1990 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 the state 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 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 1990 Nebraska wheat crop was again highly variable. The fall planting season was generally dry and most growers were able to plant near optimum times. The winter had a few sharp and bitter cold periods, but the crop generally survived the cold with little winterkilling. The spring season began with minimally adequate moisture, but due to cool temperatures, the wheat crop grew well. The cool spring season increased the symptoms of wheat soilborne mosaic virus in southeastern Nebraska. In early summer most of the state experienced severe heat, often combined with drought. In many areas the heat and drought prematurely ended grain fill (for example, wheat plots were harvested at North Platte on July 2). In these heat and drought stressed areas, low test weight was a severe quality problem. In other parts of the state, rains came just before and during harvest which produced weathered grain. In areas of adequate rainfall, foliar diseases were significant (mainly powdery mildew, leaf rust, leaf blotches, and some stem rust). In western Nebraska, Russian wheat aphid was prevalent and many fields were sprayed.

The environmental conditions allowed wheats with normally marginal winterhardiness to perform well in Nebraska. Of the released lines in the state variety trial, Abilene and TAM 200 (both are short semi-dwarfs with strong straw), Arapahoe, and Redland performed well. TAM 200 has minimally adequate winterhardiness for eastern Nebraska. As many of the testing sites had severe lodging, Abilene and TAM 200 performed well under those conditions. Maturity was not as pronounced a factor in yield performance as it had been in recent years; TAM 107 and Karl (both early wheats had average records). Early maturity may have been an advantage for maintaining test weight.

2. Diseases

Foliar diseases are highly dependent on moisture for their development and spread. Leaf rust was prevalent in eastern Nebraska and as far west as

North Platte. Leaf rust at North Platte was unusual. However in May, North Platte had many more days than usual with measurable precipitation. The total precipitation for May was average. Hence the precipitation was ideal for leaf rust development, but only normal for crop development. Stem rust was also present in some fields in eastern Nebraska, but probably did not reduce yield. At Clay Center, leaf rust was present but the main diseases were leaf blotches (Septoria spp. or tan spot). As mentioned previously, the cool spring increased the expression of soil borne mosaic virus and powdery mildew in southeastern Nebraska. The symptoms of soil borne mosaic virus and powdery mildew are greatly reduced by hot weather. No new races of diseases were identified. In general, most varieties developed in the southern Great Plains are susceptible to leaf rust (Arapahoe and Karl have moderate resistance). 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

By far the most important insect pest in 1990 was the Russian Wheat Aphid. Infestations of the aphid were high enough that many growers in western Nebraska decided to spray their fields even at the lower yield potential due to drought. An ecological barrier (perhaps related to moisture or humidity) seems to be present between Ogallala and North Platte as the aphid has established itself in western Nebraska and migrated thousands of miles to the north, but has not been found in significant quantities at North Platte or in areas east of North Platte. Hessian fly was not present at significant levels in any fields in Nebraska. 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. Where the Russian wheat aphid is present, it can be devastating.

4. Wheat Production

The estimated wheat production for Nebraska is 85,500,000 bushels from 2,250,000 harvested acres. The average yield was 38 bushels/acre which is very close to the five year average. While this production and yield is average, it is good crop when compared to 1989 when the wheat yield for Nebraska was 27 bushels per acre 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 the Doty Laboratories Inc. were as follows:

1990 DATA:

Nebraska	Protein Ave. (12% moisture)	Overall Evaluation
Northeast	12.0	Fair+
Southeast	12.4	Very Good-
Northcentral	12.2	Good+
Southwest	12.4	Good
Panhandle	12.7	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 heat/drought and diseases. In areas where yields were high, low protein was a problem.

