IMPROVING WHEAT VARIETIES FOR NEBRASKA

2015 STATE BREEDING AND QUALITY EVALUATION REPORT

Report to the

NEBRASKA WHEAT DEVELOPMENT, UTILIZATION
AND MARKETING BOARD

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I. INTRODUCTION

Development research on Nebraska's wheat varieties is a cooperative effort between the Agricultural Research Division, IANR of the University of Nebraska-Lincoln, and the Agricultural Research Service/USDA, Northern Plains Area. Winter wheat breeding, which includes variety, line, and germplasm development, is a major component of the state's wheat improvement research. This report deals only with the state portion of the total wheat breeding effort (located in the Department of Agronomy and Horticulture at the University of Nebraska-Lincoln). Very important contributions come from state and federal researchers and from Nebraska research and extension centers, as well as from state and private researchers in South Dakota, Wyoming, Kansas, Oklahoma, Texas, and Colorado. Other important contributions come from researchers in the Department of Plant Pathology (both state and federal); plant pathologists located at the USDA Cereal Disease Laboratory in St. Paul, MN, and USDA entomologists in Manhattan, KS and Stillwater, OK. All of these programs invest time and funds into this program. Grants from the Nebraska Wheat Development, Utilization and Marketing Board, provide key financial support for this research. Without the Wheat Board's support, much of the state breeding efforts would be curtailed and many of the wheat quality analyses to evaluate our breeding material would not be available.

II. THE 2014-2015 NEBRASKA WHEAT CROP

1. Growing Conditions

The 2014-2015 growing season would be considered being very heterogeneous for production. Western Nebraska was planted into generally acceptable moisture and then had a very unusual winter with highly fluctuating temperatures leading to more winterkill than normal. Most Nebraska lines fared well. Rains at harvest delayed the harvest and weathered the grain. Southwestern had generally good growing conditions throughout the year and produced very good quality grain. Eastern Nebraska had a normal growing season with the exception of very heavy rains right after planting for early-planted wheat which hurt emergence. At flowering, there was excessive moisture leading to severe epidemics of stripe (yellow) rust and Fusarium head blight (scab).

2. Diseases

In 2015, the main disease was stripe rust which was found widely across Nebraska and adjacent states due to a cool wet spring. Before and during flowering in eastern, south central, and southwest Nebraska, there was excessive moisture and most fields if not protected by a fungicide had severe infections of Fusarium head blight (the worst infections in my 30 years of breeding in NE). Disease losses due to yield and test weight reductions were high (up to 40%) in some fields. In addition, high levels of mycotoxins affected the commercial price paid for harvested grain. Although there were other foliar diseases, their development was minimal because most of the wheat foliage was destroyed by stripe rust whose onset was early in the growing season. Drs. Stephen Wegulo (plant pathologist), Jeff Bradshaw and Gary Hein (entomologists monitoring insect vectors of disease), and Satyanarayana Tatineni (USDA-ARS virologist) continue to be invaluable in disease identification, survey, and understanding.

3. Insects

Nebraska continues to have small outbreaks of Hessian fly and the diseases vectored by aphids or mites (specifically WSMV - and the other mite-transmitted viruses and barley-yellow dwarf virus). However, the major concern remains the continued spread of wheat stem sawfly into Nebraska. This is an emerging pest and currently the most used resistance mechanism is through plant breeding (solid stem lines), which carries a yield drag. Hence, in collaboration with Montana State University and Colorado State University, we are looking for novel resistance genes and mechanisms. Unfortunately, breeding for this insect pest will require more time and resources in the future. We are past the stage of wondering if it will come and find a home in Nebraska and are now wondering if there are any "natural" barriers to its spread. For example, the wheat stem sawfly seems to have spread further east into Kansas than in Nebraska. The Entomology Program at the UNL Panhandle Research and Extension Center continues to work with the UNL Wheat Breeding Program to evaluate existing and new sources of resistance.

4. Wheat Production

In 2014-2015 season, Nebraskans planted 1,490,000 acres of wheat and harvested 1,210,000 acres with an average yield of 38 bushels/acre for a total production of 45,980,000 bu. This production was much lower than the production in 2014, but higher than the production in 2013. The high level of planted acres that were not harvested is likely due to winterkilling in western Nebraska due to fluctuating temperatures. In 2013-2014 season, Nebraskans planted 1,550,500 acres of wheat and harvested 1,450,000 acres with an average yield of 49 bushels/acre for a total production of 71,050,000 bu. In 2012-2013 season, 1,470,000 acres of wheat were planted in Nebraska and 1,130,000 were harvested with an average yield of 35 bu/a for a total production of 39,550,000 bu. The 2012-2013 crop was one of the smallest crops in the last 50 years and certainly highlighted the effect of drought. In 2012, 1,380,000 acres of wheat were planted in Nebraska and 1,300,000 were harvested with an average yield of 41 bu/a for a total production of 53,300,000 bu. Despite continued genetic improvement, the main determinant in wheat production seems to be acres harvested, government programs, the price of corn, and weather (which also affects disease pressure and sprouting). This is an economic reality in understanding wheat yields and productivity in Nebraska.

5. Cultivar Distribution

Nebraska has begun retaking the variety surveys. In 2015, Settler CL (9.5%) was the most widely grown variety in Nebraska followed by TAM 111 (6.0%), SY Wolf (5.6 %), BrawlCL Plus (5.3%) and Overland (4.2%). An additional, 15 varieties were grown on 1% or more of the acreage. 1.4% were blends and 29% of our acreage where grown in varieties having individually less than 1% of the acreage. This variety distribution is remarkable in that no variety has over 10% of the acreage. The 2016 variety survey is similar with SY Wolf (7.4%) becoming the most widely grown variety followed by Winterhawk (7.0%) and Settler CL (6.8%). In 2014, Settler CL (a one-gene Clearfield wheat) had the most reported acres of production followed by Overland, then Brawl CL+ (a two-gene Clearfield wheat), then Robidoux, Byrd, and Infinity CL (a one-gene Clearfield wheat). As Clearfield wheats require 100% certified seed planted every year, the total acreage of a variety within the state may be more for non-Clearfield wheat varieties that have some growers' planting back their harvested seed. It should be noted that many commercial lines do not report their seed production for proprietary reasons, so without the survey, it is impossible to know how much of those varieties are produced within the state. While no wheat listed below has all of the characteristics of an ideal wheat, the diverse wheat varieties provide the grower an opportunity to choose high yielding, high quality wheat varieties that have resistance or tolerance to the diseases or insects prevalent in his or her region. Variety diversity is useful, as it should reduce genetic vulnerability to disease and insect pests.

6. New Cultivars

In 2015, NE10589 was released. Its full description and data can be found at: http://agronomy.unl.edu/Baenziger/NE10589SignedRelease.pdf . Briefly, NE 10589 is a hard red winter wheat (*Triticum aestivum* L.) cultivar developed cooperatively by the Nebraska Agricultural Experiment Station and the USDA-ARS. It was released primarily for its superior adaptation to rainfed wheat production systems throughout Nebraska and in adjacent wheat producing states. NE10589 will be marketed as Husker Genetics Brand 'Ruth' Hard Red Winter Wheat. It was named in honor of our greenhouse manager who was a huge aid to the breeding program and who died far too young. NE10589 genetically is a semi-dwarf wheat, containing the RhtB1b allele (formerly known as Rht1). NE10589 was selected from the cross 'OK98697'/'Jagalene'//'Camelot' where the pedigree of OK98697 is 'TAM 200'/'HBB313E'//'2158'. The final cross was made in 2004. This line seems to be very broadly adapted and was selected using both phenotypic and genomic selection.

NE10589 was evaluated in Nebraska replicated yield nurseries starting in 2010, in the USDA-ARS coordinated Northern Regional Performance Nursery in 2013 and 2014, in the Southern Regional Performance Nursery in 2014, and in the University of Nebraska Fall Sown Wheat Performance Trials in 2014 to 2015. In the Nebraska Intrastate Nursery (2012 to 2015), NE10589 performed extremely well across Nebraska in head-to-head comparisons for grain yield with the currently popularly available wheat cultivars. These data are supported by the 2013 and 2014 USDA-ARS Northern Regional Performance Nursery where NE10589 ranked 9th and 2nd region-wide of the 37 and 40 entries tested in those years (data available at http://www.ars.usda.gov/Research/docs.htm?docid=11932). For a more northern adapted wheat cultivar, it also performed well in the 2014 Southern Regional Performance Nursery where it ranked 19th of the 40 lines tested in that year. In the last two years it has been tested in the Nebraska State Variety Trials across 25 environments. NE10589 (3436 kg/ha) had higher grain yield than all currently popular winter wheat cultivars that were tested state-wide (e.g. Overland,3275 kg/ha; Freeman,3214 kg/ha; and Wesley, 2947 kg/ha). Based upon these data, NE10589 is adapted to all rainfed wheat production in NE. NE10589 is moderately late in maturity which is very similar to Overland and two days later than Freeman and one day later than Settler CL. The mature plant height of NE10589 is similar to Robidoux, but shorter than Camelot, Goodstreak, Panhandle, and Overland. NE10589 is taller than Wesley, Settler CL, and Freeman. NE10589 has moderate straw strength for a semi-dwarf wheat with little lodging reported in the years it has been tested. The winter hardiness of NE10589 is good and comparable to other winter wheat cultivars grown in Nebraska.

NE10589 is resistant to *Soilborne wheat mosaic virus* in field nurseries in Nebraska It is moderately resistant to stem rust (caused by *Puccinia graminis Pers.: Pers. f. sp. tritici* Eriks & E. Henn.) in field nursery tests at St. Paul, MN and to stripe rust (caused by *P. striiformis* Westendorp f. sp. t*ritici*), in field nurseries in Nebraska. It is moderately susceptible to susceptible for leaf rust (caused by *P. triticina* Eriks,). By molecular markers, it is believed to carry the Lr37/Sr38/Yr17 translocation. NE10589 is moderately susceptible to Fusarium head blight (caused by *Fusarium graminearum*, data from greenhouse and field observations in Nebraska and Kansas) and moderately susceptible to DON accumulation. NE10589 is moderately resistant to moderately susceptible to Hessian fly (*Mayetiola destructor* Say,), but its reaction can be quite variable among greenhouse seedling tests. It is susceptible to *Barley yellow dwarf virus*, and

Wheat streak mosaic virus (data obtained from the USDA-ARS Northern Regional Performance Nursery and field observations in NE).

NE10589 has high grain volume weight which is similar to most high grain volume weight wheats. The overall end-use quality characteristics for NE10589 (scored as 4.0, where 3 is fair, 4 is good and 7 is excellent) was lower than Wesley, but higher than Overland and similar to many commonly grown wheat cultivars. NE10589 should be acceptable to the milling and baking industries.

In positioning NE10589, based on performance data to date, it should be well adapted to most rainfed wheat production systems throughout Nebraska and in adjacent areas of the Great Plains. NE10589 is not recommended for irrigated wheat production due to it's not having similar straw strength and comparable yield potential to the best available irrigated wheat cultivars (data not shown**).** Where adapted, NE10589 should be a replacement for Overland (under rainfed production). NE10589 is genetically complementary to virtually all wheat cultivars grown in Nebraska with the exception of Camelot and Jagalene.

NE10589 is an awned, tan-glumed cultivar. Its field appearance is most similar to Wesley, but can be easily separated from Wesley because Wesley has bronze chaff. After heading, the canopy is moderately closed and erect to inclined. The flag leaf is recurved and twisted at the boot stage. The foliage is green with a waxy bloom on the leaf sheath, with little waxy bloom on the spike at anthesis and on the leaves. The leaves are glaborous. The spike is tapering, narrow, and lax. The glume is short and wide, and the glume shoulder is square to elevated. The beak has an acuminate tip. The spike is predominantly inclined at maturity with some recurved spikes. Kernels are red colored, hard textured, and mainly ovate in shape. The kernel has no collar, a medium brush of short length, rounded cheeks, midsize germ, and a narrow and shallow crease.

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III. FIELD RESEARCH

1. Increase of New Experimental Lines

With the release of new varieties Husker Genetics Brand Ruth, Overland, Camelot, Freeman, Goodstreak, McGill, Panhandle, Robidoux, and Settler CL, many of the most advanced current breeding lines are not expected to be released. Also, as our seed increases were at Lincoln or Mead in 2015, both sites having suffered severe damage due to disease, no new lines are expected be recommended for release in 2016. However, a number of promising lines are tracking through the program for future release.

2. Nebraska Variety Testing

Numerous entries were included in some or all of the locations in the Fall Sown Small Grain Variety Tests in 2015. Thirteen dryland locations in Nebraska were harvested for yield data. Both irrigated sites were lost. One surprise was how well Overland, despite being severely infected in many locations with stripe rust, did across Nebraska. However, many of the growers used fungicides on their fields and hence the State Variety Trials on farmers' fields were protected from stripe rust. NE10478 which was a very promising experimental line was also very susceptible to stripe rust again indicating the value of fungicides or that NE10478 continued to yield well with disease (e.g. the classic definition of being tolerant to the disease).

In 2015, the top ten entries for dryland production (13 environments) were:

Dryland	Yield		Yield
Entry	bu/a	Entry	bu/a
NE10589	42.9	Freeman	39.9
NE10478	41.7	LCH13NEDH-5-59	39.9
Overland Ever	41.2	Overland Ever & Gau	39.8
Overland	40.8	NE09521	39.1
Overland Gau	40.6	NI10718W	39.0

Numerous entries were included in some or all of the locations in the Fall Sown Small Grain Variety Tests in 2014. Twelve dryland locations, plus one irrigated location, in Nebraska were harvested for yield data.

In 2014, the top ten entries for dryland production (11 environments) were:

Dryland	Yield	Dryland(?)	Yield
Entry	bu/a	Entry	bu/a
NE10589	61.7	NE07531	58.7
LCS Mint	60.9	Freeman	57.8
Overland	59.5	Camelot	56.9
NE09521	59.4	T158	56.8
NE09517	59.3	NE10478	55.8

As would be expected, the two lowest yielding lines were Scout 66 (46.3 bu/a) and Turkey (47.8 bu/a), which were 25% and 23% lower yielding (respectively) than the highest yielding line. That Turkey had a higher yield than Scout 66 may be due to the late rains, which favored late cultivars.

In 2013, the top ten entries for dryland production (11 environments) were:

	Yield		**Yield**
Entry	bu/a	Entry	bu/a
LCS Mint	57.03	NE06607	55.07
Overland	55.82	NE08499	54.88
NE09517	55.28	T158	54.81
NE09521	55.24	NI08708	54.80
Freeman	55.17	BL11002	54.40

As would be expected the two lowest yielding lines were Scout 66 (44.38 bu/a) and Turkey (42.10 bu/a) which were 22% and 26% lower yielding (respectively) than the highest yielding line.

3. Irrigated Wheat Trials:

In 2015, both irrigated sites were lost to hail or other inclement weather. Hence no new data are reported.

In 2014, harvesting only occurred at the Hemingford site.

The top ten lines in 2014 were:

Entry	Yield	Entry	Yield
	bu/a		bu/a
WB-Grainfield	126.7	Brawl Cl Plus	119.5
WB-Cedar	125.3	NE10478	119.4
Denali	123.7	Wesley	119.3
WB4458	121.9	NX04Y2107W	118.8
Byrd	120.3	Antero	117.7

As compared to 2013 this trial would be considered very high yielding and it is interesting to see how the rankings change with the overall environmental level. When breeding for higher grain yield potential, irrigated wheat trials are very helpful.

In 2013, only the site at Hemingford was harvested.

The top ten lines in 2013 were:

	Yield		**Yield**
Entry	bu/a	Entry	bu/a
SY Wolf	114	NW07505	110
NE09517	114	Mattern	108
LCH08-80	112	T163	108
Anton	110	NI06736	108
Armour	110	Panhandle (NE05548)	107

The irrigated data this year continues to show the benefits of having a dedicated irrigated wheat development nursery to select lines that have excellent performance (e.g. NI06736). Interestingly, Panhandle, a very tall semi-dwarf wheat, did well in this trial, which may indicate that it has a higher potential than our conventional tall wheat cultivars, when the conditions are right.

The top ten lines in 2012 were:

	Yield		Yield
Entry	bu/a	Entry	bu/a
WB-Aspen	86.87	NI07703	77.80
Brawl CL Plus	85.10	NE06430	77.80
Anton	82.63	SY-Wolf	76.57
WB- Armour	79.17	Byrd	76.47
Mattern	78.13	Settler CL	75.73

As in the past, we have an experimental line irrigated nursery, which grows under irrigation in western Nebraska and under dryland conditions throughout the state. The goal of this nursery is to identify higher yielding lines under irrigation and under higher rainfall conditions, which periodically occur in Nebraska. In 2015, the irrigated site was lost, hence only the dryland sites are reported. At Lincoln, the lines were treated with fungicides, so disease damage (primarily due to stripe rust and Fusarium head blight) was greatly reduced. The data are color coded with dark green having the most desirable values and red having the least desirable values. It should be noted that the tallest wheats will be coded red (undesirable for this nursery), while the highest yielding and test weights, will be in dark green.

The data for 2015 are:

Name	Lincoln	North Platte	Alliance	Average	RANK	Winter Surv.	Antheis Date	Height
	Bu/a	Bu/a	Bu/a	Bu/a		%	D after Jan.1	(in)
Antelope	59.5	33.3	31.8	41.53	21	98.6	140.8	33.2
NI04421	45.8	41.0	38.8	41.87	19	79.2	141.3	35.8
NI08707	63.6	39.9	45.9	49.80	2	97.4	145.4	31.4
NI10718W	56.0	56.0	35.5	49.17	3	97.3	140.6	34.4
WESLEY	55.1	47.8	38.9	47.27	5	101.3	140.7	33.9
NW07534	53.7	42.7	34.7	43.70	10	99.6	141.9	33.4
NI12713W	48.5	36.1	29.4	38.00	24	98.6	140.1	35.5
NI13703	49.9	25.7	28.3	34.63	32	92.1	140.1	32.6
NI13704	52.9	24.6	26.0	34.50	33	99.8	140.1	31.8
Settler CL	62.8	34.4	33.9	43.70	11	100.1	140.9	34.3
NI13717	48.1	27.6	28.6	34.77	30	98.3	142.8	31.8
NI14719	37.3	20.6	12.2	23.37	39	95.7	141.4	31.7
NI14721	48.3	26.7	32.4	35.80	27	100.2	142.7	34.1
NI14722	50.0	36.3	40.3	42.20	17	100.7	139.1	30.2
WB CEDAR	59.2	37.9	30.0	42.37	16	100.6	138.6	28.0
NI14727	53.4	41.0	35.1	43.17	15	100.2	141.6	37.5
NI14729	65.2	63.4	44.9	57.83	1	100.4	141.9	36.6
NI14732	42.7	31.3	26.7	33.57	34	92.4	140.9	31.5
NI14733	32.2	32.4	31.3	31.97	35	91.4	144.5	36.5
NI14735	52.9	43.2	46.3	47.47	4	98.7	142.0	35.4
SY Wolf	49.3	32.3	24.1	35.23	29	87.4	142.5	30.9
NE07531	63.3	33.2	33.6	43.37	13	95	140.3	35.3
NI15701	46.6	35.1	44.5	42.07	18	85.7	143.9	34.4
NE15434	43.0	55.2	43.1	47.10	8	93.6	144.7	35.1
NI15702	30.6	26.5	10.5	22.53	40	58	142.7	33.4
NI15703	45.4	22.1	21.0	29.50	36	95.8	149.3	35.5
NE15420	52.7	39.4	37.7	43.27	14	85.9	143.7	30.2
NI15704	48.2	31.6	45.2	41.67	20	85.8	143.4	29.7
NI15705	41.1	38.0	38.0	39.03	23	82.9	145.6	29.8
NI15706	36.6	40.2	30.0	35.60	28	77.4	141.4	32.5
NE15484	56.1	33.8	22.5	37.47	25	92.8	144.1	38.7
NI15707	53.8	19.3	31.1	34.73	31	90.7	138.8	30.3
NI15708	38.2	20.2	22.8	27.07	38	79	142.4	29.4
NI15709	52.3	46.0	32.4	43.57	12	89.2	145.1	33.1
NW15677	57.1	48.4	36.2	47.23	6	93	142.6	31.8
NI15710	53.7	47.3	38.8	46.60	9	94	141.3	35.1
NI15711	61.6	38.1	23.4	41.03	22	99.3	139.4	30.6
NI15712	54.2	25.3	30.9	36.80	26	96.2	141.1	30.2
NE15558	32.9	36.4	16.2	28.50	37	90.5	141.2	32.0
NI15713	58.9	42.5	40.3	47.23	6	94.1	142.4	35.3
Alpha level	0.05	0.05	0.05			0.05		
CV	13.2	21.6	13.9			9.8		
GRAND MEAN	50.32	36.32	32.31			92.71	142.08	33.04
Heritability	0.59323	0.56512	0.77265			0.36415		
LSD	10.9	12.8	9.1			14.8		

The data from 2014 are:

entry	Name	Dryland Lincoln Yield bu/a	Dryland Nplatte Yield bu/a	Dryland Alliance Yield bu/a	Dryladn Average Yield bu/a	Rank	Irrigated Hemmingford Yield bu/a	Rank	Test Weight Average lbs/bu	Height Average in
1	Antelope	68.2	39.6	57.1	54.97	31	113.6	13	60.25	32.23
2	NI04421	78.9	41.2	54.8	58.30	17	83.7	39	58.70	34.05
3	NI08707	78.6	49.6	63.4	63.87	2	116.7	12	58.30	32.40
4	NI09707	74.1	46	64.5	61.53	6	103.1	33	59.85	31.80
5	NI10718W	73.6	44.5	60.9	59.67	8	105.8	29	57.85	33.30
6	NI10720W	80.9	49.4	44.1	58.13	18	108.5	25	59.25	34.53
7	WESLEY	71.1	46.9	59.9	59.30	10	110.1	22	59.00	30.95
8	NW07534	69.9	51.1	53.1	58.03	20	120.4	5	59.00	31.33
9	NI12713W	66	44.6	53	54.53	33	122.2	4	60.45	33.75
10	NI13703	70.2	39	57.1	55.43	30	91.7	36	60.15	32.73
11	NI13704	65.7	37.2	63.9	55.60	29	117.9	10	60.40	31.83
12	NI13705	63	42.3	51.8	52.37	40	110.3	21	61.00	32.98
13	NI13711	70.5	42.5	57.3	56.77	25	100.7	34	60.25	33.15
14	NI13713	69.8	40.2	48.7	52.90	37	104.5	31	58.80	31.55
15	Settler CL	72	47.4	56.6	58.67	16	113.5	14	58.85	32.40
16	NE09481	68.7	44.5	44.1	52.43	39	91.3	37	59.25	31.23
17	NI13717	71.6	48.9	65.8	62.10	5	125.6	1	59.50	33.83
18	NI13720	72	39.6	51.6	54.40	34	113	16	59.60	30.33
19	NI14719	64.3	44.5	55.9	54.90	32	119.7	7	59.50	29.88
20	NI14720	62	47.7	67.5	59.07	14	112.4	17	58.35	32.93
21	NI14721	72.3	53.1	69.4	64.93	1	110.6	19	59.60	33.35
22	NI14722	72.1	42.1	54.9	56.37	28	118	9	59.00	30.00
23	NI14723	70.5	44.1	63	59.20	12	108.2	26	61.45	32.48
24	NI14724	69.7	39.7	64.8	58.07	19	117	11	59.95	35.33
25	Anton	69.6	41.9	60.4	57.30	23	108.6	24	58.40	31.55
26	WB CEDAR	64.7	38.4	54.7	52.60	38	110.6	19	59.70	28.85
27	NI14727	76.5	41.6	59.5	59.20	12	118.1	8	59.95	34.90
28	NI14728	70.6	42.2	49.2	54.00	36	113.1	15	59.15	31.73
29	NI14729	72.9	48	66.4	62.43	4	108.7	23	60.55	34.08
30	NI14730	74.1	39.8	56.6	56.83	24	111.7	18	60.10	33.93
31	NI14731	70.2	46.5	55.7	57.47	22	106.8	27	59.00	34.93
32	NI14732	66.6	44.4	52.2	54.40	34	120.2	6	58.10	31.13
33	NI14733	68.7	46.9	72.7	62.77	3	122.8	3	59.50	36.23
34	NI14734	75.3	40.2	53.9	56.47	26	87.6	38	58.55	34.45
35	NI14735	74.5	46.3	57.3	59.37	9	94.4	35	59.25	33.33
36	NI14736	75.7	44.1	49.5	56.43	27	82.9	40	58.40	33.68
37	NI14737	74.9	45.6	53.3	57.93	21	104.8	30	58.75	32.25
38	NI14738	68.6	45	63	58.87	15	106.1	28	60.25	30.98
39	NI14739	61.8	50.8	65.1	59.23	11	103.7	32	58.70	30.03
40	SY Wolf	73.6	47.9	62.8	61.43	7	125.1	2	59.20	32.03
	GRAND MEAN	70.84417	44.38	57.89333			109.1			
	LSD	7.59559	6.81723	10.38016			19.1			
	CV	6.59576	9.3951	11.0302			10.7			
	Heritability	0.36551	0.34889	0.4305			0.3			

