IMPROVING WHEAT VARIETIES FOR NEBRASKA

1991 STATE BREEDING AND QUALITY EVALUATION REPORT

Report to the

NEBRASKA WHEAT DEVELOPMENT, UTILIZATION
AND MARKETING BOARD

P. S. Baenziger and D. R. Shelton

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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. A grant 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 1990 NEBRASKA WHEAT CROP

1. Growing Conditions

The state wheat crop was highly variable with production estimated at 67.2 million bushels harvested from 2.1 million acres and with a state average of 32 bushels per acre. This represents a smaller crop and lower yields than normal. In eastern Nebraska, a cool spring and excessive rains caused severe lodging, high levels of powdery mildew and scab, and an epidemic of leaf rust. Stem rust was present, but fortunately was too late to damage the crop. However, other parts of eastern Nebraska were droughty and yields were reduced by insufficient moisture. In southcentral Nebraska, disease levels (including the above mentioned diseases and foliar blotch diseases) were also high. In southwest Nebraska, the yield was reduced by a short grainfilling period (premature finish due to heat). In general, in the Panhandle, where moisture was sufficient, the crop was good despite a higher than normal level of leaf rust. Unfortunately, leaf rust appeared to change its pathogenic spectrum and formerly moderately resistant wheats, such as Arapahoe, now appear to be susceptible. With this change in virulence, few wheats are available that have good leaf rust resistance.

The extremely variable environmental and disease conditions allowed different wheat varieties to perform well in different areas. In eastern and southcentral regions, early, leaf rust resistant wheats were favored (such as Karl). However, early to moderately early, leaf rust susceptible lines such as TAM107 and Rawhide performed well only where leaf rust was relatively low. In western Nebraska, later wheats (such as Arapahoe) 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.

2. Diseases

Foliar diseases are highly dependent on moisture for their development and spread. Leaf rust was prevalent throughout most of Nebraska which is

unusual. However adequate moisture, and spores from diseased fields in the southern Great Plains, were present during most of the growing season. Stem rust was also present in some fields in eastern and western Nebraska, but probably did not reduce yield. The main leaf blotch diseases were Septoria spp. or tan spot which were present mainly in eastern and southcentral Nebraska. Powdery mildew was more severe than normal in southeastern Nebraska due to the generally cooler than normal conditions. Powdery mildew is a disease where symptoms are greatly reduced by hot weather. As mentioned previously, it appears that a new race of leaf rust may have developed that is more virulent on previously moderately resistant cultivars such as Arapahoe. No other new races of diseases were identified. In general, most varieties developed in the southern Great Plains are already or becoming susceptible to leaf rust (Karl remains moderately resistant). The recently released Nebraska-USDA wheat varieties are all resistant to stem rust. 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 1991. Russian wheat aphid and Hessian fly may have caused sporadic losses in some fields. Russian Wheat Aphid would be considered the main insect pest of wheat in 1991, 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 present in southeast Nebraska in high levels.

4. Wheat Production

The estimated wheat production for Nebraska is 67,200,000 bushels from 2,100,000 harvested acres. The average yield was 32 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 increased as a result of farm programs. Quality determinations by Doty Laboratories Inc. were as follows:

1991 DATA:

Nebraska	Protein Ave. (12% moisture)	Overall Evaluation
Northeast	12.2	Good
Southeast	12.6	Good+
Northcentral	12.7	Good
Southwest	12.4	Good
Panhandle	12.0	Good

Quality standards are being impacted by no-time baking methods and high speed mixers. These procedures require stronger gluten proteins (longer dough mixing times and tolerances). Heat stress reduces mixing time and tolerance which reduced the quality of the crop. Of the quality characteristics that growers are paid for, test weight was the most significant trait adversely affected by lodging, heat/drought, or diseases.

5. Cultivar Distribution

Redland became the most popular variety (14.9% of the total acreage) in 1991. Previously, Siouxland had been the most widely grown cultivar (18.7% of the 1990 total acreage). Redland was the second most widely grown variety in 1990 (15.2% of the total acreage). Redland's acreage may have peaked at about 15% of the total acreage. Redland is a selection from Brule (5.4% of the total acreage), hence the combination of Redland and Brule were easily the most popular varieties in Nebraska (20.3% of the total acreage). Thunderbird was the third most popular variety (12.8% of the total acreage) and Centura was the fourth most widely grown variety (10.4% of the acreage). Arapahoe has been quickly accepted by the growers and increased from 1.8% of the acreage in 1990 to 8.5% in 1991. 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. Overall, publicly developed varieties were grown on 75.7% of the state. USDA-Nebraska releases are grown on approximately 67.7% of the state. Privately released varieties are grown on the remaining 24.3% of the state with Thunderbird and Abilene being the most popular private varieties.

