1988 NEBRASKA COOPERATIVE WHEAT INVESTIGATIONS

Report to the

NEBRASKA WHEAT DEVELOPMENT, UTILIZATION
AND MARKETING BOARD

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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 experimental line testing would be curtailed and many of the wheat quality analyses would not be possible to evaluate our breeding material.

II. THE 1988 NEBRASKA WHEAT CROP

1. Growing Conditions

The 1988 Nebraska wheat crop was highly variable. The fall planting season was generally dry and most growers were able to plant at near optimum times. The winter was moderate and winterkilling was generally not a problem (in part due to good fall establishment). It was the spring growing season that was highly variable. Wheat streak mosaic virus caused significant losses in southwestern Nebraska. Insufficient and spotty spring rainfall limited yields in central and eastern Nebraska. Excessive heat also reduced yields in southern Nebraska. However, growers that received adequate rainfall, avoided wheat streak mosaic virus, and whose crop was at a heat tolerant stage during the periods of excessive heat were able to produce good crops. The heat and drought conditions favored early wheats. TAM107 performed well in Nebraska. However, some of the later wheats such as Redland and Siouxland also performed well. Our most recent release, Arapahoe, which also tends to be late and was previously thought to require ample moisture to finish, had a respectable year. Evidently these wheats' adaptation characteristics allowed them to perform despite the drought and heat.

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

Hessian fly and the Russian wheat aphid 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. It can be devastating.

4. Wheat Production

The wheat yield for Nebraska was 36 bushels per acre from 2,000,000 harvested acres for a total production of 72,000,000 bushels. This yield is below last year's record yield and is slightly below the previous five year average. The decline in planted and harvested acres continues as a result of the low wheat prices and the farm programs. Quality determinations by the Doty Laboratories Inc. were as follows:

Nebraska	Moisture %	Protein Ave.	Test Weight
Northeast	10.05	12.40	60.50
Southeast	9.18	12.35	61.00
Northcentral	12.12	12.28	55.75
Southwest	10.12	12.93	58.20
Panhandle	10.51	11.86	57.90

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/heat and wheat streak mosaic virus.

5. Cultivar Distribution

Siouxland replaced Brule as the most widely grown cultivar in 1988 (21.3% of the total acreage). Brule was the second most widely grown cultivar with 17.1% of the total acreage. This is a reduction from its peak of being grown on 32.6% of the total acreage in 1985. With the release of Redland (4%), a selection out of Brule, and the favorable 1987 and 1988 yield performances, the combined acreage (21.1%) of Redland and Brule may increase in future years. An example for the above is that the combined acreage Centurk and Centurk 78 (9.8%) and of the "Centurk-type" wheats, Centura (11.9%) and Cody (1.2%), is 22.9% of the total acreage and exceeds the acreage 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 84.3% of the state. USDA-Nebraska releases are grown on approximately 79.8% of the state. Privately released varieties are grown on the remaining 15.7% of the state.

TABLE 1. NEBRASKA--WHEAT VARIETIES
ESTIMATED PERCENTAGES PLANTED TO EACH VARIETY, 1984-1988

Variety	1984	1985	1986	1987	1988
			Percent		
Brule	20.1	32.7	28.6	22.5	17.1
Siouxland	----	----	2.8	17.0	21.3
Centura	----	1.2	6.9	14.3	11.9
Centurk & Centurk 78	28.1	20.5	19.0	12.4	9.8
Colt	----	----	3.5	4.2	4.4
Agripro Thunderbird	----	----	0.1	0.7	4.0
Redland	----	----	----	----	4.0
Buckskin	4.4	6.0	5.4	3.8	2.8
Scout & Scout 66	6.4	5.1	5.0	3.5	2.7
AgriPro Hawk	3.5	4.5	4.7	3.4	3.9
AgriPro Rocky	4.4	3.9	3.3	1.7	1.1
AgriPro Wings	8.4	3.9	2.6	1.7	----
Newton	2.5	1.5	1.5	1.5	1.5
Bennett	3.1	2.5	1.3	1.2	----
Vona	5.2	3.8	3.2	1.2	1.3
Gage	2.1	2.5	1.0	1.0	----
Arkan	----	----	----	.9	1.7
Other Public Varieties	8.7	6.7	4.5	3.9	4.6
Other Private Varieties	3.1	5.2	6.7	5.8	6.7