Data from 2013:

	Lincoln	Alliance	Dryland Avg.	Rank	Sidney Irr.	Rank	Testweight	Height Avg
Name	bu/a	bu/a	bu/a		bu/a		lbs/bu	in
Antelope	68.5	42.4	55.45	37	93.5	35	61.3	34.10
NI04421	66.5	52.7	59.60	18	111.1	2	62.9	34.13
NI06736W	81.5	48.3	64.90	5	99.5	25	61.7	32.30
NI06737W	72.2	42.1	57.15	32	101	23	62.4	33.70
NI07703	69.2	48.8	59.00	22	101.4	22	61.9	33.87
NI08707	67.8	53.3	60.55	15	109.9	3	60.8	32.67
NI08708	71.3	46.5	58.90	23	104.7	15	61.4	33.10
NI09707	65.3	48.7	57.00	33	109.7	4	61.6	31.73
NI09710H	76.8	49.7	63.25	7	95.3	33	60.1	33.23
NI10707	67.9	47.8	57.85	29	98.3	28	61.2	36.17
NI10712	64.3	49.0	56.65	34	107.7	6	61.4	35.50
NI10718W	67.5	54.6	61.05	13	107.1	7	62.5	34.43
NI10720W	68.5	50.8	59.65	17	112.3	1	62.8	33.43
WESLEY	74.0	48.2	61.10	12	103.8	17	61.2	33.17
Settler CL	69.8	46.9	58.35	28	106.2	13	61.8	32.83
NE09481	73.4	51.7	62.55	10	103.9	16	62.5	32.80
NW07534	65.1	48.2	56.65	34	106.3	12	61.2	31.37
NI12702W	84.9	45.8	65.35	2	85.8	38	61.6	34.33
NI12709	81.0	45.0	63.00	8	99.3	26	62.6	33.97
NI12713W	72.4	43.0	57.70	30	99.3	26	62.2	34.27
NI13701	58.5	44.8	51.65	39	76.7	40	61.3	36.57
NI13702	56.1	40.8	48.45	40	86.4	37	62.3	36.53
NI13703	73.1	52.7	62.90	9	106.9	9	63.4	33.87
NI13704	72.0	44.7	58.35	27	105.1	14	61.6	34.73
NI13705	72.6	47.5	60.05	16	106.6	10	63.7	34.90
NI13706	80.1	50.0	65.05	3	98.3	28	61.8	32.57
NI13707	69.5	48.2	58.85	24	103.3	18	62.6	31.43
NI13708	76.5	53.6	65.05	3	95.4	32	62.6	31.80
NI13709	68.3	41.1	54.70	38	94.3	34	60.8	35.10
NI13710	68.2	44.8	56.50	36	106.6	10	63.8	33.43
NI13711	71.4	49.7	60.55	14	107	8	62.9	34.97
NI13712	68.6	48.9	58.75	25	102.2	21	63.1	33.47
NI13713	71.6	47.6	59.60	19	102.4	20	63.5	33.70
NI13714	75.2	43.5	59.35	20	92	36	62	33.10
NI13715	68.0	46.5	57.25	31	100.6	24	61.5	35.93
NI13716	74.9	47.9	61.40	11	96	30	61.6	34.53
NI13717	81.3	48.3	64.80	6	108.7	5	62.4	35.33
NI13718	69.5	47.4	58.45	26	85.7	39	60.6	33.77
NI13719	71.0	47.5	59.25	21	95.5	31	61.1	34.80
NI13720	83.6	47.5	65.55	1	102.5	19	61.9	31.10
Mean	71.45	47.66	59.555		100.72		61.99	
LSD	7.87	9.11	8.49		11.44		1.1	
CV	6.74	11.75	9.245		6.94		1.09	
Heritability	0.98	0.52	0.75		0.98		0.98	

The three-year averages for the lines tested in all three years (2013-2015) are below. The importance of the sustained effort in irrigation is very obvious in that it provides us with a window into the highest yielding environments, something that rainfed environments rarely do. The mean yield of the lines in the irrigated environments (108 bu/a) is roughly twice the average of the rainfed environments (52 bu/a) for the same years. As can be seen in the table, Robidoux (NI04421) continues to be an excellent rainfed wheat with broad adaptation. Settler CL continues to be one of our most broadly adapted wheats from rainfed to irrigated. Additional wheat experimental lines perform well in either rainfed or irrigated production systems. The question will be, "Can a wheat with excellent irrigated production capabilities have a sufficient market to warrant its release for irrigated production environments alone?"

2013-2015 Name	Linc. bu/a	N. Platte bu/a	Alliance bu/a	Dryalnd AVG. bu/a	RANIK	IRRI. Avg bu/a	Rank
	3	2	3	8		2	
Antelope	65.4	36.5	43.8	50.05	9	103.6	8
NI04421	60.6	41.5	50.6	52.09	6	109.9	6
NI08707	70.1	40.6	51.3	55.68	2	96.8	11
NI10718W	67.4	52.8	51.2	57.65	1	111.9	5
NI12713W	64.8	40.3	44.4	51.05	7	102.6	9
NI13703	63.0	35.2	44.7	49.16	10	114.6	2
NI13704	65.0	31.8	42.6	48.31	11	98.4	10
NI13717	65.0	32.4	46.9	50.09	8	113.3	3
NW07534	63.5	45.8	49.6	53.84	4	116.0	1
Settler CL	67.5	42.8	44.6	52.74	5	113.3	3
WESLEY	67.0	47.6	47.9	55.00	3	108.7	7
Grand Mean	65.4	40.6	47.1	52.3		108.1	

4. Nebraska Intrastate Nursery:

The 2015 Nebraska Intrastate Nursery (NIN) was planted at eight locations in Lincoln, Mead, Clay Center, McCook (added due to generous support from Ardent Mills), North Platte, Grant (added due to a generous gift from Marvin Stumpf), Sidney, and Hemingford, NE. In addition, two replications at Lincoln were sprayed three times with fungicides to control disease, while two replications were not treated which allowed a comparison of diseased vs. largely disease free genotypes. The sites at Grant, McCook, and Alliance were also sprayed with a single application of fungicide mainly to control stripe rust. All sites were harvested. The low yields at Mead, Clay Center, and unsprayed Lincoln (28.9 bu/a) were due to heavy and persistent rains, which led to severe stripe rust and Fusarium head blight infections. The fungicide treated plots at Lincoln (51.5 bu/a) indicated disease reduced yield by 44% (which clearly would have paid for the fungicide treatment).

	Mead	Linc+fung	Linc.	C. Center	N. Platte	McCook	**Grant**	Sidney	Alliance	Avearge	Rank	Disease	Winter	Flowering	Height	Test	Stripe
	Yield	Yield	Yield	Yield	Yield	Yield	**Yield**	Yield	Yield	Yield		effect	Survival	Date		Weight	Rust
	(bu/a)	(bu/a)	(bu/a)	(bu/a)	(bu/a)	(bu/a)	**(bu/a)**	(bu/a)	(bu/a)	(bu/a)			(%)	d after Jan.1	(in)	(lbs/a)	1=R,9=S
name	yb_m15	yb_lim15	yb_l15	yb_cc15	yb_np15	yb_mc15	**yb_grd15**	yb_s15	yb_al15								strp_cc15
WESLEY	17.1	44.5	25.0	17.4	43.4	27.2	**52.4**	37.9	34.1	33.22	43	0.56	92.5	143.9	35.2	54.05	9
OVERLAND	19.7	50.0	27.2	28.1	43.8	37.1	**55.9**	38.7	30.0	36.72	32	0.54	75.0	146.2	37.7	57.85	7
NE06545	29.2	62.3	35.7	18.9	38.9	34.8	**51.6**	37.1	29.1	37.51	30	0.57	52.5	142.5	36.2	54.60	1
NE09517	19.1	44.1	24.2	32.2	45.4	30.2	**48.7**	34.8	34.4	34.79	38	0.55	85.0	144.1	38.2	57.45	2
NE09521	22.2	53.9	39.1	27.5	47.6	33.9	**52.8**	39.4	34.5	38.99	19	0.73	85.0	142.6	38.4	53.95	7
NE10478	26.1	63.7	35.2	28.8	39.7	28.0	**53.3**	40.1	32.6	38.61	21	0.55	67.5	141.1	34.7	56.20	6
NE10507	25.9	44.6	29.5	22.2	38.8	38.2	**44.2**	34.4	20.2	33.11	44	0.66	57.5	143.9	36.0	52.80	5
NE10589	25.9	69.6	37.7	38.9	42.8	31.6	**55.0**	41.5	39.0	42.44	6	0.54	82.5	145.2	37.4	55.15	3
NE10683	16.9	47.9	21.0	11.7	37.0	32.9	**41.1**	23.6	21.1	28.13	58	0.44	65.0	143.8	37.3	51.15	9
LCH13NEDH-3-31	25.8	57.9	31.3	26.1	50.1	35.0	**58.0**	42.6	37.9	40.52	14	0.54	77.5	143.9	34.4	56.10	7
NW07505	10.2	52.3	15.0	14.3	38.2	35.9	**55.8**	42.9	35.2	33.31	42	0.29	87.5	143.4	37.8	55.95	9
NW11511	18.3	59.8	28.2	28.8	45.8	31.5	**43.4**	32.2	24.3	34.70	39	0.47	80.0	140.3	35.1	56.10	1
NI12702W	30.4	61.4	52.1	30.5	52.8	38.1	**45.0**	33.1	28.4	41.31	9	0.85	82.5	145.6	36.6	60.80	1
NI13706	36.5	65.9	41.2	27.4	47.0	31.5	**46.5**	28.8	25.0	38.87	20	0.63	72.5	141.5	34.6	59.85	5
NI04421	22.8	53.9	33.2	30.4	40.4	37.0	**51.7**	34.2	35.9	37.72	29	0.62	82.5	143.0	37.2	58.10	7
Settler CL	19.3	49.9	22.2	17.0	35.2	33.1	**49.7**	27.1	27.5	31.22	52	0.44	85.0	142.2	34.1	58.65	9
NE12429	16.9	59.3	20.6	22.0	32.5	36.7	**51.0**	29.3	26.4	32.74	48	0.35	72.5	144.0	35.3	57.25	9
NE12443	28.7	56.1	40.1	31.1	41.7	41.9	**48.8**	33.3	23.8	38.39	25	0.71	80.0	142.3	38.3	57.80	1
NE12444	25.9	55.8	35.0	18.0	19.3	27.6	**40.5**	22.0	42.3	31.82	50	0.63	42.5	141.5	34.5	52.95	6
NE12488	18.3	49.6	27.3	25.0	31.3	33.4	**49.6**	24.8	19.4	30.97	53	0.55	67.5	142.5	37.0	52.60	8
NE12561	31.3	52.2	35.9	36.0	48.2	29.9	**46.6**	38.0	27.5	38.40	23	0.69	82.5	141.9	35.4	58.55	3
NE12571	21.0	57.9	23.4	23.5	37.7	38.6	**52.4**	35.3	30.9	35.63	35	0.40	85.0	143.6	37.7	56.65	8
NE12589	30.1	62.9	35.8	26.5	46.8	30.6	**53.9**	38.3	31.0	39.54	18	0.57	75.0	143.9	35.8	57.80	9
NE05548	13.6	39.1	14.7	14.5	39.6	34.5	**52.2**	39.6	37.3	31.68	51	0.38	95.0	145.4	41.6	51.45	9
GOODSTREAK	23.6	57.9	33.4	23.2	45.1	35.1	**50.7**	40.0	34.8	38.20	28	0.58	97.5	145.5	42.0	56.65	9
SCOUT66	24.3	25.7	32.4	19.8	35.8	31.4	**46.1**	39.6	19.2	30.48	54	1.26	87.5	143.6	42.0	57.25	5
CHEYENNE	16.8	20.2	25.0	15.1	35.9	42.8	**44.6**	38.9	30.9	30.02	55	1.24	87.5	149.2	45.5	53.05	6
NE13405	21.8	65.6	28.5	18.8	37.2	28.9	**46.7**	25.9	19.3	32.52	49	0.43	65.0	141.6	34.8	56.80	9
NE13425	36.0	44.9	37.2	37.6	47.5	38.9	**45.8**	44.9	32.7	40.61	12	0.83	82.5	142.2	36.6	55.25	1
NE13434	30.4	60.2	33.9	38.0	51.6	33.3	**54.0**	47.3	42.0	43.41	4	0.56	82.5	143.4	36.5	54.85	6
NE13445	27.1	52.7	30.8	31.8	40.3	31.5	**55.0**	35.3	40.9	38.38	26	0.58	82.5	142.0	38.4	55.80	5
NW13455	18.9	51.3	29.8	16.2	35.2	40.5	**52.2**	32.3	29.8	34.02	41	0.58	70.0	143.6	36.0	57.50	9
NE13483V	20.2	52.5	29.0	23.5	36.5	39.3	**50.9**	39.1	33.1	36.01	33	0.55	67.5	144.2	38.7	55.35	6
NW13493	35.3	52.1	42.8	38.3	55.6	50.8	**53.6**	30.9	32.1	43.50	3	0.82	75.0	144.4	35.9	58.30	1
NW13499	9.8	40.4	22.8	18.5	34.9	33.6	**45.5**	27.9	25.1	28.72	57	0.56	72.5	144.9	38.7	55.15	9
NE13511	18.0	50.1	21.5	26.2	39.8	42.4	**54.6**	30.4	39.4	35.82	34	0.43	82.5	146.4	36.0	54.90	9
NE13515	33.6	57.7	40.4	40.6	56.8	42.4	**56.0**	52.4	47.0	47.43	1	0.70	90.0	144.8	39.0	56.90	3
NE13554	26.4	52.6	40.4	31.6	53.4	43.0	**50.7**	28.5	18.3	38.32	27	0.77	75.0	147.7	40.9	56.65	1
NW13570	39.3	50.2	40.9	29.7	45.6	44.0	**56.0**	32.5	29.5	40.86	11	0.81	67.5	145.7	35.7	53.65	1
NW13574	17.8	43.9	26.2	36.2	45.8	39.0	**52.6**	47.5	36.6	38.40	23	0.60	85.0	145.4	40.6	55.45	5
NE13593	18.7	46.0	16.6	16.9	43.7	29.8	**58.7**	41.7	36.5	34.29	40	0.36	97.5	144.7	37.2	55.90	9
NE13597	17.9	53.9	26.5	32.5	50.8	43.2	**49.0**	51.9	35.9	40.18	17	0.49	92.5	143.8	35.5	54.90	6
NE13604	23.1	54.1	31.9	28.3	51.0	43.6	**59.1**	37.9	36.0	40.56	13	0.59	87.5	147.1	39.1	57.85	7
NE13625	27.3	63.0	29.5	26.4	52.3	36.6	**57.7**	43.5	37.9	41.58	8	0.47	95.0	143.3	38.1	61.45	9
NE13629	10.6	45.4	17.2	16.8	41.4	44.9	**47.5**	35.2	36.3	32.81	47	0.38	87.5	147.0	40.1	56.75	9
NE13660	16.8	55.6	24.7	20.5	34.4	35.5	**45.1**	33.8	30.3	32.97	45	0.44	60.0	147.2	35.6	57.90	4
NW13669	25.4	39.1	32.4	37.4	54.3	51.7	**58.3**	42.8	41.8	42.58	5	0.83	70.0	147.2	38.0	54.30	1
NE13672	8.9	62.0	17.1	17.8	41.4	35.5	**55.5**	26.6	30.9	32.86	46	0.28	95.0	146.2	35.9	56.95	9
NE13683	15.3	49.1	27.2	23.6	43.7	37.2	**52.0**	33.5	34.2	35.09	36	0.55	87.5	145.7	34.9	58.90	9
NE13687	12.8	55.6	20.0	25.6	38.0	38.3	**55.7**	44.0	46.5	37.39	31	0.36	77.5	148.0	36.1	55.15	5
LCH13NEDH-11-24	19.8	44.2	28.9	24.8	47.7	50.9	**59.8**	46.5	39.4	40.22	15	0.65	95.0	146.8	41.1	58.90	9
LCI13NEDH-14-53	16.7	51.2	25.4	31.2	45.9	36.0	**59.0**	48.2	48.3	40.21	16	0.50	87.5	146.6	35.0	54.25	5
PSB13NEDH-15-58W	18.3	49.3	20.2	27.7	50.2	34.4	**59.5**	50.0	37.1	38.52	22	0.41	95.0	144.7	36.4	56.70	6
PSB13NEDH-14-83W	27.9	60.9	33.6	41.3	50.7	41.7	**53.8**	37.8	44.4	43.57	2	0.55	90.0	146.8	37.6	58.30	5
NI13717	18.5	44.1	24.6	16.2	28.5	33.6	**44.9**	23.9	26.0	28.92	56	0.56	55.0	141.6	35.0	52.15	8
NI14721	1.6	36.2	5.1	7.8	32.6	29.4	**45.6**	17.5	19.2	21.67	60	0.14	67.5	144.7	34.7	52.55	8
NI14729	28.2	54.2	35.3	31.6	62.4	41.3	**51.4**	32.2	33.0	41.07	10	0.65	82.5	144.9	37.6	55.55	1
NI14733	7.2	33.0	12.6	11.9	29.7	29.7	**50.4**	35.2	26.5	26.24	59	0.38	72.5	144.0	38.1	49.25	8
NE09517-1	16.6	46.7	23.9	34.6	53.2	28.9	**47.8**	37.5	24.8	34.89	37	0.51	85.0	144.1	39.1	55.60	1
NE10478-1	29.1	55.9	37.7	32.2	49.4	32.8	**55.7**	45.2	36.8	41.64	7	0.67	92.5	140.9	34.3	56.55	8
CV	14.42	13.62	13.54	11.67	13.36	6.97	**5.09**	16.18	10.81				14.24	0.65	5.74	4.09	19.24
GRAND MEAN	**21.86**	**51.54**	**28.93**	**25.79**	**43.02**	**36.35**	**51.34**	**36.45**	**32.34**				7.95	144.31	37.22	55.96	**5.88**
Heritability	0.85	0.56	0.81	0.87	0.59	0.83	**0.75**	0.57	0.79				0.31	0.80	0.55	0.37	0.87
LSD	6.10	14.23	7.95	5.83	11.50	5.13	**5.23**	11.36	8.36				0.83	1.86	4.21	1.19	1.84
R-Square	0.94	0.90	0.95	0.94	0.79	0.96	**0.88**	0.74	0.90				0.41	0.91	0.82	0.47	0.94

Of the released lines, NE10589 did extremely well in part because it has good stripe rust resistance. Freeman also had good stripe rust resistance. Many other released lines had average years. While Cheyenne and Scout 66 did poorly as expected, they were not the lowest yielding lines, probably due to their having good winter hardiness.

In 2015 Nebraska Intrastate Nursery (NIN) advance wheat, fifty-one wheat cultivars were analyzed for kernel characteristics, milling attributes, ash and protein contents, dough rheological and breadmaking properties.

There were significant differences in kernel characteristics among these cultivars. The kernel hardness indexes were 49.9±9.7. 37% cultivars include Cheyenne and Settler CL were classified as HARD, 51% cultivars include Goodstreak, Wesley, and Overland were MIXED, and the rest of cultivars were SOFT. The wheat kernel hardness indexes were lower than normal ranges, most likely due to the rain at harvest which delayed the harvest. The kernel diameters and weights were 2.8±0.1 mm and 35.7±2.4 mg, respectively. All cultivars, including all checks had large diameter (≥ 2.4 mm) and weight (≥ 30.0 mg). A few samples (8%) had large kernel hardness deviation (> 17), no samples had diameter deviation (> 0.4), and a lot of samples (80%) had large weight deviation (> 8) in 300 kernels.

There were significant differences in milling properties among these cultivars. The flour, bran and short yields were 72.2±7.8%, 25.6±1.5%, and 2.3±0.5%, respectively. Except of NE14419, all other cultivars including checks produced high flour yield (≥ 68.0%). The bran, short and milling rates were 3.3±0.9, 3.2±0.9, and 3.4±0.9, respectively. Most cultivars (88%) including all checks gave fair or better bran cleaning and milling performance. The kernel hardness indexes were significantly positively with short yield and bran cleaning rate, and protein contents.

There were significant differences in ash and protein contents, respectively, among these cultivars. The ash contents of white flour at 14% mb were 0.41±0.04%. All cultivars, including checks had lower ash content (< 0.50%). The protein contents of whole wheat at 12% mb were 14.3±0.8%. All cultivars including checks had higher protein contents of whole wheat (> 12.0%). The protein contents of white flour at 14% mb were 12.8±0.8%. All cultivars including checks had higher protein contents of white flour (> 10.0%). After milling protein contents were lost 1.1±0.7%. The protein contents of white flour were correlated positively significantly with that of whole wheat.

