IMPROVING WHEAT VARIETIES FOR NEBRASKA

1997 STATE BREEDING AND QUALITY EVALUATION REPORT

Report to the

NEBRASKA WHEAT DEVELOPMENT, UTILIZATION
AND MARKETING BOARD

P. S. Baenziger, D. R. Shelton, and D. D. Baltensperger

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I. INTRODUCTION

Wheat variety development research in Nebraska is 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, hybrid parent, 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 state and private researchers in South Dakota, Wyoming, Kansas, Oklahoma, Texas, and Colorado, from researchers in the Department of Plant Pathology (both state and federal), from plant pathologists located at the USDA Cereal Disease Laboratory, St. Paul, Minnesota, and USDA entomologists at Manhattan, Kansas and Stillwater, Oklahoma. All of these programs invest time and funds in 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 1996 NEBRASKA WHEAT CROP

1. Growing Conditions

The 1997 crop was planted in generally wet soils in western Nebraska with the soils becoming progressively drier to the east. Planting was delayed in much of western Nebraska, whereas in eastern Nebraska emergence was hurt by exceptionally dry soils especially if the wheat followed another crop. Winterkilling was generally not a problem throughout Nebraska except on winter tender lines in experimental nurseries. In the spring, the moisture trend reversed with very dry early spring conditions in western Nebraska and timely rains in eastern Nebraska. In general, diseases were relatively low in Nebraska, though some areas in western Nebraska were severely affected by wheat streak mosaic virus, and southern Nebraska was affected by leaf rust and to some extent soilborne mosaic virus. Stem rust was present in eastern Nebraska, but at a low level which did not cause economic loses. As such, later lines with good winterhardiness finished well, as did early lines with very high yield potential (i.e. 2137 and Alliance). Varieties, which performed well in the past, were affected by the spring drought. Most notable was Karl 92 in the southwest district where its earliness coincided with the drought and it finished before the late rains. In the southwest district, the average yield of Karl 92 was 43 bu/a, while the average yield of Turkey (a much later line) was 44 bu/a. In the southwest district, Arapahoe also seemed to be affected by the early drought and was unable to fully recover when the late rains came. Arapahoe yielded 52 bu/a compared to Alliance at 57 bu/a and Windstar at 56 bu/a.

2. Diseases

Foliar diseases are highly dependent on moisture, hence foliar diseases were important on the southern wheat crop. In 1997, the main disease was leaf rust in southern Nebraska, wheat streak mosaic virus in western Nebraska, and wheat soilborne mosaic virus in eastern Nebraska. Stem rust was also present, but below economic loss levels. A new disease to the United States, karnal bunt, was not found in Nebraska in 1995, 1996, or 1997, though it was found in Texas in 1997.

Many diseases (wheat streak mosaic virus, barley yellow dwarf virus, leaf rust, stem rust, and various leaf blotches) can be extremely destructive under the appropriate conditions and will continue to need close monitoring, as will the survey for karnal bunt. Dr. John Watkins continues to be invaluable in disease identification, survey, and understanding.

3. Insects

In general, most insect pests were at low levels on wheat in 1996. Russian wheat aphid damage was small and required little spraying. Chinch bugs and Hessian fly were generally minor. Wheat curl mite, the vector for wheat streak mosaic virus, and aphids, the vectors for barley yellow dwarf virus, are important insect pests because they can carry devastating diseases.

4. Wheat Production

The 1997 Nebraska Wheat Crop was estimated at 70,300,000 bu, which represented a 37 bu/a state average yield on 1,900,000 harvested acres. 2,000,000 acres were planted to winter wheat. This crop was smaller than the 1996 crop (73,100,000 bu harvested from 2,150,000 acres with a 34 bu/a yield average) and the 1995 crop of 86,100,000 bu (41 bu/a). Despite continued genetic improvement (see above comparisons of Turkey to Arapahoe, Alliance, and Windstar), the main determinant in wheat production seems to be acres harvested and weather. It may also be that corn or other crops are moving increasingly into the better wheat production areas and the relatively stable state average wheat yield represents the loss of these higher production acres.

Quality determinations by CII Laboratory Services were as follows: HELP DAVE!!

Wheat Protein Content (12% moisture basis)

	Wheat Protein		Test Weight	
Nebraska	1996 %	1995 %	1996 (lb/bu)	1995 (lb/bu)

Northeast	12.9	11.4	59.1	60.8
Southeast	13.0	11.7	59.0	59.8
Northcentral	13.1	11.2	59.4	60.9
Southwest	13.2	11.0	59.1	60.8
Panhandle	12.0	10.7	60.6	60.8

The quality of the 1996 Nebraska hard red winter wheat crop was exceptional. Wheat protein contents were substantially higher while test weights were 59.0 lb/bu or higher.

The predominant breadmaking procedure used in the United States is the sponge and dough process. The method requires strong gluten proteins during dough mixing and fermentation. The selection of wheat lines with the quality characteristics of medium-strong mixing properties, superior crumb grain and texture, and increased water absorption are the current priorities of the Nebraska Wheat Quality Lab. The focus on these properties will insure that the superior reputation of Nebraska wheats will be maintained in the marketplace.

5. Cultivar Distribution

Arapahoe continues to be the most popular and widely grown variety (30.1% of the state) in 1997. To put Arapahoe's acceptance in perspective, it was grown on more acres than varieties developed by other states and by commercial seed companies combined in Nebraska. Centura was the second most widely grown variety followed by Alliance and Karl/Karl 92.

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 or her region. Cultivars developed by the cooperative USDA-University of Nebraska wheat improvement program occupied 75.7% of the state acreage. Other public varieties occupied 9.3% and private varieties occupied 15.0% of the state acreage.

NEBRASKA—WHEAT VARIETIES
ESTIMATED PERCENTAGES PLANTED TO EACH VARIETY, 1990-1997

	Percent						
Variety	1990	1991	1993	1994	1995	1996	1997
Agripro Abilene	5.5	7/3	6.2	3.0	4.1	4.2	2.2
Agripro Laredo	-----	-----	-----	-----	1.2	1.1	-----
Agripro Ogallala	-----	-----	-----	-----	-----	2.2	1.5

Agripro Thunderbird	10.7	12.8	12.4	10.0	7.8	5.9	5.7
Agripro Tomahawk	-----	-----	1.0	3.9	3.1	2.9	2.5
Agripro Victory	-----	1.7	1.3	-----	1.0	1.2	-----
Alliance	-----	-----	-----	-----	-----	2.7	7.3
Arapahoe	1.8	8.5	28.6	32.9	33.6	31.7	30.1
Buckskin	1.9	2.2	4.7	5.5	4.0	5.8	6.0
Centura	9.6	10.4	8.5	11.1	8.0	9.2	9.8
Centurk & Centurk 78	4.4	3.3	1.6	-----	1.3	-----	-----
Cody	2.4	1.8	-----	-----	-----	-----	-----
Ike	-----	-----	-----	-----	-----	1.6	1.3
Karl/Karl 92	-----	-----	2.1	3.8	6.9	7.3	6.9
Lamar	-----	-----	-----	-----	-----	1.2	-----
Niobrara	-----	-----	-----	-----	-----	1.4	6.5
Rawhide	-----	-----	2.1	2.0	1.0	-----	-----
Redland	15.2	14.9	7.9	6.3	4.3	3.4	1.2
Scout & Scout 66	2.2	2.4	2.8	1.6	3.4	2.4	1.6
Siouxland	18.7	14.5	8.2	6.4	4.0	4.7	3.2
All TAM wheats	6.0	8.0	3.4	2.8	2.5	2.1	1.1
Vista	-----	-----	-----	-----	4.6	3.6	4.6
Other Public Varieties	4.0	4.3	4.2	6.0	5.9	4.9	5.4
Other Private Varieties	3.1	2.0	1.9	3.3	1.9	0.8	3.1

6. <u>New Cultivars</u>

Windstar was formally released and plant variety protection was applied for under P. L. 910577 with the certification option in 1997. It was in the process of being released in 1996 and its description is included in that annual report.

III. FIELD RESEARCH

1. <u>Increase of New Experimental Lines</u>

Three experimental lines are under large-scale increase for possible release in 1998. **NE93405** (NE85707/Thunderbird) is a Thunderbird derivative with a long coleoptile, good winterhardiness, good testweight, large kernels, and very strong straw strength. The pedigree of NE85707 is Wrr*5/Agent//Kavkaz/4/NE63218/KY58/3/NTH/2*CMTH//PNC/*2 CNN. It is a white chaffed, awned, hard red winter wheat. It is medium early in maturity and medium tall in plant height (probably has a semi-dwarfing gene that does not affect coleoptile length). In the first year of testing in the state variety trial, its grain yield (47.3 bu/a) was less than Alliance (50.6 bu/a), Arapahoe (48.9 bu/a), Niobrara (49.3 bu/a), and Windstar (50.6 bu/a). The best performance area seems to higher moisture areas of Nebraska similar to Thunderbird. The relatively lower statewide performance of NE93405 compared to many widely grown varieties probably represents its narrower adaptation and many of the testing sites are outside of its adapted area. NE93405 is moderately resistant to stem rust (contains Sr5 and Sr31 or Sr24), moderately susceptible to leaf rust, and susceptible to Hessian fly, barley yellow dwarf virus, wheat soilborne mosaic virus, and wheat streak mosaic virus. A sister line, NE93496 may be a slightly higher yielding line and could be released in 1999.

NE93554 was derived from the cross NE82419/Arapahoe. The pedigree of NE82419 is Trapper//CMN/OT/3/CIMMYT /Scout/4/ Buckskin sib/Homestead. NE93554 is an Arapahoe derivative with a medium length coleoptile, good winterhardiness, average testweight, medium kernels, and moderately strong straw strength. It is a white chaffed, awned, hard red winter wheat. It is medium in maturity and medium tall in plant height (probably a taller, semi-dwarf). In the first year of testing in the state variety trial, its grain yield (50.7 bu/a) was similar to Alliance (50.6 bu/a) and Windstar (50.6 bu/a) and better than Arapahoe (48.9 bu/a) and Niobrara (49.3 bu/a). NE93554 seems adapted to all of the areas where Arapahoe has been successfully grown. Though it yielded better than Arapahoe, NE93554, like Arapahoe, also seemed to have a growth pattern where early spring drought can lower its performance. NE93554 is moderately resistant to stem rust (contains Sr6 and Sr36 and other unnamed resistance genes) and leaf rust (similar to Arapahoe), moderately susceptible to wheat soilborne mosaic virus, and susceptible to Hessian fly, barley yellow dwarf virus, and wheat streak mosaic virus. A sister line, NE93613 is also being advanced for possible release in 1999.

