PROCEEDINGS

Ninth Hard Red Winter Wheat Workers Conference

UNIVERSITY OF NEBRASKA

Lincoln, Nebraska

JANUARY 16-18, 1962

UNITED STATES DEPARTMENT OF AGRICULTURE *--*

AGRICULTURAL RESEARCH SERVICE

Crops Research Division

and cooperating

STATE AGRICULTURAL EXPERIMENT STATIONS

in the Hard Red Winter Wheat Region

PROCEEDINGS

NINTH HARD RED WINTER WHEAT WORKERS CONFERENCE

The Nebraska Center
for
Continuing Education
University of Nebraska
Lincoln, Nebraska
January 16-18, 1962

(NOT FOR PUBLICATION WITHOUT PERMISSION)1/

Agronomy Department
Agricultural Experiment Station
Lincoln, Nebraska
CR - 40, 1962

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FOREWORD

The Hard Red Winter Wheat Workers Conference held at Lincoln, Nebraska, January 16-18, was the ninth in a series dating to 1929. The 2½-day conference was attended by 130 workers from 19 states, the District of Columbia, Canada, and Mexico. State and federal research workers, research administrators, and representatives of the wheat industry attended the meeting. The conference was sponsored by the Hard Red Winter Wheat Improvement Committee composed of 28 members from 11 states that cooperate in the hard red winter wheat regional research program. Local sponsorship was by the Agronomy Department of the University of Nebraska.

The Hard Red Winter Wheat Improvement Committee met on the evening of January 15. Seventeen members were present. Dr. A. M. Schlehuber was re-elected chairman of the committee. Other meetings held in conjunction with the conference included the National Wheat Improvement Committee and the North American Leaf Rust Workers Committee.

The conference program was a departure from previous conferences in that it involved a broad examination of wheat problems and wheat research by state and federal workers and industry representatives. On April 9, 1935, Dr. M. A. McCall in a letter to the Third Hard Red Winter Wheat Conference meeting at Lincoln, Nebraska, had this to say: "This conference is tangible evidence of a viewpoint which is going to do a great deal toward the advancement of our crop improvement research. The state agricultural experiment stations and the Department of Agriculture carry a heavy responsibility in assisting to solve the problems of American Agriculture----. Efficiency of production is a factor which must never be lost sight of in any proposed solution, and, likewise, efficiency in research is of paramount importance. The union of forces which this conference typifies is one of the most effective means of insuring efficiency in our efforts---."

It is significant that the statement could have been directed appropriately to the Ninth Hard Red Winter Wheat Conference, also meeting at Lincoln, Nebraska, 27 years later; for the goal of this ninth conference was an examination of problems and research needs in wheat quality, production practices, and genetics and breeding as a basis for the development of a program leading to improved production and marketing efficiency in hard red winter wheat.

Abstracts and, in some cases, full texts of presentations are contained in this report. A fairly complete account of discussion in connection with formal presentations also is included. Some editorial changes were made in the interest of brevity and clarity. It is hoped that the ideas expressed and points wade were not altered appreciably by these changes.

A large word of appreciation is due Dr. Schlehuber, chairman of the hard red winter wheat improvement committee, for his leadership and many contributions to the development of the conference program. My thanks also are extended to the local arrangements committee composed of John Schmidt, Rosalind Morris, Paul Mattern, and Jerry Eastin and to the staff of the Nebraska Center for Continuing Education whose efforts made possible the smooth functioning of the conference. Finally, a word of thanks is extended to the several organizations which sponsored the dinner on January 15 and coffees during the conference.

V. A. Johnson
Regional Wheat Improvement Leader

Conference Work Session

Quality of Product (Market Requirements)

General Considerations

- Domestic market quality requirements
- Export market quality requirements
- Weather (temperature, moisture,etc.)
- Choice of varieties
- Kind, rate, and time of application of fertilizers
- Use of irrigation water
- Insect and disease effects
- Harvest and handling
- Processing techniques and requirements

Goals of Session

- Evaluate quality research contributions to production efficiency and marketing
- Consider projected quality contributions to production efficiency and marketing
- Identify research required for projected contributions

Conference Work Session

Production Practices (Farm Operation)

General Considerations

- Choice of varieties
- Machinery
- Soil management
- Water management
- Erosion control
- Use of fertilizers
- Disease control
- Insect control

Goals of Session

- Identify and evaluate contributions of various research disciplines to winter wheat production efficiency
- Identify specific problems of winter wheat production
- Relate production problems and trends to present and future research needs

Conference Work Session

Genetics and Breeding (Varieties)

General Considerations

- Agronomic characteristics (Yield, test wt., plant type, etc.)
- Physiological characteristics (winter-hardiness, drought resistance, etc.)
- Quality factors
- Disease resistance
- Insect resistance
- Present and future roles of Experiment Stations and Private Enterprise in genetics and wheat breeding

Goals of Session

- Role and contribution of varieties to marketing and production efficiency
- Identify production and marketing problems associated with HWW varieties
- Examine future contributions of varieties in the light of current trends in genetics and wheat breeding

Research Program Leading To

Improved Production and Marketing Efficiency in Hard Red Winter Wheat

Conference Theme

HARD RED WINTER WHEAT IN THE NEXT DECADE

Program

Morning, January 16

Afternoon, January 16
Chairman, R. V. Olson

Morning, January 17
Chairman, I. M. Atkins

Afternoon, January 17
Chairman, T. E. Haus

Evening, January 17

Morning, January 18
Chairman, J. W. Schmidt

Afternoon, January 18

Conferences with University of Nebraska staff and visit Nebraska wheat research facilities.

TUESDAY MORNING, JANUARY 16

Chairman, A. M. Schlehuber

WHEAT RESEARCH - PAST, PRESENT AND FUTURE

An Administrator's Views
Louis E. Hawkins, Director
Oklahoma Agricultural Experiment Station

You outstanding scientists who make up this Conference, dedicated to the improvement and advancement of wheat, and your illustrious professional forebears, individually and collectively, have written an enviable record and established a highly merited reputation, for remodeling one of the most ancient plants of civilized agriculture, and remolding an industry, based upon the fruit of that plant, for greater usefulness to mankind.

It would be both redundant and presumptious for me to attempt to recount the steps of progress which reflect the marvelous research accomplishments with this miracle plant in the past fifty years. Intimate knowledge of that story is a vital part of your stock in trade. Perhaps it would not be out of order, however, for me to undertake to describe and evaluate the current status of wheat in the United States, with emphasis on The Great Plains; and to attempt, with you, to take a look at the potential future of the crop, through research.

Incidentally, definitions, specifics and selected names, while useful in their place, usually are delimiting and restricting if not an outright strait jacket. If you take to heart some of the notions that will be shot at you later in this little harangue, you may conclude that Hard Red Winter Wheat, much as you love it, is a trammeling moniker for your Conference of would-be unfettered scientists. If irrigation water, and sacked or bottled nitrogen, should make Soft Red Winter, Soft Red Spring or even White or Speckled, another wheat to grow profitably in the Great Plains States would you shun the potential because your name, Hard Red Winter, excludes all else?

My petition here is that you wipe your minds clear if you will, not necessarily clean but clear, and dwell upon the possibilities, with no thought for the difficulties. A dear old mentor of mine, since gone to his reward which is a rich one, I am certain, said to me on occasion, "Louis, let your mind run, without let nor hindrance." So, let your minds run, if you will. You have all to gain by it for the next few minutes.

The Status of Wheat in the United States

1. Domestic consumption is static, <u>in toto</u>, notwithstanding domestic population increase.

2. Export is substantial under either or both of two subsidies: 1) outright market export subsidy; 2) give away in so-called foreign aid. Substantial export at world prices, with no export subsidy, will occur only under some sort of a domestic 2-price system.

3. The quality of the wheats grown throughout the United States, as we now define quality for an end use, is generally good and generally fairly uniform for a specified kind of the market product. Example, hard red winter.

4. The range of characteristics of the grain as it moves from field to storage, transit or mill, within a major growing area, is quite narrow and restricted, generally. Eighty per cent of the Great Plains area grows hard red winter, one-fourth of the Great Plains grows hard red spring, it is white wheats in the Northwest, and soft winter in the Corn Belt. Furthermore, the genetic base of most varieties within such a major growing area is relatively common to all such varieties, with attendant restriction or limitation in adaptability among the group of varieties to take advantage of unusual conditions of weather, disease or other adversity or opportunity.

5. Wheat is a valuable feed grain. It never has been developed for feed uses primarily, in the Great Plains.

6. Much attention has been given to development of wheat in The Great Plains for drouth resistance and per acre yield without fertilizer. Very little emphasis has been placed on ability to respond favorably to water (supplemental irrigation or favorable rainfall) and to added fertilizer, and still retain quality.

Now The Look Ahead

The foregoing observations have been presented as/partial, though a very important part, of the status of the crop and commodity. Now for a venture of desirable objectives for the wheat of the future:

1. The most valuable and profitable outlet for wheat will continue to be as a food commodity. But American bakers typically turn out unpalatable bread; hence the rapidly decreasing per capita consumption of wheat. There is critical need for tasty breads and coffee cakes that will please the palate. To say that the battle of the bulge which men and women fight with such unhappy determination nowadays accounts for the ever shrinking taste for bakery products is a dodge and an alibi. The plain fact is that the flavor and pleasant feel, in the mouth and stomach are not there, to compete successfully with other starchy, sugary and fatty foods.

   There is a crying need - certainly the wheat grower and trade may well cry for it - for wheat food products that people will eat, in quantity. And an assortment of such foods, in quantities, might well call for production of an assortment of wheats for specified food uses.

2. Quality characteristics of wheat grain are most difficult to predict or measure in the truck or bin at present. We desperately need quick, dependable tests for important internal characteristics of the berry. This need will be even greater if a wider assortment of wheat foods is offered to the not-so-hungry American consumer.

Incidentally, an increasing number of our people will depend upon industry and the restaurant for mixes, doughs, half-baked and fully finished products in the future. These large volume operators and suppliers fortunately can better standardize ingredient and product than the housewife can. Dependable and workable tests for quality characteristics of wheat and flour are further highlighted when related to such quantity cookery.

3. There is serious question whether the number of good varieties of wheat is extensive enough to best meet the varying and localized conditions of soil, moisture, temperature, disease, insects and other variables which exist throughout The Great Plains. Let's concede, however, that the quality and many of the agronomic characteristics of the varieties that are to be grown and marketed in any one community or sizeable section, say several counties, <u>should be sufficiently uniform</u> to <u>permit</u> indiscriminate mixing in the truck, car and bin.

   Since no living organism rises perceptibly above the ceiling of its blood lines, wouldn't it be well to broaden the genetic base of our wheats, for insurance against unexpected onslaughts of insects, disease, drouth, cold, storm and delayed harvest; and to permit the crop to take advantage of better than expected climatic and plant nutrient conditions? Also, there must be varied local conditions of soil topography, nutrient content and drainage, within a sizeable community, to be met with appropriately different varieties every year, each variety for its set of local conditions.

4. Millions of acres of wheat land in the Great Plains, land better suited to the growing of wheat than any other crop, could grow wheat profitably at today's feed grain prices. If the usually effective talent and attention of the wheat breeder were turned to increased acre yield of feed grain quality, under supplemental irrigation with fertilizer, there's no telling what sort of acre return could be had from the land put to such use. One hundred bushels per acre would contest the better hybrid sorghums, and there would be wheat pasture additional presumably; also, another crop with a different growing season than sorghum for a choice and a chance of success.

   If the corn growers have succeeded in outlawing wheat as a feed grain it is high time the wheat growers did some balloting in their own interest and in the interest of The Plains States.

A Recap

1. Wheat is a miracle plant, pliable in the hands of the plant breeder and a staple in the food supply and economy of man ever since the dawn of civilization.

2. Wheat in The Great Plains of the United States has been reduced and restricted to a small number of varieties, highly similar to one another in composition, character and genetic base. This uniformity has been carefully built in on demand of the trade for a wheat for one specific use, mainly, baker's bread.

3. Opportunities in the future, through research, invite attention to:

   a. Development of a wider assortment of palatable wheat foods;

   b. Development of a wider assortment of wheats to go into such new foods, and for feed grain, and to better adapt to variables of growing conditions;

   c. Dependable and workable quick tests to measure internal character of the berry and to predict its performance in the mill, the mix and the end product.

It is a multi-faceted job and might well be approached by parceling the several segments of the program out among yourselves. How adequate is the latest version of your published program toward delineating such a broad-front undertaking? How good is your imagination at visualizing new uses for wheat and new kinds of wheat to fill some of those new uses? Finally, how venturesome and ambitious are you toward making new work for yourselves and plunging into it with new zest, anticipation and enthusiasm?

QUALITY OF HARD RED WINTER WHEAT IN RELATION TO MARKETING AND PRODUCTION EFFICIENCY

Leonard W. Schruben
Kansas State University

The marketing system is designed to supply products in a form and at a time and place desired by the consumer. If it worked perfectly you would always know what consumers wanted. The greater or lesser knowledge you have about what kinds of wheat consumers want the greater or lesser degree of perfection there is in that part of the marketing system.

In the final analysis, the consumer is boss. We all know that a technically perfect product can be a failure in the market. Our efforts at this conference and away are directed ultimately to provide a consumer's item that will meet with his acceptance. We are concerned with the final product, even if our work only remotely brings us into contact with consumers.

But wheat is not a final product. It enjoys a derived demand; a demand that exists because consumers demand products made from wheat. A given product, say bread, can be made from a large number of different kinds of wheat. Thus each of these different kinds of wheat compete in the market for inclusion in the final product.

More realistically, each end product more often than not is made from a blend of different kinds of wheat. The blend used in a given instance depends upon a number of factors. Technical feasibility sets the boundaries of substitution and combination. Economic feasibility determines within these boundaries which of the different kinds of wheat will be included.

Buyers will not pay more than necessary to obtain the components for the blend or mix of wheat which will result in a satisfactory final product. When low protein wheats are available at very low prices, high protein wheats will bring high premiums, if they are in short supply. The problem is to find the least cost combination.

As a consequence, workers improving wheat for specific end uses must never overlook the fact that end use may change over time. The principal use of wheat is for human consumption. The hard wheats contain a relatively large quantity of strong elastic gluten, an essential characteristic for bread making.

If you neglect to consider end uses, you may find out you have perfected something no one wants. As a result, I suspect, this factor stimulates multipurpose research.

Two important considerations need to be taken into account. One is quantity, the other is quality. Over a long span of history, efforts to improve yields have no doubt received the greater emphasis.

What about the supply-demand balance for wheat in the world? Where are the markets for Hard Red Winter Wheat? What quality characteristics are desired in these markets?

Wheat has not shared in expanding U. S. markets as a result of population growth as have some other farm commodities. The amount of wheat used for food in the U. S. has remained steady at nearly 500 million bushels. This trend is shown in Figure 1.

The effect of population growth has been almost exactly offset by a decline in the amount consumed per person. These two trends also are shown in Figure 1. It would be a substantial accomplishment to hold the consumption per person at present levels. If this could be done, markets in the U. S. could expand as population grows.

The grain marketing system in the U. S. has gone through a substantial change the past 15 years in the identification of wheat as it flows through channels. Point of origin has become an important factor in wheat pricing. Those who early advocated this procedure were almost universally met with a "can't do" attitude.

How, they asked, can you hope to keep wheat separated by points of origin as it flows through market channels? It wasn't easy, but it is being done in the domestic market.

Several years ago, market researchers at K-State were examining the ability of the market system to reflect quality premiums and discounts to farmers. We were concerned with eliminating poor quality wheat which had high protein, high test weight and high yield. Pleading with farmers had little or no effect on the kind of wheat they planted. Premiums and discounts were not reflected to individual farmers.

Premiums for wheat having the same grade and protein out of Imperial (Nebr.) brought 26 cents per bushel more in Kansas City than from Southwest Kansas. This research set the stage for the discount in the price support level for undesirable varieties. The variety problem was solved as soon as premiums and discounts were put into effect and began to affect earnings of individual farmers.

Today, it is almost universal practice for domestic millers to specify origin of wheat. The grain marketing system has responded by making it possible to acquire wheat and know the area where it was grown. What was believed impossible a short time ago now is commonplace.

Our grain production and marketing system needs to go through much the same sort of change to supply the growing foreign market. The exact same procedure may not fit the foreign market, but changes of comparable scope may well be in order.

It has been said that man is born hungry. For many millions in the world hunger is a way of life. Nearly 2 billion people today live in 70 countries where there isn't enough food. Hunger, starvation, and famine are well known to these people who make up two-thirds percent of the world's population.

The remaining one-third percent of the human race live in 30 industrialized countries where there is enough food. New knowledge of how to produce food has made hunger largely unknown in these countries. How much more food

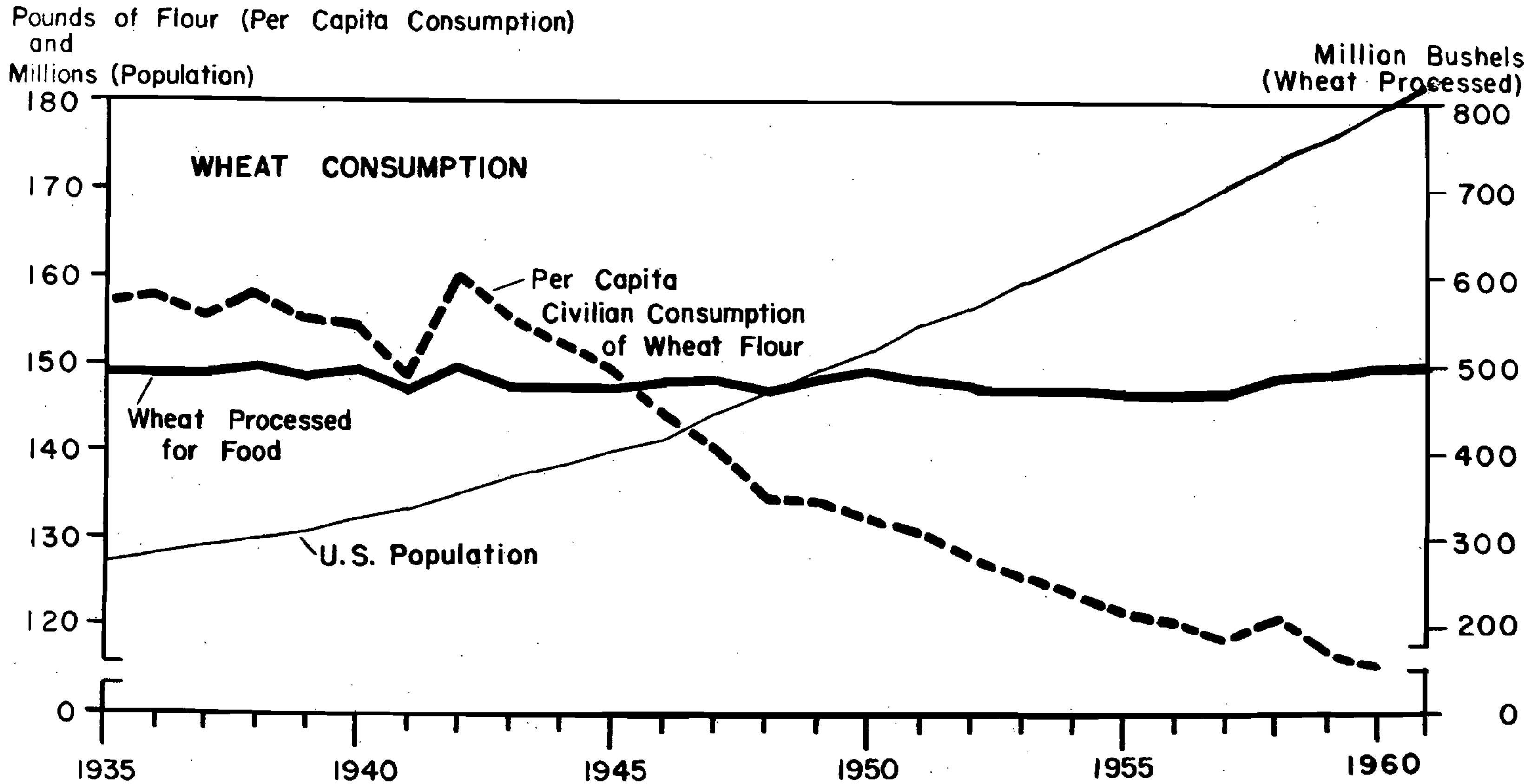

Fig. 1. Wheat: per capita civilian consumption of wheat flour, wheat processed for food, and U. S. population, 1935-1961.

do these hungry nations need? A tentative answer is available in a report recently released by the U. S. Department of Agriculture.[1]

This report indicated the food needs and food supplies of 100 countries in which 3 billion people live. Information on a country by country basis as well as for different commodities is shown in this report.

In order to estimate how much food is needed in any given country, minimum nutritional standards were estimated. A group of nutritionists took into consideration such things as the size of the people and the climate of each country.

Supplies of different kinds of food were then estimated, taking into account home production as well as food brought into the country from outside. These supplies were then matched against requirements to give an indication of too little or too much of each type of food available in that country.

The equivalent shortage of over 1 billion bushels of wheat was reported and is of special interest to the group assembled at this conference. This 1 billion bushel wheat equivalent deficit is in addition to all the wheat now being exported.

Clearly there is a human need for all the food that can be produced. The problem is to achieve economic balance so that this need can be translated into market demand. Just as clearly, export markets must be maintained if the region represented at this meeting expects to grow wheat.

If our wheat exports ever dropped to the average before World War II, Kansas and its neighboring states could forget about growing wheat. There still would be a surplus.

Holding and developing world markets isn't an easy job. We have strong competition because Canada, Argentina, Australia, and recently Russia also want to sell wheat.

The big reason we have a stake in sending more wheat to foreign countries is the build-up in supplies here at home. Our economy depends a lot on finding a market for wheat. Unless a market can be found, our people must turn to other occupations and for farmers in the main wheat areas, no other crop seems as well adapted.

Since 1951, the supply of wheat has risen rapidly. Figure 2 pictures the three principal ways U. S. wheat supplies are distributed. It shows that domestic use (wheat used in this country for food, feed, seed and for other purposes) has remained fairly stable since the mid-1950's at a point slightly under pre-World War II levels.

Also shown is export volume of wheat. Notice this goes up and down from one year to the next. The export market has become as important as the home market. This wasn't true before World War II. During the period 1935-43, the very thin band marked "exports" in Figure 2 shows that the U. S. withdrew from the foreign market.

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1. Detailed data are published in a report, "The World Food Budget, 1962 and 1966," published by the U. S. Department of Agriculture (Foreign Agricultural Economic Report No. 4, October, 1961).

The third part of the chart is the reason why farmers must find markets or quit growing wheat. It is the "carryover" that has been building up year after year.

A reasonable amount is needed for emergencies. In a world of uncertainty there isn't any sense of running short on food if it can be helped. This means that the carryover isn't all "surplus" by any means. But most people now agree that there is enough wheat on hand.

Clearly, the challenge is to expand markets at home and abroad or reduce wheat acreage still further.

Building export markets isn't easy! Wheat surpluses are world-wide. You can see in Figure 3 that production in the four major exporting countries has increased since 1930. Wheat acreage in these same countries has been reduced.

The other countries need to find markets too. How we manage our wheat industry has an impact on our total international situation.

Experience has demonstrated that price cutting by the U. S. is met immediately by other exporters. We are the only major trading nation seriously attempting to maintain a private grain trade. The challenge is to preserve this system in a world of state trading monopolies.

Wheat exports have been expanding since the mid-1930's. This can be seen by looking at Figure 4. Here is shown a comparison of the home market for food use and the export market. You can see how much more wheat is being shipped now compared to pre-war.

Almost every avenue has been tried in recent years to enlarge exports. The government has followed a vigorous policy of expanding export sales and developing new markets. At the same time established markets of other exporting nations have not been greatly disrupted.

Wheat growers also have supported market development work. In eight states, including Kansas, wheat growers pay a small fraction of a cent per bushel to be used to expand markets. Greatly increased sales have accompanied this effort.

The U. S. and Canada are the two largest wheat exporting nations. The quantities each has exported by years since 1930 is pictured in Figure 5. The solid line shows the U. S. export, and dash line - Canada.

During the 1930's Canadian exports remained at a higher level than U. S. Both countries had surpluses. Canada developed a world marketing program whereas the U. S. wheat went mostly to U. S. mills. The grain marketing system in the U. S. over the years was geared to moving wheat to markets within the country. It now needs to develop a means of supplying foreign buyers the kind of wheat they want.

You will notice in Figure 5 that the U. S. exports have been larger than from Canada since the end of the war. However, Canadian exports have not declined as ours have expanded.

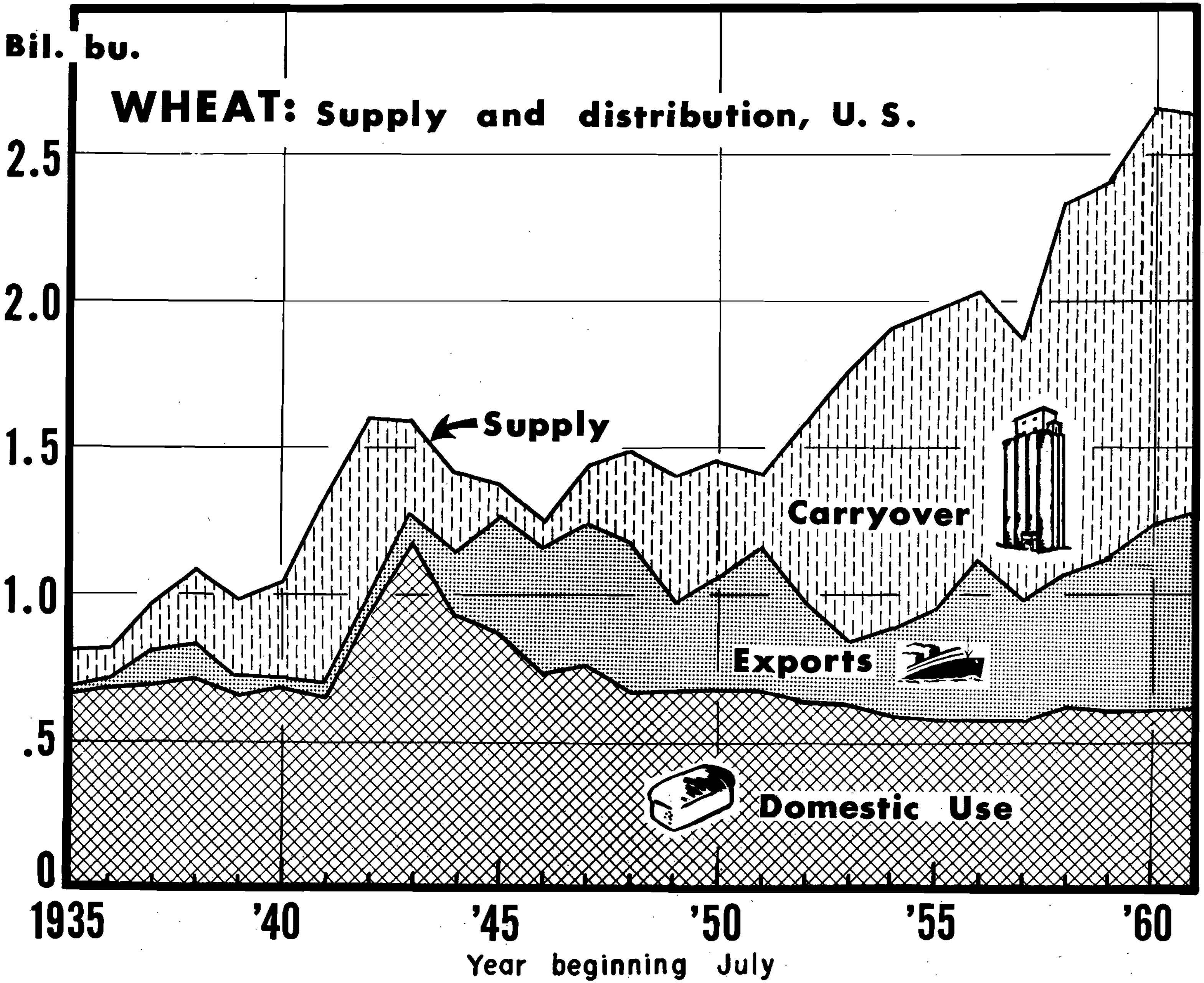

Fig. 2. Wheat: Supply and distribution, United States, 1935-1961.

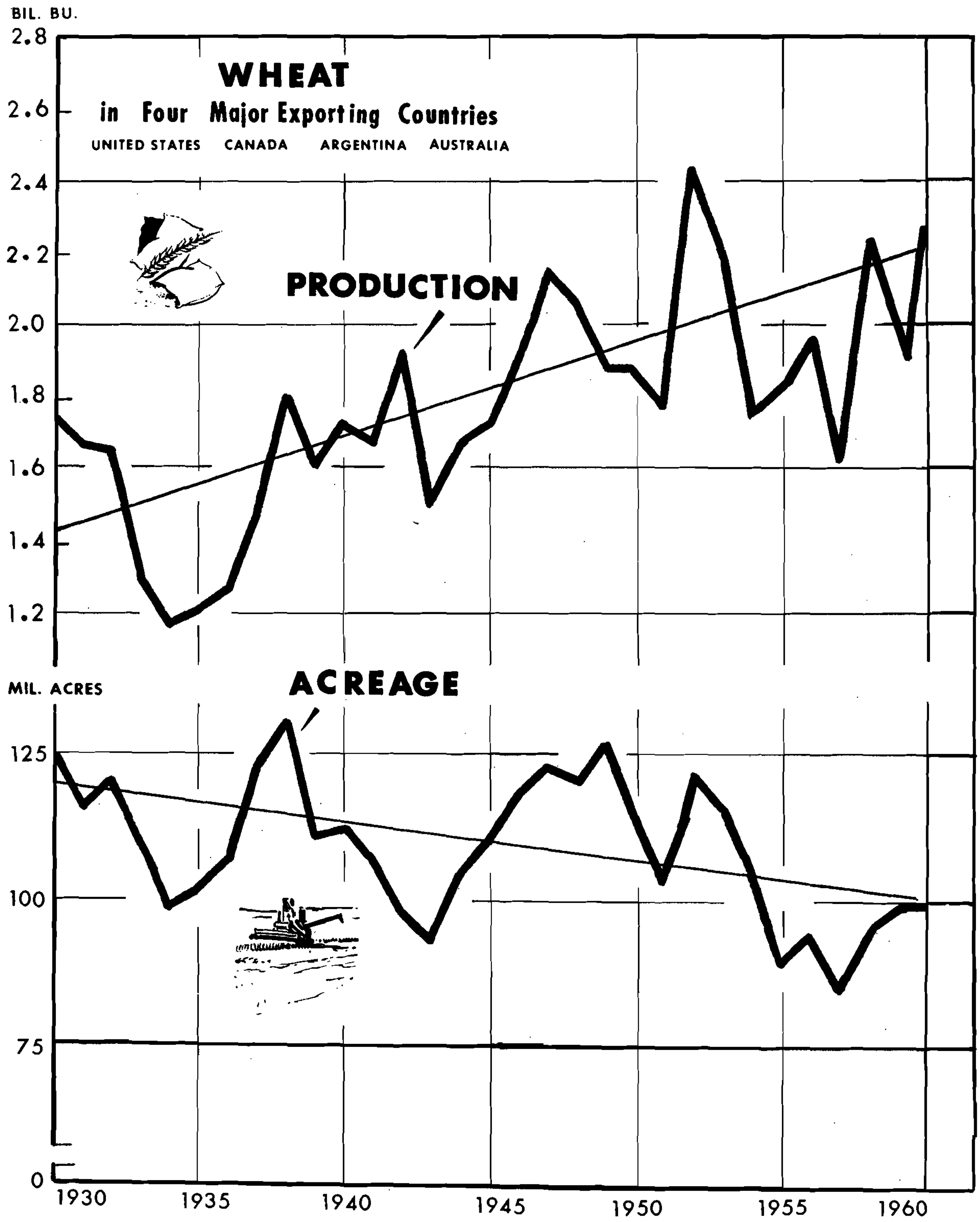

Fig. 3. Trends in wheat production and acreage in 4 exporting countries, 1930-1960.

