1989 NEBRASKA COOPERATIVE WHEAT INVESTIGATIONS

Report to the

NEBRASKA WHEAT DEVELOPMENT, UTILIZATION
AND MARKETING BOARD

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December 1989

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I. INTRODUCTION

Wheat improvement 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 wheat improvement research. This report will deal only with that portion of the total wheat research effort. The basic project is located in the Department of Agronomy at the University of Nebraska-Lincoln. Very important contributions come from researchers at the Nebraska outstate stations, 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-wide breeding efforts would be curtailed and many of the wheat quality analyses would not be possible to evaluate our breeding material.

II. THE 1989 NEBRASKA WHEAT CROP

1. Growing Conditions

The 1989 Nebraska wheat crop was severely injured by winterkilling and drought. The fall planting season was generally dry and most growers were able to plant at near optimum times. The winter was moderate until February when a number of quick, hard freezes occurred. Temperature changes were extreme. Despite the extreme temperature changes, much of the winter wheat crop survived. The most heavily damaged wheat was in light soils where early planting is required to prevent erosion and near the Kansas border where the crop had broken dormancy and the growing point was killed. The spring and summer was characterized by very little rainfall and extreme drought hurt the surviving crop. Subsoil moisture and water conservation practices were very important in allowing the crop to finish. Wheat streak mosaic virus again caused significant losses in southwestern Nebraska. In addition, a number of fields were sprayed for Russian Wheat Aphid. However, growers that received adequate rainfall, avoided wheat streak mosaic virus, and whose crop was dormant during the freezes were able to produce good crops.

The freezes favored later maturing winterhardy varieties and drought conditions favored early wheats. TAM107 performed well in Nebraska. However, some of the later wheats such as Arapahoe, Redland and Siouxland also performed well. Evidently these wheats' adaptation characteristics allowed them to perform despite the freeze and drought.

2. Diseases

With the exception of the wheat streak mosaic virus, disease problems were moderate. The incidence of leaf and stem rust was reduced by the drought and probably did not or only slightly affected the crop. The races of leaf rust identified last year in Nebraska that are virulent on the previously

resistant cultivars Siouxland (Lr24 and Lr26) and Norkan (Lr1 and Lr24) were again found. Cephalosporium stripe infections were very rare, but when present could be severe. All of these diseases can be extremely destructive under the appropriate conditions and will continue to need close monitoring.

3. Insects

Infestations of the Russian wheat aphid were high enough that some growers decided to spray their fields, even at the lower yield potential due to drought. Hessian fly infestations were generally low and probably did not affect significant areas of the winter wheat crop. The wheat curl mite, the transmitting vector for wheat streak mosaic virus, was widely present. As many of the wheats grown in Nebraska have resistance to the Hessian fly, a concern will continue to be the Russian wheat aphid. Being a new pest, it is difficult to know how severe a pest it may become and which parts of the state it will infest. Despite its spreading rapidly northward into the Pacific Northwest and Canada, it has not spread into eastern Nebraska. It is assumed that the high moisture conditions of eastern Nebraska currently prevent its establishment. Where the Russian wheat aphid is present, it can be devastating.

4. Wheat Production

The wheat yield for Nebraska was 27 bushels per acre from 2,050,000 acres for a total production of 55,350,000 bushels. This was a very poor crop compared to last year's crop of 36 bushels per acre from 2,000,000 harvested acres for a total production of 72,000,000 bushels. This 1989 yield is well below the previous five year average. Planted and harvested acres increased as a result of the farm programs and generally more favorable prices for wheat. Quality determinations by the Doty Laboratories Inc. were as follows:

Nebraska	Protein Ave.	Overall Bake
Northeast	13.1	very good-
Southeast	14.2	excellent
Northcentral	13.5	very good
Southwest	14.2	good+
Panhandle	12.6	fair+

Quality standards are being impacted by zero-time baking methods and high speed mixers. These procedures will require stronger gluten proteins (longer dough mixing times and tolerances). Of the quality characteristics that growers are paid for, test weight was the most significant trait adversely affected by both the drought/winterkilling and wheat streak mosaic virus.

