IMPROVING WHEAT VARIETIES FOR NEBRASKA

1992 STATE BREEDING AND QUALITY EVALUATION REPORT

Report to the

NEBRASKA WHEAT DEVELOPMENT, UTILIZATION
AND MARKETING BOARD

P. S. Baenziger and D. R. Shelton

December 1992

Summary

A below average crop was harvested in 1992 with production estimated at 55.5 million bushels harvested from 1.85 million acres and with a state average of 30 bushels per acre. In eastern Nebraska, early and late freezes, diseases (leaf rust, barley yellow dwarf, and leaf blotches), and rain at harvest reduced the crop. In southwest Nebraska, the crop was injured by drought or a frost at heading. In western Nebraska, a dry fall leading to a poor seedbed and root rots increased winterkilling and reduced yields.

The extremely variable environmental and disease conditions allowed different wheat varieties to perform well in different areas. In eastern and southcentral regions, leaf rust resistant or tolerant wheats were favored (Karl and Redland). In southwestern Nebraska, disease was less important and Thunderbird and Redland performed well. In western Nebraska, taller or root rot resistant wheats (Sandy and Lamar) were favored. Many wheats with previously good performance and with previously poor performance did not perform as they had in the past which makes variety recommendations and experimental line selection difficult.

Arapahoe continues to be quickly accepted by the growers. Rawhide, released in 1990, had a tough year in eastern Nebraska where the early and late freezes caused increased winterkilling. Previously, Rawhide had not shown winterkilling in Nebraska.

Vista (formerly tested as NE87615) was released in 1992. It is an awned, white glumed, semi-dwarf, hard red winter wheat. In two years of testing (1991 and 1992) in the Nebraska Fall-Sown Small Grain Variety Tests (26 location-years), Vista (3250 kg/h) was 3% higher yielding than Redland, 4% higher yielding than Arapahoe, 11% higher yielding than Siouxland, 12% higher yielding than Rawhide, and 13% higher yielding than TAM107. In the Uniform Southern Regional Winter Wheat Performance Nursery, Vista (3680 kg/h) was the highest yielding line of those tested in both years across the region (48 location-years) and yielded 2% more than TAM107. Current information suggests that it could be grown in southwest Nebraska under dryland production practices and in western Nebraska under late planted irrigation practices.
Three experimental lines (NE87612, NE88427, and NE88595) will be available for possible release in 1993. Three additional lines (N87V106, NE89522, and NE89526) are under small scale increase for possible release in 1994.

Basic research to improve breeding efficiency continued in three areas: 1. wheat tissue culture which will decrease the time required to develop new varieties which will be particularly important in breeding for new pests or disease races, 2. recombinant and reciprocal chromosome substitution line analysis which will provide a better genetic understanding of agronomic performance, 3. improving testing sites and data analysis to insure representative and accurate data for selection. The winter triticale program will continue and be positioned as a feed grain or forage alternative to winter wheat and barley for growers needing small grain feeds or forage.

Support from the Wheat Board, Foundation Seeds Division, and the Institute for Agriculture and Natural Resources is gratefully acknowledged as it is only through their generous contributions that the wheat breeding and experimental line testing efforts are possible.

1992 STATE BREEDING AND QUALITY EVALUATION REPORT

I. INTRODUCTION

Wheat variety development research in Nebraska is cooperative 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 wheat improvement research. This report will deal only with the state portion of the total wheat breeding effort. The basic project is located in the Department of Agronomy at the University of Nebraska-Lincoln. Very important contributions come from state and federal researchers in the department and at the Nebraska research and extension centers, from researchers in the Department of Plant Pathology (both state and federal), from plant pathologists located at the USDA Cereal Rust Laboratory, St. Paul, Minnesota, and USDA entomologists at Manhattan, Kansas. All of these invest time and funds in this program. Grants from the Nebraska Wheat Development, Utilization and Marketing Board provides 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 1992 NEBRASKA WHEAT CROP

1. Growing Conditions

The state wheat crop was highly variable with production estimated at 55.5 million bushels harvested from 1.85 million acres and with a state average of 30 bushels per acre. This represents one of the smallest crops in recent history and lower yields than normal. The smaller crop and lower yields were due to a myriad of factors including dry seedbeds, earlier than normal fall freezes and later than normal spring freezes, spring droughts, cool growing season including a hard freeze at heading, and rain at harvest. In eastern Nebraska, winterkilling due to the unusual freezes and root rots was a greater problem than normal. Leaf rust was prevalent and reduced yields in southeast Nebraska. Barley yellow dwarf virus also was prevalent in eastern Nebraska. Stem rust was present, but fortunately was too late to damage the crop. In southcentral Nebraska, much of the crop was abandoned due to excessive rains during harvest. The crop was previously thinned by winterkilling and foliar diseases. In southwest Nebraska, the yield was reduced by drought or the frost at heading (causing male sterility). In the Panhandle, the crop was reduced by drought and root rots (poor seedbed preparation due to drought in 1991). Though Kansas has reported a change in leaf rust virulence (Arapahoe becoming more susceptible in their trials), no virulence changes were identified in Nebraska.

The extremely variable environmental and disease conditions allowed different wheat varieties to perform well in different areas. In eastern and southcentral regions, later maturing or leaf rust resistant wheats were favored (such as Redland or Karl). In southwest Nebraska, maturity and disease resistance was not as important and lines such as Thunderbird and Redland performed well. In western Nebraska, the taller or root rot resistant wheats (Sandy and Lamar) performed well. Many wheats with previously good performance and with previously poor performance did not perform as they had in the past which makes variety recommendations and experimental line selection more difficult.

2. Diseases

Foliar diseases are highly dependent on moisture for their development and spread. Leaf rust was prevalent mainly in eastern Nebraska. Barley yellow dwarf virus also was prevalent in eastern Nebraska. Stem rust was present in some fields in eastern Nebraska, but probably did not reduce yield. The main leaf blotch diseases were Septoria spp. which may have caused blank heads and glume discoloration in eastern and southcentral Nebraska. Root rots were present throughout Nebraska wherever the seedbed was not firm. The recently released Nebraska-USDA wheat varieties are all resistant to stem rust and some have moderate leaf rust resistance. All of these diseases can be extremely destructive under the appropriate conditions and will continue to need close monitoring.

3. Insects

In general, most insects pests were at low levels on wheat in 1992. Russian wheat aphid caused losses in some fields. Russian Wheat Aphid would be considered the main insect pest of wheat in 1992, but was less important than during the serious infestation of 1990. Cinch bugs, generally assumed to have relatively little effect on wheat but severely damaging on sorghum, were again present in southeast Nebraska in high levels. The presence of cinch bugs is a major factor limiting wheat production in areas where wheat and sorghum are grown in proximity. Sorghum is considered to be the more profitable crop in these areas, and growers tend to reduce their wheat acreage.

4. Wheat Production

The estimated wheat production for Nebraska is 55,500,000 bushels from 1,850,000 harvested acres. The average yield was 30 bushels/acre which is a short crop and below the five year average (38 bu/a). The poorest crop in last five years was the 1989 crop when the wheat yield for Nebraska was 27 bu/a from 2,050,000 acres for a total production of 55,350,000 bushels. Planted and harvested acres fluctuate with climate and farm programs.

Quality determinations by Doty Laboratories Inc. were as follows:

1992 DATA:

Nebraska	Protein Ave. (12% moisture)	Overall Evaluation
Northeast	12.2	Good
Southeast	12.8	Good+
Northcentral	13.0	Good
Southwest	12.9	Good
Panhandle	12.5	Good+

From time to time, varietal comparisons of wheat and flour quality characteristics are made. The following table indicates the results of a study dome with ten wheat varieties planted at three Nebraska locations (Mead, Clay Center, and Sidney). Not all varieties were harvested at Clay Center due to severe weed infestations caused by a rain delayed harvest. Interestingly with rain delaying harvests at both Mead and Clay Center, most flour falling number values were near or above 300 seconds. Drought accounted for the increased protein content at Sidney. However, the increased protein content did not provide stronger mixing doughs as evidenced by the shorter peak times and generally lower tolerance values.