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

No new cultivars were released in 1991. Rawhide was formally released in December 1990. It was jointly released with the USDA and South Dakota State University. Its pedigree is Warrior*5/Agent //Kavkaz /4/Parker*4/Agent

//Beloterkovskaia 198 /Lancer/3/Vona. 1991 can best be described a tough year for Rawhide with its average state yield being 92% of the combined average yield of Arapahoe, Redland, and Siouxland. Previously, Rawhide had performed well in areas which favor a medium-early wheat. In 1986, Rawhide also performed below average, however it performed above average in 1987-1990. Its earliness makes it attractive for southern Nebraska, and in areas where an a medium early maturing wheat is needed to complement later maturing wheats. As mentioned above, early wheats with leaf rust susceptibility tended to perform poorly in Nebraska. TAM107 averaged only 88% of the checks. Rawhide seems to have fairly good tolerance to heat and drought stress (hence its name) which often tend to favor early wheats. In summary, additional data may be needed to properly target Rawhide. Currently, it appears to be a TAM107 replacement and has the variable performance that TAM107 is also know for in Nebraska.

III. FIELD RESEARCH

1. Increase of New Experimentals

Two experimental wheats are currently under large scale increase. They are NE87612 [Newton//Warrior*5/Agent/3/NE69441] and NE87615 [NE68513/NE68457 //Centurk/3/Brule]. NE69441 is an Agate sib. NE68513 is Warrior//Atlas 66/Cheyenne/3/Cheyenne/Ottawa. NE68457 is Ponca/*2 Cheyenne/4/IL#1-Chinese Spring 2*/Triticum timopheevi//Cheyenne-Tenmarq-Michigan-Hope/3/Sando 60. NE86501 [Colt/Cody] was increased last year but due to last year's highly variable season will not be considered for release until additional data is obtained.

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.

NE87615 is a "pretty" semidwarf. It is shorter than Arapahoe and Brule with moderate straw strength. NE87615 has exhibited moderate resistance to leaf rust (may be lost with recent leaf rust race changes), resistant to the Great Plains Biotype of Hessian fly, and moderately resistant to stem rust (contains genes Sr6, Sr17, and Sr36); and is susceptible to soilborne mosaic virus. Its reaction to wheat streak mosaic virus needs further testing, however, in the greenhouse it appears to be superior to Brule and Redland. The winterhardiness of NE87615 is good, superior to NE87612. NE87615 is a genetically lower test weight wheat, though superior to Redland. If released, NE87615 would probably be targeted to southwest and western Nebraska dryland wheat production though its short stature may pose problems in droughty years. Its short stature is beneficial under irrigation which preliminary data indicate NE87615 performs well (see section on irrigated wheat below).

NE86501 is a taller wheat (similar in height to Cody and Centura) with moderately strong straw for a conventional height wheat, but less straw strength than many short statured wheats. NE86501 is susceptible to leaf rust, soilborne mosaic virus, and wheat streak mosaic virus; resistant to stem rust (contains genes Sr6, Sr17, and Sr24); and moderately resistant to Hessian fly. NE86501 has medium maturity. The test weight of NE86501 is similar to Siouxland and superior to Redland or Brule. NE86501 if released, would be targeted to areas where tall wheats are needed.

The following lines are under small scale increase with earliest possible release in 1993: NE83404 [CIMMYT/Scout//Bennett sib/4/Parker/*5 Agent// Beloterkovskaia 198/Lancer/3/Bezostaia/Centurk 78], NE88427 [Bennett/TAM107], and NE88595 [Arkan/Colt//Chisholm sib].

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

2. Field Plot Trial and Statewide Testing

Thirty-eight entries were included in statewide testing at 15 dryland and 1 irrigated locations in 1990. The top ten lines were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
NE87615	46.4	Newcale	44.1
Arapahoe	45.8	KS87H6	43.3
Karl	45.3	KS8010-70	43.1
Redland	44.3	NE86501	42.5
NE87612	44.1	Siouxland 89	42.1

Turkey had the lowest yield (71% of the average of Arapahoe, Redland, and Siouxland). In 1989, the highest yielding line was Abilene with 50.5 bu/a. Hybrids continue to do well in these tests, but not sufficiently well to pay for the increased cost of seed.

3. Irrigated Wheat Trials

Irrigated wheat trials were planted at Sidney in cooperation with Dr. D. Baltensperger. After many difficult years, irrigated trials at North Platte and Mead were permanently abandoned. The Sidney irrigated trial is a new trial that attempts to simulate the majority of irrigated wheat planting conditions: planted late as would be the case after a summer crop harvest. The initial stands were excellent despite late planting and the crop looked well at the boot stage and at maturity. The top seven lines at Sidney were:

1991 Results at Sidney		1990 Results at Sidney	
NE87615	62 bu/a	NE88556	44.7 bu/a
Arapahoe	61	NE87615	42.6
2163	59	NE86501	42.6
KS87H6	59	NE87613	41.3
NE83407	58	KS8010-12	40.6
Newcale	57	Abilene	40.1
Tomahawk	57	Arapahoe	40.0

Also a greater effort will be expended in intercepting earlier generation lines that may have potential under irrigation, but not necessarily under dryland conditions.