5. Cultivar Distribution

Siouxland continued as the most widely grown cultivar in 1989 (18.7% of the total acreage). Its acreage may have peaked at about 20% of the total acreage. Redland was the second most widely grown variety (15.2% of the total acreage). As Redland is a selection from Brule (9.4% of the total acreage), Redland and Brule were the most popular varieties in Nebraska. Thunderbird was the third most popular variety (10.7% of the total acreage) and Centura was the fourth most widely grown variety with 9.6% of the acreage. 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 78.3% of the state. USDA-Nebraska releases are grown on approximately 71.0% of the state. Privately released varieties are grown on the remaining 21.7% of the state.

NEBRASKA--WHEAT VARIETIES
ESTIMATED PERCENTAGES PLANTED TO EACH VARIETY, 1986-1990

	Percent				
Variety	1986	1987	1988	1989	1990
Brule	28.6	22.5	17.1	12.0	9.4
Siouxland	2.8	17.0	21.3	20.5	18.7
Centura	6.9	14.3	11.9	12.4	9.6
Centurk & Centurk 78	19.0	12.4	9.8	4.6	4.4
Colt	3.5	4.2	4.4	2.3	1.5
Agripro Thunderbird	0.1	0.7	4.0	7.2	10.7
Redland	---	---	4.0	10.0	15.2
Cody	---	---	1.2	2.9	2.4
Buckskin	5.4	3.8	2.8	2.2	1.9
Scout & Scout 66	5.0	3.5	2.7	2.6	2.2
AgriPro Hawk	4.7	3.4	3.9	2.9	4.4
AgriPro Rocky	3.3	1.7	1.1	---	---
Newton	1.5	1.5	1.5	---	---
Vona	3.2	1.2	1.3	---	---
Arkan	---	.9	1.7	1.6	---
Abilene	---	---	---	1.0	5.5
All TAM wheats	0.9	1.1	1.0	3.8	6.0
Norkan	---	---	---	0.7	2.0
Arapahoe	---	---	---	---	1.8
Other Public Varieties	4.5	3.9	4.6	4.3	4.0
Other Private Varieties	6.7	5.8	6.7	6.0	3.1

6. New Cultivars

NE83498 has been recommended for release under the proposed name 'Rawhide'. Formal release is waiting for University and USDA release approvals. It will be jointly released by South Dakota State University. Its pedigree is Warrior*5/Agent //Kavkaz /4/Parker*4/Agent //Beloterkovskaia 198

/Lancer/3/Vona. Rawhide has performed well in areas which favor a medium-early wheat. Its earliness makes it attractive for southern Nebraska and in areas where an early maturing wheat is needed to complement later maturing wheats. It seems to have fairly good tolerance to heat and drought stress (hence its name) which often tend to favor early wheats. In five years of testing in the Nebraska Intrastate nursery, its yield is similar to Siouxland, less than Arapahoe, and superior to Redland and Colt. It has good winterhardiness and has a medium height (is a semidwarf) with moderately strong straw. It is moderately resistant to the currently prevalent races of stem rust (contains Sr17, Sr24, and/or Sr31), 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 acceptable intrinsic quality with slightly higher protein than Brule or Redland.

III. FIELD RESEARCH

1. Increase of New Experimentals

Three experimental wheats are currently under large scale increase. They are NE83407 [Cimmyt/Scout//Bennett sib//Parker*4/Agent //Beloterkovskaia 198 /Lancer/3/Bezostaia 1/Centurk 78], NE86501 [Colt/Cody], and NE86606 [Warrior/Scout //MoW6811/3/Agate sib)/4/Cody]. NE83407 was under large scale increase last year, but the production fields were considered too variable for plant characteristics, even after roguing, to meet certification standards. Rawhide was also variable, but after roguing could meet certification standards. The difficulties with too much variability in foundation seed fields has led the breeding program to 'head row' all advanced experiment lines to insure more uniform plant types are being increased.

NE83407 performed very well throughout the state and was the highest yielding line in the 1989 Variety Trials. 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. If released it would be targeted to the semidwarf acreage.