NE93427 was derived from the cross Bez/CTK78//Arthur/CTK78/3/Bennett/4/Norkan. It is a Norkan derivative with a medium length coleoptile, medium winterhardiness, good testweight, medium kernels, and moderately strong straw strength. It is a white chaffed, awned, hard red winter wheat. It is medium early in maturity and medium tall in plant height (probably a taller, semi-dwarf). In the first year of testing in the state variety trial, its grain yield (47.6 bu/a) was less than Alliance (50.6 bu/a), Arapahoe (48.9 bu/a), Niobrara (49.3 bu/a), and Windstar (50.6 bu/a). NE93427 seems best adapted to the higher rainfall areas of southeastern and southcentral Nebraska near the Kansas border, an area where few of our previous releases are well adapted. The relatively lower statewide performance of NE93427 compared to many widely grown varieties probably represents its narrower adaptation and many of the testing sites are outside of its adapted area. NE93427 is moderately resistant to stem rust (contains Sr5, Sr6 and Sr24) and whet soilborne mosaic virus, moderately susceptible to leaf rust, and susceptible to Hessian fly, barley yellow dwarf virus, and wheat streak mosaic virus.

NE92662, which was under consideration for release in 1997, was deemed to have insufficient agronomic performance to merit release. Two lines that were dropped from our release efforts (**NE90476 and NE92458**), but previously had performed well in Kansas were given to Kansas for further evaluation. On the basis of further evaluation, Kansas also determined the lines did not have sufficient agronomic merit for release and were dropped.

As state experiment stations expand their focus on regional efforts, we will need to discuss how best to release lines that were initially developed in one state, but have utility in other states or niche markets. Currently, this is not a problem because many state experiment stations have compatible release procedures for hard red winter wheat. However, there are different marketing mechanisms for hard white wheat (i.e. grower organizations, or contract production via seed companies and milling companies). The market place will continue to diversify and regionalize especially for niche market wheats (purple, blue, organic, etc.), hence it should be expected that new relationships will be developed which may include marketing publicly varieties outside the state of origin in small multistate niche areas

Five lines are under small-scale increase: NE93496 (NE95707 x Thunderbird), NE93613 (NE82419/Arapahoe), NE94479 (Arapahoe/Abilene//NE86488), NE94482 (Arapahoe/Abilene//NE86488), and NE94653 (Arapahoe 2*/Abilene). As mentioned previously, NE93496 is a sister line to NE93405 and NE93613 is a sister line to NE93554. NE94479 and NE9482 are also sister lines, semi-dwarf wheats, and possible Arapahoe replacements with very broad adaptation and excellent agronomic performance. NE94653 is a high yielding semi-dwarf line with broad adaptation.

With the release of new varieties Windstar, Pronghorn, Niobrara, Nekota, Alliance, Vista, Rawhide, Arapahoe, and co-release of Ike and TAM 200, many of the most advanced current breeding lines are not expected to be released.

2. Nebraska Variety Testing

Fifty-six entries and three seed treatments were included in some or all of the locations in the Fall Sown Small Grain Variety Tests in 1997. Thirteen dryland, one irrigated, and one ecofallow nurseries were harvested for yield data.

In 1997, the top ten entries for dryland production were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
Alliance-D*	51.6	Arapahoe-D*	48.5
2137	50.2	Nekota	48.1
Alliance	49.7	Pronghorn	48.0
NE93554	49.3	Arapahoe	47.8
Windstar	49.3	Niobrara	47.4

*"-D" denotes the seed was treated with Dividend seed treatment.

The top ten lines in 1996 for dryland production were:

Entry	Av. Yield bu/a	Entry	Av. Yield Bu/a

Alliance	56.5	Windstar	52.7
2137	56.0	Niobrara	51.5
NE92662	54.0	Vista	51.5
Arapahoe	53.0	Pronghorn	51.4
NE91648	52.9	Nekota	51.3

In 1995, the top ten lines were:

Entry	Av. Yield bu/a	Entry	Av. Yield Bu/a
Vista	58.0	NE90625	55.2
NE91631	58.0	Redland	54.5
TAM200	56.5	Niobrara	53.6
Karl 92	55.5	NE91648	52.8
Alliance	55.4	Arapahoe	52.7

Of the lines tested in all locations except the irrigated test, Turkey had the lowest grain yield (38.7 bu/a) which was as expected when winterkilling is relatively minor. Jagger (46.3 bu/a), a Kansas wheat that can be hurt by late freezes, performed well which indicated a relatively mild winter or good snow cover during cold temperatures.

Hybrid wheat lines, which have performed extremely well in the test in the past, had an average year. All hybrids and many varieties were not tested in allocations, hence some high yielding hybrids and varieties may be overlooked when using statewide averages.

3. Irrigated Wheat Trials

The irrigated wheat nursery was planted in Cheyenne County on a commercial farm by Dr. D. Baltensperger. The top ten lines for grain yield were:

Ap 7510	98 bu/a	2137	88
Jagger	94	Laredo	88
Coronado	89	AP 7501	87
N95L159	88	Karl 92	84
N95L158	88	Ogallala	83

The irrigated data this year was quite interesting as lines previously recommended for irrigation (Rawhide, Yuma, Vona) generally performed poorly. It is not known what caused this reduced performance, but high yielding lines that consistently perform well under irrigation are a definite need for this high production area. One of the concerns with the irrigated wheat trials is that many high yielding lines were not specifically developed for irrigated production and we have not developed a truly adapted irrigated wheat.

In 1996, a change in irrigated wheat development was undertaken. 250 early generation (F5, equivalent to our preliminary dryland observation nursery), short, semi-dwarf lines were tested at the Sidney High Plains Agricultural Laboratory using an augmented design in cooperation with Dr. Baltensperger. In 1997, the 45 best lines, based on height, grain yield, and standability, from this test were advanced to a second year of irrigated and dryland testing (data below). An additional 262 early generation lines were planted this year in the preliminary irrigated observation nursery. A major goal of this program will be to develop high yielding, irrigated wheat varieties with and without straw for bailing. For some irrigated producers the straw is a salable by-product of their production, hence they like Rawhide. For other irrigated producers, excessive straw causes difficulties with their rotational practices and they do not like Rawhide. Yuma and its derivatives appeared to do extremely well in the preliminary irrigated nursery, as did 2137. As this nurseries is amply watered and fertilized, it may be a very good nursery to identify strong strawed cultivars needed both for irrigation and for high rainfall conditions of southeastern Nebraska. We will begin a crossing block between elite irrigated wheats and strong strawed Kansas wheats to develop the high performance wheats needed for irrigation and high rainfall areas. The new Kansas line 2137 performed extremely well under irrigation and topped the irrigated experimental line evaluation nursery. However, when the irrigated experimental line nursery was grown in dryland eastern Nebraska, where there was high rainfall and more severe winterkilling, a number of experimental lines had better performance than 2137. The rationale behind testing irrigated wheats in eastern dryland conditions is that the very strong straw strength and high yield potential of an irrigated wheat might be beneficial for the higher rainfall, higher input wheat agriculture of eastern Nebraska.. Four lines from the irrigated testing program have been advanced to the dryland intermediate nurseries (the Nebraska Triplicate Nursery) and five lines were maintained in the irrigated advanced nursery. What was quite interesting was that none of the four "irrigated" lines with good dryland performance were selected in our initial dryland-screening nursery. Most likely this result can be explained by the dryland-screening nursery being very variable due to blowing and winterkilling two years ago. However, it will be worth monitoring to determine if the irrigated observation nursery is capable of selecting high-yielding lines which, for whatever reasons, were not selected in the dryland observation nursery. If this is the case, the irrigated nursery program may have a very beneficial effect on our dryland wheat-breeding program.

Entry	Linc.	ClayC.	N.Plat bu/a	Cheyn. Irr.	Avg.	Rank	DryAvg. bu/a	DryRank
NI97401	37.55	19.65	38.00	66.75	42.85	42	34.88	48
NI97402	35.55	12.25	45.03	72.10	40.30	48	29.70	49
NI97403	45.25	32.25	42.03	55.93	44.00	39	40.02	34
NI97404	42.05	25.33	44.80	73.32	48.67	22	40.45	32
NI97405ϕ	47.60	29.53	60.40	85.46	54.28	6	43.89	14
NI97406	49.80	44.15	40.88	46.78	47.46	25	47.68	3
NI97407	39.80	39.68	45.88	62.84	48.33	24	43.50	16
NI97408	38.40	36.88	33.25	44.02	38.03	50	36.04	43
NI97409ϕ	39.05	42.43	48.28	83.98	52.24	10	41.66	25
NI97410*ϕ	54.75	50.03	40.28	79.72	54.75	4	46.42	7
NI97411	47.35	46.73	42.23	63.26	49.35	20	44.71	11
NI97412	41.50	34.40	40.05	77.36	46.85	31	36.68	40

NI97413	43.25	46.78	49.03	68.32	49.76	18	43.57	15
NI97414	37.60	28.85	49.63	59.44	42.35	44	36.66	42
NI97415	44.55	38.00	41.93	77.68	50.98	13	42.08	22
NI97416	42.45	37.88	44.45	65.44	47.02	29	40.88	30
NI97417	44.65	33.15	48.55	66.04	46.46	32	39.94	35
NI97418*	50.90	51.53	46.03	76.82	56.61	3	49.87	2
NI97419	39.15	45.38	39.38	49.95	44.38	36	42.53	20
NI97420	33.30	35.25	45.63	65.13	42.96	41	35.56	46
NI97421	36.15	25.30	47.63	59.77	41.92	45	35.96	44
NI97422	44.35	48.98	33.48	72.23	50.46	17	43.20	17
NI97423*	51.35	56.70	50.88	75.56	57.64	2	51.67	1
NI97424*	47.30	43.03	50.90	74.53	53.72	7	46.79	6
NI97425	42.45	35.63	38.33	77.44	50.77	15	41.88	23
NI97426	35.50	31.58	33.58	55.19	40.45	47	35.54	47
NI97427	37.90	32.45	36.93	56.45	41.62	46	36.67	41
NI97428	39.25	31.85	50.65	64.00	47.30	26	41.74	24
NI97429	40.55	50.48	46.10	51.23	48.39	23	47.44	4
NI97430	37.45	44.60	41.98	60.70	47.21	27	42.71	18
NI97431	39.50	35.70	44.78	63.98	45.72	35	39.63	36
NI97432	42.25	48.93	44.50	64.43	50.88	14	46.36	8
NI97433	45.70	40.30	48.40	73.80	49.41	19	41.28	29
NI97434	45.60	47.13	31.35	77.68	50.57	16	41.53	28
NI97435ϕ	44.35	40.83	39.38	81.96	51.65	11	41.55	27
NI97436	45.85	33.70	43.80	53.58	43.86	40	40.62	31
NI97437	46.70	34.73	46.65	66.41	46.92	30	40.43	33
NI97438	49.40	23.05	44.63	63.97	42.77	43	35.70	45
NI97439	45.10	53.75	35.80	52.10	46.24	33	44.29	13
NI97440	39.10	45.98	37.88	50.62	44.36	37	42.27	21
NI97441	48.20	39.18	36.65	77.55	51.30	12	42.54	19
NI97442ϕ	38.15	51.98	47.58	78.23	53.20	8	44.85	10
NI97443	40.50	30.55	38.93	63.67	44.14	38	37.63	38
NI97444ϕ	40.85	49.38	38.03	80.03	54.57	5	46.09	9
NI97445	40.25	38.93	44.00	70.11	48.69	21	41.55	26
2137	53.95	36.83	47.18	90.06	57.70	1	46.92	5
ABILENE	39.40	35.10	45.38	69.56	46.02	34	38.17	37
RAWHIDE	44.15	32.00	35.10	78.38	47.19	28	36.79	39
VISTA	38.70	52.58	36.93	77.40	52.65	9	44.40	12
YUMA	41.90	4.33	33.58	72.61	38.08	49	26.57	50
Mean	42.73	38.11	42.73	67.87	47.86		41.19	
CV	12.39	16.15	16.43	12.36				
LSD	8.88	10.32	11.77	14.07				