10 WHEAT VARIETIES WERE PLANTED IN 3 NEBRASKA LOCATIONS.
WEED GROWTH PREVENTED COMPLETE HARVEST AT CLAY CENTER.
WHEAT WAS TEMPERED TO 15.2% MOISTURE CONTENT AND MILLED ON THE QUAD JR. MILL.
TEN GRAM MIXOGRAPH ANALYSES WERE DONE AT 60% ABSORPTION.

LOCATION	VARIETY	LAB #	FLOUR PROTEIN CONTENT KJELDAHL METHOD (14%mb) %	FLOUR YIELD FROM QUAD JR. MILLING %	MIXOGRAPH PEAK TIME MIN	MIXOGRAPH PEAK HEIGHT %	MIXOGRAPH BAND* WIDTH AT PEAK HEIGHT (TOLERANCE) %	MIXOGRAPH BAND* WIDTH AT 2 MIN. AFTER PEAK (TOLERANCE) %	MIXOGRAPH TOLER-* ANCE SCORE (AREA)	FLOUR FALLING NUMBER VALUE SEC
MEAD	ARAPAHOE	11	11.8	68.5	3.6	67.5	30.0	22.5	48.5	356
	CENTURA	12	11.7	68.2	3.5	75.2	35.5	25.1	57.3	261
	CODY	13	11.0	69.3	5.9	67.1	26.9	19.6	47.3	291
	COLT	14	11.7	69.4	3.6	71.5	29.9	17.7	44.7	343
	KARL	15	12.7	67.1	3.8	81.8	40.5	23.0	60.4	325
	SCOUT66	16	12.3	68.3	2.3	83.3	41.0	22.2	55.5	299
	SIOUXLAND	17	12.0	67.8	3.3	64.8	23.8	15.3	36.3	296
	TAM107	18	12.9	63.5	3.3	76.5	37.1	24.3	49.5	373
	TOMAHAWK	19	13.6	66.3	2.3	90.0	43.4	29.9	69.2	378
	VONA	110	11.5	66.4	2.7	75.4	36.5	25.4	53.2	379
CLAY CENTER	ARAPAHOE	21	11.3	65.6	5.0	63.7	26.2	18.5	48.0	378
	CENTURA	22	12.2	63.1	4.3	74.1	32.8	22.5	51.8	259
	CODY	23	11.3	64.0	5.0	69.2	31.6	18.8	46.2	247
	COLT	24	11.6	66.4	2.7	70.3	31.7	18.8	40.4	306
	KARL	25	13.9	64.7	3.9	86.4	40.9	29.6	68.2	291
SIDNEY	ARAPAHOE	31	15.5	58.4	1.6	84.2	39.5	11.9	33.1	336
	CENTURA	32	15.3	60.5	2.1	93.6	47.0	21.2	60.3	362
	CODY	33	14.7	62.0	2.8	85.2	40.3	22.8	57.9	370
	COLT	34	15.6	62.5	1.4	88.6	38.6	11.1	36.2	343
	KARL	35	18.0	54.7	2.7	100.6	50.3	22.8	57.3	363
	SCOUT66	36	15.5	61.8	1.6	96.2	47.2	17.7	48.0	299
	SIOUXLAND	37	14.7	59.4	2.1	79.1	32.8	16.1	37.3	272
	TAM107	38	14.1	56.2	1.9	78.9	36.3	20.1	47.3	337
	TOMAHAWK	39	15.0	58.8	1.8	93.4	42.9	19.0	49.2	379
	VONA	310	12.4	60.9	2.1	80.7	34.2	20.4	52.2	399

* HIGHER VALUES INDICATE STRONGER DOUGH MIXING TOLERANCES

The results in the above table have been used both by the wheat development team at Nebraska and sent to interested wheat importers in the Philippines, Malaysia, and England.

Domestically, quality standards are being impacted by long fermentation time (sponge and dough) methods. These procedures require stronger gluten proteins (longer dough mixing times and tolerances). Drought and heat stress can reduce mixing time and tolerance which may have reduced the quality of the crop. Internationally, the trends are varied. Some countries prefer doughs with good fermentation tolerance, while others use mechanical dough development or short fermentation processes. Of the quality characteristics that growers are paid for, test weight was the most significant trait adversely affected by diseases, drought, frost, or cool growing conditions.

5. Cultivar Distribution

No variety survey was done in 1992 so the data from 1991 (last year of the survey) are reported here. Using anecdotal information from the Nebraska Crop Improvement Association and talking with growers, Arapahoe has been quickly accepted by the growers and may become one of the main varieties in 1992. Redland, Thunderbird, and Centura will continue to be strong varieties. The acreage of Siouxland probably is dropping. While no wheat listed below has all of the characteristics of an ideal wheat, the diverse wheats provide the grower an opportunity to choose high yielding, high quality wheats that have resistance or tolerance to the diseases or insects prevalent in his region.

NEBRASKA--WHEAT VARIETIES
ESTIMATED PERCENTAGES PLANTED TO EACH VARIETY, 1987-1991

	Percent				
Variety	1987	1988	1989	1990	1991
Brule	22.5	17.1	12.0	9.4	5.4
Siouxland	17.0	21.3	20.5	18.7	14.5
Centura	14.3	11.9	12.4	9.6	10.4
Centurk & Centurk 78	12.4	9.8	4.6	4.4	3.3
Colt	4.2	4.4	2.3	1.5	---
Agripro Thunderbird	0.7	4.0	7.2	10.7	12.8
Redland	---	4.0	10.0	15.2	14.9
Cody	---	1.2	2.9	2.4	1.8
Buckskin	3.8	2.8	2.2	1.9	2.2
Scout & Scout 66	3.5	2.7	2.6	2.2	2.4
AgriPro Hawk	3.4	3.9	2.9	4.4	1.5
AgriPro Rocky	1.7	1.1	---	---	---
Newton	1.5	1.5	---	---	---
Vona	1.2	1.3	---	---	---
Arkan	.9	1.7	1.6	---	---
Agripro Abilene	---	---	1.0	5.5	6.3
All TAM wheats	1.1	1.0	3.8	6.0	8.0
Norkan	---	---	0.7	2.0	---
Arapahoe	---	---	---	1.8	8.5
Agripro Victory	---	---	---	---	1.7
Other Public Varieties	3.9	4.6	4.3	4.0	4.3
Other Private Varieties	5.8	6.7	6.0	3.1	2.0

6. New Cultivars

'Vista' was released to producers in 1992 and is a hard red winter wheat developed cooperatively by the Nebraska Agricultural Experiment Station and the USDA-ARS. Vista was selected from the cross NE68513/NE68457// Centurk/3/Brule which was made in 1981 by J. W. Schmidt. NE68513 is Warrior//Atlas 66/Cheyenne/3/ Cheyenne/Ottawa. NE68457 is Ponca/*2 Cheyenne/4/IL#1-Chinese Spring 2*/Triticum timopheevi// Cheyenne-Tenmarq-Mediterranean-Hope/3/Sando 60. Vista is an awned, white glumed cultivar. The awns are usually white, but in some environments may have a bronze cast. The spike is middense and generally fusiform but may be tapering to clavate. The foliage is green with a waxy bloom at anthesis. The glume is midlong and midwide to wide. The glume shoulder is midwide and sloping to square. The beak is acuminate and medium to moderately long. The kernel is short, red colored, hard textured, and elliptical to ovate. The kernel has no collar, rounded cheeks, midsize germ, large brush, and a narrow and shallow crease.