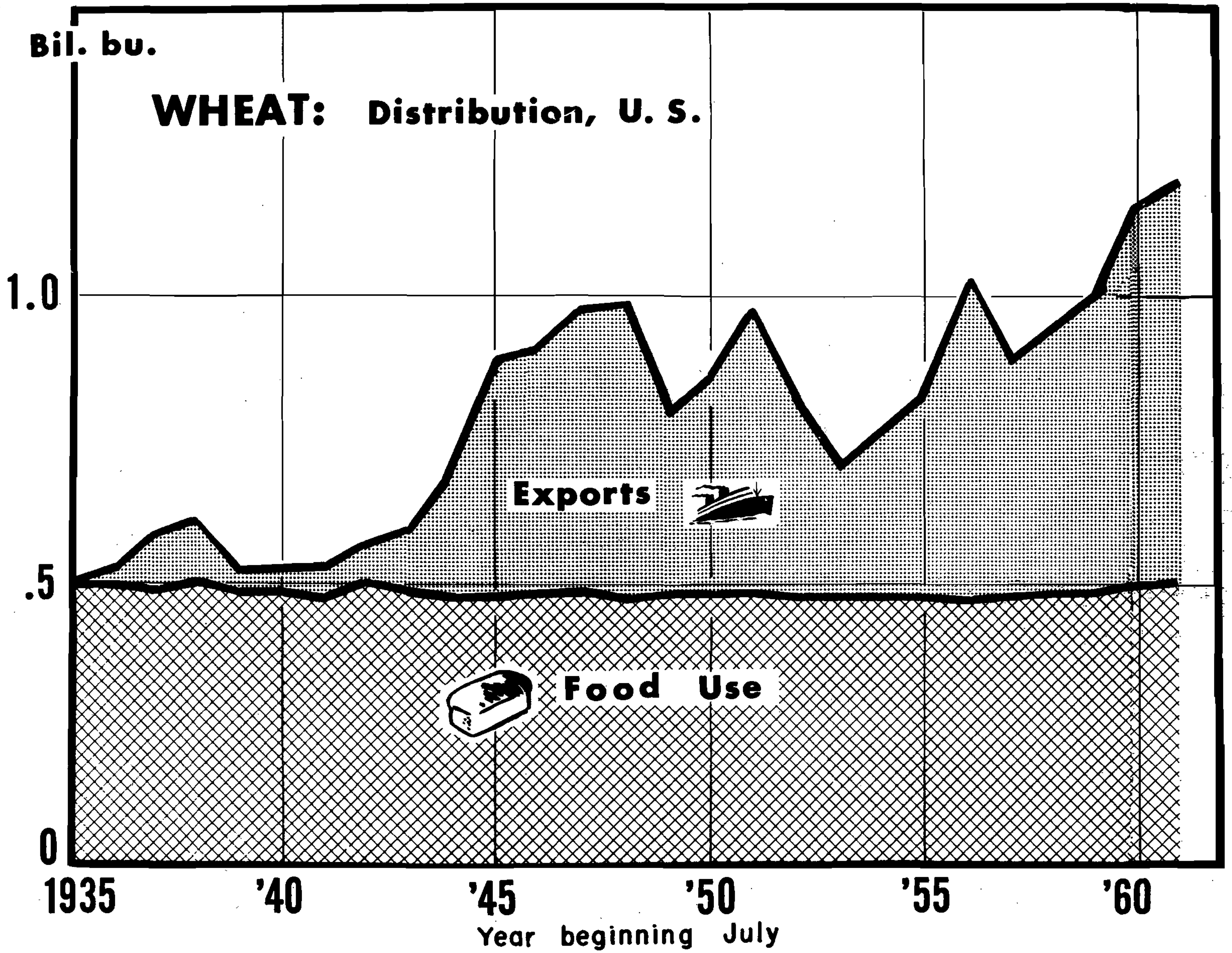

Fig. 4. Wheat: Distribution, U. S., 1935-1961.

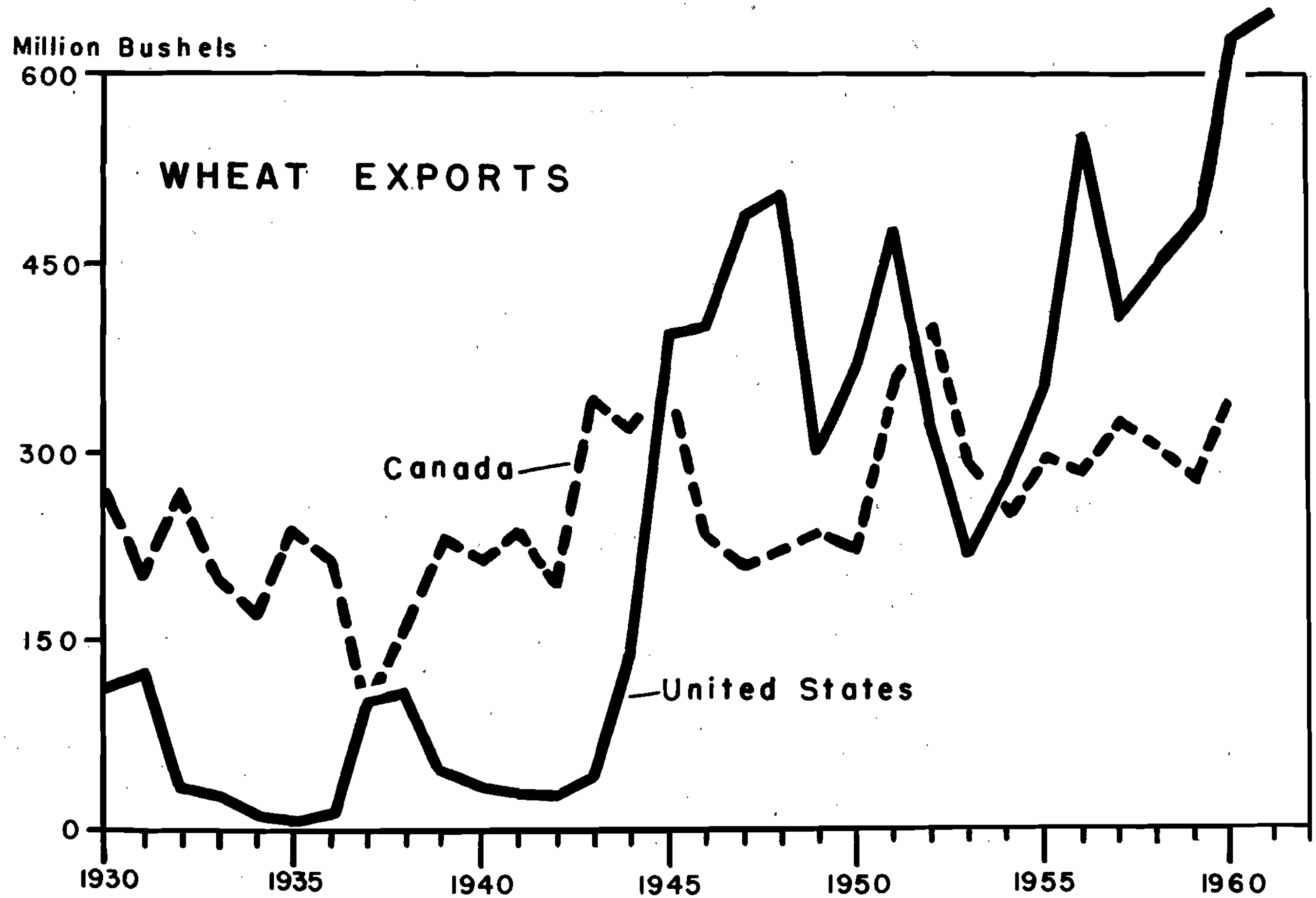

Fig. 5. Wheat exports, United States and Canada, 1930-1961.

Wheat is the largest food resource available for export by the U. S. We can produce in most years 2½ to 3 times more wheat than is used in this country. Plantings of 60 percent of the record acreage presently is providing crops double our own needs.

The importance of the foreign market can easily be overlooked. It is a market which has grown rapidly in recent years largely through special export programs by the government. Currently more wheat is being shipped to foreign markets than is being used for food in this country.

Can we hold the export market to present size, or even expand it? The prospect is for the number of people in the world to double by year 2000. You can get an idea of this growth by looking at Figure 6. These people will need something to eat.

Offsetting population growth to a certain extent will be improved techniques of food production. There is a race between population growth and the ability of the world to feed an increasing number of people. The outcome isn't clear at this time.

Most of U. S. wheat is exported with the assistance of government. Dependence on the whimsical winds of government subsidies is no proper foundation for an industry as large as the wheat industry although at times there doesn't appear to be a suitable alternative.

Within the U. S. we must strive to get our own house in order. We must supply the kind of products our customers want.

For wheat producers this means close attention to growing the kind of wheat wanted in foreign markets while not neglecting the home market. Wheat improvement is the place to start. We can sell only what we grow and if someone else grows a better wheat and is willing to price it below ours, they will supply the market.

Foreign importers do not complain very much about quality if the U. S. treasury finances their purchase. After all, a donee should not look a gift horse in the mouth. If we contemplated a permanent situation where the bulk of our wheat were given to foreign countries our interest in quality would not be very great.

But we do not plan to continue for all time free gifts of wheat. When buyers begin to pay dollars for wheat, they become much more discriminating. However, they may become accustomed to the kind of wheat received from the U. S. under terms of concessionary sales. So, if we send them poor wheat, they may not know that we have good wheat. Thus, wheat improvement is important as a market builder even for that we give to others.

What kinds of wheat do foreign buyers want? This question hasn't been answered very well and cannot be answered in finality except in very general terms. Price-quality relationships are important as well as the quality of wheat grown in the country in question.

In the past few years many trade teams have contacted foreign users of wheat. A summary of the reports is shown in Table 1.

Table 1. Wheat Requirements in Foreign Countries

Angola	80% soft, 20% hard - all imported
Austria	Hard, high protein, strong gluten
Belgium	High quality hard winter
Brazil	High quality durum; HRW
Burma	White
Ceylon	Wheat flour
Columbia	High quality durum; No. 1 HRW, 13% protein
Dominican Republic	High quality durum
Ecuador	No. 1, HRW, minimum 13% protein
El Salvador	Hard winter and spring
Finland	Hard, high protein, strong gluten
French West Africa	Bulgor
Ghana	High quality wheat flour
Greece	Hard, high protein, strong gluten
Guatemala	Hard wheat; Durum
Haiti	High quality durum
India	Strong preference for white; hard red (less than 13% moisture)
Italy	Durum, hard winter
Japan	Government policy favors U. S. hard; bakers' requirement is soft or lower grade wheat for noodles
Kenya	Strong gluten
Korea	Soft white
Mozambique	Hard
Netherlands	Recleaned Hard Winter
Nicaragua	High quality durum
Nigeria	High quality wheat flour
Pakistan	Bulgor
Peru	No. 1 hard winter, 12-14% protein (uniform gluten strength)
Phillippines	Dark northern spring; would like 16-17% protein wheat from West Coast
Spain	11% protein
Switzerland	Hard winter (low absorption requirement)
Thailand	Wheat flour
United Kingdom	Hard
Uruquay	Hard winter
Venezuela	Durum
Central and South America	Need hard wheat to mix with domestic soft wheat

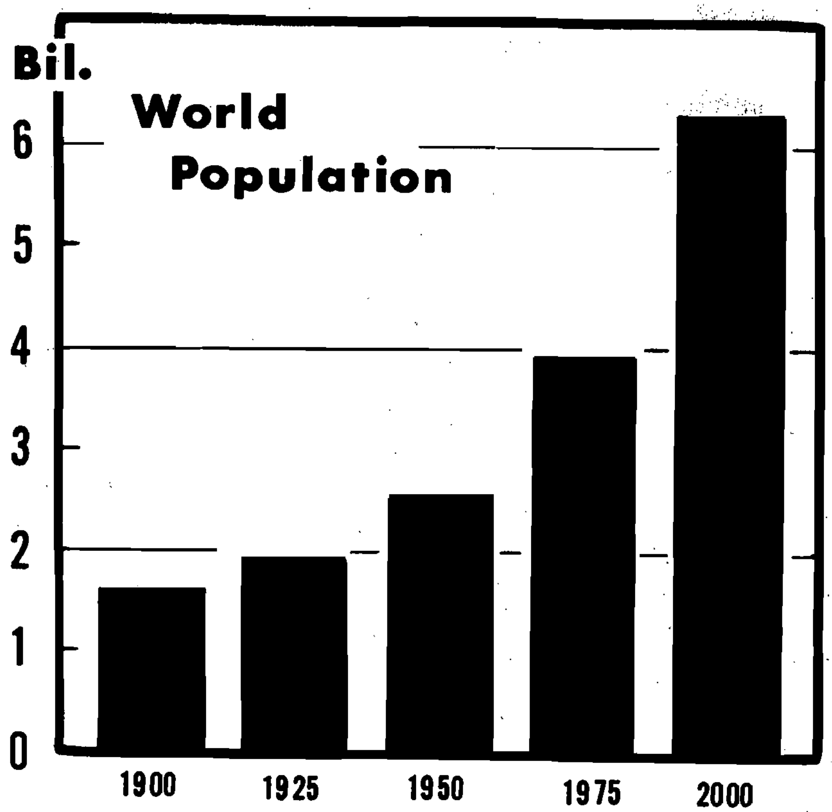

Fig. 6. World population, with projection to 2000.

We need to realize the day of selling just wheat is over; especially wheat going to customers who pay for it with dollars. Attention must be given to supplying wheat that buyers want. This process starts with the kind of wheat we produce. The efficiency of the private enterprise grain marketing system is needed in this effort.

We need more market development work. This activity has many phases. Teaching people to use wheat products is one thing. Helping lower or remove barriers is another.

We should secure and hold a large share of the European market. The European Economic Community presents us with a situation we have never faced before. These 6 countries; Belgium, West Germany, France, Italy, Luxembourg, and the Netherlands have agreed to eliminate trade restrictions among themselves. They are virtually self-sufficient in wheat on a quantity basis. But they need strong gluten wheats to blend with their soft varieties.

We need market research into the kind of wheat foreign buyers want. The summary set forth in Table 1 isn't sufficient as a guide to the many elements involved in wheat improvement.

There is a bright future for the Great Plains in the foreign market if we are big enough to live up to our potential. Properly handled and backed up by sound marketing practices, the U. S. should be able to increase exports of wheat to the billion bushel per year level. We have been exporting about 1 out of 3 bushels of our wheat. Our goal should be to export 2 out of 3 bushels we grow.

Working together to build a market overseas will improve our economic situation and hungry people will be better fed as a result. This would seem to be a very worth-while goal.

RESEARCH RELATING TO PRODUCTION PRACTICES IN HARD RED WINTER WHEAT

James S. Plaxico and Odell L. Walker
Oklahoma State University

We have elected to organize this paper into two separate but highly related sections. Section I is titled Research Perspective and related to the economics, psychology, and philosophy of research planning. We attempt to gain a perspective of research including its orientation, objectives, alternatives, and the implications of its results. In Section II, we emphasize specific interests of economists in the wheat research program. These interests reflect our analysis of wheat production research planning for the next decade, as discussed in Section I. We emphasize the role and potential contribution of economists in the wheat production research effort, because it is probably the least exploited of the disciplines involved in wheat research.

I. Research Perspective

The theme of this Conference is Hard Red Winter Wheat in the Next Decade. The purpose of the Conference is to examine existing research programs and develop a research program for the years ahead. This orientation implies a belief that research can be planned and oriented so as to achieve pre-selected or specified objectives. It further implies that research results or research accomplishments are in some sense predictable. We do not imply that we can perfectly predict results, for there will always be uncertainty attached to resource expenditures for research. Yet, there is ample evidence that if research efforts are allocated in a specific direction, results are forthcoming in this area. Perhaps the development of the atomic bomb during World War II and our current crash program in space exploration are examples of such possibilities.

If we accept the notion that research results are in some sense predictable and results obtained are correlated with effort expended, then research planning becomes an economic question or management question similar to any resource allocation problem. Given limited resources in terms of trained personnel and supporting budgets, the problem is to maximize the accomplishment or satisfaction of objectives. Thus, research planning is basically a matter of selecting and defining objectives, specifying alternative research areas, strategies, or organizations for accomplishing the stated objectives within resource limitations and making a decision.

Objectives are essential for planning research. Whether called basic or applied, the objectives of scientific research are to (1) describe, (2) predict, and (3) control. Flowing from these general objectives are more specific objectives both of a practical or applied nature and of a more basic nature. Certainly a major objective of scientific research is that of the advancement of the various areas of science concerned. Science can advance only if each generation leaves its successor a foundation of basic knowledge on which to build an ever increasing structure of applied accomplishments or results. Basic findings may be a by-product of applied research in the sense that some basic deficiency in knowledge must be filled before an applied problem can be solved. Or, effort may be centered on answering specific questions of fact *per se*.

We desire to predict, control, or describe natural phenomena because we seek to improve the status or well being of society in general or specific segments of society such as individual farmers or regions in particular. Society tends to reap the major share of the benefits or rewards of agricultural research in the form of resources released from agriculture and lower food and fiber costs. Certainly, as additional research is planned, the improvement of the welfare of society should be an ever increasing objective. Lacking such an objective one cannot build a particularly convincing case for the need for publicly supported research efforts.

Individual farmers encounter many problems in organizing and operating their farming units to maximize profits or to achieve other goals. The solution of such problems is obviously an important objective of hard red winter wheat research. Further research related to wheat should be designed so as to improve farmer predictions of the outcome of alternative production practices. Such information would assist individuals in choosing between wheat production alternatives as they proceed with their day by day decision making.

Although we usually think that what is good for one farmer is good for agriculture and we seldom speak of competition among farmers, we should clearly recognize that an important effect, if not objective, of research is to maintain or improve one region's competitive position relative to that of another region. Presumably an important objective of this group is to improve the producing area's competitive position with other producing areas and to improve the competitive position of wheat with other enterprises competing for farmer resources. Obviously, this objective is closely tied and essentially consistent with the objective of improving the welfare of general society. For example, research efforts designed to decrease costs and increase economic efficiency of farm operations in a given area result ultimately in a gain to society. Obviously, however, the resources devoted to such research must be offset by the gain in society welfare.

The objectives of decreasing production costs for a given amount of output and increasing output from a given input are frequently assigned to biological-physical research. The implication is that, since resources of individuals and society are limited, welfare of all will be increased. Cost decreasing innovations have been developed which allow substitution of new resources or production processes for more expensive old ones. Similarly, research on varieties and practices has allowed higher production for given, improved resources. Such innovations have modified real supplies and prices of productive factors and products. Pressures to increase farm size, reallocate resources within agriculture and between agriculture and other industries, and adopt new innovations have clearly resulted. The success of research devoted to development of these innovations is manifest in lower real costs of food and fiber. This success may well be clouded by failure of decision makers at all levels to respond to the adjustment pressures of an innovating industry. The idea that cost decreases and output increases are relevant research objectives is surely sound. However, all involved must recognize that the effects described here require complex adjustments throughout the industry before the desired goal is reached.

In addition to choosing research alternatives according to desired results, researchers can choose according to timing of results. For example, this group could conceivably develop a program which would give quick but small gains in the form of more or "better"products for the same or lower costs. Alternatively, a program could be adopted which concentrates on a sharp revolution in the wheat production industry at some indefinate, distant point in time. In addition to introducing obvious public psychology, and thus, feasibility problems, that course of action would require assessment of impacts of innovations appearing at different points in time.

The interests of the group represented here and our own experiences indicate that wheat research is an integrated rather than a specialized activity. Such an organization implies that individual research disciplines are complementary inputs rather than competitive. An efficient research program requires full utilization of such complementary relationships. Section II of this paper emphasizes the complementary relations of agricultural economists to wheat research. A farmer is taught to use an input combination such that if one unit of an input is substituted for another, output will decrease more than costs or costs will increase more than output. An efficient research group can usefully adopt the same criterion in choosing its research inputs.

II. Contributions of Economists to Wheat Research Efforts

The framework for research orientation presented is clearly relevant for economists as well as natural scientists. Economists have a responsibility to provide data, analyses, and managerial training to decision makers at all levels so that their resource allocation responsibilities can be efficiently met. We can summarize the sorts of contributions economists can potentially make to the wheat research effort in the course of carrying out their research and educational functions as follows:

1. Provide information about managerial choice (e.g., about relevant choice criteria for use in decision making). Such information is useful for designing experiments, choosing statistical tests and selecting forms in which research results will be reported.

2. Evaluate present and, possibly, potential technology. Three interrelated types of evaluation are needed:

   (a) Estimates of effects on individual farmers or areas.

   (b) Estimates of effects on the industry.

   (c) Estimates of effects on society's welfare.

3. Assist in selecting important research problems.

4. Integrate advanced technology into modern, efficient farming systems.

As we look at specific wheat research areas, our suggestions will relate to the types of contributions cited. We will look primarily at research as a means of providing knowledge useful for solving existing or anticipated managerial problems. We shall emphasize that different farmers have different objectives and, thus, different data and managerial needs.

Breeding and Variety Research

Farmers must choose between varieties which react differently to varying climatic, disease, insect, and managerial factors. Researchers can provide data which indicate that, on the average, variety A significantly out yields varieties B and C. Recommendations of A assume that farmers want or can afford to maximize yields over time. In the following we will suggest other ways of analyzing variety data and presenting it to farmers.

Table 1 contains a hypothetical decision problem facing wheat farmers. They can choose between three varieties having equal quality, resistance, harvest and other properties. However, each variety reacts differently to weather conditions S_1, S_2, and S_3. On the basis of average yields, (assuming equal probabilities for the S_j) variety A would be chosen. However, in some years, the farmer would get lower yields with variety A than variety B. If levels of income in every year are critical, the farmer may prefer a variety strategy which assures him of a minimum yield, thus, income, in any year. Such a strategy, derived by use of Game Theory,[1] would be to plant 63 per cent of the land to variety A and 37 per cent to variety C. Assuming that S_1, S_2, and S_3 are representative of all types of years, the lowest yield resulting from that strategy in any year would be 17. Thus, a three bushel gain in minimum possible yield (security level) is obtained with a one bushel sacrifice in average yield. If one variety were preferred, variety B would allow the highest minimum yield (security level) in any year. Other choice criteria emphasizing other outcome characteristics may be used to solve the variety selection problem.[2] In addition, characteristics other than yield level may be included in the outcome description.

Our knowledge of farmer situations and attitudes lead us to conclude, roughly, that some farmers may wish to make the kind of analysis presented here. As a result, experimentation, including choice of experimental material, analysis and research reports may need modification. For example, varieties may be tested or developed which have different reactions to varying natural conditions. Research reports would logically include a full analysis or report of yields and differences between yields of varieties observed under different climatic conditions.

Changes in the structure and technology of agriculture have presented us with new management problems related to varieties. Increased use of irrigation and fertilization require testing varieties under varying moisture and nutrient conditions. Supplementary grazing and grazing out of wheat is highly suited to capital intensive wheat farming. In addition, wind and water erosion hazards, along with low potential return from reseeded perennial grasses, suggests that use of small grains for pasture might be increased. Thus, research on the forage producing capabilities of wheat appears justified. Such research would provide farmers with knowledge necessary for integrated, whole farm planning.

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[1] For a discussion of the application of game theory to farmer decision problems see Odell L. Walker *et al.*, "Application of Game Theory Models to Decisions on Farm Practices and Resource Use," Iowa State Agricultural Experiment Station Bulletin 488, December, 1960.

[2] *Ibid.*

Table 1. Farmer Variety Selection Problem

	States of Nature			
	S_1	S_2	S_3	
	Late Wet Harvest	Favorable Spring Weather	Favorable Fall, Hot-Dry May and June	Average
Variety A	20	33	14	22.3
Variety B	15	30	16	20.3
Variety C	12	25	22	19.7

Fertilization

We can anticipate increased interest in fertilization as more producers become acquainted with opportunities for squeezing more profit out of their resources. Much of the land on which hard red winter wheat is grown will soon have been tilled long enough for organic matter and nutrient depletion to be reflected in fertilizer responses. One objective of fertilization research is to predict yields from different fertilizer applications so that farmers can evaluate costs and returns and decide how much of which nutrients to use. Economists and agronomists have cooperated in many areas to provide this information very efficiently. Experiments have been designed so that a continuous fertilizer response function could be estimated. Economic choice criteria, for example, profit maximization or game theoretic criteria, are then applied to obtain recommendations. Additional cooperation in this research area is needed.

Experiments cannot normally be conducted on each type of soil. Thus, a technique is needed for adjusting fertilizer response functions for one soil to that of another soil. A great deal of uncertainty about fertilizer use exists because: (a) climatic conditions cannot be predicted, (b) limited information is available about fertilizer response under varying climatic conditions, (c) carryover effects of fertilizer have not been estimated, and (d) experiments have been conducted over only a few years and few detailed analyses of climatic conditions accompany experimental reports. Fertilizer research can be designed to reduce this uncertainty. Well planned, long-term experiments or increased use of controlled experimental conditions appear to be the answer. Obviously, controlled experiments will require additional investment in laboratory facilities. However, such facilities may allow researchers to look far ahead at organic matter and nutrient depletion problems, physical and chemical effects on soils and the carryover problem. The challenge of interpreting laboratory data in terms of field results must also be met.

In addition to providing additional data needed, we can make more efficient use of existing data. Frequently, concurrent experiments on similar soils in different areas can be spliced together to secure information about effects of different climatic conditions. One year's data gives two years of results in that way. Climatic variables can successfully be included in response equations estimated by regression. Ideally, the climatic variable would be one affecting fertilizer response which is known before the fertilizer is applied (e.g., February climatic conditions prior to applying N to wheat). If climatic variables are not known before fertilizer is applied, probabilities of different conditions can be estimated for use in long-run profit maximizing models. A number of choice criteria for decision making under uncertainty can be used to devise recommendations for farmers having constraints on their long-run profit maximizing abilities.

Tillage Practices

Machinery costs are increasing over time as capital is substituted for labor and as competition for resources devoted to producing machinery increases. Thus, farmers have an incentive to reduce tilling costs. Uncertainty exists about effects of different tilling practices on costs and returns. Each practice offers a wide range of timing, intensity, machinery, and frequency alternatives. A farm manager must make a choice from the multitude of alternatives. In general, research indicates that farmers tend to over-mechanization and over-tillage. However, recommendations for change must consider the farmer's emphasis on security versus long-run profits, and requires quantification of costs and returns resulting from varying practices.

Currently, minimum tillage systems are receiving research attention. Tillage may range from no tillage with chemical weed control to present, heavy tillage. The research data must come from varied natural conditions so that insect, disease, and climatic effects can be ascertained. The time required for such experiments can be reduced by utilizing a number of different experimental sites.

Important managerial problems facing farmers considering stubble mulch systems are (1) estimating potential values added to land or (maintained in land through stubble mulching), and (2) planning the change in machinery requirements. Effects of stubble mulching might be as indicated in Table 2.

Table 2. Potential Effects of a Given, Minimum Tillage System

	Increase Yields	Decrease Yields	Yields Constant
Increase Costs	(1)	(2)	(3)
Decrease Costs	(4)	(5)	(6)
Cost Constant	(7)	(8)	(9)

Some evidence exists that case (9) may be the true situation. If so, a decision to adopt the stubble mulch program will depend upon expected differences in long-run land productivity as reflected by discounted land values. Even if cases (1), (2), (3), (5), and (8) occur, changes in land productivity may be the key to choosing alternatives. Governmental programs designed to conserve soil resources can be administered more efficiently if program formulators have estimates of tillage systems' effects on land productivity. Agronomists and economists can cooperate in making such estimates.

Few farmers with existing machinery investments can change to a stubble mulch system overnight. Thus, a multi-stage changeover system needs to be devised. Different degrees of stubble mulching can be defined for use during the transition period. Finally, farmers and machinery manufacturers need specific information on types of equipment required for stubble mulching.

A number of other practices require additional research. Farmers need information on costs and returns resulting from alternative seeding arrangements. As pasture becomes more important, early seeding may well be emphasized. Good estimates of grain yields from early seeding, under various climatic conditions, are not readily available for all areas. Data on practices such as fallowing might be reviewed in light of improved varieties, new insect and disease control measures, different tilling practices, including chemical control of weeds and zero tillage, and new techniques for solving decision problems under uncertainty. Agencies such as SCS and ASC look to research for results on which they can build and administer their programs. With the initiation of each new program, agricultural economists, agronomists, and other researchers, are asked for specific cost and return data for practices. Frequently, we must reply that such specific results are not available.

Insect and Disease Control

Alternatives for research on insect and disease control apparently fall into two groups: Genetic control and mechanical control. The two avenues of attack may have different effects on production costs of farmers. Genetic control costs will be borne largely by all of society and farmers will pay a tax payer's share, assuming that the seed resulting from the breeding research will not add to the farmers cost. That is, assuming the seed will be released, produced, and sold at about the same price, once it is established, as the older seed. Mechanical control will require direct inputs of materials and other factors by farmers. However, all of society will pay for the research. Technical considerations will probably outweigh cost bearing considerations. However, we should be aware of our ability to influence direct wheat production costs.

A decision to use an insect and/or disease resistant variety which is at least equal to other varieties in yield and quality is not difficult. A decision model for use in selecting a mixture of varieties suited to different climatic, insect, or disease conditions was presented above.

Producers are also uncertain about when to apply mechanical control measures, what levels of controls to use, and how often to use them. They must balance yield and quality gained against cost of each time, amount, and frequency of control combination. Research must provide the necessary data. One source of such data, which could augment controlled experimental data, is from selected farmers themselves. For example, farmers in the farm management--record keeping--organization in Kansas could be used to obtain estimates of wheat yields resulting from different insect or disease control programs. Statistical techniques are available for analyzing the effects of different locations, soils, and managerial levels in such a sample.

The concept of area or regional control of insects and diseases might well be considered in research. Difficult problems of control success and inter-firm or area conflicts can be traced to infeasibility of micro control techniques, that is, control by the individual farmer, ignoring what his neighbor might do. For example, spraying may damage other crops and new infestation may come from adjacent, untreated fields. The fact that these conflicts or problems do arise seems to indicate that we should consider the possibility of area or regional control. Researchers must devise the mechanical techniques, that is, the technology. Economists and other scientists working together can make suggestions about arrangements for achieving the area or regional control.

Whole Farm Research

Producers, agricultural businesses and governmental agencies are looking into the future of wheat production. Each needs to know what the efficient, economically stable wheat farm of the future will be like. Producers want to evaluate their income potential and make long-term plans for combining resources efficiently. Agricultural businesses want to know what kinds, sizes, and amounts of agricultural inputs to provide. That is, they seek guides for organizing the distribution of their goods and services. Governmental agencies must develop programs for the future which will lead to results consistant with long-term policies. Schools, churches and local governments need to anticipate changes affecting demand for their services so that adjustments can be made more efficiently. Thus, a demand exists from many sources for integration of research results into optimum, futuristic farming systems.

Close coordination between all sciences is required so that a comprehensive view of wheat production can be presented. We have oriented our suggestions for research in specific areas toward providing data needed for the whole farm analysis. Economists have worked with natural scientists to integrate the latest technology in efficient whole farm plans. Such cooperation not only provides best estimates of data required by farmers, other businesses and sociological groups, but also provides a broad perspective of wheat production to the scientists involved. New research problems are frequently uncovered and new vigor in existing research may result.

GENETICS AND WHEAT BREEDING

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Most of the emphasis in plant breeding, ever since man first selected plants for propagation, has been to increase the productivity of the species under study. Because we do not know, we could assume that the first wheats selected by man may have been the progenitors of the diploid species. If this makes the origin of the diploid Triticum too recent, it perhaps is reasonable to assume that man may have propagated some of the first ploidy types to occur, i.e. the tetraploid group of Triticum. The more complex hexaploid certainly has originated within the period of recorded history which gives us late-comers a very interesting species to work with.

It is only natural that man has strived to increase productivity, because the past history of man has been one of a series of sufferings from hunger. The accomplishments of pre-Mendelian breeders and selectors of cultivated crops is much more significant than the advancements made since 1900. That is, I consider the selection from a wild species to a successful cultivar a very remarkable feat. However, the advances also have been great since the birth of genetics in 1900. These changes, or let us say "tailor-made" variations, have largely been accomplished by development of varieties adapted to new areas of production. A statement by de Candolle about 75 years ago is worth quoting:

"I have not observed the slightest indication of an adaptation to cold. When the cultivation of a species advances toward the north it is explained by the production of early varieties which can ripen before the cold season, or by the custom of cultivating in the North, in summer, the species which in the South are sown in winter . . . periods of more than 4 or 5 thousand years are needed apparently to produce a modification in a plant (species) which will allow it to support a greater degree of cold."

I am sure there are many of you here that would like to show de Candolle, if he could return, Minter, Yogo and Cheyenne wheat varieties. These varieties adequately show the development of variations for adaptation to different agricultural areas, particularly if we assume that common wheat actually was Triticum aestivum, i.e., a spring wheat. Such improvements, I believe, can be considered as advances that relatively are of a permanent nature.

Adaptation alone is not the only category in which the plant breeder can improve the crop. It is recognized that the type of wheat we call Turkey, introduced into Kansas in 1873, is the granddaddy of all the wheats in the hard red winter wheat producing area. What has been done to this type of variety? I would say some notable changes have been made. For one thing, a little "starch" has been put in the straw, and nearly without exception, all varieties released since modern breeding programs began, withstand lodging better than Turkey. Again Cheyenne is a good example of this change as well as Blackhull and the excellent lodging resistance in its progenies, BlueJacket and RedChief. Other traits, as less shattering or even easier threshing, shorter straw, higher test weight, physiological features, change of dormancy or maturity all can be considered agronomic characteristics that can and have been altered. Thus it is evident, without giving examples, that success or improvements by plant breeding in improving upon agronomic characteristics is possible and, in general, relatively permanent in nature.