*Advanced to NTN

ϕAdvanced to Replicated Irrigated Trial

4. Nebraska Intrastate Nursery:

The Nebraska Intrastate Nursery (NIN) was planted and harvested at seven locations. Most trials had four replications, but Mead and McCook had two replications. McCook was outstanding for grain yield (70 bu/a). Lincoln was good (45 bu/a range). Clay Center was a good site for winterinjury notes and some of the better plots probably yielded quite well (i.e. lines developed south of Nebraska and some lines developed here were severely injured, but other lines were very good--very good separation among the lines). North Platte was similar to Lincoln for yield potential but the field was more variable. Sidney was hurt by wheat streak mosaic virus (WSMV) and drought but still yielded well (38 bu/a average). Sidney was an excellent nursery to identify more WSMV tolerant lines though this must be done with caution as it seemed lines that had seed treatments were better in the trials which would imply there is some interaction between plant growth/vigor and WSMV that could be masking WSMV tolerance. Alliance was quite good (45 bu/a), but with a completely different "look" than our other nurseries (Alliance looked as if the wheat could finish quite well, but the best lines would be those that can handle stress). The data is listed below:

VARIETY	Yield (bu/a)								State
	Linc	Mead	Clay C.	N.Plat	McCook	Sidney	Allianc	Avg.	Rank
ARAPAHOE	45.48	28.60	54.58	51.25	73.11	34.46	46.96	47.774	21
NIOBRARA	47.12	24.58	38.78	57.76	69.62	37.87	44.32	45.722	33
PRONGHORN	48.26	29.64	49.29	59.04	71.05	34.09	48.60	48.566	18
WINDSTAR	47.71	30.20	61.38	59.79	69.96	33.59	46.83	49.923	12
NE91518	50.50	25.47	38.01	61.66	65.94	38.12	46.80	46.641	28
NE91631	43.94	31.34	38.10	52.39	70.40	43.08	39.85	45.586	36
NE92628	43.87	21.20	50.62	56.72	69.87	39.39	41.68	46.190	32
NE92646	49.20	25.02	46.64	52.07	75.09	36.54	44.65	47.030	26
NE92662	46.92	34.94	39.94	57.86	74.57	44.93	46.32	49.355	15
ALLIANCE	42.38	30.38	55.95	58.34	69.77	45.19	54.88	50.983	5
VISTA	40.51	26.05	45.17	52.91	70.69	41.83	48.24	46.484	30
NE93405	49.69	32.79	54.64	56.48	68.86	39.70	46.65	49.829	14
NE93496*	46.59	32.60	60.51	57.25	67.58	34.40	50.02	49.849	13
NE93522	43.70	27.38	46.81	50.97	63.16	26.61	46.12	43.534	46
NE93554*	47.77	30.62	51.42	53.96	79.26	41.70	50.67	50.772	8
NE93613	41.57	24.33	57.53	60.64	80.88	44.42	42.80	50.309	10
NE94445	50.80	26.96	40.30	57.37	67.03	41.25	47.33	47.289	24
NE94479*	57.73	33.74	57.86	58.03	73.70	53.39	51.00	55.063	1
NE94482*	50.38	27.56	54.60	59.22	69.54	52.23	50.91	52.062	3
REDLAND	43.14	28.90	52.55	51.06	72.74	46.04	45.54	48.566	17
TAM107	44.26	22.10	22.34	51.71	71.58	35.62	43.34	41.566	58
NE94489	44.33	22.81	47.39	53.02	64.57	31.93	47.76	44.545	40
NE94567	39.01	22.40	24.93	60.12	68.57	39.80	44.07	42.697	52
NE94588	41.71	25.03	36.65	61.35	70.32	26.95	40.79	43.257	48
NE94589	42.80	25.89	47.21	63.33	68.63	39.90	37.70	46.494	29
NE94632*	47.24	19.26	52.87	52.48	69.87	33.86	43.81	45.625	35
NE94653*	48.55	30.91	56.10	61.84	72.19	37.49	50.32	51.058	4
NE94654	43.58	30.82	48.01	59.37	81.70	44.19	47.98	50.807	7
NE94655*	44.85	29.44	52.44	52.83	67.92	34.88	44.29	46.665	27
NEKOTA	41.84	26.16	45.85	63.26	65.12	44.41	46.71	47.621	23
KARL92	38.81	24.70	17.30	43.65	67.20	30.10	45.49	38.178	59
NE95417	48.38	23.84	25.95	53.34	67.30	35.01	48.57	43.196	49
NE95473	50.69	28.77	49.84	53.80	71.56	50.01	51.67	50.906	6
NE95482	49.05	28.91	54.32	57.53	78.69	53.41	48.66	52.937	2
NE95489	46.66	26.90	53.61	52.37	67.39	37.20	46.78	47.271	25
NE95509	40.45	29.52	20.82	36.90	61.39	32.47	45.09	38.091	60
NE95510	44.29	27.19	48.62	52.84	75.98	52.26	50.07	50.179	11
NE95536	44.01	28.66	40.20	56.83	71.24	37.67	40.89	45.640	34
NE95537	48.94	25.95	48.72	53.31	69.83	26.77	45.00	45.503	37
SCOUT66	36.86	26.93	41.40	57.30	56.10	36.94	41.56	42.440	55
CENTURA	33.87	28.14	42.02	55.62	66.15	35.78	39.34	42.989	50
NE95546	40.54	29.86	28.58	57.70	71.92	39.66	36.99	43.606	45
NE95553	45.06	27.84	47.87	66.35	78.84	34.66	44.45	49.295	16
NE95587	42.88	24.84	47.09	52.94	68.95	41.81	45.68	46.313	31
NE95593	47.30	25.00	52.33	60.73	77.79	32.60	43.94	48.528	19
NE95632*	36.63	23.88	38.85	50.62	55.81	46.36	45.74	42.555	54
NE95656	41.72	23.88	30.09	56.83	67.81	29.06	41.78	41.595	57

NE95686	48.74	26.73	49.94	58.83	61.87	45.38	43.43	47.845	20
N94L212	48.87	27.20	47.46	50.24	66.02	30.84	46.58	45.315	38
CHEYENNE	39.86	26.94	39.67	61.95	55.83	39.45	34.77	42.637	53
BUCKSKIN	39.44	34.33	39.55	57.11	63.16	31.89	39.78	43.609	44
NE93549	36.43	22.57	45.81	48.33	72.12	27.17	46.46	42.699	51
NE94481	45.90	28.16	51.41	58.49	74.17	44.78	51.16	50.582	9
NE95518	38.54	24.88	38.29	57.34	64.31	35.38	38.02	42.393	56
NE95683	36.76	27.29	35.81	56.06	68.02	43.22	48.82	45.141	39
NE94507	41.29	32.19	41.59	59.29	64.71	25.19	43.52	43.969	42
NE95451	45.05	27.94	34.18	52.93	67.89	38.01	42.28	44.040	41
NE95508	42.27	28.51	45.68	55.99	60.12	34.93	39.79	43.896	43
NE95520	39.57	32.39	47.82	57.52	60.25	32.65	33.06	43.322	47
NE92652*	49.69	29.07	44.61	55.62	68.67	40.15	45.70	47.644	22
GRAND MEAN	44.40	27.50	44.63	55.87	69.07	38.31	45.03		
CV	11.38	13.26	14.20	8.40	5.98	17.63	8.78		
LSD	5.91	6.09	7.41	5.49	6.90	7.90	4.62		

*Advanced to USDA regional nurseries

DAVE: NEED TO UPDATE THIS SECTION:

The Nebraska Wheat Quality Lab analyzed for milling and baking characteristics 36 advanced experimental lines and check varieties from the 1995 NIN which were retained for further testing in the 1996 NIN. Again this year the Nebraska Wheat Quality Lab evaluated wheat samples from the NIN and Triplicate Nursery. In the NIN wheat protein contents (14%mb) of the 34 samples ranged from 10.5% (NE90625) and 12.8% (NE93405). Wet, cool growing conditions in 1995 contributed to lower protein contents. Strong dough mixing properties, as determined with the Mixograph, were evident for NE90476, NE90479, NE90625, NE91631, NE92608, NE92646, NE92662, and E93522. Experimental lines with notable baking performance included NE90476, NE90479, NE90625, NE92456, NE92608, and NE92662.

The Nebraska Wheat Quality Lab analyzed for milling and baking characteristics 24 advanced experimental lines and check varieties from the 1995 Triplicate Nursery which were advanced for further testing in the 1996 NIN. The Nebraska Wheat Quality Lab evaluated nine samples as having notable promise for end-use processing. Breads baked from NE93403, NE93405, NE93451, NE93496, NE93522, NE93535, NE93549, NE93554, NE93597, and N93l005 have loaf volumes in excess of 900cc. Additionally, the external appearance and internal characteristics of these experimental lines were scored good to very good. Two lines, NE93406 and NE93427, were rated as having sticky dough handling properties after mixing. These and three other lines, NE93435, NE93477, and NE93618, made less than satisfactory bread.

The Triplicate Nursery was comprised of 28 wheat samples. Wheat protein contents (14%mb) ranged from 9.8% (NE94482) to 13.6% (NE94661). Dough mixing characteristics indicated that NE94512 and NE94589 had the strongest tolerance properties, a trait desired by the milling and baking industries. After baking two samples were evaluated as having notable promise: NE94507 and NE94653. The external appearance and internal characteristics of these experimental lines were scored as good. Other lines in the Triplicate Nursery were evaluated as less than satisfactory. NE94661 had soft milling characteristics and choked (plugged) the Buhler mill. Two other lines (NE94413 and NE94577) were rated as having sticky dough-handling properties after mixing.

Each wheat sample from the Triplicate and NIN Nurseries was evaluated by growing location on the Single Kernel Characterization System 4100, which determined individual kernel

moisture content, weight, diameter, and hardness. Results for each characteristic were expressed as an average of 300 kernels and as a distribution. Three experimental wheat lines (NE94407, NE94654, and NE94567) were scored as mixed wheat. One sample (NE94661) scored as soft wheat. At one or more locations the following lines were scored as mixed wheat: NE90476 and NE90479. Results from the SKCS 4100 will be used to make selections for advancement in the future. This device may be adopted by the Federal Grain Inspection Service as part of the grain grading system. Also this device has the potential to select wheat lines that are less effected by growing conditions and have uniform seed size.