5. Cultivar Distribution

Siouxland continued as the most widely grown cultivar in 1989 (20.5% of the total acreage). Centura was the second most widely grown cultivar with 12.4% of the acreage. Brule dropped to the third most widely grown cultivar with 12.0% of the total acreage. This is a reduction from Brule's peak of being grown on 32.6% of the total acreage in 1985. With the release of

Redland (grown on 10% of the acreage), a selection out of Brule, the combined acreage (22.0%) of Redland and Brule exceeds that of Siouxland. While no wheat listed in Table 1 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 81.2% of the state. USDA-Nebraska releases are grown on approximately 73.7% of the state. Privately released varieties are grown on the remaining 18.8% of the state.

TABLE 1. NEBRASKA--WHEAT VARIETIES
ESTIMATED PERCENTAGES PLANTED TO EACH VARIETY, 1985-1989

	Percent				
Variety	1985	1986	1987	1988	1989
Brule	32.7	28.6	22.5	17.1	12.0
Siouxland	----	2.8	17.0	21.3	20.5
Centura	1.2	6.9	14.3	11.9	12.4
Centurk & Centurk 78	20.5	19.0	12.4	9.8	4.6
Colt	---	3.5	4.2	4.4	2.3
Agripro Thunderbird	---	0.1	0.7	4.0	7.2
Redland	---	---	---	4.0	10.0
Cody	---	---	---	1.2	2.9
Buckskin	6.0	5.4	3.8	2.8	2.2
Scout & Scout 66	5.1	5.0	3.5	2.7	2.6
AgriPro Hawk	4.5	4.7	3.4	3.9	2.9
AgriPro Rocky	3.9	3.3	1.7	1.1	---
Newton	1.5	1.5	1.5	1.5	---
Vona	3.8	3.2	1.2	1.3	---
Arkan	---	---	.9	1.7	1.6
Abilene	---	---	---	---	1.0
Other Public Varieties	6.7	4.5	3.9	4.6	4.3
Other Private Varieties	5.2	6.7	5.8	6.7	6.0

6. New Cultivars

Siouxland 89 was released by Texas in cooperation with the University of Nebraska and USDA. Siouxland 89 is a selection out of Siouxland which is more uniform for its vernelization requirements. Due to poor production of Siouxland 89 in Texas, foundation seed was not made available to certified seed producers. Newcale, a triticale, was released in 1989 and will be discussed in the triticale section. Arapahoe was jointly released with South Dakota State University in 1988. It has an excellent performance record in Nebraska through 1987 and performed well in 1988 and 1989. One of Arapahoe's most distinguishing characteristics in the 1989 season was its superior winterhardiness to many other cultivars. It may be the most winterhardy Nebraska release since Lancer. Arapahoe is similar to Redland for flowering date, kernel weight, and height, but has a longer coleoptile. Arapahoe has a

higher grain protein content, grain volume weight, and winterhardiness level than Redland. Arapahoe is moderately strong strawed, but not as strong strawed as Redland. Arapahoe is resistant to stem rust, moderately resistant to leaf rust and the to the Great Plains race of Hessian fly, and has some tolerance to Cephalosporium stripe. It is susceptible to wheat streak mosaic and to soilborne mosaic viruses.

