R. M. Sandstedt

REPORT

OF THE

FIFTH HARD RED WINTER WHEAT

IMPROVEMENT CONFERENCE

Manhattan, Kansas
February 12, 13, and 14, 1945

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Mimeographed by
Division of Cereal Crops and Diseases
Bureau of Plant Industry, Soils, and Agricultural Engineering
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INTRODUCTION

At Manhattan, Kansas, February 12-14, 1945, the cooperators of the coordinated hard red winter wheat improvement program met for a discussion of results obtained to date and to make plans for the future. State and Federal workers were in attendance, as well as a number of men from the grain trade. This was the fifth conference to be held for the purpose of discussing the hard wheat improvement program. The first two meetings, held in 1929 and 1930, were for the purpose of organizing and initiating the work, while results and accomplishments were discussed in 1935 and again in 1938. Since no meeting had been held for 7 years, and a total of 14 years' results have now been accumulated, there was much to discuss; and as a result, the 3-day program was very full.

All meetings were held in Waters Hall on the Campus of the Kansas State College, with the Kansas Experiment Station acting as host. In addition to the program which is reported in detail, there were tours of the greenhouses and the experimental mill. On Tuesday evening, February 13, a dinner was held at the College Cafeteria. Dean L. E. Call acted as toastmaster and President Milton Eisenhower, of Kansas State College, discussed the world food situation in a very thorough and most interesting manner.

MONDAY MORNING, FEBRUARY 12

The conference was opened by Dean L. E. Call of Kansas, who welcomed the group to Manhattan, and then briefly outlined the history of the improvement work with winter wheat since the project was planned in 1929. Some of the first objectives were early maturity, more winter hardiness than is carried by Tenmarq, resistance to rusts, stiffer straw, high yield, and acceptable quality. Some of these objectives have been realized with the development of Comanche, Pawnee, and Wichita, the new varieties recently released.

Dean Call pointed out that there was still need for more improvement, and stressed such problems as: More winterhardiness, stiffer straw, high test weight combined with desirable milling and baking qualities. He also stressed the need of a better understanding between the agronomist, farmer, miller, and baker as to just what constitutes a desirable variety from the standpoint of quality. There is also a decided need for simplified methods of determining grain quality.

The meeting was then turned over to Dr. D. W. Robertson of Colorado, who was chairman of the session on Present Status of Agronomic Work.

PRESENT STATUS OF AGRONOMIC (BREEDING) WORK

Chairman; D. W. Robertson, Colorado

At this session each of the cooperators present gave a brief report on the progress of his work. Abstracts of the papers presented follow in the order given.

WHAT IS BEING DONE WITH SPECIES HYBRIDS IN TEXAS-- SOME NEW SYNTHETIC HEXAPLOID WHEATS

E. S. McFadden, College Station, Tex.

Through colchicine treatment of the F_1 hybrids, Dr. E. R. Sears and the author have produced twelve synthetic hexaploids involving tetraploid wheats and various species of Aegilops. Several other combinations are undergoing snythesis at present. One of the forms which involves Triticum dicoccoides and Aegilops squarrosa has all of the taxonomic characters of T. spelta, and produces completely fertile and cytologically regular F_1 hybrids with that species and with T. vulgare, indicating that Ae. squarrosa contributed the C genom of the cultivated hexaploid wheats. This information should make it possible to utilize Ae. squarrosa in transferring characters from tetraploid to hexaploid w heats by providing a means of avoiding the sterility usually encountered in direct crosses between these groups. Following addition of the Ae. squarrosa genom to the tetraploid carrying the desired character, the resulting synthetic hexaploid should yield highly fertile hybrids with the cultivated hexaploid, T. vulgare.

Several of the other synthetic hexaploid forms produced carry factors for resistance to several diseases and insect enemies of wheat as well as other factors of possible value. Hybrids between T. vulgare and some of these forms have been found to be at least partially fertile. This suggests a possible value of the synthetic forms as parental material in a wheat breeding program. A further suggestion is that it might be possible to produce a superior hexaploid wheat suitable for domestication in which the third genom would be derived w holly from diploid species of Aegilops other than Ae. squarrosa. The following synthetic hexaploid forms have been produced to date:

Triticum dicoccoides Koern. X Aegilops caudata L.
T. dicoccoides Koern. X Ae. sharonensis Eig.
T. dicoccoides Koern. X Ae. speltoides Tausch.
T. dicoccoides Koern. X Ae. umbellulata Zhuk.
T. dicoccoides Koern. X Ae. comosa Sibth. and Smith
T. dicoccoides Koern. X Ae. squarrosa L.
T. dicoccoides Koern. X Ae. uniaristata Vis.
T. persicum Vav. X Ae. sharonensis Eig.
T. dicoccum (Schrank) Schubl. var. Vernal X Ae. sharonensis Eig.
T. timopheevi Zhuk. X Ae. squarrosa L.
T. timopheevi Zhuk. X Ae. uniaristata Vis.
T. timopheevi Zhuk. X Ae. bicornis (Forsk.) Jaub. and Spach.

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THE PRESENT STATUS OF WHEAT IMPROVEMENT WORK IN NORTH TEXAS

I. M. Atkins, Denton, Tex.

With the distribution of Comanche, Wichita, and Westar wheats, one goal in wheat improvement work in Texas has been accomplished. Farmers in the hard wheat section of the State now have available satisfactory varieties of acceptable milling and baking characteristics. However, much remains to be done before disease-resistant adapted varieties are available for the entire State.

The breeding program in Texas has as its objective the transfer of disease resistance, and in some instances improved quality, to the adapted varieties and strains of hard red winter wheat. Breeding projects are centered at Denton and Amarillo, with smaller cooperative tests at Greenville, Iowa Park, Chillicothe, Spur, and Amarillo. As selections are developed in the breeding nursery, they are tested in a single plot uniform preliminary nursery grown at Denton, Chillicothe, and Amarillo. Very rapid elimination of strains is possible, based on observations of disease resistance and adaptation at these three points. Following these tests, strains are advanced rapidly to replicated nurseries at one or more points. From these they go into intra-state tests at five locations, from which they may be recommended for regional tests.

The most advanced material now being tested comes from crosses of Martin-Tenmarq (C.I. 11805), a high quality bunt-resistant strain, with the commercial varieties Kharkof, Tenmarq, Chiefkan, and Blackhull. Strains from these crosses are included in the advanced nursery or variety tests at four locations. Two are in the Uniform Yield Nursery and five others in the Uniform Bunt Nursery.

A second group of crosses involving rust-and smut-resistant parental material is now in advanced generations. This group includes crosses on the commercial varieties Kharkof, Tenmarq, Kawvale-Tenmarq, Chiefkan, Comanche, and other adapted strains in various combinations introducing the smut resistance of Martin-Tenmarq, Comanche, Hope-Mediterranean (loose smut) and the rust resistance of the Hope-Mediterranean strains. Selections from these crosses now make up most of the preliminary and advanced nurseries at Denton, Chillicothe, and Amarillo. Two strains are included in the plot tests.

A third group of crosses, now in the second to fourth generations, was planned in order to introduce rust and smut resistance from several sources into the newer varieties Comanche, Wichita, Westar, Pawnee, and Red Chief. These varieties have been crossed in various combinations with the rust-resistant strains of Hope-Mediterranean, Hope-Turkey, Marquillo-Oro, Kenya, and <u>Triticum timopheevi</u>. Bunt resistance is introduced from Comanche, Martin-Tenmarq, Hope-Turkey, Marquillo-Oro, and Oro-Turkey-Florence, and loose smut from Pawnee and Hope-Mediterranean. The possibilities in these crosses seem infinite.

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AGRONOMIC WORK WITH WINTER WHEAT IN SOUTHWESTERN OKLAHOMA

W. M. Osborn, Lawton, Okla.

At the Lawton station no breeding work is done, but an attempt is made to test in plots all new material that may have value for southwestern Oklahoma. In the area, Blackhull types, Tenmarq, Comanche, and Turkey are grown on farms. In the variety tests, dating back to 1922, 57 varieties have been grown, and from this work Tenmarq, Comanche, Pawnee, and Wichita have been shown to be adapted to the local conditions. These varieties are among the highest yielding ones at the station. Early-maturing types which carry disease resistance are needed. Lodging is often a factor so that stiffness of straw is desirable.

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AGRONOMIC WORK WITH WINTER WHEAT AT STILLWATER

C. B. Cross, Stillwater, Okla.

Mr. Cross reported on the plot and nursery experiments being carried at Stillwater. Uniform plot and nursery varieties are grown, as well as some early generation material. One of the chief objectives is to combine resistance to leaf and stem rust with high yield and quality.

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HIGH LIGHTS OF THE WHEAT WORK AT WOODWARD

V. C. Hubbard, Woodward, Okla.

Owing to shortage of time and labor, the cereal nursery at Woodward has been considerably reduced in size. However, it now covers about 6 acres, four in 1/51st-acre plots and the remainder in nursery material.

Plots

Rate and Date of Seeding on Fallow and on Cropped Land:

One variety of winter wheat seeded at three rates on each of four dates. One variety winter barley sown at four rates on each of four dates. One variety rye sown at three rates on each of three dates.

Variety test

Seventeen hard red winter wheat varieties and hybrids grown in quadruplicate, half on fallow and half on cropped land. Pure-seed increase plots involves one 264-foot drill strip (rows 14" apart) of each of about four varieties each year. A clipping and yield experiment involving duplicate plots of Pawnee and Cheyenne wheat, rye, and Ward barley so arranged that one set of duplicates are not clipped at all, whereas others are clipped at three dates in the spring.

Nursery Experiments

Nursery material is on fallow land and involves the uniform yield nursery in quadruplicated 3-rod row plots; twenty Woodward selections or varieties are grown in this set; an observation nursery in duplicated 3-rod row plots composed of 115, largely, Blackhull-Oro x Pawnee hybrids; a uniform and supplementary hard red winter wheat bunt nursery composed of 58 varieties and hybrids; and 1,712 head rows, largely Pawnee x Oro but some Oro x Blackhull-Hard Federation and rye x wheat hybrids.

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PROBLEMS OF VARIETAL PURITY

H. H. Laude, Manhattan, Kans.

The main objective of this discussion is to stimulate thought and suggestions for obtaining a higher degree of purity at the time a variety is ready to release to growers and maintaining higher purity in the seed stocks. Impurities are considered as coming from outside the plant by mechanical means, and from within the plant through inherent variations that stem from the origin or early history of the variety and through crossing which occurs during the process of testing or in the production of seed supplies.

To aid in solving the mechanical phase of the problem it is suggested that a trained engineer be added to the staff at certain of the experiment stations, whose responsibility it would be to cooperate and associate closely with the plant breeders and agronomists to ascertain exactly the objectives of the plant science worker and to observe the mechanical limitations. The design of appropriate and superior equipment for crop science would be the engineer's research project.

With respect to inherent variations, it may be noted that for five pairs of factors about 1/12 of the individuals in the F_6 generation are heterozygous for some of the factors. Cross fertilization and subsequent segregation also present a problem in maintaining varietal purity. In view of these conditions it should be assumed that every variety is at least slightly variable or impure. If the plants that deviate are as strong in competition and as productive in number of seeds as those of the variety type, it is evident that a deviation once introduced will remain in the constant proportion unless it is altered by roguing or selection. Cross fertilization between the true-variety type and off-type plants will increase the impurity, the rate depending upon the prevalence of crossing. Assume, for example, that an off-type plant furnishes pollen for two kernels on nearby plants of the true-type, and in turn the true-type furnishes pollen for one seed of the off-type. In a good field of wheat about 3,000 seeds of the true-type will be produced within a radius of 15 inches from the off-type plant which will produce about 40 seeds. If the variety is 99.99% pure the field will contain perhaps 75 off-type plants per acre; thus in the crop that is harvested there would be about 225 hybrid seeds which would amount to about three hybrid plants or 8 heads to each acre that is planted with that seed. If these hybrids should possess a character distinctly different from the true-variety type, the crop may not meet purity requirements for certification within 1 or 2 years.

Even though a variety were free from observable deviations it must not be overlooked that unobserved deviations possibly prevail. As noted by L. P. Reitz, a variety developed by present practices "may be called a pure line for certain observable or other characteristics which have been studied, but it may vary for many other characteristics." It is likely therefore that many varieties are far from 99.99 percent pure with respect to many characteristics, some of which probably are important. For example, a new variety might possess the gene composition in 10 percent of the plants for such characters as weak straw, cold susceptibility, or susceptibility to disease. This 10 percent would amount to about 75,000 plants per acre. If crossing should occur to produce three hybrids for each of these plants, as in the previous illustration, the following crop would have 7,500 hybrids per acre. The result would be an increase in the undesirable characteristics, not by the addition of only a few plants each year but by the addition of perhaps several thousand.

Roguing is an effective means of maintaining purity with respect to observable characteristics but the practice generally has no influence on the prevalence of plants whose deviation is in unobservable characteristics.

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BREEDING HARD RED WINTER WHEAT IN KANSAS

L. P. Reitz, Manhattan, Kans.

The breeding of new varieties in Kansas is accomplished in approximately the following manner. New crosses are made at Manhattan or Hays after joint consultation by entomology, pathology, and agronomy specialists in wheat. The F_1 to F_6 generations are grown in appropriate nurseries where selections can be made for desirable, resistant plants. Usually a hybrid population is rotated from one nursery to another until resistant selections of the better agronomic types are isolated. On occasion a hybrid is grown concurrently in two environments while at other times several epiphytotics are built up in one nursery, thus combining hazards against which resistance is desired. By F_4 or F_5 the more promising families are given preliminary yield and adaptation tests and may be tested for quality. Advanced nursery and plot tests follow when selections justify it.

Progress during the last seven years of breeding is indicated in the following classification of the entries grown in rod rows at Manhattan in 1937 and in 1944.

Character	Percentage in 1937	Percentage in 1944
Higher yield than Tenmarq	49	83
Higher test weight than Tenmarq	62	94
Less lodging than Tenmarq	54	80
Less leaf rust than Kawvale	22	43
Less stem rust than Kawvale	16	37
Less Hessian fly than Kawvale	0*	34*
Oro type bunt resistance	23*	15*

* based on reports from Departments of Entomology and Botany, K.S.C.

In 1937 there were no hybrids tested in rod rows involving either Hope or Marquillo, while in 1944 about one-fourth had Hope in their pedigree and one-third were from Marquillo. Resistance to bunt appeared in more strains tested in 1937, partly because selections from the cross from which Comanche came were at the peak of testing in rod rows at that time. The range in quality changed but little in this span of years, varying from Blackhull quality to that of Tenmarq.

The above tabulation is encouraging, yet no single variety or strain is available combining the good points desired. Selections not yet tested in rod rows, and not yet isolated, will have combined resistance to the hessian fly, to stem rust, leaf rust, septoria, loose smut, and bunt, and have gluten properties and agronomic characters equal to or better than Comanche or Pawnee. The highest type of resistance may not be secured in one step and new varieties may be released falling short in some respect but a coordinated effort toward the ideal will be maintained.

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EFFECT OF AWNS ON YIELD AND OTHER CHARACTERS IN HARD RED WINTER WHEAT

E. G. Heyne, Manhattan, Kans.

Chiefkan, a good-yielding, high test weight, awnless wheat, was used as one parent in crosses to the bearded varieties Tenmarq, Comanche, and Cheyenne. The study is divided into two sections. In one the segregating population is being studied, maintaining heterozygous material in which to select isogenic lines in each successive generation beginning with F_3. In each succeeding generation the awnless and bearded pairs selected are becoming more homozygous for all characters except awns. In the other part of the study, backcrossing to each parent is being carried on. In this case each succeeding backcross should become more like the recurrent parent with an awnless and bearded bulk made up from each backcross. Only preliminary data are available as the F_5 generation was grown in 1944.

Chiefkan has awn tips and this character was inherited as a simple dominant over the bearded types of the other three parents. The three bearded parents apparently have a similar genetic makeup for expression of awns. In the F_2 segregation, 710 bearded plants were observed and 2,110 awnless and heterozygous plants; the expected numbers are 705 and 2,115.

Number of culms, height of culms, and weight grain per plant in the F_2 generation did not differ between awnless, heterozygous, or bearded plants. The weight of grain per unit measure appears to be heaviest for the bearded plants.

In number and weight of kernels per head there probably was no difference between random head samples and sister pair samples.

Observed differences appeared to be that bearded segregates yield more grain, have a higher test weight, and a greater weight per 500 kernels. The latter characteristic is the most obvious and consistent difference.

Separating out the large seed from bulk populations by mechanical methods (Clipper mill) alters the expected genetic ratio. In screened bulk populations the bearded segregates increased and the awnless group (awnless and heterozygous types) decreased in number.

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PRESENT STATUS OF THE AGRONOMIC WORK WITH WINTER WHEAT AT COLBY

E. H. Coles, Colby, Kans.

At the Colby station the wheat work is made up of the following tests: Variety test with 18 to 20 varieties grown in triplicated 1/50-acre plots; Supplemental w inter hardiness nursery; Intra-State yield nursery; and a date of planting test in which duplicate plantings are made every 10 days from August 20 to November 10.

At present Comanche wheat seed is being increased for distribution to farmers.

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PRESENT STATUS OF WINTER WHEAT WORK AT THE FORT HAYS STATION

A. F. Swanson, Hays, Kans.

The winter wheat work at the Fort Hays Station is limited to the final testing of a group of progenies from crosses involving the parents Cheyenne, Early Blackhull, Blackhull, and Tenmarq. These crosses now are in the 11th or 12th generations and have shown good yields and high test weight. Quality studies are also carried on with these varieties.