Vista has been tested in Nebraska yield nurseries starting in 1988, and in the Uniform Southern Regional Winter Wheat Performance Nursery in 1990 and 1991. In four years of testing (17 location-years) in the Nebraska Intrastate Nursery, Vista's grain yield (2570 kg/h) was similar to 'Rawhide', 2% less than 'Arapahoe', 3% less than 'Redland', 4% less than 'Siouxland', and 11% greater than 'TAM107'. In two years of testing (1991 and 1992) in the Nebraska Fall-Sown Small Grain Variety Tests (26 location-years), Vista (3250 kg/h) was 3% higher yielding than Redland, 4% higher yielding than Arapahoe, 11% higher yielding than Siouxland, 12% higher yielding than Rawhide, and 13% higher yielding than TAM107. In the Uniform Southern Regional Winter Wheat Performance Nursery, Vista (3680 kg/h) was the highest yielding line of those tested in both years across the region (48 location-years) and yielded 2% more than TAM107. Vista is best adapted to the northern high plains region (southwest Nebraska, western Kansas, and northeastern Colorado). In this region (10 location-years), Vista (3420 kg/h) yielded 6% more than TAM 107. Vista is a semi-dwarf cultivar that is 10 mm shorter than TAM107 and 150 mm shorter than 'Scout 66', a conventional height tall wheat. Vista has a short coleoptile (63 mm) compared to TAM 107 (80 mm) and Scout 66 (103 mm). Vista is not recommended for very dry wheat growing conditions where its short coleoptile and short plant height may cause seedling emergence and harvest difficulties. Vista (3390 kg/h) may also be adapted to late planted, irrigated fields (2 location-years) in western Nebraska where it is 3% higher yielding than Arapahoe and 21% higher yielding than TAM 107. Under irrigated conditions, the short stature of Vista is beneficial.

The test weight of Vista is similar to Arapahoe, less than Siouxland and Rawhide, and superior to Redland. The winterhardiness of Vista is adequate for Nebraska growing conditions, superior to 'Vona', 'TAM200', and Rawhide, and similar to perhaps slightly less than Scout 66. Vista is a medium-late cultivar, similar in anthesis date to Arapahoe and Redland, 1 day later than Siouxland, 2 day later than Rawhide, and 5 day later than TAM107. The straw strength of Vista is less than Redland, Siouxland, 'Abilene', and 'Thunderbird', and most similar to TAM200 which under Nebraska conditions may lodge early (shortly after anthesis) if there is lush spring growth.

Vista is moderately resistant to the currently prevalent races of leaf rust (incited by Puccinia recondita Roberge ex Desmaz.), contains Lr3 and Lr16 which are the same known genes as in Redland, though Redland may contain additional genes. Vista is resistant to the Great Plains Biotype and Biotype C, and expresses a heterogeneous reaction to Biotype B of Hessian fly (Mayetiola destructor Say) which indicates it contains H3 derived from IL#1 or Ottawa and some plants contain another gene (possibly H6). It is moderately resist-

ant to stem rust (incited by P. graminis Pers. : Pers.) and contains genes Sr6, Sr17, and Sr36. It is susceptible to soilborne mosaic virus. Vista's reaction to wheat streak mosaic virus needs further testing; however, in the greenhouse it appears to be more tolerant than Brule and Redland.

Based on composite samples from Nebraska, the wheat and flour protein content of Vista is similar to Scout 66 and less than Arapahoe. Vista has strong mixing characteristics as determined by the mixograph. With the exception of a low water absorption, the other milling and baking characteristics of Vista are acceptable, equal to or better than Scout 66 and Arapahoe, and superior to TAM200 and TAM107. The kernels of Vista have been classified by the Federal Grain Inspection Service as being hard red winter wheat.

III. FIELD RESEARCH

1. Increase of New Experimental Lines

Two experimental wheats were advanced to large scale increase. They are NE88427 (TAM107/Bennett) and NE88595 (Arkan/Colt//Chisholm sib). In addition, seed of NE87612 [Newton//Warrior*5/Agent/3/NE69441] which was increased in 1992 was saved for possible release in 1993. NE69441 is an Agate sib.

NE88427 is a medium height semi-dwarf wheat (slightly taller than Vista and similar to TAM107) with a intermediate coleoptile (longer than TAM107). It is susceptible to leaf rust, and soilborne and wheat streak mosaic viruses, and Hessian fly. It is moderately resistant to stem rust (contains genes Sr6 and is heterogeneous for the Amigo gene). NE88427 has good test weight characteristics (similar to Siouxland, and superior to Redland and Arapahoe) and winterhardiness. Straw strength is adequate (superior to Vista). The recommended growing region for NE88427 needs further refinement, however it appears to do well in most parts of Nebraska in the absence of leaf rust. The end-use quality of NE88427 is adequate, most similar to Scout 66 for protein and ash content, gluten strength as determined by the mixograph, and loaf characteristics.

NE88595 is a medium height wheat (slightly taller than Vista and similar to TAM107) with a short coleoptile (similar to Vista and shorter than TAM107). It is susceptible to leaf rust, and soilborne and wheat streak mosaic viruses. It is heterogeneous to the Great Plains Biotype of Hessian fly (indicating it probably carries the Marquillo-Kawvale gene). It is moderately resistant to stem rust (contains gene Sr24). Preliminary indications are that NE88595 may have greater tolerance to root rots than most Nebraska developed varieties. NE88595 is a genetically lower test weight wheat (similar to Redland) and has good winterhardiness. Straw strength is adequate (slightly better than Vista). The recommended growing region for NE88595 also needs further refinement, however it appears to do well in areas were root rot is common and in southwest and western Nebraska. NE88595 is a genetically lower protein wheat similar to Redland. In poorly fertilized or very high yielding fields (where the N fertility may not be adequate for the yield), the lower protein content may be deleterious for baking. Gluten strength as determined by the mixograph is slightly stronger than Scout 66 and loaf characteristics are similar to Scout 66.

NE87612 is a medium height wheat (similar to Arapahoe and Brule) with moderate straw strength. NE87612 is susceptible to leaf rust, and soilborne mosaic and wheat streak mosaic viruses; resistant to the Great Plains biotype of Hessian fly, and moderately resistant to stem rust (contains genes Sr17, Sr24, and segregates for Sr6). NE87612 is a genetically lower test weight wheat, though superior to Redland. If released, current performance data would suggest it be targeted for dryland production in western Nebraska.

While adapted to many of the same areas as Arapahoe and having satisfactory winterhardiness for Nebraska, NE87612 is not as winterhardy as Arapahoe. It was not released this year because its performance in 1992 was considerably less than expected in the Panhandle. In 1991, NE87612 had an excellent yield record. The wheat protein content of NE87612 is less than Scout 66 and Arapahoe. Mixograph analyses indicate strong mixing properties. With the exception of lower loaf volumes and water absorption values, NE87612 has comparable baking characteristics to Scout 66.

The following lines are under small scale increase with earliest possible release in 1994: NE89522 (TAM105*4/Amigo//Brule), NE89526 (Lancota sel/Siouxland//TAM103/KS73167), and N87V106 (Centurk/3/Atlas66/Comanche //TX2607-6). Lines beginning with NE were developed primarily by the University of Nebraska Wheat Improvement program. Lines beginning with N were developed primarily by the USDA-ARS Wheat Improvement program.

With the release of new varieties Vista, Rawhide, Arapahoe, Siouxland, Redland, Cody, and co-release of TAM 200, many of the most advanced current breeding lines are not expected to be released.