III. FIELD RESEARCH

1. Increase of New Experimentals

Two experimental wheats are currently under large scale increase. They are NE83407 [Cimmyt/Scout//Bennett sib//Pkr*4/Agent //Belot198 /Lcr/3/Bez1/Ctk78] and NE83498 [Wrr*5/Agent//Kavkaz /4/Pkr*4/Agent //Belot198 /Lcr/3/Vona]. NE83407 performed very well throughout the state and was the highest yielding line in the Outstate Test. NE83407 averaged 41.1bu/a vs. Siouxland, Redland, Abilene, and Arapahoe averaging 39.0, 38.4, 37.2, and 37.0 bu/a, respectively. NE83407 is a medium maturity, winterhardy wheat with medium to good straw strength and short plant height. It is resistant to the currently prevalent races of stem rust, heterogeneous (but mainly susceptible) to leaf rust, and susceptible to soilborne mosaic virus and Hessian fly. It has above average tolerance to wheat streak mosaic virus resistance in trials where that disease has been present. Its test weight tends to be lower than some wheat varieties and similar to Brule or Redland. It has good intrinsic quality with slightly higher protein content than Brule or Redland. NE83498 has performed well in areas which favor an medium-early wheat particularly Southeast Nebraska. Its earliness makes it attractive for southern Nebraska. It averaged 39.9 bu/a state-wide. It has good winterhardiness and has a medium height (is a semi-dwarf) with moderately strong straw. It is resistant to the currently prevalent races of stem rust and moderately resistant to Hessian fly. It is susceptible to leaf rust, wheat soilborne mosaic virus, and wheat streak mosaic virus. It has good test weight characteristics, superior to Redland and similar to Siouxland. It has good intrinsic quality with slightly higher protein than Brule or Redland. NE84557 was dropped from further consideration due to its susceptibility to wheat streak mosaic virus. NE83432 was dropped from further release in Nebraska because it is a late semi-dwarf which does not offer advantages above current wheat experimental lines and cultivars. It has performed well in South Dakota and will be tested for possible future release there. Three experimental lines are under small scale increase. They are NE86501 and NE86503 (sister lines with the pedigree Colt/Cody), and NE86606 (WRR/SUT//MoW6811/3/Agate sib)/4/Cody).

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

2. Field Plot Trial and Outstate Testing

Twenty-seven entries were included in statewide testing at 11 dryland locations in 1988. The top ten lines were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
NE83407	41.11	Redland	38.41
NE83432	39.99	Brule	38.15
NE83498	39.87	Abilene	37.16
Siouxland 89	39.83	Arapahoe	36.95
Siouxland	39.00	Tam107	36.81

Norkan had the lowest yield with 30.39 bu/a. In 1988, the highest yielding variety was TAM107 at 48.8 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 Mead, North Platte, and Scottsbluff. The North Platte and Mead trials were abandoned due to poor plant stands and poor survival from the winter. The Scottsbluff irrigated trial was harvested. The top seven lines at Scottsbluff were:

NE86501	55 bu/a
NE83407	51
Colt	50
NE86503	50
Vona	49
Arapahoe	49
NE87457	49

The strategy of testing irrigated wheats has changed. As much of the irrigated wheat is planted in rotation, the irrigated wheat is often planted late. Hence future irrigated tests will emphasize late plantings. Also a greater effort will be expended in intercepting earlier generation lines that may have potential under irrigation, but not 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 all locations were harvested. Sidney was severely damaged by hail and the yield data collected was more for recovery measurements than true estimates of agronomic potential. Excellent data was obtained from one location (Lincoln). Adequate data was obtained from Mead and Clay Center (affected by drought) and North Platte (affected by winter injury and freeze damage and drought), and Alliance (affected by blowing and drought). Experimental lines continue to be identified with excellent performance characteristics in comparison to previously released lines. The top ten lines (Lincoln, Clay Center, North Platte, and Alliance data) for yield were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
NE83404*	44.2	NE87612*	42.0
NE87613*	42.7	NE83406	42.0
NE83503*	42.5	Arapahoe	42.0
Siouxland	42.3	Brule	41.7
NE83498*	42.2	NE87615*	41.3

* Entered into USDA regional trials

For comparison, Tam 107 and Centurk 78 yielded 35.1 and 37.6 bu/a. NE83404 and NE83406 are sister lines of NE83407 (40.7 bu/a in this trial) which performed well in the Out State Test. Eighteen experimental lines were retained for further testing. This is a normal retention rate compared to previous years.