Perhaps the most widely recognized achievement in the field of plant breeding has been the development of pest-resistant crops. Equally good examples of insect-resistant and disease-resistant varieties can be given. Resistance to hessian fly, bunt, leaf rust, stem rust, soil-borne mosaic, wheat-streak mosaic, and loose smut can be found in varieties now growing in the hard winter wheat area. I am not going to name any varieties, but you all know, in general, the large strides that have been made in this category of breeding. Each one of you can shout out your own achievements. If I knew how I would make a big "brag" for all at this time. Although we often use resistant varieties as the striking example of plant breeding results -- and it is -- we still don't have all the necessary disease and insect resistance combined in any one variety. This is because the effort to keep pest-resistant varieties in the field is a continuous race between evolution controlled by man and natural evolution, which endlessly grinds away effectively nullifying our striking achievements. Therefore this category of breeding results can be considered only improvements of a temporary nature.

Breeding for adaptation, agronomic characters, and pest resistance are all operations that have led to increased productivity, whether they are real or delusive. There still is another feature of plants that can be improved upon and not necessarily be considered breeding for or maintaining yield and that is the quality of the species as used for food or feed. Specifically for wheat, this refers to that illusive thing called quality, especially when you attempt to ascertain its value by micro evaluation.

This is one phase of our breeding efforts in hard winter wheats in which we cannot shout too loudly, but I would like to give a big hurrah for such varieties as Tenmarq, Nebred, Comanche, Ponca, Tascosa, Warrior and perhaps Kaw. This, too, is somewhat of a temporary type of improvement and I must hasten to add, as in demand today, the varieties I mentioned are satisfactory. The continuous baking process and air separation of flour and other yet undiscovered processes may rapidly change the quality requirements and, therefore, keep the breeders busy changing quality traits. This is what makes plant breeding so interesting, as life really is not fun without being continuously challenged to use our abilities to their greatest extent.

Very quickly, then, I wish to repeat what I have said. The contributions of breeding developments have been striking and effective. We can consider some of them as being of a permanent nature in that the area of adaptation has been enlarged and certain agronomic features refined. The other advances can be considered as somewhat ephemeral. Not that they are unimportant but that they present ever-changing situations because of the dynamic conditions in nature and man's fantastic progress in mechanical tools and changing tastes.

I hope I do not disappoint too many of you because I have given only a few discreate examples, but I did compile figures and names of varieties, but when gathered together this information seemed dull and uninteresting. Even though such facts emerged, as that of the ten varieties of hard winter wheats now grown on over 1,000,000 acres, none were on farms 20 years ago and some not even grown ten years ago. Really no useful purpose can be served by rehashing our past achievements except that we know what they have been. Neither is it fitting to bask in the sunshine of our successes for this is only a fleeting moment of light and darkness will overtake us if we do not move on.

The value of this conference will come in the work sessions where we will direct our thinking to the future as to how to make further permanent-type improvements in winter hardiness, specific areas of adaptation, create better and more accurate control of parasitic pests, develop better agronomic features and increase our understanding and control of quality characteristics in this great plant species of Triticum.

Many people may question why those engaging in wheat research should be giving so much attention to wheat improvement, particularly in the face of our present hard wheat surpluses as well as other agricultural products in the United States. Of course this is a shortsighted viewpoint. We all know that any breeding work started in 1962 will have no practical impact until about 1975 and even other research done now in wheat may not come into full practice for another 25 years. Some people have predicted a tremendous population explosion by that ime, and I for one believe a surplus of essential items is much better than a shortage. I wish to quote the opinion of the King of Brobdingnag from that fantastic story of Gulliver's Travels written over 200 years ago who said: . . . "That whosoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicans put together." Plant research already has done this and I say we should do it again.

Is there another breakthrough to speed us along our way as occurred in the rediscovery of genetic principles in 1900? Even this was slow to take effect but once it was appreciated and practiced, the results were fabulous. Are we now in the midst of such important landmarks of progress? The transformation principle demonstrated in 1928 and finally about 20 years later and its explanation that this was brought about by DNA, may be one. However, those that are present at the times of such great events often do not recognize their significance. As I cannot judge where we are or what will come, I will merely pose some questions for consideration in the future that need our consideration.

I sometimes look at plant breeding from two aspects: 1) the positive approach, and 2) the negative approach. The positive approach is where we genetically increase the yield potential. The only significant example is perhaps the use of hybrid vigor. Nearly all other approaches have been cases of merely protecting the potential yield we now have by adding disease resistance, assuring complete harvest of the grain produced by having non-shattering or stronger-strawed types. This negative approach has been highly effective and seemingly has increased the potential yield and certainly must be an important feature of any breeding project in the immediate future. This negative approach was delightfully illustrated by the late John Unrau when he said the addition to the fame of the Model-T of a battery, then lights, glass instead of isinglass, treads on the tires, a self-starter instead of the crank resulted in still having an old Model-T Ford. Thus the whole must be overhauled and changed to represent true progress.

Are there any approaches of a positive nature for wheat? I believe there are. Perhaps James Wilson's enthusiasm concerning hybrid wheats will fire others to wider visions of wheat improvement. Listen to him tomorrow.

Perhaps we will have to change the very nature of the organism we are working with; that is, the old frame perhaps needs extensive changes and remodeling. Students of evolution say that self-fertilization is a form of retrogression and leads to a phylogenetic blind alley. Perhaps this is so. If so, can we do anything about it? Evidence and avenues of research are available in which changes could be made. Studies in Manitoba and Spain have suggested that the D genome adds little or perhaps nothing to the hexaploid species as far as vigor is concerned. However, when the rye genome (R) is substituted for the D genome tremendous vigor results in the hexaploid. Also when the E genome, the one from the diploid Agropyron elongatum, replaces the D genome, great vigor is expressed. Maybe we could proceed to make such Triticums cross-fertilizers and again why should we if the cross-fertilizer rye is an example.

What about the quality of such new types? Perhaps they may not have the same quality as our present wheats, but by the time such new creations are practical species on the farms I predict the cereal chemists will be able to do many things with Triticum protein and carbohydrates that will produce attractive, nutritive and tasty foods. We can also change our food habits if necessary.

About 25 years ago when Harland discussed the genetical concept of a species he suggested that homologus genes lying in different genomes will mutate in different directions. Eventually they will become so diverse from each other that they will become non-allelic. This process has undoubtedly resulted in the diploidization of many species of polyploid origin. Who has a better species to work with than we have in the hexaploid wheat which is a polyploid of fairly recent origin. For simple illustration we can assume that we have six large A's (A_1 A_1 A_2 A_2 A_3 A_3) which are all exact duplicates. If only one mutated, if not in one step then in several, so that the new gene reacted with the originals to produce a heterotic effect, we would then have a true breeding hybrid, that is, four large A's and two altered A's would in a sense be a heterozygous condition that would breed true. In fact, I believe some of our recently developed varieties already show evidence of this built-in vigor. If this is so, or possible, this retrogressive evolutionary feature of self-fertilization is a value to wheat breeders. To my knowledge only one laboratory is doing any planned research along this line.

In our workers conference there will be discussions on blends and multilineal varieties. Is it too much to hope that some method of breeding might be devised that would incorporate the advantages of selfing but not reduce plasticity of the variety? At present we assume that many of the economic characters we work with are controlled by a large number of genes, each of which has a small effect. The chance of choosing a single plant homozygous for all the assumed large number of genes is obviously remote, especially when we consider all the gene complexes involved for all traits. Thus another avenue of approach is needed and perhaps blends or multilineal varieties are the answer. At least this is a problem I feel I am qualified to work on, as well as a number of others now working in wheat breeding. However, I believe at best, this will only be a temporary solution if progress in improvement of the wheat plant is to continue.

Very little has been added to the emperical approach to testing for cold hardiness in the past 30 years. Are there no answers to this general problem of winterhardiness so that more regular progress can be made in breeding for this character? The answer may be that our crop physiologists should be more fluent in the language and habits of the biochemists and biophysicists but yet retain a feeling and understanding of living organisms.

I repeatedly tell my students that when they try to flatter their instructor because he appears to know so much, that the future has many more secrets to divulge than has been extracted in the past. Anyone traversing in the field of plant breeding in the future with only my knowledge and training, has struck out before he gets to bat. Those of us who are in position to influence students should give careful consideration to their basic training.

I could satire a bit more but you all look hungry, so will close by saying: - not quoting Jonathan Swift but Heyne - "Those of us who call ourselves plant breeders today and brag about our feats in juggling genes will soon be superseded by those plant breeders or genetic chemists who manipulate the purines and pyrimidines."

Whence and Whither in Wheat Research

Banquet Address
By L. P. Reitz
Agricultural Research Service

The first hard winter wheat workers conference met on this campus 27 years ago. One of the high-lights of the program was a talk by Dr. T. A. Kiesselbach entitled "Whence and Whither in Crops Research." You will note that I am using the same title. No, it is not a bereft imagination that brings me to talk on the same subject. Rather, I think a workers group such as this must always be concerned with "whence and whither." Whence in terms of from what place or position we have come; what premises or theories guided us aright, which astray; what efforts were futile, which rewarding; what problems can be or are being truly solved, which only superficially are influenced by our labors; what new experiments do we need, and which ones have outlived their usefulness (only we don't realize it); what data have been significant for making predictions, which merely record occurrences.

In looking back over the course, the trail of research and discovery has not been smooth, nor straight. In fact, a mole's burrow and our course have much in common and for similar reasons. The mole does not see where he is going, and sometimes we cannot see where we are going, yet an unerring general sense of direction is there. The mole's path zig zags around obstacles; so does ours. Sometimes our paths stop abruptly and make no further progress. Finally, the mole traverses some of the same burrows repeatedly, scurrying back and forth, often daily, until he gets caught. I have seen some of this in so-called research, and so have you. But, of course, that occurred in another department.

Whither is the natural corollary of whence. It asks us to what place, to what end or conclusion do we aspire, or seek with eagerness. Whither is used with verbs of motion; action and direction are implied. It involves goals to be achieved, generally hypotheses for testing, always thought. Research, like life itself, is dynamic, or it is dead. If a glimpse of "whither" is not gleaned from this conference then it has lost its main purpose. I shall deal more with this later.

I clearly recall the attitude of Dr. Kiesselbach when, 27 years ago, he was introduced to speak, not on his announced subject, but on "Hither and Thither" in Crop Research. The chairman of that meeting meant no harm; he intended a bit of humor. But to "T. A." this was an affront, a deliberately offensive utterance, an attack on research and research workers, an implied suggestion that biologists drift - now here, now there - not knowing their direction nor caring.

There is a barb here from which we can gain meaning and, while most research is of a high order, admittedly some of it is of the hither-thither type.

The series of wheat conferences since 1935 serve ably to show from whence we have come to this point. Your discussions yesterday and today have both brought us up to date and have on several occasions looked into the future. An indoors sport of mine is to review, after a conference has adjourned, the new - clearly, new ideas obtained, and contemplate whether I contributed a new idea myself. (The latter can be most embarrassing.) It will come as no surprise to you that most conferences yield relatively few new ideas, and that some yield none at all. They generally transmit much new information and this has a useful function.

The U. S. Department of Agriculture and the Land Grant College System came into existence 100 years ago this year. A research program was one of the first functions of the Department. The colleges soon learned that they had little to teach in agriculture; consequently, a research program was initiated. Research in agriculture has continued to expand to the present day. There does not appear to be any diminution of it in prospect for the future.

I will show by a series of slides where we are in some branches of wheat research and where we were as much as 100 years ago, and point to some goals for the future.

In 1859, wheat was an important crop only in the eastern States and Pacific Coast valleys, but the Plains had not yet been settled.

As settlers moved into the mid-continent area they advanced wheat westward decade by decade. Turkey winter wheat (1873) and Marquis spring wheat (1913) did much to assure success in the Plains. The Washington wheat hybrids increased success in the Palouse.

Plowshares sliced the sod and made way for the fuller exploitation of wheat. From such crude beginnings, research and its application with respect to power, improved machinery and good land management made it possible to place wheat farming on a scientific basis.

Now, wheat spreads across the Nation with a major concentration of acreage in the HRWW region. Except for economic reasons, wheat can be grown in every State.

The yield per harvested acre has been on the rise, especially in recent years. This was accelerated by the pressure on the land brought on as farmers selected their best land, used the best varieties and imposed more good practices on that land. Since 1955 the yields have been above the projected level (1961 = 23.6 bushels per acre).

Salmon calculated the benefit from nine varieties of hard red winter wheat to be over 81 million bushels per year and stated that new improved varieties in the United States could be credited with a 40% increase over varieties available from 1890-1900.

About 10 years ago the Department undertook an estimate of losses in agriculture. The report was not specific as to wheat but from the cereal losses I drew off these data. Weeds, diseases and storage losses head the list. Much of the improvement in yields has come from the reduction of such losses by application of research findings.

Earliness of maturity combats several problems at once and has become a universal goal in many parts, but not all, of the hard winter wheat region. The regression for Manhattan shows an average gain of 0.8 bushels per acre per day of earliness. Improved quality has cut our acreage of poor quality wheats from about 10% in 1944 to less than 1%.

Weed control is sometimes a matter of winterhardiness in the wheat. These views taken at Brookings in 1959 tell how plant breeding and weed control are linked activities. Bison, Pawnee and Wichita were thinned while Marmin survived and eliminated weed competition.

The rusts and smuts have been our arch enemies for many years. Great advances have been made in their control. It appears that common bunt is definitely on the way out and is no longer a national menace. Mercurials are unsatisfactory where soilborne bunt spores are important. HCB is much more effective. Recently, TCNA, most effective of all, has been discovered; it controls flag smut, too.

In each of the last 3 years, carlots grading smutty in the Pacific Northwest have been below 1% of the shipments. This results from the use of two hammers, not nne, to beat down the smut -- resistant varieties plus seed treatment. A major disease seldom is controlled by a single method.

The spring-durum area is protected from the prevailing stem rust races through a highly successful breeding program. The International Rust Nursery, Puerto Rico testing, uniform rust nurseries and barberry eradication have helped, but the main credit goes to the teams of breeders and pathologists who have kept this problem uppermost in their programs. Progress with winter wheat has been slower due to lack of resistant parent stock in winter wheat, adverse linkages involving adaptation factors -- especially heat, drought and brown necrosis, greater relative importance of other problems, and the need for vernalization to advance generations rapidly. Hard winter wheat resistance is about 20 years behind schedule.

An all too common situation is the shift to new races, or cultures of rust, here illustrated by leaf rust. We desperately need a second method of combatting the rusts and until we find it, is variety breakdown to be the ultimate destiny of our resistant varieties?

Stiff strawed varieties have been produced in all regions and now there is a trend to semidwarf and short wheats. The PNW has already released one to farmers. It is named Gaines. Short wheats are under extensive study in all parts of the U. S.

In 1959, about 11% of the national wheat acreage was sown to hessian fly resistant varieties and about 1 1/2% was sown to sawfly resistant varieties. I believe we need 35% and 10%, respectively, of our national acreage in varieties resistant to these two insects.

Reasonably good progress is being made in transferring virus (soil-borne) tolerance to adapted varieties, especially in the soft red winter area. We have a low level of tolerance to streak but higher levels from Agropyron, rye and certain common wheats are becoming available. We know very little about yellow dwarf in wheat, except that is is destructive, and no resistant varieties are available.

And now, some problems we know even less about: Septoria nodorum, S. tritici; root rots, firing and related maladies; transmission of soilborne mosaic virus; utilizing transfers from wide crosses; mutations; abandonment; stand establishment under adverse conditions; hail protection; surplus of 1,400,000,000 bushels (mostly HRW); hybrid vigor in wheat; air classification of flour.

This panorama testifies to a glorious past and hints at some of our immediate problems and challenges. Will we be able to say 5 years hence (or 27) that you have added significantly to science and have solved a few more of the wheat farmers problems? This is your mission!

The setting for wheat research has been changing. At one time Federal workers were largely concerned with breeding varieties for local adaptation and for similarly localized applied research. Now, the States are doing this to a greater extent, although the U.S.D.A. supports these activities in greater or less degree in many States.

Central laboratories are much more prominent now than formerly. This could lead to a separation of State and Federal workers but we definitely hope to avoid a separation and break-down of cooperation. These laboratories, however, should permit adequate concentration on tough problems.

Research is expensive. Each professional man on my staff involves a cost per hour of $8.67. This means every wasted hour of official time, every ruined experiment by poor planning, every unnecessary trip is a squandering of $8.67 per hour. Sitting here listening to me harangue you about is using a half hour of your time equivalent to $4.33 1/2 (only it's after hours). I find my professional men do not have adequate assistance in many instances. To correct that we are projecting ahead a goal of $30,000 per man, per year. Obviously, this will not be your salary. Most of this will go for support of program activities and thereby we hope to provide a means to obtain full value from our scientists. It means our scientists will be more thoroughly grounded than heretofore, better managers, better planners, and freer from "mole burrow" procedures. You will hear questions like the following more frequently:

Is this research necessary?
Is the proposed approach suited to the problem?
Is the investigator adequately prepared to lead the work?
Is the research situation favorable?

If we do not do this, research in biology will drop in prestige and relative effectiveness in modern society.

We hear a great deal these days about nuclear explosions and population explosions but far too scanty attention is paid to the knowledge explosion. While I have been talking, 50 scientific articles have been released to the public, and by breakfast time tomorrow morning 600 new papers will have appeared, so vast is the knowledge explosion. Truly, this is the most impressive area of man's exploits, and also the most humbling because so much more knowledge is needed.

Elementary college texts today contain material that was not known or was theory discussed only in graduate classes when I was in college. This is especially true of chemistry and physics but it is no less true of genetics, statistics, soil science, all branches of botany and biology. Scientists are in constant danger of being the objects of resistance to their own discoveries. I fear they sometimes resist the current of progress that would rush a front of science out of their reach because they cannot keep up. It is easier to go back and forth along the familiar pathways, mole-like, than to break new ground.

We believe our scientists must protect themselves and be protected from the endless digressions thrust upon them -- serving as guides to visitors, acting as tutors to students who fail to synchronize their stay to a school term, maintaining good will in non-effectual situations, doing administrative and clerical chores, committee work, too many trips and meetings, and answering questionnaires from the RBO or Washington. (You State men have your problems, too.) Not any of these activities hurt the individual or are beneath a scientist's dignity. They use up his time and energy and eventually bog him down.

I have said that research is expensive. I should say also that outstanding scientists are scarce who have the ability to explore and advance the fringes of science. Not so scarce, but nevertheless vital, are the scientists who make initial applications of fundamental findings and make use of discoveries.

In 1780 Benjamin Franklin wrote: "The rapid progress true science now makes, occasions my regretting sometimes that I was born so soon. It is impossible to imagine the height to which may be carried, in a thousand years, the power of man over matter. We may perhaps learn to deprive large masses of their gravity, and give them absolute levity, for the sake of easy transport. Agriculture may diminish its labor and double its produce; all diseases may be by sure means prevented or cured, not excepting even that of age, and our lives lengthened at pleasure even beyond the antediluvian standard. O that moral science were in a fair way of improvement, that men would cease to be wolves to one another, and that human beings would at length learn what they now improperly call humanity."

Franklin's predictions about agriculture have already more than come true, and some of the others are well advance. Will the remainder come true in the 818 years remaining? Dedicated scientists with moral responsibility as citizens can help make this happen.

TUESDAY AFTERNOON, JANUARY 16

Chairman, R. V. Olson
Discussion Leader, B. S. Miller

General Topic

WINTER WHEAT QUALITY IN RELATION TO PRODUCTION AND MARKETING

DOMESTIC MARKET REQUIREMENTS

E. J. Stone
International Milling Co.

We are going to look into the domestic requirements of Hard Red Winter Wheat for family flours and bakery flour use.

In family flours we have primarily two types; - the phosphated or self-rising flour for biscuits and the bleached, enriched flour for use in home bread baking. From the varietal point of view the needs of the phosphated type of market are relatively easily satisfied. A low protein wheat that would class as a mellow bakers' variety will generally be satisfactory. Another very good blend consists of the mellow bakers' variety with a substantial percentage of what we class as a soft or semi-soft variety. Knox is a good example of a soft variety that is useful in a wheat blend to make self-rising family flour. The home baker can produce excellent bread, rolls and cake from a low protein flour milled from varieties such as Triumph and Wichita.

The choice of varieties and wheat characteristics for milling into bakery flours is an infinitely more complex problem. We know that the main use of wheat in the United States is bread or bakery products. The aim of every commercial baker is to produce the best quality and most uniform product possible in his shop. To help him meet this goal he has various specifications for the guidance of his suppliers. These specifications on a bakery flour may cover moisture, ash, protein, maltose, amylograph or pressuremeter, color, and various farinograph characteristics. Of these specifications, the moisture content of the finished flour is the only item that is not influenced by wheat variety. It is to varietal characteristics then that the miller looks to meet the specifications demanded by his customer, the baker. Those of us who must deal with specification problems daily and who are accustomed to thinking in terms of variety, have a neat little file pigeon-holed in the back of our mind, outlining the characteristics of the major varieties. We file them under "good varieties - strong and mellow" and unsatisfactory varieties" on account of weakness or other objectionable factors. When we talk about good varieties we must keep in mind that having the best variety in a given year does not necessarily assure us that we can meet the requirements of the baking industry with the quality necessary to fulfill their demands. Climatic and other conditions we are going to hear about later this afternoon can greatly alter the characteristics of a variety. In a dry year when we have a high protein crop, most of the popular varieties will produce good bakery flour but in a crop such as was harvested in 1961 when the protein level is very low, even the strong varieties do not meet all the requirements for a good bakers flour.

What is this thing called quality we are referring to? For a wheat to class as a high quality variety it has to meet three major requirements. The first requirement is the agronomic one. Many of you men are Agronomists and know far more about this phase than I do. I will pass this requirement by stating that regardless of how good the milling quality and the baking quality are, a variety cannot succeed and will be virtually useless to the milling and baking industry unless it is completely satisfactory to the farmer. We have had in the past, and still do have at the present time some good varieties from the milling and baking point of view that are losing out in acreage each year to inferior varieties with more favorable agronomic characteristics. Therefore, we must concede that the agronomic characteristics of a wheat variety is of first importance.

The second requirement of a satisfactory wheat variety is good milling characteristics. A good test weight is desirable. The endosperm should be hard but not too hard to be readily reduced with modern milling techniques. The bran should be tough so that it will remain intact during the milling process and not contribute excessively to ash nor detract from the appearance of the flour through poor dress. It should clean up well so that the miller can obtain a satisfactory percentage of flour from the wheat and thus make the economics favorable from his point of view.

The third requirement which a variety must meet is baking quality. The term baking quality as most of us use it is actually a summary of the effect on baking of the many physical and chemical balances that constitute the character of a flour. In the introduction to the report (1) on "Quality Characteristics of Hard Red Winter Wheat Crop", the Crops Research Division of the USDA and the Kansas Agricultural Experiment Station characterize good baking quality as follows: "A flour to be of good quality for baking bread, should produce a dough having high water absorption and a medium to medium-long mixing requirement. A flour with a medium to medium-long mixing time almost invariably will have a satisfactory mixing tolerance, desirable elastic dough properties and stability throughout the entire baking process. If the flour in addition has good loaf volume potentialities (considering the protein content) and has good internal crumb grain and color, it possesses, as a rule, the requirements of a good bread baking quality wheat." In a paper (2) entitled, "Testing Wheat for Quality", Miller and Johnson state, "stability to mixing is the flour characteristic in great demand by commercial bakers. This demand is troublesome to millers because only flour with a long development time exhibits good tolerance to mixing and frequently is in short supply. Actually bakers would prefer flour with a short dough development time and good stability to mixing because it would require less power to mix." These two statements summarize what we are looking for in baking quality. First of all the flour must handle well in the shop and must produce a good loaf of bread . . . under the many and varied systems of baking in use today. The mixing characteristics of a flour, which reflect the mixing characteristics of the wheat varieties used in the wheat blend, are of extreme importance to the baker. The trend as pointed out in these two quotations is towards a long mixing time. By this definition, to classify as a strong baking variety the variety must exhibit long mixing characteristics. Is this what we are really looking for or is it merely a means of achieving what we are looking for? The baker is looking for tolerance in his flour. He requires tolerance to mixing, tolerance to fermentation and mechanical strength in his dough that will be tolerant to the automatic handling of the dough throughout the baking process. Long mixing time, for the sake of long mixing time, therefore, is not what we are looking for. Granted long mixing time wheats are necessary in the blend to make up for the short mix time and short tolerance of some of the varieties now grown, however, if the weaker varieties can be replaced by a relatively short mix time variety possessing good tolerance to mixing, the need for long mix time varieties will be greatly reduced. The new Continuous Mix Baking Processes amplify the demands for tolerance. The dough must be developed rapidly under severe conditions, it must also withstand the pressure of extrusion panning. The trend towards automation in bakeries abuses a dough more than the old methods. This makes strength essential. The need is for strength and stability without buckiness or toughness of gluten which requires long mix time to break down.

Let us again read the final sentence from the paragraph by Miller and Johnson, "actually bakers would prefer a flour with a short development time and good stability to mixing because it would require less power to mix." I do not think that statement can be over emphasized. It is tolerance we are looking for and if the Agronomists can come up with a variety of short to medium mixing time but with good tolerance, that variety would be welcomed by the miller and baker.

Table I. Percent of total Hard Red Wheat acreage occupied by each variety in 1959.

Variety	Percent % U.S. H.R.W. Total	1959 Trend	1962 Trend (Estimated)	Quality Category
Triumph	19.4	+	+	Mellow
Wichita	19.0	-	-	Mellow
Pawnee	12.2	-	-	Mellow
Cheyenne	7.8	+	-	Strong
Comanche	5.7	-	-	Strong
Ponca	5.1	-	-	Strong
Kiowa	5.0	-	-	Mellow
Nebred	4.3	-	-	Strong
Bison	4.2	+	+	Strong
Concho	3.7	+	-	Mellow
	86.4			

Let's look at the existing varieties and see just where they fit into the picture. If we refer to the U.S.D.A. Statistical Bulletin Number 272, (3) "The distribution of the varieties and classes of wheat in the United States in 1959," we find the top ten in the Hard Red Winter Wheat hit parade as shown in Table I. The total percentage of the Hard Red Winter Wheat acreage occupied by each variety in 1959 is shown along with the trend for that variety. That is whether it's acreage has been increasing or decreasing up to 1959 and we have projected this through to 1962 on the basis of limited information.

Of the top ten varieties so far as acreage is concerned, five are considered strong varieties. In the Hard Red Winter Wheat states from Kansas south, Cheyenne and Nebred are definitely on the decline. Comanche and Ponca have been decreasing in acreage and Bison is the sole strong variety showing an increase in acreage from year to year. The only other variety continuing to increase is Triumph. Triumph is a good quality mellow wheat but in the years when the average protein content of the crop tends to be on the low side, Triumph does not have adequate strength by itself to satisfy the baker's demands. This leaves us with four mellow varieties, each declining in acreage. As we have pointed out earlier, a good variety, even though it be mellow, if growing conditions are favorable can produce a very fine baking quality flour which will meet the baker's demands, but, we cannot put ourselves in a position where we are dependent upon the whims of nature for satisfactory quality to create a demand for our wheat crops. Therefore the strong varieties with some unsatisfactory characteristics and the more mellow varieties which are declining in acreage are obviously being replaced. In Table II we have a list of some of the main contenders to replace declining varieties. Of the five varieties listed, Warrior, Kaw, and Tascosa are generally conceded to be strong varieties with desirable characteristics for the milling and baking industry. Ottawa and Omaha are mellow varieties with some characteristics more favorable than the varieties they are designed to replace.

Table II

Variety	Quality Category
Kaw	Strong
Tascosa	Strong
Ottawa	Mellow
Warrior	Strong
Omaha	Mellow

To summarize the choice of varieties suitable for domestic market requirements we would note that in Table I, 86.4 percent of the Hard Red Winter Wheat acreage is occupied by these ten varieties. Even though only three out of those ten are what we consider to be strong varieties with satisfactory bake characteristics, the average quality of these ten is good. However, they are not necessarily good enough to meet baking quality requirements evefy year.

With the exception of Cheyenne, none of these varieties appear in the U.S.D.A. variety survey prior to 1944. This indicates real progress in the development of more satisfactory wheat varieties. We cannot forcast the impact of the new strong varieties Warrior, Kaw, and Tascosa or of the mellow varieties, Ottawa, and Omaha, however we think it safe to say that the direction of the activity and the development of new varieties of Hard Red Winter Wheat has been excellent, we have every reason to believe that with the high degree of cooperation between Federal, State and Industry representatives and with the improved tools now available, the varietal progress in the immediate future will greatly exceed that of recent years.

The agronomists might keep in mind that whenever they think in terms of the quality required in the wheat variety for the milling and baking industry, they should hear a loud chorus of millers and bakers crying "Give Us Tolerance".

References

(1) Quality Characteristics of Hard Winter Wheat Varieties Grown in the Southern, Central, and Northern Great Plains of the United States - 1959 Crop. K. F. Finney et al. U.S.D.A. processed report CR-11-61.

(2) Testing Wheat for Quality. Byron S. Miller, John A. Johnson, Production Research Report No. 9, U.S.D.A., A.R.S. July, 1957.

(3) Distribution of the Varieties and Classes of Wheat in the United States in 1959, Statistical Bulletin No. 272, U.S.D.A., A.R.S., Nov. 1960.

MILLER: There may be some questions on these aspects. If there are, we would like to have them at this time.

SCHLEHUBER: Mr. Stone, in your experience have you ever encountered a wheat variety with so-called short mixing time that has the kind of tolerance that you want?

STONE: We would say when we run into that sort of thing it is due more to environment than variety characteristics. We do find that hard red winters and hard red springs vary widely probably due to a conglomeration of protein content and sources or points of origin. We find a wide variety of mixing times and mixing tolerances and we do find from time to time shorter mixing wheats with good mixing tolerance. If you are talking of a fairly long mixing variety with short mixing time per unit protein, then occassionally you will come across an odd ball that will mix three or four minutes less than expected. Say you are mixing for a total of 12 minutes, you find you can mix 6 to 8 minutes or go up to 12. I have been assured by one of your group that, from time to time, selections are found that appear to have short mixing time and good tolerance.

CHOICE OF VARIETIES AND WHEAT CHARACTERISTICS FOR MILLING INTO SPECIALTY FLOURS (Abstract)

G. W. Schiller
The Pillsbury Company

Requirements of the milling industry for ideal HRW wheats indicate not only a need for increased amounts of strong varieties, but in addition a need for wheats of higher protein content. In years when climate is conducive to high protein wheats the need for strong varieties diminishes. After years of testing pure wheat varieties for show purposes, I am convinced it is possible and perhaps even now practical to produce HRW wheats with protein content from 2 to 5% above the average.

<u>CONVENTIONAL FLOURS</u> Heavy test, good yields, low ash, good color, easily milled.

Buns and Rolls: A reasonably strong bakery type flour--Cheyenne, Kaw, Bison, Ponca, Tascosa.

Sweet Goods: A mellow type HRW flour with sufficient strength to be handled easily in making up. Stronger if machine handled. Blends of Early Triumph and Wichita with above strong wheats.

Rye, Wheat & Hollywood Breads: Strong flour produced by Cheyenne, Comanche, Kaw, Bison Rodco and often fortified with gluten flours or air classified proteins.

Pasta Products: In recent years, due to inadequate supplies of Durum wheats some HRW stocks have been used for Pasta products. In general, these were high protein content but not necessarily strong wheats. The wheats were often selected on the basis of only protein, high yellow pigment content, and short hydration time. These wheats are milled into granular products and often blended with existing supplies of Durum flours to satisfy both domestic and export demands for Pasta products. Most any existing HRW varieties are suitable.

Refrigerated Biscuit: A medium strength flour with sufficient tolerance to withstand mechanical production methods, blends of Early Triumph and/or Wichita with strong varieties.

Pie Crust - Both Fruit & Meat: A weak type gluten, usually low protein that produces a short crust, Pawnee, Wichita, Triumph.

Pizza Shells: A strong flour to withstand various manipulations in production--Bison, Rodco, Kaw, Ponca, Tascosa. If mechanical production is used strong flour may <u>not</u> be desirable due to shrinking or drawing up. Low protein Triumph, Wichita or Pawnee.

Breakfast Cereals: Low protein, mellow gluten wheats of low diastatic activity.

Commercial Uses: Foundry, oil well mud, sizing, fiber boards. Primarily Clear or low grade flours. Any varieties acceptable.

AIR CLASSIFIED FLOURS

In addition to having all the desirable milling qualities for conventional milling, the wheats for air classification should have mellow endosperm, large starch cells, desirable gluten quality. Varieties usually quite suitable are Early Triumph, Wichita, Pawnee, and Concho. In some years these varieties must be blended with other varieties to secure proper A/C properties. Gluten quality is more important than quantity.

Cakes: Wheats with mellow endosperm and an abundance of large, prime starch is desirable.

Cookies: Much the same as cakes except greater amounts of small starch cells can be tolerated. Good spread factors often absent in HRW flours, but formula adjustments can help cope with this (higher sugar, higher soda).

Ice Cream Cones: Much the same as cakes, but requiring special treatment and short hydration time.

Crackers: Flours with soft, mellow gluten that have short hydration properties and good buffering properties to withstand long cracker sponge fermentation.

Sweet Goods: Air classification makes possible the production of certain special flours for sweet goods production. The Danish pastry flours are good examples.