6. New Cultivars

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. 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

No experimental wheat is currently under large scale increase. Two wheats, NE82533 and NE82438, were grown under small increase in 1988, but have been dropped from further consideration. 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. Four lines under small increase are:

NE83407 [Cimmyt/Scout//Bennett sib//Pkr*4/Agent //Belot198 /Lcr/3/Bez1/Ctk78], NE83432 [(Ftn/Mi/ Hope) //Pnc/2*Cnn /3/Pnc/3*Cnn /4/Pnc /2*Cnn//Ill#1-Cns-Tt1(Ctmh) /Sando60 /5/Vona/6/Wrr*5/Agent //Kavkaz], NE83498 [Wrr*5/Agent//Kavkaz /4/Pkr*4/Agent //Belot198 /Lcr/3/Vona], and NE84557 [Wrr/Sut//MoW6811 /3/Agate sib/4/NE68457 /Ctk78]. All of the lines are resistant to stem rust, and have good quality and agronomic performance. NE83432 and NE83498 are moderately resistant Hessian fly. All four lines are susceptible to wheat soil-borne mosaic and wheat streak mosaic viruses.

2. Field Plot Trial and Outstate Testing

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

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
TAM107	48.75	Redland	45.07
Abilene	48.12	Brule	44.94
Siouxland	45.76	Thunderbird	44.91
Arapahoe	45.72	Karl	44.66
Cody	45.52	Centura	44.25

Turkey had the lowest yield with 36.01 bu/a. In 1987, the highest yielding variety was TAM107 at 61 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. All of the trials were harvested. There was considerable variation as to performance between the three sites. The top five lines at each site were:

Mead		North Platte		Scottsbluff	
Siouxland	60.8	NE83407	56.5	Centura	54.3
NE83432	55.5	Siouxland	52.9	NE84557	53.0
NE84557	55.5	Thunderbird	51.8	NE83407	52.8
Arapahoe	55.2	Arapahoe	51.5	Thunderbird	52.7
NE84581	53.2	Brule	50.1	Colt	52.3

It was surprising to see the dryland, tall (conventional) height wheats perform as well as they did under irrigation. However, the yields are relatively low for irrigated wheat and may represent normal yields under rainfed 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. Sidney was lost to hail. Excellent data was obtained from one location (Lincoln). Adequate data was obtained from Mead and Clay Center (both affected by drought), North Platte (affected by Cephalosporium stripe and heat, and Alliance (affected by productivity gradient presumably due to previous cropping practices). As opposed to previous years, experimental lines have been identified that are superior to Siouxland, Arapahoe, and Redland which have been very difficult to exceed in performance. It was also interesting to note the generally good performance of the lines selected in 1983 (designated by NE83...). These lines were not as impressive in 1986 when I first joined the program. As such they were not advanced as rapidly as may have been justified based upon previous or post 1986 experience. This lost time in variety release is due to the transition between breeders. The top ten lines for yield were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
NE83498*	60.1	Siouxland Comp	58.0
NE86606*	60.0	NE83404*	57.6
NE83407*	59.6	NE86503*	57.3
Siouxland	58.5	NE84557*	57.3
NE86501*	58.3	NE86482*	57.1

* Entered into USDA regional trials

Nineteen experimental lines were retained for further testing. This is a normal retention rate compared to previous years.