5. Nebraska Triplicate Nursery

Excellent experimental lines also were identified in the Nebraska Triplicate Nursery (NTN). As opposed to 1985, 1986, and 1987, experimental lines topped the NTN. Previously, Siouxland and/or TAM 107 had been the highest yielding lines in the NTN. The top ten lines for yield were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
NE88635	46.2	NE88629	42.6
NE88634	43.6	Cody	41.8
NE88595	43.4	NE88556	41.7
Abilene	43.1	NE88528	41.6
NE88458	42.7	NE88446	41.5

Seventeen lines were advanced to the Nebraska Intrastate Nursery which is the normal advancement from this nursery.

6. Regional Nurseries

The Southern Regional Performance Nursery (SRPN) was harvested at Lincoln, Mead (one replication), Clay Center, North Platte, and Alliance. Yields were generally similar to the NIN and NTN. NE83407 (45.0 bu/a) topped the trial. The next four highest yielding lines were XH900 (44.1 bu/a), XH884 (43.6 bu/a), T21-1 (40.9 bu/a), and RL844677 (40.8 bu/a). The XH lines are hybrid wheats. In general the hybrid wheats perform better in western Nebraska and perform poorly in eastern Nebraska. The other three wheats are purelines. The Northern Regional Performance Nursery (NRPN) was harvested at Lincoln, Mead (one replication), North Platte, and Alliance. Yields were also similar to the NIN and NTN. The five highest yielding lines were: NE83432 (41.2 bu/a), XH878 (40.4 bu/a), ND8215 (39.3 bu/a), NE83404 (39.1 bu/a), and ND8212 (39.0 bu/a).

7. Multiple-Location Observation Nursery

Five of six replications (locations) of this nursery were harvested. As mentioned previously, Sidney was lost to hail. Of the 312 lines including checks and 20 higher protein lines from Dr. C. J. Peterson's germplasm program that were evaluated, 64 were advanced to the NTN. As with the more advance nurseries, a number of experimental lines performed better than the average of the five checks. Redland and Siouxland were the highest yielding checks in the nursery. The highest yielding lines were NE89518 (55.6 bu/a) and NE88523 (54.9 bu/a). The closest check cultivar plots had yields of 52.9 bu/a (Siouxland) and 48.9 bu/a (Redland). As was the case last year, the high protein lines generally did not perform well across Nebraska. However they are superior to Lancota, have excellent plant types, performed well in some locations, and were selected as future parents.

8. Early Generation Nurseries

a. Single-plot Observation Nursery

Eighteen hundred and ninety-three lines including checks were evaluated in 1989. Of this group over 600 were selected for further testing and genetic studies (about 200 lines). In order to decrease the testing efforts of lines with good agronomic performance, but unacceptable quality characteristics, the selected lines were screened for end-use quality prior to planting. Two hundred and thirty-one lines were advanced for further testing on the basis of their agronomic, seed, and end-use quality characteristics. An additional 41 lines that came from the USDA high protein program.

b. Headrow Nursery

Over 27,000 headrows were planted at Mead. All of the headrows survived the winter and with the exception of the drought were rated as fair for selection. The headrows were irrigated twice to help alleviate the effect of the drought. The major difficulty with this nursery is that due to the drought, we were unable to obtain a good infection with stem rust. Hence we were unable to select on the basis of this critical factor. Over 1500 were selected for further testing. This is a normal level of selection.

a. F_3 bulk hybrids

The F_2 bulk hybrid nursery contained only 318 bulks. This is more than the previous year, but still lower than desired. The reduced numbers were due to lag between Dr. Schmidt's retirement and hiring his replacement. Most bulks survived the winter and approximately 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 482 bulks and check plots. This number of bulks represents the restoration of the breeding program to its full size and genetic diversity. While many bulks from exotic crosses

winterkilled, a number of the bulks were very promising. All of the bulks were advanced to the F_3 nursery.