The 1996 NIN yield data are given below. NEAVG is the yield average across all locations. NERANK is the rank of this mean. NEMODRNK is the rank of NEAVG_NM which is the yield average of all the locations except Nelson and Mead. One experimental line deserves particular notice, NE93554. It was the highest yielding line at Lincoln, Sidney, and McCook, and among the top four lines at Hemmingford and Mead (unreplicated trial).

1996 Nebraska Intrastate Nursery:

VARIETY	NEAVG bu/a	NERANK	NEMODRNK	NEAVG_NM	Hemming.	Lincoln	Mead bu/a	Sidney	Nelson	McCook
ARAPAHOE	41.786	25	29	52.00	64.92	41.79	27.80	55.10	14.93	46.18
NIOBRARA	40.780	34	11	54.34	62.68	30.58	20.10	61.91	7.22	62.19
PRONGHORN	42.866	18	10	54.37	70.65	31.81	30.20	50.96	9.51	64.07
NE90476	41.171	31	14	54.02	66.20	28.96	19.80	58.44	11.13	62.50
NE90479	39.258	45	49	49.03	58.52	26.24	30.20	49.31	9.21	62.07
WINDSTAR	43.342	16	16	53.82	63.52	33.25	33.90	60.72	10.88	57.78
NE91518	43.991	10	9	54.70	64.38	33.15	32.80	63.14	12.33	58.14
NE91631	42.166	22	23	53.01	58.74	39.05	26.80	59.77	14.16	54.48
NE91648	40.030	41	39	50.32	59.91	19.45	30.20	54.83	8.70	67.09
NE92456	38.915	49	48	49.10	58.92	28.25	26.70	49.15	10.40	60.07
NE92458	37.455	53	51	48.32	61.48	30.13	24.20	43.36	7.27	58.29
ALLIANCE	44.839	8	2	59.29	67.83	42.20	25.50	62.56	6.38	64.57
RAWHIDE	42.169	21	13	54.12	65.56	34.43	28.40	55.18	8.13	61.31
VISTA	40.333	40	33	51.30	59.52	27.40	26.00	57.76	10.80	60.52
NE92603	41.683	27	40	50.21	62.38	27.28	37.10	49.50	12.14	61.70
NE92608	40.613	35	28	52.12	66.23	12.51	25.90	65.11	9.29	64.64
NE92628	41.317	30	36	50.83	65.73	18.19	34.00	57.91	10.59	61.48
NE92646	39.937	42	38	50.67	65.84	21.69	28.20	59.86	8.74	55.29
NE92662	42.015	23	26	52.26	65.94	24.73	30.30	57.01	12.74	61.37
NE93405*	41.677	28	27	52.17	62.97	35.32	29.60	47.70	11.77	62.70
NE93427*	39.033	47	50	48.90	63.39	34.64	31.00	55.47	7.60	42.10
NE93496*	44.012	9	19	53.36	64.45	37.69	34.90	51.04	15.73	60.26
NE93522	43.482	14	20	53.34	62.28	41.51	36.70	50.06	10.84	59.50
REDLAND	40.906	32	42	50.11	63.15	24.76	34.70	48.97	10.28	63.57
TAM107	35.389	58	57	44.13	56.72	21.07	32.30	51.85	3.50	46.90
NE93549	43.721	13	22	53.17	67.18	37.13	36.30	53.02	13.34	55.36
NE93554*	50.208	1	1	63.42	68.97	47.49	38.60	68.94	8.98	68.27
NE93613*	45.776	6	5	56.99	67.54	30.64	34.10	64.44	12.61	65.33
NE93649	43.782	12	21	53.18	62.69	40.13	35.70	50.48	14.27	59.42
NE94407	35.509	57	59	43.71	61.09	15.60	29.90	50.78	8.33	47.35
NE94413	39.690	44	46	49.81	62.16	28.10	32.40	53.02	6.51	55.95
NE94445	42.857	19	18	53.61	68.65	30.46	36.30	54.58	6.39	60.76
NE94479*	42.638	20	15	53.84	63.08	34.97	27.10	57.83	13.36	59.49
NE94481*	43.377	15	17	53.71	67.22	27.60	28.70	60.30	16.74	59.70
NEKOTA	40.573	36	47	49.43	56.73	37.30	37.30	56.66	8.43	47.02
KARL92	38.001	52	54	45.92	56.76	26.49	36.90	51.46	7.42	48.97
NE94482*	41.344	29	37	50.70	68.64	29.44	32.50	55.87	12.76	48.86
NE94489*	40.483	37	43	49.98	63.17	21.80	33.60	57.84	9.40	57.09
NE94507	40.470	38	45	49.88	65.69	32.23	36.40	46.64	6.92	54.94
NE94512	43.252	17	30	51.79	66.01	27.38	38.90	50.74	13.46	63.02
NE94518	38.965	48	24	52.57	67.32	30.01	11.90	55.31	11.61	57.64
NE94567*	40.442	39	35	50.90	63.40	27.28	32.00	55.35	7.04	57.58
NE94577	41.766	26	31	51.65	61.95	34.54	36.10	54.64	7.88	55.49
NE94585	38.748	50	32	51.58	61.54	28.75	18.10	62.22	8.07	53.81
SIOUXLAND	45.419	7	6	56.57	65.44	38.52	34.90	60.98	11.33	61.34

SCOUT66	39.812	43	44	49.90	62.35	37.82	32.30	47.64	6.99	51.77
NE94588	43.943	11	12	54.21	66.56	37.01	37.60	55.89	9.22	57.38
NE94589	46.725	2	3	58.29	70.48	37.74	37.90	64.84	9.31	60.08
NE94632*	41.906	24	25	52.43	65.50	32.17	30.50	56.72	11.23	55.31
NE94653*	45.830	4	7	56.18	61.91	47.34	34.70	52.07	15.56	63.40
NE94654*	45.779	5	4	57.01	65.58	34.74	32.00	62.33	14.65	65.38
NE94655	46.193	3	8	55.44	61.69	48.17	39.20	52.58	16.19	59.33
NE94661	34.634	59	56	44.24	60.73	15.09	26.70	48.50	4.15	52.63
NE94665	37.052	54	58	43.80	59.48	24.53	39.20	42.68	7.91	48.51
NE94666	35.857	56	55	44.67	56.56	23.23	27.70	43.92	8.76	54.97
NE94673	40.788	33	34	50.97	57.82	35.67	29.10	47.62	11.74	62.78
NE94685	39.188	46	41	50.18	64.55	30.27	26.10	52.01	8.31	53.89
CENTURA	36.139	55	53	47.11	60.10	31.28	18.20	44.43	10.18	52.64
CHEYENNE	38.084	51	52	48.16	58.85	25.27	26.90	52.48	8.96	56.05
BUCKSKIN	33.520	60	60	41.91	52.98	25.71	25.50	51.61	7.99	37.33
GRAND MEAN	0.000				63.20	30.9	7	54.55	10.17	57.46
LSD	0.000				4.89	16.6	2	5.70	3.57	20.70

* Advanced to USDA regional nurseries.

5. Nebraska Triplicate Nursery:

The same comments about the NIN data apply to the Nebraska Triplicate Nursery (NTN) with the exception Mead was not harvested. Data for the 1997 NTN follow:

VARIETY	LINC.	CLAYC.	N.PLAT	MCCOOK	SIDNEY	ALL.	AVG.	Rank
				Yield (bu/a)				
NE96435	40.10	52.02	50.28	75.05	36.51	50.49	50.74	1
NE96455	34.97	28.99	38.53	64.93	33.61	44.66	40.95	54
NE96458	38.58	21.93	44.17	65.70	36.71	46.04	42.19	48
NE96461	48.50	39.76	53.07	76.53	30.20	45.88	48.99	5
NE96462	35.99	34.72	31.30	67.30	41.37	42.54	42.20	47
NE96473	39.43	48.90	42.64	59.33	26.95	45.48	43.79	37
NE96476	42.07	30.12	24.63	62.19	29.21	38.26	37.75	59
NE96510	43.76	53.87	40.25	65.85	43.27	40.71	47.95	10
NE96515	43.37	40.82	36.41	62.40	32.94	47.26	43.87	36
NE96518	36.59	28.46	27.41	69.98	39.84	42.12	40.73	55
NE96520	40.04	41.42	42.00	62.78	17.14	47.87	41.87	51
NE96526	42.22	38.85	33.68	63.75	38.09	39.12	42.62	45
NE96566	32.29	37.05	30.09	70.32	23.13	47.42	40.05	56
NE96573	37.71	54.35	53.69	74.04	34.44	48.13	50.39	2
ALLIANCE	43.63	43.88	39.92	65.43	42.43	49.86	47.52	14
NE96577	40.83	40.55	38.09	65.87	35.96	43.12	44.07	33
NE96579	42.22	38.63	44.01	68.31	37.63	45.37	46.03	17
NE96580	38.22	41.89	44.97	62.84	36.82	44.70	44.91	27
NE96584	36.04	37.32	48.60	60.50	19.25	51.38	42.18	49
NE96585	42.72	27.97	42.38	60.13	31.74	44.28	41.54	52
NE96605	38.13	42.74	55.67	66.25	40.95	47.81	48.59	6
NE96607	46.13	46.16	51.51	62.13	36.99	42.94	47.64	12
NE96618	41.18	37.51	47.47	71.35	30.05	45.43	45.50	21
NE96621	34.75	44.43	38.93	69.41	37.34	42.50	44.56	30
NE96622	36.60	44.29	36.45	73.96	33.90	42.43	44.60	29
NE96623	36.92	47.50	40.72	67.43	34.21	45.01	45.30	22
NE96625	38.74	45.49	32.16	70.38	37.57	45.38	44.95	26
NE96627	37.02	47.19	44.41	72.36	46.00	41.99	48.16	7
NE96628	38.34	48.97	48.42	59.45	34.55	45.22	45.83	19
ARAPAHOE	41.52	55.57	43.56	70.99	48.03	41.55	50.20	3
NE96630	43.73	34.47	38.58	69.30	37.96	42.25	44.38	31
N396632	39.76	52.51	38.84	64.27	37.40	49.93	47.12	15
N396638	39.71	42.80	33.19	69.31	39.22	41.61	44.31	32
N396641	45.01	37.13	45.49	69.31	24.88	46.08	44.65	28