4. Nebraska Intrastate Nursery

The Nebraska Intrastate Nursery (NIN) was seeded at six locations (Mead is a single replicate for winterhardiness notes) and five locations were harvested. With the wide variation in climate and yield, the nurseries (with

the exception of Sidney) were generally poor. The average yields at the breeding locations are as follows: Lincoln, 27 bu/a; Mead, 29 bu/a; Clay Center, 28 bu/a; North Platte, 16 bu/a; and Sidney, 43 bu/a. These yields are extremely low and less than 60% of the normal yield at our testing sites (with the exception of Sidney). Lincoln and Mead suffered severe lodging and disease infections (due to the cool wet spring and high soil fertility). Clay Center had some winterkill, but mainly was heavily diseased. At North Platte, the early planting (necessitated by our tight planting schedule) led to a severe Cephalosporium stripe infection. Hence lines that performed poorly may have done so due to susceptibility to the disease and not due to lack of adaptation. On the positive side, lines that performed well at North Platte must be both resistant to the disease and well adapted. Only at Sidney, did experimental lines perform as they had in the past. The testing site at Alliance was harvested by the custom grower prior to our harvest crew's arrival. To avoid future problems at Alliance, the breeding nursery was moved to Hemingford in cooperation with Mr. H. Cullan.

With the low yields, it is difficult to identify superior lines. For example, due to a heat-induced rapid finish at Lincoln and Mead, early lines such as Karl and TAM107 were favored. These lines have not performed well in Eastern Nebraska in previous years. Hence experimental lines that performed well under these conditions, may be unsuitable under more "normal" conditions. This discrepancy between years explains in part why many higher yielding lines in 1991 were not under increase in 1991 for regional testing in 1992. It is also difficult to know how to summarize data over locations when severe weather or diseases affect the performance data. However, several experimental lines were identified with good agronomic performance compared to released varieties. The results of the NIN are as follows:

	Yield (bu/a)						
ENTRY	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
NE89468	31.18	30.58	23.94	44.41	32.53	35.39	11
NE86503	33.70	36.97	16.09	42.84	32.40	37.84	12
NE88427[1]	32.03	30.17	16.45	49.66	32.08	37.29	13
NE89657[1]	27.20	22.60	21.79	54.79	31.60	34.86	14
NE89565	29.53	29.34	18.04	49.36	31.57	36.08	15
NE89522[1]	34.60	24.75	20.60	45.91	31.47	35.09	16
NE89534	30.70	31.94	16.69	45.03	31.09	35.89	17
NE89504[1]	24.23	29.03	18.50	51.60	30.84	34.95	18
KARL	31.23	32.70	20.53	38.83	30.82	34.25	19
NE88595[1]	24.60	29.08	22.91	46.43	30.76	33.37	20
NE89665	27.30	31.13	17.45	43.69	29.89	34.04	21
NE88536[1]	31.08	28.06	14.79	45.15	29.77	34.76	22
REDLAND	27.15	26.88	18.69	45.20	29.48	33.08	23
CODY	27.63	28.78	13.80	47.33	29.39	34.58	24

NE89622	27.35	25.79	22.53	41.66	29.33	31.60	25
NE88588[1]	25.53	33.31	13.86	44.23	29.23	34.36	26
CENTURA	19.80	37.06	13.84	46.14	29.21	34.33	27
NE86606	27.68	28.01	21.15	39.44	29.07	31.71	28
NE88584[1]	24.73	31.65	13.79	46.01	29.05	34.13	29
NE86501	30.68	30.90	19.55	33.98	28.78	31.85	30
ARAPAHOE	29.15	23.14	14.13	48.40	28.71	33.56	31
NE87513[1]	24.80	34.65	17.18	37.44	28.52	32.30	32
NE83404	30.80	23.77	12.11	47.08	28.44	33.88	33
NE89544	22.00	27.35	16.01	47.93	28.32	32.43	34
NE87612	23.95	22.04	16.61	49.98	28.15	31.99	35
NE83T12	40.80	12.64	18.28	40.34	28.02	31.26	36
NE89523	24.63	27.20	16.49	43.75	28.02	31.86	36
KS87H6	24.75	23.04	18.34	45.85	28.00	31.21	38
NE87615	24.60	25.01	21.79	40.00	27.85	29.87	39
NE88635	19.40	26.66	19.23	45.93	27.81	30.66	40
NE87409	26.53	24.36	21.78	38.43	27.78	29.77	41
NE83498	27.90	24.79	15.73	41.66	27.52	31.45	42
NE89532	28.00	32.09	9.35	40.05	27.37	33.38	43
BUCKSKIN	19.45	34.42	12.00	41.15	26.76	31.67	44
NE87522	24.15	31.18	8.43	42.20	26.49	32.51	45
NE83407	26.78	22.02	13.44	42.03	26.07	30.28	46
CENTURK78	22.83	31.08	8.48	41.76	26.04	31.89	47
NE89529	24.55	29.83	10.03	39.50	25.98	31.29	48
ROUGHRIDER	16.65	26.40	13.70	46.53	25.82	29.86	49
NE87451	33.33	26.80	10.21	32.68	25.76	30.94	50
NE89646	24.78	25.43	15.74	35.74	25.42	28.65	51
NE89511	26.70	23.97	10.54	39.18	25.10	29.95	52
SCOUT66	10.25	28.85	17.83	43.24	25.04	27.45	53
NE87613	21.40	21.55	12.91	43.49	24.84	28.81	54
COLT	24.25	25.74	8.66	36.83	23.87	28.94	55
LANCER	18.85	26.41	8.63	40.74	23.66	28.67	56
TAM107	31.23	14.94	14.91	32.80	23.47	26.32	57
GAGE	15.30	26.85	13.44	35.10	22.67	25.75	58
HOMESTEAD	20.75	24.87	10.44	34.43	22.62	26.68	59
TV1405	32.03	19.56	7.30	23.28	20.54	24.96	60
NE86L177	28.93	19.30	1.10	27.86	19.30	25.36	61
TAM200	22.63	16.32	10.16	25.35	18.62	21.43	62
CHEYENNE	11.88	14.09	5.49	25.49	14.24	17.15	63
GRAND MEAN	26.76	27.58	16.27	42.74			
CV	19.08	19.48	26.77	15.38			
LSD	7.47	7.86	6.37	9.62			
MSE	26.09	28.85	18.96	43.23			
SED	3.61	3.80	3.08	4.65			
ALPHA	0.04	0.04	0.04	0.04			
R-SQUARED	0.66	0.58	0.70	0.68			