9. Winter Triticale Nursery

Good progress in developing high yielding, lodging and disease resistant, high test weight triticales with wheat maturity was made in 1989. Two lines, NE83T12 and NE86T666 were tested in the NIN. While both lines were generally inferior to winter wheat, they did perform well in some environments. Both lines were extremely susceptible to Cephalosporium stripe and performed poorly at North Platte. Both lines are superior for grain yield to existing commercially available winter triticale varieties based on tests at Lincoln. At Lincoln, the five highest yielding lines were Siouxland (67.7 bu/a), Redland (64.3 bu/a), NE86T653 (61.2 bu/a), NE83T12 (60.6 bu/a), and Trical (60.5 bu/a). The good performance of Siouxland, Redland, and Trical relative to NE83T12 may be explained by their having a better level of winterhardiness and being slightly later (able to use late rains), as well as their known genetic potential. On the basis of its performance, NE83T12 was released as 'Newcale.'

Newcale is an increase of a hexaploid F_3-derived line from the cross 6TA131/dwarf selection 6TA131//short selection of 'Fain'/'Centurk 78' made in 1977. Centurk 78 is a hard red winter wheat. The other parents are triticales. Newcale was identified as a line in 1983 and tested in yield nurseries in Nebraska starting in 1984.

Newcale is an awned, white glumed winter triticale whose primary use will be as a feed grain triticale. The awns are rough, moderately long and brown to black in color. Floret fertility is good. The kernels are red, elliptical, large and slightly wrinkled as is common with triticale. Newcale has a 1000 kernel weight and kernel protein content that is higher than most wheats. Newcale's test weight generally exceeds the triticale standard of 48 lbs/bu. Newcale under good conditions can yield similarly to winter wheat (compared on a lbs/acre basis), however, due to its lower level of winterhardiness, it has on average yielded less than the best winter wheats. In preliminary tests, its forage yield has been similar to winter wheat, but less than winter forage triticales adapted to Nebraska. Newcale is earlier in flowering than most winter wheats and winter forage triticales, and is later than most winter barleys adapted to Nebraska. Newcale has good straw strength for a winter triticale, but would be considered as having fair straw strength when compared to winter wheat. Its winterhardiness level is superior to winter barley, similar to the more winter tender winter wheats that may be grown in Nebraska (Vona and Tam 200), and less than winter wheats that are widely grown in Nebraska (Siouxland or Redland). Newcale is slightly taller than Siouxland, a conventional height winter wheat, but shorter than most forage triticales.

Newcale is moderately resistant to the currently prevalent races of leaf and stem rust and contains probably Sr31. It is susceptible to Hessian fly (Great Plains Biotype) and wheat soil borne mosaic virus, and very susceptible to Cephalosporium stripe. In greenhouse tests in 1988 and 1989 and in 1989 field trials, it is heterogeneous for resistance to wheat streak mosaic virus with most plants being phenotypically resistant to the virus (little stature reduction and little effect on seed set). Ergot has not generally been found in this variety when the disease was present in other triticales under similar

growing conditions.

10. Doubled Haploid Study

Forty-four doubled haploid lines (DHL) of Centurk were compared to Centurk, Centurk 78, Rocky, and a composite of the 44 DHLs in replicated yield trials harvested at Mead, Lincoln, North Platte, and Alliance. The purpose of this study is to evaluate whether a new and potentially much more efficient breeding strategy may have utility in the breeding program. The doubled haploids were developed by using tissue culture in which plants are regenerated from immature pollen grains (saving a minimum of two years in the breeding program). This year completed the data analysis. The results indicated that the tissue culture technique may have induced deleterious changes in the regenerated plants. However, high yielding lines were identified and more importantly, the doubled haploids were as environmentally stable the more heterogeneous parent, Centurk. Hence, doubled haploid breeding should be able to produce high yielding and environmentally stable wheat lines. Mr. Yuan Han-min a visiting scientist has greatly improved the efficacy of the tissue culture technique. Dr. Randy Simonson, a post doc, has joined the project and has also greatly improved the efficiency of the technique, particularly the calli initiation phase and the plant regeneration phase. Work on improving the technique and verifying its efficacy continue.