NE96644	38.65	41.49	46.02	69.28	28.00	46.76	45.03	24
NE96647	35.49	37.39	43.84	70.46	28.41	45.84	43.57	38
NE96649	35.44	41.81	40.39	72.13	49.49	45.98	47.54	13
NE96650	32.63	46.63	38.26	59.41	37.73	43.62	43.05	43
NE96652	40.25	52.96	45.57	71.35	36.40	41.31	47.97	9
NE96654	42.47	46.76	50.62	68.19	26.12	43.55	46.29	16
NE96658	40.48	42.50	36.43	62.34	34.28	42.56	43.10	42
NE96659	29.77	35.80	33.72	67.58	33.52	37.58	39.66	58
NE96661	32.47	55.54	38.88	51.52	36.49	39.92	42.47	46
NE96676	42.04	51.94	45.05	59.66	33.61	37.72	45.00	25
KARL92	39.18	29.51	33.87	59.41	29.98	46.72	39.78	57
NE96677	31.94	55.48	46.05	64.92	32.69	44.16	45.87	18
NE96679	37.21	41.72	35.12	63.41	37.88	42.09	42.90	44
NE96682	37.07	56.47	40.21	48.23	25.74	45.22	42.16	50
NE96690	42.29	48.53	40.54	61.35	43.00	35.95	45.28	23
NE96697	36.46	50.35	44.40	57.81	33.90	37.10	43.34	41
NE96700	28.89	34.19	44.23	62.93	49.88	40.64	43.46	40
NE96704	38.00	18.50	38.37	60.91	24.20	37.70	36.28	60
NE96722	42.45	21.71	42.52	67.12	43.72	46.77	44.05	34
NE96723	41.76	38.92	40.67	64.80	30.79	44.16	43.52	39
NE96727	35.76	38.49	36.86	59.52	49.52	43.40	43.93	35
NE96737	48.90	45.21	41.65	68.50	36.28	46.81	47.89	11
NE96740	41.76	19.01	36.66	60.25	47.32	43.42	41.40	53
NE96744	35.58	39.36	52.81	55.26	49.24	41.72	45.66	20
NE96747	37.35	45.61	52.43	66.15	40.55	46.20	48.05	8
PRONGHORN	38.29	48.40	45.88	69.83	45.71	50.92	49.84	4
GRAND MEAN	38.99	41.54	41.54	65.36	35.84	44.04	44.55	
CV	10.63	12.80	22.84	6.72	16.20	7.99		
LSD	5.61	7.20	12.85	7.34	7.86	4.76		

Twenty-nine lines were advanced to the Nebraska Intrastate Nursery which is slightly above normal for advancement from this nursery. ***DAVE: The Nebraska Wheat Quality Laboratory milled and baked the 59 wheat samples from the 1995 Duplicate Nursery which were tested in the 1996 NTN. Wheat protein contents (14%mb) ranged from 10.6% (NE95684) to 13.4% (NE95535). Strong dough mixing properties were noted for NE95410. Five samples were evaluated as having notable promise: NE95417, NE95451, NE95473, NE95508, and NE95510. These experimental lines had high loaf volumes. Additionally, the external appearance and internal characteristics of these experimental lines were scored as good or very good in at least one category. Other lines were evaluated as less satisfactory. NE95526 had soft milling characteristics and plugged the Buhler mill. Two other lines (NE95535 and NE95538) had poor milling characteristics. Two lines, NE95575 and NE95577, were rated as having sticky dough handling properties after mixing. Bread made from the following lines was rated as poor in one or more quality characteristics: NE95450, NE95575, NE95577, NE95583, and NE95589.***

Each wheat sample from the Duplicate Nursery was evaluated by location on the Single Kernel Characterization System 4100. At Sidney the following hard red winter wheat lines were scored as soft wheat: NE95526, NE95538, and NE95684. Eight other samples were scored as mixed wheat. Analyses of samples, grown at Hemingford, indicated that one line (NE95538) scored as soft, while five lines were rated as mixed wheat. Two lines from Clay Center (NE95526 AND NE95538) scored soft and five lines scored as mixed wheat. Evaluation of experimental wheat lines from North Platte indicated eight lines were scored as mixed wheat. The lines that scored as soft wheat (NE95526 AND NE95538) also presented problems during Buhler milling.

The data for the 1996 NTN follow:

VARIETY	Linc.	Nelson	McCook	Sidney	Hemmin.	Mead	Avg.	RANK	AVG_NM	Rank
			bu/a						bu/a	
NE95410	41.763	7.353	55.045	39.877	62.028	27.800	38.978	43	49.678	42
NE95413	21.475	4.637	29.733	51.879	55.092	20.100	30.486	60	39.545	59
NE95417	41.448	10.810	59.308	44.215	60.214	30.200	41.033	29	51.296	32
NE95444	42.805	10.605	49.551	40.264	67.629	19.800	38.442	48	50.062	40
NE95447	44.164	9.791	57.479	48.450	62.160	30.200	42.041	19	53.063	19
NE95450	34.133	7.318	54.463	55.587	61.881	33.900	41.214	28	51.516	29
NE95451	34.386	6.400	48.816	52.218	62.650	32.800	39.545	38	49.518	43
NE95473	40.086	13.979	60.702	56.560	67.698	26.800	44.304	8	56.262	6
NE95480	32.966	6.191	46.231	46.371	58.112	30.200	36.679	57	45.920	56
NE95481	32.065	8.805	50.580	60.539	60.531	26.700	39.870	36	50.929	34
NE95482	37.066	5.638	59.314	52.262	63.137	24.200	40.270	34	52.945	21
NE95489	43.032	4.639	60.875	52.375	63.399	25.500	41.637	21	54.920	10
NE95499	17.201	2.170	44.236	39.811	53.613	28.400	30.905	59	38.715	60
NE95506	35.118	12.814	57.036	46.268	58.760	26.000	39.333	40	49.296	46
ARAPAHOE	40.904	14.422	57.987	57.280	62.784	37.100	45.080	3	54.739	11
NE95508	37.905	13.332	55.431	48.545	60.811	25.900	40.321	33	50.673	36
NE95509	41.317	13.829	64.296	50.502	61.161	34.000	44.184	9	54.319	13
NE95510	43.182	11.201	57.603	49.587	61.416	28.200	41.865	20	52.947	20
NE95518	47.327	6.536	58.274	55.760	60.409	30.300	43.101	15	55.443	7
NE95520	32.391	-0.028	51.370	57.564	64.644	29.600	39.257	41	51.492	30
NE95521	46.353	9.463	55.300	49.729	61.690	31.000	42.256	18	53.268	18
NE95526	46.951	7.365	60.231	60.593	59.719	34.400	44.877	6	56.874	3
NE95530	23.925	6.021	52.430	55.506	61.746	36.700	39.388	39	48.402	47
NE95535	33.339	12.854	55.720	54.451	57.038	34.700	41.350	27	50.137	39
NE95536	45.547	9.528	61.431	49.914	63.308	32.300	43.671	11	55.050	9
NE95537	33.554	5.148	54.530	53.527	65.550	36.300	41.435	24	51.790	28
NE95538	36.875	14.204	62.530	47.682	62.998	38.600	43.815	10	52.521	24
NE95541	28.958	9.756	46.922	46.460	57.782	34.100	37.330	52	45.031	58
NE95543	29.099	10.156	48.570	51.618	57.829	35.700	38.829	44	46.779	53
REDLAND	42.548	13.309	64.097	46.319	60.895	29.900	42.845	16	53.465	17
NE95544	31.944	7.224	47.592	50.459	62.998	32.400	38.770	46	48.248	49
NE95546	47.525	4.909	52.177	59.318	59.933	36.300	43.360	14	54.738	12
NE95553	46.567	7.050	56.452	58.839	65.054	27.100	43.510	12	56.728	4
NE95567	37.618	8.822	48.648	51.179	56.152	28.700	38.520	47	48.399	48
NE95572	34.925	3.793	52.998	40.912	62.806	37.300	38.789	45	47.910	50
NE95575	36.558	17.078	65.250	53.777	59.811	36.900	44.896	5	53.849	14
NE95576	37.022	10.413	49.953	54.230	64.409	32.500	41.421	25	51.404	31
NE95577	37.390	7.323	61.957	47.825	61.363	33.600	41.576	23	52.134	27
NE95583	27.355	1.536	44.037	53.171	59.355	36.400	36.976	56	45.980	55
NE95587	42.775	11.204	53.713	51.095	62.594	38.900	43.380	13	52.544	23
NE95589	43.625	5.704	59.288	36.401	57.957	11.900	35.813	58	49.318	45
NE95593	49.885	2.880	57.971	37.889	64.982	32.000	40.935	31	52.682	22
NE95632	46.250	8.856	63.001	62.476	64.546	36.100	46.872	1	59.068	1
NE95650	40.806	7.394	56.033	52.676	59.159	18.100	39.028	42	52.169	26
KARL 92	35.228	10.108	58.063	50.640	57.128	34.900	41.011	30	50.265	37
NE95656	48.066	9.124	58.451	58.608	68.351	32.300	45.817	2	58.369	2
NE95668	37.847	6.078	54.680	48.747	59.508	37.600	40.743	32	50.196	38
NE95676	40.547	4.517	48.149	35.352	61.092	37.900	37.926	50	46.285	54
NE95683	46.091	9.194	51.512	56.671	59.636	30.500	42.267	17	53.478	16
NE95684	43.400	8.374	58.519	62.178	62.697	34.700	44.978	4	56.699	5
NE95685	40.755	7.279	44.668	39.374	57.890	32.000	36.994	55	45.672	57
NE95686	35.572	7.486	53.447	48.066	65.727	39.200	41.583	22	50.703	35
NE95697	42.670	7.210	49.172	53.168	59.133	26.700	39.676	37	51.036	33
CRL87049	47.548	8.555	54.908	60.161	57.838	39.200	44.702	7	55.114	8
N94L005	37.179	8.092	47.448	46.767	58.794	27.700	37.663	51	47.547	51
N94L036	37.523	6.824	46.050	49.658	54.593	29.100	37.291	53	46.956	52

N94L154	28.895	6.163	53.126	55.161	60.783	26.100	38.371	49	49.491	44
N94L205	34.148	5.887	51.111	50.164	63.481	18.200	37.165	54	49.726	41
N94L212	41.220	7.121	53.474	56.960	62.485	26.900	41.360	26	53.535	15
TAM107	37.784	5.441	54.333	58.695	58.626	25.500	40.063	35	52.360	25

6. Regional Nurseries

The Southern Regional Performance Nursery (SRPN) and Northern Regional Performance Nursery (NRPN) were harvested at Lincoln, Clay Center (SRPN only), North Platte, Sidney, and Alliance. Yields were as follows:

SRPN:

VARIETY	Linc.	ClayC.	N.Plat. bu/a	Sidney	All.	Avg.	Rank
CI1442	23.47	36.71	45.18	32.08	36.60	33.11	23
CI13996	35.42	46.82	59.40	37.55	37.70	40.86	6
PI495594	37.60	15.78	56.21	36.81	38.25	28.84	36
OK93617	37.90	27.37	44.30	23.86	32.07	29.71	35
OK94P549	41.00	40.94	55.89	32.45	39.52	38.97	11
OK94P461	38.04	14.55	50.87	36.39	36.37	27.98	38
TX91D6825	41.30	32.47	61.24	34.55	30.67	34.29	18
TX91D6856	46.16	39.19	61.02	40.66	36.17	40.27	7
HBG0358	39.31	15.02	60.82	29.33	38.40	27.42	40
TX94V2327	35.94	13.40	56.91	35.13	42.05	27.98	37
TX94V3329	32.02	13.06	52.63	36.74	29.30	24.84	43
TX95V4926	36.65	36.95	47.62	41.86	44.30	39.34	10
TX95V926	40.08	22.86	59.15	43.60	37.67	33.41	21
TX95V5332	40.47	39.68	51.48	38.95	41.68	40.09	8
TX94V2130	36.45	13.38	51.80	42.07	45.62	30.18	34
CO910424	48.54	19.16	55.27	38.38	37.63	32.57	27
CO920696	40.46	17.58	58.62	42.54	43.23	32.28	30
CO9440700	49.04	38.15	62.72	40.13	45.90	42.27	5
KS94H147	37.31	14.86	58.39	30.06	42.77	27.97	39
KS941064-6	48.00	30.33	56.22	24.62	38.40	34.33	17
KS940935-125	44.01	36.87	49.50	21.04	29.72	33.70	19
KS85W663-11-	48.74	-1.32	43.23	30.47	44.92	24.30	45
KS84W063-9-3	47.54	6.16	59.14	34.02	41.95	27.17	41
N95L158	51.50	41.91	56.33	35.85	40.70	42.37	4
NE93405	44.97	41.18	60.81	34.56	38.20	40.02	9
NE93427	48.81	29.80	60.82	32.39	40.38	36.24	14
NE93496	45.19	52.84	65.08	30.90	38.97	44.15	2
NE94632	47.30	48.42	56.28	33.06	38.82	43.20	3
W94-042	43.98	34.43	70.60	34.62	34.75	36.44	13
W94-137	37.54	15.45	55.50	32.07	34.00	26.90	42
W94-320	41.64	22.77	52.60	37.22	39.65	32.81	26
W94-245	33.29	6.67	48.74	36.05	39.13	24.36	44
W94-435	42.27	26.24	50.84	32.19	37.77	32.94	24
WX94-3504	48.54	24.89	54.01	29.98	39.75	33.61	20
WX94-1604	44.09	28.56	62.83	29.86	44.65	35.14	15
XH1877	46.17	25.06	64.62	30.68	35.70	32.54	28
XH1881	49.89	37.75	68.70	52.36	48.92	45.33	1
WX95-2401	54.68	16.52	53.76	38.68	48.55	34.99	16
T89	40.41	29.37	43.07	24.37	41.05	32.91	25

T86	37.21	27.17	55.79	27.40	42.77	32.35	29
T93	41.48	20.19	48.69	27.79	42.20	30.37	32
T94	47.65	31.40	56.60	37.92	46.08	38.89	12
G1594	39.10	18.59	62.09	29.06	45.78	30.22	33
G1720	48.52	32.72	54.57	21.03	31.95	33.39	22
G12017	48.50	20.00	55.11	32.02	40.25	32.15	31
Grand Mean	42.40	26.71	55.89	33.85	39.58	33.85	

Data for the NRPN:

VARIETY	Linc.	N.Plat.	Sidney bu/a	Alln.	Avg.	Rank
Kharkof	29.08	50.35	28.25	37.80	36.370	30
Roughrider	37.03	58.45	25.32	41.10	40.475	23
Abilene	45.48	51.56	43.26	41.97	45.568	12
SD92107	33.82	50.82	52.22	39.80	44.165	17
SD92191	31.05	50.49	36.04	36.22	38.450	26
SD92227	34.77	60.23	40.18	41.67	44.213	16
SD93267	29.70	49.29	24.70	41.77	36.365	31
SD93336	32.82	52.92	40.67	36.85	40.815	22
SD93364	32.09	54.29	30.03	38.50	38.728	25
SD93380	40.95	54.20	39.41	36.35	42.728	19
SD93500	36.81	55.96	49.65	39.83	45.563	13
NE92652	46.18	61.03	38.85	41.37	46.858	6
NE93554	45.32	56.85	44.41	39.48	46.515	8
NE93613	35.56	52.00	51.72	44.17	45.863	10
NE93669	41.11	54.97	47.07	43.57	46.680	7
NE94479	41.69	51.21	40.91	45.03	44.710	15
NE94481	35.93	56.28	50.17	41.67	46.013	9
NE94482	38.61	52.67	52.78	46.23	47.573	3
NE94489	38.74	49.12	23.54	38.43	37.458	28
NE94567	29.74	55.39	44.55	37.65	41.833	21
NE94653	37.94	52.44	48.32	43.60	45.575	11
NE94655	32.27	49.09	44.28	43.77	42.353	20
N95L164	44.02	57.72	42.62	43.88	47.060	5
XH1920	37.23	60.65	53.84	38.28	47.500	4
XNH1824	48.53	57.37	43.95	43.45	48.325	2
XH1881	43.59	56.90	56.97	46.92	51.095	1
MTS92042	12.05	30.21	11.73	33.37	21.840	35
MT91192	28.61	55.36	36.22	39.52	39.928	24
MT9222	25.05	48.66	39.26	40.12	38.273	27
ND9257	34.16	55.87	48.51	32.45	42.748	18
ND9272	30.19	41.20	32.56	39.23	35.795	32
IDO467	23.57	40.10	11.96	27.47	25.775	34
AMP3JP4A7A	45.40	70.29	31.14	35.40	45.558	14
AMQ3NQ4A7D	29.29	62.50	27.79	28.77	37.088	29
AMQ3KF4B7A	32.91	57.68	14.43	30.77	33.948	33
GRAND MEAN	35.47	53.55	38.50	39.33		
CV	14.12	10.69	15.64	14.77		
LSD	6.82	7.79	8.20	7.91		

In this nursery, the hybrids (XH and XNH lines) continue to perform well as do many of the Nebraska experimental lines.

7. Multiple-Location Observation Nursery

Seven replications (locations) of this nursery were harvested and used for selection. Due tot he size of this nursery, spatial variation continues to be a concern at many locations. Enhanced statistical analyses for these trials continue to be sought. Fifty-two lines (including three lines from Dr. C. J. Peterson's breeding efforts) were advanced to the Nebraska Triplicate Nursery. An additional four lines from the irrigated wheat efforts were advanced to the Nebraska Triplicate Nursery.

8. Early Generation Nurseries

a. Single-plot Observation Nursery

Seventeen hundred ninety-eight lines including checks were evaluated at Lincoln and Mead in 1991. Of this group, approximately 400 lines were submitted for Quadrumat Junior milling, flour protein content, and dough mixing properties. A major improvement in this nursery has been the planting of a single 10' row at Mead for every plot planted at Lincoln. Hence, if one nursery is lost, a second row is available for selection and harvesting. As in the past, the turn-around time was excellent (all quality evaluations completed by the end of August). On the basis of agronomic and quality performance, 286 lines were selected for further testing. The cooperative test became larger with the addition of about 30 lines from Dr. Peterson.

b. Headrow Nursery

Over 40,000 headrows were planted at Mead. In general, the headrow nursery was adequate. The early planted portion of the nursery followed oats, but was close to an alfalfa field and suffered poor emergence and grasshopper damage. The later planted portion followed soybeans and was irrigated to insure emergence. Irrigation was extremely valuable and the later planted portion was the better nursery. Over 1750 rows were selected and 1720 lines were advanced to the observation nursery. In addition, 20 lines were submitted to Gary Hein and Ms. Cheryl Baker (USDA-ARS at Stillwater, Ok.) for Russian wheat aphid testing, 34 lines to Dr. Joe Martin (Kansas State University at Hays, Kansas) for wheat steak mosaic field testing to complement our greenhouse testing and 345 strong strawed semi-dwarf lines were directly advanced to an irrigated observation nursery in cooperation with Dr. David Baltensperger.

a. F3 bulk hybrids

The F3 bulk hybrid nursery contained 730 bulks and check plots and were planted at Mead and Sidney. Most bulks survived the winter and were good for selection. Heads were selected from the Mead bulks and the seed quality would be considered as average. The number of F3 bulks is larger than normal due to our planting segregating red and white F3 and F4 bulks. The frequency of white segregants should be higher in F4 bulks than in F3 bulks. Over 40,000 head rows were selected for fall planting. The headrows were planted very early into good moisture while we were planting our western nurseries. Their emergence and stand was excellent. The project goal remains to have sufficiently good segregating F3 material to select about 40 - 45,000 headrows.

b. F2 bulk hybrids

The F2 bulk hybrid nursery contained 876 bulks and check plots. These bulks generally survived the winter, but seemed to be hurt by drought. In order to control weeds, the Mead nursery follows early soybeans. This rotation is better for weed control that wheat fallow wheat, but does deplete residual soil moisture, hence the droughty appearance in this part of the field. We are now using a three year rotation of Round-up Ready, full-season soybeans, followed by spring oats, and are using better herbicides to control weeds. As in the past, we continue to share our bulks with other programs (Colorado State University and South Dakota State University) and receive bulks from other programs (Colorado State University, Kansas State University, Texas A&M University, and South Dakota State University). This germplasm sharing should continue as many more crosses are made among breeding programs than can be fully evaluated (i.e. my crosses are evaluated in Nebraska, but could have utility elsewhere if they were evaluated). Similarly, germplasm developed in other programs could be evaluated in Nebraska for utility. Bulks that segregated for red and white seed types were advanced to the F3 nursery and planted with the 1998 F2s bulks for combine harvest.

9. Winter Triticale Nursery

The triticale nurseries this year were average. Sidney trials were very good, but the Mead and Lincoln trials were partially damaged by winterkill and drought stress. Visual selection was used to select early generation lines and head rows for advancement. The key to improved triticale varieties remains access to improved triticale germplasm and efforts continue to increase germplasm diversity. Triticales with high grain and forage yield potential are available and may be useful as a feed grain or forage crop. Triticale research has replaced our research on feed wheat. Dr. Ken Vogel (USDA-ARS, forage grass geneticist) has begun evaluating some of the forage triticales for forage potential and preliminary data indicate some lines may be commercially competitive with the best available forage triticale varieties. Dr. Jim Peterson also makes a valuable contribution to this project by planting and harvesting for grain, the forage triticale trials at McCook and Sidney.