5. Nebraska Triplicate Nursery

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

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
NE87619	52.1	NE87499	49.3
NE87612	50.9	NE87403	48.8
NE87457	49.5	NE87613	48.6
Siouxland	49.3	NE87408	48.3
NE87615	49.3	Cody	48.2

Sixteen lines were advanced to the Nebraska Intrastate Nursery.

6. Regional Nurseries

The Southern Regional Performance Nursery (SRPN) was harvested at Lincoln, Mead, Clay Center, North Platte, and Alliance. Yields were similar to the NIN and NTN. Arapahoe (56.8 bu/a) and NE83407 (55.5 bu/a) topped the SRPN. The next three highest yielding lines were: AGC-112 (55.2 bu/a), I180-1251 (53.2 bu/a), and NE84557 (53.0 bu/a). The Northern Regional Performance Nursery (NRPN) was harvested at Lincoln, Mead, North Platte, and Alliance. Yields were also similar to the NIN and NTN. The five highest yielding lines were: Abilene (55.3 bu/a), XH947 (52.1 bu/a, a hybrid), NE84581 (51.0 bu/a), Arapahoe (50.7 bu/a), and NE83432 (50.3 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 300 lines including checks and 20 higher protein lines from Dr. C. J. Peterson's germplasm program that were evaluated, 58 were advanced to the NTN. As with the more advance nurseries, a number of experimental lines performed better than the five checks. The checks, Siouxland, Redland, TAM107, Lancota, and Colt ranked 5, 19, 174, 217, and 227 respectively in the nursery. The highest yielding line, NE88526 with a yield of 62.4 bu/a was 7.2 bu/a than Siouxland (55.2 bu/a). While high protein lines generally did not perform well across Nebraska, they are superior to Lancota, have excellent plant types, and were selected as future parents.

8. Early Generation Nurseries

a. Single-plot Observation Nursery

Fifteen hundred sixteen lines including checks were evaluated in 1988. Of this group 290 were selected for further testing. Included were 27 lines that came from plants selected for resistance to the Hessian fly by the USDA/ARS entomology team at Manhattan, Kansas. Additional lines having Hessian fly resistance would have been selected, but poor agronomic performance limited their use.

b. Headrow Nursery

Over 37,000 headrows were planted at Mead. All of the headrows survived the winter and with the exception of early drought and late weathering were excellent for selection. 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 1800 were selected for further testing. This is a significant increase over the three previous years. The reasons for the significant increase in selected lines are: 1. generally good material for selection, 2. the inability to cull on the basis of stem rust susceptibility, and 3. a lower than normal number of segregating bulks being available for selection in the next two years due to transition between breeders.

c. F_3 bulk hybrids

The F_3 bulk hybrid nursery contained only 272 bulks. This is lower than previous years and represents the reduced crossing efforts due to the approaching retirement of Dr. Schmidt. Those bulks that survived the winter and approximately 26,000 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.

d. F_2 bulk hybrids

The F_2 bulk hybrid nursery contained only 318 bulks. This low number was due to the absence of a project leader during the transition. The staff should be commended for carrying on the project at this level during this period. All of the bulks were advanced to the F_3 nursery. The number of bulks advanced to the F_3 nursery was increased by Dr. C. J. Peterson graciously sharing 18 "F_2" bulks that he had made using a chemical hybridizing agent as part of a hybrid wheat and heterosis experiment. These bulks were added to the 1989 F_3 nursery.

9. Winter Durum and Triticale Nursery

The decision to begin an orderly close-out of the winter durum breeding efforts was made in 1987 due to resource limitations. All of the durum materials were distributed in 1988 to interested breeders. Somewhat remarkably, at the time we decided to end our durum project Ohio and Oregon began new programs. No durum lines were planted in 1989 and no new crosses were made.