2. Nebraska Variety Testing

Forty-three entries were included in some or all of the locations in the Fall Sown Small Grain Variety Tests in 1992. Due to various inclement weather conditions, 11 dryland, one irrigated and one ecofallow nurseries were harvested for yield data. The top ten lines for dryland production were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
NE88595	49.25	Arapahoe	43.15
NE88427	48.18	NE87612	42.75
Vista	47.55	TAM107	42.63
Redland	45.97	NE83404	42.44
N87V106	44.24	Yuma	42.31

Turkey had the lowest yield (36.29 bu/a) In 1991, the highest yielding line was Vista (NE87615) with 46.4 bu/a. Hybrids continue to do well in these tests, but may not be economical for many growers. Not all lines were tested in all locations, hence other high yielding lines may be overlooked when using state averages.

3. Irrigated Wheat Trials

Irrigated wheat trials were planted at Sidney in cooperation with Dr. D. Baltensperger. The Sidney irrigated trial attempts to simulate the majority of irrigated wheat planting conditions: planted late as would be the case after a summer crop harvest. The nursery was very late planted and did not emerge before the Halloween blizzard of 1991. The nursery emerged in the spring, hence the conditions were less than ideal, though the crop looked good at maturity. The top seven lines at Sidney were:

1992 Results at Sidney		1991 Results at Sidney	
NE88427	42 bu/a	Vista	62 bu/a
Vista	39	Arapahoe	61
TAM200	38	2163	59
Arapahoe	37	KS87H6	59

Agripro Sierra	37	NE83407	58
Hybrid F2#2	36	Newcale	57
Redland	36	Tomahawk	57

Efforts continue to identify lines that may have potential under irrigation, but not necessarily superior performance under dryland conditions.

4. Nebraska Intrastate Nursery

The Nebraska Intrastate Nursery (NIN) was seeded at seven locations (Mead is a single replicate for winterhardiness notes) and five locations were harvested. The nurseries at Sidney (due to root rot and winterkilling) and Clay Center (due to excessive rain during harvest) were abandoned. McCook suffered severe drought, but was harvested. Lincoln, Mead, North Platte, and Hemingford were excellent though rain at harvest at Lincoln increased lodging and reduced seed quality. The main diseases at Lincoln were leaf rust, barley yellow dwarf, and foliar blotches. None of the other sites had significant disease losses. The NIN data follow:

1992 NIN Yield Summary Data:

	Yield (bu/a)						Without McCook		
Variety	LincNA	N.P.	McCNA	HemNA	AVG	RANK	AVG	RANK	KEEP*
N87V106[1]	62.57	73.23	39.44	41.89	54.283	1	59.230	1	1
Newcale	44.78	64.60	30.69	61.45	50.380	2	56.943	6	1
NE89671	50.50	56.25	33.30	60.78	50.208	3	55.843	7	2
NE90524[1]	49.63	65.90	26.17	55.31	49.253	4	56.947	5	1
NE90411	57.64	59.95	27.19	49.71	48.623	5	55.767	8	1
NE90518	60.48	54.30	23.25	56.42	48.613	6	57.067	4	4
NE89523	46.94	67.25	17.95	62.25	48.598	7	58.813	2	3
NE90625[1]	51.64	58.83	27.38	54.94	48.198	8	55.137	12	1
NE90626	54.09	56.38	26.18	55.61	48.065	9	55.360	11	4
NE89522[1]	45.97	57.30	24.04	62.13	47.360	10	55.133	13	2
NE88526[1]	46.93	55.60	25.17	61.31	47.253	11	54.613	14	1
NE90479[1]	53.29	61.45	30.08	43.26	47.020	12	52.667	17	1
NE89439	41.01	48.88	36.68	61.26	46.958	13	50.383	33	4
NE90461	48.67	57.28	26.67	53.65	46.568	14	53.200	15	3
NE89504	53.86	61.50	18.80	51.30	46.365	15	55.553	10	3
NE90501	51.60	62.30	25.70	45.10	46.175	16	53.000	16	3
NE90616	53.89	62.13	10.56	56.79	45.843	17	57.603	3	1
NE90617	51.04	54.68	26.54	50.78	45.760	18	52.167	20	3
NE89429	43.07	60.33	23.54	53.96	45.225	19	52.453	19	3
NE90476	54.06	53.90	24.06	48.51	45.133	20	52.157	21	1
NE90574[1]	52.04	65.80	13.33	49.32	45.123	21	55.720	9	1
NE90509	42.86	56.30	26.04	53.18	44.595	22	50.780	30	1
NE88595[1]	45.89	51.38	24.09	56.97	44.583	23	51.413	26	1
NE89479	47.86	54.15	24.74	51.10	44.463	24	51.037	28	3
REDLAND	48.74	56.80	21.54	50.75	44.458	25	52.097	22	1
SIOUXLAND	44.21	54.15	25.23	53.82	44.353	26	50.727	31	1
CENTURK78	39.19	49.30	26.98	61.88	44.338	27	50.123	35	1
NE88588[1]	42.05	62.70	21.48	50.12	44.088	28	51.623	24	1
NE90477	49.53	57.40	20.79	48.47	44.048	29	51.800	23	3
NE86501	54.35	53.80	19.92	46.19	43.565	30	51.447	25	3
CENTURA	47.00	46.68	32.00	48.24	43.480	31	47.307	44	1
NE87522	52.28	49.60	15.90	55.54	43.330	32	52.473	18	1
NE89657[1]	50.92	52.03	19.94	49.87	43.190	33	50.940	29	1

CODY	46.13	52.85	18.61	53.02	42.653	34	50.667	32	1
NE90506	45.38	63.63	15.67	44.60	42.320	35	51.203	27	3
NE88536	44.13	55.50	22.83	46.23	42.173	36	48.620	40	3
NE90623	42.87	55.78	21.72	48.18	42.138	37	48.943	38	3
NE88584[1]	36.36	41.30	31.23	59.02	41.978	38	45.560	50	1
Rawhide	30.89	61.15	23.24	52.08	41.840	39	48.040	41	1
NE90508	44.71	51.53	18.42	51.95	41.653	40	49.397	36	3
NE87612	43.89	51.08	19.52	51.99	41.620	41	48.987	37	1
ARAPAHOE	47.65	55.83	14.44	47.31	41.308	42	50.263	34	1
BUCKSKIN	35.41	45.05	25.09	58.10	40.913	43	46.187	47	1
NE87451	50.20	41.08	24.17	46.43	40.470	44	45.903	48	3
NE90671	39.40	46.63	18.45	56.83	40.328	45	47.620	42	3
KARL	44.29	54.48	19.35	42.85	40.243	46	47.207	45	1
NE87513	46.09	49.40	20.07	45.13	40.173	47	46.873	46	3
NE83404	44.00	54.68	17.45	43.37	39.875	48	47.350	43	3
NE90416	51.85	55.00	11.82	39.82	39.623	49	48.890	39	3
VISTA	40.21	47.33	20.39	48.88	39.203	50	45.473	51	1
NE88427	50.72	41.48	19.05	44.96	39.053	51	45.720	49	1
ROUGHRIDER	40.01	38.70	17.34	53.43	37.370	52	44.047	53	1
HOMESTEAD	39.87	45.13	17.24	46.10	37.085	53	43.700	54	1
SCOUT66	35.31	37.25	22.47	53.11	37.035	54	41.890	56	1
COLT	46.17	35.10	12.88	51.39	36.385	55	44.220	52	1
NE89526[1]	43.06	46.00	14.87	40.14	36.018	56	43.067	55	1
GAGE	37.33	37.80	19.61	48.66	35.850	57	41.263	57	1
TAM200	12.90	45.70	27.75	54.15	35.125	58	37.583	62	1
LANCER	34.89	43.38	17.30	44.46	35.008	59	40.910	58	1
TAM107	33.56	40.70	20.91	44.30	34.868	60	39.520	59	1
NE90442	31.19	36.53	14.34	48.49	32.638	61	38.737	61	3
CHEYENNE	27.77	33.63	11.88	55.66	32.235	62	39.020	60	1
GRAND MEAN	45.20	52.67	23.04	51.21	43.030		49.693		
CV	7.84	14.04	16.96	4.94					
LSD	12.25	10.82	10.85	9.29					
R-SQUARED	0.80	0.66	0.80	0.80					

* Keep: 1=acceptable yield and quality (keep), 2=questionable quality (may keep), 3=drop on yield or quality, 4=good yield and poor quality (keep only for parent)

[1] Advanced to USDA Regional Nurseries for further testing.