Commercial Starches: The prime requisite for these are an abundance of large starch cells that separate easily with a minimum of damage. The starch should have proper hydration and gelatinization properties and have low diastatic activity.

Wheat Glutens: The production of natural wheat gluten is closely associated with starch production. In concentrating wheat protein the plus-neutral-minus quality theory is applied. To concentrate plus quality protein makes it better. The neutral quality does not change appreciably, while concentrating negative quality wheat protein only makes it poorer in over-all quality.

Thickeners for Soups & Gravies: These can be produced by either conventional or air classification. They usually require special gelatinization properties and air-classified production methods are well suited for this type of flour.

The air-classification of HRW flours makes it possible to produce nearly any type flour that can be produced in a conventional manner. In addition, it makes the production of the above specialty flours possible. As improvements are made in A/C methods and equipment, perhaps new and different products from HRW may be forthcoming that may require new emphasis on certain quality factors of HRW wheats.

HARD WHEAT QUALITY REQUIREMENTS OF FOREIGN MARKETS

Edward F. Seeborg
Foreign Agricultural Service
USDA

The emergence of the United States into a leading position in world wheat trade is a relatively recent occurrence. This emergence has been accompanied by a rapid change in the economic status of most wheat deficit countries with resulting far-reaching effects upon their quality requirements. As they have become more and more discriminating, the net result has been a serious deterioration in the competitive position of the U. S. hard wheat in all major commercial markets outside our boundaries. We are now in a very critical deficit supply position regarding strong gluten bread wheat, with indications of a further worsening of this position as present trends continue.

Total exports of U. S. wheat exceeded 660 million bushels in the 1960-61 marketing year, a new high for exports from any country. Commercial sales for dollars, however, accounted for only 30 percent of the total, or about 200 million bushels. The most serious limiting factor to the expansion of exports to dollar markets has bwen the shortage of strong gluten wheat, or to put it another way, an over-abundance of hard wheat with unsatisfactory or inferior bread baking strength.

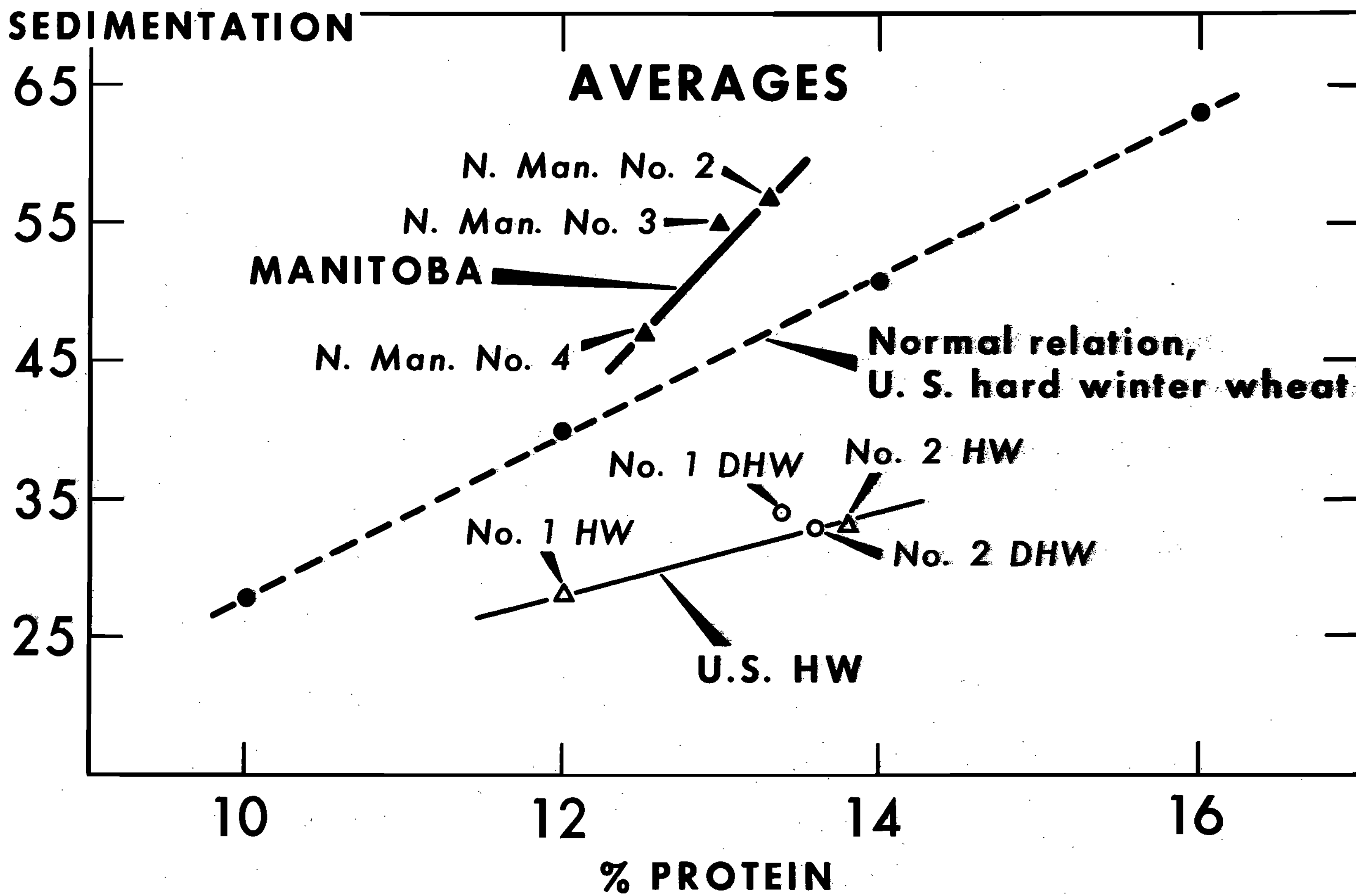
The baking strength requirements for imported wheat of foreign markets varies somewhat, depending upon: (1) The amount and quality of indigenous production, and (2) the quality requirements of bakers in each market area. These requirements now and in the foreseeable future can be summarized as follows:

MARKET	STRENGTH 1/
Western Europe	Medium to very strong
Japan	Medium to strong
Phillippines	Very strong
Latin America	Medium to very strong
Africa	Strong to very strong

1/ Medium strength, 40-50 Sedimentation
Strong, 50-60 Sedimentation
Very strong, Over 60 Sedimentation

You will note I have avoided the use of a specific protein level as a guide to wheat strength, using the sedimentation value in its place. This change is based on several exhaustive studies which show that the baking strength of U. S. hard wheat available for export has a significantly lower value at any given protein level than the average level of hard wheat being produced. The marketing system within the United States not only allows, but encourages very careful segregation of high baking strength (strong gluten) wheat from each crop for domestic milling purposes. While only a few milling firms in the U. S. are making use of the sedimentation test to segregate strong gluten wheat from mellow or weak gluten wheat, the combination of tests used for this purpose by most mills has the same effect.

WHEAT: QUALITY FACTOR AT EUROPEAN PORTS



(GRAPH, WHEAT: QUALITY FACTOR AT EUROPEAN PORTS)

The above graph illustrates the poor competitive position of the U. S. hard wheat in the European markets, showing that at similar and relatively high protein levels U. S. Hard Winter wheat sold for export is (1) significantly lower in sedimentation value than Canadian Manitoba, and (2) significantly lower in sedimentation than the average being produced. The correlation between the sedimentation value and bread-baking strength in this study was 0.87, highly significant at the one percent level.

The similar requirement for strong gluten wheat in all markets is due to differing combinations of the basic factors mentioned earlier; namely, the amount and quality of indigenous production and the quality requirements of bakers. In Europe, the indigenous production is large, the six countries in the European Economic Community (EEC) being more than 90 percent self-sufficient in total quantity of wheat requirements. In Germany, millers are required to use 75 percent of domestic wheat, most of which has a short mixing time and tolerance and a low sedimentation, in their mill blend. Wheat of maximum bread-baking strength is, therefore, preferred for blending. In addition to the baking strength, millers prefer a wheat with low oxidation requirements, a low flour ash and good water absorption. The oxidation requirements are of major importance in Germany, as in many other foreign countries because of laws prohibiting the use of most gaseous or chemical oxidizing agents in flour.

As there are quite wide differences in the baking response of varieties to oxidants, and in the total oxidation requirements, it is quite possible to select for this characteristic early in the breeding program. A suggested level of oxidation requirement which would be satisfactory is 10 to 15 PPM of potassium bromate. The current average level for winter wheat is between 30 and 40 PPM.

The need for medium to very strong wheat in the Philippines, Latin America and Africa is due to a market demand created by flour exports. Most of these markets produce none of their wheat requirements and have traditionally been flour importers. Construction of mills has now changed former flour markets into wheat markets with a demand for strong wheat having a long fermentation tolerance and low oxidation requirement. In most cases, this need is based on tropical or semi-tropical climatic conditions and the lack of temperature controls in bakeries. In Japan, the millers have adopted Canadian Manitoba as a standard of quality, although a winter wheat of good baking strength, good flour color and low flour ash would find acceptance as a replacement for a portion of the Manitoba.

Plant breeders in the United States have demonstrated quite conclusively that any quality characteristic of economic importance can be selected for in the breeding programs. An outstanding example is the recent development of semi-dwarf wheat with very significantly higher yields per acre. By the expansion of quality testing for bread-baking properties in the early generations, it will be possible to achieve this improvement very rapidly. Micro milling and subsequent micro quality testing in the F_3 should, in my opinion, have the highest priority in your work.

Summarizing, we are in a serious deficit supply position with hard wheat having good bread-baking strength in commercial foreign markets; development of new varieties should be based on the need for the following quality characteristics:

(1) As strong a gluten as possible, high sedimentation.
(2) Minimum oxidation requirements in baking, preferably between 10 and 15 PPM potassium bromate.
(3) Low flour ash and good white flour color.
(4) Good absorption, equivalent to Selkirk in spring wheat.
(5) Good flour yield.

A large increase in the planting of strong gluten wheat is recommended immediately along with the breeding program to develop varieties with the above characteristics. It is an economic waste to use good productive resources to produce hard wheat of insufficient baking strength to meet market requirements at home and abroad.

REITZ: This will be a short question, but it may take a long answer. We hear a lot from India that they don't like red wheat, they want white wheat. Would you say something about that?

SEEBORG: I had only fifteen minutes. I specifically avoided commenting about our PL 480 accounts because in this case, India has no choice; it must take what is offered. We hear stories about India that they don't like red wheat; other stories that they are quite accustomed to red wheat and even prefer it.

The utilization picture in India, while not as complex as ours, is not as simple as some people believe. There is commercial milling in India, where they mill flour like ours. About ten percent of their total wheat goes into this type of mill, but about ninety percent is milled in small villages on stone mills, and is ground like corn meal with about 95 to 98 percent extraction.

In this product, the color of the meal is very important to the housewife and she prefers the white bran. It is simply the color of the bran that makes the difference. This is why India prefers western white wheat for import purposes.

India is buying on PL 480 and she is also buying on certain barter programs in which she can buy any type of wheat she wants. Last year, every bushel of wheat bought on the dollar program was white wheat. That might answer your question.

SCHLEHUBER: Ed, do you feel that it is primarily the kind of wheat or the quality of wheat produced in the United States or is it the mechanics of our export marketing system that contrasts our wheat from Canadian wheat?

SEEBORG: I don't think the Canadian system of marketing leaves much to be desired for building a quality reputation in the foreign market. I think it is almost ideal. They have almost complete control. Canada does not allow any selection domestically. The fair average quality of production is protected.

Actually our marketing here needs to be improved tremenduously. I think that is not basically the biggest problem in our foreign market. An exporter can only sell what he has available for export, he does not manufacture this low quality, it is grown in a far greater amount than we need.

C. O. JOHNSTON: I would like to ask Mr. Seeborg, along this same line, how much of this poor quality is actually associated with low protein as opposed to quality of protein per se? By this, I mean, don't we have quality of protein if we had the quantity?

SEEBORG: The quality of protein, I believe, is a primary factor in the foreign market. Very little wheat is sold today without protein specification. Nearly all of the wheat sold contains 12½, 13 or 14 percent protein, but the quality of that protein is about equivalent to 10 or 11 percent protein in the domestic market. It does not have the baking strength, or bread baking characteristics that you would expect in that protein level. This has been amply shown.

SCHILLER: These exporters you are talking about have quality specifications in the domestic market. Do export specifications say anything about quality?

SEEBORG: You are talking about whether a foreign importer is specifying quality?

SCHILLER: Yes.

SEEBORG: They are more and more. There is very little wheat going into the dollar market today bought without quality specifications. Importers are having difficulty though, in getting strong wheat even with quality specifications. For example, the U.K. is purchasing around a million bushels a month of 14% protein hard northern spring wheat. This is being used as a filler wheat in their blend to a maximum of 15 percent. That's all they are allowed to use. No. 1, 14 protein dark hard Canadian Manitoba is the basis of this grade. Our commodity credit requirement is fairly good absorption and protein content to meet the basic guaranteed protein specifications.

SCHILLER: I would like to add one more comment, Ed, and I am not trying to belittle your opinion. I am inclined to believe, rightly or wrongly, that the reasons these countries don't import our wheat is because (1) they don't know what they want, and (2) they don't come out and buy it.

SEEBORG: This is not true any more, George. The reason importers don't use real tight specifications for quality such as is used in the milling industry, is that they cannot buy it at competitive prices. This is where we have to become competitive. We do not have sufficient supplies of quality wheat to be made available for export at prices which would allow us to be competitive with Canada. It isn't here in sufficient quantities, and it would push the price up too high. It just isn't here.

SCHLESINGER: Wouldn't a good way of solving this problem be to raise the protein level of our better existing varieties? It takes a long time to develop varieties to solve this problem. We can do this very quickly by raising the protein level of our better varieties. Wouldn't that be a practical approach to the solution of this problem?

SEEBORG: I think it would help tremenduously. Do we have varieties that have low oxidation requirements, high absorption, low flour ash, good flour yield and good mixing tolerance in winter wheats?

SCHLESINGER: I think there are varieties which meet those specifications. We need to raise the protein content to a high level. I think Dr. Schlehuber came up with very remarkable wheats in collaborative tests in 1961. I don't know what he did to them. They were high protein that would be just what you want. I don't know how he did it, maybe you and he can get together and we can get some of this wheat.

SEEBORG: Segregation takes place in domestic marketing which leaves a residue of relatively poor baking strength wheat of high protein. This is due to weather as well as variety.

I don't know whether varietal limitations alone would do the job. It would help tremenduously if we could eliminate Wichita and Pawnee and eliminate hard winter wheat being grown in Eastern Kansas.

FINNEY: I feel certain if protein level of our strongest winter wheat could automatically be raised one to two percent, we would have winter wheats that would compete against spring wheats. There are commercial people in the spring wheat area, who are not hesitating, who have not been the least reluctant to point out that they often obtain winter wheats which are better than spring wheats that they purchase in the spring wheat area.

SEEBORG: That is a very encouraging note.

EFFECTS OF WEATHER ON QUALITY
(Abstract)

K. Finney

Subnormal loaf volumes have been consistently associated with high temperatures (above 90° F.) during the last 15 days before harvest. High temperature, however, does not always impair loaf volume potentialities. The association was only partially (51 to 84%, depending on variety) accounted for in terms of amount of high temperature, percentage of protein in wheat, and the quality of protein as reflected by the mixing time of the dough. The physical and chemical condition of the soil appears to be an important factor in regulating the extent of injury from a given amount of high temperature during the last 15 days of the fruiting period. In the absence of high temperatures during the last two weeks before harvest, other environmental factors such as rainfall and the chemical and physical composition of the soil appear to have relatively minor effects on protein quality. Protein content accounted for about 95% of the variations in loaf volume if temperature during the fruiting period was not a limiting factor. Varieties with longer mixing times were more tolerant or resistant to the detrimental effects of high temperature during fruiting than those with shorter mixing times.

Studies at Manhattan, Kansas, have shown that high temperatures and drought, when accompanied by high relative humidities, do not impair loaf volume potentialities, absorptions, and mixing properties, apparently because the transpiratory system of the wheat plant is not unduly burdened under these conditions. These data obtained at Manhattan indicate that high temperatures probably will not impair baking properties of wheat grown in the low plains or other areas where relatively high humidities prevail.

High temperatures during fruiting did not impair loaf volume and mixing properties of wheats grown in the eastern 40% of Kansas where relative humidities generally were high; whereas they severely damaged these properties for the same wheats when grown in the western 60% of the state where humidities were relatively low (about 30% or less).

EFFECTS OF WEATHER BETWEEN MATURITY AND HARVEST ON WHEAT QUALITY
(Abstract)

John A. Johnson

With the advent of the combine, the farmer has been forced to assume greater risks between the time when wheat is mature and harvest. Among the post-mature factors of greatest importance is the effect of moisture.

Wetting of wheat lowers the test weight, the kernel density, vitreousness and increases mellowness and, therefore, improves the milling quality. If wetting is for an extended period of time, in which the moisture reaches above 28% in the wheat, the enzymes of germination are activated. Repeated wetting and drying cause the bran coat to fissure, crack and become ruffled upon drying. Such wheat will have reduced test weight and grade.

Recent radiographic measurements indicate that the wheat kernel fissures toward the center both radically and transversally when wetted. Fissuring can be followed by amplification of the sounds created by wheat as it absorbs water. Wheat is placed in a sound proof box in which a microphone is placed. Each new fissure in the kernels of wheat is represented by a cracking sound. The natural fissures in the wheat has been found to assist in actual grinding of wheat.

Further research on the effect of wetting between maturity and harvest is needed to elucidate the effect on enzyme substrate relationships.

Table 1.
Effect of repeated wetting and drying on test weight of mature wheat.
(Swanson, 1946).

% Moisture	before drying	after drying 1	after drying 6	after scouring 1	after scouring 6
10.3 (control)	61.3	61.3	61.3	64.3	64.3
12.0	59.6	60.1	59.0	63.3	62.0
16.0	57.3	58.1	57.7	62.0	60.3
20.0	54.0	57.3	55.7	61.5	59.5
24.0	50.0	56.8	55.5	61.1	59.0
28.0	49.7	56.5	54.7	60.8	58.2

Table 2.
Effect of repeated wetting and drying on market grade of mature wheat.
(Swanson, 1946).

% Moisture	Market Grade 1	Market Grade 6	Dark, hard vitreous % 1	Dark, hard vitreous % 6
10.3 (control)	1DHW	-	88	-
12.0	1DHW	2DHW	92	87
16.0	2DHW	3DHW	88	89
20.0	3DHW	4 HW	81	60
24.0	3 HW	4 HW	65	27
28.0	3 HW	5 HW	27	27

Table 3.
Effect of wetting on sprouting of wheat (Swanson, 1935)
(Wetted for 72 hours)

Moisture	Maltose mg/10 gram
10.3	240
24.0	220
27.0	370
30.0	500
36.0	755

Table 4.
Effect of repeated wetting and drying on flour yield and ash (Swanson, 1946).

% Moisture	yield % 1	yield % 6	ash % 1	ash % 6
10.3 (control)	73.9	74.6	0.43	0.43
12.0	73.2	74.6	0.43	0.43
16.0	73.0	72.6	0.40	0.43
20.0	76.1	74.3	0.42	0.42
24.0	73.5	76.2	0.43	0.43
28.0	73.6	75.4	0.43	0.41

EFFECTS OF NITROGEN FERTILIZERS ON WHEAT QUALITY
(Abstract)

Mark A. Barmore

Miscellaneous trials of the effects of nitrogen fertilizers (aqueous and anhydrous ammonia, calcium nitrate, ammonium nitrate and sulphate) up to 120 lbs. per acre have been made in the Pacific Northwest with both white winter and spring and hard red winter wheat. The fertilizer was added either at planting time or early in the spring (on winter wheat). In general, increases in yield, nitrogen content and strength resulted. Exceptions in yield were due to shallow soil or insufficient moisture. Increases in nitrogen content of the grain were general. Increases in strength did not always follow increases in nitrogen content of the grain. The fertilizers sometimes decreased hard wheat flour quality as well as soft wheat flour quality. A few cases were due to sulphur deficiency but others were unexplainable.

EFFECTS OF NITROGEN FERTILIZER ON PHYSICAL CHARACTERISTICS OF WHEAT
(Abstract)

F. W. Smith

The role of nitrogen fertilizer for increasing yield of hard red winter wheat is well established. Moderate applications of nitrogen generally increase grain production substantially. Straw yields may be increased more readily than grain yields.

Protein percentage of the wheat grain usually is not increased much by moderate applications of nitrogen. As a matter-of-fact, if substantial yield increases occur as a result of moderate nitrogen fertilization, a grain protein percentage may be slightly less than in unfertilized wheat. This is especially true when small applications of nitrogen are made in association with phosphate and potash. Protein percentages of straw is much easier to increase than is protein percentage of grain.

Heavy applications of nitrogen (100 pounds per acre of N) generally cause increases to grain protein percentage. It has been observed that incidence of yellow berry declines when this occurs. Test weight of the grain generally declines if an appreciable increase in protein percentage is effected. Conversely heavy applications of phosphate and potash, which tend to increase plumpness of grain and thereby raise test weight values, may actually result in a reduced protein percentage of grain.

Limited data suggest that sedimentation values for wheat grain may be correlated with previous nitrogen history of the soil which produced the wheat. However, changes in sedimentation value will not be large unless the protein percentage of the wheat was markedly altered as a result of nitrogen fertilization or soil management practices.

EFFECTS OF SULFUR COMPOUNDS APPLIED BY FOLIAR SPRAYING ON WHEAT QUALITY
(Abstract)

Carl Hoseney

In foliar spraying experiments on the 1961 crop, Kaw and Pawnee wheats were sprayed with urea, thiourea, 1,3-Dimethylurea, Ethylenethiourea and 1,3-diethylthiourea. Three sprayings at the rate of 50 lbs. N/acre were applied 14, 11 and 7 days prior to flowering. Crude protein was increased from 2.5 to 6.9% depending on the compound used. Data on test weight, yield and baking characteristics varied from normal for urea to much below normal for ethylene-thiourea.

EFFECTS OF STORAGE CONDITIONS ON WHEAT QUALITY
(Abstract)

G. L. Kline

Desirable conditions for maintaining grain quality in storage are measured in terms of grain temperature, grain moisture, and length of time in storage. The temperature - time - moisture relationship is basic to an understanding of the effect of various storage conditions on quality.

Under unfavorable storage conditions of high temperature and moisture, mold growth and respiration of the grain proceed rapidly. Heating and quality deterioration may occur. Under favorable storage conditions, changes occur very slowly with only minor losses in grain quality over a period of several years in storage.

Desirable limits of temperature and moisture for wheat storage are indicated by results of laboratory tests published in the literature. Investigators report that grain molds grow slowly at temperatures below 70°F, and very slowly or not at all below 40° F. Also, that wheat stored with a moisture of 13% and below is relatively free of mold growth although microorganisms may be present.

Grain storage operators have established practidal limits of temperature and moisture for storing wheat for various lengths of time. For the temperature conditions prevailing in the Hard Winter Wheat Area, operators store wheat at a moisture content of 13% for periods up to one year. For long term storage, operators prefer wheat with a moisture content of 12% or below. Wheat with a moisture content of 13 to 15% may be stored satisfactorily for a few months, dependent on the temperature of the grain.

We can illustrate the grain temperature conditions encountered in the commercial storage of wheat in the Hard Winter Wheat Area during the first year after harvest. The example is typical of upright storages utilizing aeration. In the summer, new harvest wheat with temperatures up to 100° F or more can be cooled to approximately 85° F. In the fall, wheat can be cooled to 60 to 70° F. In the winter, wheat is cooled to 50° F or below in all parts of the bin. This establishes a favorable condition for grain storage -- restricted mold development, minimum insect activity, and uniform grain temperatures. Wheat temperatures in bins that are turned two or three times during the storage year will lag those in aerated bins, being some 10 to 15° F higher throughout the storage period.

Unfavorable storage conditions as measured in terms of the time - temperature - moisture relationship may result in loss of wheat quality in storage. Such losses may be physical, chemical, or nutritive in character. Deterioration of wheat quality in storage is evidenced by loss in germination, darkening of the germ ("sick" wheat), increase in fat acidity, other biochemical changes, loss in milling and baking quality, development of odors, discoloration of the kernel, and heating in storage.

EFFECTS OF STORAGE CONDITIONS ON WHEAT QUALITY (Abstract)

Pekka Linko

The complex mechanism of deterioration of wheat in storage is likely triggered by certain biochemical and physiological changes normally associated with life itself, changes which accompany a primary increase in moisture content. There is some evidence that such metabolic changes may make the kernel more susceptible to the attack by molds, and thus favor rapid deterioration.

An activation of a number of enzymes at relatively low moisture levels is characteristic to incipient deterioration. The initial biochemical changes are thus largely enzymatic. After the death of the embryo, these are followed by nonenzymatic deteriorative reactions. Typical changes taking place during deterioration are an increase in fat acidity and inorganic phosphorus, a decrease in nonreducing carbohydrates followed by an increase in reducing sugars, and dissipation of free glutamic acid accompanied by an increase in free gamma-aminobutyric acid and, later, by an increase in several free amino acids owing to enzymatic breakdown of proteins. Free amino acids may then react with reducing sugars eventually resulting in discoloration of the embryo ("sick" wheat). Finally, with progressing deterioration, the potential activity of certain enzymes decreases in relation to the degree of deterioration.

Such biochemical changes generally follow closely the decrease in wheat quality and thus may be used to estimate the degree of deterioration. Recently, glutamic acid decarboxylase activity (GADA) of wheat has been successfully used for such a purpose. It has also been possible to prepare a nomogram relating GADA and germination percentage with wheat moisture, temperature, and time of storage.

THE EFFECT OF FUMIGATION ON WINTER WHEAT QUALITY AS RELATED TO PRODUCTION AND MARKETING
(Abstract)

Harrison E. McGregor

The Pure Food and Drug Administration has established safe tolerances for pesticide residues on raw agricultural food commodities. The wheat farmer, the commercial grain companies, and the millers must protect their commodities from insect attack without exceeding those tolerances set by law. The commercial seed grower must protect his grain from insect attack without damaging the viability of the seed.

The manner and method of application can determine to a large extent the ultimate effects of fumigation on sound wheat. The men who apply the fumigant are, therefore, directly responsible for improving the condition of the grain rather than lowering the quality. Fumigants are tools, and the right tool should always be used for the job at hand. Some fumigants have no effect on either the germination or the baking qualities of flour milled from the wheat. Some fumigants will damage the germ and lower the germination when they are applied to wheat of high moisture content. Other factors that have a damaging effect on the germination of seed wheat are: Overdosage of fumigant, overexposure, and temperatures of more than 85° F.

In a test of the effects of methyl bromide fumigation on the viability of barley, corn, grain sorghum, oats, and seed wheat, Whitney, in 1958, found that little or no injury generally occurred under the following conditions: (1) the seed moisture was less than 12 percent, (2) the dosage was less than two pounds per 1,000 cubic feet, (3) the exposure period was less than 24 hours, and (4) the temperature was 80° F.

Dean and Swanson, in 1911, found that HCN would reduce the loaf volume of bread if the flour was not aerated sufficiently.

When the common liquid fumigants such as carbon tetrachloride, carbon disulfide, ethylene dichloride, and ethylene dibromide are used in mixtures in accordance with USDA recommendations, the initial residues in grain will be high. The length of time the residues remain depends upon a number of factors, including the temperature of the grain, size and tightness of the bin, and the number of times the grain is turned. These fumigants, except possibly ethylene dibromide, when used in accordance with recommendations, will not carry through into finished foods that are ready to eat. No ethylene dibromide will be found in the finished foods, but slight traces of inorganic bromide may sometimes be found.

Mixtures containing carbon tetrachloride, carbon disulfide, and ethylene dichloride are safe to use when fumigating seed wheat if the seed is aerated after three to five days exposure.

Phosphine gas may be used to fumigate either seed wheat or wheat to be milled without danger of damaging the germ or the milling and baking qualities.

CHEMICAL, PHYSICAL, AND BAKING PROPERTIES OF PRERIPE WHEAT DRIED AT VARYING TEMPERATURES (Abstract)

Merle D. Shogren

Pawnee wheat harvested from 6 days preripe to ripe and containing 27 to 12.4% moisture was dried at 90, 100, 110, 120, 160, 200, 240, 280, 320, and 360° F. Weight per bushel remained constant through 120 or 160°, thereafter decreasing. Loaf volume and crumb grain were normal through 160°. Thereafter, loaf volume and crumb grain decreased to a minimum as drying temperature increased to about 280°. However, damage to loaf volume increased with moisture level at a given temperature above 160°. Data indicated that as wheat moisture content increases, maximum allowable drying temperature decreases. Mixing time increased with increased damage to loaf volume and crumb grain.

WHEAT REQUIREMENTS BY NEW MILLING PROCESSES

A. B. Ward

Milling Processing Centers Over 100 years ago the milling center in the United States was in Rochester, New York. The local area had soft wheat and with the aid of the stones it was possible to make good white flour. St. Louis also made similar flour from their local wheats.

Along came the roller mill and with it good white flour could be made from hard wheats. About 100 years ago some millers, whose names have since become prominent in our industry, gambled and built large roller mills in Minneapolis shifting the milling center closer to the harder wheats.

Now the air classification process is available to us and the question to be determined is this going to shift the industry -- possibly back to the East. Some companies are spending large sums of money on this air classification process to keep up with the changing wheat supply.

The milling industry is vitally effected by government actions on the raw material supplies and is continually trying to adjust to the changing availability of wheats.

Processing Markets There are two major processing markets -- domestic and foreign. (In both cases hard red winter wheats produced in the United States are in competition with strong wheats which can be blended with weaker wheats and still have good bread baking properties. In many cases this means costly transporting of wheats great distances to make mill mix blends to satisfy the bakers' needs.)

Kinds of Quality At the present and for some time to come, there are two sides to quality:

1. Inherent = potential 2. Actual = realized

The first is bred into the wheat by the wheat workers who have been guided by the following:

a. Higher protein
b. Stronger gluten
c. Mixing tolerance
d. Higher absorption
e. Increased loaf volume
f. Lower endosperm ash
g. Mellowness

In other words, the inherent or potential quality is what is available to the processor.

Great strides have been made and are bing made in all of the above-mentioned areas. (Some research workers have crossed rye and wheat and have made a grain with 29% protein -- still an unknown material, but interesting.)

The second "Actual Quality" is in the finished flour (produced today by the conventional processing machinery) modified and treated in different ways to meet the specifications of the customer.

Grain processors have and are continually trying to modify and develop their process to fit the wheat available to them. In so many words, millers are trying to undo what nature has done and make uniform flour from not uniform wheat.

There is no question that present day processing techniques damage some of the inherent quality. With the following constituents -- starch, protein, bran and germ, there are many chances to change quality by mishandling. It is known that commercial flours have considerable starch damage. This meeting is taking place in the shadows of some of the high priests of starch damage. Most excellent work is being done here.

Objectives of Wheat Workers Many objectives of the hard red winter wheats have been clear cut. Such as:

a. More bushels per acre
b. Higher test weight
c. Disease and insect resistance
d. Agronomic factors
e. Meet environmental conditions
f. Higher protein

All of the above factors have a direct bearing on the income to the wheat producer.

Another primary objective is to produce a hard red winter wheat for bread baking. Many improvements have been made in this area for which the wheat workers are to be commended.

The processing needs of wheat have not been neglected but have been more difficult to explain. New methods have been and are being developed to make "Milling Value" a standard index generally accepted.

Naturally, a high percentage of highest grade flour is wanted from wheat. (But along with this, it is necessary to have a favorable purity-ash distribution of the flour grades and feeds.)

Conventional Wheat Processing

Three steps with near equal importance are:

1. Wheat Selection
2. Conditioning of Wheat
3. Milling of Wheat = Grinding and Separations.

It is necessary to have each of these at near optimum to survive in the milling industry.

Wheat - must have the baking quality to meet customers needs. It must give a favorable yield of best flour grades. Familiarity with "Milling Value" of the available wheats helps in this respect.

Conditioning of Wheat - The preparation of the grain for milling by various means does improve the separability of bran and endosperm of wheat into flour and feeds. Since wheat, even in the same lot, varies considerably in vitreiousness, it is very difficult to prepare wheat mixes with a uniform mellowness for ideal milling.

Milling of Wheat - The process still has some art left in it besides the growing proportion of engineering. However, the conventional process used by most millers all over the world is quite similar. Efficient, quality producing mills must be very well maintained and have good operating practices in order not to damage the flour by excessive pressure, heat and evaporation.

The Air Classification Protein Shift Process - Briefly it is a method of grinding flour to free the protein matter from the starch granules and air separate it into different fractions. A simplified protein shift process diagram is shown in Fig. 1. After regrinding the flour, the flour is separated on an air separator which is set to make one cut at approximately 40 microns. This gives two fractions of flour. The fine fraction is separated on an air separator with a setting of approximately 15 microns, also giving two flours. Thus, three fractions are made:

Coarse Fraction	Over 40 Microns	Endosperm Protein Level	EP
Medium Fraction	15 to 40 Microns	Low Protein	LP
Fine Fraction	Under 15 Microns	High Protein	HP

The air classification process has two uses in the cereal processing field:

1. It gives a tool to fractionate flour to help study its properties and push back some of the horizons of the unknown.
2. It provides a practical commercial process to utilize certain wheats in new applications to make new products not possible a few years ago. In the Hard Red Winter wheat it means we are concerned with the cake baking properties of some of the fractions.