There were significant differences in dough rheology among these cultivars. The flour water absorptions (abs) at 14% mb were 65.8±1.6%. All cultivars including checks had higher water abs (> 62.0%). The mixography peak times (PT), which indicated dough extensibility, were 4.6±1.2 min. Except Overland, Scout 66, Goodstreak, NE12561, NI13706 and NE13425 got lower dough extensibility (PT < 3.0 min), all other cultivars including checks got larger dough extensibility (PT 3.0-7.0 min). The mixograph peak torques (PQ), which were dough maximum strengths, were 48.0±3.2 %TQ. Except 8 cultivars (NE06545, NI04421, NE13604, NE13672, LCH13NEDH, NE14434, NE146.63, and NE14700) got lower dough strength (PQ < 45.0%TQ), all other cultivars including checks got stronger dough strengths (45.0-55.0 %TQ).The mixograph total areas (TA) in 8 min and mixing tolerance scores (TS)., which were dough resistances for mixing, were 110±14 %TQ·min and were 3.6±1.0, respectively. The TA was correlated significantly positively with TS. Eight cultivars had low dough resistance for mixing (TA < 100 %TQ·min or TS < 3.0).

There were significant differences in breadmaking performances among these cultivars. The baking water abs at 14% mb were 64.2±1.1%. All cultivars including checks got higher water abs (≥ 62.0%).The mixing times (MT) were 5.1±1.2 min. All cultivars including checks gave normal MT (3.0 - 7.5 min).The loaf volumes and specific volumes were 1012±42 cc and 7.3±0.3 cc/g, respectively. All cultivars including checks got volumes > 850 cc or specific volumes > 6.5 cc/g. After stored overnight, the breadcrumb firmness was 2787±485 Pa. The crumb brightness and non-uniformity were 147±5 and

6.3±3.7, respectively. The cell number, diameter, and elongation were 7036±256, 2.0±0.1 and 1.5±0.0, respectively. Most cultivars got good crumb texture and structure. The overall bread scores were 4.6±0.4. All cultivars including checks got fair or better bread quality.

The flour protein was correlated significantly positively with flour and baking water abs, dough strength, loaf volume, crumb softness and cell diameter, and negatively with dough extensibility, mixing time, and crumb elasticity. The flour ash was correlated significantly positively with baking water abs, crumb softness, and cell diameter, and negatively with dough tolerance for mixing, crumb elasticity, and bread rates. The dough extensibility was correlated significantly negatively with dough strength, baking water abs, loaf volume and area, cell diameter and non-uniformity, and positively with dough resistance for mixing, mixing time, and bread rate. The dough strength was correlated significantly positively with dough resistance for mixing, baking water abs, loaf volume and area, and cell diameter, and negatively with mixing time and crumb firmness. The dough resistance for mixing was correlated significantly positively with dough handling rate and cell uniformity.

The data for 2014 are:

2014	Mead	Linc.	ClayCen	McCook	Nplatte	Sidney	Alliance	**Average**		Average	Average	Average	Average	Average
	Yield	Yield	Yield	Yield	Yield	Yield	Yield	**Yield**	**Rank**	Testwt	Height	Hdate	WintSurv	BacStreak
name	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	**bu/a**						
WESLEY	25.7	70.0	51.5	87.6	58.3	56.2	66.9	**59.5**	**41**	60.2	30.8	148.4	100	5.7
OVERLAND	34.1	71.9	60.7	82.8	56.9	70.8	68.3	**63.6**	**16**	61.2	33.8	148.4	100	3.4
NE01481	26.7	68.3	49.0	87.2	56.4	73.8	50.5	**58.8**	**49**	61.1	33.5	148.0	100	5.9
NI04420	33.0	71.2	53.1	83.0	53.8	74.3	70.2	**62.7**	**20**	61.9	31.7	148.3	95	5.5
NE06430	31.4	72.1	47.5	82.5	54.6	64.0	59.6	**58.8**	**50**	61.0	32.2	147.7	98	6.2
NE06545	30.9	72.6	56.4	70.6	51.6	74.5	72.2	**61.3**	**30**	59.8	30.8	147.9	94	3.9
NE07486	33.2	73.9	50.8	81.4	49.5	70.4	62.8	**60.3**	**34**	61.1	31.4	147.5	100	4.4
NE07531	27.9	74.7	52.9	81.5	52.2	72.5	68.9	**61.5**	**27**	60.3	32.4	148.0	100	6.0
NE08499	34.7	72.7	56.9	80.4	45.4	66.9	61.2	**59.7**	**39**	60.5	32.4	147.7	95	3.8
NE09517	33.5	72.7	59.2	86.3	54.9	79.5	67.3	**64.8**	**8**	61.6	32.9	148.2	100	5.6
NE09521	31.9	69.4	55.0	80.5	55.1	71.3	57.9	**60.2**	**37**	60.8	34.0	148.1	89	5.6
NE10478	30.8	79.1	52.6	87.5	54.2	62.6	56.4	**60.5**	**32**	61.0	29.5	148.0	97	6.2
NE10507	34.1	76.2	53.4	87.8	56.9	77.2	52.7	**62.6**	**21**	59.7	32.8	148.0	98	4.9
NE10589	26.2	77.9	63.5	85.6	54.5	77.7	71.8	**65.3**	**4**	60.9	32.1	148.3	94	5.4
NE10683	35.6	73.2	59.5	91.9	60.5	73.0	61.9	**65.1**	**7**	58.3	33.4	148.7	100	5.5
NH11489	31.2	78.7	56.2	90.5	61.4	76.9	62.1	**65.3**	**5**	61.9	31.5	147.7	98	5.5
NH11490	31.3	79.1	62.9	91.9	57.0	70.3	65.1	**65.4**	**3**	61.8	29.9	147.3	100	5.8
NHH11569	43.9	77.9	68.4	86.2	56.5	77.0	64.7	**67.8**	**1**	60.7	33.3	147.7	97	3.2
NI09710H	21.9	70.1	45.6	89.9	62.1	61.7	64.3	**59.4**	**42**	58.7	31.0	150.1	100	6.5
NW03666	32.5	67.9	54.3	86.3	53.1	69.8	53.7	**59.7**	**40**	61.0	33.3	148.9	84	3.9
NW07505	36.9	73.8	58.0	94.1	53.7	72.8	61.2	**64.4**	**12**	60.5	32.9	148.1	92	4.9
NW09627	33.3	68.3	48.7	76.2	47.3	72.1	68.6	**59.2**	**46**	60.5	31.3	147.2	97	5.4
NW11511	29.3	69.6	51.3	85.6	58.0	68.2	71.7	**62.0**	**26**	59.5	30.8	149.2	88	5.7
NI12702W	30.2	73.0	58.6	84.0	57.0	68.3	67.1	**62.6**	**23**	62.6	32.1	148.4	91	3.8
NI12709	31.2	77.0	57.6	89.5	56.3	70.3	60.1	**63.1**	**17**	61.7	31.6	147.8	100	5.0
NI13703	30.3	67.6	48.3	92.3	54.9	64.1	55.7	**59.0**	**48**	62.2	31.2	146.1	95	5.7
NI13706	36.9	75.1	56.3	97.3	55.0	81.3	64.9	**66.7**	**2**	61.5	30.5	147.6	100	6.2
NI13708	32.8	67.6	50.6	88.4	57.1	69.6	54.3	**60.1**	**38**	61.5	29.1	147.8	100	6.8
Camelot	35.3	75.7	58.7	83.6	51.6	76.5	68.1	**64.2**	**13**	61.1	34.5	149.9	97	4.4
NI04421	28.3	69.4	56.2	95.4	59.6	78.5	58.3	**63.7**	**15**	60.8	32.2	148.8	98	5.8
Settler CL	25.9	69.3	46.6	90.0	57.9	70.5	54.8	**59.3**	**45**	61.4	30.9	148.8	100	5.8
NI13717	24.8	70.6	47.9	84.2	56.8	66.9	71.1	**60.3**	**33**	61.0	31.7	148.4	95	5.9
NI13720	34.2	70.8	55.5	87.9	56.9	65.0	64.2	**62.1**	**25**	60.9	28.3	148.2	100	5.5
NE12408	32.4	69.0	55.6	62.3	53.2	71.5	51.8	**56.5**	**56**	60.0	30.7	147.9	97	5.6
NE12409	26.7	58.4	39.1	76.3	47.1	61.9	58.8	**52.6**	**58**	60.8	29.9	148.8	83	5.4
NE12429	32.0	73.0	58.2	89.2	59.3	75.8	63.5	**64.4**	**11**	61.6	31.1	148.9	100	4.8
NE12430	29.3	74.0	49.4	76.6	53.6	69.1	59.7	**58.8**	**51**	61.2	30.8	148.2	89	6.4
NE12438	37.9	72.4	57.1	87.1	58.2	76.0	62.8	**64.5**	**10**	61.0	33.1	147.7	98	3.8
NE12439	40.6	72.0	57.2	83.6	58.2	75.7	69.7	**65.3**	**5**	60.7	31.7	147.0	90	3.5
NE12443	29.9	71.6	56.0	67.1	54.4	71.7	70.6	**60.2**	**35**	60.6	33.6	147.9	100	3.6
NE12444	24.7	60.1	51.0	82.0	48.0	76.7	71.8	**59.2**	**47**	62.3	31.8	148.1	97	5.3
NE12461	25.4	70.2	49.9	89.0	54.5	69.4	56.8	**59.3**	**44**	60.7	30.7	148.5	95	4.7
NE12464	21.9	68.3	47.0	81.0	59.5	74.8	68.6	**60.2**	**36**	60.4	31.6	148.0	95	5.7
NE12483V	33.2	71.4	45.3	83.3	45.5	68.9	61.5	**58.4**	**52**	61.1	30.6	147.7	95	5.6
NE12488	30.2	69.2	52.2	85.2	57.4	72.9	71.2	**62.6**	**21**	61.7	32.2	147.8	100	5.2
NE12510	22.9	73.9	59.2	81.8	30.5	55.2	51.9	**53.6**	**57**	54.4	30.0	149.0	95	4.5
NE12518	19.7	73.6	56.3	72.7	48.3	69.2	62.5	**57.5**	**54**	60.2	34.6	148.3	98	5.5
NE12524	31.3	71.2	42.5	81.2	41.5	68.6	66.1	**57.5**	**53**	60.7	31.4	149.0	100	6.7
NE12561	31.8	79.2	54.1	87.3	57.6	74.3	63.5	**64.0**	**14**	62.1	31.0	150.2	98	6.2
NE12571	26.8	75.2	57.4	95.4	48.6	72.2	63.7	**62.8**	**19**	61.3	33.5	148.5	93	5.4
NE12580	27.4	67.6	46.6	90.0	47.1	67.3	52.1	**56.9**	**55**	61.7	30.9	150.9	95	6.2
NE12589	35.3	76.7	59.0	86.6	52.5	70.4	71.5	**64.6**	**9**	61.7	31.9	149.1	94	3.5
NE12630	38.5	69.5	55.4	76.8	48.2	70.9	68.3	**61.1**	**31**	60.4	32.7	147.9	98	4.5
NE12637	27.4	67.6	60.4	84.8	54.5	72.9	70.2	**62.5**	**24**	61.3	31.7	150.4	97	2.7
NE12662	37.4	72.4	56.5	78.7	44.2	64.9	61.2	**59.3**	**43**	61.7	32.9	147.7	97	4.8
NE12686	23.9	70.2	56.9	99.6	53.4	68.7	67.3	**62.9**	**18**	60.9	30.2	148.1	95	5.9
NE05548	30.3	68.9	54.6	82.4	52.7	75.3	65.3	**61.4**	**28**	61.1	36.1	148.5	100	5.9
GOODSTREAK	39.1	74.8	50.5	84.9	46.6	73.3	60.0	**61.3**	**29**	60.4	37.3	148.1	100	3.7
SCOUT66	32.0	57.3	36.5	67.3	40.4	60.1	37.1	**47.2**	**60**	60.6	38.0	148.2	100	5.9
CHEYENNE	25.8	52.2	42.1	70.0	44.9	54.6	47.5	**48.2**	**59**	59.9	37.6	131.8	100	4.3
Mean	30.9	71.3	53.5	84.2	53.1	70.5	62.6	**60.9**		**60.8**	**32.1**	**148.0**	**96.5**	**5.1**
LSD	7.8	7.4	6.8	10.5	10.0	7.4	9.6	**8.5**						
CV	15.5	7.5	7.9	6.1	11.6	6.5	9.5	**9.2**						

The data for 2013 are:

	Mead	Lincoln	C Center	McCook	Alliance	Average	Rank	Hutcheson	NE+KS Avg	Rank	Avg. L and CC	Average
								KS			Test Wt	Height
name	Bu/a	Bu/a	Bu/a	Bu/a	Bu/a	Bu/a		Bu/a			lbs/bu	(in)
WESLEY	70.0	66.6	73.3	43.1	56.5	61.9	46	61.7	61.9	47	56.95	39.2
OVERLAND	71.0	73.7	73.8	39.6	59.8	63.6	31	73.9	65.1	18	58.9	42.4
NE01481	70.6	71.1	67.4	38.9	49.8	59.6	53	66.0	60.5	51	57.75	42.7
NE06430	72.8	76.8	73.1	44.5	56.0	64.6	20	67.4	65.0	20	58.7	42.1
NE06545	80.6	82.4	72.4	40.6	61.2	67.4	5	64.3	67.0	6	56.4	40.9
NE06607	76.5	74.8	76.7	46.6	58.6	66.6	7	64.0	66.3	10	58.45	41.1
NE07486	75.9	72.8	79.6	46.7	52.8	65.6	14	71.9	66.5	7	59.4	41.5
NE07531	77.8	77.5	83.3	43.4	60.4	68.5	3	68.9	68.5	2	58.7	41.6
NE08499	76.5	77.4	74.5	44.5	57.6	66.1	10	57.8	64.9	22	59.45	42.5
NE08659	59.5	60.3	71.7	32.2	54.5	55.6	57	66.5	57.2	57	57.6	42.4
NE09517	73.4	73.1	82.4	39.6	60.7	65.8	11	64.3	65.6	14	60	43.3
NE09521	75.4	70.8	77.5	36.1	62.5	64.5	22	65.6	64.6	23	58.05	42.0
NE10418	70.7	72.1	71.4	40.2	55.2	61.9	44	67.2	62.7	42	59.45	43.8
NE10442	79.8	77.4	66.8	39.1	58.6	64.3	23	61.7	64.0	29	60.25	42.2
NE10478	74.3	77.9	81.3	45.7	56.5	67.1	6	69.8	67.5	4	60.9	40.3
NE10507	79.2	82.2	73.7	41.8	55.5	66.5	8	65.7	66.4	9	56.95	41.5
NE10589	79.8	80.4	71.4	46.6	68.5	69.3	1	65.2	68.7	1	59.1	41.6
NE10625	73.4	71.7	71.3	40.3	61.8	63.7	30	57.8	62.9	39	58.75	41.6
NI04421	69.2	71.1	67.5	53.0	55.6	63.3	35	67.1	63.8	30	58.1	41.4
NE05496	66.1	67.5	78	54.0	54.8	64.1	24	66.6	64.4	24	57.85	42.1
NE10683	78.9	84.0	77.2	40.5	58.0	67.7	4	70.0	68.0	3	57.1	41.6
NE11415	71.2	76.9	74.7	41.8	55.0	63.9	27	65.6	64.2	26	59.5	40.5
NE11455	69.5	77.2	73.1	37.6	55.8	62.6	39	65.2	63.0	37	60.35	42.2
NE11472	74.2	76.6	73.3	44.4	55.9	64.9	18	67.1	65.2	15	59.65	41.8
NE11482	74.7	76.5	74.3	44.6	57.3	65.5	17	62.9	65.1	17	58.85	43.1
NE11499	73.4	72.7	71.3	49.0	49.8	63.2	36	65.3	63.5	31	60.2	39.9
NE11536	73.8	60.6	74.6	43.6	58.2	62.2	43	66.0	62.7	41	58.35	40.8
NE11560	75.6	80.8	74.3	31.1	57.5	63.9	28	60.8	63.4	34	58.05	40.5
NE11607	73.2	72.1	61.4	45.7	57.1	61.9	45	64.8	62.3	43	54.5	42.7
Camelot	71.3	65.9	76.9	46.5	61.8	64.5	21	68.4	65.0	19	58.45	42.7
NH10665	76.6	70.0	71.6	43.4	56.0	63.5	33	61.1	63.2	36	59.3	43.6
NH11489	72.2	77.6	73.9	44.2	59.6	65.5	16	71.6	66.4	8	59.15	41.3
NH11490	74.7	81.7	74.1	49.6	62.6	68.5	2	61.1	67.5	5	60.95	40.8
NH11563	77.0	73.7	73.6	35.9	58.6	63.8	29	66.3	64.1	27	59.05	43.8
NH11565	76.2	74.8	76.8	31.3	53.0	62.4	41	66.5	63.0	38	59.25	39.7
NH11668	64.7	69.0	72.9	37.6	56.7	60.2	52	58.9	60.0	52	59.2	42.0
NHH09655	67.6	65.3	71.7	32.9	50.0	57.5	56	57.3	57.5	56	55.7	39.9
NHH11569	68.6	68.7	74.6	46.6	53.9	62.5	40	59.8	62.1	44	59.5	43.3
NHH11638	78.0	78.9	70.9	48.4	51.4	65.5	15	68.2	65.9	11	60.15	42.9
Settler CL	67.9	68.0	72.7	52.4	56.0	63.4	34	69.2	64.2	25	58.7	41.0
NI04420	77.7	76.7	75.2	40.4	58.5	65.7	12	60.3	64.9	21	59.7	42.0
NI07703	73.7	65.8	71.6	42.4	59.9	62.7	37	63.8	62.8	40	57.9	41.5
NI08708	70.3	69.0	74.5	41.4	62.6	63.6	32	60.9	63.2	35	57	41.0
NI09710H	71.9	69.1	76.8	42.9	67.8	65.7	12	66.9	65.9	12	55.25	40.2
NI10712	66.2	63.3	68	36.2	59.8	58.7	54	61.2	59.1	55	55	41.5
NI10718W	72.0	67.6	70	38.0	54.6	60.4	50	62.1	60.7	50	57.15	41.4
NI12702W	73.7	73.0	72.2	44.7	60.3	64.8	19	59.7	64.1	28	59.85	42.4
NW03666	75.0	67.2	80.8	50.8	57.8	66.3	9	61.6	65.6	13	58.8	42.3
NW07505	71.0	70.1	75.1	42.0	61.9	64.0	26	60.4	63.5	32	57.6	42.6
NW09627	57.1	62.4	77.8	45.5	64.5	61.5	47	60.3	61.3	48	57	40.3
NW10487	53.0	54.9	67.7	41.7	59.1	55.3	58	61.0	56.1	58	55.55	42.0
NW11510	72.7	76.9	62.6	40.0	53.4	61.1	48	67.1	62.0	46	59.05	41.6
NW11511	78.5	73.6	64.3	46.6	57.2	64.0	25	71.6	65.1	16	57.55	40.5
NW11590	70.0	68.9	67.5	40.4	54.9	60.3	51	54.2	59.5	53	58.65	42.0
NW11598	69.1	74.4	72.6	40.4	56.9	62.7	37	68.1	63.5	33	58.7	41.0
NE05548	68.0	66.6	72.1	38.4	59.9	61.0	49	59.8	60.8	49	57.95	44.8
NE11688	76.2	78.3	64.6	38.4	54.4	62.4	42	60.3	62.1	45	55.95	42.1
GOODSTREAK	64.2	59.6	66.5	40.4	62.2	58.6	55	64.7	59.5	54	58.7	43.8
SCOUT66	51.2	47.7	60	37.9	51.0	49.6	59	52.0	49.9	59	58	44.4
CHEYENNE	41.1	39.1	56	40.0	44.3	44.1	60	53.4	45.4	60	57.85	47.1
GRAND MEAN	**71.4**	**71.22**	**72.45**	**42.21**	**57.37**	**62.932**		**63.99**				
LSD	8.54	6.42	8.79	11.27	8.38			7.2				
CV	**7.37**	**6.45**	**7.5**	**13.17**	**7.55**			**6.93**				
Heritability	**0.99**	**0.99**	**0.72**	**0.98**	**0.98**			**0.98**				

Data from 2013 to 2015 (three year average) from the Nebraska Intrastate Nursery for Grain Yield (bu/a) are presented below:

2013-	Mead	Linc.	Linc.	C. Center	N. Platte	McCook	Grant	Sidney	Alliance	**NE Avg.**	
2015		Fungicide	yb_ln11	yb_cc11	yb_np11	yb_mc11			yb_al11		**Rank**
		Yield	Yield	Yield	Yield	Yield	Yield	Yield	Yield	**Yield**	
Name	(bu/a)	(bu/a)	(bu/a)	(bu/a)	(bu/a)	(bu/a)	(bu/a)	(bu/a)	(bu/a)	**(bu/a)**	
	3	1	3	3	2	3	1	2	3		
CHEYENNE	27.9	20.2	38.8	38.0	40.4	50.9	44.6	46.8	40.9	39.5	**18**
GOODSTREAK	42.3	57.9	55.9	47.0	45.9	53.5	50.7	56.7	52.3	50.8	**12**
NE05548	37.3	39.1	50.1	47.2	46.2	51.8	52.2	57.5	54.2	48.6	**15**
NE06545	46.9	62.3	63.6	49.3	45.3	48.7	51.6	55.8	54.2	52.6	**3**
NE09517	42.0	44.1	56.7	58.7	50.2	52.0	48.7	57.2	54.1	52.3	**6**
NE09521	43.2	53.9	59.8	53.9	51.4	50.2	52.8	55.4	51.6	52.2	**7**
NE10478	43.7	63.7	64.1	53.3	47.0	53.7	53.3	51.4	48.5	52.6	**4**
NE10507	46.4	44.6	62.6	49.6	47.9	55.9	44.2	55.8	42.8	50.9	**11**
NE10589	44.0	69.6	65.3	57.3	48.7	54.6	55.0	59.6	59.8	56.4	**1**
NE10683	43.8	47.9	59.4	49.2	48.8	55.1	41.1	48.3	47.0	49.8	**13**
NI04421	40.1	53.9	57.9	51.4	50.0	61.8	51.7	56.4	49.9	52.5	**5**
NI12702W	44.8	61.4	66.0	54.4	54.9	55.6	45.0	50.7	51.9	54.1	**2**
NW07505	39.4	52.3	53.0	49.9	46.0	57.3	55.8	57.9	52.8	51.1	**9**
NW11511	42.0	59.8	57.1	49.2	51.9	54.6	43.4	50.2	51.1	50.9	**10**
OVERLAND	41.6	50.0	57.6	53.7	50.4	53.2	55.9	54.8	52.7	52.0	**8**
SCOUT66	35.8	25.7	45.8	39.1	38.1	45.5	46.1	49.9	35.8	40.7	**17**
Settler CL	37.7	49.9	53.2	46.5	46.6	58.5	49.7	48.8	46.1	48.4	**16**
WESLEY	37.6	44.5	53.9	46.0	50.9	52.6	52.4	47.1	52.5	48.6	**14**
Average	40.9	50.0	56.7	49.7	47.8	53.6	49.7	53.3	49.9	50.2	

As can be seen from the excellent three-year yields of released lines (NE10589 [Husker Genetics brand Ruth], Robidoux (NI04421), and Freeman), our new and released lines continue to do well, but we have many experimental lines with excellent grain yields in the east, central, or west parts of Nebraska. Of particular note is the NI12702W which is a high yielding white wheat. As expected Cheyenne and Scout 66 were the lowest yielding lines. Both broadly and more narrowly adapted lines have value in wheat production.