Progenies from the cross Chiefkan x Oro-Tenmarq now in the 7th generation are being studied for yield, test weight, quality, and resistance to such diseases as mildew, leaf and stem rust, and smut. Lodging, shattering, and stiff straw are also noted. Other crosses under way in the F_2 generation are those of Chiefkan-Oro-Tenmarq x Marquillo-Oro and Early Blackhull Hybrid x Marquillo-Oro-Tenmarq.

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RESULTS ON WINTER WHEAT GROWN AT HIGH ALTITUDES ON FORT LEWIS SUBSTATION

Dwight Koonce, Fort Lewis, Colo.

The Fort Lewis Substation is located in the southwestern part of Colorado in what is knownas the San Juan Basin. Because of the high altitude (7,610 feet) the growing season is relatively short. The frost-free period is about 110 days. The temperature is not extremely high in summer nor very low in winter. The average yearly mean is about 43° F. The average annual precipitation is about 18 inches, 35 to 45 percent of which occurs in July, August, and September; while June is the driest month. A heavy snowfall usually covers the ground from December to April providing excellent winter protection and furnishing considerable spring moisture.

Diseases and insects are not a serious problem in this section. Rust has not caused any serious damage except on late spring wheat and most of the grain is treated for the control of smut.

Results at the station show that the optimum planting date is September 15. All planting should be done by October 1. The average date of maturity for winter wheat at the station is August 1. When harvesting is done by combining, the date of harvest is August 15 or later. Because of the short interval between harvesting and the optimum planting date and because of unfavorable moisture conditions some years, much of the winter wheat acreage is planted too late to become well established in the fall.

Due to the distribution of the precipitation and to the necessity for using irrigation water from stream flow, the moisture conditions on both irrigated and nonirrigated land are conducive to good vegatative growth rather than to grain yield. A good June rain, which seldom occurs or a late irrigation, for which there usually is no water, would materially increase yields.

Blackhull is the principal variety grown on nonirrigated land while Turkey Red, Kanred, and Tenmarq are the principal varieties grown on irrigated land. Results in the uniform nursery test show that Blackhull outyields Comanche, Wichita, and Pawnee. The yields compared with Pawnee-= 100% are Wichita 102%, Comanche 121%, and Blackhull 135%.

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WINTER WHEAT IMPROVEMENT IN NEBRASKA

O. J. Webster, Lincoln, Nebr.

The testing of the winter wheat varieties in Nebraska by the experiment stations and the Out-State-Testing Project is under a well-coordinated program. Testing is being done both in 1/40-acre plots and in nursery-size plots, 4 rows 10 feet long.

At Lincoln Pawnee excels all other varieties grown in plots. At North Platte its yield is unpredictable; one year it was nearly completely winter killed, but the following years it was one of the highest in yield. The average yield of Pawnee at North Platte for 6 years nearly equals that of Cheyenne. At Alliance, Cheyenne and Nebraska No. 60 have the best records.

The most promising selections in the nursery are Marquillo x Oro (Ks. 3464), Cheyenne x Turkey 1062 (N. P. 40410), Nebraska No. 60 x Mediterranean-Hope (366-26) and (366-93), and Cheyenne x Early Blackhull (C.I. 12122). None of these varieties have all of the characteristics of hardiness, resistance to bunt and the rusts, strength of straw, quality, etc. that are needed for a good Nebraska variety.

The breeding work is carried on at Lincoln, North Platte, and Alliance. Progress is being made towards a better adapted bunt-resistant variety from the selections made in the crosses Oro x (Oro x Turkey-Florence), Nebred x (Oro x Turkey-Florence), Oro x (Hussar-Hohenheimer), and Comanche x (Oro x Turkey-Florence). Races of bunt found in the State are being studied.

Winter hardiness is being studied in a freezing chamber as well as in the field. A high correlation has been found between the controlled freezing tests and the survival data taken in the field at several stations for several years.

Breeding for stem rust resistance is carried on in a nursery under artificial epidemics. The hybrid material in this nursery is usually grown in bulk, the rust-free plants being selected and the grain from these is rebulked. The present head rows include selections from Hope-Ridit x Nebred, Ceres x (Hope-Florence) x Turkey, Blackhull x Ceres-H44, (Ceres x Hope-Florence) x Nebred, Ceres-H44 x Cheyenne, and Ceres-H44 x Turkey. Backcrossing is being used to improve some of the resistant selections. At present only the resistant winter types are being used for breeding for stem rust resistance.

An effort is being made to improve the appearance of the threshed grain by using Blackhull types in crosses.

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BREEDING WINTER HARDY WHEATS FOR THE NORTHERN GREAT PLAINS AREA

E. R. Ausemus, St. Paul, Minn.

In the northern area there are three major problems in the development of better winter wheat varieties; (1) greater winterhardiness, (2) greater disease resistance, and (3) better baking quality. We have four wheats which are very winter hardy under our conditions, Minhardi, Minturki, Marmin, and Yogo, but these wheats are deficient in certain other characters.

New sources of wheats with either greater winterhardiness or containing other genetic factors controlling winterhardiness are continually being sought. Recently, wheats have been received from China and tested for winterhardiness under these severe conditions. Three of these varieties, Nanking 68, 221, and 239, have winter survival percentages of 63, 55, and 34 percent, respectively, while Minturki had 58 and Minhardi 49 percent during the years they were tested. Emphasis will be put on crossing these Chinese wheats with our disease-resistant winter wheats now being tested.

Because of the necessity of obtaining greater disease resistance and higher quality in our commercially grown winter wheat varieties, a backcross program of crossing Minturki and Marmin was started using H44 and Hope (two spring wheats) as non-recurring parents and the two winter wheats as the recurring parents. As many as four backcrosses have been made and from these strains have been obtained which are as winterhardy as the Minturki or Marmin parent, equal them in yield, are much more disease resistant, and have a better baking quality.

The plan of procedure except where backcrossing has been followed has been to grow the early generation material F_1 to F_5 by the pedigree method in the field since our conditions are ideal in most years for studies of winterhardiness. In the early generations, F_3 to F_5, 3 to 4 systematic replications are grown, spacing the seed so that individual plants can be harvested. Selections are based on the lines having the highest percentage of strong healthy plants.

Since cold resistance is so important in this area, varieties grown in the field plots and rod-row nursery trials are tested in the greenhouse and in controlled temperature chambers. Correlation coefficients were then calculated between the winter injury in the field and cold resistance as determined by freezing in cold chambers during the years 1933 to 1942. The number of pairs correlated varied from 27 to 139 during the various years and the coefficients obtained ranged from -.10 to +.34. Three of the coefficients were statistically significant at the 5 percent point, with an average coefficient of .14, significant at the 1 percent point.

Winterhardiness as determined in the field is due to a number of causes, principally, cold resistance, resistance to smothering, heaving and thawing, and drought conditions either in the spring or fall. These small correlation coefficients are probably due to the fact that lines grown in rod-rows and field plots are all highly cold resistant because they have been selected for cold resistance in the field.

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PROBLEMS IN BREEDING WINTER WHEAT FOR WINTERHARDINESS IN MONTANA

R. H. Bamberg, Bozeman, Mont.

Breeding for winterhardiness is being done in Montana for two rather distinct conditions: (1) Dwarf smut areas and (2) areas where dwarf smut is not yet a factor. Cache and Wasatch, two new dwarf smut resistant varieties developed in Utah, are being used successfully in the dwarf smut areas of the Flathead and Gallatin valleys, but these varieties are not sufficiently winterhardy for most other sections of the State.

In breeding for resistance to dwarf smut, selections from Martin x Tenmarq^3 and from Turkey (C.I. 11530) x Oro are being advanced as rapidly as possible. This material is already in yield nurseries. Selections from these crosses apparently are more winterhardy than Wasatch and Cache, but they may not be as hardy as Karmont and Yogo.

Resistance to dwarf smut probably will be needed in the most winterhardy varieties within a few years. In order to have winterhardy varieties resistant to this disease if it spreads to the more important winter wheat areas, Wasatch has been crossed and backcrossed to Yogo and two other very w interhardy wheats.

In breeding for winterhardiness and dwarf smut resistance, three conditions somewhat peculiar to Montana tend to delay advancement of the work:

1. Complete winterkilling in some years, making it impossible to select for winterhardiness and high-yielding ability or to obtain samples for quality tests.

2. Limited time between harvest and seeding, preventing a thorough review of results before seeding time.

3. Slowness of the trade, particularly the local buyers, to accept new winterhardy varieties.

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WINTER WHEAT BREEDING PROGRAM AT FORT COLLINS

D. W. Robertson, Fort Collins, Colo.

The chief effort to date has been to secure disease resistance, stiff straw, yield, and quality. Bunt resistance has been given the most emphasis. Recently, however, an effort has been made to include stem rust and leaf rus t resistance with other desirable characters. In 1944 a severe rust epidemic enabled us to select some desirable material which shows rust resistance and at least will provide parental stocks for further crossing.

Another problem which may or may not be serious is that of date of planting. Our recommendations have been made on data obtained from experiments with Kanred wheat. From preliminary studies it would seem that not all winter wheats react alike as to date of planting. Additional studies when conditions improve are contemplated.

Another problem has to do with seeding wheat in dry soil in the fall and which does not emerge until March, April, or early May. Considerable data on this subject are available for summarizing, when time permits.

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PROBLEMS PECULIAR TO IOWA IN THE IMPROVEMENT OF WINTER WHEAT VARIETIES

L. C. Burnett, Ames, Iowa

The wheat acreage in Iowa is very small. One-hundred and eighty thousand acres is the goal set for 1945. The winter wheat acreage reached its peak, 864,588 acres in 1919. The acreage averaged about 500,000 from 1912 to 1938. Since that time it has decreased rather steadily. Iowa is located in the region south of the spring wheat, east of the hard winter, and north of the soft winter areas. All of these areas have their boundaries within the limits of the State. Types and varieties grown come from all three areas to a limited extent but at least 90 percent of the acreage is sown to hard red winter varieties.

Winter hardiness is of particular interest to Iowa wheat growers since extreme and rapid changes in winter temperatures often destroy the less hardy varieties. Lodging resistance is more important than in most wheat-growing areas. The high nitrogen content of many Iowa soils, together with high rainfall during the spring-growing season, causes many varieties to grow rank and lodge, also wheat diseases cause greater damage than in areas that have a lower rainfall in May and June. They may be classed in five groups; (1) the rusts; (2) smuts; (3) leaf spots; (4) head blights; and (5) root blights.

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WINTER WHEAT WORK IN SOUTH DAKOTA

J. E. Grafius, Brookings, S. Dak.

The present winter wheat varieties used in South Dakota are Turkey, Nebred, and Yogo. There seems to be a need for more winter hardiness and more rust resistance. Bacterial blade blight and pythium root rot are minor problems in the State.

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SUMMARY OF THE REGIONAL REPORT FOR 1944

K. S. Quisenberry, Lincoln, Nebr.

The 1944 Regional report presents the 14th year's data from plot tests, and the 13th year's data from nursery tests. Since the program has been under way, five wheats have been thoroughly tested and released: Comanche, Pawnee, Wichita, Westar, and Austin. Much promising material is coming along and in many respects the program is just well under way.

In plot tests in 1944 early wheat had a decided advantage in both the southern and central districts. Stem rust was of little importance in the south, but it had an influence on yield farther north. Such varieties as Cheyenne x Tenmarq (C.I. 11972) and Wichita in the southern district; Wichita, Pawnee, and Cheyenne x Tenmarq (C.I. 11972) in the central district; Yogo and H44 x Minturki^2 (C.I. 12138) in the northern district have the best records at present. The blackhull wheats are still outstanding for test weight per bushel.

In the uniform yield nursery for the last 2 years, five strains have had average yields above Pawnee. Cheyenne x Early Blackhull (C.I. 12122) was outstanding for yield in 1944. The desired amount of stem rust resistance is still not available in any of the wheats.

Over the years 349 strains have been tested in plots for an average of 4 years each, with 17 strains having been tested for 14 years. In the uniform yield nursery, 106 strains have been tested on an average of 4 years, with 39 station years results being recorded for each. With the data available, it is possible to make certain studies such as correlations between yields of the varieties at various stations; relation between yield and date of heading, yield and leaf rust infection, and yield and stem rust infection. More of this work needs to be done in order to make it possible to more accurately set our sights for future work.

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MONDAY AFTERNOON, FEBRUARY 12, 1945

NEW METHODS AND TECHNIQUES
Chairman: J. Roy Quinby, Texas

TECHNIQUES AND PROGRESS IN BREEDING WHEAT

S. C. Salmon, Beltsville, Md.

It is doubtful whether any wheat breeder needs to be reminded of our indebtedness to improved techniques for the phenomenal progress made in breeding wheat during the past 30 or 40 years, nor of how desirable it is that these techniques be further improved at every opportunity. Perhaps it may be worth while to review very briefly some of the improvements that have been made. Many here will remember when a nursery of 500 or 1,000 rows was considered a large one. Today one of 20,000 rows causes no surprise. There may be better men these days but many of us prefer to attribute the difference to better and more efficient equipment and techniques. For one thing, we no longer depend exclusively on yield, partly because we know more about the relation of such factors as disease resistance, time of maturity, etc., to yield, and because we more clearly see that yield is not the only worthwhile objective. For these reasons many nursery rows are planted that are never harvested, with a very material saving in labor and expense and probably with little or no loss of useful information.

A corollary of this and an important reason why it can be done is the enormous advances that have been made in our understanding of and methods of determining resistance to disease and insect pests - for which we are mostly or wholly indebted to our associates in pathology and entomology; and in making rapid tests or observations of winterhardiness, lodging, shattering, quality, etc. By these various means, we are able to discard much undesirable material at the end of a season or in many cases after only a few weeks of growth instead of being compelled to wait for a "test" season which may not come along for 5 or even 10 years.

The use of greenhouses has made it possible to grow as many as three generations per year, thus shortening by 2 years the period required to reach the segregating generations. Recent development in breeding techniques such as the backcross method for certain problems, and the use of summer nurseries for determining rust resistance may be cited as examples of rather recent developments likely to play prominent roles in the future. Exchanges of breeding material, making use of the best locations for testing for special characteristics such as winterhardiness, and resistance to dwarf bunt are other examples of improvements in technique that seem especially related to and dependent upon a coordinated, cooperative program.

It is not possible to say which of these have been most valuable but certainly it can be stated without fear of contradiction that taken together they have increased the speed and effectiveness of the breeding program to an extent not dreamed of 40 years ago.

Many will remember when a typical variety test consisted of single 10th-acre plots of each variety. The smaller plots replicated three or more times now generally used are certainly an improvement. For this we are largely indebted to tools forged by the statistician which have enabled us to measure variation very accurately and have made us more conscious of its importance. Probably equal in importance is the greater care with which land is now chosen and prepared for experimental plots and our increasing knowledge of sources of error.

One cannot discuss field plot techniques these days without referring to modern designs or causing an audience to wonder why they are not mentioned. Since they will be discussed later on this program, little will be said about them here. It seems appropriate, however, to point out that the principal purpose of these designs is to assure a precise and accurate estimate or measure of random variation and that regardless of how well they do this, the plant breeder and agronomist are still faced with the necessity of evaluating all kinds of errors whether random or otherwise, some of which are not fully accounted for by any designs within practicable limits. Furthermore, some of the things we do or are urged to do in the interests of precise estimates of error actually increase the real errors in more ways than one. We cannot have both any more than we can eat our cake and have it too. Sooner or later we must decide which it will be or accept some reasonable compromise.

These remarks may be concluded by suggesting that though we should continue to look for better techniques, that the possibilities should be considered from a broad point of view. For example, it may well be that by improved methods we can reduce the number of plots by 10 or 20 percent or perhaps more for a given degree of accuracy. If, however, we can reduce the number of varieties or of segregates from crosses that should be grown in yield tests by 90 or 95 percent, we will do far better. This does not seem to be an idle dream. We have already gone a long way in that direction. In the spring wheat belt we no longer consider it worthwhile to determine the comparative yields of varieties that are not highly resistant to leaf and stem rust, or in the western United States those that are not highly resistant to bunt. Judging by action, breeders in the hard winter wheat area seldom consider it worthwhile to test varieties for yield that lodge as much as Turkey or those not as early as Turkey. The only reason that breeders in this area continue to test for yield some that are susceptible to rusts and bunt is because these diseases are less important. The question now is can we go farther in this general direction.

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THE USE OF NURSERY PLOTS VS. FIELD PLOTS FOR VARIETAL EVALUATION

I. M. Atkins, Denton, Tex.

In 1943 the method of advanced testing of varieties of small grain was changed, at most Texas stations, from 1/44-acre field plots of four replications to 4 row 10 foot nursery plots of eight replications in randomized blocks. A single drill plot is planted for demonstration and observation purposes and this may be harvested for seed or combine harvested for milling samples as needed. This change was prompted largely because of limitations of labor, equipment, and personnel to handle the more extensive tests.

In practice the method of using nursery plots for varietal evaluation has been found to have several advantages over the field plot method. These are:

1. By using nursery plots, an increased number of strains can be tested. This permits the testing of many new strains in comparison with commercial and check varieties on a more extensive basis than would be possible in field plots. This is also an important consideration on outlying field stations where no small grain experimental equipment is available. Tests on these field stations can be expanded to include many new strains, and these tests can be handled easily from the central station.