Very good bread and cake baking flours can be made from 12 to 12.5 protein Hard Red Winter wheats.

Markets - Many countries are concerned with the same problems we have, so breeding wheats that satisfy this country will also have characteristics wanted by importers of our wheats.

The processing industry has to continually face changes which must be met successfully to keep their plants operating at their present location. Some of these changes are - - -

Raw Matefial Supply
Transportation and Traffic Rates
Customer and Customer Location
Operating Cost
Changing Product Images

If a plant cannot meet these changes, usually one of two things happen. The mill goes out of business or they relocate in a more favorable position.

Quality - A closer look at quality is in order. There is still a need to improve and maintain good milling and baking quality wheats. It is possible that the high protein shackle that is worn by the grain buyer and plant breeder can be loosened - - provided there is good protein Quality present.

A new Hard Red Winter wheat quality factor to consider is the cake baking properties of the low protein fraction.

Objectives - The objectives are still the same - concentrate on producing high quality wheats.

Conventional Milling - This will remain basically the same. The need for better milling and baking wheats is always with us.

WHEAT NEEDS FOR PROCESSING

Quality - Good Protein Quality and strength. Good and high yield bread and cake fractions from Hard Red Winter wheats.

Mellowness - This is partially a variety characteristic, effected by climate. It can be improved by wheat conditioning.

Less Starch Damage - Some varieties reduce easier than others suffering less starch damage. Mellow varieties are favored. Improved conditioning helps in this respect.

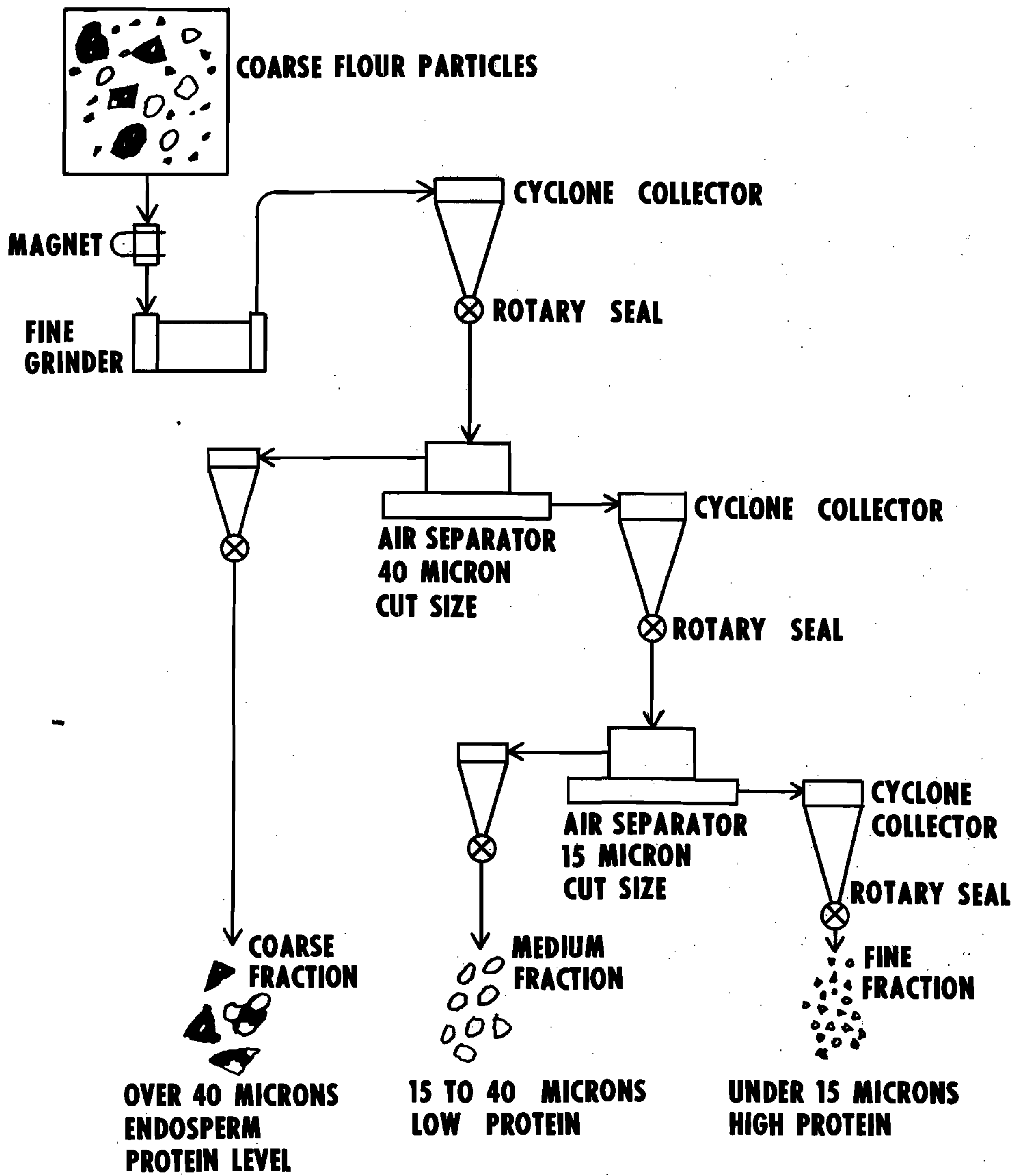
Good Air Separating Properties - Have starch separate from protein easily. Most soft wheat varieties do. Spring wheats do not.

More Knowledge on Protein Damage - In processing of wheat to flour - in conventional air classification. Learn ways to retain some of the inherent potential quality of the wheat.

Bran Contamination in Flour - More knowledge is needed about the effects of our present processing system in regard to breaking of bran and germ and enzymes ending up in the flours different ways after air separation.

Summarizing - Continue to concentrate on Protein Quality

SIMPLIFIED PROTEIN SHIFT PROCESS DIAGRAM



QUALITY OF HARD RED WINTER WHEAT AS RELATED TO IRRIGATION WATER MANAGEMENT AND NITROGEN FERTILIZATION
(Abstract)

K. F. Finney, J. T. Musick, D. W. Grimes, and G. M. Herron

Grain, flour, and bread-baking quality data were determined from water management and nitrogen fertilization studies on irrigated winter wheat at the Garden City Experiment Station, Garden City, Kansas, for four years. Data are presented for a range of nitrogen treatments at each of three selected irrigation treatments, "dry", "medium", and "wet", at selected stages of plant growth. Data for dryland fallow for 1958 and 1959 crop years are included for comparisons. Comanche variety was used in 1954 and Bison in 1957-59.

Wheat quality was related to both available soil moisture as controlled by irrigation and to applied nitrogen. Quantity of protein was decreased by maintaining higher levels of soil moisture, but quality of protein was improved. The improved quality as reflected by larger, corrected-for-protein loaf volumes compensated, at least in part, for the lower quantity of protein.

Applied nitrogen increased grain protein ffom 0.013 to 0.022 percent per pound of N for rates to 60 pounds per acre. The average increase was 0.018 percent per pound. The experiments were on Ulysses clay loam soil which was above average in fertility. Higher rates of applied nitrogen had a much smaller effect on grain protein in two of three years, indicating that the nitrogen-protein relationship may be curvilinear. The shapes of the nitrogen-protein curves were similar for different irrigation treatments.

Good irrigation water management and nitrogen fertilization produced wheat having consistent grain protein of 13 to 14 percent and other satisfactory quality characteristics. Protein content on dryland fallow for two years of above average yields, 1958-59, were 15.6 and 16.7 percent respectively.

Efficient management of water and fertility for high production is consistent with maintaining acceptable quality. Excessive irrigation, for example, not only decreased protein content but decreased yields and efficiency of water use and increased lodging potential.

Maximum experimental yields were 50 to 55 bushels per acre and seasonal water use, 22 to 26 inches.

EFFECTS OF TWO SMALL GRAIN VIRUSES ON MILLING AND BAKING QUALITY, PHYSICAL AND CHEMICAL COMPOSITION, AND PROBABLE NUTRITIVE VALUE OF WINTER WHEAT
(Abstract)

W. H. Sill, Jr.

Over a period of 5 years, several hundred samples of various wheat varieties infected with soilborne wheat mosaic virus and wheat streak mosaic virus have been tested to see what effects these diseases have upon milling and baking quality, physical characteristics, chemical composition, and livestock nutritional values.

Grain samples representing both diseases have shown that physical and baking properties of the diseased samples, for example, water absorption, mixing time, crumb grain, and loaf volume were not significantly different from the controls. Although not significant, there was often a slight, but rather consistent, improvement in mixing time ($\frac{1}{4}$ minute average) in diseased samples. Bread made from diseased and healthy samples was essentially identical.

Test weights for the badly diseased samples were consistently and usually significantly less than the healthy controls. Yield reductions were 10 to 70 percent in different varieties of varying susceptibility to the 2 diseases. Protein levels in both the wheat and the flour were consistently higher in the diseased samples. Since wheat having a low test weight tends to show a higher protein content, it was difficult to tell whether the low test weight or the presence of virus was more important in producing higher protein levels, although both are definitely involved. Since flour from diseased samples had slightly higher protein levels and was not altered otherwise, wheat infected with these 2 virus diseases might be slightly preferable to that from the healthy controls, except where badly shriveled.

Wheat forage samples infected with wheat streak mosaic virus were tested for chemical composition and probable livestock nutritive value. A significant increase in protein at the 0.1 percent level was found in the susceptible varieties when compared with healthy controls. In the intermediate and tolerant varieties, protein levels were consistently, but not always significantly higher in diseased plants. The diseased susceptible varieties of wheat also averaged significantly higher in protein than the tolerant ones. There were consistently lower levels of crude fiber in diseased as compared to healthy plants. This is probably directly correlated with the hypoplastic or general stunting effects of the virus on susceptible diseased plants. No significant differences were found between diseased and healthy plants in moisture content, ash, nitrogen free extract, or total carbohydrates, although there was a consistent tendency for diseased plants to have a slightly lower moisture content and carbohydrate level.

The stunting of the diseased plants decreases the quantity of forage significantly, particularly in the spring, but from a nutritive standpoint, the forage value of the diseased wheat would be as good or perhaps slightly better than healthy plants because of consistently higher protein levels.

MILLER: This has been a very long afternoon. Unfortunately, we have had to curtail questions for lack of time. I am sure you are all impressed, as I am, with the complexity of quality in wheat. Perhaps, one or more of these aspects that we have discussed this afternoon should be the subject of an entire symposium and gone into in a much more thorough fashion than we have been able to do this afternoon. I want to thank the participants in this program for being so cooperative and willing as they have been this afternoon.

WEDNESDAY MORNING, JANUARY 17

Chairman, I. M. Atkins
Discussion Leader, E. R. Hehn

General Topic

HARD WINTER WHEAT PRODUCTION PRACTICES AND PROBLEMS

SWEEP TILLAGE HELPS KEEP PLANT RESIDUE AT THE SOIL SURFACE1/

C. D. Fanning and H. V. Eck
Presented by K. B. Porter

The value of surface residues for wind erosion control is well established. But small grain growers, especially in areas where wind erosion is a hazard, are often confronted with the problem of retaining ample residues on the surface when several tillage operations are necessary between harvest and seeding time.

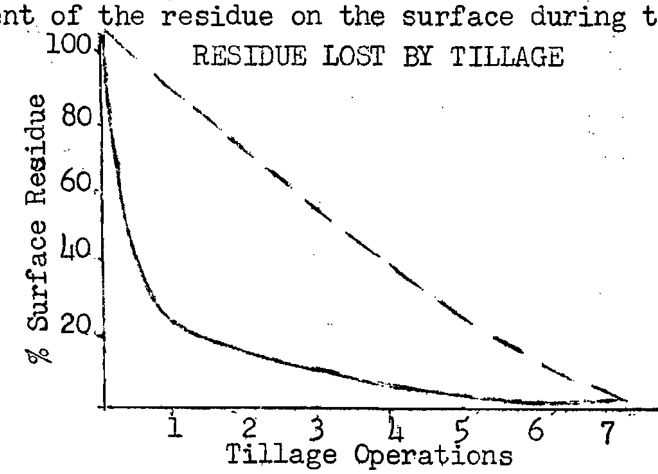
This problem is amplified if a fallowing system is followed, and a farmer often asks the question: "How much residue is buried with each tillage operation?"

Surface residue curves (see graph) have recently been obtained for two commonly-used implements through seven tillage operations. The two implements were (1) a sweep plow using 30-inch sweeps, and (2) a one-way disk plow. The initial residue consisted of 2,600 pounds per acre of wheat straw.

The 30-inch sweeps covered about the same small percentage (15 to 20 percent) of the initial residue with each successive tillage operation. However, the one-way disk plow covered the bulk (70 percent) of the crop residue in the initial tillage operation. The leveling-off effect after the first tillage with the one-way is a result of this plow uncovering some of the previously-covered residue.

The seven tillage operations occurred in a normal fallow system of tillage. Three tillage operations were made following harvest but before entering the winter season. The remaining four operations took place during the following spring and summer for weed control and seedbed preparation.

Little residue was left on the soil surface at the end of the fallow period with either tillage implement, but the sweep-tillage implement left about 50 percent of the residue on the surface during the winter months.



1/ This article was published in Crops and Soils, Volume 12, No. 9, August-September 1960 and reproduced with the permission of Crops and Soils.

OBSERVATIONS ON THE DEVELOPMENT OF THE COLEOPTILE IN WHEAT VARIETIES
(Abstract)

R. W. Livers

In New Mexico it has been found that some wheat varieties, notably Westar and Comanche, frequently fail to give satisfactory stands under difficult emergence conditions. Deep planting followed by rainfall often leads to poor emergence of these varieties. By comparison, the Blackhull group of varieties all emerge quite well. Stubble-mulch wheat farming has been reported by some growers to intensify the problem of seedling emergence. Stubble-mulch seedbeds may be quite variable from place to place, resulting in variable depth of planting with the shovel-type drills in use.

Strong seedling emergence seems quite a desirable characteristic in a semi-arid wheat area with tight soils. Growth chamber tests to determine emergence ability have been adopted as standard procedure for use on all materials in the wheat evaluation program in New Mexico.

Until recently, nothing tested at Clovis seemed to offer a better level of seedling emergence ability than Blackhull. In 1961 a group of 16 varieties introduced from South Africa were tested, and several of these appear to have a much higher level of emergence ability. In some cases the outstanding length and weight of coleoptiles may have been partially due to larger seed size. However, several strains developed remarkably strong coleoptiles from normal sized seeds. Data presented on these varieties was obtained by growing seedlings in four inches of soil at 65° F. Coleoptiles were removed from other tissue and oven-dried.

Variety	Average coleoptile length, mm.	Dry weight of 20 coleoptiles, mg.	Mg. per cm.
Westar	88	48	5.5
Blackhull	104	61	5.9
Sterling 1364	121	107	8.8
Goudveld	129	89	6.9
Dr. Swart	110	84	7.6
Queen Fan	108	81	7.5
Punjab	113	81	7.2
Red Spitzkop	124	81	6.5
Penkop	125	80	6.4
Sputnik	116	77	6.6
Sonop	102	76	7.5
Red Victory	112	76	6.8
Lalkasarwali	130	75	5.8
Betana	110	74	6.7
Bethmark	120	71	5.9
White Spitzkop	120	70	5.8
Vorentoe 1368	110	69	6.7
Daeraad	110	64	5.8

RELATIONSHIP OF SOIL EMERGENCE TO LENGTH AND GROWTH RATE OF THE COLEOPTILE IN WINTER WHEAT

K. E. Bohnenblust, B. J. Kolp and L. R. Richardson
(presented by L. R. Richardson)

Twenty winter wheats were used in this study to determine the interrelationship of percentage of emergence, length of coleoptile, rate of soil emergence and coleoptile growth rate as determined in two concentrations of mannitol.

These wheats were germinated in mannitol solutions of 0 and 7 atmospheres of tension. Measurements were made in millimeters after seven days at 0 and 7 atmospheres and again at eleven days at 7 atmospheres.

Length of coleoptile, rate of soil emergence and emergence from different depths in soil was determined in the greenhouse. The depth of planting was controlled by leveling a large soil-filled greenhouse bench. Next a frame was placed on the leveled bench. These frames were 3, 4 and 5 inches in height. The seed was planted in the bottom of the frame on the leveled greenhouse bench. After planting the frame was filled and leveled. The only compaction was that of normal settling of the soil upon watering. Ten seeds of each wheat were planted in each replication and four replications were planted in each frame.

The mean values for the characters studied are reported in Table 1. The varieties were significantly different for all of the characters studied except percentage of emergence from a 3-inch planting depth. As the planting depth was increased, the difference among varieties were greater in percentage of emergence.

Length of coleoptile seemed to be the most important character in determining percentage emergence at the 5-inch depth of planting. Percentage of emergence and length of coleoptile was highly correlated. As the planting depth increased, Blackhull continued to have a high percentage of emergence. It had the longest coleoptile of any of the wheats tested.

Rate of emergence was also significantly correlated with percentage of emergence at the 3-, 4- and 5-inch planting depth. These correlations were lower than when comparing length of coleoptile to percentage of emergence. As the depth of planting was deeper, the correlation between percentage emergence and rate of emergence was just significant. This would indicate that rate of emergence was not as important as length of coleoptile in emergence at deep plantings. Under field conditions, where the ground tends to dry out after planting, rate of emergence may be more important than shown in this test.

Rate of emergence and growth in mannitol at "0" atmospheres was highly correlated. This would indicate that selection for rate of emergence could be done in petri dishes in distilled water.

The mannitol readings were generally not correlated with percentage of emergence and length of coleoptiles. An emergence experiment should be run

Table 1. Percentage emergence, rate of emergence, length of coleoptile and growth of the coleoptile in mannitol of twenty winter wheats.

	Percent Emerged 5 in. Depth	Percent Emerged 4 in. Depth	Percent Emerged 3 in. Depth	Rate of Emergence 3 in.	Length of Coleoptile 5 in. Depth mm.	Length of Coleoptile 4 in. Depth mm.	Length of Coleoptile 3 in. Depth mm.	Mannitol 0 Atmos. 7 Days mm.	Mannitol 7 Atmos. 7 Days mm.	Mannitol 7 Atmos. 11 Days mm.
Blackhull	93	98	98	10.4	120	111	83	43	10	36
RedChief	65	100	98	10.3	113	108	83	57	12	41
Wichita	52	95	100	9.8	98	101	77	54	18	46
Nebred	47	100	100	9.3	109	109	80	58	9	26
Ponca	46	98	93	9.8	99	101	79	57	15	43
Yogo	42	98	100	9.7	107	105	82	64	17	50
WS 618	35	88	90	9.3	97	101	77	60	17	42
Minter	33	78	95	10.3	98	99	79	62	20	48
WS 650	33	95	95	9.7	104	103	79	60	17	40
Kiowa	29	90	98	10.1	88	93	77	56	17	44
Triumph	28	72	90	10.8	83	85	75	40	10	33
WS 349	27	75	89	9.9	89	91	78	51	22	37
WS 89	26	84	85	11.7	99	99	78	51	9	37
Pawnee	24	80	98	10.1	85	88	74	52	24	43
WS 21	20	54	95	10.9	90	92	74	49	13	39
WS 318	19	78	90	10.8	89	88	75	49	11	33
Ottawa	18	62	95	10.7	86	88	75	46	16	44
Cheyenne	16	73	88	10.9	90	93	76	52	12	39
WS 513	14	75	95	10.8	89	92	76	52	14	59
Commanche	11	73	90	11.1	90	92	76	52	15	41
LSD .05	14	19	N.S.	0.7	4	3	2	6	4	6
LSD .01	18	26	N.S.	0.9	6	4	3	8	5	8

where the soil is below field capacity in moisture content. The percentage emergence under stress conditions and mannitol readings may become related. This was shown by R. H. Helmerick and R. P. Pfeifer at shallow planting depths. It would also be interesting to see the effect of limited moisture on total coleoptile length.

In another experiment four-hundred and twelve wheats from the world collection were screened at a 5-inch planting depth for length of coleoptile. Forty were chosen for further screening at a seven inch planting depth. Of these 24 had mean coleoptile lengths of 127 mm. (5 inches) or above. The mean of Blackhull and WS 318 were 117 and 90 mm. respectively. Several plants were measured at the 5-inch planting depth with coleoptiles in excess of $5\frac{1}{2}$ inches. This depth of planting was not deep enough to obtain maximum coleoptile elongation.

EFFECT OF LIGHT QUALITY UPON COLEOPTILE ELONGATION (Abstract)

Bruce McCallum and Erhardt R. Hehn

Field observations have revealed that the coleoptiles of winter wheat seedlings under some conditions do not emerge above the soil surface. Failure of the coleoptile to penetrate the soil surface results in underground development of the foliar leaves. This usually results in plant mortality.

It has been hypothesized that inhibition of the coleoptile growth below the soil surface may be the result of the effect of specific transmitted spectral regions. An investigation on the effect of the visible light spectrum indicated that light of all wavelengths was capable of inhibiting the coleoptile growth of exposed germinating seed.

Preliminary investigations suggest that portions of the blue and yellow spectrum are capable of penetrating various soil depths in sufficient quantity to inhibit coleoptile growth.

INHERITANCE OF COLEOPTILE LENGTH AND ASSOCIATION WITH PLANT HEIGHT

R. E. Allan

Stand establishment of fall sown wheat in the Pacific Northwest has become a serious problem only during the last 10 years. Within that time several events have occurred that intensified the emergence problem.

Acreage restrictions made the practice of summer fallowing common even in areas where annual cropping was possible. Farmers soon learned early planting in summer fallow paid off generally in increased yield and protection from erosion due to run-off. Early seeding required deep planting, however, which intensified the emergence problem. Difficulty in securing a proper stand from early seeding of the variety Brevor was common. The emergence of this selection from late seedings, however, was excellent. Furthermore, the introduction of semidwarf germplasm brought into the breeding program the undesirable traits of slow seedling growth rate and short coleoptile length and further complicated the possibility of securing selections which emerge suitably.

Several workers have related emergence rate and total emergence to coleoptile development, particularly weight and length. A survey of over 100 semidwarf selections being tested at Pullman, Washington showed that their coleoptile lengths were generally 60 to 75% of the length of most standard height selections. Based on this information a study was initiated on the inheritance of coleoptile length and its association with culm length.

To date inheritance of coleoptile length has been studied in 8 crosses, all involving semidwarf selections. Monosomic analysis has been attempted with one semidwarf selection, Norin 10-Brevor 14.

The inheritance of coleoptile length has been found to be generally complex or quantitative in nature; heritability estimates of coleoptile length are shown below:

Cross		Heritability %	Correlation Col Lgh/Plt Ht
Royal x SD Nrn 10-Bvr 14	F_2	47	+.583
Royal x SD 50-3-3	F_2	15	+.094
Nigger x SD Nrn 10-Bvr 14	F_2	38	+.277
Nigger x SD 50-3-3	F_2	57	+.260
Itana x SD 562292	F_3	50	+.526
Hymar x SD 562280	F_3	66	+.747
Omar x Suwon 92	F_3	66	+.731
SD Nrn 10-Bvr $14\text{-}B^2$ x B	F_4	91	+.826

In the first four crosses Frey and Horner's standard unit method of determining heritability was followed; in the four other crosses, a progeny parental variance method was used. With the exception of the cross Royal x SD 50-3-3, heritability of coleoptile length was high and suggested selection would be possible in the F_2 generation in some crosses.

A graduate student, Mr. A. R. Chowdhry estimated the maximum number of genes governing coleoptile length in the above first four crosses varied between 2 to 6.

Monosomic analysis of coleoptile length in the cross SD Norin 10-Brevor 14 x Chinese series substantiated the inheritance of coleoptile length to be complex and indicated that seven chromosomes influenced coleoptile development. Loss of chromosomes II (2A or B), XII (3A), XIII (2B or A), XIV (1A), and XX (2D) reduced coleoptile length whereas loss of VIII (4B) and XI (7A) increased coleoptile length. All members of homologous group 2 affected development.

A positive correlation between coleoptile length and culm length has been found within crosses involving semidwarf selections and selections of standard height; correlation values between the two measurements are shown above.

In the first four crosses F_2 coleoptile length was correlated with F_2 plant height. In the remaining crosses F_2 plant height was correlated with F_3 coleoptile length. Values obtained in crosses Royal x SD 50-3-3, Nigger x SD Norin 10-Brevor 14, and Nigger x SD 50-3-3 offer encouragement for separation of short coleoptile and short plant height. These values still must be verified in more advanced generations. A more complete study was made of the association between coleoptile and culm length in the four remaining crosses. Although the correlations are not exceedingly high, no instances of complete disassociation were found. We are presently carrying on a back cross program with the objective of developing short-strawed selections with long coleoptiles and rapid seedling growth rates. Preliminary results have not been encouraging, however.

THE ASSOCIATION OF EMERGENCE RATE AND TOTAL EMERGENCE WITH SEVERAL LABORATORY MEASUREMENTS

R. E. Allan

Work on seedling emergence began in 1954 at Pullman, Washington. It was apparent from the beginning that evaluation of breeding material for emergence ability would be a difficult problem.

Both total emergence or percent stand and rate of emergence have been measured under field conditions for several years. These field tests are costly, must be performed during the busy summer months, and are often quite variable due to erratic climate, topography and soil texture which occurs at Pullman. The amount of nursery space required, plus the time and labor necessary to perform field studies on a large scale has precluded its use for early generation testing of large numbers.

For these reasons we have begun a series of laboratory tests on a group of 33 semidwarf selections in order to develop a laboratory method which will come fairly close to predicting field emergence performance. We chose to work with semidwarf selections primarily because it is within these wheats where the most improvement in emergence is needed.

Field emergence data was obtained on these 33 selections from three separate (three replicate) plantings made on summer fallow ground during 1960. Both total emergence and rate of emergence were measured. For evaluation of rate of emergence we use a value which we call the E.R.I. or emergence rate index. This figure is a weighed value which gives those selections whose seedlings emerge most rapidly extra credit; the value also reflects total emergence. Total emergence and E.R.I. correlate well (in this particular test +.871). We favor use of E.R.I. values slightly over total emergence because often our total emergence values are confounded by post-emergence-seedling-blight or what the farmers call die-back.

To date we have studied the associations of 16 laboratory measurements with emergence rate index and total emergence of these 33 semidwarf selections. Laboratory measurements included: coleoptile length of seedlings grown at both 50 and 90° F; seedling height at 90° F, 3, 4, 5, and 7 days after planting; seedling height at 50° F, 10, 12, 15, and 18 days after planting; growth of seedlings under 7 and 9 atmospheres of osmotic pressure; germination rate; hours required for the coleoptile to rupture; seed weight and water uptake per gram of seed during four hours soaking.

Table 2 shows that correlations significant at the 1% level occurred between E.R.I. and seedling growth 90° at 3 and 7 days; seedling growth 50° at 15 days, and germination rate. Correlations were significant at the 5% level for coleoptile length at 50 and 90° F; seedling growth 90°, 5 days and for growth at 50°, 10 and 12 days.

Laboratory tests which would be most useful in evaluating semidwarf selections for emergence rate would be those that correlate with E.R.I. and are independent of plant height. Therefore, partial correlations were calculated for these 9 lab tests independent of plant height differences (Table 2). Seedling growth at 90°, 7 days after planting still correlated at the 1% level. Seedling growth 50° at 15 days and growth at 90°, 3 days and germination rate correlated at the 5% level. Correlations involving the other five measurements were no longer significant after adjustment for plant height differences.

Similarily correlations were determined between the 16 laboratory methods and total emergence (Table 2). Only four methods gave significant values. These were coleoptile length at 50°; seedling height 90° at 7 days; seedling height 50° at 15 days; and germination rate. When adjustment for plant height differences were made none of these methods gave significant correlations with total emergence.

Among the 9 methods which correlated with E.R.I., partial correlations with one another suggested that seedling growth 90° at 7 days, germination rate, and possibly coleoptile length may be valuable means of classifying semidwarf selections for E.R.I. Seedling height at 90°, 7 days was the only method which proved significant following adjustment for the other three methods which correlated with total emergence.

Results of these tests are considered preliminary and must be confirmed with actual early generation breeding material which should represent a wider base of germplasm. We currently are in the process of doing this.

Table 2

Laboratory Method	E.R.I. Simple R	E.R.I. Partial[a] R	Total Emergence Simple R	Total Emergence Partial[a] R
Coleoptile Length 90°	+.367*	+.200	+.319	---
Coleoptile Length 50°	+.395*	+.163	+.400*	+.186
Seedling Height 90°,3 days	+.537**	+.395*	+.339	---
Seedling Height 90°,4 days	+.287	---	+.190	---
Seedling Height 90°,5 days	+.383*	+.154	+.253	---
Seedling Height 90°,7 days	+.628**	+.521**	+.483**	+.331
Seedling Height 50°,10 days	+.358*	+.237	+.162	---
Seedling Height 50°,12 days	+.382*	+.295	+.176	---
Seedling Height 50°,15 days	+.500**	+.423*	+.385*	+.293
Seedling Height 50°,18 days	+.183	---	+.180	---
Mannitol 7 Atmospheres	+.230	---	+.247	---
Mannitol 9 Atmospheres	+.186	---	+.124	---
Germination Rate	+.507**	+.415*	+.404*	+.297
Coleoptile Ruptured	-.246	---	-.072	---
Seed Weight	+.120	---	+.224	---
Water Uptake	-.102	---	-.195	---

a/ Independent of plant height.

A NEW DEEP FURROW DRILL AND OPENER DEVELOPED FOR THE BIG BEND AREA OF EASTERN WASHINGTON

Robert Zimmerman and W. Nelson
(Presented by R. E. Allan)

Prior to the release of Gaines wheat, extension workers warned farmers in the low rainfall areas of Eastern Washington that the new semidwarf would probably not emerge suitably under their conditions. Not wanting to be left out, a dry land farmer, Robert Zimmerman, of Almira, Washington decided to develop a new opener and deep furrow drill which would allow for early seeding of the newly developed wheat in the low rainfall areas. Mr. Zimmerman, who worked closely with Walt Nelson, Superintendent of the Lind Dry Land Experiment Station has come up with a new opener and drill which he thinks will fill the bill.

According to Mr. Nelson, Mr. Zimmerman's new openers and drill are designed to put the seed in maximum moisture with as little soil distrubance and with a minimum of depth of coverage. The opener has these characteristics:

1. The design causes less fracturing of the moist soil area which reduces the loss of soil moisture and allows the seed to germinate more rapidly.

2. A narrow runner extends below the base of the opener. The runner inserts the seed into a narrow groove an inch or so in moist soil.

3. Design of the opener and runner is such that the opener floats on the moist seed bed and is less affected by changes in soil density or compaction due to the suction effect caused by the runner. In wet or soft areas the runner causes little suction due to its narrow width, and in drier land the narrow point has a tendency to keep the shovel down in good moisture.

The drill has these characteristics:

1. To eliminate the problem of a shovel throwing loose soil into other furrows the unit is built on line in contrast to staggering of other deep furrow drills.

2. V-shaped press wheels carry the weight of the drill. The weight is placed on the side of the furrow and not directly upon the seeded rill.

3. An adjustable packer wheel allows for regulation of the amount of packing directly over the seed.

4. The V-shaped press wheels can be adjusted so that the amount of soil placed over the seed can be regulated.

5. The press wheels act as "rolling wings" so loose soil and trash have little chance of plugging the drill.

According to Mr. Nelson the new opener was used in seeding over 8,000 acres last fall. He states that all the fields have good stands and are appreciably better than surrounding fields seeded with conventional openers.

HEHN: Is there one short question?

QUESTION: I would like to ask Kenneth Porter if it is not necessary to increase the rate of nitrogen fertilizer in order to bring up wheat yields under stubble mulching?

PORTER: It isn't necessary at the Southwestern Great Plains Field Station, or in the western parts of the plains. In higher moisture areas it probably is necessary. I think this probably is true over in Oklahoma and higher rainfall areas. It isn't true in our area. We provided no fertilizer.

MICROBIOLOGICAL STUDIES OF SUBBLE-MULCH FARMING
(Abstract)

W. D. Guenzi and T. M. McCalla

Stubble-mulch farming is very effective in controlling erosion by wind and water; however, occasionally yield reductions have resulted. These yield reductions may be due to lack of good farming techniques, lack of proper equipment, weed problems, cooler soil temperatures in the spring, and less nitrate production on stubble mulching than on plowing. In addition to these, another factor may be phytotoxic substances present in crop residues or soils, or produced by microorganisms.

Stubble-mulch farming increases the number of soil microorganisms in the surface inch of soil. Nitrogen, carbon, organic matter, phosphorus, and HCl soluble and adsorbed phosphorus are slightly higher in the surface inch of soil with stubble mulching as compared with plowing. In the 1- to 6-inch depth, there is no difference between stubble mulching and plowing. Amino acids are slightly higher in the 0- to 3 inch depth of soil, with no measurable difference in the 3- to 6-inch depth of soil.