NE86501 and NE86606 are taller wheats (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. NE86606 is susceptible to leaf rust, soilborne mosaic virus, and wheat streak mosaic virus; and resistant to stem rust (contains genes Sr6, Sr17, and Sr24) and Hessian fly. The test weight of NE86501 is similar to Siouxland and superior to Redland or Brule. NE86606 has medium early maturity. The overall quality of both NE86501 and NE86606 are acceptable to good. In 1989, the falling number of NE86606 was relatively high which may indicate a tendency for sprouting under wet conditions. The test weight of NE86606 is similar to Siouxland and superior Redland or Brule. Both NE86501 and NE86606, if released, would be targeted to areas where tall wheats are needed.

NE86503, a sister line of NE86501, was dropped from further testing as

its performance was inferior to NE86501. NE83432, a line that was dropped in 1989 continues to perform well in South Dakota where it is still being tested for possible future release.

Four experimental lines are under small scale increase. They are NE87612 [Newton//Warrior*5/Agent/3/NE69441], NE87613 [NE76668/4/TAM105 /3/Larned//Eagle/Sage], NE87615 [NE68513/NE68457//Centurk/3/Brule], and KS87H6 [H15A133333/3/5*Larned/Eagle//Sage/4/TAM105]. Of these lines, NE87612 and NE87613 have historically been the best. NE87615 is a "pretty" semidwarf which on this year's data performed very well in southwest Nebraska and western Kansas. This is an area where our breeding nurseries do not well represent. Consideration will be given to adding a site in the southwest district. KS87H6 has been dropped for release by Kansas as it does compete with TAM107 in western Kansas, however, with preliminary data it performs well in Nebraska.

With the release of the outstanding new varieties Siouxland, Redland, Cody, TAM 200, Arapahoe, and Rawhide, many of the most advanced current breeding lines are not expected to be released. Currently, the most likely candidates are NE86501 (possible release in 1991) and NE87615 (possible release in 1992). NE83407, also, is a likely candidate for release once the seed and plant type are uniform.

2. Field Plot Trial and Statewide Testing

Thirty-eight entries were included in statewide testing at 13 dryland locations in 1990. The top ten lines were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
Abilene	50.5	TAM200	48.6
NE83407	49.4	Redland	48.2
NE86501	49.3	Karl	47.3
Arapahoe	49.2	TAM107	47.2
Rawhide	49.1	NE86606	47.2

Turkey had the lowest yield with 36.6 bu/a. In 1989, the highest yielding line was NE83407 at 41.1 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. 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. Unfortunately, an irrigation pump broke and the trial finished under extreme heat and drought stress. The top seven lines at Sidney were:

1990 Results at Sidney		1989 Results at Scottsbluff	
NE88556	44.7 bu/a	NE86501	55 bu/a
NE87615	42.6	NE83407	51
NE86501	42.6	Colt	50
NE87613	41.3	NE86503	50
KS8010-12	40.6	Vona	49
Abilene	40.1	Arapahoe	49
Arapahoe	40.0	NE87457	49

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 all locations were harvested. The trials at Lincoln were excellent, but had more lodging than normal. Winterkilling at Mead was minor. Clay Center had more foliar blotch diseases than normal, but a better than average crop. North Platte, despite leaf rust and drought at finish, was an excellent nursery. Sidney was heat and drought stressed and an average nursery. Alliance was a very good nursery due to a late rain that allowed the grain to finish and a massive effort by Dr. Baltensperger and his crew to remove volunteer wheat and downy brome grass that would have otherwise destroyed the nursery. Experimental lines continue to be identified with excellent performance characteristics in comparison to previously released varieties. Only one line in the top ten lines was a released variety. 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

For comparison, Tam 107 and Centurk 78 yielded 46.1 and 47.2 bu/a. NE83404 is a sister line of NE83407 which performed well in the Statewide Test. Twenty-one experimental lines were retained 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.