1997 Triticale Results:

VARIETY	Linc.	Mead	Sidney	Avg.	Rank
		bu/a*			
PRESTO	37.55	24.00	49.12	36.89	12
NE90T413	37.88	18.03	34.58	30.16	23
TSW250783	37.44	27.55	53.72	39.57	5
NE92T422	37.09	33.95	50.57	40.54	4
NEWCALE	27.83	19.45	43.22	30.17	22
NE94T407	37.44	22.88	50.10	36.81	13
NE94T416	34.66	18.33	62.80	38.60	7
TRICAL	24.82	17.50	32.90	25.07	29
NE95T423	38.76	24.33	48.07	37.05	10
NE95T424	38.98	22.15	51.70	37.61	9
NE95T426	47.59	29.38	48.65	41.87	2
NE95T427	37.62	18.25	61.60	39.16	6
NE95T436	34.61	24.35	55.22	38.06	8
ARAPAHOE	31.74	19.68	42.05	31.15	19
NE96T404	24.61	28.48	50.02	34.37	15
NE96T410	25.97	21.80	47.07	31.61	18
NE96T411	31.06	31.15	27.30	29.84	24
NE96T412	32.16	22.23	38.15	30.85	20
NE96T413	34.92	35.88	58.55	43.12	1
NE96T418	21.55	18.88	40.15	26.86	28
NE96T420	36.40	20.68	53.77	36.95	11
NE96T421	32.47	22.23	42.45	32.38	17
NE96T422	34.80	16.53	30.75	27.36	25
NE96T423	24.01	22.63	34.33	26.99	27
NE96T424	28.09	14.43	20.88	21.13	30
NE96T429	30.77	18.30	50.93	33.34	16
NE96T431	42.74	16.80	49.68	36.40	14
NE96T440	37.95	23.33	61.60	40.96	3
NE96T441	33.75	22.68	25.48	27.30	26
NE96T451	28.96	14.78	47.18	30.30	21
GRAND MEAN	33.47	22.35	45.42	33.75	
CV	9.40	28.75	23.78		
LSD	4.29	10.92	14.74		

* using a 60 lbs/bu for easy comparison to winter wheat yields. The actual standard for triticale is a 48 lbs/bu.

1996 Triticale Results:

VARIETY	Lincoln	Sidney	Avg.	Rank
		bu/a*		
PRESTO	33.49	63.07	48.280	25
NE90T413	44.73	69.73	57.230	8
NE91T425	46.83	58.37	52.600	17

NE90T404	44.42	62.52	53.470	14
TSW250783	42.38	91.37	66.875	1
NE90T406	41.38	54.64	48.010	27
NE92T422	53.66	65.49	59.575	5
NE94T417	36.14	72.63	54.385	12
NE95T451	32.92	66.45	49.685	22
NEWCALE	25.47	59.78	42.625	30
NE94T403	32.06	67.93	49.995	20
NE94T406	38.16	61.68	49.920	21
NE94T407	41.47	65.05	53.260	15
NE94T408	31.43	60.87	46.150	28
NE94T410	31.20	71.13	51.165	19
NE94T411	29.62	66.73	48.175	26
NE94T413	29.33	68.59	48.960	23
NE94T415	46.96	60.55	53.755	13
NE94T416	43.16	71.98	57.570	7
TRICAL	39.69	46.71	43.200	29
UGO	34.77	77.24	56.005	10
NE95T409	33.45	63.73	48.590	24
NE95T418	35.92	75.91	55.915	11
NE95T423	47.21	73.77	60.490	4
NE95T424	40.34	81.85	61.095	3
NE95T426	45.12	81.54	63.330	2
NE95T427	42.31	73.26	57.785	6
NE95T431	38.61	66.54	52.575	18
NE95T436	45.90	68.10	57.000	9
ARAPAHOE	36.90	68.32	52.610	16
GRAND MEAN	38.83	67.85	53.340	
CV	17.73	9.08		
LSD	9.40	8.41		

* using a 60 lbs/bu for easy comparison to winter wheat yields. The actual standard for triticale is a 48 lbs/bu.

10. Wheat Transformation and Tissue Culture Studies

Due to a successful grant writing efforts (both within the university and for nationally competitive grants; approximate funding is $1,500,000 over three years), a team of scientists (Dr. A. Mitra, Dr. J. van Etten, Dr. R. French, Dr. P. Staswick, Dr. J. Morris, Dr. T. Elthon, Dr. P. Blum, and Dr. Baenziger) at the University of Nebraska has developed a major effort on wheat and soybean transformation. In wheat, the key goals for transformation will be disease and stress (mainly heat) resistance. As part of this effort and those of the Biotechnology Center, a new Biotechnology Core Facility on Plant Transformation was developed with Dr. Tom Clemente as the facility coordinator. The wheat transformation efforts are led by Ms. Shirley Sato, formerly with Monsanto, who has almost twenty years of experience in plant tissue culture and transformation. From particle bombardment, we have produced 194 plants that were confirmed transgenic by either GUS assay, nptII leaf bleach, or nptII ELISA. These 194 plants represent 130 independent transformation events. There are 13 more putative transformants representing 8 independent events awaiting verification (leaf bleach and ELISA) when they have grown larger. All gun experiments are complete at this time. From *Agrobacterium* mediated transformation, we have produced 10 plants in soil representing 8 independent events. Of these 10 plants, 1 has been confirmed transgenic by npt ELISA and the other 9 plants are considered at this point putative transgenics. Dr. Jai-hoen Lee and Mr. Kamil Haliloglu, in cooperation with Ms. Sato and Dr. Clemente, are conducting research on optimizing the Agrobacterium mediated transformation of wheat. Drs. Mitra, Clemente and Ms. Sato have incorporated genes for virus, fungal, and bacteria resistance in wheat. Mr. Todd Campbell is beginning to study the expression and inheritance of the wheat viral resistance transgene. We have also looked at optimizing the culture conditions for the transformation of Bobwhite, the main wheat used in transformation (work done by Dr. Jan Rybczynski, a Fulbright visiting professor, and Mr. Kim Kyung-moon). A grant for continuing the Area of Concentration grant was submitted in late 1997. Plant transformation is considered a key technology for modern crop improvement.

11. <u>Chromosome Substitution Lines</u>

This research was undertaken with the expectation as we learned more about the wheat genome, we would be able to develop better breeding strategies. Mr. Mohammed Maroof Shah completed the data analysis of the field evaluations of the recombinant inbred chromosome lines (RICLs) for Cheyenne (CNN)-Wichita (WI) chromosome 3A lines. As in our previous studies, CNN(WI3A) had significantly higher grain yield, and kernel weight CNN. CNN(WI3A) was also significantly earlier flowering than CNN. The parent lines were not different from each other for grain volume weight, which may reflect the fewer environments in which we have completed our measurements for this trait. Hence the quantitative trait loci (QTLs) for grain yield on chromosome 3A, despite having a significant G x E interaction, have been identified in 8 (Berke et al., 1992a), 4 (Yen et al., 1997), and now in 7 environments.

Significant differences were identified among the RICLs for those traits that the parent lines were significantly different which indicate that the parental QTLs are segregating among the RICLs.   Among the RICLs there appeared to be relatively little statistically significant transgressive segregation, which can be interpreted as the parent lines differing by one gene or by genes in coupling phase. The frequency distributions were tested for normality and all of the distributions were statistically normal. However, upon looking at the frequency distributions, anthesis date appeared to be bimodal with the peaks being similar the parental values. When grouped by the parental values, a chi-square test indicated 1:1segregation for anthesis date, which we interpreted as single gene segregation. Visual evidence of bimodality also was observed for plant height and 1000 kernel weight in some environments, whereas grain yield, kernel tiller^{-1}, tiller m^{-2}, and grain volume weight were normally distributed. A significant correlation was found between anthesis date, plant height, and 1000 kernel weight. Generally, most of the early flowering and short statured lines were similar to CNN(WI3A) for 1000 kernel weight while most of the late flowering and taller lines were similar to   CNN   . However, two lines had plant heights similar to CNN(WI3A) but were as late as CNN which we believe indicates crossing over between the gene controlling anthesis date and the gene(s) or QTLs for plant height. Larger GxE effects for yield and its component traits; kernel tiller^{-1} and tiller m^{-2}, and for grain volume weight may be the reasons of not detecting major genes for these traits.

A second goal of this research was to screen for polymorphic molecular markers on chromosome 3A so that we can map the regions of chromosome 3A that contain gene(s)/QTLs affecting these important agronomic traits. The screening has been initiated in cooperation with Dr. Kulvinder Gill, molecular cytogeneticist at the University of Nebraska, and Dr. Yang Yen, a biochemical cytogeneticist at South Dakota State University. Of the fifty-one RFLP probes we were able to test in our initial screens, 78% detected polymorphism between CNN and WI with one or more of the seven restriction enzymes, 43% detected polymorphism for chromosome 3A, 66% probes were found polymorphic for chromosomes 3B or 3D. The average RFLP frequencies detected per restriction enzyme for 3A, 3B/3D, and for the whole group 3 chromosomes were 13.8%, 30.3%, and 22%, respectively. This high level of RFLPs between these cultivars was unexpected and may be somewhat fortuitous. Dr. Gill is also interested in looking at recombination in-group 1 chromosomes and the level of polymorphisms does not appear to be as high as for group 3 chromosomes. These results (and those described below for SSRs) indicate it should be possible to construct a reasonably dense map of chromosome 3A. Using Mapmaker Macintosh 3.0 (Lincoln et al., 1992) we were able to develop a tentative map of our RFLP probes and using single factor analysis of variance followed by stepwise regression, we were able to tentatively map some of the QTLs controlling our traits. An affiliation was found for anthesis date with plant height and kernel weight and is of particular interest because it will useful to know if the traits are linked (as our empirical data seems to indicate) or pleiotropic. In dryland winter wheat production, anthesis date is often critical for determining grain yield because it is a main factor in how the plants respond to sporadic rains during the grain filling period.

A total of 135 PCR primer sets have been screened for polymorphisms. Of the 68 STS primer sets screened, three (E14, ABG57.1 and ABG471) generated polymorphisms between WI and CNN, but only one (ABG471) generated an about 800-bp DNA fragment that showed polymorphisms between CNN3A and WI3A. Total of 40 RAPD primer sets were screened, and only eight were able to generate polymorphism between Wichita and Cheyenne. However, none of the eight primer sets generated a polymorphism between CNN3A and WI3A. Of the 35 SSR primer sets screened, six generated polymorphisms between CNN and WI, of which five (WMS30, WMS114, WMS155, WMS369 and *Xpsp*3047) generated polymorphisms between CNN3A and WI3A (Fig. 3). This preliminary screening indicated that, for us, SSRs might be the most useful PCR-based molecular markers. Therefore, our screening efforts for PCR-based markers will be more focused on SSR markers.

The RFLP work will continue in collaboration with Dr. Gill and the PCR-based markers will continue in collaboration with Dr. Yen if funding can be acquired. A grant to support this research was submitted to the USDA-CREES National Research Initiative.

12. <u>Effect of 1A.1R on Agronomic Performance</u>

Previously, Dr. Benjamin Moreno-Sevilla, now with HybriTech, 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, but that 1B.1R and 1B lines derived from the heterogeneous cultivar Rawhide (a variety containing 1B and 1B.1R plants) were not different for grain yield. The 1A.1R translocation has similarly been reported to enhance grain yield. A replicated study conducted by Dr. Eduardo Espitia-Rangel, a former graduate student, using Nekota (a heterogeneous variety for 1A and 1A.1R was completed to determine if 1A.1R has beneficial effects for yield and detrimental effects on end-use quality. Dr. R. A. Graybosch (USDA-ARS) helped identify which lines contain the rye translocation. The presence of 1AL.1RS translocation in the Nekota background increased kernel weight (3.3%) and grain volume weight (0.4%), had no effect on grain yield, kernels per spike, and anthesis date, and decreased kernels per spike (0.4%), plant height (1.2%), and spikes per square meter (2.9%). The 1A and 1AL.1RS were equally stable for grain yield, kernels per spike, spikes per square meter, and plant height. For kernel weight, the 1A lines were more responsive and tended to have heavier kernels under favorable environments, while the 1AL.1RS lines had heavier kernels under less favorable environments. For grain volume weight the 1A lines were more responsive than the 1AL.1RS lines, which had heavier grain volume weight under less favorable environments.

