereal Chem 88(1):95-102.

Graybosch RA, Peterson CJ, Baenziger PS, Baltensperger DD, Nelson LA, Jin Y, Kolmer J, Seabourn B, and Beecher B. 2011. Registration of 'Anton' hard red winter wheat. J Plant Regist (I press).

Hansen LE, Jackson DS, Wehling RL, and Graybosch RA. 2010. Functionality of chemically modified wild-type, partial waxy and waxy starches from tetraploid wheats. J Cereal Sci 51:409-414.

Hansen LE, Jackson DS, Wehling RL, Wilson JD, and Graybosch RA. 2010. Functionality of native tetraploid wheat starches: Effects of waxy loci alleles and amylose concentrations in blends. J Cereal Sci 52:39-45.

Mengistu N, Baenziger PS, Nelson LA, Eskridge KM, Klein RN, Baltensperger DD, and Elmore RW. 2010. Grain yield performance and stability of cultivar blends vs. component cultivars of hard winter wheat in Nebraska. Crop Sci 50: 617-623.

Mi X, Eskridge K, Wang D, Baenziger PS, Campbell BT, Gill KS, and Dweikat I. 2010. Bayesian mixture structural equation modeling in multiple-trait QTL mapping. Genet Res Camb 92:239-250.

Mi X, Eskridge K, Wang D, Baenziger PS, Campbell BT, Gill KS, Dweikat I, and Bovaird J. 2010. Regression-based multi-trait QTL mapping using a structural equation model. *In:* Statistical Applications in Genetics and Molecular Biology 9:1-23.

Tatineni S, Graybosch RA, Hein GL, Wegulo SN, and French R. 2010. Wheat cultivar-specific disease synergism and alteration of virus accumulation during co-infection with Wheat streak mosaic virus and *Triticum* mosaic virus. Phytopathology 100:230-238.

Wegulo SN, Zwingman MV, Breathnach JA, and Baenziger PS. 2011. Economic returns from fungicide application to control foliar fungal diseases in winter wheat. Crop Prot (In press).

NEW YORK

BORLAUG GLOBAL RUST INITIATIVE
Cornell University, Ithaca, NY USA.

Message from Ronnie Coffman, Vice Chair of the Borlaug Global Rust Initiative (BRGI)

Dear friends and colleagues,

Thank you and commendations to the 250 participants from 33 different countries who attended this year's BGRI Technical Workshop in St. Paul, Minnesota, 13-16 June. We were there to network, share successes and challenges related to wheat rust, and learn from each other.