5. **Nebraska Triplicate Nursery (NTN):**

The same comments about the NIN data apply to the NTN. Due to fewer replications, all replications of the NTN was treated with fungicides at Lincoln. The rest of the plots in eastern NE were diseased.

The data for 2015 are:

TRP15	Mead	Lincoln	Clay Cen.	N. Platte	McCook	Grant	Sidney	Alliance	Average	Rank
	Yield	Yield	Yield	Yield	Yield	Yield	Yield	Yield	Yield	
Name	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	
NE14401	11.9	54.6	25.1	37.2	35.5	42.7	47.4	28.6	35.4	40
NE14412	7.4	50.4	21.6	35.5	39.7	43.2	30.6	34.8	32.9	50
NE14416	10.3	58.5	20.0	31.5	33.7	44.9	35.0	35.3	33.7	48
NE14419	27.0	51.3	35.9	39.4	40.8	37.1	48.2	31.1	38.9	15
NE14421	17.5	43.1	44.9	50.6	35.6	51.3	52.0	46.2	42.7	7
NE14427	13.6	63.8	22.1	42.0	34.7	40.4	44.4	36.3	37.2	30
NE14428	7.4	41.9	16.1	39.3	34.6	37.7	36.4	35.3	31.1	55
NE14431	6.2	58.4	16.0	38.7	37.5	52.3	40.1	33.7	35.4	41
NE14434	23.6	66.4	43.1	47.3	41.9	57.1	49.4	38.0	45.9	4
NE14436	4.8	51.0	25.1	22.6	35.5	34.2	30.2	34.6	29.8	59
NE14442	13.5	50.1	21.2	36.7	25.9	40.2	36.8	27.4	31.5	54
NE14448	17.2	57.6	35.2	52.6	42.7	53.8	42.2	37.9	42.4	8
NE14449	8.1	58.2	15.3	39.4	39.7	48.9	35.9	41.9	35.9	36
NE14457	4.9	55.9	21.8	43.8	47.5	50.8	44.3	36.4	38.2	18
NE14480	9.7	58.0	30.3	45.5	38.1	50.6	52.2	42.1	40.8	10
NE14484	8.2	48.3	20.0	40.4	44.4	48.8	27.1	26.0	32.9	49
NE14492	2.9	47.7	14.9	31.6	34.4	46.3	26.7	37.3	30.2	58
NE14494	27.1	71.7	45.0	63.6	38.9	48.8	46.5	40.0	47.7	2
NE14495	13.9	54.7	26.2	33.4	34.5	50.2	31.7	25.9	33.8	47
NE14496	11.1	55.0	28.1	39.0	34.8	54.7	41.8	35.4	37.5	26
NE14498	13.2	48.2	28.3	43.2	43.2	39.2	44.9	23.1	35.4	38
NE14500	3.9	56.5	10.2	33.7	37.9	47.0	21.8	33.1	30.5	57
NE14502	7.6	50.4	17.9	43.9	37.5	45.1	26.8	26.4	32.0	52
NE14511	9.4	44.7	33.9	40.2	38.1	51.5	40.8	32.8	36.4	34
NE14523	20.8	48.8	28.6	40.8	33.8	41.5	25.1	21.7	32.6	51
NE14531	22.1	63.5	36.3	48.3	38.4	56.6	38.1	30.1	41.7	9
NE14534	16.7	46.0	33.0	47.0	32.0	35.0	47.5	32.2	36.2	35
NE14538	23.7	56.1	28.9	52.1	43.4	41.7	45.0	34.3	40.7	11
NE14545	7.8	45.1	26.2	36.4	45.4	44.4	44.4	33.5	35.4	39
NE14546	24.9	53.3	32.5	46.7	33.7	47.2	44.2	38.8	40.2	13
NHH14550	13.8	62.8	20.1	31.1	27.9	39.9	30.2	21.3	30.9	56
NE14557	10.0	52.4	19.5	41.4	39.2	41.4	41.1	35.1	35.0	44
NE14561	15.5	54.1	21.7	49.8	31.1	51.2	40.6	39.8	38.0	22
NE14563V	9.4	49.5	20.6	47.6	38.8	49.7	46.5	38.9	37.6	25
NE14569	13.7	58.9	22.4	48.7	32.4	45.3	45.6	42.4	38.7	16
NE14575	19.3	45.2	30.7	51.6	43.7	38.9	32.7	32.9	36.9	32
NE14594	14.3	51.6	25.7	46.7	32.7	52.3	40.9	33.9	37.3	27
NE14604	7.2	58.9	16.8	36.9	35.7	50.9	40.0	35.8	35.3	42
NE14605	8.3	48.7	18.4	41.7	36.2	41.8	45.1	32.1	34.0	45
NE14606	23.0	57.9	38.4	59.7	42.6	53.1	59.7	43.0	47.2	3
NE14607	4.3	56.3	19.3	43.0	34.6	49.6	43.1	36.5	35.8	37
NE14617	6.1	48.6	25.3	42.2	34.7	50.8	41.8	32.7	35.3	42
NE14629	11.6	55.4	22.5	31.6	34.3	39.5	16.3	22.1	29.2	60
NE14632	6.4	51.7	23.6	53.0	40.3	41.8	48.5	36.8	37.8	23
NE14651	10.1	60.4	17.3	31.1	31.2	39.3	31.5	31.9	31.6	53
NE14654	20.8	54.8	26.6	47.4	48.1	44.5	38.8	36.5	39.7	14
NE14656	8.8	57.2	20.7	38.6	34.1	46.4	48.2	43.5	37.2	28
NE14658	6.8	66.1	17.1	33.5	39.2	43.0	21.7	44.4	34.0	46
NE14663	16.5	62.1	34.2	41.3	38.2	53.1	39.7	19.8	38.1	20
NE14666	20.4	49.2	38.1	41.8	38.5	42.2	34.8	32.4	37.2	29
NE14672	21.9	49.8	35.5	40.8	44.8	43.4	40.3	29.8	38.3	17
NE14674	19.5	56.3	35.4	49.7	36.6	51.2	51.1	41.7	42.7	6
NE14686	11.5	56.4	22.5	44.4	45.7	54.1	51.3	37.6	40.4	12
NE14688	18.7	66.7	24.1	42.4	47.9	43.3	31.5	16.8	36.4	33
NE14695	8.4	62.9	23.0	46.1	37.3	52.4	35.8	35.6	37.7	24
NE14696	30.5	61.6	44.6	51.8	47.7	60.6	57.2	47.7	50.2	1
NE14700	10.8	50.8	34.5	57.0	46.3	53.6	59.5	38.0	43.8	5
GOODSTREAK	15.7	60.8	22.7	42.1	43.5	49.7	38.9	31.8	38.2	19
Freeman	15.9	55.8	27.5	49.2	37.2	44.2	43.3	31.2	38.0	21
NI04421	14.9	52.4	28.4	36.3	33.5	50.0	46.2	33.8	36.9	31
CV	21.72	11.01	12.88	13.90	10.22	6.23	14.54	11.86		
GRAND MEAN	**13.50**	**54.75**	**26.35**	**42.66**	**38.13**	**46.68**	**40.32**	**34.07**	**37.06**	
Heritability	0.83	0.44	0.85	0.54	0.54	0.78	0.68	0.68		
LSD	5.68	11.67	5.51	14.18	9.47	7.07	11.35	8.08		

The data for the 2014 TRP:

2014	Mead	Linc	Ccenter	Nplatte	McCook	Sidney	Alliance	Average	rank	Average	Average	Average
	Yield	Yield	Yield	Yield	Yield	Yield	Yield	Yield	Yield	Hdate	Hegith	Testwt
name	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	Julian	(in)	lbs/bu
Camelot	37.9	75.4	59.9	38.4	90.2	73.5	62.9	62.6	11	149.12	35.19	61.70
Freeman	28.2	70.2	52.6	48.5	82.0	63.4	67.4	58.9	39	148.15	32.31	61.85
GOODSTREAK	39.3	74.4	53.5	41.0	85.4	74.8	58.3	61.0	21	148.98	40.37	61.90
NE13402	23.8	63.4	40.5	47.8	78.5	56.5	59.4	52.8	58	146.15	28.49	61.20
NE13405	37.7	75.9	64.6	40.1	91.1	75.2	64.1	64.1	4	147.18	32.56	62.60
NE13412	31.8	56.8	42.1	35.0	81.9	61.3	52.4	51.6	59	147.84	34.34	62.03
NE13420	31.3	68.8	52.7	36.5	77.6	65.3	53.6	55.1	53	148.25	33.91	62.55
NE13425	38.3	71.1	61.1	41.9	81.9	67.9	65.5	61.1	19	147.54	32.56	62.38
NE13430	28.2	67.0	54.3	47.1	74.1	66.3	58.6	56.5	50	148.04	35.74	62.08
NE13434	54.1	74.5	64.1	46.9	85.9	74.7	63.1	66.2	1	148.86	33.69	62.03
NE13438	23.9	65.1	59.3	39.1	88.5	72.8	65.8	59.2	35	148.84	30.54	62.83
NE13443	7.2	45.5	40.9	40.1	76.4	60.5	57.9	46.9	60	149.20	29.39	61.85
NE13445	39.0	69.4	61.1	41.9	76.8	78.9	63.6	61.5	16	148.02	35.91	62.08
NW13455	46.5	68.6	62.0	41.7	89.8	74.9	59.3	63.3	8	148.84	34.09	62.30
NW13457	30.4	66.4	55.7	43.6	72.1	77.4	67.6	59.0	38	148.49	34.16	62.85
NW13458	24.4	62.1	53.2	40.9	82.2	71.7	49.6	54.9	55	149.26	34.51	64.30
NE13471	25.5	67.1	50.7	38.3	81.2	56.5	59.0	54.0	57	148.28	33.71	60.95
NW13480	28.6	64.0	53.4	42.9	78.9	68.4	66.6	57.5	47	149.95	31.83	60.30
NE13482	26.5	69.8	57.2	42.2	87.2	64.7	64.2	58.8	40	149.65	34.13	60.60
NE13483V	28.1	62.8	57.5	44.5	88.1	81.1	61.2	60.5	26	149.93	35.00	63.60
NE13484V	24.5	67.0	56.6	39.4	82.0	66.0	50.1	55.1	54	148.97	33.01	61.23
NW13491	20.1	63.7	52.4	50.1	94.5	60.7	55.8	56.8	48	149.86	31.07	62.58
NW13493	31.5	70.9	64.8	47.7	93.9	77.2	57.1	63.3	7	149.63	32.50	62.50
NW13494	32.6	64.2	60.5	44.1	90.9	69.4	60.0	60.2	27	148.98	32.64	62.90
NW13499	31.8	69.0	60.0	38.5	83.9	78.4	51.8	59.1	37	149.51	37.23	62.00
NW13502	34.9	77.2	59.5	40.5	90.1	75.3	60.2	62.5	12	149.40	33.90	62.08
NE13510	39.2	66.3	54.0	37.9	81.0	67.6	50.7	56.7	49	148.84	31.03	61.00
NE13511	26.8	74.2	61.5	51.1	87.9	78.3	59.8	62.8	10	150.02	32.64	62.33
NE13515	31.3	71.3	56.6	33.4	97.0	73.3	67.3	61.5	17	149.00	34.14	62.28
NW13516	27.4	67.7	56.6	43.9	74.7	79.2	71.0	60.1	29	149.65	32.61	60.68
NW13518	30.4	65.6	54.1	45.0	80.0	71.0	61.2	58.2	44	149.80	32.19	60.25
NW13535	29.8	67.9	55.5	42.1	82.8	65.3	49.3	56.1	51	149.47	32.64	62.18
NW13536	32.9	66.3	63.0	41.9	82.6	68.0	58.8	59.1	36	149.33	29.86	62.55
NW13542	42.3	69.6	57.9	42.3	82.4	72.9	52.6	60.0	30	149.77	35.24	62.98
NE13544	39.1	62.4	61.2	49.9	81.6	75.0	47.3	59.5	34	149.67	32.91	62.20
NE13545	23.2	75.3	64.2	43.1	80.6	75.0	55.5	59.6	33	150.16	35.16	62.48
NE13546	35.6	70.3	56.9	38.1	59.6	62.4	59.6	54.6	56	148.97	34.87	60.58
NE13550	30.8	75.4	53.9	44.8	79.3	78.6	56.3	59.9	31	148.13	32.91	62.60
NE13554	23.4	71.5	62.2	51.7	84.8	81.4	66.1	63.0	9	151.63	35.73	62.40
NW13560	36.4	68.1	56.4	42.1	78.0	74.8	70.2	60.9	23	150.40	32.84	60.33
NE13564	24.2	66.7	55.5	39.6	74.6	68.2	60.0	55.5	52	149.16	32.91	62.08
NW13570	37.4	66.5	57.2	48.7	95.6	79.0	53.0	62.5	13	150.00	32.46	61.28
NW13574	33.7	73.6	61.3	41.2	75.8	79.0	67.8	61.8	14	149.65	36.76	62.95
NE13583	31.7	66.7	58.2	39.7	91.4	74.7	61.9	60.6	25	149.63	31.74	61.80
NE13585	32.1	67.7	57.3	39.8	81.5	70.3	61.2	58.6	42	148.80	31.73	60.53
NE13589	33.0	73.2	56.0	42.0	70.6	77.2	66.9	59.8	32	149.70	34.87	62.38
NE13593	31.8	68.7	58.2	43.4	93.2	73.3	60.0	61.2	18	149.40	34.77	62.38
NW13596	33.3	74.2	58.4	41.5	78.8	75.5	58.9	60.1	28	150.07	34.61	60.05
NE13597	25.4	63.7	54.0	52.3	92.9	69.6	69.2	61.0	20	150.02	31.30	61.73
NE13604	25.5	74.2	62.3	49.1	89.5	84.5	72.6	65.4	2	150.85	35.40	62.33
NE13624	32.1	60.4	66.0	43.8	65.3	72.7	64.9	57.9	45	149.36	33.71	62.10
NE13625	51.2	82.2	70.0	40.1	83.0	77.0	53.4	65.3	3	147.70	33.44	62.80
NE13629	22.2	70.2	62.0	30.4	78.5	77.0	64.5	57.8	46	151.08	36.16	61.63
NW13647	18.1	60.8	57.6	49.0	88.0	75.9	61.6	58.7	41	150.22	33.00	63.78
NE13660	24.1	64.5	63.7	47.5	90.3	73.7	62.8	60.9	22	150.63	32.86	62.38
NW13669	28.0	67.8	57.9	54.3	89.8	85.1	64.1	63.9	5	151.03	34.70	61.88
NE13672	34.5	68.9	55.3	47.5	101.5	81.2	56.0	63.6	6	149.34	33.23	60.05
NE13681	25.1	68.5	65.1	29.2	81.0	78.5	62.1	58.5	43	149.38	35.24	62.70
NE13683	27.3	71.6	59.4	50.4	86.5	76.3	59.4	61.6	15	149.69	32.34	63.18
NE13687	17.5	56.8	60.2	52.4	94.0	78.2	65.5	60.7	24	152.71	32.96	61.98
Mean	**30.7**	**68.2**	**57.7**	**43.1**	**83.7**	**72.7**	**60.4**	**59.5**		**149.33**	**33.53**	**62.00**
LSD	9.7	9.5	6.9	11.1	12.0	7.3	9.4	9.4				
CV	16.2	7.2	6.2	15.8	5.9	6.2	9.6	9.6				

The data for the 2013 TRP:

2013 name	Mead Yield bu/a	Lincoln Yield bu/a	C. Center Yield bu/a	McCook Yield bu/a	Alliance Yield bu/a	NE. Avg. Yield bu/a	Rank	KS Yield bu/a	Rank
NE12406	67.7	71.0	73.2	48.0	51.0	62.18	44	55.2	55
NE12408	71.7	75.1	84.9	54.5	54.5	68.14	10	58.2	48
NE12409	72.9	72.1	76.5	48.5	59.7	65.94	29	60.3	36
NE12416	72.7	66.5	72.3	45.2	53.6	62.06	46	61.5	30
NE12417	75.9	75.9	69.2	48.0	62.9	66.38	24	56.1	54
NE12429	78.4	77.0	73.8	47.5	64.0	68.14	11	60.7	34
NE12430	77.1	77.7	82.2	51.5	64.3	70.56	2	60.1	42
NE12435	65.1	70.3	68.6	43.2	56.9	60.82	51	60.2	39
NE12438	74.4	73.1	86.4	48.5	69.4	70.36	4	65.3	10
NE12439	74.3	77.3	79.1	52.5	64.3	69.50	7	66.4	8
NE12443	78.0	79.0	84.6	47.6	56.6	69.16	8	69.2	2
NE12444	73.2	68.3	76.5	50.0	65.9	66.78	21	58.1	49
NE12450	65.0	87.3	76.1	46.5	63.1	67.60	14	61.9	27
NE12456	60.3	71.2	72.7	41.7	56.7	60.52	55	54.3	56
Camelot	73.0	70.6	78.9	48.9	64.7	67.22	18	60.7	34
NE12459	71.7	72.8	72.4	46.6	57.9	64.28	36	62.4	20
NE12461	76.6	82.1	79.1	47.5	54.9	68.04	12	68.5	4
NE12464	75.9	75.6	81.3	44.9	66.4	68.82	9	64.5	12
NE12467	64.3	74.4	70.9	33.8	56.3	59.94	56	54.0	57
NE12480	62.4	60.8	77.9	34.9	61.6	59.52	59	61.1	32
NE12482	68.6	67.2	70.9	34.9	64.2	61.16	50	62.4	20
NE12483V	70.3	63.2	78.2	49.5	69.6	66.16	26	72.9	1
NE12486	70.5	71.3	63.5	37.6	60.5	60.68	53	61.8	28
NE12488	68.9	78.3	75.7	46.4	60.9	66.04	27	60.2	39
NE12503	70.7	78.2	76.4	44.2	66.5	67.20	19	62.4	20
NE12509	69.7	69.4	70.9	49.6	51.0	62.12	45	62.7	19
NE12510	73.4	76.8	78.2	46.7	53.9	65.80	30	65.1	11
NE12518	75.2	70.1	79.6	51.8	59.6	67.26	17	62.4	20
NE12521	63.5	63.1	77.0	42.9	56.4	60.58	54	51.8	59
GOODSTREAK	72.3	61.6	71.1	47.5	61.9	62.88	42	62.1	25
NE12524	75.8	73.4	77.2	55.3	67.3	69.80	6	57.7	50
NE12538	66.7	69.7	67.2	45.3	54.8	60.74	52	64.4	13
NE12539	63.3	69.0	64.6	40.0	55.4	58.46	60	51.5	60
NE12550	69.8	75.4	75.2	39.8	58.2	63.68	38	67.1	6
NE12561	71.7	76.1	80.1	45.2	62.1	67.04	20	59.7	45
NE12563	69.3	73.5	81.5	42.4	57.4	64.82	35	65.5	9
NE12568	73.6	67.6	65.3	42.3	59.5	61.66	48	61.0	33
NE12571	75.0	75.5	76.1	53.7	53.0	66.66	22	66.9	7
NE12578	75.8	72.1	75.7	43.3	52.1	63.80	37	64.4	13
NE12580	71.8	76.1	79.3	56.1	54.3	67.52	15	62.3	24
NE12582	67.6	73.2	74.0	41.9	56.1	62.56	43	53.9	58
NE12583	64.0	71.2	75.2	44.3	55.5	62.04	47	62.0	26
NE12585	68.9	71.3	78.3	46.3	59.6	64.88	33	58.5	47
NE12589	78.5	77.1	86.4	45.0	62.7	69.94	5	67.5	5
OVERLAND	73.6	78.3	84.4	42.5	53.8	66.52	23	59.9	44
NE12595	64.8	61.6	78.3	36.4	58.2	59.86	58	61.8	28
NE12596	64.1	64.1	72.2	39.3	60.0	59.94	56	58.7	46
NE12598	70.1	72.4	76.5	41.7	55.8	63.30	41	56.2	53
NE12630	67.4	65.7	78.6	52.8	65.3	65.96	28	57.7	50
NE12634	70.9	69.4	77.2	50.6	57.2	65.06	32	60.3	36
NE12637	68.4	74.8	80.1	46.8	57.8	65.58	31	63.9	15
NE12639	62.4	65.8	72.9	45.7	60.0	61.36	49	63.4	16
NE12659	74.8	72.2	75.1	45.8	56.5	64.88	34	60.2	39
NE12662	78.8	78.6	81.9	50.9	62.5	70.54	3	63.1	17
NE12668	72.4	74.5	72.2	49.7	63.0	66.36	25	60.3	36
NE12675	69.2	73.9	72.8	44.0	57.2	63.42	40	57.1	52
NE12685	73.7	70.7	73.1	45.9	55.0	63.68	38	61.5	30
NE12686	73.3	75.4	89.5	57.2	61.6	71.40	1	68.8	3
NE12689	72.7	74.1	80.9	47.3	63.2	67.64	13	60.1	42
NH12615	73.2	70.7	84.0	47.2	61.7	67.36	16	63.0	18
MEAN	**70.92**	**72.35**	**76.39**	**46.09**	**59.43**			61.35	
LSD	**8.18**	**7.48**	**9.19**	**8.38**	**9.18**			**5.98**	
CV	**5.96**	**6.37**	**7.44**	**8.89**	**9.52**			**6.01**	
Heritability	**0.99**	**0.99**	**0.7**	**0.99**	**0.97**			**0.99**	

6. Regional Nurseries

In 2015, we continued to combine the Southern Regional Performance Nursery (SRPN) and the Northern Regional Performance Nursery (NRPN) into one larger nursery. These were planted at Lincoln, North Platte, Sidney, and Alliance. At Clay Center, only the SRPN was planted. To fill out the nursery, we added a few other lines mainly to compare selections out of research for scab tolerance or drought tolerance to determine if they had merit. The NRPN and SRPN data from all locations is available at: http://www.ars.usda.gov/Research/docs.htm?docid=11932. It was useful to see Kharkof and Scout 66, older wheat cultivars, continue to be very low yielding, indicating that breeding progress has been made.