The NIN data illustrates two very important points about 1992. First, the limited testing sites and diverse conditions at those sites caused great differences in yield rank from previous NIN data. For example, Newcale (ranked 2, a triticale) was the highest released cultivar, Redland (ranked 25) was the highest yielding released wheat cultivar. The new release, Vista which had an excellent yield record in the state variety trial was ranked 51 in the NIN. Obviously, conflicting data (either with previous data or with the state variety trial) makes selection difficult. Second, as mentioned in last year's annual report, field trends can be quite important in Nebraska testing conditions. Field trends are field variations that are not readily analyzed by standard blocking techniques. Analyses of three of the four test locations were improved using field trend statistical analysis (denoted by NA at the end of the abbreviated test site). Fortunately, most the field trends were minor, though McCook had major field trends and would have been hopeless to interpret without the field trend analysis. This is the second year that the testing locations have provided data that are difficult to use in identifying superior lines.

Twenty-one of the above experimental lines were continued in the NIN for further testing. This is a normal retention rate compared to previous years. All lines were thoroughly analyzed for milling and baking quality including an optimized bake test prior to retention. In 1991, the top ten lines for yield were:

ENTRY	Yield (bu/a) Linc.	Clay Center	North Platte	Sidney	Avg.*	Avg.**	Rank
NE88526	36.78	26.07	29.43	56.49	37.19	39.78	1
NE89526[1]	38.48	35.16	13.65	57.11	36.10	43.58	2
NE89482	33.05	32.18	28.05	44.40	34.42	36.54	3
NE88453[1]	28.83	31.46	21.88	52.24	33.60	37.51	4
NE89479[1]	31.68	35.88	24.14	42.43	33.53	36.66	5
NE89439[1]	24.53	32.21	25.90	50.49	33.28	35.74	6
NE89429	28.80	32.92	22.18	49.09	33.25	36.94	7
SIOUXLAND	30.28	33.42	20.25	48.85	33.20	37.52	8
NE89671	30.58	31.79	21.74	47.80	32.98	36.72	9
NE88556	31.35	31.17	22.38	46.13	32.76	36.22	10

* Averaged over Lincoln, Clay Center, North Platte, and Sidney.

** Averaged over Lincoln, Clay Center, and Sidney.

[1] Advanced to USDA Regional Nurseries for further testing.

5. Nebraska Triplicate Nursery

All of the concerns about the NIN data are also true for the Nebraska Triplicate Nursery (NTN) though the NTN generally were grown in better parts of the field. As in 1985, 1986, and 1987, a released variety (Redland) topped the trial. The yield data are:

VARIETY	Yield (bu/a) Linc.	N.P.NA	HemNA	AVG.	RANK	KEEP*
REDLAND	72.20	72.50	55.57	66.757	1	3
NE91648	66.43	72.60	61.15	66.727	2	1
NE91631	64.13	70.33	65.71	66.723	3	1
NE91564	68.10	72.67	58.07	66.280	4	1
NE91632	63.53	70.68	62.56	65.590	5	3
NE91571	65.87	70.94	58.21	65.007	6	1
NE91405	57.20	79.06	57.01	64.423	7	3
NE91635	60.33	74.69	55.81	63.610	8	1
NE91562	63.83	68.40	58.45	63.560	9	1
NE91525	58.23	75.54	56.11	63.293	10	1
NE91467	65.37	65.30	57.50	62.723	11	2
NE91629	62.63	72.72	52.74	62.697	12	1
NE91607	65.47	70.98	49.67	62.040	13	3
NE91429	60.73	72.37	52.83	61.977	14	3
NE91651	62.40	76.21	46.85	61.820	15	1
NE91608	63.53	70.99	50.28	61.600	16	1
NE91561	58.47	71.00	54.79	61.420	17	3

NE91703	44.27	80.50	58.39	61.053	18	3
NE91586	51.20	65.70	63.95	60.283	19	3
NE91422	59.13	69.67	51.59	60.130	20	3
NE91527	52.67	69.92	57.70	60.097	21	1
NE91518	55.40	69.84	55.03	60.090	22	4
NE91542	62.97	67.43	48.41	59.603	23	1
NE91515	66.37	61.95	50.35	59.557	24	1
NE91509	49.40	83.15	44.92	59.157	25	2
NE91512	60.97	59.97	55.82	58.920	26	3
NE91582	50.77	72.60	52.98	58.783	27	3
NE91639	58.93	67.33	50.02	58.760	28	3
NE91702	56.53	71.83	47.85	58.737	29	3
NE91642	55.93	69.10	50.89	58.640	30	3
NE91539	60.50	67.43	46.28	58.070	31	3
NE91543	65.27	54.72	53.50	57.830	32	3
NE91569	44.30	70.02	58.22	57.513	33	1
NE91578	54.03	61.84	56.33	57.400	34	3
ARAPAHOE	65.27	54.46	52.22	57.317	35	3
NE91423	57.87	65.07	48.95	57.297	36	3
SIOUXLAND	52.93	60.53	58.18	57.213	37	3
NE91691	47.00	78.03	46.58	57.203	38	1
NE91552	55.97	55.10	60.25	57.107	39	3
NE91472	49.23	66.22	55.57	57.007	40	3
NE91633	44.13	66.12	59.48	56.577	41	1
TAM107	54.10	58.42	56.92	56.480	42	3
NE91555	55.23	58.35	53.81	55.797	43	1
NE91637	48.70	68.47	50.01	55.727	44	3
NE91479	52.97	63.50	50.27	55.580	45	3
NE91647	46.30	74.31	45.33	55.313	46	1
NE91551	49.90	65.76	50.18	55.280	47	3
NE91434	47.43	62.27	55.22	54.973	48	3
NE91541	58.90	58.58	47.25	54.910	49	3
NE91597	41.50	67.39	54.49	54.460	50	3
NE91548	53.43	61.81	47.63	54.290	51	3
NE91523	50.63	58.93	50.52	53.360	52	3
NE91507	49.40	65.00	45.52	53.307	53	3
NE91546	60.17	51.32	46.65	52.713	54	3
NE91559	58.83	42.99	54.44	52.087	55	3
NE91537	59.70	49.64	46.56	51.967	56	3
ABILENE	51.73	60.83	38.06	50.207	57	3
NE91493	47.77	47.05	53.52	49.447	58	3
NE91573	47.37	47.57	52.33	49.090	59	3
NE91534	52.07	39.62	54.49	48.727	60	3
NE91714	34.40	68.55	40.20	47.717	61	3
NE91432	38.70	54.55	46.90	46.717	62	3
NE91708	40.77	46.15	49.80	45.573	63	3
NE91615	44.73	54.51	36.80	45.347	64	3
NE91709	17.50	65.32	36.54	39.787	65	3
GRAND MEAN	54.80	65.46	52.09	57.450		
CV	13.10	6.30	5.32			
LSD	12.16	12.46	8.46			
R-SQUARED	0.72	0.80	0.80			

* Keep: 1=acceptable yield and quality (keep), 2=questionable quality (may keep), 3=drop on yield or quality, 4=good yield and poor quality (keep only for parent)

In 1991, the top ten lines were:

ENTRY	Yield (bu/a) Linc.	Clay Center	North Platte	Sidney	Avg.*	Avg.**	Rank
NE90461	33.07	42.57	34.88	61.88	43.10	45.84	1
NE90573	41.27	31.84	25.43	63.62	40.54	45.58	2
NE90574	23.77	38.15	33.83	61.15	39.23	41.02	3
NE90506	41.73	34.96	27.05	52.22	38.99	42.97	4
SIOUXLAND	29.53	29.54	29.52	61.77	37.59	40.28	5
NE90624	27.33	36.40	26.40	59.73	37.47	41.15	6
NE90625	29.30	28.70	32.18	59.33	37.38	39.11	7
NE90641	34.17	26.94	29.33	58.58	37.26	39.90	8
NE90479	27.37	36.16	31.10	52.95	36.90	38.83	9
NE90671	29.43	31.75	29.40	55.88	36.62	39.02	10

* Averaged over Lincoln, Clay Center, North Platte, and Sidney.