* 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.

Twenty-two 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 1990, the top ten lines (Lincoln, Clay Center, North Platte, Sidney and Alliance data) for yield were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
NE88427*	55.2	NE88556*	53.8
NE87451*	54.5	NE83404	53.7
NE88588	54.1	NE87615*	53.5
NE88595*	54.1	NE87513	53.2
Arapahoe	53.9	NE83407*	53.0

* Entered into USDA regional trials

5. Nebraska Triplicate Nursery

All of the concerns about the NIN data are also true for the Nebraska Triplicate Nursery (NTN). As opposed to 1985, 1986, and 1987, experimental lines topped the NTN. Previously, Siouxland or TAM 107 had been the highest yielding lines in the NTN. The yield data were:

ENTRY	Yield (bu/a)						Rank
	Linc.	Clay Center	North Platte	Sidney	Avg.*	Avg.**	
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
NE90411	27.77	36.40	30.28	49.22	35.92	37.80	11
REDLAND	27.83	32.29	26.48	55.52	35.53	38.55	12
NE90509	21.27	24.85	31.12	64.67	35.48	36.93	13
NE90626	32.17	26.58	23.37	59.50	35.41	39.42	14
NE90632	31.30	25.05	27.30	56.80	35.11	37.72	15
NE90442	37.63	25.45	20.50	55.85	34.86	39.64	16
NE90501	33.87	33.99	20.38	50.85	34.77	39.57	17
NE90524	24.70	32.69	23.10	56.95	34.36	38.11	18
NE90559	30.73	28.41	21.22	56.68	34.26	38.61	19
NE90571	31.43	24.93	24.93	55.20	34.12	37.19	20
NE90416	31.00	29.64	22.70	51.08	33.61	37.24	21
NE90567	24.00	34.19	22.40	53.68	33.57	37.29	22
NE90508	23.00	19.38	23.27	68.05	33.43	36.81	23
NE90476	32.47	24.21	24.27	52.20	33.29	36.29	24
NE90618	21.77	29.49	29.78	52.00	33.26	34.42	25
NE90477	33.20	33.41	20.73	45.08	33.11	37.23	26
NE90518	26.57	18.02	24.10	63.58	33.07	36.06	27
NE90623	31.73	32.24	18.10	50.17	33.06	38.05	28
NE90614	31.03	24.55	24.97	50.70	32.81	35.43	29
NE90648	23.90	25.49	28.27	53.00	32.67	34.13	30