2. Because of the small amount of seed required for seeding the nursery tests, promising new strains can be advanced to varietal trials 1 year sooner, and often to Intra-State tests 2 years sooner than would be possible if field plots were used.

3. It enables one person to more closely supervise all operations concerned with the experimental tests than was formerly possible. There is some reduction in the amount of labor required to handle the tests and by threshing all material on the nursery thresher, there are fewer mixtures which in turn reduces the amount of effort necessary to keep strains pure.

4. From the standpoint of experimental methods, the experimental area is greatly reduced with accompanying reduction in soil heterogeneity, moisture variation, etc. Yields may be quickly and easily calculated by the methods usually employed for nursery plots. Standard errors to date by this method compared favorable with previous seasons when plots were used and with other stations growing uniform tests.

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FIELD VS. NURSERY PLOTS FOR VARIETAL EVALUATION

H. H. Laude, Manhattan, Kans.

In comparing these two methods, consideration should be given to labor involved in harvesting and planting, land requirements, grain supplies, seed supplies, and the accuracy and refinement of experimental data. Combine harvesting and threshing field plots have required about 13 man minutes per plot. The labor required to harvest, move to the threshing room, and thresh nursery samples is estimated at 9.8 man minutes per plot. The labor involved in planting field plots is estimated at about 14 man minutes per plot. The time for planting nursery plots is estimated at 2.5 man minutes per rod row. A 50th-acre plot with roadway occupies about 65 times as much land as a single rod row with an alley at the end. The larger area of land in the field plot yield experiments produces grain sufficient for fairly extensive milling and baking investigations, whereas the amount of grain available from nursery experiments permits only limited quality studies. It is ordinarily not feasible to harvest supplies of pure seed with the combine from variety yield field plots. A separate series for the production of seed is preferable. Variability of variety yield, as derived from variety-block interaction, is perhaps the best basis for consideration of the dependability of mean yields and of significance of difference between mean yields of varieties.

In reports issued by K. S. Quisenberry from 1932 to 1944, it is shown that both variety field tests and the uniform yield nursery were conducted concurrently 98 times on experiment stations in the hard wheat region. The average of the standard deviations for the 98 station tests was 2.64 bushels for field plots and 3.88 bushels for nursery plots. The corresponding least significant differences between mean annual variety yields were 3.93 bushels for field plots and 5.64 bushels for nursery plots. In order to get the same degree of refinement as is now attained in the field plot tests and to permit distinguishing equally well between varieties with respect to yield, it appears that several more replicates must be included in the nursery tests than is the present practice. The field plot experiments, as now conducted, average 3.8 replicates. Comparable refinement in nursery yield data would require 9.2 replications of the nursery test. Considering the labor involved in planting, harvesting and threshing yield experiments, it appears that 4 replicates of field plots would require about 108 man minutes and 10 replicates of nursery plots in which 3 rod rows are planted and the middle one is harvested, would require about 173 man minutes for a variety.

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USE OF NEW EXPERIMENTAL DESIGNS

E. G. Heyne, Manhattan, Kans.

Triple lattice and lattice square designs were used in testing oat varieties. Both methods make adjustments for yield. The triple lattice may have special merit under certain conditions. Both designs require handling many figures and without proper statistical equipment the calculations are quite tedious. In 3 years of use of these designs it was concluded that very little or nothing was contributed toward the selection or discard of strains or in isolating superior varieties. The conclusions arrived at after studying these designs as applied to rod-row testing of oat varieties is as follows: (1) Estimates of error are valuable. (2) Adjustments of yields are questionable for at best, yields before adjusting are only estimates. (3) Lattice designs do not contribute enough to practical results to repay for the extra time necessary for their use. (4) A few refined tests are not substitutes for less accurate tests in many locations and several seasons. (5) More research should be done on methods of plant breeding. (6) Experimental methods of plot technique and rod-row test should be further investigated. (7) Statistics applied to crop research should be used only as a guide or aid in making decisions and not as a solution to the problem.

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MACHINES FOR HARVESTING NURSERY ROWS

V. C. Hubbard, Woodward, Okla.

Problems encountered in harvesting cereal nursery material with a hand sickle in four states over a period of 15 years brought about the construction of a small harvester that could be pulled and a sickle actuated by a hand lever.

The machine, illustrated and described in the January 1941 issue of the Journal of the American Society of Agronomy, was used at Woodward over a 3-year period and proved to be quite an advantage over a hand sickle; however, in 1943 a Jari power mower, with a 30" sickle, was purchased at Woodward for mowing out plot alleys. This mower equipped with a 14" sickle bar and mower assembly is being used for all nursery harvesting of wheat, oats, barley, flax, and safflower. A cradle of 1/4" round rods was designed to fit over the machine to catch the stalks of grain. Three boys are required to operate it efficiently, one to drive the machine, as the other two alternate, pushing the grain by hand into the cradle and tying the bundles. Danger of varietal mixture with the slatted cradle device is very slight.

Harvesting with a Jari power is appreciably faster than with a hand sickle and varies according to how fast the helper can walk down the row "reeling" grain into the cradle. The speed of the machine is easily regulated by a hand throttle. The length of the Jari mower is such that at least a 4-foot alley is needed for turning.

Perhaps the chief objection to this mower is the hazzard of a continuously running sickle requiring constant vigilance on the part of the workers.

After cutting and tying the heads of the bundles, they are covered with a number 20 paper bag. Then the replicates of each variety are tied together prior to storing in the loft of a work barn until they can be threshed in routine fashion.

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A NURSERY-ROW SMALL GRAIN HARVESTER USED IN NEBRASKA OUTSTATE TESTS

G. T. Webster, Lincoln, Nebr.

In 1944, the outstate small grain, soybean, and sorghum variety tests in Nebraska were harvested with a specially adapted power mower. The mower which was used was manufactured by the Jari Products, Inc., Minneapolis 8, Minn., retailing at $160.00 F.O.B. Minneapolis. It is operated by a 1 h.p. 4-cycle air cooled engine which drives a 36-inch sickle mounted in front of the machine.

For harvesting small grain nursery rows, metal hoppers were mounted on both sides of the mower behind a 24-inch sickle. Two men are required, one to operate the mower and one to "reel in" the grain with a lath. In tall grain the "reel" is needed only at the ends of each plot. Shorter grain requires traveling at slower speed and constant use of the "reel."

In harvesting 3-row plots, it was necessary to start from one side of the fields, alternately removing two border rows, then harvesting one yield row. The harvester was most efficient in 4-row plots since both center rows could be harvested at one time and removal of the border rows was not necessary.

No check was made to determine the difference in time required in harvesting with this machine in comparison with hand harvesting. Most of those who used the machine were of the opinion that it was much faster. There is no doubt that harvesting is accomplished with much less effort.

Considerable time was also saved by the use of this machine in cutting out alleys, and trimming the ends of plots. Since the harvested small grain material was shipped in for threshing, this machine was found to be useful in trimming the butts of bundles to reduce the volume.

The chief objection to the use of the Jari mower for this purpose is the danger involved, since the sickle is driven directly from the engine, and cannot be stopped without shutting off the engine. This can be corrected by mounting a simple clutch consisting of a belt tightener on the main drive belt.

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SELF-CLEANING ALL-METAL NURSERY THRESHER FOR SMALL SAMPLES

L. P. Reitz, Manhattan, Kans.

Several all-metal nursery threshers have been in use in Kansas for several years and have given satisfactory results. This model was designed by June Roberts, Department of Agricultural Engineering, Kansas State College, and built in the shops of the Department of Agricultural Engineering. The machine is capable of handling bundles of wheat up to about 2 inches in diameter and individual plants may be threshed at a rapid rate. The machine is driven by a one-fourth horsepower electric motor, and by means of block V-type pulleys, a variable speed is obtained from 800 to 4,000 R.P.M. The cost of our machine was about $50. Complete details concerning the construction of this machine were published in Agricultural Engineering 22:14, 32, 1941. Information may also be secured by writing to F. C. Fenton, Head, Department of Agricultural Engineering, Kansas State College.

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V-BELT NURSERY PLANTERS

E. R. Ausemus, St. Paul, Minn.

Various types of planters have been used for planting small grain nurseries. The old Columbia was perhaps the one most commonly used during the earlier years. This was a hopper type of planter and required changing of discs for different types and sizes of seed. In 1936, a type of planter known as the V-belt nursery planter was introduced by Mr. H. J. Kemp of Swift Current, Saskatchewan. In the meantime, L. C. Burnett of Iowa made a seed dropper adapted from the chain-drive model of the Columbia planter. This planter consisted of a belt operating in the bottom of a trough, with an adjustable gate that could be set for various row lengths.

The V-belt planter did an excellent job of planting but it was too heavy to handle in the field. This V-belt was then adapted to the chain drive model of the Columbia planter at a cost, before the war, of about $35.00. The speed of the belt can be adjusted for seeding different lengths of rows by changing the sprockets on the chain drive. The planter has a detachable wind guard for seeding during higher wind velocities when it is almost impossible to seed by hand.

The seed must be packeted for each row. For special breeding work, where it is necessary to space seed singly at certain distances apart, it is essential that the seed be spaced uniformly on the belt. The shape of the V-belt aids considerably in getting the seeds arranged and a slight vibration given the belt will often assist in shaking the seeds in a single line on the belt. Preliminary trials will indicate the best settling of the planter.

Care must be used in operating the planter to have the seed distributed evenly on the belt, that seeding starts at the proper place in the row, and that the entire row is seeded. Two experienced operators can seed 100 to 150 rows per hour of wheat, barley, oats or flax. A 4-foot alley may be more convenient because of the lag of the planter in starting to seed. After the grain has emerged, guide strings are stretched and the alleys are cleaned with a wheel hoe.

This V-belt planter is easily cleaned, is light to operate, does not require the opening of furrows, gives uniform distribution of seed and depth of planting and puts all the seed down in moist soil.

Another type of planter is a modification of the Planet Junior planter by Mr. Moore of Minnesota. This machine has a flat belt operating at the bottom of a trough and is as satisfactory as the V-belt planter for bulk planting of rod rows. It is somewhat less desirable than the V-belt planter for space planting because the seed cannot be lain directly on the belt.

The funnel type of drill is preferred by some workers. This machine is operated by two men, one dropping the seed in the funnel while the other pushes the planter. It is very light and easy to handle.

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THE DISK-TYPE FOUR ROW SEEDER

J. E. Grafius, Brookings, S. Dak.

The use of the disk-type four row seeder was discussed. The advantages and disadvantages of the present set-up were mentioned and some possibilities for improvement were given. Some 2' x 2" slides were shown.

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TUESDAY MORNING, FEBRUARY 13

PRESENT STATUS OF INSECT AND DISEASE RESISTANCE WORK
Chairman: L. P. Reitz, Kansas

Resistance to Insects

SOURCES OF RESISTANCE TO THE HESSIAN FLY

Elmer T. Jones, Manhattan, Kans.

In 11 years of field tests in Kansas and Missouri, several thousand, virtually all available, varieties and strains of wheat have been tested for fall and spring infestations of hessian fly, in both the hard and soft wheat-growing sections.

Most of these varieties and strains were supplied for the Kansas-Missouri tests from the files of the Bureau of Plant Industry, Soils, & Agricultural Engineering through the cooperation of B. B. Bayles of the Division of Cereal Crops and Diseases. Many disease-resistant and otherwise desirable selections and varieties were supplied from time to time by our cooperators and various State Experiment Stations. The varieties were classified into four levels of resistance corresponding to certain varieties: (1) Kawvale, semi-resistance, useful only in the hard wheat region; (2) Marquillo, moderate resistance, practical throughout the border area of the hard and soft winter wheat regions; (3) Illinois No. 1 W38, high resistance, and (4) Durum P.I. 94587, extreme resistance types. Varieties included in 1 and 2 with minor exceptions are red wheats. Types 3 and 4 contain many w hite-seeded varieties.

A list of 95 varieties representing possible sources of breeding material was presented. All other varieties tested are considered of doubtful value as sources of resistance. High temperatures, abundant moisture and insufficient light during the growth of the plant preceding and during development of infestation and other factors are believed to cause a breakdown of the fly resistance of many varieties. The resistance of some of the common spring and durum wheats, apparently immune to fall infestation in the rosette stage of growth, breaks down completely when the plants are infested in the spring at a critical period during jointing and elongation of the stems.

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BREEDING FOR RESISTANCE TO HESSIAN FLY IN HARD RED WINTER WHEAT

Reginald H. Painter, Manhattan, Kans.

A study of hessian fly resistance in wheat was begun at Kansas State College in 1916 by Professors McCollouch and Salmon. A formal cooperative project for the purpose of breeding for insect resistance in crop plants was begun in 1926. The cooperating agencies were the Departments of Entomology and Agronomy, Kansas State College. These departments were joined in this project by the Bureau of Entomology, U. S. D. A., in 1934.

Pawnee wheat (Kawvale x Tenmarq) is the first commercial wheat derived in part from this breeding program. Pawnee is characterized so far as fly resistance is concerned by having about half as many plants infested as Tenmarq. This difference in infestation occurs only in the hard wheat belt, and the difference between Pawnee and other hard red winter wheats generally increases toward the north and west. In addition, Pawnee has considerable tolerance to infestation by fly. On the basis of present data, it appears that while fields of other varieties of wheat are frequently abandoned because of fly infestation, this is unlikely to occur in the case of Pawnee. On the other hand, better sources of resistance to hessian fly are now known. There is also considerable probability of an increase in that part of the hessian fly population which is able to survive on Pawnee.

Levels of fly resistance, which are often indistinguishable under normal field conditions, may sometimes be separated by infesting spring-planted winter wheats or by infesting such plants heavily under warm greenhouse conditions. In addition, under field conditions, resistance derived from Marquillo has behaved as a recessive in F_1, while that derived from other spring wheats has behaved as a dominant.

The resistance of Marquillo to hessian fly of both the hard and soft wheat areas was discovered in the fall of 1931 and first crosses made in the spring of 1932. Hybrid selections derived from these crosses were of sufficient promise to be grown in plots in Manhattan but were deficient in winterhardiness and not resistant to loose smut. However, the results gathered gave evidence of a yield equal to or better than current commercial wheats and satisfactory milling and baking quality.

The simple Marquillo hybrids were first crossed back to winter wheats in 1935. These earlier compound Marquillo hybrids have often been outstanding in seedling resistance to leaf rust as well as resistance to fly. They may prove useful as pasture wheats as well as having apparently good yielding ability and satisfactory quality. These are now being tested in yield trials. Later compound Marquillo hybrids may prove to have even better combinations of fly and disease resistance.

Hessian fly resistance from several other spring wheat sources has now been transferred to the best winter wheat hybrids. Such hybrids are now available for use as parental material and some crosses involving them have already been made. Under severe infestations and greenhouse tests some of these hybrids have shown a much higher level of resistance to hessian fly than do the Marquillo hybrids.

Plans for future work include: (1) The combination of the highest type fly resistance with disease resistance, especially stem rust resistance derived from Hope, into a commercial wheat of high test weight and good quality. (2) Attempts will be made to combine if possible different genes for fly resistance into one hybrid. (3) A survey of fly resistant strains derived from foreign plant introductions in a search for new genes for fly resistance and other useful characters which might aid in the breeding program.

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OBSERVATIONS ON RESISTANCE TO GREEN BUGS IN CEREAL CROPS

I. M. Atkins, Denton, Tex.

The green bug (Toxoptera graminum Rond.) has been a pest of small grain in the Great Plains area since 1890, causing important losses in a number of seasons. The most destructive outbreak was in 1942 when the loss was estimated at 62 million bushels of grain.

Resistance to aphid attack has been observed in cantaloupes, corn, peas, prunes, and strawberries. In 1942 a large number of barley varieties from world-wide sources were growing at Denton, Tex., and Lawton, Okla., in the center of the green-bug area, and offered a favorable situation for observation of varietal resistance in barley. Observations on reaction of wheat and oat varieties also made at several points but the material available was of more localized origin. In the Denton area of North Texas, the insect attack started in the fall and increased throughout the w inter, finally destroying nearly all grain. At Chillicothe, Tex. and Lawton, Okla., the infestation resulted to a large extent from migration which started in February and was brought under control by natural enemies about April 1. The attack was less severe and some fields of grain survived to produce a partial crop.

At Denton and Lawton from over 200 varieties of barley under observation, approximately 15 were found that showed high resistance to green-bug attack. These strains survived to produce a good crop when all surrounding strains were either killed or severely damaged. Most of the resistant varieties had their origin in China or Chosen (Korea). American varieties that showed resistance were, in all instances, the result of crosses on these Chinese barleys, indicating that the insect resistance can be transferred by hybridization.

Observations on wheat varieties at Denton and Chillicothe and at Lawton were in general agreement and indicated definite differences in varietal reaction, although the resistance was not as high as was observed in barley. Relatively good resistance was observed in Marquillo-Oro strains with moderate resistance in Mediterranean strains and their hybrids, and in Blackhull strains and their crosses. A few strains introduced from China and Russia were resistant, although some of their resistance may have been due to earliness. Commercial plantings added evidence to experimental field observations as some fields of Mediterranean survived in North Texas and many fields of Early Blackhull survived in the Rolling Plains area. The survival of Early Blackhull may have been due in part to earliness and stage of growth at the time of the migration.