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
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. Alliance was lost to volunteer wheat. Yields were generally similar to the NIN and NTN. KS87H6 (56.2 bu/a) topped the trial. The next four highest yielding lines were TX86V1405 (55.9 bu/a), KS8010-72 (55.0 bu/a), OK87630 (54.4 bu/a), and NE87615 (54.1 bu/a). Interestingly, in this year's trials no hybrid was in the highest yield group. That a Texas line was second in the nursery indicates that winterkilling was not a problem. The Northern Regional Performance Nursery (NRPN) was harvested at Lincoln, Mead (one replication), North Platte, Sidney, and Alliance. Yields were also similar to the NIN and NTN. The five highest yielding lines were: NE87612 (52.8 bu/a), NE87613 (51.2 bu/a), NE83407 (51.2 bu/a), NE83404 (50.6 bu/a), and XNH1450 (50.5 bu/a, a hybrid).

7. Multiple-Location Observation Nursery

Five of six replications (locations) of this nursery were harvested. The trial at Alliance was lost to volunteer wheat. Of the 298 lines including checks and 38 higher protein lines from Dr. C. J. Peterson's germplasm program that were evaluated, 56 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 (53.4 bu/a) was the highest yielding check in the nursery. The highest yielding lines were NE90573 (59.6 bu/a) and NE90506 (59.4 bu/a). As was the case last year, the high protein lines generally did not perform well across Nebraska. However as a group they are superior to Lancota, have excellent plant types, performed well in some locations, and were selected as future parents. Some high protein lines were very good and were advanced for further testing for possible variety release. All lines were thoroughly analyzed for milling and baking quality including an optimized bake test prior to advancement.

8. Early Generation Nurseries

a. Single-plot Observation Nursery

Sixteen hundred and seven lines including checks were evaluated in 1989. 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 and forty-four lines were advanced for further testing on the basis of their agronomic, seed, and

end-use quality characteristics. An additional 50 lines came from the USDA high protein program.

b. Headrow Nursery

Over 32,000 headrows were planted at Mead. All of the headrows survived the winter and with the exception of a severe 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 the susceptible and moderately susceptible lines. A second difficulty was that the just prior to harvest a 7" rain severely weathered and sprouted the grain. Approximately 1500 lines were selected for further testing. This is a normal level of selection.

a. F_3 bulk hybrids

The F_3 bulk hybrid nursery contained 482 bulks and check plots. This is 50% more than the previous year. The number of F_3 bulks is near the optimal size. Most bulks survived the winter and approximately 33,000 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 495 bulks and check plots. 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. In addition to the Nebraska developed bulks, over 1,000 F_3 bulks were given to the wheat breeding programs in the Great Plains by Pioneer Hybrid Seed Company which terminated its domestic hard red wheat development program. Five hundred of these bulks were advanced to the F_3 bulk nursery. About 90 F_4 bulks were also donated by Pioneer and advanced to an F_4 breeding 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 1990. 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. The advanced triticale variety trial was grown at both Lincoln and Sidney. 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 is indicative of little winterkilling. Newcale had a fair to good year with an average yield of 38.3 bu/a.

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 concentrated on improving the tissue culture techniques. Dr. Randy Simonson, a post doc, has joined the project in 1898 has greatly improved the efficiency of the technique, particularly the calli initiation phase and the plant regeneration phase. The major finding is that wheat starch (a gelling agent) is a superior to Ficoll 400. Wheat starch in very inexpensive whereas Ficoll 400 costs approximately $400/lb. Using wheat starch and Pavon 76 (a highly respon-

sive variety), Dr. Simonson is now able to obtain 1.5 embryoids per anther and approximately 2 shoots per anther. Work on improving the technique and verifying its efficacy continue. In addition, an alternative method for creating haploids using intergeneric hybridization (wheat x corn or wheat x pearl millet) was initiated. This alternative method may have less tissue culture induced variation (usually deleterious variation).