ARAPAHOE	32.37	20.41	26.43	51.00	32.55	34.59	31
NE90613	25.27	23.95	21.80	58.18	32.30	35.80	32
NE90409	24.07	31.10	22.42	50.67	32.07	35.28	33
NE90617	31.23	29.80	17.55	47.92	31.63	36.32	34
NE90414	26.93	19.81	24.47	53.08	31.07	33.27	36
NE90419	19.93	30.97	25.47	47.72	31.02	32.87	37
NE90494	18.67	36.60	22.95	45.67	30.97	33.65	38
NE90424	24.17	26.32	25.03	46.65	30.54	32.38	39
NE90691	28.03	24.07	12.05	57.30	30.36	36.47	40
NE90688	24.87	25.08	21.33	47.95	29.81	32.63	41
NE90418	26.20	19.95	19.02	53.05	29.56	33.07	42
NE90646	26.63	14.01	24.35	53.18	29.54	31.27	43
NE90633	29.93	27.78	21.57	37.28	29.14	31.66	44
NE90417	29.63	22.20	18.93	45.32	29.02	32.38	45
NE90676	27.10	24.71	21.15	41.95	28.73	31.25	47
TAM107	39.40	17.32	19.92	35.87	28.13	30.86	48
NE90616	25.30	18.77	12.82	55.48	28.09	33.18	49
NE90647	29.63	15.38	27.77	37.13	27.48	27.38	50
NE90644	31.87	19.39	10.53	48.05	27.46	33.10	51
NE90475	35.37	16.38	14.48	38.67	26.23	30.14	52
NE90682	39.70	21.51	8.18	35.42	26.20	32.21	53
ABILENE	25.07	25.27	11.38	42.82	26.14	31.05	54
NE90533	25.50	15.36	18.55	44.60	26.00	28.49	55
NE90569	19.90	24.03	17.82	41.95	25.93	28.63	56
NE90503	24.53	20.43	19.87	36.77	25.40	27.24	57
NE90473	34.20	15.04	5.55	39.65	23.61	29.63	58
NE90683	32.83	21.35	5.10	34.30	23.40	29.49	59
NE90445	22.07	24.88	10.78	32.93	22.67	26.63	60
NE90431	19.87	27.33	17.27	25.18	22.41	24.13	61
NE90663	37.50	17.27	5.62	23.67	21.02	26.15	62
NE90488	20.03	17.83	11.42	33.13	20.60	23.66	63
GRAND MEAN	28.72	26.11	21.77	49.68			
CV	14.79	25.39	20.45	11.77			
LSD	7.20	11.24	7.55	9.91			
MSE	18.05	43.95	19.81	34.16			
SED	3.47	5.41	3.63	4.77			
ALPHA	0.04	0.04	0.04	0.04			
R-SQUARED	0.72	0.61	0.79	0.82			

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

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

In 1990, the top ten lines were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
NE89534	58.9	Redland	54.5
NE89526	58.1	NE89498	54.2
NE89529	56.3	NE89495	54.1
NE89657	55.9	NE89482	54.1
NE89504	55.2	NE89523	54.1

Twenty 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), Clay Center, North Platte, and Sidney. Yields were as follows:

ENTRY	Yield (bu/a)					Rank
	Linc.	Clay Center	North Platte	Sidney	Avg.	
WI88-083	35.30	45.74	12.75	56.73	30.10	1
TX88V5433	37.80	44.02	24.43	43.70	29.99	2
T19-3	35.13	43.06	17.15	53.12	29.69	3
T67	32.33	43.38	11.20	52.40	27.86	4
NE88427	30.17	39.28	14.60	50.63	26.94	5
TH901	34.87	36.43	14.48	48.67	26.89	6
TH902	29.87	38.91	17.17	45.70	26.33	7
KSSB-192-3	52.77	31.45	4.63	40.43	25.86	8
NE88595	29.30	30.47	19.67	48.32	25.55	9
T21-3	17.03	45.77	16.35	48.47	25.52	10
KSSB-369-7	40.53	38.10	13.73	34.75	25.42	11
NE87615	29.63	29.00	18.67	48.62	25.18	12
TAM 107	44.60	26.48	16.53	37.35	24.99	13
KS88H12-1	28.63	26.02	14.80	54.70	24.83	14
HBC197F	30.53	33.54	11.90	48.05	24.80	15
KS88H12-2	31.07	26.39	17.47	47.75	24.54	16
XH1514	30.03	34.60	7.23	50.67	24.51	17
XH1322	35.50	38.47	7.90	40.33	24.44	18
TX88V5440	31.57	36.45	14.27	38.32	24.12	19
TX84V1418HF	31.40	41.31	6.48	41.08	24.05	20
NE87409	27.63	22.96	24.30	44.15	23.81	21
XH1231	28.93	33.22	8.87	47.67	23.74	22
TX88V4524	44.33	34.05	7.83	32.43	23.73	23
KS87H6	27.77	26.73	11.78	51.17	23.49	24
XH900	31.60	33.84	6.93	40.35	22.54	25
TX86D1310	29.70	33.65	12.25	37.05	22.53	26
OK88767	40.77	29.29	7.47	32.67	22.04	27
NE87451	35.63	26.40	12.02	36.05	22.02	28
WI88-024	24.73	26.28	9.42	44.53	20.99	29
TX86D1332	29.43	30.37	9.82	34.58	20.84	30
C0850061	31.33	31.74	4.53	35.75	20.67	31
TX89V4138	27.03	30.59	11.55	32.57	20.35	32
OK87542	30.53	31.60	5.57	33.67	20.27	33
SCOUT 66	9.67	28.65	19.23	42.30	19.97	34
OK87630	40.80	23.93	2.22	28.08	19.01	35
OK88W833	37.43	27.36	4.95	23.52	18.65	36
TX88V4635	19.23	27.13	4.87	40.90	18.43	37
TX87V1613	33.63	23.38	2.80	29.70	17.90	38
C0860094	23.07	14.19	1.30	48.87	17.49	39
TX88V4636	20.73	14.77	8.10	41.83	17.09	40
C0860086	17.30	15.80	7.87	41.38	16.47	41
OK87W663	33.63	17.08	4.83	20.05	15.12	42
C0850034	23.60	17.25	5.08	22.28	13.64	43