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R. H. BAMBERG. The sawfly is a serious problem in the Canadian spring wheat area extending into Montana and North Dakota. Damage is caused by the cutting off of the culm above the ground just prior to harvest. In 1944 thousands of acres of Canadian wheat were damaged 90 percent or more, and 30 percent damage was reported on 500,000 acres in Montana and North Dakota. Solid stem wheats are resistant and considerable work is being done primarily by the Canadians in breeding for resistance.

A. W. ERICKSON. The sawfly is down as far as the North-South Dakota line. Fields damaged by the insect offer difficulties for adjusting for hail loss.

B. B. BAYLES. Sawfly has been found in Pennsylvania and Ohio. The first damage was serious but apparently parasites have reduced the insects.

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PROGRESS IN BREEDING FOR RUST RESISTANCE IN WHEAT

C. O. Johnston, Manhattan, Kans.

Breeding for rust resistance in hard red winter wheat is under way at most of the state agricultural experiment stations in the hard red winter wheat area. The most extensive programs are in progress at Denton, Tex., Manhattan, Kans., and Lincoln, Nebr. At all of the stations combined resistance to leaf rust and stem rust, and in many crosses, to bunt, loose smut, and hessian fly is sought. The combination of so many characters requires the study of large numbers of crosses. At Manhattan alone nearly 100 crosses are under study, necessitating the growing of a rust nursery of about 3,500 rows each year.

The crosses in pedigreed lines under study at Manhattan vary from F_1 through F_6. Nearly all crosses now are compound, many of them involving three to five varieties in the parentage. The most promising crosses are those in which rust-resistant selections of simple crosses, such as Mediterranean x Hope, Hope x Turkey, Hope x Cheyenne, Marquillo x Oro, and Kawvale x Marquillo, have been combined with good hard red winter wheats such as Tenmarq, Comanche, Pawnee, Nebred, and Oro. Large numbers of strains having combined resistance to leaf and stem rust have been selected and the best selection in advanced generations now are being studied in yield tests. Some appear promising. For example, two selections of the cross Mediterranean-Hope x Pawnee had the highest yield in the rod row tests at Manhattan in 1944.

Many winter x spring crosses also are being studied. These involve not only rust resistant hard red spring wheats such as Renown, McMurachy's, and Premier but foreign springs such as Kenya Sel. R.L. 1373 from East Africa, Eureka and Sinvalocho from Argentina and Bobin-Gaza-Bobin from Australia. In tests at Manhattan most of the crosses involving spring wheats have been disappointing both in rust resistance and agronomic characters.

Several crosses involving selections of the Wisconsin backcrosses Triticum vulgare x T. timopheevi x T. vulgare as well as Kansas backcrosses of Marquillo-Oro x T. timopheevi x T. vulgare are being studied. Most of the selections are late maturing, extremely leafy, and weak strawed, and many stem-rust resistant selections have brown necrosis.

Seedling resistance to leaf rust is becoming more important as the farmers make greater use of winter wheat for pasture and change to earlier sowing. Tests with known races in the greenhouse and natural infection in the field have shown that many selections with mature plant resistance also have seedling resistance.

Physiologic races 9, 15, 44, and 126 of leaf rust and races 56, 17, and 38 of stem rust are the most important ones in the hard red winter wheat area. Hybrid material should receive thorough tests with those races. All of them are used in producing an artificial epiphytotic in the Manhattan rust nursery. The leaf rust races 15 and 126 seem to be increasing and to be at least partially responsible for heavier infections on resistant varieties in 1944.

Brown necrosis still is a problem in selecting stem-rust resistant strains from crosses involving Hope and H44. However, selections with satisfactory resistance having little brown necrosis have been made and seem to be stable. The development of light or moderate amounts of color seem to have little effect on yield.

There still is need for a barrier of resistant wheats for southern and central Texas to reduce overwintering and to delay and dissipate the northward movement of rust in the spring.

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BREEDING WHEAT FOR DISEASE RESISTANCE IN OKLAHOMA

K. Starr Chester, Stillwater, Okla.

A principal objective of the Oklahoma wheat breeding program, in which departments of plant pathology and agronomy cooperate, is an attempt to combine resistance to leaf rust, the most destructive disease of this area, with desirable agronomic characters.

Of 700 selections from segregating hybrid lines received from the Woodward, Okla. station, the best 10, now in F_6 to F_8 generations, are being increased, each in 500 head rows, in 1944-1945. These are compound crosses involving Oro, Tenmarq, Hope, Cheyenne, Hussar, Mediterranean, Nebred, Kanred, Kawvale, and H-44 as parents. All 10 show a high degree of resistance to leaf and stem rusts and have been selected on the basis of yields, earliness, good stooling, stiff straw, resistance to shattering, grain quality, and pearling and dough-ball tests. They will be tested for milling and baking qualities and distributed for competitive tests in other parts of the winter wheat area in 1945.

Rust reactions have been controlled by the use of cultures of all physiologic races of rust prevalent in Oklahoma, in the greenhouse and in field epiphytotics. One line appears to be practically immune to both rusts; it has been hybridized with the common commercial wheats of the Southwest.

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NEW SOURCES OF RUST RESISTANCE IN WHEAT

E. S. McFadden, College Station, Tex.

In the past 8 years, approximately 2,000 foreign introductions of wheat have been put through field tests for reaction to stem rust and leaf rust at College Station, Tex. Out of this number, 43 varieties of *Triticum vulgare* have been found which show various degrees of resistance to stem rust. Some of these are also resistant to leaf rust. All of the wheat-growing continents of the world are represented by these resistant varieties. Several distinct types of resistance to stem rust are clearly recognizable in these wheats, which suggests that many different factors may be involved. The possible utilization of the various factors in breeding for resistance to different environmental conditions is suggested; also the possibility of combining the different factors to give resistance over a wide range of conditions.

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STEM RUST RACES IN NEBRASKA

M. E. Yount, Lincoln, Nebr.

This discussion presented a picture of the prevalence, distribution, and changes that have taken place in the wheat race complex of stem rust in Nebraska during the period of 1924-1944, inclusive.

The once-prevalent races such as 3, 10, 11, 18, 21, 32, 36, 39, and 49 have, for all practical purposes, disappeared from the State, the dominant races now consisting of races 56, 38, and 17. The average number of races occurring annually has declined approximately 31 percent, the decline taking place simultaneously with approximately a 62 percent increase in the number of isolations identified.

A point even more encouraging is the fact that only two or three races have appeared in more than trace amounts during recent years.

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BREEDING RUST RESISTANT WINTER WHEATS FOR THE NORTHERN GREAT PLAINS AREA

E. R. Ausemus, St. Paul, Minn.

Breeding rust resistant winter wheats is one of the important phases of the winter wheat improvement program. Minturki and Marmin, the two commonly grown winter wheats, are somewhat resistant to stem rust but susceptible to leaf rust. Since H44 and Hope (two spring wheats) have been resistant not only to leaf and stem rust but to loose and covered smut, crosses were made between these two wheats and the commercially grown Minturki and Marmin varieties. The backcross method has been used, with Marmin and Minturki as the recurring parents. Four backcrosses have been made. Lines are now being tested in the rod-rows and 1/40-acre plots from the second, third, and fourth backcrosses. A large number of the backcross lines have been tested in rod-row trials and 1/40-acre plots which have only a trace of stem rust as compared with 50 to 70 percent on Minturki and 70-85 percent on Minhardi. In leaf rust resistance, the hybrid lines averaged from a trace to 14 percent, while Minturki had 41 percent and Minhardi 62 percent.

An H44 x Minhardi selection N.S.No. II-26-29 which was resistant to both rusts has been used also to cross with other winter hardy wheats lacking rust resistance. Hybrid lines, grown in rod-row trials, have shown a high degree of leaf and stem rust resistance.

From these two types of crosses, it has been possible to obtain a number of lines which appear to be as winterhardy as Minturki and Minhardi and are much more resistant to leaf and stem rust, yield higher, and are better in baking qualities.

Hope was found susceptible to stem rust in Peru, and, in general, the mature plant type of resistance is not a satisfactory means of controlling stem rust in Chile. In controlled experimental tests, where environmental conditions have been favorable to the infection with stem rust, considerable infection has been obtained on several highly resistant wheats.

Certain spring wheats, such as some of the Kenyas, McMurachy, Kenya Gular, T. timopheevi-Steinwedel and Red Egyptian, have been found to be resistant to a large number of races in the seedling stage as shown in Table 1.

Table 1. Seedling reaction in greenhouse tests of certain spring wheat varieties to physiologic races of stem rust.

Variety	No. of races Resist.	No. of races Susc.	Total races tested
Hope	17	11	28
Thatcher	13	17	30
Kenya Gular	30	2	32
T. timopheevi-Steinwedel	27	1	28
Kenya, Minn. 2693	35	2	37
Kenya, Minn. 2694	34	3	37
Kenya, Minn. 2695	32	5	37
Kenya, Minn. 2696	32	5	37
Kenya, Minn. 2697	26	9	35
McMurachy	31	4	35
Red Egyptian	26	3	29

With the finding of the newer sources of seedling resistance in the Kenyas, McMurachy, Kenya Gular, T. timopheevi-Steinwedel and Red Egyptian, it seems desirable now to combine these with the mature plant type of resistance carried by our present winter wheat varieties. Crosses are now being made between our present winter wheats and these wheats so that physiologic resistance to all races may eventually be transferred to winter wheats.

The discovery of a biotype of race 15, called 15B presents another problem. This biotype is differentiated by Rival being resistant in the seedling stage to race 15 and susceptible both in the seedling and mature plant stage to race 15B. Hope, Thatcher, some of the Kenyas and _T. timopheevi_-Steinwedel, and our present winter wheats are susceptible to race 15B both in the seedling and mature plant stage under controlled experimental conditions. Two Kenya wheats, K58 and 117A, are highly resistant to race 15B and Red Egyptian is moderately resistant. Crosses are now being made between these three wheats resistant to race 15B and some of the better Hope or H44 x Minturki backcross strains.

Another important problem is leaf rust resistance. Our present commercially grown winter wheats are susceptible to leaf rust and the Hope or H44 x Minturki strains as well as most of the spring wheats having the Hope type of leaf rust resistance were severely attacked by leaf rust in 1944; the winter wheats less than the spring wheats probably because they matured earlier. According to present information, it seems necessary to use several varieties to combine resistance to the various races in a single variety as none were highly resistant last year. There is, however, a difference in their reaction to individual races now prevalent. Three varieties, _T. timopheevi_-Steinwedel S990, Brevit, and Carina, each carrying resistance to certain leaf rust races, are now being crossed in an attempt to combine in a single variety resistance to a number of races. This resistance will then be transferred to the winter wheats.

Our present viewpoint is to add particular types of resistance in the seedling stages to the seedling and mature plant resistances now carried by commercially important winter wheat varieties. The aim is to retain resistances to rust now available and incorporate resistances to new races whenever possible. The backcross method will be used extensively. In this manner it appears possible to solve new problems soon after they become known.

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BREEDING FOR RESISTANCE TO BUNT

R. H. Bamberg, Bozeman, Mont.

Breeding for resistance to bunt has occupied the attention of wheat breeders for a number of years. In this country the work was pioneered by Gaines at Pullman, Wash.

At the present time, there are two lines of attack--breeding for resistance to dwarf smut and to the races of ordinary smut. In the areas where dwarf smut is severe, it overshadows ordinary bunt because of its destructiveness and the complete lack of control methods other than resistant varieties.

The basis of almost all the discussion on the reaction of individual varieties to the races of _Tilletia caries_ and _T. foetida_ (_T. tritici_ and _T. levis_, respectively) is the work of Drs. Rodenhiser and Holton.[1]

1/ Rodenhiser, H. A., and Holton, C. S. Distribution of Races of _Tilletia caries_ and _T. foetida_ and Their Relative Virulence on Certain Varieties and Selections of Wheat. Phytopathology [In manuscript] 1945.

Of the hard red winter group, four varieties are resistant to all races. These are Oro x Turkey-Florence (C.I. 11865), Rex x Oro (C.I. 12421), Rex x Rio (C.I. 12234), and Rio x Rex (C.I. 12422). H44 x Minturki (C.I. 12414) is resistant to all except the two new races of T. tritici T-15 and T-16 identified from Idaho and West Virginia, respectively. This variety is intermediate in reaction to these.

In most selections from crosses of winter wheats with Hope and H44, the resistance of Hope as a spring wheat is not retained. Hope is resistant to all races of bunt when seeded in the spring but is completely susceptible to a number of races when seeded in the fall.

Comanche is very susceptible to race L-8 which is prevalent in Colorado and in Montana. It is intermediate in reaction to L-1 and T-16. L-1 occurs in Minnesota, Missouri, and Wyoming.

Pawnee is susceptible to T-2, T-6, T-8, T-13 and L-7 and L-8 and partially susceptible to a number of races. T-2 and T-6 occur in the Northern Plains states and L-7 and L-9 in the Central Plains states.

Among the hard red spring wheats there are five varieties resistant to all races: namely, Hope, Komar x Hussar (C.I. 11715), Regent x Pilot (C.I. 12317), Reliance-1018 x Mercury (C.I. 12204), and Renown.

Triticum timopheevi is another source of resistance, as it appears to be immune to all races. Fertile selections from crosses with Timopheevi seem difficult to obtain, but Dr. Shands at Wisconsin has a number of wheats now from this cross which are highly self-fertile. Several selections have been tested to all races or a large number of races, but all those tested have been found rather susceptible to some races. All of the 26 tested by the writer for reaction to dwarf smut seem completely susceptible.

In breeding for resistance to dwarf bunt the Ridit, Hussar, and Martin factors are fairly effective in controlling resistance to this type. Several fairly successful varieties have been produced which are sufficiently resistant to hold losses rather low. Relief (Hussar x Turkey), Cache (Ridit x Utah Kanred), Hymar (Hybrid 128 x Martin), and Wasatch (Ridit x Relief) are commercially grown. Wasatch is the most resistant of these to dwarf bunt. Turkey (C.I. 11530) is also very resistant.

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RESISTANCE OF WINTER WHEAT VARIETIES TO ARTIFICIAL INOCULATION WITH LOOSE SMUTS[1]

I. M. Atkins, Denton, Tex.

During the 5-year period, 1935-1939, loose smut, Ustilago tritici (Pers.) Rostr., caused an estimated annual loss of 2,577,000 bushels of wheat in the four principal hard winter wheat states of Texas, Oklahoma, Kansas, and Nebraska. Because of the difficult method of seed treatment, it is highly desirable to develop varieties resistant to this disease.

The reaction of approximately 275 varieties and strains of winter wheat, including most of those commercially important, at one or more of the locations, Denton, Tex., Manhattan, Kans., and Urbana, Ill., has been determined. Methods of inoculation successfully used include the vacuum-spore suspension, hypodermic needle with spore suspension, and hypodermic needle with dry spores. Inoculation as near as possible to anthesis is desirable. The highest resistance, considering all three stations, was found in the soft wheat varieties Kawvale, Currell, Trumbull, and Leap. Several leaf- and stem-rust resistant strains of Hope-Mediterranean have been resistant through 6 years' tests at Denton, Tex., and are considered valuable breeding material. They have not been tested at other stations. Pawnee is the only hard red winter wheat, adequately tested, that has been highly resistant, although the moderately leaf and stem rust resistant Hope x Turkey (C.I. 11964) has been moderately resistant to loose smut. Several Kawvale-Marquillo x Kawvale-Tenmarq strains have been highly resistant at Manhattan, Kans., and are promising breeding material. They have not been tested at other stations. The most promising resistant varieties to use as parents appear to be Currell, Kawvale, Leap, Trumbull, Newturk, Pawnee, Yogo, and Hope x Mediterranean (41-33-1-J19-4).

Marked differential reaction of varieties was evident at the three locations. The soft winter wheat varieties Early Premium, Purplestraw, Gasta, Gladden, Forward, Fulhio, and Zimmerman were highly susceptible at Urbana, Ill.; showed moderate to low susceptibility at Manhattan, Kans.; and were resistant through 6 years' testing at Denton, Tex. In contrast, Denton, Mediterranean, and Fultz are highly susceptible under Texas conditions but showed low percentages of infection at Manhattan and Urbana. The varieties Gipsy, Minhardi, and Valley were highly susceptible at Manhattan, but showed low susceptibility at the other locations. This lends emphasis to the danger of sending infected seed to other sections of the country.

1/ These studies include work by Dr. E. D. Hansing, Pathologist, Kansas Agricultural Experiment Station and Dr. Wayne Bever, Pathologist, Division of Cereal Crops and Diseases and the Illinois Agricultural Experiment Station as well as the writer. Thanks are due these men for permission to use their data in this report.

Breeding programs to develop adapted loose smut resistant varieties are under way at several stations. Studies of the inheritance of loose smut resistance are under way at, at least, two stations.

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STUDIES ON BUNT AND LOOSE SMUT IN KANSAS

E. D. Hansing, Manhattan, Kans.

Bunt and loose smut are major diseases of wheat in Kansas. During the last 10 years the average reduction in yield in Kansas, from these diseases, was estimated at 2,105,000 bushels. Bunt may be controlled by treating the seed with New Improved Ceresan, copper carbonate, Arasan, or Spergon. Loose smut may be controlled by treating seed with the modified hot water treatment. These diseases, however, may be most effectively controlled by breeding and growing of resistant varieties.

Four physiologic races (L-3, L-4, L-5, and L-7) of Tilletia foetida have been identified in Kansas.1/ L-3 was found to be the most common, representing 82 percent of the collections. At least three races of Ustilago tritici have been identified.