** Averaged over Lincoln, Clay Center, and Sidney.

Twenty-five lines were advanced to the Nebraska Intrastate Nursery which is the normal advancement from this nursery. All lines were thoroughly analyzed for milling and baking quality including an optimized bake test prior to advancement.

6. Regional Nurseries

The Southern Regional Performance Nursery (SRPN) was harvested at Lincoln, Mead (one replication), North Platte, and Hemingford. Yields were as follows:

VARIETY	Yield (bu/a) Linc.	N.P.	Hem.	Avg.	Rank
N87V106	62.81	87.47	42.67	64.32	1
NE88595	66.65	70.90	52.37	63.31	2
T21-3	68.49	78.60	41.87	62.99	3
XH1497	63.48	74.60	50.77	62.95	4
T67	59.85	80.83	48.10	62.93	5
XH1437	56.32	76.67	54.63	62.54	6
OK89421	56.68	73.97	49.33	59.99	7
KS84170E-8-3	68.21	67.53	41.77	59.17	8
NE88584	63.77	59.03	54.63	59.14	9
NE88427	62.06	65.40	49.73	59.06	10
TX84V1418HF	57.25	77.67	42.07	59.00	11
KS831374-142	64.21	75.37	35.20	58.26	12
W87-018	59.81	69.00	43.93	57.58	13
HBC302E	38.78	87.50	46.23	57.50	14
KS89H48-1	67.80	69.17	33.83	56.93	15
TX88A6533	57.71	68.23	44.43	56.79	16
TAM 107	53.32	67.40	48.97	56.56	17
KS89H50-4	72.40	55.60	40.90	56.30	18
XH1413	58.48	64.97	45.07	56.17	19
TH901	56.97	73.97	37.43	56.12	20
OK88W833	53.67	72.47	41.93	56.02	21
T13	60.99	55.53	50.10	55.54	22
NE88588	53.28	67.47	45.07	55.27	23

TH902	54.71	76.10	33.80	54.87	24
TX88V5433	62.71	64.77	36.53	54.67	25
OK89399	53.78	64.40	45.10	54.43	26
TX89V4138	44.54	61.27	57.13	54.31	27
OK89499	54.66	61.23	42.13	52.67	28
TX88V4635	52.03	58.87	46.97	52.62	29
TX88A6480	49.29	67.47	40.60	52.45	30
TX87V1613	42.78	64.40	48.80	51.99	31
TX88V4636	41.32	67.00	47.37	51.90	32
CO860094	64.70	33.50	53.33	50.51	33
TX88V5440	63.16	51.70	32.67	49.18	34
TX88V4524	47.73	64.30	35.37	49.13	35
CO860086	48.16	50.70	48.00	48.95	36
KS87H325-2	59.90	56.43	30.13	48.82	37
KHARKOF	48.73	48.33	49.27	48.78	38
WI88-181	43.12	66.73	33.07	47.64	39
XH1319	44.57	56.77	40.03	47.12	40
CO870449	42.86	53.00	44.93	46.93	41
KSSB-369-7	23.23	78.50	38.37	46.70	42
CO860235	56.37	25.00	55.63	45.67	43
SCOUT 66	40.63	39.30	52.97	44.30	44
WI88-028	28.39	38.13	27.07	31.20	45
GRAND MEAN	54.45	64.16	44.01	54.21	
CV	15.40	16.06	11.55		
LSD	14.28	17.53	8.65		
R-SQUARED	0.70	0.71	0.76		

The Northern Regional Performance Nursery (NRPN) was harvested at Lincoln, Mead (one replication), North Platte, and Hemingford. Yields were as follows:

	Yield (bu/a)					
VARIETY	Linc.	N.P.	Hem.	Avg.	Rank	Height (in)
ND8944	67.06	60.53	62.20	63.263	1	26
ND8844	60.26	57.95	70.87	63.027	2	25
XNH1605	56.41	53.45	71.53	60.463	3	29
ND8955	60.09	61.25	59.17	60.170	4	29
SD89102	56.45	64.25	59.43	60.043	5	26
SD89204	59.54	55.00	61.73	58.757	6	27
ND8892	56.99	49.35	67.93	58.090	7	28
XNH1629	51.71	48.52	74.03	58.087	8	26
NE88536	54.45	62.72	55.63	57.600	9	26
NE89657	64.27	54.00	54.20	57.490	10	25
SD88201	57.88	55.60	55.60	56.360	11	27
SD88137	64.97	51.65	51.10	55.907	12	27
NE89479	54.38	54.50	57.63	55.503	13	30
NE87513	53.01	67.28	45.23	55.173	14	26
ROUGHRIDER	52.00	57.52	56.00	55.173	15	29
SD88171	49.94	53.97	59.23	54.380	16	31
KHARKOF	50.15	54.12	58.83	54.367	17	32
NE89526	66.62	47.28	47.80	53.900	18	27
NE89522	57.00	39.98	62.73	53.237	19	30
ND8933	54.80	48.20	55.37	52.790	20	27
SD89271	63.55	40.42	53.27	52.413	21	24
SD87143	64.52	33.07	58.13	51.907	22	27
SD88185	50.81	43.60	59.30	51.237	23	28
ND89142	50.73	46.00	55.77	50.833	24	26

XNH1598	45.91	49.77	54.67	50.117	25	25
COLT	59.18	41.57	47.70	49.483	26	25
XNH1597	45.05	42.67	55.57	47.763	27	26
SD88191	49.90	40.68	48.20	46.260	28	23
MT8719	35.33	49.48	51.70	45.503	29	26
ND8930	50.93	34.30	46.87	44.033	30	28
W-236	33.04	43.18	52.53	42.917	31	27
MT8713	32.90	43.48	51.93	42.770	32	24
W-193	33.84	43.30	50.97	42.703	33	29
W-198	33.81	36.68	54.57	41.687	34	27
GRAND MEAN	52.87	49.57	56.69	53.043		
CV	12.39	19.71	9.34			
LSD	11.20	16.71	9.06			
R-SQUARED	0.77	0.56	0.72			

The data from the Regional Nurseries are interesting because Nebraska lines did well in the SRPN and North and South Dakota lines did well in the NRPN. This result would indicate that later lines were favored this year. In general, the performance of lines in the NIN, NTN, SRPN, and NRPN was similar in all nurseries despite the fewer locations and the unusual climate.

7. Multiple-Location Observation Nursery

Four of six replications (locations) of this nursery were harvested. As mentioned earlier, the nurseries at Clay Center and Sidney were lost. Of the 320 lines including checks and 38 higher protein lines from Dr. C. J. Peterson's germplasm program that were evaluated, 56 (4 from Dr. Peterson's program) were advanced to the NTN. A number of experimental lines performed better than the average of the six checks. To equate the results across the locations, the data were converted to percent of checks and using this system the highest yielding line was NE92638 (OK83396=Aurora/2*TAM 101//Redland) which had a yield that was 129% greater than the checks. All lines were thoroughly analyzed for milling and baking quality including an optimized bake test prior to advancement. The lines were grouped by anthesis dates with the earliest lines being designated in the 400's. This means that NE92401 will be earlier than NE92605. This change should allow better identification of early lines and better selection among lines with similar maturities. Heading date will vary from year to year, hence misclassifications could and did happen.