TX88D3424	24.00	14.45	3.55	24.00	13.20	44
KHARKOF	13.53	12.25	4.97	32.62	12.67	45
GRAND MEAN	30.54	30.13	10.74	40.62		
CV	20.54	18.66	40.92	16.31		
LSD	10.68	9.57	7.48	11.28		
MSE	39.34	31.62	19.33	43.89		
SED	5.12	4.59	3.59	5.41		
ALPHA	0.04	0.04	0.04	0.04		
R-SQUARED	0.72	0.79	0.73	0.74		

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

	Yield (bu/a)				
ENTRY	Linc.	North Platte	Sidney	Avg.	Rank
XNH1419	36.00	28.70	64.27	42.99	1
SD88218	22.13	29.87	60.35	37.45	2
SD87144	29.27	24.67	57.30	37.08	3
SD87143	23.90	25.40	56.80	35.37	4
ND8844	20.37	25.95	59.03	35.12	5
SD88137	17.47	22.42	63.08	34.32	6
Rawhide	29.57	23.00	50.02	34.20	7
NE83407	33.13	21.33	43.85	32.77	8
NE88635	17.60	25.10	55.48	32.73	9
NE87613	24.03	22.52	51.03	32.53	10
NE88536	27.47	20.77	48.25	32.16	11
SD88171	21.17	19.30	55.62	32.03	12
ND8892	18.83	25.37	51.85	32.02	13
ND85137	22.43	19.35	53.72	31.83	14
SD88201	23.83	13.55	57.87	31.75	15
ND86105	16.27	17.43	57.85	30.52	16
ROUGHRIDER	20.27	14.12	56.43	30.27	17
SD88240	16.40	17.90	56.50	30.27	18
SD88148	15.23	16.73	57.88	29.95	19
COLT	29.93	14.70	43.65	29.43	20
NE87612	18.57	17.13	51.22	28.97	21
SD88250	22.17	14.92	49.50	28.86	22
SD88192	22.53	12.42	50.63	28.53	23
XNH1401	27.63	13.27	42.42	27.77	24
XNH1469	24.13	14.07	40.33	26.18	25
XNH1486	21.73	14.87	36.77	24.46	26
SD88120	20.90	10.03	40.00	23.64	27
KHARKOF	13.13	12.00	33.73	19.62	28
GRAND MEAN	22.72	19.17	51.62		
CV	20.52	18.75	8.58		
LSD	8.01	6.18	7.61		
MSE	21.72	12.93	19.60		
SED	3.81	2.94	3.61		
ALPHA	0.04	0.04	0.04		
R-SQUARED	0.68	0.78	0.83		

In general, the performance of lines in the NIN, NTN, SRPN, and NRPN was similar in all nurseries despite the higher than normal field variation.

7. Multiple-Location Observation Nursery

Five of six replications (locations) of this nursery were harvested. The trial at Alliance was lost as previously mentioned. Of the 314 lines including checks and 41 higher protein lines from Dr. C. J. Peterson's germplasm program that were evaluated, 60 (6 from Dr. Peterson's program) were advanced to the NTN and one of the high protein lines was advanced to the NIN (on the basis of the combined data from observation nursery and replicated USDA trials). As with the more advance nurseries, a number of experimental lines performed better than the average of the five checks. Because of the variation for yield among locations and variation for yield within the trials (a 314 entry trial is the largest trial in the breeding program), I decided that it was best to advance lines on the basis of their performance relative to the nearer checks instead of the yield average. Using this system the highest yielding line was NE91525 which had a yield that was 136% greater than the nearer checks. All lines were thoroughly analyzed for milling and baking quality including an optimized bake test prior to advancement. A major change occurred in this nursery beginning in 1992. Previously the lines were grouped by parentage, in 1991-1992 the lines are 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.

8. Early Generation Nurseries

a. Single-plot Observation Nursery

Fifteen hundred ninety lines including checks were evaluated in 1991. 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 450 lines were screened in four weeks prior to planting for end-use quality. Two hundred sixty-five lines were advanced for further testing on the basis of their agronomic, seed, and end-use quality characteristics. An additional 38 lines came from the USDA high protein program for further testing.

b. Pioneer Screening Nursery

An additional 319 lines were screened from the lines donated by Pioneer to Kansas State University. Of these lines 35 were selected on the basis of agronomic performance and quality characteristics for advancement to a two replicated 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 than many Nebraska experimentals. These lines also represent a different gene pool and should add diversity to the program.

c. Headrow Nursery

Over 33,000 headrows were planted at Mead. All of the headrows survived the winter and with the exception of a poor stem rust epidemic were rated as fair to very good for selection. A difficulty with this nursery was that the severity of stem rust did not allow clear differentiation between susceptible and resistant lines. Approximately 1500 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 495 bulks and check plots. The number of F_3 bulks is near the optimal size. An additional 500 F_3 and 92 F_4 bulks were obtained from the bulks donated by Pioneer to Kansas State University. Most bulks survived the winter. Though the bulks looked very promising early in the season, they were severely lodged from heading to maturity. Hence it was almost impossible to effectively select among the bulks. Selections were made on early season notes and on notes from the previous year. Over 31,000 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 473 bulks and check plots. These bulks also suvived the winter, but lodged severely from heading to maturity making note taking virtually impossible. Barely enough seed was obtained, but all bulks were advanced to the F_3 nursery. In addition to the Nebraska developed bulks, another 399 Pioneer F_3 bulks donated to Kansas State University and shared with us were planted. It is hoped that 1992 will be a good season and the bulks can be efectively evaluated before selection must be made.