In 1943 and 1944, 31 wheat varieties and advanced hybrids, grown in 1/40-acre plots at the agronomy farm, were inoculated with the bunt races L-3, L-4, L-5, L-7, L-8, and L-10. Comanche, Nebred, and Oro were resistant to all of the races except L-8, to which they were intermediate in susceptibility. Iobred Selection was resistant to L-3, L-8, and L-10. Pawnee and Turkey were resistant or intermediate in susceptibility to all of the races. All of the other varieties were intermediate or susceptible to all of the races of bunt. Comanche, Pawnee, and Wichita were each more resistant to bunt than either of their parents.

In 1944, 58 different crosses, involving the Oro type of resistance or higher, were grown in the bunt nursery. In six of these crosses an attempt is being made to combine the bunt resistance of Oro x Turkey-Florence and Hussar-Hohenheimer into a winter wheat for Kansas, Nebraska, and Colorado at the same time obtaining as high resistance to rust and hessian fly, and as good agronomic characteristics as possible. The F_5 population will be harvested this June.

Twenty-four Tenmarq selections have been made which are resistant to loose smut. Five of these have been advanced to the agronomy nursery. Several Fulcaster selections were found to be resistant to loose smut. The better of these will be advanced to the agronomy nursery or to the Thayer, Kans., nursery in the fall of 1945.

A study is being made of the inheritance of loose smut resistance in five different crosses. Kawvale has a dominant gene for resistance and possibly some modifying factor.

1/ Reported in Transactions of the Kansas Academy of Science. [In press.]

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L. E. MELCHERS. Emphasized the possible danger of spreading disease and insects by shipping seed from station to station, and asked that more care be taken to see that material is clean.

R. H. BAMBERG. In 1931 dwarf smut was recognized as different from ordinary bunt. It has been found in northern Idaho, Utah, eastern Washington, western Montana, and two or three counties in northwestern Colorado. It has not been found in the irrigated areas of Montana or the spring-wheat section. Breeding nurseries are located in areas where the soil is naturally infected because the disease has not been found to infect plants grown from artificially inoculated seed.

B. B. BAYLES. Dwarf smut has been found in New York State.

K. S. CHESTER. Oklahoma has developed a portable seed treater with a 500 bushel capacity per day for treating seed for loose smut. Because of the shortage of manpower, the unit is not being operated at present although there are numerous requests for seed treatment.

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RESISTANCE TO SEPTORIA SPECKLED LEAF BLOTCH

Hurley Fellows, Manhattan, Kans.

Most of the work done so far has been confined to the checking of varieties as to their reaction to Septoria. Based on 2 years' work, several varieties show resistance. Some of those showing the most resistance are: Red Chief, Ukrainka, Wisc. Ped No. 2, Brill, Mediterranean, Valley, Jenkin, Triplet, Yorkwin, and Minhardi. Slightly less resistant were Sibley 81, Bald Rock, Denton, Nabob, Gladden, Prairie, Thorne, Illinois No. 2. Within certain hybrids considerable resistant material was found. Some of these combinations are: Gelow x Oro F_7, Clarkan x Eureka F_3, *T. vulgare*-*T. timopheevi* x *T. vulgare*, Marquillo-Oro x Hope-Kawvale, Marquillo x Oro F_{12}, and several other combinations having *T. timopheevi* as one parent.

In the discussion that followed, K. S. Chester emphasized that Septoria did considerable damage because of the leaf killing at jointing time or earlier.

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TUESDAY AFTERNOON, FEBRUARY 13

QUALITY OF HARD RED WINTER WHEAT VARIETIES

Chairman: S. C. Salmon, U. S. Dept. of Agriculture

WHEAT AND FLOUR QUALITY REQUIREMENTS

T. C. Roberts, General Mills Inc., Minneapolis, Minn.

A number of years ago when I was closer to the milling appraisal of wheats than has been my fortune recently, I reached the conclusion that wheat varieties were in some respects like people. There were dependable ones, seldom brilliant, seldom poor in their baking behavior; brilliant but erratic ones, outstanding on one test, in the depths on another; some that occasionally showed good possibilities but in the main were mediocre to poor, and some that just seemed to have no place at all in our particular stratum of milling society.

While I have no proof of it, I am confident that the wheat varieties that have achieved wide and continued acceptance in the market all possessed in substantial degree the characteristics of dependability in producing flours that had acceptable uniformity of baking behavior and good tolerance to a reasonable range of formulas and treatments.

The market for flour includes demand for a variety of characteristics dependent upon use. This is true not only over the whole flour market, but in appreciable degree in that portion served by hard winter wheat flours.

The quality demands for flours designed for a particular type of use tend to be more constant than the quality of flour derived from any given variety of wheat raised under varying environments.

While there are some relatively slow changes in flour quality demands, the chief variable in appraising the relative value of wheat varieties having generally good flour characteristics lies in the effect of environment upon them.

Even to individual millers of relatively similar flours, a given parcel of wheat is not always of equal interest - at time of sale it competes not only with other current offerings but is affected by stocks available.

Accurate appraisal of the future acceptability of a wheat variety for flour milling involves, therefore, clairvoyance as to future weather conditions as well as flour quality demand trends and the relative supply of and demand for that particular variety and for other varieties and even types of wheats that may supply satisfactory milling blends.

The scientific breeder of improved varieties must attempt to appraise the future of this flour quality factor and deserves every possible assistance from millers and users of flour, but must realize that accurate appraisal is impossible, even general statements being open to error.

No one mill supplies in equal proportion all the types of flours in demand for various uses. Each specializes to some extent and the wheat breeder must take this fact into account and realize that we must weigh accordingly the information received from any one miller.

For example, about eighty percent of the flour production of the company employing me are various types of hard wheat flours, and our thoughts and efforts run proportionately.

In the last several years, the increased recognition of the value of the cereal component of our diet, aided by scarcities of other foods, has tended to increase as well as add dignity to the consumption of bread.

Lack of time and increased incomes have resulted in a decline in the use of flour in the kitchen though there has been an increased demand for prepared flour mixes and for an increased percentage of high grade family flours.

Commercial baking has increased, both of bread and "sweet goods", and while this situation may partially reverse itself at the war's end, when time becomes of less value and money more, and rationing of sugar and shortening ends, it seems reasonable to us that increased commercial baking will remain as a characteristic of postwar flour use.

We believe it reasonable to at least hope also that the per capita consumption of wheat products will not show further declines.

The increase in commercial bread production by continuous synchronized equipment has given impetus to greater demand for uniformity in behavior of flours. This uniformity is not confined to the finished product but extends to the behavior of doughs as they are processed - uniform mixing time, uniform fermentation, uniform satisfactory action through dividers, rounders, molders, and proofers are all of importance.

Aside from uniformity in performance, acceptable flours must possess at least reasonable tolerance to variation in baking formulas and procedures. There are always variables in process details to which acceptable flours must be tolerant. Formulas (or recipes) often vary considerably in ingredients and ingredient proportions. Some of the factors composing uniformity and tolerance can be regulated in part in milling but others lie within the varieties themselves, and the existing differences between flours stem directly from them.

While specific wheat varieties tend to vary in particular doughing and baking characteristics, many of them are still acceptable to millers if they produce good bread within the range of normal procedures and consumer quality requirements.

Those varieties that fail to do so by themselves and can only be utilized at all in limited quantities and occasionally without noticeable damage to the quality of finished baked goods are a serious menace to continued commercial acceptance of the flours containing them. Breeders and growers of such varieties are guilty of serious short-sightedness if they fail to recognize the damage they are doing to their own and their neighbor's market by such practice. There is historical evidence of the injurious effect of such practice. Some thirty to forty years ago an inferior baking variety known as "Humpback" seriously contaminated certain Minnesota spring wheat areas to the point where it had to be recognized by grading action. More recently "Garnet" wheat in Canada brought about grade distinctions in order to protect the reputation of the Canadian spring crop in world markets. A similar situation seems to be developing in hard red winter varieties in certain sections in the southwest.

Until this last year, for well over a decade much of the hard wheat, both spring and fall sown, raised in the plains area has been relatively high in protein. Our company records show clearly that our hard wheat flours milled east of the Rockies have averaged, type for type, a full percent or more higher in protein than did those same types during the Twenties. Protein is to some extent a measurement of "strength" in flour and in almost all cases we have had ample strength in all flours - in some more protein and strength than needed or even desired for the uses for which the particular flours were designed. To some extent this excess has masked the effect of varieties of poorer baking quality. The undesirability of such wheats is emphasized as weather conditions cause lower protein levels in the entire crop. Unfortunately, poor baking hard winter wheats are increasing rapidly just at a time when protein levels are lower, and the result is already becoming apparent in poorer baking quality in some commercial flours milled at points where the use of such wheats cannot be avoided.

It does not seem necessary to report in detail on the milling and baking characteristics of hard winter varieties - you all know more about them than I do, or, if by chance you do not, there are milling technologists in plenty who have much sound information they will gladly furnish.

I have obtained the conclusions of the four men in our company who are the best informed currently on hard red winters and do wish to briefly summarize certain of these:

1. While there is not entire unanimity among them in the exact order of general quality ratings given the varieties listed, all are agreed emphatically as to the varieties that are most satisfactory and unsatisfactory for use in our mill blends.

2. Recognition is given to the fact that varieties having quite different and distinctive characteristics are of good commercial value when properly utilized, provided only they have generally good baking quality when handled within the limits of general commercial practice.

While varieties such as Turkey, Tenmarq, Pawnee are recognized as of basic value in many commercial mill blends, other wheats, notably Blackhull and even Kawvale, are well regarded for their own distinctive properties, as such, or as contributing factors in blends.

3. No good word is said for Chiefkan, Superhard Blackhull or Red Chief. These varieties all fail to meet the requirements necessary for any of the flour types we produce and their presence in our blends in any appreciable quantity is regarded as a definitely degrading factor in the acceptability of our flours.

These varieties may have an economic place commercially but at present it appears very limited, indeed, in food flours, and as potential feeds or as sources of starch or industrial products they will normally have to compete with other grains normally valued and priced substantially lower per unit than wheat varieties of acceptable food characteristics.

In conclusion, there are two facts regarding the distribution and the milling of flour that have a direct bearing on the position of both users and flour millers which I wish to emphasize -

1. In many markets of the United States, flours of different origin are in close cost competition with one another. I cite as a specific example the fact that hard winter wheat bakers patents of reasonably similar commercial characteristics were deliverable in the New York market as of January 26th this year at a cost range of less than 10 cents per cwt. when milled at the Buffalo, Kansas City, Oklahoma City, or Wichita Falls plants belonging to our company. A similarly narrow range in cost existed in the same type of flour in the Chicago and St. Louis markets when milled at the last three points named above. Buyers in those and many other large and small markets have, therefore, a free choice and little penalty as to the origin of the flours they desire to use.

2. The milling business, in common with certain other staple food manufacturing businesses, is one of relatively large volume and good turnover conducted on a narrow margin of profit in terms of value of goods sold. Reference to the annual statements of milling companies affords ready proof of this fact. You will find among successful firms whose main business is milling that profits in terms of goods sold are usually between 1 and 3%. The significance of this, so far as this discussion is concerned, is that a mill in any given location, to be competitive and at the same time profitable, is committed to draw its wheat from certain areas and to market its flours in certain others. It must be located within the normal flow of grains to consumer markets and must as well have a reasonably ready acceptance for its products. The fact that the margin between a profitable and an unprofitable operation is so narrow means that a mill cannot go too far afield for its supplies or its markets and can afford to take little chance on the acceptability of every sack of flour produced.

Knowledge of these two facts is important to an understanding of the quality requirements of wheat varieties on the part of the milling industry and should be of interest to all who are engaged in the development or committed to the growing of wheats.

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PROBLEMS IN EVALUATING QUALITY

J. A. Shellenberger, Manhattan, Kans.

The wheat breeder, farmer, grain dealer, miller, and baker all have their own particular interpretation of the term quality when applied to wheat. Many chemical and physical tests have been developed and applied to cereals but as the number of tests for quality increases there is ever increasing difficulty in obtaining similar interpretations from the same data. Because of the opportunity for differences of opinion, it is generally both unsound and unwise for any one chemist or any one laboratory to either promote or condemn a wheat variety without considerable supporting evidence gained from a number of sources.

The correct appraisal of wheat varieties calls for a great deal of wisdom. It is necessary to be guided by the proved preferences of the miller and baker for certain wheat characteristics and yet not become too engrossed in present preferences to recognize the inevitable changes which time will bring in our concepts of wheat quality. Within certain limits, there is justification for the policy of establishing a fixed quality standard and then ruthlessly condemning all varieties that fail to meet the standard. However, when such a policy is followed to extremes, no provision is made for the development of wheats possessing unusual properties. Such wheats may be invaluable some day in meeting a special food product or industrial need.

The bread baking test continues to be one of the principle procedures for the evaluation of wheat quality. The American Association of Cereal Chemists baking method has been very helpful in quality testing, particularly for the broader classification of wheat varieties into categories such as "good", "bad" or "intermediate". Since it is only a laboratory test procedure, caution must be used before interpreting fine distinctions in dough properties or loaf characteristics in terms of commercial preference. What is urgently needed are better micro methods for milling and baking. It should be possible to obtain all the quality information now generally reported without using more than 100 gms. of wheat. The successful application of micro methods should supply all essential information well in advance of our present system. On the other hand, the hard winter wheat breeding program would be greatly helped if the smallest commercial size machine operated bakery equipment were available. In no other way can the dough handling properties and baking quality be definitely determined in terms of commercial utility.

In the future, we should devote more effort to evaluating such properties of wheat varieties as: toasting value, staling rate, blending characteristics, and suitability for hearth bread, for example. There is also need for basic research on the wheat proteins. Perhaps the application of newer technics such as electronics, infra red and electrokenetics might lead to the elucidation of the fundamental characteristics of wheat quality. If we had knowledge of the chemical and physical distinction between the constituents of wheats of "good" and "poor" baking quality, we could probably proceed to bring about the necessary changes in the poor wheats to make them bake satisfactorily. Such knowledge would certainly be invaluable at the present time when farmers are disregarding wheat quality from a baking standpoint in order to profit by the market advantage of high test weight varieties.

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WATER REMAINING HYDRATED AGAINST CENTRIFUGAL FORCE AS AN INDEX OF THE PROTEIN QUALITY OF HARD WHEATS

K. F. Finney, Wooster, Ohio

Hydration capacity and loaf volume data covering a wide range in protein content are reported for samples of pure hard winter and hard spring wheat varieties derived from a very wide range of climatic and soil condition. The hard winters and hard springs are represented by 3 crop years and 1 crop year, respectively.

Water remaining hydrated after the application of centrifugal force is determined by treating 5 g. of flour in a test tube with water to which lactic acid is later added. After centrifuging and pouring off the supernatent liquid, hydration capacity is determined from the increase in weight.

Hydration capacity for Buhler experimentally milled flour is a reliable index of loaf volume or protein quality. The hydration values ranged from 150 percent for the lowest loaf volume of 650 cc. to 300 percent for the highest volume of 1365 cc. Based on the hydration and loaf volume differences required for statistical significance, hydration capacity gives about twice as much differentiation between samples as loaf volume.

An extremely simple milling of 75 g. of tempered wheat involves 2 grindings on the Hobart Coffee Mill with 2 siftings from which flour yields of from 70 to 75 percent are obtained. The average total time for grinding, sifting, weighing and labeling products, calculating yield, and cleaning out the grinder for the next sample requires only 11 to 12 minutes.

Data are presented which indicate that Hobart flour hydration values should be corrected to a constant ash basis depending on the protein content of the flours.

Hydration capacity corrected for ash is essentially a linear function of protein content within a variety. However, certain varieties have distinctly different regression lines, the slopes of which, in general, increase with hydration level at a given protein content.

The relative order of ranking of the hydration-protein content regression lines corresponds to that of the loaf volume - protein content regression lines for the same varieties. Accordingly, the hydration capacity differences between regression lines represent differences in protein quality.

By correcting hydration capacity values of new wheat varieties for ash and then to a constant protein basis, an estimation of their protein quality or bread making capacity relative to that forknown varieteis can easily and accurately be made.

When considered along with several other important wheat and flour properties such as mixing and bromate requirement, kernel hardness, millability, and pigment content, hydration capacity for estimating protein quality has excellent possibilities of being particularly valuable in wheat breeding where the limited amounts of material in the early phases of the program are insufficient for the usual milling and baking. In addition, the hydration test has excellent possibilities in the inspection and purchasing of wheat in areas where undesirable varieties are grown.

A scheme is outlined whereby a new variety of bread wheat can be accurately evaluated relative to its suitability from the standpoint of certain important flour properties by making several simple physical, chemical, and physico-chemical tests.

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After the paper by Mr. Finney, the meeting was thrown open for questions and discussion. Not all of the statements were recorded, but a few that seemed to be of most interest follow.

K. F. FINNEY. There is a relation between doughball time and mixing time.

K. S. QUISENBERRY. How much time is required to run a hydration test?

K. F. FINNEY. A 75 g. sample requires 11 to 12 minutes for milling, and 48 samples may be run through the hydration test in an 8-hour day. Pearling is used to some extent to determine hardness of the sample.

R. O. PENCE. Reported that he had found no relation between the pearling test and milling hardness.

R. N. McCAULL. Mida is more mellow in dough handling properties than is Thatcher. Mida is a good milling wheat. An important factor for plant breeders to keep in mind is the desirability of a low ash content of the flour.

T. C. ROBERTS. Ash content has been often used as a "yard stick" but it is not so important if a variety is good in all other characters.