All of the plant residues used for mulching purposes, such as wheat and oat straws, soybean and sweetclover hay, corn and sorghum stalks, bromegrass, and sweetclover stems, contain water-soluble substances toxic to germinating seedlings of wheat, sorghum, and corn. Phytotoxic substances have been extracted from the soil of stubble-mulch plots with sodium pyrophosphate.

A Penicillium, which was isolated from stubble-mulch plots at Alliance, Nebraska, that showed reduced wheat growth, produced a phytotoxic substance that reduced germination and root and shoot growth of corn and wheat seeds. The substance, separated by paper chromatography, has an elemental analysis of carbon, hydrogen, and oxygen; is insoluble in water, dilute acids and bases; is soluble in concentrated H_2SO_4, ethyl alcohol, diethyl ether, carbon tetrachloride, and chloroform. The infrared spectrum shows strong absorption at 1779 cm^{-1}.

The influence of the phytotoxic substances on crop yields in the field has not been critically evaluated.

FUTRELL: Is this compound isolated in all organisms?

GUENZI: This organism is a Penicillium. Its exact name is not known, but it is one of the Penicilliums.

BUCHENAU: In the summer of 1960 we observed a stubble mulch field of wheat in western South Dakota which had a very high percentage of a leaf spotting disease. The wheat was on ground that was summer fallowed the previous year. I am sure that by the late milk stage all of the leaves were killed in this field. It still made a fairly good yield. I am confident that certain minor diseases such as this might be increased by stubble mulching. Retention of moisture and other advantages of stubble mulching might be offset by development of some of these so-called minor diseases.

I believe people in the Pacific Northwest also have found increased disease incidence in that area. Is there anyone here from that area who can comment?

V. R. STEWART: We pathologists at the Bozeman Station, in conjunction with other stations, set up an experiment starting in 1957. This was done on spring grains, particularly barley. We found that stubble mulch increased diseases, and decreased yield. There seemed to be a real correlation between disease readings made by the pathologists and yields we obtained.

THE EFFECT OF TILLAGE PRACTICES AND CROPPING SYSTEMS ON INSECT POPULATIONS (Abstract)

C. F. Henderson

Very little can be said at this time regarding the effect of stubble mulching on populations of wheat insects. A review of the literature of the past ten years has failed to reveal any direct references to this subject. However, since deep tillage and clean cultivation are used as control measures against some wheat insects, it is logical to suppose that the lack of these practices, as with stubble mulching, would tend to increase populations of these insects. Of course, there is a possibility that natural enemies might also increase where the environment has a minimum of disturbance, and the resulting biological control might be as effective as that brought about by deep tillage and clean cultivation.

Tests are being conducted in Kansas, Oklahoma and Nebraska to determine the effect of different tillage practices and cropping systems on populations of wheat insects. From an entomological standpoint the problem consists of: 1, a detailed ecological study to determine population levels of insects associated with different types of tillage practices; 2, plant damage associated with these populations; 3, the need for chemical control measures to keep insect populations below the economic level in mulching as compared with clean cultivation; 4, the relative cost of these control measures; and 5, the degree of natural control associated with different tillage practices.

In order to be of value these studies must be conducted over a period of years. It will also be necessary to have observations in areas where insects that are directly affected by tillage operations are present.

SCHLEHUBER: Charley, although I realize you have just one year's data, would you anticipate in the years to come that this matter of insect control is an insurmountable problem?

HENDERSON: I don't think it is. We have various methods of controlling insects, so it isn't an insurmountable problem.

SCHLEHUBER: I am glad to hear you say that because I think it is the philosophy we must have if we are going to get insect problems worked out.

EFFECT OF ALTERED LIFE CYCLE UPON YIELD AND CROP QUALITY

B. Tucker

Does soil fertility affect the life cycle of the wheat plant? We know that the amount of the essential chemical elements in the soil influences crop growth--both the amount of growth and rate of growth. If the rate of growth can be increased then, at least, the timing of certain morphological activities can be altered. It is frequently stated that phosphorus fertilization hastens maturity and that nitrogen fertilization delays maturity. Are these statements necessarily true? At best they are only broad generalizations. In a variety-fertility interaction study conducted in Oklahoma, we found that all fertility treatments except the 40-0-0 treatments headed earlier than the check plot. On many soils in Oklahoma nitrogen application alone will hasten maturity. Isn't the normal maturity date of a variety the maturity date obtained with all nutrients adequate and none present in harmful excess?

Shouldn't investigators study more thoroughly the influence of added nutrients on the morphological development of the wheat plant? Are the following morphological stages the ones on which measurements should be taken:

1. Germination and seedling emergence
2. Tillering
3. Stem development or shooting
4. Heading
5. Flowering
6. Ripening

What type of studies should be conducted to gain information on the influence of soil fertility on the above?

There are also some general questions that might be raised in connection with soil fertility-variety interactions. The most important of which might be: Can plant breeders select plants exhibiting an increased favorable response to fertilizer elements? To answer this question, perhaps, we need to consider the following:

1. Are there differences in rooting patterns of wheat varieties?
2. Do all wheat varieties possess about the same amount of roots?
3. Is there a relation between wheat yield and quantity of root growth?
4. What relation is there between varieties and root energy reserves (i.e., do varieties differ in nutrient uptake capacity)?
5. Why do some varieties outyield other varieties (i.e., what yield components are responsible for increased yields)?

We must know whether or not differences in responses to fertilization are genetically controlled and if so, how?

A question that many breeders would apparently like to resolve immediately is: at what level of soil fertility should variety tests be conducted?

To answer many of the questions raised will require close cooperation and team effort between the plant breeder and investigators in soil fertility.

SELECTION OF PLANTS WITH INCREASED YIELD AND QUALITY RESPONSE TO FERTILIZER ELEMENTS

A. M. Schlehuber

Little or no specific research information is available to answer specific questions on this subject. However, one may ask some rather pertinent questions which have a bearing on this problem. For example, are there certain basic principles with respect to plant nutrition in relation to yield and quality which would tend to limit selection for certain plant and grain characteristics? Stated another way: Is it possible to devise nutrition regimes favorable for both yield and quality without regard to specific plant and grain characteristics?

Experimental data at the Oklahoma Experiment Station show that, in general, ca. a 2:1 ratio of N:P produces the most favorable combination of grain yield and quality. This fertilizer ratio also produced the highest percentage of dark, hard, vitreous kernels and the highest number of seeds per head. On the other hand, high P ratios generally produced the highest seed weights. However, the highest yield (and the highest number of heads per area) was produced when the number of kernels per head and the average seed weight had intermediate values; i.e. when there was a "balanced" compensation. Will this same association hold true for all conditions, or are there indications that certain yield components can be increased or decreased without sacrificing quality?

Yield is a very complex character, so it would seem to me to be important to study the various yield components and how these are affected by various levels of nutrition. This is being investigated at the Oklahoma Station but so far we have only preliminary results.

ALLAN: Semi-dwarf selections are more efficient in the utilization of fertilizer. Dr. Schlehuber doesn't go all the way in his selection for kernel number or kernel weight. He stays in the middle of the road in dealing with these various yield components in order to get all working together. You have to work with the median type for best performance.

HEHN: (Quoted from a letter from the Deere Company) "We should be striving to develop better seeding machinery and varieties with seedling characteristics that would make them more resistant to fertilizer damage in areas where fertilizer use is on the increase."

SCHILLER: From the standpoint of testing these varieties, I would add a word of caution. In testing these varieties that you people are going to develop, from the standpoint of commercial acceptance of quality, it is always very difficult to evaluate varieties when they differ in protein level. In your testing, I would suggest that you make an effort to keep the varieties within limits of protein, if possible, that can be expected from commercial production. It is pretty hard to find out whether the quality is good in a variety with 17% protein as compared to one that is 10% protein. Keep this in mind.

BETTER WEED CONTROL BY INCREASING COMPETITIVE ABILITIES OF PLANTS AND BY SELECTION OF TOLERANT PLANTS TO HERBICIDES

G. A. Wicks

Increasing the competitive abilities of wheat is something that should interest every plant breeder -- this should mean higher yields. Let us imagine the wheat breeder has developed a new highly competitive variety -- one that is able to utilize moisture and nutrients better than any other variety. This variety would produce just enough tillers to utilize the available moisture and nutrients in order to obtain maximum yields. Ideally you would want a variety that would produce the same yield with or without weed competition. Granted, this is impossible. The next best choice is a winter wheat variety that would give high yields under weed competition. This is not advocated for a substitute for clean farming. It is better to have the competition in the form of other wheat plants rather than weeds.

Some interesting research work (2,5) has been conducted in California and Kansas on natural selection of wheat and barley. An equal number of wheat seed of several varieties were mixed and planted. The same procedure was used for barley. Seeds from the previous crop were used to sow each succeeding generation. This system was carried out for several generations. Percentages of the component varieties were obtained each year. At Manhattan, after 9 years, better than 90% of the grain was Kanred in comparisons between Kanred and Harvest Queen and Kanred and Currell. Research at Davis, California showed similar trends in regard to one variety becoming dominant. The interesting point was that when the varieties were grown by themselves for the same period of time there was little difference in yields. This points out that some varieties are more competitive than others.

At the North Platte Experiment Station, Paul Nordquist and I have been conducting an alfalfa establishment experiment. In part of the experiment alfalfa was planted in corn. The alfalfa was seeded in three corn varieties immediately after the corn was planted, and the last cultivation. Silage and grain yields from these treatments were compared with corn grown without alfalfa. We were quite surprised at the differences in yields. Also, there was a striking difference in vigor of the alfalfa under the three varieties.

Another interesting phase of the plant competition is plant population experiments in corn. In Nebraska (1) six hybrids were planted at 12,000, 16,000, 20,000 and 24,000 plants per acre. It was evident that certain hybrids reacted differently under these populations. A.E.S. 806 reached its peak between 16 and 20,000 plants/A; Nebr. 401 reached its peak at 20,000 plants/A and Ia. 4417 yields were still increasing at 24,000 plants/A.

For the remainder of my time I would like to focus our attention on the topic "increasing herbicidal selectivity by selection of tolerant plants".

Since you are familiar with 2,4-D, I would like to start with this herbicide. Varieties of winter wheat appear to be relatively tolerant to 2,4-D while there is a marked difference in the susceptibility of sorghum varieties and hybrids. Since there are differences in monocots I will ask you this question. Where can the winter wheat breeder fit into the weed control program by selection of wheat plants tolerant to certain herbicides? Many of you probably have some good ideas that are connected with the weed problems you have in your state. Probably the most important place this type of program has merit in our state is with chemical fallow. Much of the winter wheat is produced in a wheat-fallow rotation. In Nebraska and neighboring states stubble mulching is highly encouraged. This practice is an excellent method of reducing wind and water erosion. In Western Nebraska downy brome (Bromus tectorum) is threatening the continuation of stubble mulching. Farmers prefer not going back to the plow and black fallow methods of the past even if is a better method of controlling downy brome. They are more interested in chemical fallow which is an excellent way of controlling downy brome. The ideal practice would be to apply a semi-soil sterilant herbicide as soon as the wheat was harvested. This herbicide would then control the weeds for 12 to 14 months. The farmer would have ample time to prepare his seedbed prior to planting. The chemical would be completely dissipated and he wouldn't have to worry about herbicide residual.

There is one herbicide that comes close to this now; this is atrazine. The only problem is that it doesn't always dissipate by planting time. If not enough has dissipated the farmer may have trouble growing wheat. Atrazine does an excellent job of killing the downy brome and other weeds found in the winter wheat rotation. However, there are some species of weeds that are fairly tolerant to atrazine. These weeds, if present, are the first to survive when the atrazine has dissipated to levels they can tolerate. Tillage would have to be used to kill these weeds. This is a minor problem compared to herbicide residue.

If the wheat breeder could select a variety that is tolerant to atrazine then chemical fallow with the present herbicides would be practical. Atrazine could be present at low rates at planting time without danger of injuring the wheat and this carry over may control some downy brome. The farmer who wants to chemical fallow and uses this wheat variety wouldn't have to worry about losing his wheat from too much herbicide residue.

So far as I know no one has ever checked wheat varieties for tolerances to atrazine. I do know that there are differences in tolerance in sorghum and oat varieties to atrazine. Paul Nordquist and I at the North Platte Experiment Station have applied atrazine to soil in which several different hybrids of sorghum were planted. We sprayed 42 hybrids with atrazine and propazine; there were 11 hybrids that were not visibly injured with atrazine. Twenty-five of the hybrids were almost or completely eliminated.

Smith and Bucholtz (4) in screening trials in the greenhouse found that oat varieties Minhafer and Beedee appeared to be fairly tolerant to atrazine while Fayette and Branch were not. In the field the tolerance of Beedee wasn't apparent. Field experiments showed that Minhafer, X643-41 and Newton were significantly more tolerant than the other varieties. Fayette, Portage and Branch were the varieties most injured.

Now suppose that the wheat breeder has selected a variety that is tolerant to atrazine. Two things could happen that would counteract the breeder's gains from this program. One, better herbicides may be found that will replace atrazine in the chemical fallow program. Two, volunteer wheat in certain years is a great problem, especially a year in which there has been hail prior to harvest. Volunteer wheat is considered a serious weed and we would like to have the chemical kill it when present. If the variety was too tolerant to atrazine another chemical with short residual could be used to kill the volunteer winter wheat.

Another possible place where selection of a tolerant winter wheat variety to certain herbicides would have merit would be for controlling downy brome in plantings of winter wheat. This should be a post emergence treatment. I have no good suggestions of herbicides for this unless it would be atrazine or endothal.

Sugar beets are a good example of what has been done in other crops for increasing herbicial selectivity by selection of tolerant plants. In 1950 endothal was first tried on sugar beets. Endothal was applied at different stages of growth and on different soil types. The most consistant weed control and the least amount of beet injury were obtained with preplant or preemergent applications to heavier soils. However, when the rate was high enough for optimum weed control there was considerable injury and sometimes reduction in stand to the sugar beet on some soil types. These beets were not as vigorous as untreated plants. Occasionally there would be beets that were not visibly affected by endothal. In December of 1957, Nelson, Wood, and Oldemeyer (3) of the Great Western Sugar Company decided they would investigate the possibilities of selecting for an endothal-tolerant sugar beet.

Their first attempt to separate the genetic difference within a variety was by germinating seed on blotters impregnated by a solution of endothal. This method soon gave way to one in which the beets were planted in sand and watered with a solution of endothal.

They made selections by two methods. Selection A consisted of applying 10 lb/A of endothal to the sand in sufficient water to wet the entire volume of sand. They selected approximately 120 plants on the basis of normal development of the primary root of the beet seedling.

Selection B consisted of applying 140 lb/A of endothal in a similar manner and selections were made from the remaining plants. In both Selection's A and B the selected plants were about 4% of the parent population. These selections were allowed to produce seed. The seed was collected and a progeny test was conducted using flats and course sand. The flats were sprayed with endothal at 10 and 140 lb/A. Selections were again made and the seed was planted in the field.

Rates of endothal were applied in the field at 0, 5.5, 11.0 and 16.5 lb/A. Seedling vigor for the three groups (Parent, Selection A and Selection B) was quite striking at the higher rates of endothal. Selection B plants were much more vigorous than the other two groups. Under the conditions of their tests the vigor differences weren't apparent at harvest.

Last year there was a limited supply of endothal tolerant seed available to the sugar beet farmers. They planted this seed on fields where they had their worst weed problems and on sandy soil.

I understand that selections have been made in flax for a variety that is more tolerant to MCPA. This herbicide is used to control broadleaf weeds in present flax varieties. With this new variety it is anticipated that farmers will be able to use higher rates of the MCPA. If selection had been made earlier there would have been less problem with flax injury. I believe that the world collection of sugar beets and flax is now being screened for certain herbicide tolerance.

In summary, increasing competitive abilities of wheat is important but it cannot be a substitute for good weed control. Increasing herbicidal selectivity by selection of tolerant wheat plants has great merit especially if the herbicide is not replaced in the very near future by another herbicide. Other important agronomic and physiological characteristics should not be sacrificed to obtain these goals.

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WATER USE EFFICIENCY OF IRRIGATED WINTER WHEAT AS INFLUENCED BY MOISTURE TREATMENT IN THE SOUTHERN HIGH PLAINS
(Abstract)

W. H. Sletten, J. Musick, and M. E. Jensen

Results from experiments of irrigated winter wheat at Bushland, Texas and Garden City, Kansas, which consisted of nitrogen-moisture treatment combinations, are discussed. The concept of water use efficiency (pounds of grain produced per unit depth of water used in evapotranspiration) is used to demonstrate the response of wheat grown under conditions of moisture stress and excessive irrigation at various stages of growth.

Certain conditions of limited water supply, which resulted in low total water use without drastically reducing yield, brought about highest water use efficiency. The amount of evapotranspiration under different moisture regimes was determined largely by time and amount of rainfall and irrigation, and ranged from about 17 to 32 inches at Bushland and from 19 to 27 inches at Garden City. This was for the years 1956, 1957, and 1958 at Bushland and 1957, 1958, and 1959 at Garden City.

At Bushland, highest water use efficiency of 2.6 bushels per acre-inch occurred in 1957 from a moisture treatment from which there were 17 inches

of evapotranspiration; however, lowest water use efficiency of only about 0.9 bushels per acre-inch occurred in 1956 with this same amount of evapotranspiration. This emphasizes that time, degree, and duration of soil moisture stress greatly affects return per acre-inch of water.

Detrimental effects of ample nitrogen in combination with excess water supply are shown by yield reductions caused by lodging and comparatively low percentage of grain protein. These result in low total water use efficiency as well as low irrigation water use efficiency. In most years, two 4-inch irrigations, one in the fall (preplanting) and one in the spring near boot stage, brought highest efficiency of water use. In years of above-average and well-distributed rainfall, one irrigation resulted in highest water use efficiency.

MAINTAINING ACCEPTABLE LEVELS OF WHEAT PROTEIN (Abstract)

Karl F. Finney

My comments on this subject pertain primarily to new progenies submitted to the Hard Winter Wheat Quality Laboratory for chemical, milling, and baking evaluation. Irrigation of wheat without the addition of nitrogen often results in the production of wheats containing 11% or less protein. Flours therefrom would contain about 10% or less protein. Evaluations of most of their properties usually are questionable when flour protein contents are low. For example, mixing times are unusually long and indicate pseudo mixing tolerance, and loaf volume differentiation is approaching a minimum. At 9% protein, loaf volume differentiation is only about 1/3 that at 14%. Raising the protein content of irrigated wheats by 2% would facilitate materially their evaluation.

DISEASES OF WHEAT IN IRRIGATED FIELDS AS COMPARED WITH DRY LAND FIELDS

M. C. Futrell

The rusts, streak mosaic virus and the Helminthosporium diseases are the three predominant diseases of wheat in irrigated areas of Texas. Moisture is essential for most fungi to penetrate a plant and cause disease development. It is not a direct factor in wheat streak infection. However, it may have an indirect effect on the vector.

The northward movement of rust in the spring and the southward movement in the fall across Texas has probably been affected by growing wheat under irrigation. There are two major areas where rusts build up in the spring to move northward into the winter wheat belt and the spring wheat belt. These areas are north of Dallas and Fort Worth and the Rolling Plains area. There is no irrigated wheat grown north of Dallas and Fort Worth but there is a sizeable acreage grown on the Rolling Plains near Iowa Park. In years when rust inoculum has been blown into this area from southern Texas and Mexico, build-up of the disease was faster in irrigated fields than in dry land fields. Generation turn-over of the rust was faster and urediospores were produced more profusely in irrigated fields.

When rusts move southward during fall months irrigated wheat fields play a major role in the build-up and spread of the disease. When the growing season was dry, as occurred from 1953 to 1957, the prevalence of stem and leaf rust was much higher in irrigated than in dry land fields. During the race 15B epiphytotic much of the inoculum that was blown into southern Texas and Mexico was generated in irrigated wheat fields of the Texas Panhandle. Volunteer wheat growing near irrigation ditches and wells play a role in the fall build-up of rusts. In fall growing seasons when rainfall has been ample for wheat to grow rust prevalence and severity were about equal in irrigated and dry land fields.

During 1959-60 a study (1) was made of the wheat streak mosiac in Texas. This disease was found in native grasses and early seeded wheat fields. Eriophyid mite populations were heavy on early seeded and volunteer wheat.

High temperatures and abundant moisture favor infection of wheat plants by Helminthosporium sativum Pamm., King and Bakke. Wheat seeded under irrigation while temperatures were still high during the early fall months developed foot rot the following spring near Hereford, Texas, in 1958. No studies have been made to determine if foot rot is more severe in dry land or irrigated fields. Wheat straw decomposes much faster when ample moisture is present and this could reduce the inoculum of H. sativum thus reducing the disease.

Early sowing to provide wheat pasture in the Texas Panhandle during the fall months has intensified wheat disease problems and they are usually most pronounced in irrigated fields. Wheat seeded and irrigated during the late summer or fall months produces abundant grazing for livestock at a period of the year when feeds are expensive. The number of wheat growers that follow this practice is increasing annually. In these fields rusts become established early in the fall thus providing profuse inoculum of urediospores to be blown southward. Eriophyid mites build up and spread the wheat streak virus. Root rot infections are established.

Yields of grain and forage are higher on irrigated than on dry land wheat, and where water is available farmers will irrigate wheat. Control measures can be worked out for these diseases and additional increments of yield of forage and grain can be added to the wheat crop.

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ROW SPACING WORK WITH WINTER WHEAT IN MONTANA

D. E. Baldridge and J. L. Krall

Row spacing studies with winter wheat have been conducted at Moccasin, Montana, since 1948. Spacings of 12, 18, 24, and 30 inches were used by Krall in 1948 to 1951. In 1952, the following treatments were established: (1) alternate crop-fallow, 12 inch rows (2) 24 inch rows on an alternate crop-fallow basis, (3) 24 inch rows on a continuous cropping basis, (4) 36 inch rows on a continuous cropping basis, and (5) 36 inch rows as a fallow substitute using 12 inch solid in even years and 36 inch rows in odd years.

The twenty-four and thirty-six inch rows were cultivated for weed control and the 12 inch sprayed with 2,4-D. The yield components were studied and a significant positive correlation between head number and yield was observed.

The twelve inch solid stand method produced the highest individual yearly yield on either the alternate fallow or 12-36 inch system. The land was idle one year out of two under the alternate crop-fallow system and total yield over a seven year period was lower. The total yield obtained from the five treatments studied for the period of 1953-1959 was as follows:

1. Alternate-crop fallow - 12 inch - 79.7 bushels
2. Alternate-crop fallow - 24 inch - 72.7 bushels
3. Continuous cropping - 24 inch - 103.5 bushels
4. Continuous cropping - 36 inch - 101.5 bushels
5. Continuous cropping 12- 36 inch - 109.9 bushels

An evaluation of the results obtained from this study revealed the following aspects: (1) Stands were hard to establish on continuous cropping during dry falls and it might become necessary to use spring wheat occasionally. (2) Weeds became more prevalant in the continuous cropping in spite of cultivation. (3) Yields were higher from the alternate fallow method in the years that the land was in crop, but the total production was lower. (4) The erosion problem was not of any consequence on the continuous cropping system. (5) The use of 36 inch cultivated rows as a fallow substitute was successful and resulted in the greatest amount of grain produced over the seven year period. (6) The fallow substitute system was also the most economical in terms of net return.

The interrelationship of row spacings and seeding rates is currently being studied under different fertility levels at Moccasin, by Mr. Choriki.

The growth performance of tall and short isogenic lines of Yogo x (Yogo-16 x Norin 10-Brevor-17-4) is being studied at the Huntley Branch Station under two moisture levels, two row spacings, and two nitrogen levels. The twelve inch row spacing was superior to the twnety-four inch spacing in both 1960 and 1961.

ROW WIDTH AND SEEDING RATE AS FACTORS INFLUENCING WINTER WHEAT YIELDS AND COMPONENTS OF YIELD (Abstract)

F. C. Stickler

In 1959 and 1960 at Manhattan, Kansas, three seeding rates (0.5, 1.0 and 1.5 bu. per acre) and 3 row widths (7, 14 and 20 inches) were evaluated in all possible combinations to determine their influence on grain yields and yield components.

In 1959, the 0.5 bushel seeding rate was slightly superior to heavier rates. Mean yields obtained from 7-, 14- and 20-rows were 25.9, 21.1 and 14.3 bu. per acre. In 1960, the 1.5 bushel rate gave highest yields. Yields of 14- and 20-inch rows were 81 and 68 percent of the yield of 7-inch rows, respectively.

In both years, the number of heads per unit area was more closely associated with yield differences than were either of the other components, seeds per head or seed weight.

In neither year was there significant interaction between seeding rate and row width for yield or yield components, which suggests that these two variables need not be evaluated together in subsequent studies.

Lodging decreased and weed growth increased as row width increased from 7 inches. Excessive weed growth, however, was noted only with 20-inch rows.

The results indicate that for increase of a small allotment of a new variety, a light seeding rate and narrow row width should be used. In this study, average seed return per bushel planted varied from 71 bu. for 0.5 bu. per acre in 7-inch rows to 17 bu. for 1.5 bu. per acre in 20-inch rows.

EFFECT OF ROW SPACING AND PLANTING ON WINTER WHEAT PRODUCTION (Abstract)

K. B. Porter

A row spacing and planting rate test was conducted at the Southwestern Great Plains Field Station during 1960 and 1961 by O. R. Lehman. Results of Mr. Lehman's test indicate that lower grain and straw yields will result as row spacings are increased. There appeared to be little interaction of planting rate and row spacing.

WEDNESDAY AFTERNOON, JANUARY 17

Chairman, T. E. Haus
Discussion Leader, B. C. Curtis

General Topic

ROLE OF GENETICS AND WHEAT BREEDING IN PRODUCTION AND MARKETING EFFICIENCY

PURE LINES AND BLENDS

E. G. Heyne

The concept of a broad adaptation base for agricultural varieties is by no means a new one. Pre-mendelian plant breeders generally used mass selected stocks which were maintained by frequent reselection of desirable types. Prior to this, most species grown were mixtures of many genotypes. Thus the use of mixed cultures even embracing different species is an old practice and the unconscious cultivation of varietal mixtures of one species is equally ancient.

After the rediscovery of Mendel's work and Johannsen's concept concerning pure lines there was a change made to develop pure line varieties. This approach was highly successful and resulted in marked improvement of varieties among the self-fertilized species.

Recently there has been renewed interest in maintaining some variability in the varieties of self-fertilized crops. On a theoretical basis a variety composed of different genotypes would be expected to possess greater stability of production, broader adaptation to environment and greater protection against disease than a pure line. Is it possible to include such characteristics in one variety without having both genotypic and phenotypic differences? There seems to have been few attempts to develop such "universal" or "plastic" varieties. In fact, the chance of choosing a single plant homozygous for all genes necessary is obviously remote.

Therefore if the concept of variability as being advantageous is valid, some sort of inter-intra-varietal blends or mixtures are required in self-fertilized species for best performance over a period of time and under different conditions.

In order to meet the changes in environment imposed upon plant growth by the unavoidable variation by weather, soil and management the plant breeder has the choice among four alternatives.

1. He may produce a variety of great adaptability, an-all-round variety to suit the requirement of a larger area or region.
2. He may produce varieties suitable for more narrowly confined conditions, thus aiming at a higher degree of specialization. This situation would apply, provided the climatic conditions were relatively constant within the specific area of adaptation.

3. He may advocate the cultivation of several varieties separately by the grower that had adaptation to an area but did differ in certain respects. Such a procedure would expect to level out the uncertainties resulting from seasonal fluctuations among the varieties.

4. Actually grow several varieties as a blend or intra-varietal mixtures of known but different genotypes.

The present objections to growing blends or mixtures is that:

1. They are less attractive because of lack of uniformity in such characters as height, color or maturity.

2. They are difficult to maintain and identify under our present concepts of pure seed and certification programs.

3. They generally are lower yielding than the best lines.

Repeating again the possible advantages:

1. They respond more readily to changes in environment.
2. Give a more stable production.
3. May give more disease protection.

With these comments in mind we have conducted two experiments to test some of the concepts prevalent pertaining to the degree of purity in varieties of wheat and the suitability of blends.

The experiment was designed to study the effects of pure lines and inter-varietal mixtures. The material was grown at Hutchinson and Manhattan for three years. One year was below average conditions, one average and the other above average. At Manhattan no significant differences occurred among the three groups but on the average the pure lines yielded the least. No pure lines exceeded the reconstituted bulk or original. At Hutchinson, where environment was more variable and severe, significant differences occurred in two of the three years. In 1958, an above average season, no differences occurred. The pure lines were significantly lower in yield in 1956 and 1957. A combined analysis of the three years data showed a more consistent year-to-year performance at both locations in the case of purified bulks and the original strains than in the case of pure lines. We can conclude from these data that intra-varietal variation is useful.

In another experiment, still in progress, two different blends were prepared. One was made up of three pure lines that were similar phenotypically and the other of three varieties that differed considerably in a number of traits, but actually have given about equal yields in Kansas. The material studied was given V numbers from V1 to V10.

There were no significant differences in yield among the five entries during the four years studied. Therefore, no superiority was indicated for the blends. However, there were significant differences in test weight. As expected, RedChief was the best.

At no time did the blends give the poorest performance, neither did they exceed the best pure line. This may bear out the assumption that such blends will tend to stabilize production from season to season, but not necessarily give the best performance in any one year.

A number of us thought that the farmers would not accept varieties that were obviously mixtures and lacked uniformity and attractiveness. The growers of Rodco have refuted this. The ready acceptance of hybrid sorghums with the many and unsightly outcrosses indicates farmers will accept unattractive material if it performs. Rodco represents a blend in which the components complement each other, particularly for quality and straw strength. Kansas farmers have also mixed Concho and Bison and plan to mix Kaw and Ottawa. Thus, I believe we need not be concerned too much about appearance as long as there is performance. The problem that remains unsolved is the one of maintaining identity and equal representation of the genotypes from year to year.

SCHLEHUBER: I think I can contradict Dr. Heyne, with data we have in Oklahoma, where we also have constituted varieties into a blend. We used four varieties, Comanche, Concho, BlueJacket and Wichita, and we have about 14 or 16 station-years of data from four locations. Not only was the yield of the blend lower than the highest yielding strain, but it also showed greater variability. This is different from your results, Elmer. So, I think it depends a little bit upon the area and the varieties used in the blend.

V. JOHNSON: I would like to ask Dr. Heyne if this willingness on the part of the farmers to grow mixtures of pure lines is a trend that is likely to continue?

HEYNE: I think you would have to ask people in extension. I don't see the farmers often enough to know. They have accepted Rodco. I didn't think they would. It appears to be a trend but I don't know how far it will go.

SCHILLER: I understand that Rodco has been grown for a number of years. Has it been reconstituted each year?

HEYNE: I think you can answer that as well as I can, George. I would say it hasn't been reconstituted and we have notable changes in it.

SCHILLER: If you don't reconstitute Rodco, what happens?

HEYNE: It depends upon where it is grown. John Schmidt will have to back me up, but in Nebraska the white component of Rodco now constitutes 90 percent and the red component only 10 percent of the mixture. In Kansas, the red component has been increasing at the expense of the white one. From what we know, we might expect this, because the red component is winter tender, or less winter hardy than the white component. I have seen shifts both ways in Kansas. However, the red component is the one generally increasing in Kansas-grown Rodco.

SCHLEHUBER: Elmer, has any quality work been done on blends you have been studying?

HEYNE: No, we haven't done any quality work since we know from earlier studies that we will reduce the quality of the blend by approximately the amount of low quality wheat in the blend.

PERFORMANCE OF WINTER WHEAT VARIETAL MIXTURES AT 3 LOCATIONS IN NEBRASKA, 1958-60 (Abstract)

John W. Schmidt

Two groups of varieties and all possible combinations within each group were grown at Lincoln, North Platte, and Alliance in 1958 and 1960. In 1959 only the test at North Platte was harvested. One group of varieties, designated the Nebraska Composite, was made up of Omaha, Warrior, CI 13007 (Pn x Cnn) and CI 12711 (Tk x Cnn). The other group, designated the Regional Composite, contained Concho, Bison, Warrior and CI 12711. At Lincoln, yields of mixtures over a 2-year period averaged 1.7 bushels less than expected from component performance, while at North Platte and Alliance mixtures on the average yielded .83 (3-year average) and .5 bu. (2-year average), respectively, better than expected from component performance. No general trends could be established, although Warrior tended to carry mixtures with it at North Platte and Alliance. Ranges in yields for mixtures were narrower generally than those of the varieties. Varieties tended to occupy the top spots. Contradictory results were obtained regarding test weight per bushel. The 1958 average test weights of mixtures exceeded those calculated from components at all locations. In 1960, the reverse was true. The greatest average increase was .2 lb/bu. at North Platte in 1958, while the greatest average decrease was 1.1 lb/bu. at Lincoln in 1960.