8. Early Generation Nurseries

a. Single-plot Observation Nursery

Fourteen hundred and ninety lines including checks were evaluated in 1992. Of this group over 450 were selected for further testing. In order to decrease the testing efforts of lines with good agronomic performance, but unacceptable quality characteristics, the lines were weighed and those lines with low yield were discard. About 400 lines were selected on the basis of yield and disease resistance and screened in four weeks prior to planting for end-use quality. Two hundred fifty-three lines were advanced for further testing on the basis of their agronomic, seed, and end-use quality characteristics. An additional 40 lines came from the USDA high protein program for further testing.

b. Kansas State University-Pioneer Screening Nursery

Of 319 lines donated by Pioneer to Kansas State University and screened in 1991, 35 were selected on the basis of agronomic performance and quality characteristics for advancement to a two replication test at McCook, Hemingford, and Lincoln in 1992. These lines are viewed as an important addition to the program because they were developed in Kansas under more severe diseases (leaf rust, leaf blotches, soilborne mosaic virus) and have better straw strength than many Nebraska experimental lines. These lines also represent a different gene pool and should add diversity to the program. The results of the screening nursery are:

	Yield (bu/a)				Heading				
VARIETY	Linc.	McCNA	HemNA	AVG.	Rank	Keep*	DATE	HT	LR
HBF0263	74.15	38.30	50.32	54.257	1	1	21	32	1
HBC208	67.30	44.14	47.95	53.130	2	1	20	28	1
VBF0168	54.15	48.24	51.18	51.190	3	1	17	30	9
HBF0255	59.65	41.19	51.89	50.910	4	1	19	29	7
VBF0589	50.75	46.54	54.68	50.657	5	1	19	29	1
HBF0337	68.35	35.68	44.92	49.650	6	2	17	30	1
HBF0133	52.50	41.94	54.43	49.623	7	2	20	34	5
HBF0431	59.80	36.94	50.73	49.157	8	3	19	32	1
REDLAND	56.30	33.77	57.12	49.063	9	3	26	37	5
TOMAHAWK	51.95	39.70	52.21	47.953	10	3	21	34	1
VBF0589	50.15	39.80	53.87	47.940	11	2	18	27	1
SIOUXLAND	50.80	33.44	59.24	47.827	12	3	26	37	2
VBF0576	46.25	37.22	58.73	47.400	13	2	24	27	1
HBE0321	58.20	37.65	46.13	47.327	14	3	23	32	2
HBF0209	56.40	38.06	47.07	47.177	15	3	18	33	2
HBE1066	66.05	33.16	41.46	46.890	16	3	19	29	1
HBF0303	58.85	33.67	48.10	46.873	17	3	23	31	1
HBE0249	57.00	29.37	49.78	45.383	18	3	22	31	2
HBF0276	63.35	25.03	47.59	45.323	19	3	24	30	5
HBB114	64.30	27.87	42.69	44.953	20	3	19	33	1
VBF0159	57.25	32.12	44.98	44.783	21	3	18	25	3
HBE0321	49.25	42.48	39.35	43.693	22	3	22	32	1
VBF0573	47.50	38.15	43.76	43.137	23	3	17	32	1
VBF0576	48.05	32.64	47.56	42.750	24	3	22	26	2
HBF0302	64.30	27.13	35.97	42.467	25	3	20	28	1
HBF0303	59.80	30.47	36.90	42.390	26	3	23	28	1
VBF0589	36.85	41.01	48.61	42.157	27	3	22	26	1
HBE0780	40.95	38.00	47.33	42.093	28	3	21	27	2
HBC652	35.30	43.29	45.21	41.267	29	3	21	27	3
HBF0277	58.50	25.58	39.18	41.087	30	3	18	26	5
VBE0269	39.45	37.97	45.54	40.987	31	3	25	31	7
HBF0350	52.80	33.31	36.69	40.933	32	3	19	26	1
KARL	61.90	24.15	31.58	39.210	33	3	17	31	1
ARAPAHOE	57.80	17.24	42.50	39.180	34	3	23	38	3
HBF0345	49.75	17.48	50.02	39.083	35	3	19	26	6
HBF0114	40.50	38.20	38.22	38.973	36	3	22	25	2
HBF0471	55.60	28.10	31.57	38.423	37	3	19	30	1
HBF0340	35.25	42.41	37.39	38.350	38	3	21	26	2
HBF0361	55.75	30.25	25.00	37.000	39	3	17	29	4
VBF0576	31.25	24.40	46.20	33.950	40	3	24	30	3
GRAND MEAN	53.60	31.11	45.88	43.530					
CV	11.88	10.52	7.77						
LSD	13.53	9.04	9.35						
R-SQUARED	0.83	0.80	0.80						

* Keep: 1=acceptable yield and quality (keep), 2=questionable quality (may keep), 3=drop on yield or quality, 4=good yield and poor quality (keep only for parent)

On the basis of these trials, five lines were advanced to the NIN for further testing. Seed was saved for complete quality analyses this year. An additional 151 new KSU-Pioneer lines were received from Kansas State University which were grown at Mead. These lines were a disappointment and not a single line was selected for further testing. The main problem with the lines was insufficient winterhardiness. The best lines were less vigorous than the poorest randomly selected lines for a population (from NE83404 x Colt) for a genetic study.

c. Headrow Nursery

Only 31,000 headrows were planted at Mead due to severe lodging in the F_3 populations in 1991. Included in the 31,000 headrows were 5,000 headrows selected from segregating bulks shared with us by Kansas State University and donated by Pioneer. The Nebraska headrows, generally survived the winter, but almost all of the KSU-Pioneer headrows were injured. Hence effective selection was from only 26,000 headrows. A difficulty with this nursery was that the severity of stem rust did not allow clear differentiation between susceptible and resistant lines. Fourteen hundred ninety-five lines including checks were selected for further testing. This is a normal level of selection.

a. F_3 bulk hybrids

The F_3 bulk hybrid nursery contained 473 bulks and check plots. The number of F_3 bulks is near the optimal size. An additional 399 F_3 bulks were obtained from the bulks donated by Pioneer to Kansas State University. Most bulks survived the winter and were satisfactory for selection. Over 38,000 head rows were selected for fall planting. The project goal remains to have sufficiently good segregating F_3 material to select about 40 - 45,000 headrows.

b. F_2 bulk hybrids

The F_2 bulk hybrid nursery contained 636 bulks and check plots. These bulks survived the winter and yielded well providing ample seed for planting the F_3 bulk nursery in 1993 at Mead and select bulks at Sidney.

9. Winter Triticale Nursery

Thirty-one lines were tested in the advanced nursery. The lines come from international programs and from the Nebraska breeding efforts. The yields (assuming a 60 lbs/bu test weight) are listed below:

Level	Yield (bu/a)	Rank	Entry
23	64.25	1	NE91T401
26	63.78	2	NE91T410
31	62.05	3	GWT88-16
25	59.63	4	NE91T409
1	59.00	5	PRESTO
9	58.48	6	NE90T413
4	56.98	7	NE90T405
29	56.68	8	NE91T425
15	56.43	9	NE88T419

3	55.60	10	NE90T404
21	53.35	11	TSW250783
5	52.73	12	NE90T406
20	52.40	13	NE88T213
18	52.33	14	NE88T229
19	52.03	15	NE88T233
13	51.55	16	NE83T12
2	51.40	17	NE90T402
6	48.80	18	NE90T407
24	48.75	19	NE91T404
7	48.00	20	REDLAND
11	47.48	21	TRICAL
12	46.75	22	NE86T653
14	46.65	23	LAD285
30	45.08	24	GWT88-12
17	42.95	25	NE77T7
10	42.80	26	NE90T422
16	42.55	27	RYMIN RYE
27	39.38	28	NE91T416
8	37.63	29	NE90T411
28	37.60	30	NE91T420
22	34.30	31	SIOUXLAND

LSD for ENTRY = 12.6432 S.E.D. = 6.0670

The key to improved triticale varieties remains access to improved triticale germplasm and efforts continue to increase germplasm diversity. Triticales with high yield potential are available and may be useful as a feed grain or forage crop. Triticale research replaced our research on feed wheat. Masrizal, a graduate student, overseas the triticale breeding program.