JOHN H. PARKER. Pawnee seems to have a low ash content when grown under varied conditions.

L. E. LEATHEROCK. Plant breeders should develop a variety to replace Red Chief and Chiefkan and the millers would not care about the ash content.

A. W. ERICKSON. Millers are disturbed by new varieties because of the economics involved. They operate on a very low margin and changes in milling operations to accomodate new varieties may involve losses. The solution for wheats of low grade or poor quality is to make determinations on each car load and then sell on the basis of the quality. Poor quality wheat would then go out.

E. G. BAYFIELD. Showed recording dough mixing curves for several varieties at different protein levels and of the same varieties grown at different points in Kansas. There was some variation in the curves of the varieties grown under different environments but in general the "lower quality" wheats had the same type of curve no matter where they were grown.

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SUMMARY OF THE MILLING OF 1944 U.S.D.A. SAMPLES

R. O. Pence, Manhattan, Kansas

The milling values of the wheat were judged as to their value in a wheat blend as considered from the commercial viewpoint. In most cases it would be possible to take the individual samples and mill them satisfactory, but when they are blended some are too soft and others are too hard. Kawvale is considered a semihard wheat and Turkey a hard wheat, Tenmarq has some peculiarities with thin bran or spring wheat characteristics, while Chiefkan and Red Chief approach the durum type.

The uniform yield nursery consisted of 25 samples. Five of these samples were checks or standard varieties.

Early Blackhull and Blackhull have thick bran and milled as semihard wheats. Kharkof, a Turkey selection, and Comanche and Pawnee have some characteristics of Tenmarq as far as the milling is concerned. Comanche has a slightly heavier bran than Pawnee or Tenmarq.

Only three samples in this group should be classified with the Blackhull types. They are samples C. I. 12117, 12121, and 12114.

Sample C. I. 12123 was very hard and approached the Chiefkan type when considered from the milling standpoint.

The 26 composites from the various districts could be divided into two classes with the exception of Early Blackhull, Chiefkan, and Red Chief which would not prove satisfactory in most wheat mixes.

The 21 individual nursery samples as a whole were off-color and very much on the soft side for good milling. In the northern section C. I. 12139 milled as a semihard wheat which would make it undesirable for milling.

In the southern districts samples C. I. 11858, C. I. 11999, 1151-19, and 366-769-150 were all too soft for good hard red winter wheats.

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SUMMARY OF BAKING QUALITY OF CERTAIN NEW VARIETIES

John A. Johnson, Manhattan, Kansas

The baking quality of new varieties of wheat were compared with old-established varieties that have been approved by the commercial consumer for white bread production. Bread making quality was considered as the sum of many characteristics such as loaf volume on the "as received" and on a 13.5 percent protein basis (Loaf Vol. = 42.4X + 343.1), mixing requirement, absorption, bread grain, and color score, and handling properties.

The data presented were obtained with a rich, commercial type, baking formula. Optimum conditions of baking were attempted in order that each sample be given its best chance to perform. Optimum mixing requirements were obtained with the aid of the mixogram and oxidation requirements obtained by baking each sample at several $KBrO_3$ levels. Optimum absorptions were determined with the aid of knowledge of the protein content of each sample.

Baking results for two crop years, 1943 and 1944, of the uniform yield nursery samples were presented separately and as an average of the 2 years. The loaf volume expressed on a 13.5 percent protein basis is considered a measure of a protein-quality factor. For the 1943 crop the adjusted loaf volume ranged from 850 to 965 cc. and for the 1944 crop from 878 to 978 cc. The varieties studied for quality of protein considering 2 years' data may be ranked in order of poorest to best quality of protein: Early Blackhull, Blackhull x Cheyenne (C. I. 12101), Cheyenne x Tenmarq (C. I. 11972), Blackhull x Tenmarq (C. I. 12102), Cheyenne x Early Blackhull (C. I. 12000), Wichita, Kanred-Hard Federation x Minhardi-Minturki (C. I. 12118), Blackhull, Pawnee, Kanred-Hard Federation x Minhardi-Minturki, Comanche, Kanred Hard Federation x Tenmarq (C. I. 12115), Kharkof, Westar, and Quivira x Tenmarq (C. I. 12116). Of these varieties all samples except Blackhull x Cheyenne (C. I. 12101) had satisfactory mixing requirement, which was longer than desired. All samples exhibited satisfactory bread grain and color scores.

Special individual samples of the 1943 crop received from Fort Collins, Colo., and St. Paul, Minn., were discussed. All samples from Fort Collins had short mixing requirement and were sensitive to overmixing. All new crosses produced larger loaf volume (13.5 percent protein basis) than the Kanred check. All samples from St. Paul exhibited excess strength in their mixing characteristic. Hope x Minturki Minn. No. 2724 had mixing requirement longer than desirable. Loaf volume (13.5 percent protein basis) ranged from 905 to 960 cc. H-44 x Minturki Minn. No. 2713 and 2714 proved quite superior in respect to quality of protein as reflected in loaf volume. Both 2713 and 2714 exhibited satisfactory bread grain and texture.

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WEDNESDAY MORNING, FEBRUARY 14

FUTURE PLANS
Chairman: F. D. Keim, Nebraska

NEED FOR ADDITIONAL RESEARCH FROM THE AGRONOMIC POINT OF VIEW

R. I. Throckmortion, Manhattan, Kans.

The need for additional research from the agronomic point of view is almost identical to the need from the point of view of the wheat producer. The agronomist and the wheat producer may not agree on the merits of a given variety, but they usually agree on the essential characteristic for a good wheat. Therefore, I am speaking for the farmer as well as for the agronomist.

The developments that have been made and the varieties that have been released by the experiment stations since the inception of the co-ordinated hard winter wheat research program represent vast improvements in the wheat variety picture of the region. In general, these improvements have not, as yet, been reflected in farm production because seed supplies are just now becoming sufficient for a marked expansion in the acreage of these wheats.

Pawnee wheat, with its high yielding capacity, high test weight, short stiff straw, high resistance to loose smut and moderate resistance to leaf rust, stem rust, bunt, and hessian fly, will undoubtedly replace most other wheats in the eastern portion of the hard winter wheat region. The production of this variety will result in an increase of several million bushels of wheat annually in its region of adaptation.

Comanche wheat, with high yielding capacity, good test weight, earliness, stiff straw, high resistance to most races of bunt and considerable resistance to leaf rust, is superior to the high quality wheats now being produced in its region of adaptation. It is superior to all varieties being grown in its region of adaptation except in test weight and appearance. As seed supplies become available, Comanche will no doubt replace other varieties in much of its region of adaptation. It will not, however, replace some of the varieties having an exceptionally high yest weight unless there is some change in grading, marketing, or purchasing practices.

Wichita wheat will no doubt replace most of the Early Blackhull because it produces higher yields and has good test weight. Although Wichita is superior to Early Blackhull in quality, it is not as good in this characteristic as is desirable.

Perhaps the first need for additional research in wheat improvement from the point of view of the agronomist and the farmer is the development of stem rust resistant varieties. L. E. Melchers and C. O. Johnston have estimated that the average annual los s from stem rust in Kansas for the period 1935 to 1944 was $4,676,000. The moderate resistance of Pawnee is not sufficient to meet the need and, in addition, Pawnee is not well adapted to all sections of the region.' This tremendous loss from stem rust needs to be eliminated and the only practical method is through the development of stem rust resistant varieties.

It is important that varieties having resistance to leaf rust be developed as soon as possible. The amount of resistance carried by Pawnee and Comanche will be helpful, but we need varieties that have greater resistance than that of these wheats. Melchers and Johnston have estimated that the average losses in Kansas from leaf rust for the period 1935 to 1944 have been $3,336,000. In addition to reduced yields of grain, an infestation of leaf rust, especially when it occurs in the fall, may materially reduce the grazing capacity of wheat.

Bunt continues to cause rather heavy wheat losses, although seed treatments are effective in the control of the disease. The resistance of Comanche and the moderate resistance of Pawnee to this disease will be a great aid in reducing the losses, but a wheat or wheats having the resistance of Comanche are needed for those sections of the region where Comanche is not adapted. Previous to the general adoption of seed treatment for the prevention of bunt, losses were extremely high in some seasons as in 1926 when the estimated loss was $19,993,000. It should not be necessary to continue indefinitely to treat seed for the prevention of bunt.

Loose smut occasionally takes a heavy toll of susceptible varieties. An increase in the acreage of Pawnee will aid materially in reducing losses from this disease, but varieties having resistance to loose smut are needed for the sections of the region where Pawnee is not adapted.

The foot rots, according to Melchers and Johnston, have caused an average annual loss of $4,914,000 in the Kansas wheat crop. The losses from these diseases are usually scattered and small on the individual farm; yet, the total loss is great. The only practical solution of preventing these losses seems to be the development of resistant varieties.

There are also minor diseases, as septoria and scab, that cause losses and that should be eliminated through the development of disease-resistant varieties.

Insects frequently cause serious wheat losses in the region. Geo. A. Dean and J. W. McColloch estimated that the average annual loss of wheat in Kansas from hessian fly during the period 1926-1935 was 6,000,000 bushels. R. H. Painter estimated that the loss in Kansas from hessian fly in 1943 was 25,000,000 bushels. The development of Pawnee will aid materially in reducing losses from this insect, but varieties having even more resistance than Pawnee are needed. Varieties having resistance to hessian fly and adaptation to regions where Pawnee cannot be grown successfully are also needed.

In the eastern part of the region, chinch bugs are considered rather closely after hessian fly as a pest of wheat, but it is difficult to measure the damage caused by this insect. R. H. Painter advises that Pawnee, Tenmarq, and Kawvale appear to be more susceptible to chinch-bug injury than are most of the varieties which they have replaced. Thus, in developing new wheats, consideration needs to be given to resistance to chinch-bug injury.

The spectacular outbreaks of green bugs in southern Kansas, Oklahoma, and Texas, although occurring only at intervals, cause heavy losses. R. H. Painter advises that Pawnee is apparently highly susceptible to injury from green bugs and that the extensive growing of this variety may serve to lessen the intervals between outbreaks. Pawnee will, no doubt, be grown most extensively in Oklahoma and Kansas in areas where green bugs have been most abundant. Attention needs to be given to the development of varieties having more resistance to green bugs.

Grasshoppers are ranked as the most important insect pest of wheat in the western portion of the region. If varieties having resistance or tolerance to grasshoppers could be developed, it would aid materially in wheat production. Present methods of grasshopper control are laborious, expensive, and sometimes ineffective.

Other insects that cause more or less local damage to wheat are wheat strawworm, false wireworm, cutworms, and white grubs, and these should not be overlooked in a wheat-breeding program.

There are several plant characteristics the agronomist and the farmer want in wheats that further emphasize the need for additional research work.

Drought resistance is important and a more definite study should be made to determine what constitutes drought resistance. What are the factors that make Comanche better adapted to the western and Pawnee to the eastern part of the region? Increased drought resistance should be one of the definite objectives in wheat breeding because during many seasons drought is the limiting factor in wheat production in the western portion of the Great Plains.

Winterkilling has not been serious in recent years, yet the possibility of heavy losses from this cause cannot be overlooked. There is a common opinion among agronomists that Comanche is not sufficiently winterhardy for the northern portion of the hard winter wheat region. Yet, Comanche has done well at Akron, Colo. This means that more study is needed on the interrelationships of drought resistance and cold resistance. More winter hardiness is needed in our wheats for the northern areas.

Varieties that will stand up for harvesting - neither lodging nor breaking over - and having short stiff straw, are desirable. Some of the newer varieties, as Pawnee, Comanche, and Wichita, are far superior to the older varieties in this respect. The greatest criticism farmers ever placed against Kanred was susceptibility to lodging, and the greatest criticism against Blackhull has been the tendency to break just below the head. As other new varieties are developed, this characteristic must not be overlooked.

Early maturing, or at least sufficiently early to escape many of the periods of drought and high temperatures, is important. However, wheats should not be so early in maturing as to reduce yields.

Wheats having an upright type of growth and that do not become dormant until late in the fall are desired in those sections where the grazing of cattle and sheep on wheat during the fall and winter has become an important industry.

The kernel characteristics of many of the varieties of wheat being produced at the present time could be materially improved. From the viewpoint of the agronomist, additional research is needed to improve kernel characteristics.

Under the present system of grading and marketing wheat, some of the best varieties from the standpoint of quality are discriminated against because of relatively low test weight. Unless some changes are made in the grading and marketing systems, the condition will continue to exist. In addition, farmers like to grow high-test-weight wheats. Because of these conditions it is imperative that wheats of good quality and having high test weight be developed.

Wheat producers and purchasers like varieties having attractive kernels that do not tend to bleach after maturing or as a result of rainfall. The tendency of Tenmarq kernels to bleach has discredited the variety with many growers and purchasers, although bleaching does not reduce the actual value of the grain. It will be an aid to the wheat industry of the region to develop new varieties having attractive kernels that retain their appearance after maturing and under adverse climatic conditions.

High-yielding capacity has always been important in wheat production. Resistance to insects, diseases, winter injury, lodging, and drought tends to lead to increased yields, yet varieties must have high inherent yielding capacity to be acceptable. High-yielding capacity is not likely to be disregarded by plant breeders.

Agronomists are distinctly conscious of quality in wheat. They are like wheat producers in that they want to see the controversy relative to quality solved at an early date. They realize that the future of the hard winter wheat industry will, in the final analysis, be determined by whether the varieties produced are acceptable to the trade.

Most of the winter wheats that are used for blending purposes are produced in the western part of the region. To meet the need for blending wheats, varieties having high-yielding capacity, high test weight and sufficient strength to meet blending requirements, must be developed for and be produced in this region. Although Wichita is a vast improvement over Early Blackhull in quality, it is not as good a variety of early wheat as is needed. Therefore, an effort should be made to produce an early wheat that is superior to Wichita in quality as well as in many other characteristics.

In addition to the vast needs for additional research in plant breeding, there are other problems that should have attention at an early date if research is to make a full contribution to the wheat industry.

The entire field of factors that influence the protein content and the quality of wheat should be studied. This means careful physiological studies of the wheat plant during its entire period of development. It also means careful ecological studies. On an average we can predict with a fair degree of accuracy the production of wheat previous to harvest by knowing the moisture content of the soil. An attempt should be made to determine whether the protein content of wheat can be forecast with reasonable accuracy previous to harvest. Such a study offers promise of valuable results.

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NEED FOR ADDITIONAL RESEARCH FROM THE STANDPOINT OF THE MILLER AND BAKER

Elmer W. Reed, Shellabarger Mill and Elevator Co., Salina, Kans.

For me, a layman, to come before this group for the purpose of talking on the subject assigned is not only confusing, but just a little terrifying. At first thought, the question arose as to what could I say to this group that would add anything to either the recounting of the things accomplished or pointing to things yet to be undertaken. The subject, "Need for Additional Research from the Standpoint of the Miller and Baker," is not only basic in its implications, but includes so much that has been said far more ably and with far better background information than I can muster that again I am just a little inclined to wonder what in the world the Program Committee could have been thinking of to ask me to talk at the end of a superbly rounded program such as has been unfolding before you the past 2 days. You have been served a delightful menu: Agronomic work throughout the entire winter wheat area, new methods of developing improved wheat varieties with greater resistance to insects and disease, reports on varieties from the standpoint of quality in milling and end use, specific comment on milling and baking quality of certain new varieties attaining considerable importance, and then the fine inspirational address by President Eisenhower. With that program one like myself would wonder what more is there to point to, since surely the scope of work outlined and in progress as reported during this meeting answers itself as to the future plans. However, when I heard Professor Throckmorton outline so clearly the need for aggressive thinking and work in fields of agronomic research I came to with a start and began letting my imagination take over with respect to those developments that might make for better and more perfectly adapted conditions from the standpoint of the processors on down the line toward that jury of final determination, the consumer. All this brings back to me sharply a recent experience in matters somewhat removed from my everyday life. It was my good fortune to sit for an entire day and evening in the company of national figures in research. With me, as with many of the laymen at that gathering, much of what was said was far over my head. We were told about many things - methods by which the soft woods of quickly growing trees may be made as strong as steel and as light as aluminum; about paper so treated that it became an acceptable substitute for textiles used in bed linens, etc., and yet so cheap it could be discarded after use; textiles similar to wool made from milk; synthetic products developed under the necessities of war that have gone far beyond the original and will undoubtedly remain as a permanent addition to those things which make the American standard of living. But one thing that stands out in my mind from that gathering is the statement quoted there, "Where there is no vision--the people perish." It seems to me that is easily the watchword for any gathering of this sort, and should be a motto placed before the people of these United States of America, before the producers, before those distributing the products of the soil, before those processing such products, before those operating the distribution system, before those financiers supplying that life blood to the industrial whole, before the service trades; briefly, before capital, labor, agriculture, statesmen, scientists, and all others that make up the rounded whole of our society- "Where there is no vision--the people perish."