RPN 2015	Winter	Lincoln	N. Platte	Sidney	Average	Rank
	Survival	Yield	Yield	Yield	Yield	
	%	bu/a	bu/a	bu/a	bu/a	
name	ws_l15	yb_l15	yb_np15	yb_s15		
Kharkof	90.8	24.4	36.2	35.9	32.2	70
Scout 66	96.7	34.0	32.7	41.2	36.0	58
TAM107	96.1	22.6	29.3	25.5	25.8	88
Jagalene	88.8	21.1	41.3	30.8	31.1	73
KS11HW15-4-1	79.6	43.0	40.4	35.5	39.6	40
KS11HW18-1-6	83.7	24.8	27.4	31.0	27.7	83
KS11HW39-5-4	85.4	46.4	42.8	53.4	47.5	9
KS11HW53-1-6	77.6	20.8	28.4	17.8	22.3	89
CO11D1767	93.2	34.8	66.8	65.3	55.6	1
CO11D446	82.2	31.7	49.5	56.4	45.9	13
CO11D1353	91.5	22.1	31.8	33.8	29.2	78
CO11D1397	80.7	14.3	38.8	40.7	31.3	72
CO11D1539	81.5	21.5	47.2	44.1	37.6	50
CO11D1316W	84.6	9.0	24.8	21.4	18.4	90
LCH13-092	93.1	20.9	31.4	26.3	26.2	87
LCH13DH-20-87	98.0	54.9	56.4	44.7	52.0	4
LCI13DH-14-53W	91.2	24.9	50.1	60.8	45.3	15
LCH11-1117	78.9	32.9	43.7	39.4	38.7	44
LCH12-012	89.1	32.8	48.1	56.9	45.9	12
KS060084-M-4	86.8	40.1	51.3	34.3	41.9	27
KS060106-M-11	79.4	32.7	50.8	39.1	40.9	33
KS060143-K-2	91.5	37.8	49.1	35.3	40.7	34
KS060371-M-3	87.1	33.1	47.1	27.8	36.0	57
KS060476-M-6	93.3	48.5	51.9	57.9	52.8	3
TX10A001099	94.3	25.5	33.5	41.9	33.6	68
TX09V7315	95.3	27.7	26.5	31.6	28.6	79
TX09V7352	86.1	17.3	33.3	33.9	28.2	81
TX09V7446	90.4	24.1	42.6	42.7	36.5	56
TX11A001295	61.0	18.0	40.2	27.0	28.4	80
TX12M4004	90.5	31.5	42.3	33.4	35.7	59
TX12M4063	84.7	36.2	38.0	29.3	34.5	63
TX12M4065	90.5	43.1	28.6	29.3	33.7	67
OK09125	84.9	25.4	35.8	23.1	28.1	82
OK1059060	75.4	21.9	50.6	43.1	38.5	47
OK10126	87.0	27.9	47.6	40.3	38.6	45
NI13706	92.4	48.2	43.1	40.5	43.9	18
NE12429	86.5	20.7	33.4	36.4	30.2	75
NE12571	89.1	29.4	38.5	44.7	37.5	51
NE10507	88.2	34.2	37.9	42.2	38.1	48
LCH13DH-3-31	94.9	27.7	48.7	42.4	39.6	41
HV9W10-0091	94.1	39.7	48.8	55.1	47.9	8
HV9W10-1002	78.8	29.4	36.2	23.2	29.6	76
OVERLAND	91.7	35.4	41.9	46.5	41.3	32
WESLEY	90.6	22.2	45.8	33.6	33.9	66
Jerry	92.7	19.4	45.6	45.2	36.7	54
N11MD2166W	86.8	45.4	51.1	51.5	49.3	5
N11MD2157W	98.0	40.0	53.2	49.2	47.5	10
AAC Gateway	88.0	24.2	45.0	51.5	40.2	37
SD08200	82.6	37.9	50.7	40.4	43.0	22
SD09113	77.4	32.2	48.7	49.8	43.6	20
SD09118	83.1	35.9	45.1	44.6	41.9	28
SD09192	59.6	20.7	33.0	51.1	34.9	61
SD09227	89.8	35.0	48.1	49.4	44.2	16
SD10257-2	77.8	38.4	60.4	60.2	53.0	2
SD10W153	68.4	27.2	37.4	37.5	34.0	65
SD110085-1	88.9	32.4	43.4	43.6	39.8	38
SD110060-7	85.4	31.7	53.0	59.1	47.9	7
SD11023-8	82.8	30.0	45.4	49.3	41.6	30
BCS-11L00002-001	80.9	24.0	46.9	38.7	36.5	55
BCS-12L00001	91.1	18.2	39.9	45.1	34.4	64
BCS-12L00003	91.9	21.7	29.8	31.1	27.5	84
BCS-12L00004	97.9	40.2	44.5	36.2	40.3	36
Nord1301	84.5	14.6	43.3	39.4	32.4	69
LCH13-054	96.9	30.2	38.9	43.3	37.5	52
LCH13DH-7-3	76.5	29.1	42.2	39.7	37.0	53
LCH13DH-5-59	85.0	24.4	45.3	47.9	39.2	42
LCI13DH-4-16W	91.8	34.1	34.3	37.7	35.4	60
NW11511	80.5	23.9	48.0	43.7	38.5	46
NI12702W	81.0	37.1	55.3	37.3	43.2	21
NI13717	85.6	26.1	28.0	33.9	29.3	77
NE12443	93.1	38.5	48.4	32.4	39.8	39
NE12444	90.9	37.2	29.6	13.1	26.6	85
NE12488	79.2	21.1	34.3	39.1	31.5	71
NE12561	90.7	37.7	40.4	48.0	42.0	26
NE12589	98.3	38.1	39.8	63.4	47.1	11
NE10683	90.0	21.8	33.5	23.4	26.2	86
MT1117	85.7	17.5	47.9	58.6	41.3	31
MT1138	91.6	15.7	44.7	57.1	39.2	43
BCS-12L00006	88.5	28.3	50.7	52.0	43.7	19
NE13470	94.7	25.0	34.8	54.2	38.0	49
NE13625	89.9	35.1	52.9	48.2	45.4	14
PSB13NEDH-14-71W	90.8	39.8	49.9	54.6	48.1	6
PSB13NEDH-7-140	92.4	35.2	38.8	54.9	43.0	23
OVERLAND_FHB1_1	93.1	39.4	41.7	50.9	44.0	17
OVERLAND_FHB1_4	90.9	30.0	33.5	27.8	30.4	74
OVERLAND_FHB1_5	85.0	36.4	42.9	45.9	41.7	29
NE12438_HRD	83.6	33.4	44.6	43.8	40.6	35
NE12439_HRD	88.4	31.8	46.3	48.7	42.3	25
OVERLAND_FHB1_9	81.7	29.2	39.1	35.8	34.7	62
OVERLAND_FHB1_10	95.9	38.0	46.2	43.1	42.4	24
CV	11.16	14.50	14.26	15.36	14.7	
GRAND MEAN	87.19	30.19	42.30	41.63	38.0	
Heritability	0.18	0.79	0.60	0.72	0.7	
LSD	15.72	8.42	11.60	12.30	10.8	

	Clay Cent.		Rank	SRPN	SRPN
	Yield			Average	Rank
name	bu/a	striperust		Yield	
				bu/a	
Kharkof	17.5	2	38	41.0	40
Scout 66	22	5	33	46.0	24
TAM107	24.5	6	28	44.7	28
Jagalene	23.5	3	30	42.1	36
KS11HW15-4-1	30.6	1	16	45.7	25
KS11HW18-1-6	24.3	1	29	43.3	33
KS11HW39-5-4	50.5	1	1	49.5	14
KS11HW53-1-6	19.5	2	37	43.6	31
CO11D1767	28.4	4	23	48.1	16
CO11D446	30.6	3	16	56.7	2
CO11D1353	17	6	39	46.2	22
CO11D1397	10.5	9	43	40.5	41
CO11D1539	27.2	1	26	44.0	30
CO11D1316W	16	9	41	38.9	42
LCH13-092	17	6	39	36.5	43
LCH13DH-20-87	42.8	1	3	52.1	6
LCI13DH-14-53W	30.2	5	20	56.8	1
LCH11-1117	36.8	2	6	51.0	9
LCH12-012	35	1	9	50.8	10
KS060084-M-4	41.7	1	4	53.5	5
KS060106-M-11	39.8	1	5	50.5	11
KS060143-K-2	35.1	1	8	50.1	12
KS060371-M-3	34.1	1	11	49.2	15
KS060476-M-6	45.3	1	2	54.7	3
TX10A001099	20.5	5	35	51.9	7
TX09V7315	13.1	5	42	43.3	34
TX09V7352	20.2	6	36	41.3	39
TX09V7446	29.5	3	22	44.4	29
TX11A001295	30.5	1	18	41.8	38
TX12M4004	33.8	1	12	42.0	37
TX12M4063	35.8	1	7	46.9	21
TX12M4065	30.3	2	19	45.6	26
OK09125	23.1	2	32	42.6	35
OK1059060	31.3	1	15	43.5	32
OK10126	28.4	2	23	46.9	19
NI13706	34.7	5	10	51.3	8
NE12429	20.7	8	34	46.9	20
NE12571	28.1	9	25	45.2	27
NE10507	23.5	6	30	47.5	18
LCH13DH-3-31	29.9	5	21	49.6	13
HV9W10-0091	32.2	6	13	53.7	4
HV9W10-1002	26	1	27	47.9	17
OVERLAND	31.7	7	14	46.1	23
CV	15.66	34.77			
GRAND MEAN	28.90	3.77		46.8	
Heritability	0.75	0.79			
LSD	8.74	2.55			

7. Multiple-Location Observation Nursery

All eight locations in Nebraska (Lincoln, Mead, Clay Center, North Platte, McCook, Grant, Sidney, and Alliance) and one in Kansas were planted and harvested. To better estimate the yield at key locations, two replications were planted at Lincoln and Alliance (but only one was harvested). The table below gives the grain yields for all of the harvested locations, the line average, and the rank of the top 10 highest yielding lines. In this nursery, we continued to use marker-assisted selection for line advancement. For the fifth year, we used genotyping by sequencing (GBS). Genotyping by sequencing was done in collaboration with Dr. Jesse Poland, KSU, because it is much less costly (less than 1/3 of the cost of other marker systems). The top ten lines out of 270 experimental lines are below:

	Mead	Lincoln	Clay Cen.	N. Platte	McCook	Grant	Sidney	Alliance	KS	Average	NE Average	Rank	NE Rank
	Yield	Yield	Yield	Yield	Yield	Yield	Yield	Yield	Yield	Yield	Yield		
	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a		
name	M	L	CC	NP	MC	GRD	S	A	WB	AVG_ALL	AVG_NE		
NE15651	22.4	41.2	34.9	58.1	46.2	59.2	56.3	51.8	58.6	47.63	46.26	2	1
NE15545	23.3	41.85	43.8	61.5	40.8	54.5	53.4	47.1	62.8	47.67	45.78	1	2
NE07486_2	21.5	36.4	34.8	60.6	38.4	51.4	62.4	35.1	68.6	45.47	42.58	4	3
NE15571	20	35.9	44.7	56.3	31.2	57.7	46.2	41.9	84.1	46.44	41.74	3	4
NE15675	16.3	38.75	32.6	64.5	37.2	39.4	58.2	40.7	75.7	44.82	40.96	5	5
NE15654	20.7	35.35	31	51.8	42.7	52.3	41.7	46.9	76.5	44.33	40.31	7	6
NE15519	18.4	35.65	30.7	54.9	30	57.2	51.3	42.9	81.4	44.72	40.13	6	7
NE15475	20.4	28.95	33.1	65.2	40.2	44.5	52.2	32.7	75.9	43.68	39.66	11	8
NE15468	17.4	31.15	41.4	51.9	37.6	51.8	40.3	44.5	81	44.12	39.51	9	9
NE15474	16.3	33.4	36.5	48.4	40	43.9	51	44.3	75.5	43.26	39.23	13	10

Camelot ranked 169 in this trial. Freeman ranked 55. Goodstreak ranked 41.

8. Early Generation Nurseries

a. Single-plot Observation Nursery

Two thousand and eighty-four lines were evaluated at Lincoln in 2015. Of the 2084 lines and checks, 1337 were red and 208 were white seeded or mixed red and white seeded. In addition, there were 440 two-gene herbicide tolerant lines, 98 possible FHB tolerant lines, 17 possible lines with WSMV tolerance, and 65 Hessian fly-tolerant lines. All 2084 lines were harvested to get better information than through visual selection. We also did genotyping by sequencing (GBS) on all of the lines (thanks to cooperation with Dr. Jesse Poland). Due to the heavy disease pressure at Lincoln, we eliminated any line that was susceptible to stripe rust or had severe scab. Those lines with acceptable disease resistance and yield were then test weighed and if the test weight. Unfortunately, the disease and rain at harvest destroyed the seed quality, so we did not send samples from this nursery for microquality evaluation. We did use our GBS data to eliminate lines carrying obvious anti-quality factors such as 1B.1R, 2 +12 glutenin bands, etc. Two hundred seventy lines were advanced. We will try to be more selective in this nursery so that harvesting all the plots will be very efficient.

b. Headrow Nursery

In 2014-15, 44, 800 headrows were planted at Lincoln. In general, the headrow nursery was about the size we prefer. Because the disease was so widespread, we harvested more than 2,500 lines. Two thousand one hundred sixty-one were selected for advancement of which 217 were for 2-gene imi-tolerant. The main selection criteria for discarding headrows was poor seed quality.

c. F_3 bulk hybrids

The F_3 bulk hybrid nursery contained 987 red, red and white segregating, or white seeded bulks. In addition, most bulks were planted at Mead (our main and best winter killing site) and many of those were planted at Sidney as a backup site in case of disaster at Mead. The number of F_3 bulks is slightly high and we intend to reduce it in future. Over 50,000 head rows were selected for fall planting in 2015 and were planted on time. In general, their emergence and stands were very good in the fall, but many were damaged by hail in 2016. The project goal remains to have sufficiently good segregating F_3 material to select about 40 - 45,000 headrows.

d. F_2 bulk hybrids

The F_2 bulk hybrid nursery contained 974 bulks and check plots that were planted at Mead. About 50 F_2 bulks with two genes for herbicide resistance were planted at Lincoln for selection. The bulks generally survived the winter, but some were winterkilled (those involving winter tender parents). We continued not sharing our bulk populations this year as the new Wheat Workers Material Transfer Agreement (WWMTA) requires prior approval of bulk sharing for any subsequent segregating generation. There is no approved bulk sharing form attached to the WWMTA and the paperwork will continue to a major hurdle. As such, the path of least resistance is simply to not share bulks except with those who we have pre-existing bulk-sharing agreements (e.g. CIMMYT). No bulk is shared that includes parental germplasm that requires approval. While this curtailment of bulk sharing is unfortunate and in many ways a waste of resources (groups making the same crosses or not having access to crosses they wished they had made), the alternative concern is that some programs prefer not to share their segregating germplasm with other institutions and businesses.

9. <u>Winter Triticale Nursery</u>

In 2015, seven winter triticale (x Triticosecale Wittmack) lines: NT05421, NT07403, NT09423, NT11406, NT11428, NT12414, and NT12434, developed cooperatively by the Nebraska Agricultural Experiment Station and the USDA-ARS and recommended for release in 2016 by the developing institutions. The lines were developed for grain or forage production primarily in the Great Plains and to provide triticale growers with greater diversity to select winter triticale lines for grain, forage, or cover crop. However, the University of Nebraska has commercial triticale partners who have tested these lines in regions beyond Nebraska and our testing network that also includes locations beyond Nebraska. Proprietary data from our cooperators are not shown and only data developed from Nebraska are presented. The previously released winter triticale ('NE426GT') that is good for both grain and forage production (Baenziger et al., 2005) was used for head-to-head comparisons. 'NE422T' (Baenziger and Vogel, 2002), also previously released was included in the comparisons as it is an excellent forage triticale (4% better forage yielding than NE426GT). However, NE422T is a lower grain yielding line (16%) than NE426GT which increases the cost of seed production. Hence, the two previously released cultivars represent the current grain and forage yield of commercially available winter triticale lines in Nebraska. In reviewing the forage data, no lines were significantly better than NE426GT, but two lines (NE11406 and NT12434) were significantly lower forage yielding than NE426GT. For grain yield, two lines (NT07403 and NT09423) were significantly better than NE426GT. No new line was significantly lower grain yielding than NE426GT. Hence, most of the modern triticale lines were similar in forage yield and equal or better for grain yield to the currently commercially available lines. Considering other attributes, for flowering date, NE422T was significantly later than NE426GT which was expected. Only NT07403 was significantly earlier than NE426GT. The remaining lines were not significantly different from NE426GT. For plant height, NE422T, NT05421, and NT11428 were significantly taller than NE426GT, while NT07403 and NT12414 were significantly shorter than NE426GT.

Triticale has few diseases in Nebraska and there are no regional nurseries, hence, there is little disease or insect data to report. Historically, triticale is very resistant to most diseases commonly found in Nebraska, such as the rusts (incited by *Puccinia spp.*) and many of the virus diseases such as wheat streak mosaic virus which is prevalent in western Nebraska. For example, in 2012, NT05421, NT07403, and NT09423 were evaluated in Kenya using field races (TTKSK and its derivatives; David Marshall, personal communication) and had stem rust (incited by *P. graminis Pers.: Pers. f. sp. tritici* Eriks & E. Henn.) infections of 10%, 1%, and 1% with infection types of S, S, and S, respectively, whereas in the same nursery 'Jagger' wheat (*Triticum aestivum* L.) ranged from 50% - 70% infection and infection type of S. For stripe rust (incited by *P. striiformis* Westendorp f. sp. t*riticina*), NT05421, NT07403, NT09423, and Jagger were all rated as having an infection type of moderately susceptible. In 2013, NT11406 and NT11428 were evaluated for stem rust resistance in Kenya using field races and both lines were rated as being resistant whereas Jagger ranged from 15% - 60% infected with a susceptible infection type of dead (killed by the disease). Stripe rust was not present in 2013. In Nebraska, when leaf rust (caused by *P. triticina* Eriks,), stripe, or stem rust were present on wheat, NT05421, NT07403, NT09423, NT11406, NT11428, NT12414, and NT12434, would be considered as resistant. In years of high infection of ergot (caused by *Claviceps purpurea* (Fr.) Tul.), NT05421, NT07403, NT09423, NT11406, NT11428, NT12414, and NT12434, had very low infections. During its selection, lines with ergot are routinely discarded. Triticale is susceptible to bacterial streak disease (incited by *Xanthomonas campestris* pv. *translucens* (Jones et al.) Dye). There were no significant differences among the lines tested. Note bacterial streak disease was absent the year that NT12414 and NT12434 were evaluated, so no data are presented for those lines.

Considering each line separately, NT05421 is a winter triticale with prostrate growth habit in the winter. It was derived from a complex cross mainly involving NE422T which the final cross was made in 1999. The F_1 was grown in the greenhouse in 2000 and the F_2 seed was planted as a bulk at Lincoln, NE and harvested with a combine in 2001 and replanted that fall at Lincoln, NE as an F_3 bulk. In 2002, $F_{3:4}$ heads were snapped from the F_3 bulk and planted in Lincoln, NE that fall as individual short rows (approximately 75 cm long with 25 cm between rows). In 2003, based upon visual selection for the absence of disease, good straw strength, and agronomic appearance, the better rows were selected. The harvested seed was visually inspected for seed quality and ergot and those samples with poor seed quality (shriveled grain) and ergot were discarded. The remaining lines ($F_{3:5}$) were planted at Lincoln, NE in four row plots that were 3 m long with 25 cm between rows in the fall of 2003 and combine harvested in 2004. The center two rows were cut and threshed using a plot thresher. There was no further selection thereafter. Based upon grain yield, seed quality, and agronomic and resistance to disease, $F_{3:6}$ lines were advanced for planting in fall of 2004 and harvesting in 2005 in a multilocation trial at Lincoln (single replication), Mead (two replications), and Sidney, NE (single replication). The name **NT05421** is derived from the line being selected in Nebraska (N) being a triticale (T) in 2005 (hence 05) and being derived from plot **421**. Thereafter it was tested in multi-location trials with three replications at the same three NE locations. The plant color at boot stage is blue-green and the stem is without anthocyanin. The neck is moderately hairy and straight. The flag leaf is upright, not twisted, and with a waxy bloom. The auricle is colorless. The seed is amber in color, oval, wrinkled, and with a large and long brush.

NT07403 is a winter triticale with prostrate growth habit in the winter. It was derived from the cross NE98T424/FLOOD//NT00418 which was made in 2001. The pedigree of NE98T424 is PRESTO/NE91T409 and the pedigree of NT00418 is RAH-123/NE94T409. The same breeding procedure as described for NT05421 was used beginning with the cross being made two years later. The plant color at boot stage is green and the stem is without anthocyanin. The neck is hairy and straight. The flag leaf is drooping, twisted and with a waxy bloom. The auricle is colorless. The head is mid-dense, clavate, awned, and the color is tan. The glumes at maturity are pubescent, mid-long, narrow, with a wanting shoulder. The beak is acute. The seed is amber in color, oval, slightly wrinkled, and with a large and long brush.
NT09423 is a winter triticale with prostrate growth habit in the winter. It was derived from the cross NE426GT/NT01417 which was made in 2003. The pedigree of NT01417 is NE85T121/NE87T148//RAH-

123. The same breeding procedure as described for NT05421 was used beginning with the cross being made four years later. The plant color at boot stage is green and the stem is without anthocyanin. The neck is hairy and straight. The flag leaf is upright, not twisted and with a waxy bloom. The auricle is colorless. The head is mid-dense, fusiform, awned, and the color is tan. The glumes at maturity are glabrous, mid-long, narrow, with a wanting shoulder. The beak is acuminate. The seed is amber in color, ovate, wrinkled, and with a large and long brush.

NT11406 is a winter triticale with prostrate growth habit in the winter. It was derived from the cross NT04427//NE92T422/NE426GT sib/3/NT02458//CTM86.101/GWT 88-12 which was made in 2005. The pedigree of NT04427 is NE422T/TX95V711, the pedigree of NE92T422 is 85LT401/NE83T24, and the pedigree of NT02458 is RAH-123/NE90T413. The same breeding procedure as described for NT05421 was used beginning with the cross being made six years later. The plant color at boot stage is yellow-green and the stem is without anthocyanin. The neck is hairy and straight. The flag leaf is upright, twisted and with a waxy bloom. The auricle is colorless. The head is mid-dense, oblong, awned, and the color is yellow. The glumes at maturity are slightly pubescent, mid-long, and mid-wide with a wanting shoulder. The beak is obtuse. The seed is amber in color, oval, slightly wrinkled, and with a mid-sized and short brush.

NT11428 is a winter triticale with prostrate growth habit in the winter. It was derived from the cross NE03T413/3/NT02458//CTM86.101/GWT 88-12 which was made in 2005. The pedigree of NE03T413 is NE426GT sib//TRICAL 2700. The same breeding procedure as described for NT05421 was used beginning with the cross being made six years later. The plant color at boot stage is green and the stem is without anthocyanin. The neck is hairy and straight. The flag leaf is upright, twisted and with a waxy bloom. The auricle is colorless. The head is mid-dense, fusiform, awned, and the color is yellow. The glumes at maturity are slightly pubescent, mid-long, and mid-wide with a wanting shoulder. The beak is obtuse. The seed is amber in color, oval, slightly wrinkled, and with a large and long brush.

NT12414 is a winter triticale with prostrate growth habit in the winter. It was derived from the cross NT05433//NE426GT which was made in 2006. The pedigree of NT05433 is NE426GT/TX95VT7117. The same breeding procedure as described for NT05421 was used beginning with the cross being made six years later. The head is mid-dense, fusiform, awned, and the color is tan. The glumes at maturity are slightly pubescent, long, and mid-wide with a wanting shoulder. The beak is acuminate. The seed is amber in color, oval, slightly wrinkled, and with a mid-size and mid-long brush.

NT12434 is a winter triticale with prostrate growth habit in the winter. It was derived from the cross NT01451/NT05434 which was made in 2005. The pedigree of NT01451 is OMI-4MI-3MI/NE91T410//RAH-123 and the pedigree of NT05434 is NE98T424/PLAI. The same breeding procedure as described for NT05421 was used beginning with the cross being made six years later. The neck is hairy. The head is mid-dense, oblong, awned, and the color is tan. The glumes at maturity are slightly pubescent, long, and wide with a wanting shoulder. The beak is acuminate. The seed is amber in color, ovate, wrinkled, and with a large and long brush.