The presence or absence of the 1AL.1RS translocation produced significant differences for all the end-use quality traits. The presence of 1AL.1RS translocation increased flour protein (4.3%), and decreased flour yield (2.3%), Mixograph mixing time (from 2.9 to 2.7 min) and Mixograph mixing tolerance (from 3.5 to 3.1). Despite higher flour protein in 1AL.1RS lines, the 1AL.1RS translocation was not beneficial for end-use quality traits. The 1A and 1AL.1RS lines had similar stability values for flour yield and flour protein; the 1A lines showed higher flour yield in all environments, while the 1AL.1RS lines had higher flour protein in all environments. For mixing tolerance and mixing time, the 1A lines were more responsive to the environment, while the 1AL.1RS lines had exceptional stability over all environments. While high levels of stability (uniformity) are desired by the milling and baking industry, the stable 1A.1R lines were uniformly poor quality in every environment. The end use quality of Nekota can be explained by a mixture of 1A lines with good quality and 1AL.1RS lines with poor to good quality. The 1A composite had improved the end-use quality compared with Nekota, however the end-use quality was still barely acceptable.

An interesting aspect of this research was that both Nekota and Niobrara, heterogeneous cultivars for 1A and 1A.1R, consisted of mainly 1A genotypes. The frequency of 1A.1R lines was less than 25%.

13. 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. As the white wheat breeding programs develop elite germplasm, more red x white crosses are being made (about 20% of the current crosses in the program) which can be used for either red or white wheat variety development. A small effort will continue in developing purple and blue wheats for unique markets. In our program we have identified a high yielding purple, softer wheat. A clearly identified (marked) soft wheat may have utility for organic or conventionally grown soft wheat production in non-traditional production areas. 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).

14. Collaborative Research on Wheat Diseases

Dr. John Watkins, Department of Plant Pathology, and his staff continue to inoculate our experimental lines with wheat stem rust, wheat leaf rust, and as time permits with wheat streak mosaic virus. We had a very successful stem rust field inoculation, which greatly aided in selected headrows with improved stem rust resistance. John's efforts to determine the virulence patterns of leaf rust in Nebraska have greatly helped understand this important disease and why some previously resistant lines became susceptible and other previously susceptible lines are becoming for resistant. His efforts are closely coordinated with Dr. Don McVey, USDA-ARS, Cereal Disease Lab, who provides stem rust inoculum and who also tests our lines with a set of stem rust races to identify the resistance genes in those lines.

Work continues on introgressing the resistance from Agropyron (the first real resistance/tolerance to wheat streak mosaic virus developed by Dr. Joe Martin, Kansas State University at Hays, Kansas and his co-workers) into adapted wheat varieties and the study of the tolerance in M08, a line identified in our program. In greenhouse (Lincoln, NE) and field (at Hays, KS) trials, genes in M08 appear to convey a low level of tolerance that may be useful. Dr. Roy French continues to provide invaluable inoculum and virus expertise.

15. 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 better planting designs. We have had a number of discussions with Dr. Walt Stroup and Dr. Kent Eskridge, Department of Biometry, and hope to begin using the improved designs in 1998. With karnal bunt being found in the United States, the decision was to move all testing sites under Dr. Baenziger's leadership back onto publicly held land. We returned to Clay Center and to Alliance in 1996 for testing purposes. As we learn more about disease, we will reconsider this decision. It is our hope that the southcentral site will again use a sustainable farm to increase our linkages with these emerging farming groups.

16. Global Change Research

One of the new areas that the project hopes to become involved in is global change scenarios. A large, interdisciplinary effort involving crop modeling (Dr. A. Weiss), crop physiology and production (Dr. T. Arkebauer, Dr. J. Maranville, Dr. Drew Lyon, Dr. Madhavan), cereal chemistry (Dr. D. Shelton), biometrics (Dr. K. Eskridge), economics (Dr. G. Helmers), and plant breeding (Dr. Baenziger) has been formed. The goal of this group will be to develop experimental techniques that will allow us to predict what may occur under various global change scenarios (e.g. global warming, elevated CO_2, etc.) and to identify germplasm that may ameliorate these changes. We are currently building at Mead, the first "field chambers" in the Great Plains to study enhanced CO_2 and warming scenarios. Too often plant breeding is reactive and not sufficiently proactive. With the twelve year time frame that it takes to release a variety, wheat breeding programs need to be as cognizant as possible of future changes. While this may seem too future oriented, it should be recognized that with the variable climate of Nebraska, many of the possible scenarios (e.g. drought or heat stress, or rapid weather change) occur annually in one or another part of Nebraska so the real effort will be to develop a integrated team that will understand wheat production at the ecosystem level. The National Institute for Global Environmental Change (NIGEC) and the National Science Foundation (NSF) is funding this research.

IV. GREENHOUSE RESEARCH

The F_1 wheat populations were grown only in the Lincoln Greenhouses to avoid possible losses to winterkilling. Over 600 F_1 populations were grown. This is higher than normal and translates to over 650 F_2 plots including checks planted in 1997-1998. An additional 600+ wheat crosses were made for breeding purposes including improving the genetic male sterile population (first planted in 1990). Some crosses were made for genetic studies. In the triticale program, over 70 crosses were made.

V. PROPRIETARY RESEARCH

With the advent of plant biotechnology and hybrid wheat, the necessity and desirability of interacting with commercial has increased. In 1996, the University of Nebraska signed its first agreement to allow a commercial hybrid wheat company to access one of its lines as a hybrid parent. Over 500 unreleased experimental lines have been sent to a hybrid wheat company for evaluation as potential future hybrid wheat parents. Eight of these were chosen for further evaluation. It is expected that a research and development fee will be assessed for hybrid parent use and that any fees returned to the University will be shared with the financial supporters of the research efforts. In the first agreement, 20% of the fees will be given to the Nebraska Wheat Board in recognition of their ongoing and significant support for the program. To the best of our knowledge, this is the first and only public program that shares its research and development income with its financial supporters.

We are currently negotiating with an agricultural chemical company for the commercial use of their herbicide tolerant wheat germplasm. We have received the germplasm and have rapidly introgressed the trait into our germplasm with the expectation that we can come to agreement on the terms of use. This germplasm is potentially quite useful as the herbicides have residual activity and control most grassy weeds (i.e. jointed goat grass, downy brome, cheat grass). Herbicide tolerance will also allow greater flexibility for cropping rotations and will involve our dryland-cropping specialists, particularly Dr. Drew Lyon.

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

VI. Spring-Sown Wheat Research

A small spring-sown wheat breeding effort was initiated in 1997. Approximately 40 spring wheat crosses were made in fall, 1997 with an additional 30-40 winter by spring crosses to be made in 1998. This effort will be used to provide the wheat producer with greater flexibility in his/her farming rotations. In addition, Mr. Mehmet Atak, a graduate student, studied twenty released cultivars and experimental lines to determine their vernalization and photoperiod response. Winter wheats with low vernalization response could be ideal for spring sowing. The study will need to be repeated to confirm the results.

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, and other interested groups and individuals. The Nebraska Wheat Quality Laboratory cooperates closely with the Wheat Quality Council and baked the large-scale cooperator samples. 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.

Summary

A below average crop was harvested in 1997 with production estimated at 70.3 million bushels from 1.9 million harvested acres with a state average yield of 37 bu/a. Winterkilling, blowing, and early drought stress were found in many parts of the state. The main diseases were leaf rust in the southern Nebraska and wheat streak mosaic virus (and high plains virus) in western Nebraska. Insects (Russian wheat aphid and Hessian fly) were relatively minor.

Arapahoe continued to be the most widely grown wheat in Nebraska in 1996. Producers are rapidly accepting Alliance and Niobrara. The acreage of tall wheats is increasing. Alliance continued to have excellent yields, as did 2137, Windstar, Niobrara, and Pronghorn.

Windstar was given to certified seed producers in 1996 and formally released in 1997. Plant variety protection was applied for in 1997. Three experimental lines are under large-scale increase for possible release in 1998. **NE93405** (NE85707/Thunderbird) is a Thunderbird derivative with a long coleoptile, good winterhardiness, good testweight, large kernels, and very strong straw strength. It is a white chaffed, awned, hard red winter wheat. It is medium early in maturity and medium tall in plant. The best performance area seems to higher moisture areas of Nebraska similar to Thunderbird. NE93405 is moderately resistant to stem rust, moderately susceptible to leaf rust, and susceptible to Hessian fly, barley yellow dwarf virus, wheat soilborne mosaic virus, and wheat streak mosaic virus. A sister line, NE93496 may be a slightly higher yielding line and could be released in 1999. **NE93554** was derived from the cross NE82419/Arapahoe. NE93554 is an Arapahoe derivative with a medium length coleoptile, good winterhardiness, average testweight, medium kernels, and moderately strong straw strength. It is a white chaffed, awned, hard red winter wheat. It is medium in maturity and medium tall in plant height. In the first year of testing in the state variety trial, its grain yield (50.7 bu/a) was similar to Alliance (50.6 bu/a) and Windstar (50.6 bu/a) and better than Arapahoe (48.9 bu/a) and Niobrara (49.3 bu/a). NE93554 seems adapted to all of the areas where Arapahoe has been successfully grown. NE93554 is moderately resistant to stem and leaf rust, moderately susceptible to wheat soilborne mosaic virus, and susceptible to Hessian fly, barley yellow dwarf virus, and wheat streak mosaic virus. A sister line, NE93613 is also being advanced for possible release in 1999. **NE93427** was derived from the cross Bez/CTK78//Arthur/CTK78/3/Bennett/4/Norkan. It is a Norkan derivative with a medium length coleoptile, medium winterhardiness, good testweight, medium kernels, and moderately strong straw strength. It is a white chaffed, awned, hard red winter wheat. It is medium early in maturity and medium tall in plant height. NE93427 seems best adapted to the higher rainfall areas of southeastern and southcentral Nebraska near the Kansas border, an area where few of our previous releases are well adapted. NE93427 is moderately resistant to stem rust and wheat soilborne mosaic virus, moderately susceptible to leaf rust, and susceptible to Hessian fly, barley yellow dwarf virus, and wheat streak mosaic virus.

Basic research to improve breeding efficiency continued in: 1. wheat tissue culture and transformation, 2. recombinant and reciprocal chromosome substitution line, 3. improving testing sites and data analysis, 4. global climate change, and 5. developing feed grain or forage triticales. Regional efforts and cooperation with commercial companies will continue to increase.

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.