Good progress in developing high yielding, lodging and disease resistant, high test weight triticales with wheat maturity was made in 1988. 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 to existing commercially available winter triticale varieties based on tests at Lincoln. At Lincoln, the five highest yielding lines were Rymin Rye (68.4 bu/a), NE86T665 (63.2 bu/a), NE86T666 (61.8 bu/a), NE86T649 (61.2 bu/a), and LAD285 (61.2 bu/a). NE83T12 had a yield of 58.6 bu/a. Siouxland and Redland had yields of 58.3 and 52.6 bu/a,respectively in the same test. NE83T12 was also put into the Out-State Testing program and given to the Foundation Seeds Division for a large increase.

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 is the final year of data collection and the study can now be summarized. Preliminary results indicated that the tissue culture technique does not appear to have induced deleterious changes in the regenerated plants. Ms. V. Keppenne, a graduate student who has been the lead researcher on this project, has transferred the tissue culture techniques to the University of Nebraska and is developing a better understanding of the utility of the technique. Mr. Yuan Han-min, a visiting scientist, has greatly improved the efficacy of the technique. A grant from the USDA Competitive Grants Office was awarded to the project.

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 and at Lincoln, Mead, and Alliance in 1988. An additional year of field evaluation are necessary before the results can be summarized. However, preliminary indications are that some chromosomes (particularly 6A and 3A) have significant effects on maturity, yield, 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, will be 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. Purple wheat , used for feed, development efforts will be phased out and replaced by triticale development efforts. One purple grain wheat is currently being tested in the NIN. 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 and purple wheats only to improve hard red winter wheat. Of course, purple and 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.

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, Scottsbluff, and Alliance. A complete report of these lines can be found in E. C. 88-102, Nebraska Spring Small Grain Variety Test. Dryland yields were very low due to drought (average yield at Mead was 23 bu/a and at Concord was 17 bu/a). Irrigated yields were also low (average yield at Scotts Bluff was 33.2 bu/a and average yield at Alliance was 27.5 bu/a). Butte 86 had the best overall yield.

14. Change in Nursery Fields

In order to improve the quality of information obtained from field testing, the decision was made to change the main testing field at North Platte to a field having less Cephalosporium stripe. A smaller field has been identified for Cephalosporium stripe testing of elite lines. In the past lines that were susceptible to this disease performed very poorly in the nursery testing program. As not all fields in southwest Nebraska have this disease, it was decided to test the main nurseries in the absence of the disease and use a disease nursery to provide the grower with the disease susceptibility information. 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. Four hundred forty F_1 populations were grown. This is more than normal and translates to 482 F_2 plots planted in 1988. An additional 362 wheat crosses were made for breeding purposes and 61 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, 54 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. 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 attempt to develop a strategic plan for Nebraska Wheat.

Summary

A slightly below average wheat crop was produced in 1988 due to heat/drought stress and to wheat streak mosaic virus infection. The estimated 36 bu/a is below the five year average for state average grain yield. Siouxland replaced Brule as the most widely grown variety in Nebraska and was grown on 21.3% of the state acreage. Brule and Redland (a selection out of Brule) were grown on a 21.1% of the state acreage. Russian wheat aphid was widespread, but rarely devastating in western Nebraska on winter wheat. The most important disease was wheat streak mosaic virus which caused significant losses in many fields.

Arapahoe was jointly released with South Dakota State University. 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 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.

Experimental lines that have been developed after the severe winter of 1983-84 which have excellent agronomic performance are beginning to be identified. In recent years, experimental lines were selected almost entirely upon their ability to survive the winter. Winterhardiness alone is insufficient for cultivar release.

The winter triticale program will continue and one experimental line, NE83T12, is under large scale increase. It is a high yielding, strong strawed (for triticale), and stem rust resistant triticale with good test weight (for triticale). Due to strategic planning and resource constraints, the white wheat program has been greatly reduced and the purple wheat and winter durum programs have been discontinued.

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

Support from the Wheat Board, Foundation Seeds Division, Agricultural Research Service (USDA), and the Institute for Agriculture and Natural Resources is gratefully acknowledged as it is only through their generous contributions that the state-wide wheat breeding and testing efforts are possible.