In 1991 when winterkilling was minimal, the ten highest yielding lines were:

	Yield (bu/a)					
ENTRY	Lincoln	Sidney	Ave.	Rank Linc.	Rank Sid.	Rank Ave.
TSW250783	55.08	58.13	56.60	2	1	1
LAD285	59.98	50.40	55.19	1	6	2
RYMIN RYE	45.03	56.24	50.63	13	3	3
NE90T405	51.68	46.19	48.93	4	8	4
NE90T406	52.85	42.91	47.88	3	12	5
REDLAND	44.03	50.71	47.37	15	4	6
NE90T404	46.58	47.95	47.26	11	7	7
NE90T413	48.88	45.41	47.14	6	10	8
SIOUXLAND	36.30	57.00	46.65	28	2	9
NE90T402	42.58	50.41	46.49	19	5	10

10. Doubled Haploid Study

Doubled haploids (completely homozygous lines) can be developed using tissue culture in which plants are regenerated from immature pollen grains (saving a minimum of two years in the breeding program). This year's efforts again concentrated on improving the tissue culture techniques. Dr. W. Navarro, a former graduate student, worked diligently on improving the efficiency of the system. Dr. Navarro found that sugars, particularly maltose and mal-

tose + glucose, were superior to sucrose for embryo initiation. Wheat starch, used as a gelling agent, was an important source of sugar in the later stages embryo initiation. Maltose and sucrose were both good sugars for plant regeneration. Maltose seemed to reduce the genotype specificity of anther culture (i.e. genotypes which normally do poorly in anther culture, did better with maltose), a limitation in anther culture. Dr. Navarro also found that exposing the anthers to colchicine for a short period (72 hours) greatly increased the level of chromosome doubling without drastically reducing the number of embryos initiated or plants regenerated. Work continues by Ms. L. Oberthur on an alternative method for creating haploids using intergeneric hybridization (wheat x corn or wheat x pearl millet). This year she regenerated her first plants using this system.

11. Chromosome Substitution Lines

A series of lines in which single pairs of chromosomes were transferred from Cheyenne, the most important ancestor in the Nebraska Wheat Improvement efforts, to Wichita, an important wheat from Kansas, and vice versa have been developed by Dr. M. R. Morris. Previous research showed that chromosomes 3A and 6A have major effects on agronomic performance (can reduce or enhance yield by 20%). Current efforts by Dr. Yang Yen are concentrating on developing recombinant chromosome lines which will be used to determine how many genes on the identified chromosomes affect yield. In cooperation with Agripro Biosciences, hybrids of the chromosome substitution lines have been made to identify chromosomal heterosis. While additional testing is needed the hybrids indicate predominantly additive gene effects. This work will allow us to better understand and hopefully manipulate genes for agronomic performance.

12. Heat Stress on Grain Filling

Research with Dr. E. Millet, of the Weizmann Institute of Science in Israel, and Dr. M. Clegg, of the University of Nebraska to study the effect of short term heat stress on grain filling in wheat. Our current procedures involve heating the spike for 96 hours with 12 hours of 38 C and 12 hours of 25 C. Ambient conditions are 26 C day and 20 C night in the greenhouse. Under the heat stress conditions, we were able to similarly reduce grain weight in both Karl (thought to be heat tolerant) and Arapahoe (thought to be heat sensitive). A wheat variety survey is currently underway to see if varieties differ in their response to the heat stress. A very low-technology method of providing heat stress is the field can be done by placing glass jars over the spikes. In sunlight, temperatures raise in the jars, thus providing a heat stress. Again both Karl and Arapahoe were similarly affected by the heat stress as determined by lower grain weight. The temperature stress increased protein content and mixograph tolerance (probably due to increased protein), and decreased mixograph peak time. Preliminary protein fractionation experiments (done by Dr. Graybosch) indicate the relative amounts of protein components were unchanged which was surprising as these protein components have been reported to be differentially heat sensitive.

13. Effect of 1B/1R on Agronomic Performance

Previously, Mr. Benjamin Moreno-Sevilla, a graduate student and research technologist on the project, had shown that lines containing 1B/1R from the cross Siouxland x Ram were 9% higher yielding than lines with 1B or lines heterogeneous for 1B/1R. Rawhide, a recent release, is heterogeneous for 1B and 1B/1R. 1B/1R and 1B lines were extracted from Rawhide and grown in three

environments in Nebraska. No difference was found for yield between the 1B and 1B/1R lines. This study is being repeated.

14. Non-red Grain Wheat

In the past, efforts have concentrated exclusively on hard red winter wheat. With the potential Far East market and domestic whole white wheat bread market, efforts will increase for hard white wheat development, mainly in Dr. C. J. Peterson's program. A small effort will continue in developing purple and blue wheats for unique markets. For example blue wheat may have potential for blue wheat flour tortillas similar to blue corn tortillas. Blue wheat can also be used as a marker for natural and induced outcrossing, and potentially as way of determining the level of stress in a field (the blue color forms late in the seed development and stress may end kernel development before the blue color is completed).

15. Spring Wheat

The spring wheat trial at Mead is part of the Nebraska State Testing Project. The trials were also at Concord, and Sidney (dryland and irrigated). A complete report of these lines can be found in E. C. 92-102, Nebraska Spring Wheat, Oats, Barley, Canola, and Crambe Variety Tests. Dryland yields (average yield at Mead was 27 bu/a, at Concord was 45 bu/a, and at Sidney was 38 bu/a) were better than normal, probably due to the cool summer. Irrigated yields were also good (average yield at Sidney was 45 bu/a). Sharp and Prospect were the two best lines (out of nine) averaged over all tests. A white spring wheat, Klassic, had the poorest average yield, but did well under irrigation.

16. Considerations on Nursery Sites

Efforts continue to develop better analytical methods for data analysis. The addition of field trend analyses has already proven itself to be beneficial for analyzing wheat data. The next project is to develop planting designs that better measure spatial variation in unreplicated or partially replicated designs. This research is done in collaboration with Dr. W. Stroup of the Biometry Department.

17. Environmental Effects on Plant Height

With the continued interest in taller wheats for western Nebraska, Mr. Necdet Budak, a graduate student, is beginning research to better understand factors determining plant height. As part of this research, all experimental lines are being classified by their response to giberellic acid (an indicator of the main semi-dwarfing genes) and all of the height data are being analyzed to look for lines that are not too tall in eastern Nebraska, but are tall in western Nebraska. In the past, tall wheats in eastern Nebraska may or may not be tall in western Nebraska which has caused problems with line selection and variety recommendations.

IV. GREENHOUSE RESEARCH

The F_1 wheat populations were grown only in the Lincoln Greenhouses to avoid possible losses to winterkilling. Over 500 F_1 populations were grown. This is higher than normal and translates to 589 F_2 plots including checks planted in 1993. An additional 610 wheat crosses were made for breeding pur-

poses including improving the genetic male sterile population (first planted in 1990). Some crosses were made for genetic studies. In the triticale program, 21 crosses were made.

V. 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, and other interested groups and individuals. The Wheat Quality Laboratory cooperates closely with the Wheat Quality Council and baked the large scale cooperator samples. These large scale samples include two experimental lines (NE86501 and NE87615) from the cooperative USDA/University of Nebraska breeding program and are among the most important quality tests for an experimental line or recently released variety. 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.