The lines have been uniform and stable since 2014. Less than 2.0% of the plants were rogued from the Breeder's seed increase in 2014-15. The rogued plants were taller in height or were awnless. Up to 3% off types may be encountered in future generations. The Nebraska Foundation Seed Division, Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, NE 68583 had foundation seed available to qualified certified seed enterprises in 2015 with the first sale of certified seed in 2016. The U.S. Department of Agriculture will not have commercial seed for distribution. The seed classes will be Breeder, Foundation, Registered, and Certified. All lines will be submitted for plant variety protection under P.L. 10577 with the certification option. A fee will be assessed on all certified seed sales. Small quantities of seed for research purposes may be obtained from Dr. P. S. Baenziger and the Department of Agronomy and Horticulture, University of Nebraska-Lincoln for at least 5 years from the date of this release. In addition, a seed sample has been deposited in the USDA-ARS National Small Grains Collection, Aberdeen, ID, and this seed is freely available to interested researchers.

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In 2015, it appears that NE422T has good forage potential for the southern Great Plains. We are beginning to move to higher and more consistent grain yield levels, but identifying excellent forage types requires forage harvesting which is expensive and difficult for widespread trials. Though the markets for biofuels fluctuate with the price of oil and other geologically based fuels, we believe that there is a future for triticale in a biobased energy system. Triticale can be grown over the winter as forage or grain crop in areas where maize cannot be grown successfully. The grain will substitute for maize in animal rations and the forage can be used as forage, cellulosic ethanol feed stocks, or as a ground cover.

The grain and forage data for 2015 are:

				Linc.	Mead.	Grain			Mead	Mead	Mead	Mead	Mead	Mead	Mead
	Winter	**Flowering**	**Height**	Yield	Yield	**Yield**	Rank	**Bacterial**	Forage	Rank	IVDMD	NDF	ADF	ADL	Nitrogen
	Survival	**Date**						**Streak**	Yield (dry)	Forage					
	Avg.	**Avg.**	**Avg.**	(lbs/a)	(lbs/a)	**Avg**		**Avg.**							
name				ydlb_l15	ydlb_m15			**(1-9)**	lbs/a						
NT441	**99.6**	**151.525**	**63.65**	817	1424	**1120.5**	29	**2.35**	9774	1	68.43	66.47	40.01	5.76	2.10
NE03T416	**100.25**	**145.87**	**50.4**	2467	1642	**2054.5**	10	**1.35**	7800	16	64.87	67.71	40.74	5.82	1.75
NE422T	**95.05**	**153.84**	**66.35**	1175	746	**960.5**	30	**2.15**	7109	21	68.49	66.76	40.22	5.62	2.10
NT05421	**100.15**	**145.535**	**59**	1907	1727	**1817**	16	**2.65**	7819	15	66.43	66.30	39.23	5.70	1.89
NT06422	**99.85**	**143.745**	**53.85**	1635	1464	**1549.5**	26	**3.00**	7610	18	65.43	67.57	41.18	5.98	1.85
NT06427	**100.35**	**145.125**	**51.2**	1981	1430	**1705.5**	19	**2.85**	6852	23	64.08	68.08	41.74	6.00	1.64
NT07403	**100.05**	**142.83**	**49**	2091	1757	**1924**	12	**2.65**	7857	14	68.08	66.23	39.66	5.70	2.03
NT09404-1	**100**	**145.945**	**55**	2722	2283	**2502.5**	1	**2.15**	6360	27	65.95	66.42	40.07	5.87	1.76
NT09423	**99.35**	**146.135**	**51.55**	2156	2236	**2196**	4	**1.30**	8462	9	65.50	67.40	40.92	5.89	1.81
NT10417	**100.05**	**146.755**	**53.2**	2097	1644	**1870.5**	13	**2.65**	8421	10	66.60	66.93	39.78	5.90	1.97
NT10418	**95.05**	**143.6**	**58.85**	1718	1437	**1577.5**	25	**3.35**	6620	24	67.51	66.66	39.49	5.76	2.07
NT11406	**100.1**	**145.82**	**51.45**	2124	1598	**1861**	14	**2.50**	6569	25	64.62	67.95	41.15	5.90	1.81
NT11428	**99.95**	**146.325**	**56.6**	1893	1448	**1670.5**	20	**2.50**	7572	19	65.46	67.47	40.66	5.91	1.84
NT12403	**99.95**	**143.44**	**52.1**	2972	1969	**2470.5**	2	**2.50**	8524	8	66.00	67.76	40.84	5.90	1.84
NT12404	**96.45**	**143.815**	**51.65**	1949	2168	**2058.5**	9	**2.35**	7400	20	65.24	68.00	41.78	6.04	1.69
NT12406	**100.15**	**146.745**	**56.45**	1882	1713	**1797.5**	18	**3.15**	8852	6	66.27	66.08	39.93	5.76	1.69
NT12425	**100**	**144.475**	**56.9**	1568	1482	**1525**	27	**3.00**	9322	3	65.49	67.79	41.08	6.11	1.83
NT13416	**91.6**	**145**	**53.5**	2051	2240	**2145.5**	7	**1.85**	8411	11	65.38	68.10	41.66	6.11	1.67
NT13443	**100**	**145.18**	**61.05**	2476	2240	**2358**	3	**2.35**	7753	17	64.71	67.34	40.79	5.93	1.68
NT14407	**98.2**	**143.295**	**55.35**	2323	1807	**2065**	8	**2.65**	9643	2	63.87	68.77	41.65	5.97	1.64
NT14410	**98.25**	**143.72**	**54.1**	2628	1735	**2181.5**	5	**3.00**	7999	13	66.64	66.62	40.01	5.95	1.78
NT14426	**96.6**	**145.025**	**57.7**	1505	1833	**1669**	21	**3.15**	5686	30	65.65	67.28	40.64	6.03	1.84
NT14429	**97.5**	**144.255**	**53.05**	1635	1608	**1621.5**	23	**2.65**	8203	12	65.40	68.76	41.86	6.07	1.87
NT14430	**100.35**	**143.095**	**50.85**	1780	1932	**1856**	15	**3.50**	6899	22	66.28	65.59	39.61	5.87	1.75
NT14433	**98.15**	**145.87**	**62.6**	1788	1444	**1616**	24	**3.00**	8814	7	66.06	66.44	40.65	5.87	1.60
NT14434	**99.05**	**143.295**	**54.3**	1887	1380	**1633.5**	22	**3.50**	8933	5	64.79	68.26	41.97	6.13	1.87
NT14435	**98.95**	**143.97**	**52**	2317	1608	**1962.5**	11	**2.65**	6246	28	63.09	68.55	42.02	6.06	1.68
OVERLAND	**96.6**	**146.445**	**42.75**	1498	1171	**1334.5**	28	**3.85**	6241	29	65.71	67.46	40.86	6.01	1.86
NT09423-1	**99.3**	**147.815**	**52.55**	2421	1914	**2167.5**	6	**1.35**	6491	26	66.84	66.20	39.97	5.47	2.04
NE426GT	**99.9**	**146.155**	**53.3**	1916	1715	**1815.5**	17	**2.20**	8956	4	65.85	68.16	41.05	6.04	1.88
Average				1979	1693				7773.142		65.82	67.30	40.71	5.90	1.83
LSD				507	649				1625.529		1.99	1.72	1.86	0.24	0.29
CV				16	23				14.87686		2.15	1.82	3.25	2.84	11.12

The 2014 grain yields from Nebraska are:

2014	Linc.	Mead	Sidney	Average	Rank	Bacterial	Winter	Height
	Yield	Yield	Yield	Yield		Streak	Survival	
Name	lbs/a	lbs/a	lbs/a	lbs/a		(1-9)	%	in
NT01451	3190	2368	3891	3150	8	3.3	100	44.1
NT05421	3641	3047	3829	3506	1	3.7	99	51.8
NT06422	3557	2476	3802	3278	5	4.5	99	48.1
NT06427	3314	1926	3742	2994	12	3.1	99	44.9
OVERLAND	3446	3019	3875	3447	2	1.8	98	36.1
NT07403	3773	2129	3481	3128	10	5.0	99	43.3
NT09423	3223	2663	3936	3274	6	2.0	100	44.6
NT10417	2291	1957	3912	2720	22	3.9	100	45.2
NT11406	3203	1697	3789	2896	14	3.0	100	44.9
NT11410	3380	1691	3440	2837	17	4.3	98	44.9
NT11428	3389	2399	3416	3068	11	3.3	100	51.5
NT12403	3258	2441	4005	3235	7	6.0	100	44.4
NT12404	3293	1868	3535	2899	13	6.1	100	43.9
NT12406	3155	2412	3859	3142	9	6.4	99	46.8
NE422T	2844	2034	3136	2671	24	4.2	100	56.9
NT12412	3008	1837	3348	2731	20	3.4	98	44.3
NT12425	3496	1956	3172	2875	15	3.0	100	51.7
NT12440	1936	1201	2910	2016	29	4.4	95	40.9
NT13403	2746	1819	3722	2762	18	5.8	99	45.4
NT13405	2259	1301	3548	2369	28	5.1	97	46.4
NT13410	2775	1812	3506	2698	23	6.3	99	47.5
NT13411	2305	1352	3563	2407	27	5.1	97	45.2
NT13412	1232	1195	3487	1971	31	4.7	91	44.5
NT13416	3444	2579	3977	3333	4	5.8	100	49.2
NE426GT	2588	2195	3499	2761	19	5.7	99	44.7
NT13420	2794	2051	3341	2729	21	6.8	99	44.7
NT13421	1817	1256	2909	1994	30	5.1	98	38.9
NT13429	2250	1720	3790	2587	26	4.8	99	47.9
NT13430	2514	1835	3627	2659	25	3.9	100	42.9
NT13443	4053	2761	3473	3429	3	3.4	99	56.3
GRAND MEAN	**2939**	**2033**	**3584**	**2852**	**16**	**4**	**99**	**46**
LSD	464	510	479			2		
CV	10	15	8			23		

The 2014 forage yields from Nebraska (thanks to Dr. Rob Mitchell, USDA-ARS) are:

entry	name	winsur	hdatejulia	height	yldlbsa	Rank	dmpercent	nitrogen	ivdmd	ndf	adf	adl
		%	After 12/31	in	lbs/a		%	%	%	%	%	%
1	NT01451	100	151	41.9	5645	9	26.8	1.92	71.33	61.07	34.95	5.13
2	NT05421	100	150	46.8	5587	11	29.3	1.67	69.11	62.02	36.19	5.35
3	NT06422	100	148	46.2	5489	15	29.9	1.80	71.53	58.58	33.63	5.01
4	NT06427	100	150	44.0	5985	6	28.4	1.75	70.10	60.32	35.00	5.15
5	OVERLAND	100	147	36.0	6059	5	29.0	1.90	71.53	60.46	34.51	5.09
6	NT07403	90	147	41.0	4896	21	31.2	1.68	69.81	60.15	34.72	5.05
7	NT09423	100	151	41.5	6569	2	27.0	1.86	70.80	61.10	35.16	5.24
8	NT10417	100	152	41.2	5189	18	26.6	1.87	71.11	61.68	35.38	5.19
9	NT11406	100	152	42.0	5348	16	28.2	1.71	70.69	59.70	34.51	5.02
10	NT11410	100	149	41.1	5598	10	28.2	1.79	70.91	59.74	34.44	5.14
11	NT11428	100	151	48.9	6244	3	27.8	1.75	70.77	61.73	35.46	5.14
12	NT12403	100	148	42.7	4964	19	29.5	1.73	69.61	59.85	34.89	5.10
13	NT12404	100	148	40.3	4825	22	30.8	1.59	69.23	59.20	34.45	4.96
14	NT12406	100	149	44.4	5863	8	29.3	1.87	69.74	59.22	34.08	5.17
15	NE422T	100	151	54.0	6241	4	27.3	1.74	69.29	63.44	37.04	5.19
16	NT12412	100	150	43.1	5294	17	28.6	1.81	70.83	59.40	33.89	4.93
17	NT12425	100	150	49.4	5923	7	29.1	1.57	69.40	61.43	35.68	5.05
18	NT12440	99	150	36.6	3051	28	28.7	1.99	72.42	58.46	32.97	4.83
19	NT13403	100	148	40.1	4028	25	29.6	1.75	71.04	58.41	33.41	4.96
20	NT13405	99	149	43.0	3015	29	28.5	2.00	71.43	59.98	34.03	4.93
21	NT13410	100	151	41.3	4070	24	28.1	1.93	71.43	59.05	33.53	5.04
22	NT13411	100	148	38.3	3907	26	28.4	1.79	70.49	58.77	33.74	4.99
23	NT13412	99	153	39.3	2599	30	26.7	2.08	70.93	61.38	34.56	5.05
24	NT13416	99	148	45.6	5557	13	30.7	1.70	70.62	58.42	33.06	4.95
25	NE426GT	100	150	42.7	5530	14	28.7	1.71	70.28	60.49	34.78	5.09
26	NT13420	100	148	42.2	4908	20	28.9	1.65	69.91	60.08	34.89	4.96
27	NT13421	96	153	34.9	3107	27	26.6	2.10	71.96	60.72	34.38	5.10
28	NT13429	99	152	44.8	4440	23	25.9	1.95	71.27	62.45	35.62	5.35
29	NT13430	100	150	40.1	5571	12	27.3	1.77	70.77	59.71	34.10	5.05
30	NT13443	100	150	54.4	7069	1	31.4	1.55	69.59	61.36	35.66	5.18
	MEAN	99.3	149.78	42.9	5086		28.6	1.80	70.60	60.28	34.62	5.08
	LSD	5.5	1.3	2.5	917		1.6	0.22	1.79	1.87	1.47	0.21
	CV	3.9	0.62	4.2	13		3.879	8.75	1.80	2.19	3.02	2.99

The 2015 Forage data from western NE (thanks to Dr. Dipak Santra) are:

2015 Sidney Forage	Dry Forage Yield	Rank	Height	Mositure	Dry Matter
Name	lbs/a		(in)	%	%
NE422T	7605	1	68.0	0.65	0.35
NT01451	7452	2	46.3	0.58	0.43
NT06427	7290	3	46.0	0.55	0.45
NT06422	6794	4	47.0	0.61	0.39
OVERLAND	5811	5	38.3	0.57	0.43
NT07403	5344	6	41.8	0.64	0.36
NT09423	5251	7	47.3	0.63	0.37
NT11428	5235	8	53.8	0.63	0.37
NT05421	4310	9	51.0	0.61	0.39
NT11406	3356	10	45.5	0.62	0.38
CV	29.2		4.0	8.8	13.4
GRAND MEAN	5844.8		48.5	0.6	0.4
Heritability	0.3		0.9	0.1	0.1
LSD	2473.2		2.8	0.1	0.1

These trial results indicate that: 1. triticale produces more biomass and grain yield generally than wheat; 2. there is considerable GxE for forage yield; and 3. it very difficult to couple grain yield with forage yield. The comparison likely was affected by different stages of harvest as seen by the different dry matter contents.

Of the lines tested in all the grain and forage trials, NT09423 had good grain yield across the state, excellent forage yield in eastern NE. This highlights the need for testing our forage triticale lines in grain and forage trials across and beyond Nebraska.

The forage results from New York in 2014 are:

Year	Line	stage	% Dry Matter	DM T/A
2014	NE422T	early 10	13.60%	4.86
2014	NT01451	late 9	14.70%	4.87
2014	NT05421	9	13.40%	4.26
2014	NT09423	early 10	14.60%	4.99

The 2014 forage data from Sidney NE (thanks to Dr. Dipak Santra) are:

name	foragedry	Rank
	lbs/a Dry	
NE422T	5920	2
NT06427	5594	4
NT01451	5030	5
NT05421	6325	1
NT07403	4844	8
NT12403	4693	9
NT06422	5631	3
NT11406	3696	10
NT11428	4884	7
NE426GT	4964	6
MEAN	5158	
LSD	1049	
CV	16.89	

The 2013 grain yields from Nebraska and a collaborative site in Kansas are:

	Llincoln	Llincoln	Lincoln	Llincoln	Mead	NEB.	Rank	Kansas	NE + KS	Rank
2013	Height	Heading Date	Grain Yld	Test Weight	Grain Yld	Avg. Yield		Grain Yld	Avg. Yield	
name	(in)	Julian	Lbs/a	Lbs/bu	Lbs/a	Lbs/a		Lbs/a		
NE422T	60.3	150	2622	50.09	3826	3224.0	23	2512	2986.5	23
NE426GT	48.7	148	2482	47.16	3180	2831.0	29	2810	2824.0	29
NT01451	49.0	149	2641	47.30	3482	3061.5	26	2474	2865.7	26
NT05421	57.3	149	3550	50.89	4620	4085.0	7	2964	3711.5	7
NT05429	48.7	147	3870	48.85	3692	3781.0	13	2467	3342.9	13
NT06422	51.7	148	4186	47.49	3854	4020.0	9	2691	3577.1	9
NT06427	49.7	148	3005	46.86	3566	3285.5	22	2447	3006.1	22
NT07403	48.0	146	4291	52.14	4652	4471.5	3	2424	3789.2	3
NT09404	53.3	148	3116	47.82	3689	3402.5	18	2475	3093.4	18
NT09423	50.0	149	3768	49.88	4298	4033.0	8	2586	3550.7	8
OVERLAND	42.0	150	2867	58.71	3859	3363.0	19	2527	3084.4	19
NT10417	52.3	148	3429	45.53	3960	3694.5	16	2275	3221.2	16
NT10429	55.7	149	3274	51.57	5055	4164.5	6	2124	3484.2	6
NT10441	48.7	149	3532	48.30	3964	3748.0	14	1880	3125.3	14
NT11404	53.0	148	3411	47.16	3195	3303.0	21	2403	3003.0	21
NT11406	48.7	149	3342	46.58	3929	3635.5	17	1712	2994.4	17
NT11410	51.0	147	3763	47.34	4131	3947.0	10	1609	3167.8	10
NT11428	55.3	149	3708	49.03	3996	3852.0	11	1966	3223.4	11
NT11444	56.3	150	3276	48.91	4191	3733.5	15	3170	3545.7	15
NT12403	50.0	147	4002	53.28	4902	4452.0	4	2515	3806.3	4
NT12404	49.3	146	4230	49.95	4812	4521.0	2	2602	3881.4	2
NT12406	50.7	147	3728	50.36	3964	3846.0	12	1985	3225.7	12
NT12411	46.0	148	2275	46.20	3683	2979.0	28	2760	2906.0	28
NT12412	52.3	149	2784	48.82	3875	3329.5	20	2532	3063.6	20

The 2013 forage yields from Nebraska (thanks to Dr. Ken Vogel, USDA-ARS) and collaborative sites in Kansas and Oklahoma are:

2013 name	Mead Forage YLD lbs/a	KS Forage YLD lbs/a	OK Forage YLD lbs/a	Aver For lbs/a	Rank Forage
NE422T	8502	6975	2859	6111.8	15
NE426GT	8700	7827	4084	6870.3	2
NT01451	8385	8669	3403	6819.1	3
NT05421	8944	7502	3403	6616.4	7
NT05429	8864	6401	3539	6267.9	11
NT06422	8725	8803	4220	7249.2	1
NT06427	8597	6517	3539	6217.6	13
NT07403	8528	4874	3948	5783.3	21
NT09404	8154	5490	4220	5954.6	17
NT09423	7955	5711	4084	5916.4	18
OVERLAND	7156	3402	2723	4427.0	24
NT10417	8239	6874	3675	6262.8	12
NT10429	8916	6097	3812	6274.9	10
NT10441	8894	5659	3948	6166.8	14
NT11404	8282	7010	3948	6413.3	9
NT11406	7883	5674	3403	5653.5	23
NT11410	8859	7306	3403	6522.7	8
NT11428	8745	5045	3812	5867.0	19
NT11444	8652	5345	3403	5800.0	20
NT12403	8706	5679	3812	6065.4	16
NT12404	8214	5435	3539	5729.5	22
NT12406	8885	6642	4356	6627.5	6
NT12411	7969	8787	3675	6810.5	4
NT12412	8608	7666	3812	6695.3	5

The forage results from New York in 2013 are:

Variety	T/A DM
NT05429	3.56
NT06422	4.00
NT07403	2.88
NT0422T	3.61

The 2013 forage data from Sidney NE (thanks to Dr. Dipak Santra) are:

2013	Height	Forage	Rank	Dry Matter
Name	in	DM Lbs/a		%
NE422T	52.4	4885	3	0.325
NT01451	39.5	4467	8	0.337
NT05421	47.3	5184	1	0.358
NT05429	41.3	4547	5	0.34
NT06422	41.0	4294	9	0.336
NT06427	40.3	5156	2	0.357
NT07403	42.5	4494	7	0.358
NT09404	42.0	4873	4	0.347
NT10429	46.0	4514	6	0.345
NT10441	40.0	4093	10	0.342
Avearge	43.21	4650.5		0.344
LSD	7.0	535.8		0.019
CV	11.1	7.9		3.9
Heritability	0.33	0.41		0.29

The three-year (2013-2015) grain-yield data summary for locations where we were able to harvest trials is presented below:

2013-2015	Grain Yield (lbs/a) Linc.	Grain Yield (lbs/a) Mead	Grain Yield (lbs/a) Sidney	State Avg Yield lbs/a	Rank	State Avg. Hdate (d after Jan.1)	State Avg. Height (in)	Test Weight Lbs/bu	Winter Survival %	Bacterial Streak (1-9)
NE422T	2214	2202	3136	2340	**15**	151.3	61.6	50.1	97.6	3.2
NE426GT	2329	2363	3499	2511	**14**	146.6	49.0	47.2	99.6	4.0
NT05421	3033	3131	3829	3189	**2**	146.0	55.4	50.9	99.6	3.2
NT06422	3126	2598	3802	2996	**6**	144.8	51.0	47.5	99.6	3.8
NT06427	2767	2307	3742	2709	**13**	146.0	48.1	46.9	99.8	3.0
NT07403	3385	2846	3481	3168	**4**	142.4	46.2	52.1	99.6	3.8
NT09423	3049	3066	3936	3183	**3**	147.4	48.1	49.9	99.6	1.7
NT10417	2606	2520	3912	2756	**12**	148.2	49.2	45.5	100.0	3.3
NT11406	2890	2408	3789	2812	**11**	147.4	48.2	46.6	100.0	2.8
NT11428	2997	2614	3416	2893	**8**	147.5	54.1	49.0	100.0	2.9
NT12403	3411	3104	4005	3364	**1**	144.7	48.3	53.3	100.0	4.3
NT12404	3157	2949	3535	3122	**5**	144.9	47.8	49.9	98.3	4.2
NT12406	2922	2696	3859	2959	**7**	146.6	51.6	50.4	99.7	4.8
NT12425	2968	2648	3172	2860	**9**	146.0	54.3	49.7	99.9	3.0
OVERLAND	2604	2683	3875	2819	**10**	145.5	39.4	58.7	97.5	2.8

The three year data for forage yield from Mead are:

name	Dry Forage	Dry matter	IVDMD	NDF	ADF	ADL	Protein	
	Yield (Lbs/a)	%	%	%	%	%	%	Rank
NE422T	7284	0.273	67.8	65.6	39.4	5.5	11.1	9
NE426GT	7350	0.285	68.8	62.7	36.8	5.4	10.9	7
NT05421	7380	0.292	67.1	64.7	38.8	5.6	10.4	6
NT06422	7022	0.294	67.7	63.2	37.9	5.4	10.0	11
NT06427	7480	0.292	69.2	62.3	36.7	5.4	11.0	5
NT07403	6595	0.307	68.8	61.6	36.5	5.3	10.3	14
NT09423	7648	0.272	68.5	64.0	37.7	5.5	11.3	4
NT10417	6683	0.282	68.9	63.5	37.4	5.4	11.2	13
NT11406	6934	0.281	68.2	63.6	37.7	5.4	10.6	12
NT11428	7838	0.285	68.5	64.3	38.2	5.4	10.5	3
NT12403	7023	0.292	67.6	63.4	38.0	5.5	10.2	10
NT12404	7297	0.306	68.2	61.7	36.6	5.2	9.8	8
NT12406	8023	0.296	67.9	62.9	37.5	5.6	10.9	1
NT12425	7865	0.293	67.3	64.5	38.7	5.6	9.4	2
OVERLAND	6569	0.300	69.5	62.2	36.8	5.2	11.5	15

It is clear that we have made progress in grain yields in triticale and that normally triticale has a higher grain yield than winter wheat. Marketing remains the major limitation to improving triticale's impact in modern agriculture.