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. The data was completely analyzed in 1990. Chromosomes were identified (particularly 6A and 3A) have significant effects on maturity, yield (can reduce or enhance yield by 20%), and test weight. Interestingly, the yield differences were not readily explained by traits such as maturity. Hence there may be genes that affect yield in unobvious ways. Obvious ways to affect yield would be enhanced wintersurvival or earliness in dry years. 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. Dr. T. Berke, a former graduate student on the project, did this research as part of his Ph.D. Efforts are continuing to determine how many genes affect yield on the identified chromosomes.

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 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).

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. 90-102, Nebraska Spring Small Grain Variety Test. Dryland yields were low due to heat and drought (average yield at Mead was 9 bu/a, at Concord was 22 bu/a, and at Sidney was 7 bu/a). Irrigated yields were only slightly better (average yield at Scottsbluff was 25 bu/a). The highest yielding varieties differed at each dryland location (Prospect and Shield at Mead, Shield and Oslo at Concord, and Prospect and Shield at Sidney). Under irrigation, Shield and Kramer (triticale) had the best yields.

14. Considerations on Nursery Sites

Efforts to improve the main testing site at North Platte by using a field having less Cephalosporium stripe continue to be 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. In addition, research has been initiated to statistically remove field trends (advantageous or disadvantageous locations in the field). Preliminary data from Alliance during a year of blowouts indicates that field trends could affect the yield of a line by as much as fifty percent of the location mean. If successful, this technique should greatly improve the precision of the data, a critical need for breeding decisions. Finally, the performance of NE87615 in western Kansas (highest yielding line at Hays and Garden City; 6th highest yielding line at Colby) was a surprise and may indicate that NE87615 will perform well in southwest Nebraska. While there has been an excellent expansion of the statewide variety trials in southwest Nebraska, currently there are no breeding nursery sites. The feasibility and logistics of adding a breeding site in southwest Nebraska will be considered this winter.

IV. GREENHOUSE RESEARCH

The F_1 wheat populations were grown only in the Lincoln Greenhouses to avoid possible losses to winterkilling. Four hundred and nine F_1 populations were grown. This is normal and translates to 495 F_2 plots planted in 1990. An additional 473 wheat crosses were made for breeding purposes. Also, over 100 crosses involving male sterility were made to facilitate random mating for population improvement purposes (long range breeding objectives for winterhardiness and quality improvement). The male sterile population was 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 are among the most important quality tests for an experimental line or recently released variety. Eighteen 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 average crop was produced in 1990 due to heat/drought stress, and disease and insect damage. The estimated 38 bu/a is near the five year state average for grain yield. Siouxland continued as the most widely grown variety in Nebraska and was grown on 18.7% of the state acreage. Brule and Redland (a selection out of Brule) were grown on a 24.6% of the state acreage. Russian wheat aphid was widespread and some growers sprayed their fields. Disease varied within the state with leaf rust probably being the most important. Soilborne mosaic virus, stem rust, and foliar blotch diseases were also present.

Arapahoe, released in 1988, performed well and may have the best winter-hardiness of the USDA/Nebraska releases since Lancer. Rawhide, has been recommended for release and the approval forms are being processed. It is a moderately early wheat that is expected to do well in hot and dry conditions. It is a semidwarf wheat, moderately resistant to the currently prevalent races of stem rust and Hessian fly, and susceptible to leaf rust, wheat streak mosaic virus, and wheat soilborne mosaic virus. In general, it has good testweight characteristics, similar to Siouxland and better than Redland. It is expected to do well in southern Nebraska where early wheats tend to be favored in hot, dry years. The experimental lines, NE83407, NE86501, and NE86606, are under large scale increase for possible release in 1990. NE83407 and NE86501 have good performance records and are the more likely for release. Four lines are under small scale increase (the step prior to large scale increase).

Basic research to improve breeding efficiency continued in three areas: 1. wheat tissue culture which will decrease the time required to develop new varieties which will be particularly important in breeding for new pests or disease races, 2. 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.

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. The importance of public wheat breeding efforts was highlighted by Pioneer's decision to end its domestic hard red winter wheat breeding program due to insufficient return on investment.