9. Winter Triticale Nursery

Thrity-three lines were tested in the advanced nursery. The origin of the lines is from international programs and from the Nebraska breeding efforts. The yields are listed below.

	Yield (bu/a assuming 60 lbs/bu)					
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
NE90T407	47.15	45.46	46.31	10	9	11
PRESTO	48.33	42.20	45.26	9	13	12
NE88T233	50.88	32.83	41.85	5	25	13
NE88T419	48.40	34.51	41.46	8	19	14
NE90T424	37.93	43.74	40.83	27	11	15
NE88T229	48.75	32.33	40.54	7	26	16
NE86T653	43.93	36.45	40.19	16	18	17
NE90T422	42.90	36.59	39.74	18	17	18
NE88T213	38.30	40.23	39.26	25	14	19
NE90T411	44.80	33.46	39.13	14	23	20
NE86T665	43.10	33.60	38.35	17	21	21
Newcale	42.43	34.05	38.24	20	20	22

NE90T425	40.78	31.89	36.33	22	27	23
NE90T412	39.10	33.48	36.29	24	22	24
NE88T222	41.13	31.21	36.17	21	28	25
NE77T7	34.98	36.89	35.93	29	16	26
NE90T423	38.23	33.26	35.74	26	24	27
NE88T211	40.05	29.66	34.86	23	29	28
NE88T436	46.43	21.59	34.01	12	32	29
NE90T421	30.53	37.23	33.88	31	15	30
OAC-85-21	34.55	28.53	31.54	30	30	31
TRICAL	25.43	22.60	24.01	33	31	32
NE90T408	28.70	17.73	23.21	32	33	33
GRAND MEAN	43.02	38.63	40.83			
CV	16.68	23.79				
LSD	10.57	13.53				
MSE	51.50	84.49				
SED	5.08	6.50				
ALPHA	0.04	0.04				
R-SQUARED	0.60	0.80				

From the yield data three points are clear. First winterkilling was minimal at Lincoln and Sidney, hence lines which previously have been injured survived well at both locations. Secondly, the key to improved triticale varieties is access to improved triticale germplasm (the two highest yielding triticales are European triticales). Continuing efforts are being made to increase the germplasm available to the triticale program. Thirdly, triticale with high yield potential is available and may be useful as a feed grain or forage crop. Masrizal, a graduate student, overseas the triticale breeding program.

In 1990, the five highest yielding lines were LAD285 (47.3 bu/a), OAC-85-21 (42.8 bu/a), Presto (42.0 bu/a), NE88T419 (41.6 bu/a), and NE86T665 (40.9 bu/a). The good performance of the top three lines also is indicative of little winterkilling.

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. J. Rybczynski, a visiting scientist from Poland, and Mr. W. Navarro, a graduate student, worked diligently on determining and improving the efficiency of the system. Dr. Rybczynski's work showed that up to one third (approximately 400) of the microspores in an anther underwent cell division, the first indication of successful anther culture. However, less than one well-formed embryo per anther developed indicating tremendous improvements still can be made with the system. Wheat starch again proved its beneficial effect. Mr. Navarro has studied the effect of sugars on the anther culture medium. Preliminary results indicate that sugars greatly affect anther culture response. What is particularly promising with the sugar work is that anther culture is notoriously genotype specific and some disaccharides seem to reduce the genotype effect. 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 alternative method may have less tissue culture induced variation (usually deleterious variation). Additional field experiments are underway to determine the efficacy of the derived lines.

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. This work will allow us to better understand and hopefully manipulate genes for agronomic performance.

12. Heat Stress on Grain Filling

Research was initiated 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. In 1991, plexiglass boxes were built to allow heating of the spikes without heating the rest of the plant. Under very high temperatures (45 C peak day temperatures), Karl wheat was able to maintain its grain filling potential better than Arapahoe. This result agreed with past field experiences that Karl may be more heat tolerant than Arapahoe. However, repeating the experiment at lower temperature (35 C peak day temperature), no differences were found between Karl and Arapahoe. Hence further refinement is needed to identify a heat stress treatment that differentiates wheat. Similar results were obtained by Dr. Millet in more extensive studies using spring wheat lines that were previously reported to differ in heat stress tolerance. Future work by Masrizal will concentrate on improving the assay system to identify wheats with heat stress tolerance.