10. <u>Collaborative Research on Wheat Diseases</u>

Dr. Stephen Wegulo, Department of Plant Pathology, and his staff continue to inoculate our experimental lines with wheat stem rust and Fusarium head blight (FHB, research funded by the U.S. Wheat and Barley Scab Initiative), and as time permits with wheat leaf rust. We continue to improve the greenhouse tests for stem rust. With the advent of the new race of stem rust, Ug99 (which can overcome some of the previously very durable resistance genes in wheat which were the main genes used in our program), we have greatly increased our efforts to introgress and pyramid new genes with our existing genes through the use of molecular markers.

Work continues on introgressing the resistance from *Agropyron* (*Wsm1*), but there appears to be a significant reduction in yield with the gene which may preclude its widespread use. The newer source for resistance/tolerance, *Wsm2*, developed by Scott Haley (CSU) in collaboration with KSU is also being introgressed. It seems to have less effect on agronomic performance, but also may not be as effective in Nebraska as *Wsm1*. Thanks go to Dr. Gary Hein, entomologist, who is testing them in the field. The frequency of lines carrying *Wsm1* resistance remains far lower than expected. With the continued spreading of wheat soilborne mosaic virus into our Lincoln fields (a key early generation testing site), we are now able to select for wheat soilborne mosaic virus resistant lines and many of lines have this beneficial trait.

11. The Effect of Fusarium Head Blight and Stripe Rust on Grain Yield of Hard Winter Wheat in Lincoln, NE. Javed Sidiqi, P.S. Baenziger, and S. N. Wegulo

To determine the effect of fungal plant pathogens on grain yield in eastern NE, we initiated a study in 2015 to compare fungicide treated and untreated plots using our elite nursery. While it is well documented that diseases reduce grain yield and fungicide use is becoming more common, growers still debate the cost and value of using fungicides. The purpose of this experiment was to provide growers with information on the value of fungicides so they can make informed decisions and also learn about our advanced breeding lines and how they respond to fungicides in the presence of disease. The Nebraska elite nursery contains 60 lines (two historic check cultivars, 6 cultivars, and 52 unreleased elite lines). Two fungicide regimens, treated vs. untreated, were utilized. In the treated plots, Cruiser Max® was used to treat the seed before planting. Then at early spring green-up the plots were sprayed with Priaxor®. At flag leaf, the plots were sprayed with Twinline® followed by Caramba® at flowering. Seed treatments and fungicides were not applied to the untreated plots. Each fungicide treatment (treated and untreated) had 60 genotypes replicated twice in an alpha lattice design with an incomplete block size of 5 entries. Grain yield was harvested using a small plot combine and the grain was weighed after drying in the seed house. Eastern Nebraska receives on average 65 to 75 cm of rainfall annually. In 2015, the Lincoln research station received 42 cm of precipitation from 1 May to 15 June. The average flowering date for winter wheat in our elite trial was 24 May with a range from 20 May to 29 May. Hence, the conditions were ideal for Fusarium head blight (FHB, incited by *Fusarium graminearum*.). The other major disease present was stripe rust (incited by *Puccinia striiformis* f. sp. *tritici*). Other diseases that are favored by cool moist conditions were present, but not to the extent of FHB and stripe rust. Average FHB index in the untreated plots was 56% (range 4% to 96%) compared to 10% in the treated plots (an 82% reduction in index; range 0% to 68%). Yield in the treated plots averaged 3460 kg/ha (range 4860 kg/ha to 1360 kg/ha) compared to 1940 kg/ha (a 44% reduction in yield; range 3500 kg/ha to 340 kg/ha). On average, the diseases caused a 44% reduction in yield (excluding the two historic check cultivars which actually yielded higher in the untreated plots; yield loss due to disease ranged from 15% to 86%). There was a significant negative correlation between FHB index and yield in the untreated plots (R = -0.38; P = 0.0034) indicating that some lines had good FHB resistance whereas others were susceptible. In contrast, there was no correlation between FHB index and yield in the treated plots (R = 0.04; P = 0.7454), indicating the effectiveness of Caramba® applied at flowering in suppressing FHB. The stripe rust reactions varied among lines from highly resistant to highly susceptible. In looking at those lines which had infection scores of 1-3 (on a 1= resistant to 9= susceptible scale) for stripe rust, the grain yield loss averaged 30% presumably due to FHB. In looking at those lines with infection scores of 7-9 for stripe rust, the grain yield loss averaged 50%. In both the resistant and susceptible to stripe rust groups, lines varied in their response to FHB with the best lines having only a 15% or 27% yield loss, respectively. Though not measured, the effects on grain volume weight and seed germination were obvious in preparing and planting seed this fall. This experiment will be repeated to provide multi-year disease loss information and to ensure having high quality seed for planting. Growers in eastern Nebraska were warned of the scab epidemic and many decided to use fungicides despite the low price of wheat. Clearly this year fungicides were economically beneficial, especially when coupled with cultivars that also had some tolerance or resistance to FHB and stripe rust.

12. Fusarium Headblight (FHB) Breeding Research: S. Wegulo, G. Bai, P. S. Baenziger

In previous research, we found *Fhb1*, a major gene for scab (syn. Fusaium head blight) tolerance, was not pleiotropic or linked to genes that reduce grain yield. We are using high yielding *Fhb1* lines from segregating populations and Wesley *Fhb1 or* Overland *Fhb1* in our crossing block. For the first time, we are seeing lines in our multiple-location observation nursery that contain *Fhb1*, indicating our breeding strategy is beginning to work. The backcrossing approach is probably the best way to move needed genes into adapted line for further wheat improvement. We wish to thank the **U.S. Wheat and Barley Scab Initiative** for funding a much improved misting system to evaluate our lines for scab tolerance.

14. Breeding for Organic Systems: R. Little, P. S. Baenziger, T. Regassa

Quality tests, soil analyses and data analyses were completed for 12 cultivars and experimental lines in environments after either soybeans or alfalfa in a "Nitrogen-Use-Efficiency-for-Quality" experiment. Baking of white bread and reconstituted whole wheat bread was completed for each of these lines at 2- or 3- protein content levels. The samples are composites of wheat from both alfalfa and soybean environments. Total soil nitrogen and mineral nitrogen changes were compared to the amount of nitrogen in the harvested grain to determine whether low-protein lines that bake well use as much nitrogen as the high-protein lines. Best performing cultivars are presented first, followed by a summary of mixograph tests from the two environments across years, and comments on using key mixograph variables for predicting bread quality based on previous tests.

NW07505 excelled for the trait of "nitrogen use efficiency for bread quality." NW07505 ranked with Lyman as the highest yielding cultivar, had a large gain in soil total N, was moderately low in soil mineral N depletion per bushel, and excelled for bread baking quality at the lowest protein content level. This distinction comes with a tradeoff. The high bread quality of NW07505 appeared to result from high Short Yield and a consequently low Flour Yield, which were consistent traits for NW07505 across years. This report should stimulate interest among farmers and bakers for the anticipated release of NW07505 on the market, while raising some concerns among millers about the low milling yield. NE06607 emerged as a star performer in this 3-year study, and must be resurrected as a potential cultivar for organic production. This is a welcome development, as NE06607 showed promise for its low DON vomitoxin content in trials in Vermont. On the other hand, NE07444, which had appeared to be a top performing line with excellent quality at low protein content, performed near the bottom of this set, next to our confirmed marginal bread quality cultivar, Overland.

Milling and dough characteristics were discovered that could predict reduction flour (RF) and reconstituted whole flour (WF) straight dough bread baking performance. The most significant predictors of excellent RF Bread Quality, along with single kernel weight (SKWT), were long dough mix time (DMT) and short dough proof time (DPT) explaining 51% of the variation in RF bread quality. A long DMT strongly contributed to improved RF bread score despite its negative correlation with specific loaf volume and exterior score. A long DPT was even more detrimental (negatively correlated) to WF bread performance.

Mixograph tests were performed on wheat cultivars from each environment (wheat after soybeans and wheat after alfalfa for two years (see table below). The search for quality characteristics that vary minimally with the environment and lack correlation with protein content singled out RFMPT, RFMTI (midline tail integral), and RFMTW (midline tail width). The values for these variables fluctuated depending on the previous crop. In the across year analysis, RFMPT was not significantly different among cultivars; whereas RFMRV (midline right value) emerged as the only variable with promise as a bread quality predictor that was significantly different among cultivars without interactions with the environment, yet was highly correlated with protein content.

Significance of Differences for Milling and Mixograph Properties, 2013 – 2014

	RFPRO	FLOURY	BRANSC	RFMABS	RFMPT	RFMPV	RFMRV	RFMRW	RFMTW	RFMTI	RFMTOLSC
Model	**	NS	**	NS	NS	*	*	NS	NS	NS	NS
YEAR	***	NS	**	***	NS	NS	NS	NS	NS	NS	NS
MP "Previous Crop"	NS	***	NS	NS	NS	NS	NS	NS	*	NS	NS
Entry "Cultivar"	***	NS	**	NS	NS	***	***	NS	NS	NS	NS
YEAR*Entry	NS	NS	**	NS	*	NS	NS	NS	*	**	**
YEAR*MP	***	*	NS	***	*	*	NS	*	*	*	NS
MP*Entry	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS
YEAR*MP*Entry	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Coefficient of Variation (%)	3.9	1.5	11.6	2.1	6.9	3.5	3.3	12.4	10.6	6.9	6.8
R-Squared	0.83	0.98	0.85	0.78	0.98	0.83	0.81	0.91	0.96	0.92	0.95

NS = not significant at P < 0.05, * is P < 0.05, ** is P < 0.01, *** is P < 0.001

While we remain committed to developing wheat cultivars for all potential uses in Nebraska, due to lack of funding, we have significantly curtailed our organic winter wheat breeding efforts. Of course, we continue to work and support our many friends in organic production. Thanks to funding from the CERES Trust, we have evolved our organic research to working on organic triticale primarily as a cover crop which can be crimped to control weeds in organic production fields. Of course, triticale is also an excellent forage crop for farms with livestock and crops.

14. Prospects for Selecting Wheat with Decreased Cadmium Concentration in Grain: C. Liu, M. Guttieri, P.S. Baenziger, D. Rose, and B. Waters

Wheat (*Triticum aestivum* L.) is a primary staple cereal and a significant source of mineral nutrients in human diets. Therefore, decreasing concentration of the toxic mineral, cadmium (Cd), could significantly improve human health. Previously we found, grain Cd concentration of some genotypes grown in Nebraska trials were above the Cd Codex guidance level (> 0.2 mg kg-1), and highly repeatable differences in grain Cd were found between pairs of low and moderate-Cd commercial cultivars. Grain Cd concentration was predicted by Cd concentration in aboveground plant tissues at anthesis. Genome-wide association scans using high density SNP markers identified markers on 5AL associated with grain Cd in a region homoeologous to the Cdu1 locus on 5BL in durum wheat (*Triticum turgidum* L. var. durum Desf.). Our current work is to study the level of Cd in mill streams, the uptake of Cd, and ways to select for lower Cd.

15. Hybrid Wheat: N. Garst, A. Easterly, P.S. Baenziger, A. Ibrahim (Texas A&M University), J. Rudd (Texas A&M University), and Bhoja Basnet (CIMMYT)

One of the great opportunities and challenges for wheat improvement is the development of hybrid wheat. Currently numerous companies have hybrid wheat breeding efforts with Saaten Union Recherche, France be one of a few companies that markets hybrid wheat. Our belief is that the public sector needs to have a public, transparent hybrid wheat breeding effort to advance the science and educate the next generation of plant breeders. As such, we have been working on hybrid wheat for the past 5 years.

Three systems by which to produce hybrid seed have been proposed in the literature. The first is through use of cytoplasmic male sterility (CMS) in a similar manner as the A-, B-, and R-Line system used in generation of hybrid sorghum. Wheat lines with a *Triticum timopheevi* Zhuk. cytoplasm are often used for the A-line and produce stable cytoplasmic male sterility. CMS presents a challenge, however, in that A-and B-lines must be developed and maintained prior to and during any large-scale production of hybrid seed. The second method of seed production is through use of thermo- or photoperiod-sensitivity genetic male sterility, a process that comes with a number of considerations for the logistics of managing and maintaining seed quality. The third involves the chemical emasculation of female parents through use of chemical hybridization agents (CHAs) — also referred to as gametocides. Commercial production of these chemicals has been in place for a number of years. The use of CHAs has limitations in that the window of application is small and requires careful calibration and application for highest efficacy, but provides a simple approach and is conducive for large-scale production of hybrid seed.

To develop experimental hybrids, crossing blocks were planted in the fall of 2014 and treated with a CHA (thanks to a collaboration with Saaten Union Recherche, France) in 2015 to develop a 650 experimental hybrids. To measure CHA-induced sterility, we visually assessed gaping heads (routinely seen in genetic and cytoplasmic male sterility) and phytotoxicity, induced male sterility using bagged heads, and then harvested yield. Over 85% of the bagged heads had three seeds or less, giving us a conservative estimate of over 90% sterility. Phytotoxicity was measured and appeared to be higher in the Nebraska germplasm than in the Texas germplasm. We believe this was most likely due to a staging error prior to the application of the CHA. The Nebraska and Texas lines were very similar in immature head length in the early spring when we sprayed; thus, we sprayed all of the lines in the female block on the same day. However, the Nebraska lines flowered three days later than the Texas lines, indicating we may have sprayed the NE lines too early. That phytotoxicity with the CHA was low in the Texas material, which indicated that when CHA is properly applied, we see low incidence and severity of phytotoxicity. In the crossing block for the 2015/16 season, staging was adjusted accordingly. Anther extrusion, how well anthers are shed out of the florets, scores were important in the crossing blocks where the male lines averaged values of four to eight, with nine indicating a line with excellent anther extrusion. The correlation between harvested grain yield and anther extrusion in the male pollinator line was $r=0.59$, $P < 0.01$). The average grain yield on the female plots pollinated by Freeman, one of our best anther extruding lines (anther extrusion score: eight), was 768 g/plot. The seed set on the female lines pollinated by Freeman was also helped in that Freeman is a moderately late line; thus, the maximum amount of pollen would be shed while the female lines were "gaping" indicating a proper nick for the parents to produce hybrid seed.

Hybrid seed comes at an annual cost to farmers, and as such, evaluation must be made to precisely determine the amount of heterosis exhibited for yield and other key traits in hybrid wheat. The 650 hybrids developed from the crossing block of 2014/15 were planted in Lincoln, North Platte, and Alliance in Nebraska to evaluate hybrid performance across the different climate zones of the state. A fourth hybrid yield trial was planted in Prosper, TX in collaboration with Drs. Jackie Rudd and Amir Ibrahim. The yield of these experimental hybrids will be compared against three standard commercial checks. Initial evaluation of the trials showed excellent purity of nearly all hybrids and ratings for performance have been noted throughout the growing season. The same hybrids will be planted again for the 2016/17 season to validate results generated this summer. These hybrids will also be used to build predictive models for the development of heterotic pools and screening of potential future hybrids.

Production costs must be controlled if hybrid wheat will be a viable option for growers in the near future. The major problem in production is the floral architecture, specifically male characteristics, of wheat. In 2014 and 2015, 290 diverse lines from across the Great Plains were rate for anther extrusion on a 1 to 9 scale with 9 indicating excellent extrusion. The results showed that many Nebraska lines were good to excellent for anther extrusion with Freeman as an example of excellent. Other lines were very poor for anther extrusion with Camelot being a line which extrudes almost no anthers. The next object for this research will be to evaluate a Camelot x Freeman doubled haploid population starting in 2017 and evaluate the association mapping panel in 2016 and 2017 for anther extrusion with the idea that we can identify markers which could aid in selection for better male parent characteristics and give an idea of the genetics behind anther extrusion.

16. Enhancing wheat (*Triticum aestivum* L.) drought tolerance using SNP markers based on high throughput genotyping by sequencing technology: Waseem Hussain, P. Stephen Baenziger, Vikas Belamkar, Mary Guttieri, Amanda Easterly, Jorge Venegas and Jesse Poland

Drought globally is the most wide spread limitation to wheat productivity and stability in rainfed systems. The Great Plains wheat belt has been battling drought for years. Consequently developing wheat cultivars with enhanced drought tolerance and high yield has been the focus of many wheat improvement programs. Improving drought tolerance is challenging due to its complex nature and previous studies conducted in identifying key genes/quantitative trait loci (QTL) were based mostly on low-density markers and not able to provide precise information about the numbers and locations of QTLs controlling the traits related to drought. To increase the power and precision of QTL mapping in wheat, the need is to develop a high density linkage maps. Genotyping-by-sequencing (GBS) is one of the next generation sequencing method that allow sequencing, discovery and genotyping of thousands of SNPs in cost effective manner and quickly. The SNPs generated through GBS can be used to develop the high density linkage maps for precision QTL mapping in wheat. High density linkage maps may be useful to genetically dissect and find the key genes underlying complex traits like grain yield in wheat. The present project was undertaken with following objectives to: (i) determine genetic variability of the recombinant inbred lines (RILs) derived from contrasting parents Harry x Wesley for several morpho-physiological traits under multiple rainfed environments (ii) develop high density linkage map based on GBS generated SNPs in 204 recombinant inbred lines (RILs) (iii) determine the reliability of the newly constructed map with known tagged genes of chaff color and wax/ glaucousness, and (iii) identify QTLs and QTL x environment interaction for several morpho-physiological traits. After stringent filtering, a high-density linkage map was constructed with 2923 SNPs distributed on 36 linkage groups. The total length of linkage map spanned 5269.34 cM with an average distance of 1.79 cM between adjacent markers. The high accuracy and reliability of this map was illustrated by finding and co-localizing the genes for chaff color and wax/glaucousness to correct and previously mapped genomic regions. For plant height in total 18 QTLs were identified across all locations on linkage groups 2DS, 2BL, 3A, 3B.3, 6A.2, 7AL and 7B.2 and phenotypic variance explained by these QTLs ranged from 4.9 to 16.8 %. Six QTLs revealed significant interactions with environment and accounted 1.11 to 2.73% of phenotypic variation. Interestingly a major QTL *qph.hw.2DS* was found in all the five environments. It explained 7.4 to 16.4% of phenotypic variation and height reducing allele for this QTL was contributed Wesley. QTL mapping for grain yield revealed in total 14 QTLs across all locations on linkage groups 2D, 3A, 4A, 4B, 5B, 6B, 6D and 7A. The phenotypic variance explained by these QTLs ranged from 3.9 to 19.47 %. QTL *qyld.hw.6B.2* was stable and detected in 3 locations followed QTL *qyld.hw.6B.1* detected in two locations. Favorable alleles for grain yield were contributed by both the parents. Digenetic interactions between QTLs was evident, however, none of the interactions were stable across locations. Six QTLs revealed significant interactions with environment and accounted 1.94 to 18.46 % of total phenotypic variation.

17. Genotype-by-sequencing for SNP discovery and genotyping; field trial analysis by incorporating spatial trends; and integration of genomic selection in the Nebraska Wheat breeding program: Vikas Belamkar, Mary J. Guttieri, Ibrahim El-basyoni, Waseem Hussain, Jesse Poland, Diego Jarquín, Aaron J. Lorenz, and P. Stephen Baenziger

The Nebraska wheat breeding program has released ~36 varieties to date, and has a vital role in feeding millions of people. In order to meet the global food demand wheat yields need to increase by 1.7% a year. However, the current increase in yield is only 0.9% a year. Genomic selection (GS) can rapidly increase genetic gain over time by increasing selection intensity and selection accuracy, and reducing generation interval time in a breeding program. The objectives of this study are (1) Build a pipeline to analyze genotype-by-sequencing (GBS) data for SNP discovery and genotyping; (2) Incorporate spatial trends while analyzing field trials to generate accurate best linear unbiased predictions (BLUPs) or estimates (BLUEs); and (3) Inspect whether GS can (a) Predict performance of new lines in a trial; (b) Improve accuracy of selection decisions; (c) Recycle elites line earlier to the crossing block; (d) Reduce costs by phenotyping a subset of lines; and (e) Predict performance of lines across locations.

This work comprised 1,100 entries from four independent $F_{3:6}$ nurseries (a.k.a. DUP trials) evaluated during 2012-2015 at 27 environments (year x location combinations). Each year the $F_{3:6}$ nursery was composed of ~267 entries and three checks, which were grown in a single replicate augmented design at five to eight locations in Nebraska. Yield (kg/h) was analyzed using a mixed model analysis pipeline built for analyzing augmented trials while accounting for global-trends (experimental design), local-trends (spatial variation within the trial), or both. For 22 of the 27 environments, models adjusting for spatial variation provided better fit to the data. Spatially corrected BLUPs from the best performing mixed model were generated and used in the downstream analysis.

Genotype-by-sequencing was used to discover and genotype SNP markers. A SNP database was built for the breeding program by analyzing GBS data of ~3,300 unique genotypes sequenced from 2012-2015. The average accuracy of SNP calling tested using lines sequenced multiple times was >95%. Nearly 206,622 SNPs were identified in the breeding program, and are available for multiple projects in the breeding program. Filtering the SNPs with maximum missing percentage of less than 80% reduced the SNPs to 79,118. These SNPs were then processed through the imputation algorithm, and the genotype calls were successively imputed. Further filtering of SNPs by applying filtering relevant to GS (SNPs with minor allele frequency greater than 0.05 and imputation accuracy value of allelic R^2 greater than 0.5) provided 26,925 high-quality SNPs across the 1,100 lines for GS.