Quality data were provided by the Hard Winter Wheat Quality Laboratory. Dough mixing times for the mixtures were slightly shorter than expected in a majority of cases. Loaf volumes were erratic. For the 3-station composites in 1958, average loaf volume increases over expected amount to 4 cc for mixtures of the Nebraska group and 13 cc for the regional group. In 1959 (North Platte only) a 5 cc average loaf volume increase over expected was recorded for the Nebraska group, but a 6 cc decrease for the regional group. Similarly for the 3-station composites in 1960, an average loaf volume increase of 17 cc was recorded for the Nebraska group but a decrease of 2 cc for the regional group.

According to these data very little advantage, if any, would accrue from the use of winter wheat varietal mixtures as opposed to the use of single varieties.

PENCE: I want to comment on Virgil's question about whether there is a trend toward varietal mixtures. I would say there is no trend. If Rodco had been uniform you wouldn't call it a trend. Rodco hit a year when there was a lot of mosaic. One component of Rodco was resistant to it and it gave a good yield and performance. There was also a lot of newspaper advertising and

16 cents a bushel premium didn't hurt any. If there is any trend it is a trend toward something that will yield.

SCHLEHUBER: I would like to ask Charley Pence a question. How do you account for the other blends the farmers have, like Concho-Bison. Does that not indicate willingness on the part of the farmer to accept blends.

PENCE: I don't know how to answer that, Dick, except to say that Concho has good yield but the disadvantage of weak straw. The producers like Concho for its yield potential, but it lodges. Bison with its stiff straw provided a way to hold up Concho and growers think they are getting more yield from a blend of the two. I don't know whether they are or not. On the basis of experiments you don't get an increased yield.

WILSON: We had an experiment at Hays, Kansas where we had Concho and Bison in a 3-variety mixture. There was no difference in yield between the mixture and Bison.

PORTER: A comment on uniformity. I might mention that one sorghum company in Texas is planning to put out a mixture of hybrid forage sorghum which is quite variable. Apparently they aren't concerned about how the farmers are going to accept it.

JOPPA: A number of studies have been done on alfalfa in relation to blends. They have found almost exactly the same thing as reported here this afternoon. Yields of the blends were about equal to the average of the varieties that went into the blend. The thing that has been most interesting in alfalfa, I think, is that the seed companies have been able to pick up varieties, blend them together, and sell them as a distinctive blend belonging to a particular company. They have made this a selling point, and it has been advantageous to sell a blend rather than a variety which the grower might get from any company. This is the reason, I think, for blends becoming so popular in alfalfa. Perhaps the same thing might become true of winter wheat.

LIVERS: We planted four varieties in a blend. There was no significant difference between behavior of blends and average of the four component varieties in yield and test weight.

CURTIS: We have seeded a blend of 65 percent Kaw and 35 percent Triumph to get some idea of what such a blend would do as far as quality is concerned, Triumph being a short mixing time wheat and Kaw a long mixing variety.

POTENTIAL OF SEMI-DWARF WHEATS ON HIGH MOISTURE AND FERTILITY LEVELS
(Abstract)

K. B. Porter

Semi-dwarf wheats appear to have the most promise when grown on high moisture and fertility levels. Semi-dwarf wheats tested in Texas since 1958 appear to be about equal to tall wheats in dryland tests at Chillicothe and Denton where the annual rainfall approximates 25 and 30 inches. At Bushland, Texas, where the annual rainfall is 18 inches, the semi-dwarfs have produced significantly lower yields than taller commercial varieties. However, yields of some semi-dwarf selections have produced yields that equaled 120 to 130 percent the yield of taller varieties when grown under high moisture and fertility levels in irrigated tests at Bushland. Resistance to lodging and the ability to produce more grain per head appear to be the primary factors contributing to the superior yield of short stature wheats when grown on high moisture and fertility levels.

The response of Concho and a Semi-dwarf selection grown with intensive irrigation on two levels of soil fertility.

	Variety	
Fert. Level	Concho	Semi-dwarf 2/
lbs N/A	bu/A	bu/A
45	62.3	69.7
135	66.3 1/	87.3

1/ These plots lodged 75%. Other plots were lodged slightly.

2/ Nebraska selection from cross Norin 16 x C.I. 12500.

PENCE: I am wondering if there is any difference in the protein decrease in semi-dwarf wheat under irrigation compared to conventional varieties?

PORTER: I can't answer your question specifically with respect to protein content. We have a number of semi-dwarfs that show very good quality characteristics and long mixing time.

SUNDERMAN: Semi-dwarfs have been grown on dry land and under irrigation at Aberdeen, Idaho. We didn't succeed in maintaining quality in irrigated semi-dwarfs unless they had adequate fertilization. They were somewhat lower in protein than regular winter wheat. When Concho was yielding around 35 bushels on dryland, the semi-dwarfs yielded around 50 to 55 bushels. Under irrigation and high fertility, our hard red winter wheats yielded from 75 to 90 bushels; the semi-dwarfs up to 140 bushels. Where we have white wheat genetic material in our dwarfs, no matter what we fertilized them with, we couldn't get the protein content up above 12 percent.

V. JOHNSON: This question is to you, Dr. Sunderman. In your fertilization practices, did you attempt a very late application of fertilizer, such as urea foliar application at heading time?

SUNDERMAN: No, we put on applications in June of 60, 70 or 80 pounds.

CYTOPLASMIC MALE STERILITY
(Abstract)

J. A. Wilson

The cytoplasm of three species, *Aegilops caudata*, *Aegilops ovata*, and *Triticum timopheevi*, interact with the wheat nucleus to produce male sterility.

Male sterility induced by *Ae. caudata* cytoplasm is sometimes characterized by complete absence of stamens, and pistillody. The accessory pistils may be partially responsible for female sterility which occurrs in at least some varieties. No other adverse side effects have been observed.

The maturation of winter wheat varieties having *Ae. ovata* cytoplasm is generally retarded at least one week in comparison to their normal counterparts. Other than anther and pollen formation, flower development appears normal. Rather high hybrid seed set (70%) has been obtained with male-sterile plants subjected to pollination in crossing blocks in the field.

Substitution of the nucleus of Bison wheat, C.I. 12518, into *T. timopheevi* cytoplasm results in male sterility. Only greenhouse observations, with limited populations, have been made. From these observations, it appears that female fertility and maturation are normal in the male-sterile plants.

FUTRELL: Jim, I wonder if you ran into this lateness factor of the original cross in transferring cytoplasm from *T. timpoheevi*. That was one of the hardest obstacles that Shands had to overcome.

WILSON: Through successive back-crosses we are gradually eliminating *timopheevi* chromatin material. We grew these under greenhouse conditions and these three backcrosses involved techniques at Hays with light to speed up development. At least in the third backcross, all the plants were identical to Bison in maturity.

FUTRELL: One other thing, was there any increase in fertility?

WILSON: If you will notice in the diagram on the last slide, the sterile type plant on the left was a little bigger and a little taller. These have only been evaluated under green-house conditions.

We have been working on crosses of Kotschyanum with common wheat. We are trying to transfer the restoration factor of the Kotschyanum to common wheat.

BRIGGLE: Perhaps you have mentioned it, Jim, but have you grown any of this material under field conditions, and if so, what are the results?

WILSON: We have not grown any *T. timopheevi* material under field conditions. This has all been done in the greenhouse. All tests have been made with Bison growing alongside.

BRIGGLE: What about ovata?

WILSON: The ovata material was in the field.

SCHLEHUBER: When will we have hybrid wheat?

WILSON: I think we have possibilities for hybrid wheat or I wouldn't have gone with a commercial company. Of course we have a lot of problems and I hope we can arouse interest on the part of the Federal and State research personnel to help us solve the problems. We would solicit your help. I went with the company because I wanted to do this kind of work full time and they were glad I wanted to do it. That is why I am commercial.

SCHLESINGER: Do you have any quality data on the male sterile wheats? Is there any difference in quality between the two types that you have, male sterile type and normal?

WILSON: That is a good question. One of the things we are striving for right now, is to get some indication of quality. The cytoplasm is modified in character to some extent, at least *Ae. ovata* modified it to the extent of delaying maturity. *Caudata* apparently modifies some aspects of flower characteristics.

YIELD COMPONENTS IN SEMI-DWARF AND TALL GROWING WHEAT VARIETIES
(Abstract)

V. A. Johnson

We have been working with semi-dwarf type wheats in Nebraska since 1948 when several of the Japanese and Korean dwarf types were crossed with a Nebraska experimental C. I. 12500 (Nebr. 60 x Mi-Hope). Progenies from crosses involving Norin 16 and Seu Seun appeared to have the most promise and our work since then has been with materials tracing to these two introductions.

Semi-dwarf selections from the 1948 crosses were entered in yield trials under irrigation at western Nebraska locations in 1955. It became immediately apparent that in addition to their short stature they also were highly productive when conditions were favorable. We have since determined that their performance is only fair when conditions are less favorable.

We became interested in identifying the component(s) of yield associated with the productiveness of the semi-dwarf strains with which we were working. Beginning in 1957 we undertook a study of the number of tillers, number of kernels per head, and the weight of kernels at locations in Nebraska and Colorado. The study was continued until 1960 during which time we collected data from 11 replicated semi-dwarf yield trials.

On the basis of this study, the head size or number of kernels per head was the yield component in which the semi-dwarfs were most consistently

superior to the tall-growing varieties with which they were compared. With only a few exceptions, the semi-dwarfs produced fewer heads and lighter grain than the varieties Pawnee and Cheyenne. The most variable component was the number of head-bearing tillers while kernel weight was the least variable. I'm refering here to inter-sample and inter-plot variations. Number of head-bearing tillers was the component most closely associated with the general yield level of a test but could not account for the yield superiority of the semi-dwarf strains over Pawnee and Cheyenne.

Although the data obtained are not conclusive, they strongly suggest the importance of head size, i.e. number of kernels per head, in the productiveness of the semi-dwarfs in Nebraska. Further they point to the need for improvement of the other two yield components if the productiveness of these wheats is to be further increased. However, at this point we do not know whether simultaneous improvement of all 3 yield components is possible. It has been suggested that increase of one component is likely to be associated with a compensating decrease in one or both of the other components.

I would raise this question with the group. In our continuing effort to increase the productiveness of wheat varieties, and make the wheat plant a more efficient grain-producing factory, should we be working with the individual components of yield in our breeding programs in addition to yield itself?

FUTRELL: Virgil, do you have any tall selections out of these crosses?

V. JOHNSON: We have taller ones. In fact, in the case of Norin 16 x C. I. 12500 we have some selections that are no different in height than Pawnee. By and large, they show the same yield component relationships as selection 551146.

HEHN: I have often wondered whether the yield we attribute to the semi-dwarfs is really due to shorter straw, or whether we haven't picked up some other genes that would give us this same thing with the straw short or long.

V. JOHNSON: I would be the first one to say that this is likely to be the case and that there is not necessarily a direct relationship between the two. In the semi-dwarf introductions we may be bringing in new genes that have to do with yield and agronomic performance that are not present in our domestic wheats.

HEYNE: In Kansas, Erhardt, using Norin 10 with Pawnee in the second back cross, we recovered the whole gamut of height from Norin 10 up to Pawnee. Those that are just below Pawnee in height are terrific in their yield potential.

SEEBORG: In work that I am familiar with in Pullman, Washington involving similar crosses with Norin material, the milling properties were very greatly affected. What quality information do you have on the Nebraska semi-dwarfs?

V. JOHNSON: We have quality information on a number of the derivatives from this series of crosses. In the case of selection 551146, which you will recall involved Norin 16, the quality is generally quite poor, also the kernel texture is soft. In the Seu Seun derivatives there are several that have much better quality. In fact, a few of these appear to be similar to our mellow gluten hard red winter wheats in this region. Does that answer your question?

SEEBORG: Yes it does. Back about ten or fifteen years ago we were calculating the theoretical separation of endosperm from the seed to be about 82 percent and currently we get 75 percent. I would like to see more work in trying to raise that extraction figure. I think we can by getting into the F_3 generation of new materials. This gives us an excellent opportunity to select for that particular factor which is highly important economically.

V. JOHNSON: The semi-dwarf types have many shortcomings, quality and otherwise. One of the things, I did not mention, which we encountered, was straw breakage. The straw of the derivatives of semi-dwarfs crossed with our own wheats collapsed under certain environmental stresses after heading. This was expressed as breakage at one of the nodes. It wasn't an internodal break, but it involved weakness at the node. We are hoping that we will be able to eliminate this as well as some of the seed deficiencies in new cycles of breeding.

REITZ: I asked Orville Vogel last summer if he had encountered this difficulty with straw breakage and commented further that reports from the hard winter wheat area here indicated that problem. He said, "Oh yes, I encountered that and decided to solve it ten years ago". He said he breeds for a resilient straw, not a brittle straw. I think we will have to devise some means of detecting this brittle straw. As you know, Orville has very keen eyes and deft hands and that is his instrument for doing this job.

SUNDERMAN: Getting back to the association of high yield and short straw, my predecessor at Aberdeen started a study of derivatives of Norin 10 crossed with six hard red winter wheats broken down into short, intermediate, and tall types under irrigation. In 4 of the 6 crosses his short type was highest in yield, in one cross the intermediate type was the high yielder, and in one cross the tall type was high yielding.

YIELD COMPONENTS AS AFFECTED BY CULTURAL EXPERIMENTS (Abstract)

A. M. Schlehuber

In the course of a wheat variety-fertilizer study conducted on the Perkins Agronomy Farm near Stillwater, Oklahoma for the past several years, a rather detailed study of yield components was undertaken of the 1961 crop.

Five varieties with seven fertilizer treatments were grown in field plots in a split-plot design with four replications. In this study of yield components each plot was divided into 4 equal parts and a 2-foot section was harvested from each plot, i.e. 4 sub-plots from each main plot. Yield components studied were: (1) number of spikes per unit area, (2) number of seeds per spike, and (3) average weight per seed.

The r values between grain yield and number of heads/area were the highest obtained, being 0.847 overall (all varieties and treatments); ranging from 0.747 to 0.888 for treatments; and from 0.848 to 0.919 for varieties. The highest number of heads were produced from the 40-80-0 fertilizer treatment. The highest number of kernels per spike and the lower average seed weights were produced from the higher nitrogen levels; and, conversely, the highest average seed weights and the lowest number of seeds per head were produced from the higher phosphate levels. The highest yield (and the highest number of heads per area) were produced at the point (40-80-0 treatment) where both the number of kernels per head and the average weight per seed had intermediate values: i.e. there was "balanced compensation".

One of the more striking results of this study was that of average seed weight which varied by treatment (low for high N; high for high P) in four varieties--Comanche, Concho, Pawnee, and Ponca--but was constant in Triumph for all fertilizer treatments.

LIVERS: Among the three yield components, the first one determined is the number of tillers, the second one is the number of spikes per head, and the last thing to be determined is size of the grain. As you indicated, seed weight in Triumph remained constant in all treatments. In a variety like Triumph, I think that the potential for increased yield under favorable late conditions by increasing seed size to the maximum is eliminated. That is just a little philosophy you might borrow from sorghum people.

I. M. ATKINS: I expected Kenny Porter to comment on this, but the short-strawed 391 hybrids which involve Seu Seun and a sister of Crockett show much better quality than Crockett. These lines, and by the way, one of them is in regional yield trials this year, have excellent quality. So far as we can tell they are just as good as Comanche. The only reason we haven't already distributed them is that they are sort of promiscuous and we have had trouble keeping them pure enough for distribution. The other thing is that their test weight is a little low.

V. JOHNSON: Might I ask you or Kenny a question? Have you observed in these, the straw-breaking characteristic, this tendency under stress for the straw to break over?

PORTER: We had a hail storm this year so we didn't get much data but the Norin derivatives took a beating, probably because they were too brittle. The Seu Seun derivatives actually took the hail pretty well and they were in the same test.

STICKLER: I would like to ask Dr. Schlehuber what the seeding rate was on the varieties in the nitrogen trial?

SCHLEHUBER: Approximately one bushel per acre.

STICKLER: Your yield is highly associated with the number of heads per given area. In other words, you are using fertility to build your stand. Perhaps we should build up the stand by heavier seeding. I have been working on this at Manhattan. The first year I used an average seeding rate and I had a fertility response for tiller number. The next year I jacked up the seeding rate and I no longer got the fertility response. I think fertility and variety interact but I think there also is an interaction with seeding rate.

PORTER: I just want to mention that the increased yield under favorable conditions of these dwarfs may be associated with their tendency to produce grain that tends to be small under most conditions. That may be contributing to their comparatively lower test weight and it may be a little difficult to get away from.

I. M. ATKINS: I would like to go back to increased yields coming out of these dwarfs. In four backcrosses of Norin 10-Brevor to one of our wheats, we haven't maintained the yield advantage that Orville picked up in the original cross of Norin 10-Brevor. If this is the case, maybe as was mentioned yesterday, we have been breeding our cousins a little too much and need to bring in more diverse germ plasm and look for the nicks if they occur.

LOCATING GERMPLASM FOR RESISTANCE TO WHEAT STREAK MOSAIC
(Abstract)

R. C. Bellingham

Tests in the past by a number of workers in the region of thousands of wheats, both domestic and foreign, winter and spring, have produced no resistant varieties.

Tests of the Sando Hybrids, Wheat x Agropyron elongatum, have revealed a number of selections with resistance to the virus. Chromosome counts by Dr. Sebesta, with whom this work is being done, of several of these wheat-like resistant selections have shown these particular selections to have 46 chromosomes, the normal wheat complement plus two alien pairs. The F_1 progeny of crosses between these selections and Wichita wheat had 44 chromosomes and were susceptible to the virus. Two of these chromosomes were univalents of the two alien pairs in the parent Sando Hybrids. Work in the F_2 and subsequent generations will be directed toward determining whether both or one of the alien pairs is necessary for resistance and toward the translocation of these chromosomes into wheat by x-ray irradiation.

KOLP: In Wyoming we have some streak mosaic tolerant spring wheat introductions selected by Dr. Sill and the late Dr. Fellows. We have crossed these on to some of our winter wheats. I don't think they are going to give the type of resistance or immunity we would like to have, yet, we feel we have an improvement. Records didn't permit us to trace the spring wheats back to a C. I. number or a P. I. number, so we have designated them W-1, W-2 and so forth. W-1 looks quite good and appears to be a white spring. We crossed these on to Bison and Triumph. In the F_2 population we got a population mean very similar to the mid-parent. When we crossed these on to Nebred and Shoshoni we got an F_2 population with a mean above the mid-parents. If we innoculated Pilot we didn't get a disease reaction for some time. Nebred, Shoshoni, Bison and Triumph all show a disease reaction a lot sooner than Pilot. When the disease did hit Pilot it was quite severe. We believe that W-1 has a useful reaction. If anyone would be interested in it, we would be very happy to provide seed.

SCHLEHUBER: Bernard, is the later effect you get on Pilot mainly associated with the stage of development of the plant? Isn't spring wheat in a later stage of development than winter wheat?

KOLP: If we compare Thatcher and Pilot, both spring wheats, both late in their development the same effect is noted. A similar situation exists in W-1 which, until later stages, showed quite a resistance. However, it shows symptoms earlier than Pilot. Mr. McKinney felt we may have another gene in Pilot which possibly could be used.

QUESTION: Were these hand inoculations?

KOLP: Part of the inoculations were in the greenhouse. These were hand inoculations. The others were under pressure in the field.

BELLINGHAM: I would like to comment that a breeding program was started a couple of years ago in which tolerant varieties were crossed in an effort to increase the degree of tolerance. We have had no success in that endeavor.

ATKINSON: Did tolerant varieties serve as source varieties for infection?

BELLINGHAM: You mean using extract from tolerant varieties?

ATKINSON: I mean the use of tolerant varieties rather than resistant varieties.

BELLINGHAM: Yes, but dilution tests have shown that tolerant varieties carry as much concentration of the virus as the susceptible varieties.

ATKINSON: Don't you feel there is a danger in growing tolerant varieties?

BELLINGHAM: We are trying to develop more resistance because we don't think the tolerance is quite good enough. Under some conditions tolerance is fine. Tolerant varieties might be affected to some extent, but they give a good yield under moderately severe conditions. These tolerances will break down from time to time and possibly a whole area will break down under severe infection.

ATKINSON: Won't your tolerant varieties, more so than your susceptible varieties, build up more virulance in the virus.

BELLINGHAM: I don't think tolerant varieties will build up any more virulence, to any appreciable extent, than susceptible varieties.

YOUNG: If a man used a tolerant variety in an area where this disease is important, and his neighbor doesn't, it isn't going to affect him, but the neighbor better get on the ball too. It is restricting the use of a tolerant variety to an area where the disease is severe where it helps whether or not over the whole region.

LEAF RUST RACE POPULATION TRENDS AND STABILITY
(Abstract)

H. C. Young, Jr.

The identification of approximately 200 leaf rust cultures each year for the past ten years in Oklahoma has shown a dominance of 4 races throughout this period. Races UN2, UN5, UN6 and UN9 have composed 95 per cent of the cultures identified each year. Although the percentage of each race varied over the years, race UN2 has been the most prevalent each year. Occasionally races UN12, and UN13 have been found. These results compare favorably with those reported by C. O. Johnston for the Hard Red Winter Wheat Region. However, it was found that the proportion of each race in the Hard Red Winter Wheat Region as a whole more closely approximated the proportion found in Texas by Mr. Johnston than it did the proportion found in Oklahoma, suggesting that the inoculum which initiated the development of rust over the region most years came from the southern-most part of the region, and only to a lesser extent from that which overwintered in Oklahoma.

Only 2 new classifiable virulences have been recognized during the ten-year period. One, a virulence on Westar C.I. 12110 and Lee C.I. 12488, increased from 20 per cent of the population in 1951 to over 90 per cent in 1960. This virulence was found associated only with race UN6 at the beginning of the period but by 1955 had been found associated with all 4 of the most prevalent races. The second new virulence attacked Westar and Lee and also a selection of Westar, Wesel C.I. 13090, and several other wheats which were resistant to the so-called "Westar-Lee" virulence. However, the second virulence has been found associated only with race UN6 and, although it has maintained a small proportion of the population each year, it has not increased in prevalence.

It was concluded that, compared to the other cereal rusts, the leaf rust organism is rather stable.

C. O. JOHNSTON: I would like to say I agree with you, Harry. These rusts are pretty stable. Changes in leaf rust races are nearly always associated with changes in varieties. When we changed to Pawnee, for example, there was a very definite shift within two years to Race 5, and then to Race 15. Regarding the Westar virulence, that shift has been going on now for several years. Although we don't see it, if you use Westar, it is just remarkable how many of the cultures it is now susceptible to, whereas in the beginning Westar was resistant to almost everything. Race 15 probably dominates the whole United States at the present time. It is an aggresive race especially in the plains area. Race 9 which almost disappeared is now coming back this year. But there are no new races, that is what is important. You find some new race, for example 143, but it doesn't persist, you see it one year and then it is gone. In leaf rust we don't get very rapid changes.

YOUNG: I could make one comment that is speculation. Westar never occupied enough acreage in the south to have brought about this change. I don't think we can lay it to the weather either, because Lee in the north and Selkirk in the north have the same resistance that Westar has. When Lee occupied this tremendous acreage in the north central part of the United

States, this terrific virulence on Westar occurred, and Selkirk is continuing it now. Insofar as 9 is concerned, we were not surprised to see it come back when the virulence on Westar and Selkirk became associated with it. In studies made many years ago, we have found race 9 cultures germinated at a lower temperature more rapidly and also reached a higher percentage of germination than the other races with which we compared it. By the same token, it will do the same thing at high temperatures, it will germinate faster to a higher percentage at high temperatures than the other races with which we compared it. So it has an adaptability that I call a survival ability. When this virulence became associated with it, back up it comes, because it has this characteristic.

C. O. JOHNSTON: I agree that race 9 has very wide adaptability. That is perfectly clear when you take results from Colorado. Nearly always you get a lot of 9 out of Colorado. Also, the disappearance of Pawnee has something to do with it. Pawnee and a lot of Pawnee derivatives are resistant to 9. They are going out and other things are coming in.

SCHLEHUBER: Dr. Young's predecessor at Oklahoma, a pathologist, some 16 or 20 years ago, had me very much excited about the fact that there was a race 21 to which we had no resistance. He predicted dire consequences for the entire wheat crop in the hard red winter wheat area. As far as I know, this race has not caused us any serious trouble in Oklahoma, or in the entire hard red winter wheat region. My question is, if and when you pathologists say there is a new race in Oklahoma, or Kansas, or Nebraska, what are we to conclude in the way of consequences?

C. O. JOHNSTON: I don't think you can conclude anything. You aren't justified in making a conclusion in the first place. Race 21 just disappeared. The same thing is true of other races. The same thing is true of 15B of stem rust. When we say we have a new race, it is important, but we have to wait to see what it will do.

YOUNG: Race 21, or race group 13, which would include 21, 54, 35 and 122 are among those you saw on the bottom of the chart. There are others, we find them because they are here. But they never increased. Why? I think that is the important question.

C. O. JOHNSTON: Race 122, in the southeastern United States is a different story.

YOUNG: Perhaps due to climatic differences, the races which we find here are not those which are found in the soft wheat belt.

GENETICS OF STEM RUST OF WHEAT
(Abstract)

W. Q. Loegering

Breeding for resistance to disease is one of the more important objectives in many wheat breeding programs. Genetic studies of reaction are very often carried on along with the breeding program. An understanding of the genetic principles involved in disease itself is a valuable tool in drawing logical conclusions from such studies. Reaction can be classified into at least two categories: non-specific and specific. A non-specific reaction to disease is a character of the plant and can be treated as such. In the case of specific reaction, the disease, as we see it, is a character of the host and pathogen together. Thus in studying the genetics of specific reaction to Puccinia graminis tritici, we cannot ignore the pathogen, and we cannot consider the disease as a character of the plant. The infection type results from the interaction between genes in the pathogen and genes in the host. The infection type is characteristic for each specific combination. Thus, generally speaking, classification must be done on the basis of infection types, not on the basis of reaction classes. In plant breeding, on the other hand, the method is much simpler since the lowest infection type, in so far as we know, is epistatic to higher infection types. Thus, by counting the number of plants in an F_2 population on which the highest infection type develops we can for practical purposes determine in the particular cross the number of genes conditioning resistance to the culture, race, or population of rust. This is the most practical application of the concepts which have developed as a result of basic studies of the genetics of the host-pathogen relationship. Another potentially valuable result of these studies is that the genetics of reaction can be successfully studied by studying the genetics of pathogenicity in the pathogen or vice versa. Studies in progress have the objective of finding exceptions, if they occur, to the hypothesis of a gene for gene relationship in disease as applied to specificity.

ALLAN: Dr. Loegering, do you mean that you never have encountered a combination of low infection type and avirulence?

LOEGERING: No, not as far as it has been studied. I want to emphasize that very strongly. I don't see why it doesn't happen, but it hasn't so far as we know.

SCHLEHUBER: Plant breeding rests on a firm foundation. That foundation is the science of genetics. It is my belief that all who know the story are impressed with the phenomenal progress made in breeding for disease resistance in plants. By far the overwhelming majority of this progress is based on the genetics of resistance of the host plant. That it has been successful cannot be denied. That the gene-for-gene concept is an important extension to our knowledge of the host-parasite relationship is also not denied. However, the genetics of host resistance is not obsolete and continues to have value in giving us further needed genetic information.

THE GENETICS OF RESISTANCE TO STRIPE RUST
(Abstract)

W. K. Pope and R. E. Allan

A summary of the classification of reaction to stripe rust of many wheat varieties grown in the Pacific Northwest was included in the 1960 and 1961 reports of the Cooperative Wheat Varietal Experiments in the Western Region.

Hard red winter wheats susceptible to stripe rust included Columbia, Westmont, and Itana from the northwest, and Blackhull, Kiowa, Ponca, Tenmarq, Triumph, Westar, and Wichita from the Great Plains.

Good resistance was found in most Turkey selections, Cheyenne, Tendoy, Hussar, Oro, Rego, Rio, Yogo, Wasatch, Cache, Ridit, Comanche and Newturk. Comanche was intermediate and most of these varieties showed considerable rust under severe conditions. Commercial seed of Turkey, Rego, Oro, and Tendoy was observed to have two distinct levels of resistance.

The genetics of the resistance of these or other types as observed in crosses made for other purposes are listed in the table below.

Table 1. Genes for resistance to stripe rust as observed in hybrid populations grown at Moscow, Idaho in 1960 or 1961.

Variety	Growth habit	Genes for resistance
1. Idaed	S	one (not in any winter wheat listed)
2. Burt	W	one - weak
3. Cheyenne	W	two- recessive
4. Rio	W	- Rio identical to Cheyenne
5. Hussar	W	one or two
6. Triplet	W	? same as Hussar?
7. Hohenheimer	W	4 Dom.-includes Cheyenne genes
8. Sarheim	W	- same as Hohenheimer
9. P.I. 178383	W	4 plus-Dom. includes Cheyenne genes
10. Ridit	W	2 plus-weak includes Burt gene
11. Brevor	W	- similar to Ridit
12. Canus	S	- weak, similar to Ridit
13. Lee	S	2 one dominant

Additive combinations
1. Ridit plus Triplet
2. Burt plus Cheyenne
3. Comanche plus Idaed (sp)
4. Marfed (sp) plus Eureka (sp)

FUTRELL: I might add that this is essentially the same pattern that we obtained at Bushland in the 1957-58 epidemic that Dr. Porter and I took notes on out there. Since that time we have been watching the pattern of stripe rust at Ciudad, Coahuila in Mexico. They have had a stripe rust epidemic almost every year. That location offers a good opportunity to study the reaction of some of our midwestern wheats to stripe rust.

BREEDING WHEATS WITH HIGH TEST WEIGHT AND GOOD QUALITY
(Abstract)

L. P. Reitz

A table of test weights based on the results from the uniform yield nursery, 1932 to 1960, is presented. Blackhull and Early Blackhull averages are compared to the average test weight of all other varieties in the test year by year. The highest and second highest ranking variety for each year are shown. In the first 10 years the 2 Blackhulls on the average exceeded other wheats by 2 pounds; in the second decade by 3/4 pounds; and in the last 9 years by 1 1/6 pounds. The manner of breeding Kaw, Aztec and Tascosa, three high test weight good quality varieties, will be discussed by Drs. Heyne, Livers, and I. M. Atkins.

A summary of weight per bushel data, Uniform Yield Nursery, 1932-1960

	Number		Weight per bushel - pounds				
Year	of Sta.	of Varieties	Blackhull + E.Blackhull	All Others	Difference	Highest Variety	Second Variety
1932	2	30	62.4	60.9	1.5	Kr x Mq 11374	Bh
1933	3	30	59.1	56.3	2.8	EB	Bh
1934	3	30	61.3	58.7	2.6	EB	Pd-Kr.11591
1935	3	30	60.8	57.7	3.1	EB	" "
1936	4	30	61.0	59.5	1.5	EB	" "
1937	4	30	59.6	57.6	2.0	EB	Bh
1938	7	30	57.3	55.8	1.5	Tq-N28 11847	EB
1939	8	30	59.5	58.2	1.3	Wi	EB
1940	11	30	60.7	58.4	2.3	Wi	EB
1941	10	30	58.5	57.2	1.3	Wi	Bh-Tq 12102
1942	8	30	59.6	58.6	1.0	Bh-Tq 12102	Wi
1943	12	30	59.5	58.6	.9	Kr.-HF x Tq 12115	Q x Tq 12116
1944	12	25	59.2	58.1	1.1	Crr	Ap
1945	12	31	59.3	58.3	1.0	Crr	EB
1946	12	28	60.4	59.8	.6	Crr	Ap
1947	15	30	59.7	59.1	.6	Crr	Cfk-O-Tq 12148
1948	14	28	60.3	59.6	.7	Crr	BJ
1949	14	25	58.3	57.6	.7	BJ	N60-MH 12500
1950	13	27	60.6	60.1	.5	BJ	B-O x Pn12516
1951	9	25	60.4	60.0	.4	BJ	Sfr
1952	14	21	61.0	59.7	1.3	BJ	EB
1953	11	26	59.4	57.3	2.1	Kaw	EB
1954	14	22	58.9	57.8	1.1	Kaw	EB
1955	15	26	60.9	59.9	1.0	Kaw	KK
1956	15	21	61.0	59.8	1.2	Kaw	KK
1957	15	19	58.1	57.4	.7	KK	Tcs
1958	20	18	60.1	58.9	1.2	Atc	IBJ x Cmn
1959	16	18	60.4	59.5	.9	Atc	"
1960	18	13	61.4	60.4	1.0	Wi-M-O	Tcs

KAW WHEAT

E. G. Heyne

Kaw wheat is a selection from the cross Early Blackhull-Tenmarq x Oro-Mediterrenean-Hope. EB-Tm (Ks 2757) is a sister selection of Wichita. Extensive wheat meal fermentation times were determined on the EB-Tm selections in F_4-F_5-F_6-F_7. M & B tests were run in F_8 and F_9. The sister of Wichita used in the cross had better quality than Wichita. In the cross from which Kaw was selected only visual examination of the grain was made, keeping only the selections with large plump grains. There were only 24 F_5 lines grown; 21 F_6 lines of which only two were harvested and in F_7 the two were planted and one harvested which was Kaw. No quality tests were made until in the F_9 generation. Therefore I conclude that it was "luck" that from such a small sample that the combination of high test weight and long mixing time was obtained.