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

Siouxland is an important wheat in Nebraska. However, it has below average end-use quality which has been attributed to the replacement of important quality genes on 1B by the 1R chromosomal segment. The 1R segment contains many genes for disease resistance and has been reported also to have genes for enhanced agronomic performance (yield). To determine if the 1B/1R translocation enhances yield, 59 F_3-derived F_6 and F_7 lines randomly lines from Siouxland x Ram were classified in cooperation with Dr. R. A. Graybosch into three groups (homozygous 1B/1R, heterogeneous 1B/1R, and homozygous 1B) and tested by Mr. B. Moreno-Sevilla, technician and graduate student, in seven environments in Nebraska. The 1B/1R group averaged 9% higher yield that the heterogeneous 1B/1R and homozygous 1B groups. Hence the 1B/1R translocation did contain genes that enhance yield. However, the translocation will be difficult to use in a breeding program due to its detrimental effect on quality (a major research area of Drs. Graybosch and Peterson).

14. Non-red Grain Wheat

As part of the Wheat Strategic Plan, a decision was made to concentrate the wheat breeding efforts exclusively on hard red winter wheat. Feed grain wheat development was replaced by triticale development efforts. Efforts in developing hard white wheat have been minimal, until there is a major change in the marketplace. Crosses continue to be made to white wheats only to

improve hard red winter wheat. Of course, white segregants will be available for testing as the need arise. Unfortunately none of the previous crosses to white wheats have led to superior experimental lines with good performance. The genetic studies with the blue aleurone trait are complete and a small effort in developing blue wheat is underway. 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 color formation).

15. Spring Wheat

The spring wheat trial at Mead are part of the Nebraska State Testing Project. The trials were also at Concord, Sidney, and Scottsbluff (irrigated). A complete report of these lines can be found in E. C. 91-102, Nebraska Spring Wheat, Oats, Barley, Canola, and Crambe Variety Tests. Dryland yields were low at some locations due to diseases and excessive moisture, but were good at other locations (average yield at Mead was 8 bu/a, at Concord was 26 bu/a, and at Sidney was 41 bu/a). Irrigated yields were better (average yield at Scottsbluff was 54 bu/a). Shield was the highest yielding spring wheat at Mead, Lincoln, and at Scottsbluff (irrigated). Shield was not significantly different from Sharp (the highest yielding line) at Sidney.

16. Considerations on Nursery Sites

Efforts to improve the main testing site at North Platte by using a field having less Cephalosporium stripe continue though early planting severely injured this year's breeding nursery. The Alliance testing site was abandoned this year and replaced with Hemingford. A new testing site has been added at McCook in cooperation with Mr. R. Peters. With the new site, the breeding program has two testing sites in the Panhandle, two in the southwest district, and two in southcentral/southeast district. In addition, research continues with Dr. W. Stroup of the Biometry Department on methods to statistically remove field trends (advantageous or disadvantageous locations in the field) which can drastically affect varietal rankings and selection.

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 636 F_2 plots including checks planted in 1992. An additional 542 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, 80 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. Sixteen 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 1991 with production estimated at 67.2 million bushels harvested from 2.1 million acres and with a state average of 32 bushels per acre. In eastern Nebraska, a cool spring and excessive rains caused severe lodging, high levels of powdery mildew and scab, and an epidemic of leaf rust which was present throughout the state. Stem rust was present, but fortunately was too late to damage the crop. However, other parts of Nebraska were droughty and yields were reduced by insufficient moisture and heat. Unfortunately, leaf rust appeared to change its pathogenic spectrum and formerly moderately resistant wheats, such as Arapahoe, now appear to be susceptible. With this change in virulence, few wheats are available that have good leaf rust resistance.

The extremely variable environmental and disease conditions allowed different wheat varieties to perform well in different areas. In eastern and southcentral regions, early, leaf rust resistant wheats were favored (such as Karl). However, early, leaf rust susceptible lines such as TAM107 and Rawhide performed well only where leaf rust was relatively low. In western Nebraska, later wheats (such as Arapahoe) 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.

Redland (14.9% of the total acreage) replaced Siouxland as the most popular variety in Nebraska in 1991. Redland is a selection from Brule (5.4% of the total acreage), hence the combination of Redland and Brule are grown on 20.3% of the total acreage. Arapahoe has been quickly accepted by the growers and increased from 1.8% of the acreage in 1990 to 8.5% in 1991. Rawhide, released in 1990, had a tough year with its average state yield being 92% of the combined average yield of Arapahoe, Redland, and Siouxland. Previously, Rawhide had performed well in areas which favor a medium-early wheat.

No new variety releases were made in 1991 due to highly variable data. Three experimental lines (NE86501, NE87612, and NE87615) will be available for possible release in 1992. Three additional lines (NE83404, NE88427, and NE88595) are under small scale increase for possible release in 1993.

Basic research to improve breeding efficiency continued in four 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. reciprocal chromosome substitution line analysis which will provide a better genetic understanding of agronomic performance, 3. development of a dominant male sterile population for long term population improvement similar to corn, and 4. 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 alternative to winter barley for growers needing small grain feeds and as a forage crop.

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.