Genomic estimated breeding values (GEBVs) were generated using BGLR package and customized R-scripts, and Reproducing Kernel Hilbert Space Regression (RKHS) model. For each of the years (2012-2015), genomic prediction ability (PAB) was estimated by randomly marking entries as missing in steps of 10% - from 10% to 90% of dataset. For example, 50% of the lines are marked as missing in 2012, and the rest of the 50% of the entries in 2012 and all of the entries from 2013, 2014, and 2015 are used to predict the performance of the 50% of the entries marked as missing in 2012. This process is repeated 10 times by randomly marking 50% of the entries missing in the 2012 trial. The correlation value between GEBVs and observed phenotypic values (OPVs; BLUPs) for each of the run is recorded. This correlation value is referred to as prediction ability (PAB). We also estimated prediction ability (PAC) by marking 100% of the entries missing in a year, and using the data from rest of the years to make predictions. This scenario is similar to predicting performance of new lines in a trial using the data from previous years. Average PAB calculated using 10-fold cross validation ranged from 0.229 to 0.552, and PAC varied from 0.167 to 0.282.

The prediction ability values may not be truly helpful from a practical breeding perspective. They do not provide enough confidence for ranking lines based on GEBVs instead of spatially corrected BLUPs, or observed phenotypic values. In order to address this question, we tracked entries from each of these four nurseries that were advanced. It was remarkably apparent that lines with "above average GEBV and BLUPs" were being retained for longer times in the breeding program. This suggests using GEBV together with BLUPs can improve accuracy of selection decisions and recycle elite lines earlier to the crossing block.

Prediction ability estimated with 50% of the entries missing in each year, found more winners (entries) with above average GEBV and BLUPs. Hence, evaluation of only 50% of the entries in a year to make accurate selections seems possible. Improving PAC from the current value of ~0.20 to >0.37 will trigger examining skipping of a field trial year.

Currently, we are exploring GS models integrating GXE information; utilizing multi-year, multi-location evaluation of $F_{3:6}$ nurseries (DUP trial) to assist in selecting entries suitable for advanced multi-location yield trials from the $F_{3:5}$ nursery (a.k.a. WS4R8 nursery), which has ~1,800 entries and is tested at a single location. Also, GS for quality traits is in progress.

IV. GREENHOUSE RESEARCH

In 2012, the majority of F_1 wheat populations were grown at Yuma, AZ. Mainly populations needing additional crosses are being grown in the Lincoln Greenhouses. This change reduced our greenhouse space and greenhouse labor, and provided much greater quantities of F_2 seed. We made more than 100 triticale, 100 barley and 1000 wheat crosses in last year's fall, winter, and spring greenhouses.

V. PROPRIETARY RESEARCH

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. Infinity CL and Settler CL are outcomes of this research. We are now concentrating on two-gene herbicide tolerant wheat cultivars. In 2009, UNL began collaboration with ConAgra (now part of Ardent Mills). They support our McCook Nursery and provide valuable information on the end-use quality of our lines at that site, which is a key sourcing site for their Colorado mills. In 2010, UNL developed a collaboration with Bayer Crop Science that allows non-exclusive access to UNL germplasm 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. This collaboration has led to extensive collaborations and interactions on genetics, plant breeding, and crop physiology. Having their excellent staff in Lincoln has been very advantageous to student and staff interactions. In 2012, we evaluated more than 900 doubled-haploid lines created in collaboration with Limagrain and are evaluating lines in replicated trials at numerous locations. We continue to develop germplasm exchange agreement with private companies as their germplasm is becoming increasingly relevant. Our goal continues to be the "People's University" and to work will all public and private wheat researchers in a manner compatible with the landgrant mission.

USDA-ARS projects at the University of Nebraska are not party to these agreements.

We received our 11th year of research and development fees from an agreement with Paramount Seed Farms (a commercial seed company) for the exclusive release of our winter barley germplasm. We are fortunate that they took the initial risk of building a market for our germplasm when no one else was interested. No new barley lines were released in 2014, but P-845 (released in 2013) and two new lines are recommended for release in 2016.

We had extensive winterkilling or drought stress on barley in Kansa and in Sidney and Mead, Nebraska. We will able to continue the nurseries and harvested sufficient seed to advance lines. We have made substantial progress in working with local brewers (which are expanding), supported growers to plant their first commercial spring malting barley field (with great advice from Drs. R. Horsley, K. Smith, and J. Wiersma) for local beer production and hope to have local craft maltsters/distillers in Nebraska in the future.

Though the winterkilling was severe in Nebraska where our main breeding nurseries are, we were able to salvage the breeding program. In fall, 2014, we planted a new set of F2s and the surviving F3 populations. Our headrow nursery was reduced by about 30%, but we expect the lines to be very winterhardy. The remaining nurseries have their normal size.

With the current level of private sector investments in research, additional public-private interactions are to be expected and we are developing relationships with many other organizations. A key goal will be to develop working relationships that benefit the producer, the customer, and the public good.

The 2015 barley data are:

2015		Yield			
Entry	Name	Lincoln	Mead	Average	**Rank**
		lbs/a	lbs/a	lbs/a	
26	NB14401	2009.3	995.7	1502.5	**20**
27	NB14403	2391.7	1855.0	2123.3	**12**
28	NB14404	3149.7	2092.5	2621.1	**6**
29	NB14405	3080.0	2123.7	2601.8	**7**
30	NB14409	2507.0	1582.0	2044.5	**13**
31	NB14412	3096.7	1373.3	2235.0	**10**
32	NB14414	2733.7	1111.7	1922.7	**15**
33	NB14417	2900.0	1086.7	1993.3	**14**
34	NB14418	2583.3	1025.5	1804.4	**17**
35	NB14422	3076.3	1395.3	2235.8	**9**
36	NB14423	2579.3	1052.3	1815.8	**16**
37	NB14428	3060.7	2084.3	2572.5	**8**
38	NB14429	3231.7	2039.0	2635.3	**4**
39	NB14430	3174.3	2464.7	2819.5	**1**
40	NB14433	3446.0	2162.0	2804.0	**2**
10	NB99845	2623.3	863.0	1743.2	**19**
1	P-713	3108.0	2196.0	2652.0	**3**
2	P-721	2491.0	1896.0	2193.5	**11**
3	P-954	3114.7	2142.0	2628.3	**5**
4	TAMBAR 5	2104.7	1391.3	1748.0	**18**

The 2014 barley data:

Name	Lincoln	Mead	Colby, KS	Colby, KS	Sidney,NE	Average	Rank	Colby, KS	Colby, KS	Average
	Winter	Winter	Heading	Yield	Yield	Yield		Moisture	Test Wt	Height
	Survival	Survival	Date							
	%	%	Julian	lbs/a	lbs/a	lbs/a		%	lbs/bu	in
P-713	19.3	68.0	141.9	2978	2041	2510	18	10.8	44.8	26.9
P-721	5.9	84.1	142.1	2872	1918	2395	23	10.1	45.9	26.2
P-954	10.9	83.3	142.9	3186	2488	2837	6	10.8	47.6	26.0
TAMBAR 501	3.3	71.4	140.2	2651	1322	1987	34	10.2	41.4	25.6
NB09437	11.5	74.7	142.6	2565	908	1737	37	11.4	47.9	27.6
NB09441	0.0	67.7	137.7	2500	879	1690	38	10.0	41.4	25.9
NB10403	11.7	79.2	137.8	2028	2763	2396	22	11.5	45.8	27.8
NB10409	8.1	74.3	143.0	2931	1507	2219	29	11.1	51.2	28.1
NB10417	0.0	80.7	139.1	2845	1986	2416	21	10.3	43.7	25.0
NB10420	2.7	40.1	139.9	2413	1719	2066	31	10.6	46.9	26.2
NB10425	2.8	67.3	141.8	3077	1555	2316	27	10.2	44.7	27.4
NB10440	2.7	71.3	139.7	2598	1543	2071	30	11.4	46.5	27.7
NB10444	0.0	64.7	140.2	2596	3157	2877	3	11.2	45.3	26.1
P-845	2.7	79.9	141.1	3084	2530	2807	7	10.8	46.9	24.5
NB11414	0.0	40.9	142.3	2841	2953	2897	2	10.7	46.0	26.0
NB11416	11.0	65.6	141.5	3212	2107	2660	12	10.6	43.7	27.5
NB11418	9.3	71.5	141.7	2885	2489	2687	10	10.5	46.0	24.8
NB11430	0.0	75.4	139.9	2925	2124	2525	17	10.9	47.9	28.0
NB12419	16.6	82.6	142.4	3153	1853	2503	19	11.0	45.4	27.1
NB12421	53.4	83.5	142.8	3423	2261	2842	5	12.0	44.8	25.9
NB12422	3.4	79.1	142.7	3359	1168	2264	28	10.4	47.8	26.1
NB12424	0.1	72.6	143.0	3181	1524	2353	25	11.0	47.4	25.3
NB12425	21.7	83.4	142.6	3336	2689	3013	1	10.8	45.4	25.7
NB12426	2.7	81.4	142.4	3249	1920	2585	15	11.2	47.3	28.2
NB12431	2.8	74.3	140.7	3266	2430	2848	4	11.1	46.5	24.4
NB12433	-0.1	52.7	141.2	3149	1929	2539	16	11.2	47.7	23.7
NB12434	18.3	76.1	140.2	3152	2360	2756	8	10.2	44.5	24.9
NB12436	5.9	65.1	140.7	3055	1646	2351	26	10.9	46.0	27.4
NB12437	21.6	73.6	141.7	3122	1637	2380	24	10.3	45.8	26.7
NB13401	0.0	82.7	142.1	3056	2266	2661	11	10.4	45.2	27.2
NB13415	9.4	61.0	141.3	2661	2532	2597	14	10.7	45.9	27.4
NB13430	0.1	51.3	141.1	2905	1965	2435	20	10.8	42.3	26.2
NB13434	0.0	30.5	144.2	2333	1641	1987	33	10.9	44.8	27.1
NB13435	0.0	46.3	143.0	2649	2624	2637	13	11.5	47.4	26.1
NB13436	0.0	38.1	143.0	2888	2617	2753	9	11.2	47.7	24.4
NB13437	0.1	21.6	142.1	2346	954	1650	39	11.0	43.0	24.9
NB13438	0.1	28.3	142.1	2509	1433	1971	35	10.9	44.5	23.3
NB13440	0.0	13.4	144.1	2295	572	1434	40	10.9	45.6	23.1
NB13441	0.0	45.3	138.4	2702	1048	1875	36	11.2	45.9	22.2
NB13442	0.0	33.2	143.5	2611	1519	2065	32	12.4	43.9	24.5
GRAND MEAN	**6.4**	**63.4**	**141.5**	**2865**	**1914**	**2390**		**10.9**	**45.7**	**26.0**
LSD	**6.8**	**19.2**	**2.1**	**633**	**1505**			**1.6**	**6.6**	
CV	**99.4**	**28.6**	**0.8**	**11**	**48**			**7.6**	**7.3**	

Of the released cultivars (Table 1), P-954 did very well as expected, because it is one of the most winter-hardy lines developed at UNL. P-845 (released last year) also did very well. One of the surprises was that TAM BAR 501 (developed in Texas and which normally has acceptable winter-hardiness) did poorer than normal in Colby, KS and Sidney, NE.

The 2013 barley data are:

	Colby			Lincoln				Mead					
	Plant Height	Grain Yield	Test Weight	Heading Date	Plant Height	Lodging (rate)	Grain Yield	Heading Date	Plant Height	Lodging (rate)	Grain Yield	Mean Yield	
Name	**Inch**	**lbs/a**	**lbs/bu**	**After April 1**	**Inch**	**0-9**	**lbs/a**	**After April 1**	**Inch**	**0-9**	**lbs/a**	**lbs/a**	**Rank**
NB12437	22	1505	45	19	33	0	5212	22	31	2	5664	**4127**	**1**
NB11430	23	1700	45	18	34	0	5369	20	31	1	5242	**4104**	**2**
NB10425	21	1946	47	19	33	0	5329	24	33	1	4993	**4089**	**3**
P-845 (NB99845)	18	1670	45	19	31	0	5247	23	30	0	5240	**4052**	**4**
NB09404	21	1720	46	18	35	0	5084	20	33	0	5242	**4015**	**5**
NB12424	18	1576	45	19	31	0	5144	23	32	0	5278	**3999**	**6**
NB12419	20	1890	48	20	31	0	4784	23	32	0	5237	**3970**	**7**
NB12434	20	1551	47	17	31	0	5155	21	30	2	5082	**3929**	**8**
NB09409	19	1782	47	19	32	0	5057	23	33	2	4942	**3927**	**9**
NB09410	21	1665	50	19	36	0	4968	22	33	0	5047	**3893**	**10**
NB10444	20	1724	49	18	29	0	4946	21	30	2	4973	**3881**	**11**
NB12431	18	1266	45	18	30	0	5485	22	30	1	4795	**3849**	**12**
NB12426	20	1609	43	19	34	0	4822	24	33	2	5062	**3831**	**13**
TAMBAR 501	19	1518	39	18	31	0	5328	20	31	1	4646	**3831**	**14**
NB12421	19	1661	45	20	30	0	4938	24	30	2	4892	**3830**	**15**
NB10417	19	1621	44	18	32	0	5429	19	30	2	4304	**3785**	**16**
NB09437	21	1463	47	19	36	0	5246	22	31	1	4550	**3753**	**17**
NB11416	20	1585	42	19	33	0	4990	22	30	4	4670	**3748**	**18**
NB10403	23	1251	43	15	34	0	5216	18	33	1	4774	**3747**	**19**
NB12425	20	1746	47	20	31	0	4709	23	33	3	4762	**3739**	**20**
NB11414	19	1859	42	18	32	0	4804	25	32	0	4456	**3706**	**21**
NB09425	18	1453	44	19	29	0	4789	23	28	1	4838	**3693**	**22**
NB10420	21	1434	36	15	35	0	5027	19	33	0	4584	**3682**	**23**
P-713	20	1638	49	19	34	0	4567	22	35	3	4724	**3643**	**24**
P-954	17	1472	38	19	31	0	4602	23	31	4	4831	**3635**	**25**
NB12422	19	1732	46	19	31	0	4307	22	31	2	4794	**3611**	**26**
NB12436	21	1713	44	20	34	2	4451	22	33	2	4622	**3595**	**27**
NB10440	21	1577	52	17	32	0	4772	21	33	1	4388	**3579**	**28**
NB12433	19	1137	33	18	31	0	4609	21	33	0	4907	**3551**	**29**
NB12408	17	1412	37	19	31	0	5041	22	26	0	4129	**3527**	**30**
NB09441	20	1063	31	18	34	0	5083	21	30	0	4420	**3522**	**31**
NB08428	22	1516	37	19	31	0	4687	23	30	2	4335	**3513**	**32**
NB11418	17	1481	37	19	30	0	4904	22	29	1	4128	**3504**	**33**
NB12440	19	1295	38	19	34	0	4544	27	32	0	4637	**3492**	**34**
NB11438	21	1360	42	18	32	0	4215	21	32	0	4857	**3477**	**35**
NB12417	17	1826	47	23	28	0	3899	27	28	2	4687	**3471**	**36**
NB12418	19	1165	45	17	31	0	4932	19	32	1	4169	**3422**	**37**
NB10409	19	1546	35	18	35	1	4124	20	32	1	4581	**3417**	**38**
P-721	19	1487	53	19	31	2	3494	22	29	3	4492	**3158**	**39**
NB12403	24	687	32	18	32	0	4240	22	33	0	4055	**2994**	**40**
Mean	**20**	**1532**	**43**	**19**	**32**	**0**	**4839**	**22**	**31**	**1**	**4751**	**3707**	
CV %	**7**	**17**	**22**	**1**	**4**	**252**	**7**	**1**	**5**	**126**	**9**		
LSD 5%	**2**	**368**	**13**	**1**	**2**	**1**	**516**	**2**	**3**	**3**	**673**		

The data for 2013-2015 is presented below:

2013-15	Yield (lbs/a)					Rank
Name	Colby	Lincoln	Mead	Sidney	average	
NB09437	2146	3899	2301	1315	2415	19
NB10403	1636	3332	2526	2845	2584	15
NB10417	2260	4054	2601	1883	2699	12
NB10425	2546	3905	2603	1362	2604	14
NB10444	2041	4014	2573	2950	2895	4
NB11414	2420	3587	2361	2897	2816	8
NB11416	2548	3892	2587	2106	2783	10
NB11430	2427	4075	2742	1658	2726	11
NB12419	2415	3650	3079	2196	2835	6
NB12421	2572	3818	2715	1653	2689	13
NB12424	2412	3458	2579	1624	2518	16
NB12425	2527	3726	2891	2529	2918	2
NB12426	2459	3193	2889	1465	2502	17
NB12434	2244	4185	3054	2173	2914	3
NB12437	2178	4355	3276	1617	2857	5
NB99845	2317	3950	2494	2509	2818	7
P-713	2299	3773	2739	2385	2799	9
P-721	2043	2979	2692	2155	2467	18
P-954	2350	3821	2997	2530	2924	1
TAMBAR 501	1920	3708	2401	1568	2399	20
Average	2288	3769	2705	2071	2708	

VI. ALLIED RESEARCH

The wheat breeding or variety development project is only one phase of wheat improvement research at the University of Nebraska-Lincoln. The project interacts and depends on research in wheat germplasm development, wheat quality, wheat nutritional improvement, wheat cytogenetics, plant physiology and production practices, and variety testing. Much of the production research is located at the research and extension centers. All components are important in maintaining a competitive and improving wheat industry in Nebraska. The allied research is particularly necessary as grain classification and quality standards change and as growers try to reduce their production costs.

The program also depends on interactions and collaborations with the Wheat Board, Nebraska Wheat Growers Association, regional advisory boards, Foundation Seeds Division, Nebraska Crop Improvement Association, the milling and baking industry, the malting and brewing industry, and other interested groups and individuals. The Nebraska Seed Quality Laboratory cooperates closely with the Wheat Quality Council to bake the large-scale cooperator samples. Ardent Mills also provides excellent milling and large-loaf baking data to support our small-loaf testing procedures. Numerous groups have visited the laboratory and participated in discussions on quality and marketing. Through these interactions, the program is able to remain focused and dedicated to being a premier provider of quality varieties, information, and technologies to help maintain the Nebraska Wheat Industry. We also wish to highlight the generosity of Mr. Martin Stumpf who recently donated one section of rainfed and irrigated land for an International Wheat Research Center in Grant, NE, and the funds for a new building on the site. Grant is one of the finest wheat producing regions in Nebraska and this location will be a huge benefit to the Nebraska wheat producers. We hope our program will live up the high expectations of the donor.

VII. COMINGS AND GOINGS

All projects are more than crosses, selections, evaluations, data, and seed. At its heart, it is the people who make this research possible. Dr. Mary Guttieri completed her Ph.D. degree and continued to help the project immensely while working on a postdoc with Dr. Brian Waters before accepting a position with the USDA-ARS in Manhattan, KS. Dr. Katherine Frels, Dr. Juthamas Fakthongphan, and Dr. Santosh Rajput Successfully complete their Ph.D.s. Dr. Hanaa Abouzeid returned home after working in the project as a Fulbright visiting scholar. Jorge Venegas and Madhav Bhatta joined the project as new graduate students. Ms. Amira Mourad and Dr. Ahmed Sallam joined the project as visiting scientists, and Dr. Vikas Belamkar joined the project as a post-doctoral research associate. Mr. Rich Little, after 7 years of leading our organic research project, accepted another position and works part time leading the organic triticale research. We are extremely grateful for the excellent work that the team has done and continues to do.

Summary:

In 2014-2015 season, Nebraskans planted 1,490,000 acres of wheat and harvested 1,210,000 acres with an average yield of 38 bushels/acre for a total production of 45,980,000 bu. This production was much lower than the production in 2014, but higher than the production in 2013. The high level of planted acres that were not harvested is likely due to winterkilling in western Nebraska due to fluctuating temperatures. In 2013-2014 season, Nebraskans planted 1,550,500 acres of wheat and harvested 1,450,000 acres with an average yield of 49 bushels/acre for a total production of 71,050,000 bu. In 2012-2013 season, 1,470,000 acres of wheat were planted in Nebraska and 1,130,000 were harvested with an average yield of 35 bu/a for a total production of 39,550,000 bu. The 2012-2013 crop was one of the smallest crops in the last 50 years and certainly highlighted the effect of drought. In 2015, Settler CL (9.5%) was the most widely grown variety in Nebraska followed by TAM 111 (6.0%), SY Wolf (5.6 %), Brawl CL Plus (5.3%) and Overland (4.2%). An additional, 15 varieties were grown on 1% or more of the acreage. 1.4% were blends and 29% of our acreage where grown in varieties having individually less than 1% of the acreage. This variety distribution is remarkable in that no variety has over 10% of the acreage.

In 2015, NE10589 was released. Its full description and data can be found at: http://agronomy.unl.edu/Baenziger/NE10589SignedRelease.pdf . Briefly, NE 10589 is a hard red winter wheat (*Triticum aestivum* L.) cultivar developed cooperatively by the Nebraska Agricultural Experiment Station and the USDA-ARS. It was released primarily for its superior adaptation to rainfed wheat production systems throughout Nebraska and in adjacent wheat producing states. NE10589 will be marketed as Husker Genetics Brand 'Ruth' Hard Red Winter Wheat in honor of our greenhouse manager who was a huge aid to the breeding program and who died far too young. NE10589 genetically is a semi-dwarf wheat, containing the RhtB1b allele (formerly known as Rht1). NE10589 was selected from the cross 'OK98697'/'Jagalene'//'Camelot' where the pedigree of OK98697 is 'TAM 200'/'HBB313E'//'2158'.

NE10589 is resistant to *Soilborne wheat mosaic virus* in field nurseries in Nebraska It is moderately resistant to stem rust to stripe rust. It is moderately susceptible to susceptible for leaf rust. NE10589 is moderately susceptible to Fusarium head blight and moderately susceptible to DON accumulation. NE10589 is moderately resistant to moderately susceptible to Hessian fly. It is susceptible to *Barley yellow dwarf virus*, and *Wheat streak mosaic virus.* NE10589 has high grain volume weight which is similar to most high grain volume weight wheats. The overall end-use quality characteristics for NE10589 should be acceptable to the milling and baking industries. Where adapted, NE10589 should be a replacement for Overland. NE10589 is genetically complementary to virtually all wheat cultivars grown in Nebraska with the exception of Camelot and Jagalene.

In 2015, seven winter triticale (x Triticosecale Wittmack) lines: NT05421, NT07403, NT09423, NT11406, NT11428, NT12414, and NT12434, developed cooperatively by the Nebraska Agricultural Experiment Station and the USDA-ARS and recommended for release in 2016 by the developing institutions. These lines will be used as forage or grain crops, and in cover crop mixtures. They are being marketed nationally. In addition, two new barley lines have been recommended for release.

While the public sector may never release a hybrid wheat variety, we are committed to developing the fundamental knowledge that will be useful in developing hybrid wheat as a commercial product in the future. Hybrid wheat is one of the most promising ways of bringing the increased productivity and technology to wheat needed to feed an ever increasing and wealthier world.

As part of the people's university, we continue to breed wheat suitable for all of our constituencies. Due to reduced funding, our organic wheat efforts have lessened, but we are committed to working with organic producers. Our efforts in healthier grains have increased by the work on breeding low Cd lines adapted to Nebraska. Breeding lines for improved biotic (disease and insect) and abiotic (winter survival, heat, and drought), better nitrogen use efficiency, and herbicide tolerance remain majors efforts.

Our program gratefully acknowledges the generous support of the Nebraska Wheat Board.