Let's see, therefore, if I might add a little to that vision which is so necessary that the people of our society not perish. This group is concerned basically with hard red winter wheat and the method of improving that wheat for the better application of it and its products to the betterment of mankind. This is principally centered in nine states where it is raised as a major crop, and those states are represented here today. To give you an idea of its importance in the food picture - hard red winter wheat represents 40 to 50 percent of the entire wheat crop; hard red spring wheat an additional 15 to 20 percent, these two making up the so-called "bread wheats." To complete the wheat picture, soft red winter wheat represents 25 to 30 percent, white wheat 10 to 15 percent, and durum 3 to 5 percent. You who have studied history do not need to be reminded of the importance of bread, not only as an economic factor, but as a means of shaping the destiny of nations throughout recorded history. It has been often said that milling is an ancient and honorable art. I will admit some say that it is more ancient than honorable. Others say honorable and <u>ancient</u>, with the accent on the ancient. Many say, mistakenly, I believe, that there has been little change in milling in the past generation. This last comment is no doubt generally accepted as being true because of the fact that basically milling is quite simple. As you all know, it consists of a series of grinding and reductions, combined with sieving, bolting or purifying to arrive at the degree of refinement, the coarseness of granulation, the type of product desired. There is considerable argument that milling is in itself behind the times, out of step, and resting on past glories, not keeping up with the procession. Without any desire to boast - certainly with no desire to apologize or defend - may I point out to you a few of the changes that have taken place in milling in the past 30 years, the period in which I have been actively engaged in this so-called ancient and honorable art. Thirty years ago the commercial bakery was small; it was what is referred to as a "hand" shop, with a minimum of machinery, and with baking an art that was learned strictly as an art and not as a science or profession. Then a baker mixed his doughs with a slow-speed mixer, or even by hand. He developed each step in the baking process by his idea as to when the dough was ready to be handled or by the timing that best fitted into his other plans. He succeeded or failed as his personal aptitude was good, bad, or mediocre. He usually wanted a flour that had plenty of gluten strength, since time was of no great importance, and he wanted plenty of time to make up his doughs on a bench and to set his doughs for greater or lesser periods, which led to a preference for spring wheat flours, giving it a popularity that still exists in some sections. With the advent of improved bakery machinery and the development of commercial baking as a skilled and highly technical operation, bakeries increased in size by leaps and bounds; production-line methods were necessary, and flour, as well as other ingredients, of strict uniformity was likewise necessary. This uniformity was defined in terms of the mixing required to develop the gluten and to obtain the desirable inside characteristics; in terms of dough time and fermentation time to permit accurate scheduling of plant operation; in terms of gluten quality, in gassing power, and in ability to produce the type of loaf rich in ingredients demanded by His Honor, the consumer. This meant a complete revolution in the so-called art of milling quality flour. No more was it possible to pick a good sound wheat, mill it with reasonable care, and necessarily have a flour that would be approved by your customer. His customers were becoming more critical of his product and he in turn was forced to become more critical of his own work, which included the material which he used in his production. Therefore, the miller had to devise methods of assuring that his operations would produce that type of loaf. Those of you who can remember the cereal laboratories of 30 years ago know the gigantic strides made in cereal chemistry in that period. Many forms of tests were developed and discarded, searching for two tests or two types of tests, the first being those that would reflect what might be expected in the bake-shop from the flour under consideration, and the second those tests which could be used in the actual milling process - control tests if you please - to assure a product that would satisfactorily meet the first type of test. We did not know what we were seeking then; we do not entirely know today, but we settled every controversy then by the baking test, just as we do today. However, today we have any number of proven tests which, properly interpreted, tell us what to expect in the final bake.

One of the developments during that period has been in the matter of the wheat itself. In those days we have in the Southwest, Turkey wheat. As a variety suitable for baking it was at the top of the list then, and today it is still right up among the leaders. It was Turkey wheat that contributed to a great extent to the development of large-scale commercial baking. Today we talk in terms of curves, graphs, gassing power and what-have-you, but we are still attempting to reflect that combined thing which we were talking about ten - twenty - thirty years ago when we said "baking quality." In those days we did not know protein as such - we washed gluten. The personal factor was too great to use gluten washing as a permanent method of procedure, but in the hands of a competent operator that old-fashioned test went far toward giving us many of the answers we are now seeking through more complicated but more exacting procedures.

During that period the agronomist was also having his growing pains. He was quietly, persistently reaching for a wheat that would combine with the desirable baking qualities of a wheat such as Turkey Red a resistance to disease, to insects, and to unfavorable climatic conditions that would mean more bushels of better quality and more money for the producer, better - or at least fully equal - in food value for the consumer. It must at times have been a discouraging search. When you found what you wanted in one respect it would after several generations show fatal weaknesses in another; if it produced as desired it had shortcomings in baking quality; if it had baking quality, yield and test weight it might develop susceptibility to insects or disease during certain weather conditions, or a weak straw might show up and spoil the work of several years. Not the least of these discouragements must have been the trick varieties commercially developed for yield and test weight without regard to their suitability for other purposes, but meeting with temporary and wide acceptance by the producer, who was at that time concerned only with what he could expect in the way of returns from his crops then going into the ground. I have in mind two wheats widely accepted in recent years: the first was generally sound, had a better yield and test weight than Turkey, and excellent baking qualities. There was only one possible basis on which it could reasonably be criticized, and that was a longer mixing time necessary to properly develop the gluten. The second wheat was greatly superior to the first in matters of yield and test weight. It was a beautiful wheat except for a fatal weakness in quality that did not permit its use in the commercial bake-shop. The first wheat was developed and distributed by a State College after extensive checking and rechecking as to its all-around value. The second wheat, developed or selected individually, was immediately placed on the market and attained substantial popularity among the farmers. We would be less than realistic if we did not recognize the seriousness of the situation described. It can be broadened to a lesser or greater degree to cover substantially the entire territory producing hard red winter wheat, and this particular instance does, I believe, point to three of the major problems for the future as it concerns the agronomist, the wheat producer, and the miller:

1st - How can the milling industry reflect to the producer of wheat the additional value in those wheats that are desirable for end use?

2nd - What changes should be made in our wheat-grading procedures to bring them up to date in order that they may reflect an end use value?

3rd - What procedures can be developed (and this is a problem for both the agronomist and the cereal chemist) to readily determine, quickly and accurately, wheat varieties or other characteristics that may be controlling in the matter of end use value?

The first is basically a problem of the milling and grain trades. It can be answered very briefly. The milling industry is not only willing, it is extremely anxious, to reflect to the producer values directly in relation to the quality of the wheat from the standpoint of flour for bread baking. Again to be realistic, however, we must recognize that that cannot be done until we have an answer to problems 2 and 3, and the answer to No. 1 will, I assure you, be completely automatic and completely satisfactory to all concerned as quickly as problems 2 and 3 have been answered.

Question No. 2 might be referred to as an example of the slowness with which procedures develop in the face of a necessary type of Governmental regulation, unfortunately, but necessarily, influenced largely by political considerations. **Thirty** years ago grain standards were set up on the then understanding of wheat value. These standards gave almost overwhelming importance to test weight. Since that time there have been a few modifications in wheat grading procedures, but basically the approach is the same. Reasonably clean, sound wheat of 60 lbs. test is No. 1 wheat, whether or not it may be suitable for food, or whether it may be of such a quality that the only practical use to which it can be put is for conversion into industrial alcohol or for feeding purposes. Over the years we have accepted the protein test as an added factor in grain grading. It should be pointed out that this test is not a part of the Federal grain standards. During the years a few of us have attempted from time to time to have the grain standards amended to include protein, with official procedures included and providing for Federal appeal on protein. Needless to say, the attempts have been unsuccessful. As of today, I think it is probably well that they were unsuccessful. What we need in Federal grain standards for wheat is not a patching on of an additional test here and an additional test there, but a complete new approach to the matter of wheat qualities so that the label, if you would call it that, placed on a lot of wheat by a Federally licensed inspector would reflect both its storage quality - but more particularly and much more important, its quality from the standpoint of the purpose for which substantially all wheat is raised - its value as a food. While, as I say, this is a problem basically for the grain man and the cereal chemist, the agronomist is going to be a vital factor in any revision of grain standards to bring them up to the place of a modern vehicle of vital importance in the marketing of grain.

Problem 3 is, I think, one that is basically that of the agronomist, and will be the point at which the agronomist contributes most to the solution of the 2nd question. Much work has already been done on procedures by which wheat may not only be grouped into classes based on end use value, but also on the question of ready determination of those groups. It has been found that certain undesirable varieties of wheat have a high specific gravity, a compactness of cell structure that may be a means of segregating those particular wheats in commercial grading. Much work has been done in an effort to determine whether or not gluten quality may be accurately set forth through a color test, possibly somewhat as we now determine protein. A question asked in the meeting of research scientists which I referred to was whether there was a test - chemical, physical, high frequency electrical or otherwise, that would detect kernels of grain of different specific gravity. Admittedly we are only beginning to get anywhere in an attempt to answer question 3, but I firmly believe that the answer is being uncovered and that within a reasonable length of time some sort of a test, quick, accurate, and dependable, will bring forth this information and eventually be a part of these new Federal grain standards as applied to wheat which we so badly need.

A suitable answer to question 3 will go far toward answering questions 1 and 2. You gentlemen are interested in improving the basic value of our crop of hard red winter wheat. On the other hand, it is difficult for you to go to the farmer and in good conscience urge him to raise types of wheat which so far as his current experience is concerned do not produce in dollars and cents the same return for the plant employed, the labor involved, and the risk on his part as will another, even though the other is not so desirable or even actually undesirable from the standpoint of the good of the industry or the good of the nation. In my opinion it is not a matter of regulation that is involved. We have had too much regulation. I do not think it proper to by law say that a farmer may plant this - he may not plant that - if he is to raise wheat he must raise certain varieties, etc. The final answer is economic advantage. It is not my thinking that a series of penalties will solve any question of this nature. The answer is in making it possible to reward those producers who through a careful study of their own situation and the demands of the time produce that type and quality of wheat of most value for food purposes. The milling industry and the baking industry combine in their intense desire to go along with the agronomist in rewarding those producers who are doing the best job from the standpoint of the economic and social well being of society. There will be many further improvements in the way of wheat varieties. They will not have the reception to which they are entitled unless our methods of marketing are so revised that the producer of those superior varieties is rewarded in terms of actual return, and the one obstacle to such reward is the present impossibility - or at least the present failure - to label such wheat for what it is when it comes to market.

So the first answer and a part of the large answer to the question "Need for Additional Research from the Standpoint of the Miller and Baker" is, I repeat:

1. How can the milling industry reflect to the producer of wheat the additional value in those wheats that are desirable for end use?

2. What changes should be made in our wheat grading procedures to bring them up to date in order that they may reflect an end use value?

3. What procedures can be developed to readily determine, quickly and accurately, wheat varieties or other characteristics that may be controlling in the matter of end use value?

and again repeating, the answer to question three is necessary before we begin to answer the other two. It is a challenge to the scientist who deals in one thing above all else--facts.

Where there is no vision - the people perish.

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HARD WINTER WHEAT IMPROVEMENT IN THE FUTURE

B. B. Bayles, Beltsville, Md.

It is relatively easy to evaluate what has been accomplished, but to anticipate what problems will be acute in the future and plan how best to attack them is much more difficult. However, the degree of success in solving future problems depends very largely on how well we anticipate them. It is therefore necessary for this group as a whole and for each individual to give very serious consideration to problems that are now important, or are likely to become important. Considering future plans for the hard red winter wheat improvement program, we should be sure that the interests of producers, processors, and consumers are all given full consideration.

Immediate and Long-Time Objectives

In discussing future programs it seems desirable to distinguish between immediate and long-time objectives. Until the War is over our principal concern must be to aid in any way we can to maintain production or increase it in the immediate future. The manpower shortage and shortage of funds make it necessary that we give very careful consideration to putting first things first. It has been necessary to put some long-time projects on the shelf, or at best pursue them only as may be necessary to avoid losses of such information and materials as have been gained. Much of our effort for the duration is being devoted to increasing seed supplies of new varieties, assuring a supply of pure seed of superior varieties, and the control of insect and weed pests and diseases.

While present production must be given primary consideration, we must not lose sight of the fact that after the War there will be serious problems. For one thing, we probably will have a surplus of wheat rather than a deficiency. This does not mean that research should be less; merely that it should be directed to somewhat different objectives. Specifically, this seems to me to mean more attention to quality and a continued effort, or more effort to control diseases and eliminate hazards of all kinds so that production may be more nearly stabilized and costs of production reduced. This would mean more certain production from fewer acres and more land in sod crops. It will also mean higher average yields per acre but less variability from year to year and fewer abandoned acres.

Some Specific Objectives

It is relatively easy to generalize. Probably all can agree that we need varieties that are satisfactory to the farmer, the miller, the baker, and the consumer; varieties that will make excellent bread, either alone or blended with weaker wheats; varieties resistant to the many races of the rusts, smuts, and septoria; to winter-killing; varieties that do not lodge or shatter; and those that mature early in order to distribute harvest labor. It is only when we come to consider specific objectives, the relative importance of each and means of attaining them, that the problem becomes difficult. The main reason for this difficulty is that we do not know enough about these objectives. It is my belief that the outstanding reason for the success attained in improving cereals in the last 30 years is that attention has been directed to the attainment of specific objectives, rather than merely breeding for high yield of quality. It is pertinent to note, however, that the desirability of the objectives that we attacked first was well established. There scarcely could have been any doubt, for example, as to the desirability of producing rust-resistant varieties of spring wheat or bunt-resistant varieties for the Pacific Northwest, or early-maturing varieties of winter wheats. As we gradually attain the most obvious objectives, however, our knowledge of those that remain is relatively less unless at the same time we have made a serious effort to add to that knowledge. It seems worthwhile, therefore, to consider some of these specific objectives and to raise the question as to whether we have sufficient knowledge of their importance and interrelations; and if not, in what way should our information be amplified?

Wheat Quality

If we have a surplus of wheat after the War, as appears probable, the quality of hard winter wheat may be even more important than now. There has been much discussion and considerable disagreement regarding the standards of quality that should be met by new varieties developed in the breeding programs. It seems to me the Kansas Wheat Varietal Committee took a very sensible stand on this question when it suggested that varieties ranging in strength from Blackhull to Tenmarq or Comanche, with a preference toward the stronger varieties, should satisfactorily meet requirements of the milling and baking industry.

Methods of testing quality characteristics have greatly improved in the last dozen or 15 years, so that we are in a much better position to evaluate quality than we were, say 25 years ago. Our information, however, is far from complete. We particularly need to know more about the characteristics of protein from different varieties which determine the value of flour for making bread. Probably the greatest immediate need is for rapid and inexpensive tests applicable to small quantities of grain such, for example, as the disc tests for durum wheats, the viscosity, pearling, and particle-size tests for soft wheats, and hydration tests for hard wheats described yesterday by Mr. Finney. Concomitant with this we must have information as to the interrelations between various quality characteristics and the relation of environment to them.

We need to know whether the high test weight of Chiefkan and Red Chief can be transferred to other varieties without, at the same time, transferring the undesirable protein characteristic of these varieties. Messrs. Finney and Heyne have made a good start on this problem. As they no doubt realize even better than most of us, other quality factors and 500, or even more, rather than only 50 segregates should be studied. If, for example, we had results from several tests such as hydration, viscosity, pearling, particle size, and, of course, baking tests with various formulas with, say, 500 segregates or crosses between Chiefkan and one or more of our leading commercial varieties for 2 or 3 years, we would not need to be speculating as to the possibility of getting the desirable test weight of Chiefkan and Red Chief combined with the desirable protein qualities of Turkey and other varieties. We would know that high test weight and certain protein characteristics can or cannot be separated. And, if so, we would probably have at hand the desired combination in a single selection. This illustrates a point often overlooked in research; that studies undertaken to secure an understanding of important relations may be expected not only to supply us with necessary information on which a sound breeding program can be based, but also the new varieties with the desired characteristics.

Early Maturity and Winter Hardiness

Another problem very much in need of study is the relation between early maturity and winter hardiness. One of the striking things about a varietal test in the hard winter wheat region these days, as compared with 30 years ago, is the predominance of early varieties. We used to think of Turkey as being moderately early. In a bulletin prepared by the Department in 1921, Kanred was hailed as an early-maturing variety because it ripened about 2 days earlier than Turkey. Kanred is now late as compared with the new varieties Pawnee and Comanche which mature nearly a week earlier. Wichita is still earlier. This gain in earliness has been achieved only at a sacrifice of some degree of winter hardiness. Probably the gain far outweighs the loss, but we would like to have both and so far as anyone knows it is possible to have both, at least to a greater degree than we have. Plant breeders, however, are going to be seriously handicapped in achieving this objective until we have a better understanding of the relation between time of maturity and winter hardiness. We know they are related but we also know there are various kinds of winterkilling, and probably time of maturity is not the simple character we are sometimes prone to believe. Carefully planned research should develop not only the relation between earliness and hardiness, but also, if it is possible to secure it, the variety possessing the desired combination of characters. The degree of earliness that will give best results in the different wheat-growing areas should also be determined.

Disease Relations

We are also in a vulnerable position with regard to information on the different factors governing resistance to the major diseases and the specific races of a disease against which each factor provides resistance. If we had this information and could locate factors for resistance to new races as soon as they appear, it would be possible to breed adapted varieties resistant to new races when they appear in a region, quickly and efficiently.

With diseases such as the rusts, where great quantities of inoculum may move long distances by air, a close watch must be kept on the races present in the entire wheat-growing area from Mexico to Canada and to the east.

It seems particularly necessary, at this time, that we have more information as to races of leaf rust and possibly stem rust. The principal advantage claimed for Kanred wheat, when it was introduced, was its resistance to the races of leaf rust and stem rust then known to predominate in the hard winter wheat belt. It was specifically noted that where these diseases were absent Kanred was frequently no better than Turkey. We no longer classify Kanred as a resistant variety, not because it has changed, but because conditions have changed. Races to which it is susceptible are with us every year. A comparable situation was present last year in the spring-wheat belt when new races attacked varieties formerly resistant to leaf rust in the field. The same situation has been encountered in the soft-wheat belt.