11. Chromosome Substitution Lines

A series of lines in which a single pair of chromosomes has been 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. These lines were evaluated at Lincoln in 1987, at Lincoln, Mead, and Alliance in 1988, and at Lincoln, Mead, North Platte, and Alliance in 1989. Preliminary indications are that some chromosomes (particularly 6A and 3A) have significant effects on maturity, yield (can reduce or enhance yield by 20%), and test weight. This research will give a better understanding of how to manipulate the genetics of agronomic performance and the role of the environment in modifying performance. Mr. T. Berke, a graduate student on the project, is in charge of this research as well as coordinating the development of the winter barley varieties.

12. 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 will be 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 should the need arise. 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 may lead to a small effort in developing blue wheat if a market can be developed similar to blue corn tortillas.

13. Spring Wheat and Triticale

The spring wheat and triticale variety trials at Mead are part of the Nebraska Out-state Testing Project. The trials were also at Concord, Sidney, and Scottsbluff. A complete report of these lines can be found in E. C. 89-102, Nebraska Spring Small Grain Variety Test. Dryland yields were very low due to drought (average yield at Mead was 10 bu/a, at Concord was 16 bu/a, and at Sidney was 16 bu/a). Irrigated yields were much better (average yield at Scottsbluff was 53 bu/a). The highest yielding varieties differed at each dryland location (Butte 86 and Shield at Mead, Guard and Oslo at Concord, and Shield and Amidon at Sidney). Under irrigation, Prospect and Amidon had the best yields.

14. Change in Nursery Fields

Efforts to improve the main testing site at North Platte by using a field having less Cephalosporium stripe were successful. A smaller field has been identified for Cephalosporium stripe testing of elite lines. Efforts are also underway to improve the testing site (remove possible yield gradients) at Alliance. Lincoln, North Platte, and Alliance historically have been excellent sites to predict wheat performance in the Great Plains.

IV. GREENHOUSE RESEARCH

The F_1 wheat populations were grown only in the Lincoln Greenhouses to avoid possible losses to winterkilling. Three hundred sixty-seven F_1 populations were grown. This is normal and translates to 495 F_2 plots planted in 1989. An additional 409 wheat crosses were made for breeding purposes and over 60 crosses for population improvement purposes (long range breeding objectives for winterhardiness and quality improvement). Some crosses were made for genetic studies. In the triticale program, 63 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 quality, wheat nutritional improvement, wheat cytogenetics, plant physiology and production practices, and variety testing. Much of the production research is located at the outlying stations. 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 attempt 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. One of the most important efforts undertaken this year was completing a strategic plan for Nebraska Wheat.

Summary

A poor wheat crop was produced in 1989 due to heat/drought stress and to wheat streak mosaic virus infection. The estimated 27 bu/a is well below the five year average for state average grain yield. Siouxland continued as the most widely grown variety in Nebraska and was grown on 20.5% of the state acreage. Brule and Redland (a selection out of Brule) were grown on a 22.0% of the state acreage. Russian wheat aphid was widespread and some growers sprayed their fields. The most important disease was wheat streak mosaic virus which caused significant losses in many fields.

Arapahoe, released in 1988, performed well and may have the best winterhardiness of the USDA/Nebraska releases since Lancer. Newcale, a winter feed grain triticale, was released. It is s superior grain triticale and has very good resistance to wheat streak mosaic virus and stem rust. Two experimental lines, NE83407 and NE83498, are under large scale increase for possible release in 1990. NE83407 has excellent yields throughout Nebraska and topped the 1989 Outstate Test. NE83498 is an early wheat with good yield performance and may be useful for southern Nebraska and for variety complementation.

Basic research to improve breeding efficiency continued in three areas: 1. wheat tissue culture which will decrease the time required to develop new varieties, 2. reciprocal chromosome substitution line analysis which will provide a better genetic understanding of agronomic performance, and 3. development of a dominant male sterile population for long term population improvement similar to corn.

The winter triticale program will continue and be positioned as a feed grain alternative to winter barley for growers needing small grain feeds. All efforts on feed wheat have stopped.

A strategic plan was developed for wheat in Nebraska in collaboration with important and interested wheat groups.

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.