It is generally known that disease problems in the hard winter-wheat belt are highly correlated with those of the areas to the north, east, and south. We know that rust spores are blown north in the spring to infect the spring wheat and back again in the fall to infect the winter wheat, thus providing quick and wide dissemination for new races. The leaf- and stem-rust resistant spring wheat varieties now generally grown should reduce the amount of inoculum that is available to be blown south. Conversely, breeding resistant varieties, such as Austin, for the south should reduce the amount of inoculum to be blown back north. What effect this may eventually have on the prevalence of rust in the hard red winter wheat region is impossible to say. It is a real possibility, however, and it seems certain that we should give more support and emphasis to breeding resistant varieties not only for the hard winter and hard red spring wheat belts, but also for South Texas and even Mexico as well.

The points just mentioned regarding races, movement of spores by air, and prevalence of the rusts may apply just as much to several other diseases about which less is known. We need information not only on the prevalence of other diseases, such as septoria, but also on the potential damage caused by them. The latter information is needed as a basis for determining whether resistance to them should be included in the breeding program. For example, it is doubtful whether at present we would be justified in undertaking a breeding program for resistance to diseases that damage the crop no more than 5 to 10 percent in epidemic years that occur, say, once in 10 years.

Lodging

Probably the greatest achievement in the Pacific Northwest aside from resistance to bunt was the creation and introduction of short, stiff-strawed, nonloging varieties to replace the older varieties which although possessing stiff straw nevertheless often lodged severely because of their height. Severe lodging is now almost a thing of the past even in the more humid portions of the Pacific Northwest. Much progress in the hard winter-wheat belt has also been made in producing varieties that lodge less, but there is much yet to be done, especially for varieties growing on fallow, where lodging may be very severe in favorable seasons. Mr. Atkins has studied the relation between culm diameter or weight and lodging, but we know little about the relation of culm diameter and tillering, which in turn may be related to yield. We also know that culm size is not the only characteristic determining resistance to lodging.

Miscellaneous Objectives

There are many other objectives that might well be considered as time and opportunity permit. We need, especially, to know more about the genetics of wheat and related species. The production of fertile crosses between various species of Agropyron and wheat in Russia, Canada, and the United States, open up some very attractive possibilities, particularly with regard to new sources of resistance to diseases and insects, and possibly greater degrees of winter hardiness and drought resistance.

We know practically nothing about drought resistance and resistance to high temperatures except that together they undoubtedly cause serious and widespread losses. It is unreasonable to assume that these losses can ever be completely avoided and perhaps they cannot be greatly reduced. To assume that nothing whatever can be done, however, is even more unreasonable. Science has performed miracles seemingly as impossible as this and certainly it is not good sense to assume that nothing can be done without knowing more about the problem than we do at the present time.

We also must bear in mind the fact that our wheat-producing area is not one uniform whole, but that it varies not only between large general regions but also within regions. Needs to meet these variant conditions should be met in our breeding operations. One of the real problem areas is the transition area between the hard red winter and the soft red winter belts. In many seasons the hard wheats give the best yields in this area because of greater winter hardiness. Usually, however, they are unsatisfactory in bread-making quality as compared with the same varieties grown in the hard winter belt. Nor are they satisfactory for pastry flour. The soft wheats often go out from winterkilling. Substitute varieties have been neither fish nor fowl. The job is to develop varieties of such gluten and texture properties that in years of low protein content satisfactory soft flour is produced, while in other years the flour will make acceptable bread. There are varieties with these quality characteristics and we need to develop others adapted to this transition zone.

At the present time, we are all concerned over the rapid increase in the acreage of Chiefkan and Red Chief, good in yield and high in test weight, but unsatisfactory in bread-making quality. I have mentioned the necessity for combining the desirable qualities of these varieties with the superior bread-making values of such wheats as Tenmarq and Comanche. While in general we can expect that new varieties combining all desirable qualities will quickly replace the undesirable sorts, there is no assurance that this can be done as easily as our saying so might imply. Greater emphasis must be placed on implementing the farm use of the results of our breeding program. The farmer must be educated to understand trade needs, and he must be interested in supplying these needs in order to protect his future market for wheat.

And finally, we must recognize that trade requirements and production problems are never static. Constant change over the years is to be expected. We must be constantly on the lookout for these new requirements and be ready to meet them as they arise. If we can anticipate them before the public is aware of them, so much the better. In any case we should know our wheats and their potentials so thoroughly that we can meet emergencies with the least difficulty. This can come only from fundamental research on the genetics of wheat, on diseases, on growth characteristics, and on the nature and characteristics of different wheats which determine their values for specific uses or manipulations. Fundamental research should be emphasized and enlarged as the real foundation of the job we must do. Above all, we must have the continued close cooperation of the agronomist, the breeder, the pathologist, the entomologist, the physiologist, and the cereal chemist, and must keep in touch with the problems of the producer, processor, and consumer.

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Following the paper read by Dr. Bayles, the chairman opened the meeting for discussion.

L. E. MELCHERS. Paid tribute to Dr. E. C. Miller, Plant Physiologist, at the Kansas State College, who will retire this spring. Dr. Miller is noted for his research in plant physiology and as a teacher and author of text books on this subject. He has always been much interested in the wheat improvement program, and many of the men now active in this work have had classes under Dr. Miller.

E. G. BAYFIELD. New varieties should be within the quality range of Turkey and Tenmarq so that there will be less variability than at present.

S. C. SALMON. Millers do not give definite answers to quality requirements because of the great variation in quality of wheat needed to produce the different types of flour required by the baker and therefore a range between Turkey and Tenmarq would be too narrow. Such a narrow range would greatly add to the difficulties of the plant breeder to produce such a variety with all the other desirable agronomic characteristics needed.

E. G. BAYFIELD. The quality goal should be above Blackhull.

J. R. QUINBY. Progress should be made by steps. Although a new wheat does not meet the ideal, if it is an improvement it should be released.

J. C. HIDE. Soil fertility will be a factor in wheat quality when soils become deficient in some nutrients. Consideration should be given to this problem.

JOHN H. PARKER. The range should not be extended beyond Wichita or Austin. Austin is a little low in quality, even among soft wheats.

S. C. SALMON. Following the war the demand will probably be for stronger wheats approaching Turkey or beyond. It would be helpful to get a definite reaction from the millers.

E. G. BAYFIELD. Wheat as low as Blackhull should be eliminated.

I. M. ATKINS. Millers first objected to Blackhull and then accepted it. Some in the trade do not object too seriously to Chiefkan in Texas.

E. W. REED. Variety names do not mean anything to millers since they deal in types. Tenmarq grown in some areas may give a Chiefkan reaction. Some system should be inaugurated to label wheat as to its use. Blackhull can be used provided it is in blends. No one can at present make a good loaf of bread out of Chiefkan or Red Chief type. Flour of the pure Blackhull types in the bake-shop causes trouble. The problem of the miller is not in toning down wheats but raising them. The plant breeder should shoot for high quality.

L. L. COMPTON. What kind of a label would Tenmarq sample from Hays have? (Behaved like Chiefkan). (This sample although pure Tenmarq milled poorly because of the particular environment under which it was grown.)

E. W. REED. D group or fourth class.

E. G. BAYFIELD. One year all varieties from Colby acted like Chiefkan.

L. L. COMPTON. Wichita will replace many of the varieties now grown in southwest Kansas.

D. W. ROBERTSON. Colorado farmers want an early and a later maturing wheat to facilitate combine harvesting. Wichita will be used as an early variety. The farmers viewpoint must be kept in mind.

S. C. SALMON. Mr. Reed should be commended for his statements as to trade requirements.

F. D. KEIM. Soil fertility in wheat production and quality must be considered.

E. G. BAYFIELD. Phosphates are improving the quality of soft winter wheat in eastern Kansas.

R. M. SANSTEDT. Recommended that no variety with good agronomic characteristics be discarded. The trade can learn to use them. The baker has changed his mind as to what quality of flour is required and will continue to do so.

K. F. FINNEY. What about the properties of mixing time and baking quality? Blackhull has a short mixing time, but can be used to make good bread even if used pure. New varieties may have a short mixing time as Blackhull but may be superior in protein content. Mixing time is not necessarily related to the blending ability of the wheat or the protein quality.

E. W. REED. The short mixing time of Blackhull is not its only objectionable feature. Although Kansas has good wheat, Nebraska has improved its wheat a lot in the past few years. Now Kansas millers are using Nebraska wheat to blend with some of Kansas' poorer quality varieties. The consumer does not have to use poor quality flour and the farmer must produce the wheat that will produce the flour which will make good bread.

L. P. REITZ. A variety will vary in quality from year to year and also when grown under different environments in the same year. The plant breeder should think in terms of a range in quality eliminating the varieties which are extreme, and should not be limited more closely than the normal range of variation. It is difficult to label threshed grain as to variety. Red Chief and Chiefkan can be identified 90 percent of the time in pure samples and 65 percent of the time in mixtures. More than 50 percent cannot be expected. Labeling can only be done within certain limitations by grouping into four classes as to grain characteristics: A, Tenmarq, Pawnee, Comanche, Iobred, Nebred (occasionally); B, Turkey, and Blackhull (sometimes); C, Wichita and Early Blackhull; D, Chiefkan and Red Chief. The grain grade or variety label is not enough in determining quality.

H. P. ENGLISH. Grain standards need revision but just how is not known. Further study is needed, and is being made.

WEDNESDAY AFTERNOON, FEBRUARY 14, 1945

R. I. THROCKMORTON. Discussed the need of a committee to formulate plans for future work in the Hard Red Winter Wheat area, and moved that such a committee be set up. The motion provided that K. S. Quisenberry, Regional Coordinator, be executive secretary, and that the Director of each station appoint one or more members to represent each State, these preferably to be State men. Seconded by D. W. Robertson of Colorado. Carried.

DEAN CALL. Stated that there should be a balance of interests on the committee, with agronomy, plant breeding, plant pathology, entomology, physiology, and milling and baking represented. He pointed out that it may be advisable to make recommendations to the Directors as to who should be appointed.

Discussion of Milling and Baking Samples

K. S. QUISENBERRY. 3,000 pounds of seed of the uniform varieties were assembled in 1944 and sent to Manhattan, Wooster, and Peoria. The question was raised as to whether it will be necessary to furnish large samples to the several laboratories in the future.

S. C. SALMON. Large samples were needed for study and that it was to the best interest of the wheat program to see to it that the different laboratories get the material needed for study.

DEAN CALL. Agreed with Dr. Salmon but suggested that work in the various laboratories should not be a duplication.

S. C. SALMON. Assured Dean Call that the laboratories were not doing duplicate work and that the samples were needed for fundamental research.

H. H. LAUDE. Suggested that any grain needed should be supplied and that at Manhattan, plenty of seed was available.

J. A. SHELLENBERGER. The same size sample should be continued, but that microtechniques be further investigated so that in the future the sample size could be reduced.

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How Long Should Standard Varieties be Kept in Plot Tests

(At present: Kharkof-Tenmarq-Early Blackhull-Chiefkan-
Blackhull, Cheyenne, and Nebred are included)

K. S. QUISENBERRY. The number of so-called standards has increased until at some stations where the number of varieties is limited, very few new strains can be added without dropping standards.

J. JOHNSON. Should have five standards to represent a range in quality.

K. F. FINNEY. Not too much information is available on Red Chief or Chiefkan. Suggested that these two varieties be continued to study any change in the quality in the future.

DEAN CALL. Questioned whether a variety would change in quality. He indicated that there had been no change in Blackhull.

H. H. LAUDE.
1. Have some old ones all the time.
2. Add or drop varieties according to their merits.
3. A small number, perhaps three, to be grown continuously.

K. S. QUISENBERRY. Raised the question of duplication of varieties in field plots and in the nursery series. Should such duplication be avoided: The opinion of the groups was it should be as much as possible. Some stations have only the uniform nursery and no plots in which case it is desirable to have included in the nursery the standard varieties.

J. H. PARKER. Suggested the need of a better system of large-scale testing with a few varieties being grown at different places in large enough plots so that 10- or 60-bushel lots of each could be harvested for milling and baking comparisons.

G. T. WEBSTER. Reported that in Nebraska the Grain Improvement Association is now growing at three places in that State five varieties each in a 1/2-acre plot. Plots are on private farms and the grain will be milled in Omaha.

R. N. McCAULL. Reported that in the spring wheat area three to six varieties are grown at five or six stations in plots large enough to harvest 35 to 40 bushels of grain. The milling is done by Pillsbury Mills and flour is sent to collaborators for baking. Milling and baking data are assembled and used to evaluate the varieties when the millers and agronomists meet for discussion.

It was concluded that each state in the Hard Winter Wheat area who cared to should carry on such a program of testing and possibly at a later date a coordinated project could be set up between states.

F. D. KEIM. Moved that the Kansas State College and especially the Agronomy Department be given a vote of thanks for providing facilities and acting as host for the Conference. Seconded by Atkins. Carried.

At this point a number of the men found it necessary to leave, but quite a few stayed on for more discussion.

D. W. ROBERTSON. Discussed the question of a uniform date of seeding test to be carried on with a number of the newer varieties. In Colorado there are indications that all wheats do not respond the same to time of seeding, and a question was raised as to whether or not such a test would be desirable. It would be grown in nursery rows with about five dates of planting. The experiment is to be started at Fort Collins and Akron just as soon as labor is available.

H. H. LAUDE. In Kansas there are data from 10 years for four varieties, indicating no differences since all reacted the same, but probably the problem needs more consideration.

ALVIN LOWE. No differences have been observed at the Garden City Station.

L. C. BURNETT. Such a test was tried with oats at Ames, Iowa, in 1944 and some wide differences were observed. The test is to be expanded in 1945.

L. P. REITZ. Indicated that he would be interested in this test just as soon as it is possible to carry on with it and just as soon as some strains are available carrying necessary resistance to leaf rust and hessian fly because such wheat would be needed in Kansas for early seeding.

R. I. THROCKMORTON. Indicated that he thought this was a good idea provided manpower is available to carry on the test.

HURLEY FELLOWS pointed out the importance of such a study from the standpoint of root rot infection.

After more discussion, it was decided that this problem is probably worthwhile, but that final action should be left up to the planning committee. In general, everyone seemed to be interested, but the labor situation at present will hardly permit the initiation of such a study.

L. P. REITZ. Stated that there is a decided need for more genetics work with winter wheat and that it would probably be desirable to set up some kind of a program to take care of this phase of the project.

E. R. AUSEMUS, who is working on a committee of the American Society of Agronomy for the listing of genetic factors in wheat, pointed out how little is really known regarding inheritance in wheat.

R. I. THROCKMORTON. There is need for a centralized laboratory to work on the genetics of various farm crops, not only wheat but also oats, barley, and sorghum.

I. M. ATKINS. Stressed the importance of the damage caused by green bugs and indicated that a more extensive survey of available material should be made in the search for resistance.

D. W. ROBERTSON. Pointed out the desirability of having the superior germ plasm lists brought up to date.

K. S. QUISENBERRY. Stated that until recently this list had been kept up to date; and an attempt made to keep viable seed on hand, but there had been so little demand for the material that the list was dropped.

B. B. BAYLES. Referring again to the need of more research work, stated that probably genetics work alone was not all that should be done, but that there should be more studies done on breeding methods, plant physiology, and various relationships to production.

H. H. LAUDE. Stressed that the efficiency of protoplasm might differ and that there was a need of the study of the inter-relationships between water, soil, temperature, and humidity and that more work along this line is needed and should be considered by the planning committee.

I. M. ATKINS. Raised the question of the danger of spreading diseases such as loose smut when seed is sent to different stations. He asked that more care be taken with the material that is sent out.

D. W. ROBERTSON. There is need for a study of the combining ability of different wheat varieties.

E. G. HEYNE. Stated that he had some crosses now made to study this question.

K. S. QUISENBERRY. Discussed the question of winter hardiness indicating that the uniform nursery had been reduced to four stations, but that there was much interest in the supplementary winter hardiness nursery at the present time. Due to a series of mild winters, so-called tender wheats have moved much farther north than had been expected. Also, it is apparent that in the vicinity of Akron, Colo., winter hardiness does not necessarily mean cold resistance because such varieties as Comanche and Wichita seem to do very well at this station. It is realized that there are different factors causing winterkilling, but some of the new wheats seem to go into the winter with a heavier fall growth than the old Turkey types and this may have some bearing on the survival of the more tender types.

H. H. LAUDE. The planning committee should consider the various types of winter hardiness and the ways in which varieties harden off.

A. F. SWANSON. Indicated that there is a great deal of interest in the pasturing of winter wheat in the fall and early winter and that this is another problem that should be given attention by the committee.

C. O. JOHNSTON. For early seeding and for fall pasture, there is need of varieties resistant to leaf rust and to hessian fly.

B. B. BAYLES. At the request of the group some information regarding perennial wheats was given. It seems that at the present time, the perennial wheats of Russia are still in the experimental stage. The grain looks like wheat and the plants grow very much like wheat, but after the crop is harvested, the second growth is rather slow and in the second and third years, the stands become quite patchy. Apparently, at the present time, nothing of economic value is available for release.

A number of other questions were discussed informally after which the Conference officially adjourned.

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Report assembled by O. J. Webster and E. G. Heyne.