AZTEC WHEAT

R. W. Livers

Aztec, C.I. 13016, is a medium-late hard red winter variety with a combination of high test weight and excellent milling and baking qualities. The strain was developed in Nebraska from the cross RedChief x Cheyenne. It was obtained by New Mexico in 1952 along with some other pure lines from the same cross. It was released in New Mexico in 1958 after emerging in the evaluation program as a strain with a number of desirable characters including the two mentioned which trace to RedChief and Cheyenne respectively. While this combination of characters has no doubt been more often sought than realized, it appears to have resulted in this case simply from good plant breeding employing visual selection during segregating generations.

COMBINING HIGH TEST WEIGHT AND QUALITY IN THE CIMARRON HYBRIDS (Abstract)

I. M. Atkins

Following the decision in 1945 to not release Cimarron wheat, a strain which combined high test weight and many good agronomic characters, the Texas Station initiated four complex crosses in an effort to combine these good characteristics with disease resistance and quality from other varieties. The plan included growing populations in bulks of increasing size to F_5 after which from 1 to 5,000 selections were made for 5 years. An estimated 22,000 selections were studied during the period 1950-55.

Severe screening for rust resistance and desirable agronomic characteristics was practiced on head selections, followed by rigid screening of preliminary strains grown at three locations. Quality testing of lines using bulks from preliminary and replicated tests at three locations permitted rapid selection of the better strains. Three strains went into regional tests in 1955. These combined with data within the state provided the basis for

release of Tascosa wheat in 1960. This new variety is one of the strongest gluten wheat varieties available and combines very high test weight with outstanding yields and agronomic characters.

Complex crosses involving several parents or F_1 combinations have provided material for new varieties Tascosa, Crockett, Quanah, and some others being considered for release. Such combinations require large samples from the populations in order to recover all the good characters in a new strain.

SCHLESINGER: I am going to make an unpopular statement and I am probably standing alone on this. I am not impressed at all with the quality of Tascosa. It is a very abnormal wheat. I don't think it is a strong wheat in character. I don't think it is going to maintain quality or reputation in baking, over a period of time. We find Tascosa wheat very difficult to bake and handle. I hate to see us go too far overboard on Tascosa. I know I am in the minority, but I think I ought to give a word of caution. In my opinion it ought to be thrown out.

SCHLEHUBER: I don't know if I can help Dr. Atkins or not, but I think this is the kind of variety we often need in our domestic consumption. I think this kind of a variety is what Ed Seeborg was talking about.

SCHLESINGER: I think Ed wants a slow mixing time wheat. I doubt that Europeans are going to be happy with it. I don't think I would be happy with it. Used as a small percentage of a flour blend it isn't going to do very much for baking quality. I may be wrong.

I. M. ATKINS: We have tested it over a period of eight years. Karl Finney was very complimentary every year. That is the basis on which we put it out.

A STUDY OF MATURITY AND CERTAIN WHEAT AND FLOUR PROPERTIES
(Abstract)

A. M. Schlehuber and D. C. Abbott

In an effort to determine whether or not any association of maturity with certain wheat and flour properties exists, seed of the cross Triumph (C.I. 12132) and Mqo-Oro x Oro-Tm (C.I. 12406) furnished the material. Triumph is an early maturing, mellow gluten type while C.I. 12406 is a medium late to late, strong gluten type. F_1 - F_3 generations were grown without selection. In the fall of 1959 the F_4 generation of 112 lines of the cross, the two parents, and seven other wheat varieties were grown in a 11 x 11 balanced-lattice nursery of six replications. The plots were harvested individually in the summer of 1960 and the grain yields, test weights and other agronomic data recorded. Three of the six replications each provided adequate seed for complete milling and baking evaluation; the seed of the remaining three replications was composited for each variety or strain to provide material for an additional milling and baking test.

In the F_2 through the F_4 generations, heading data showed that the complete range of maturity from Triumph through C.I. 12406 had been obtained. Of the 112 F_4 lines, 89 came within a Triumph to Kaw maturity range and had good test weight and straw height. Since quality data was not available at planting time in the fall of 1960, 36 of these 89 lines were selected on maturity, test weight and height for F_5 generation planting in 1960 to provide seed of these lines for F_6 generation tests. Only single 4-row, 10-foot long plots were seeded.

Milling and baking quality data have now been completed for the 3-replication composites of these F_4 lines (1960 crop) and the two parents. The 36 lines exhibited mixing times (Mixograph) ranging from 2.5 to 8.0 minutes as compared with 2.25 for Triumph and 7.0 for C.I. 12406. Loaf volumes ranged from 735 cc to 911 cc (adjusted to 12.5% protein) for the lines while Triumph and C.I. 12406 produced volumes of 854 cc and 864 cc respectively. For the F_5 generation maturity and mixing characteristics of these 36 lines closely paralleled those of the corresponding lines in the F_4.

The milling, chemical, and physical tests of the 3 individual replications of all F_4 lines and the parents have been completed. Baking tests are currently in progress on these samples. Upon completion of the baking tests, all data will be analyzed statistically.

HOW WILL UTILIZATION AND INDUSTRIAL CHANGES AFFECT PRESENTLY SOUGHT-AFTER GENOTYPES (Abstract)

K. F. Finney and G. L. Rubenthaler

Two new processing techniques have been discussed considerably in recent months. They include air classification and the continuous bread-making process. Opinions of Ed Stone of International Milling, George Schiller of Pillsbury, and Arlin Ward of Kansas State during this wheat workers' conference, together with those of other individuals in the past, indicate that our present commercial hard winter wheat varieties are suitable for both the continuous dough process and air classification.

Data obtained in the Hard Winter Wheat Quality Laboratory show that bread baked from different varieties of wheat by two pre-ferment formulas (involved in continuous bread-making) was somewhat to materially poorer, depending on variety, than that baked by a conventional straight dough formula and technique; and that the varieties of wheat with medium to medium-long mixing times usually had better crumb grains and loaf volumes than those with relatively short mix times when employing either of two pre-ferment baking formulas.

Thus, there is no consistent information or data to indicate that our present commercial varieties of hard winter wheat would not be suitable for the continuous bread-making process. To be on the safe side so far as air classification is concerned, however, it appears advisable to keep the milling properties of new varieties on the mellow side, similar to those for Triumph.

MATTERN: In a study involving the continuous mix process, a relatively high protein sample of Warrior, which is a strong variety, and a medium protein sample of Omaha, which is a mellow variety, were submitted. I was quite surprised with the report. A preference was expressed for the Omaha variety.

SCHILLER: Did they tell you the strong variety would not make a good continuous mix flour?

MATTERN: No, not necessarily, but their first choice of the two samples was the Omaha variety. They thought the stronger one was too strong because the protein was quite high. What I am trying to say is they don't want flour too strong. I think we have the problem of starches.

SCHILLER: I would like to make this statement. I make it because I would hope these people here who are going this kind of work won't get an impression that, in the long run, may prove to be without ground or without basis. I do not intend to disagree with Paul Mattern. As he indicated, in the continuous mix, one variety being lower in protein might have been most acceptable. Information recently came to me from a large milling company, not my own, who submitted eight samples of commercial flour to two commercial manufacturers for evaluation on their continuous dough mixers. These samples ran all the way from a very low protein hard red winter wheat flour to hard northern spring of a very high protein content. Both of these companies declined to make any particular distinction of acceptability between these flours in their continuous mix evaluations. The only thing they did say was that the dark hard northern spring of exceedingly high protein content was not particularly suitable. All the rest of these flours will make acceptable bread by the continuous mix method if properly handled. I toss this out to you because, I think, there is not, at the moment, enough concrete information from either manufacturer to give us much direction. I will say that the tendency, at the moment, is that flours need to be a little stronger than in the conventional method. But, don't get the impression that there is any concrete evidence of which way we should definitely go.

SEEBORG: I believe that Mr. Schiller is on the right track and I would like to support him very strongly, for the reason, a few years back, that Western Bakeries were using short mixing time wheat very successfully. Baart wheat was used to a large extent in their plants along with winter wheat. But marketing conditions changed. Centralization of baking and shelf-life of the bread became exceedingly important as did packaging, stacking ability and all these things. The short mixing time types were found to be very poor in this marketing situation. Therefore, the bakers had to go to a much stronger longer mixing time gluten to get this shelf-life. I think the same shelf-life consideration would be important in the continuous mixing process. I ask a question regarding the study made at Manhattan, whether or not exclusion of the extrusion process, which is exceedingly hard on dough, might not be significant.

FINNEY: Referring back to Paul Mattern's experiment on a few flours, I think the key there is that Omaha was low in protein and Warrior high in protein. This sort of thing makes the issue confusing. What I would like to see is a comparable protein for Omaha and Warrior, because we know that over-all strength particularly from a commercial standpoint, involves not only normal physical characteristics at a given protein level but level of protein as well. Using Pawnee and Bison as examples, if the protein level goes up, the strength of either of these two varieties, regardless of mixing time, rises. That is why it is not uncommon in the evaluation of varieties, for a variety we consider to be inherently a weak variety because of short mixing time, poor mixing tolerance, and poor dough handling properties to have desirable properties with above-normal protein content. Almost invariably it will be looked upon with satisfaction commercially as you might expect because of its higher protein level. In the case of Warrior which inherently has good physical dough-handling properties, with appreciably higher protein content it is not unreasonable at all to suspect it could well be considered too strong even for the continuous dough process.

STUDIES OF THE SEDIMENTATION TEST FOR EVALUATING THE QUALITY OF PLANT BREEDERS SELECTIONS FROM HYBRID POPULATIONS (Abstract)

I. M. Atkins

The sedimentation test of quality was used on F_3, F_4 and F_5 families each increased from an F_2 plant. A selected group of 36 families was grown in a replicated test where sufficient seed was obtained for full scale bread and other quality measurements. The cross used was Tascosa Renacimiento-Kenya x Newthatch-Frontana, the objective being to transfer resistance to the rusts to Tascosa wheat. Changes in personnel and low temperature injury to the progeny of the cross forced changes in location for the several generations.

The range of sedimentation values of hybrid family lines exceeded the range of the two parents in each of the three generations. The mean of the hybrid families was near the mean of the two parents in each of the generations. Approximately a normal distribution was obtained in F_3 but the F_4 distribution was bimodal with one peak near the Tascosa parent and the other below the average of the two parents. The correlation between sedimentation values of F_4 and F_5 families was .602.

Correlations between bread scores in F_6 and sedimentation values of F_3, F_4 and F_5 families grown in previous seasons were respectively .326, .420 and .225. There were a few families which gave results varying greatly from those expected and inconsistent from season to season. If one might assume that mistakes of planting, harvesting or identification were involved and only six families removed, the correlation of the remaining F_5 families is increased to .602.

The sedimentation test appears to have value for estimating the quality of hybrid lines but additional research is needed to determine why certain families depart so greatly from the expected value.

ABBOTT: Dr. Atkins, I would like to ask if any consideration was given or examination made of the protein content of the different samples in this material? I think you have to expect that one line might be low protein one year and high protein the next. This would affect sedimentation unless a correction was made for the protein.

I. M. ATKINS: We still have a reserve of all of this material. Our first tests were very limited and we hope to get protein tests run on the materials.

ABBOTT: The other point I would like to make involves the use of sedimentation for selection. We are not attempting to pick good lines, or exceptionally good lines on the basis of good sedimentation, but rather to discard those that are definitely inferior. This leaves a lot more to choose from. I think it excludes the possiblity of throwing out some that are intermediate, that still have some very good characteristics. Also, we usually try to use sedimentation in conjunction with the mixing characteristics.

BARMORE: What do you use as your criteria of bread quality, loaf volume alone?

ABBOTT: No. We use several different criteria. We use white wheat as well as red wheat. Most white wheats give low sedimentation values and some of the very best loaf volumes. They are very efficient in mixing time and so we use this as a comparison. We can get excellent loaf volumes and have a low sedimentation with certain white wheats.

CURTIS: This concludes this session. However, we do have a special guest with us who has agreed to talk to us briefly at this time.

NORMAN BORLAUG: Ladies and gentlemen, and fellow scientists. My work has been with spring wheats and this is the first time I have had the pleasure of being present at one of your hard winter wheat conferences. My presence here was mostly by accident but I have enjoyed very much the very fine presentations and discussions today. I would like to make a correction. I am not with the wheat program in Mexico now. But I still have to do with wheat and keep young people working in a number of different countries in Latin America.

I would just like to point out some of the things we have in common with you, even though your wheats are very different from the wheats with which we are dealing. First, I should point out that our wheats are all spring wheats, but we work with both hard and soft types and also with durum wheats. We have to try to keep hard and soft types in the proper proportions, maybe not so efficiently in recent years. This is not an easy job to have the desirable types in each of these texture classes and to keep them in proportion. When a new release of soft wheat comes out and yields more, it becomes a drug on the market. The next time it is a hard wheat and since there is no differential in price, it is practically impossible for us to keep track of them. We have problems cropping up constantly in our industry even though the basic types may be acceptable from their own particular industry's point of view.

I would just like to mention a few things concerning our experience with dwarfs, with which you have spent quite a bit of time this afternoon. We have been working, now, for quite a number of years on dwarf varieties and two of them are now grown on rather large commercial acreages. They are semidwarfs. Some others are presently being multiplied for release. Perhaps, I should say, the first two sort of realeased themselves. They got away from us. The farmers took them out and they were starting to show up everywhere, so we had no choice but to go ahead with the two best that we had the fartherest along. They did have some of the same defects that you have mentioned here, especially in test weight.

In the new ones coming along, that are now in our first commercial increase, we have corrected this through back crossing. The releases that are going out now have been back crossed to our commercial types, both hard and soft.

I would like to mention our work with the durum wheats. Several years ago, I think about 3½ years, we transferred these same dwarf genes in bread wheats into durums and back crossed them 3 or 4 times. We recovered complete fertility and now have these dwarfs in real promising durum types. I should have indicated earlier that virutally all of our wheat is grown under irrigation and so dwarfness and the yields that can come from these dwarfs if water is supplied properly, is of a great deal of importance.

In connection with the general topic you discussed earlier having to do with blending varieties, we have worked with this, but in a little different way. Our experience is based on back crossed lines rather than variety mixtures. Therefore, we are mixing together things that are much more closely related. Most of the work we have done along this line has been based on 2, 3 or 4 back crosses. We have studied these from the yield standpoint, from the disease standpoint and from a quality standpoint for a period of four years. In only one of those four years have we ever found anything that looked like a significant increase in yield over the calculated yield of the component parts grown separately. The rest of the time, they have yielded more or less what you would expect, sometimes slightly less, sometimes slightly more than the average of the component strains but not statistically different.

One of the interesting things is the comparison of yields of mixtures which have been grown for four years, and ones that were grown for two years and three years. In no case can we find significant changes in yield indicating that the mixtures are quite stable. From the standpoint of the balance in these populations, I think, we are getting something entirely different working with back-cross lines. I have seen this, not only with material that we worked with in Mexico, but in our program in Columbia. Dr. Gibbler has had the same results. I have seen mixtures grown in Columbia, Ecuador, Peru, and various other countries. They are relatively insensitive to change, you would expect this theoretically, due to great similarity in parents.

Of course, I should have pointed out we put out these multi-lineal varieties, several years ago, to see what would happen. Unfortunately, it happened that at the same time the two dwarf wheats escaped on us and everybody wanted to grow dwarfs. By back-crossing we are converting these lines to dwarfs. But it shows the problems you run into in any back-cross program, to keep pace with the changes that occur in your wheat varieties.

We do encounter a lot of things that are interesting from a scientific standpoint. As long as these varieties are put together from back cross types, it is not at all difficult to get growers acceptance of them because they are relatively uniform. They were achieved in a relatively fast, short period of time, and it was not nearly as difficult to do as we had originally anticipated.

I would like to say a few words about what we do in early generation testing for quality. I want to make it perfectly clear that our ideas of quality are quite different than yours, in some cases more complicated. The nature of the cropping practices and the way fertilizer is applied always are taken into consideration. Nevertheless, several years back, we began to discard very heavily in the F_2 generation. We are not trying to pick out a good wheat by any means, but we want to discard, at least 40, 50 or 60 percent of the population. All of this is on an F_2 plant basis, the grain that comes from an F_2 plant.

For a number of years Dr. Klein, of the Klein Seed Company in Argentina has worked with some of these early generation tests for various quality components beginning with a test of the individual F_2 plant. We have been doing this for two years. We can run through about 6000 plants in three weeks time, or roughly about 300 a day. This gives us plenty of time to decide which ones to replant. This last summer we replanted only 1400 of 6000 selections.

We know we are throwing away some that might make excellent wheats, but you can't be too concerned about this if you are going to have a successful program. Dr. Klein uses sedimentation to check the F_3, also supplemented with the Pelshenke test. We hope to decide this year whether to go ahead as we have been or convert to the sedimentation test. That final decision will be largely determined by how many we can run in three weeks time. We aren't saying we can predict the kind of bread by these tests but they will permit us to throw away what we call garbage.

THURSDAY MORNING, JANUARY 18

Chairman, J. W. Schmidt
Discussion Leader, V. A. Johnson

General Topic

WORK SESSION REPORTS
and
THE REGIONAL PROGRAM IN HARD RED WINTER WHEAT

WHEAT QUALITY IN RELATION TO PRODUCTION AND MARKETING
(Work Session Summary)

Byron S. Miller

In the part of the program dealing with wheat quality as related to production and marketing, an attempt was made to generalize concerning the influence of several factors on wheat and flour quality. These included effects of weather, effects of the kind, rate, and time of fertilizer application, effects of handling conditions, effects of irrigation, and effects of attack by disease. Attempts were also made to summarize for those who are concerned with the development of new varieties what characteristics are desired in a wheat from the point of view of both domestic and export uses. This was done with the full realization that unless plant breeders know well in advance what characteristics are desired, they will not know what factors to incorporate into new wheat varieties. There is general agreement that present and future major Hard Red Winter Wheat flour requirements are for flour with higher protein quantity (at least 2%), good protein quality, good mixing tolerance without an excessivemixing requirement, low ash, and dependable flour uniformity. Newer processing technics or new commercial uses for wheat as human food are not likely to mean that poor quality wheat can be used effectively. It is also desirable to have mellow kernel texture in Hard Red Winter Wheat varieties. Mellow kernels disintegrate easily and produce a minimum of starch damage. By way of explanation, two types of mellowness have been referred to at this meeting. One refers to milling properties and has to do with the kernel texture and the ease of reduceability to flour. The other type of mellowness refers to dough handling and baking properties.

A sober consideration of the problems of wheat and flour quality leads to recognition of the fact that major emphasis must be placed on studies of the basic reasons for quality differences. This will require the close cooperative efforts of individuals trained in different disciplines. It would appear that the days of development and application of empirical tests for wheat and flour quality are past their zenith. This does not mean that such tests should not be used but rather that major efforts need to be applied to the study of the basic reasons for quality differences among wheat varieties and the same variety grown under different environmental conditions. Since quality is very likely the result of the integration of effects caused by several factors, it seems reasonable to study all the various components of wheat and flour in both an individual and a collective fashion. Fundamental studies related to flour quality and processing conditions need to be made on the carbohydrate, enzyme, lipid, mineral, and protein components and also on the physico-chemical properties of wheat and flour. These studies should be conducted by well trained specialists in the various specific research areas of bio- and physical chemistry. All of the flour components are being studied to some degree in various laboratories but a thoroughly integrated program would do much more to hasten the acquisition of knowledge. Furthermore, this knowledge would be of major advantage in developing micro quality tests suitable for application to a few kernels of wheat.

The ideal way for basic studies of the type suggested to be carried out is to conduct them in one major laboratory. Here much expensive equipment could be used in common and ideas could be readily passed from one group to another or worked on cooperatively. The interrelationships among the components also could be studied to major advantage. That the multibillion dollar wheat crop does not justify such an arrangement is unthinkable. Such a laboratory would be comparable with those already established in other major wheat producing countries of the world and would be a focal point for study in the cereal field by foreign exchange scientists interested in research on wheat and/or comparable research on other cereal crops. Such a laboratory would not detract from the highly useful testing work performed by the four regional wheat quality laboratories but it would be reasonable to establish it where one of these laboratories is already located. It need not be a federal laboratory. It could be established on the campus of one of the midwestern universities and sponsored by the wheat growers themselves on a long-range basis.

It is extremely difficult, if not impossible, to predict what type of commercial products will be in major production or what processing machinery will be used 10-15 years from now. Who would have been wise enough or willing to predict 10 years ago that major commercial bakeries would be installing in 1962 continuous dough mixing machines as fast as they can obtain delivery. Yet plant breeders must know today the quality characteristics required in wheat varieties to be grown commercially 10 years hence.

The following are a few of the many areas where future work might be concentrated in addition to the fundamental biochemical studies mentioned above.

1) Plant breeders should breed wheats which have a maximum of mixing tolerance but without excessive mixing time requirements. Plant breeders should also breed wheats which have a minimum of ash in the endosperm. Excellent varieties in this respect are Tascosa and Triumph.

2) Geneticists should continue their search for genetic factors that control protein content and other quality characteristics.

3) Agronomists should continue to seek efficient cultural means for increasing the protein content and protein quality of wheat.

4) Biochemists should study the enzyme systems that may be involved in the maturation process of wheat.

5) Technologists should determine the flour quality requirements for new breadmaking processes in order to inform the plant breeders concerning special properties that are desired.

6) Information is required on the air classification characteristics of flours milled from different wheat varieties. Is the ease of air classification an inherited characteristic and can it be modified by wheat conditioning? The properties of the fractions need to be considered in terms of both bread and cake making quality.

7) Milling technologists need to minimize the damage to flour components during the milling process. This includes damage to protein, starch,and bran.

In consideration of these and other topics, there is a great need for the close cooperation of people in government, university, and commercial laboratories. Much is to be gained by an exchange of ideas and a mutual understanding of problems. How many of you have visited a commercial mill or bakery? Have you spent enough time and talked with the people who operate such establishments to really know and appreciate their problems?

HARD WINTER WHEAT PRODUCTION PRACTICES AND PROBLEMS
(Work Session Summary)

E. R. Hehn

Unfortunately production efficiency research has fallen into ill repute among many individuals and groups seeding a solution to the supply and demand problem of an abundant agriculture. Production efficiency is the core upon which western civilization is founded. Especially are the underdeveloped areas of the world striving to emulate United States production efficiency in agriculture. It is historically unwise and contrary to our philosophy to throttle production efficiency research in agriculture.

The domestic feed and export food and feed markets offer tremendous potential markets for wheat growers. Neither of these markets can be effectively developed unless by improved production efficiency the cost of wheat production can be reduced.

Mechanization of crop production operations has been largely responsible for the increased output per man-hour in agriculture. Machinery design is dictated by the nature of the crop plants. Tillage and planting implements must be designed to provide the optimum growth requirements for the plants. Mechanical harvesters must accomodate themselves to the physical and morphological nature of the total plant, as well as the commercially useful portions of the plant. Crop plants, such as corn and sorghum, have been altered morphologically to facilitate mechanical harvesting. Lodging and shattering resistance have been wheat breeding objectives aimed at improving harvesting efficiency. Current efforts directed toward increasing the emergence potential of winter wheat seedlings can result in varieties with a greater range of tolerance to seeding depth. An increased tolerance to seeding depth will permit placing seed into the proper soil moisture environment in seasons of deficient topsoil moisture.

In the past three decades two of the primary hazards of crop production, namely, wind erosion and moisture deficiency, have been ameliorated by the alternate crop-fallow system and stubble mulching. These two practices have created secondary problems. The straw residue frequently presents a problem during tillage and seeding operations. The plant breeder can contribute to the maintenance of optimum residue levels by modifying the amount and quality of straw produced. The straw residue may give rise to levels of toxic substances which are harmful to the succeeding crop. The depressing effect of flax and sorghum residue has long been claimed by farmers. Research results indicate that even wheat residue may be harmful to the succeeding wheat crop. This area of the unknown offers a promising field of cooperation between the plant breeder and biochemist.

The summer fallow-stubble mulch system obviously provides a new environment which may be either favorable or unfavorable to specific pathogenic organisms. Those diseases and insects favored by this environmental modification may well become serious problems in the next decade. In order that host-parasite reaction may be brought to bear upon developing parasite problems the plant breeder is well advised to maintain close liason between himself and his pathology and entomology associated.

Weeds are expensive whether controlled or uncontrolled. It is apparent that weed control by selective herbicides is potentially less costly than control by tillage. Greater specificity can be attained by the cooperation of plant breeders and chemists. Other crop plants have been selected for greater tolerance to certain herbicides. Atrazine could be safely used for the control of downy brome with a slight increase in wheat plant tolerance.

In the short span of a decade, fertilizer use has become a general practice in the Great Plains. It may be time that plant breeders in cooperation with soil scientists seriously undertake the subject, genotypic variations in efficiency of mineral element use. Instances of single gene responses to specific elements in other plant species have been reported.

In any crop year on the Great Plains water is the most critically limiting element to optimum plant growth. Water use efficiency is of equal importance whether the crop is being grown on dryland or under irrigation. Whether any real progress in drought tolerance or water use efficiency has been made in any crop since the advent of organized plant improvement is open to question. Intensive investigation of a subject of this order of importance is long overdue.

Winter wheat breeders have established enviable records in the field of disease and insect resistance. Recently they have demonstrated equal facility in the modification of quality characteristics to meet the changing trade demands. The wheat germ plasm pool is sufficiently plastic to permit comparable achievements in plant modifications contributing toward increased efficiency of production.

ROLE OF GENETICS AND WHEAT BREEDING IN PRODUCTION AND MARKETING EFFICIENCY
(Work Session Summary)

B. C. Curtis

This work session provided an opportunity for a closer look at the direction we are going or need to take in the field of wheat breeding and genetics as related to production and marketing efficiency. One might say that we stood back and looked at the broad outline without too much consideration for details. Specific problems were considered only as they were related or contributed to the goals of the session (see goals listed on conference program). Efficiency in production and marketing of hard red winter wheat is perhaps influenced more by varieties than any other single factor. For this reason much of the discussion in the session was centered on prospective varieties of the future. Included also were discussions on yield components, wheat diseases and breeding for higher quality wheats as related to the goals of the session.

In considering future varieties the relative merits of pure-lines, blends, multilines, and hybrid wheats were discussed. Limited research data indicate that heterogenous varieties offer little advantage over pure-line varieties. Possible advantages such as stability of production and depression of disease outbreaks were listed for heterogenous varieties; however, it was conceded that these advantages may be offset by the disadvantages of maintaining such varieties. It was pointed out that heterogenous varieties appear to offer no miracle in quality improvement. One significant feature brought to light by blends is that most farmers are not overly concerned about the "attractiveness" of a variety providing it will perform.

Hybrid wheat appears to be rapidly approaching a reality. The utilization of *Aegilops* cytoplasm, particularly from the *ovata* species, has led to the production of male sterile winter wheats. Recent pollination experiments on these wheats in the field has resulted in an average seed set above 70%. Research is underway to resolve the problems of fertility restoration, cross-pollination and hybrid seed production.

The use of semi-dwarfs in environments conducive to extremely high yields is gaining in momentum as strains have been developed that produce 120-130% of the taller commercial varieties. More seeds per spike, better lodging resistance and possibly the addition of yield genes, *per se*, appear to be the contributing factors of short-statured wheats. Additional research is needed to increase flour extraction and straw resiliency in short wheats.

Wheat leaf rust is a much more stable organism than previously thought. In Oklahoma only two new classifiable virulences have been recognized during the last decade. Good wheat streak mosaic resistance has been found in a Sando wheat selection. This resistance is apparently controlled by 2 alien chromosome pairs in a 46 chromosome strain. Work is underway to develop alien addition lines having only one of the two pairs. Such lines can then be used in developing translocation stocks such as was done in the development of Transfer.

Recent studies have shown that it is possible to combine good milling and baking quality into early maturing wheats. Extremely early strains have been produced that have good quality characteristics.

The lack of time prevented discussion on a number of subjects equally important in attaining the goals of the session. For example, the topic "Yield level potential in wheat" was referred to only briefly. This subject needs a thorough review by all disciplines of wheat research.

V. JOHNSON: We are ready to get down to grips with one of the important aspects of our program, that having to do with regional evaluation of our material. However, if this were the only aspect of our program, then I think the program wouldn't be fulfilling its function. I think there is a much less apparent aspect of our program; one that involves the fact that this program serves as a vehicle for contacts throughout the region, for continuing exchange of ideas, and for the stimulation, of course, that derives from the exchange of these ideas. I think all of us should keep in mind this important aspect of the program, although it is not a very apparent one.

The hard red winter wheat regional program is the oldest of the cooperative regional programs. It has been in existence now for nearly thirty years. During this time, we have had a close-knit group and we have worked well together. We have done, I think, a reasonably good job in this matter of wide-scale regional evaluation.

We should recognize that regional evaluation is not an end in itself. It is merely a reflection of the effectiveness of the individual programs that are conducted in the cooperating states. If we do not find promising materials in our regional evaluation nurseries, this is a reflection of the state programs involved.

The fact that we have carried on this work for nearly thirty years now, is not in itself a basis for continuing the work. Periodically, we must subject this aspect of our program to close scrutiny and ask ourselves what it is we are trying to do in the various nurseries and whether the nurseries, as they are set up, are accomplishing their objectives. Then we should consider ways in which we can increase their effectiveness. This is the area with which we will be dealing this morning. I sent out to the group, prior to the conference, mimeographed material having to do with the various regional nurseries. I posed some questions concerning these nurseries.

I have up here on the platform a map of the United States showing the main bread wheat producing area of the United States. The hard red winter area is indicated in blue, the hard red spring wheat area in orange. It is difficult to draw a line between these two regions. There is an area of transition and a great deal of over-lapping, but on the basis of relative acreage of hard red winter wheats and hard red spring wheats, I think the line fairly realistically represents the division between the two regions.

You will notice that, despite the fact we are hard red winter wheat people, we do a considerable part of our testing in the spring wheat region to the north. There are good reasons for this which will be apparent later in the discussion.

We will discuss first the Regional Quality Series. This is a series that evolved from the regional plot series, or regional variety tests. At the last conference, this group voted to change the plot series to a quality series.

Regional Quality Series

Check varieties
Southern District (Tex. (2), N. Mex. (1), and Okla. (4))-Pawnee and Comanche
Central District (Kans.(4), Colo.(2), Nebr.(3), Iowa (0))-Pawnee & Cmn
Northern District (Nebr. (2), Wyo. (2), S. Dak. (3), Mont. (2?), Minn. (2)) - Yogo, Minter, and Nebred
(Note; Numbrals refer to the number of testing sites in a state.)

Plot size - seed sufficient to plant a 1/50th acre drill strip furnished

Purpose - to provide seed in the amount of 5 to 10 lbs. per location to Hard Winter Wheat Quality Laboratory for state and regional quality comparisons

Eligible materials - recently-released varieties, prospective commercial varieties, strains for special quality studies

Arrangement of series - all testing locations in a district grow the same set of varieties in any year

Questions for consideration:
Is the current organization of the series satisfactory for the purpose intended?
Should Yogo be eliminated as a check variety in the Northern Series?
Is the number of testing locations in the northern district adequate?

V. JOHNSON: I have asked Karl Finney to comment on the series, to give to this group his thinking concerning its current effectiveness, and his ideas as to the ways in which the series might be improved.

FINNEY: From the quality testing standpoint, we consider the group of samples that we get from the southern, central and northern districts extremely valuable. These samples not only are representative of any given location, and permit comparison of varieties, but they give us an over-all picture of the extent of the variations that we can expect to experience at one time or another between the varieties grown throughout the hard red winter wheat region.

As Virgil has pointed out the primary purpose for samples being grown in the uniform quality series is first to be able to check the performance of prospective releases, or new varieties and to supply us with sufficient quantities of these different varieties, new releases, prospective releases, and even better yet, unusual varieties that represent the extremes in certain quality characteristics. We can conduct special quality research on these materials. Such research is useful in one way or another. In other instances it is essential for a better understanding of certain methods and techniques for evaluating the quality of these varieties. In connection with this series, I think it is important, however, that it not be too large. At the present time, there are ten varieties in the series. An increase from six to ten was brought about primarily because of our desire to get four unusual varieties into the series that would furnish desirable material from the standpoint of studying quality characteristics.

It now appears that within probably a year, these four varieties can be cut down to two. What I would like to stress at this point is that any new varieties, new releases, or prospective releases that go into this series be withdrawn as soon as you feel there is sufficient information on them. When your personal interest and regional interest in these varieties is satisfied, they can be withdrawn from the quality series. This will materially accelerate other testing and other research, because I am sure you realize this quality series could, within a couple of years, become kind of a big rock hanging over our head, if we don't keep the varieties limited to a relatively small number. On the other hand, we certainly don't want to put too many limitations on the entry of new things in the series. As soon as a variety, for any good reason, should be tested over a wide area, we certainly want to put it into this series. But by the same token, as soon as we have sufficient information, we would like to have it taken out of the series.

V. JOHNSON: Karl, in the central and southern districts, are the check varieties as they are now designated, Pawnee and Comanche, satisfactory in your opinion? Should we retain these two varieties in the southern and central districts?

FINNEY: I think Pawnee and Comanche are excellent, as far as standards are concerned, from the quality standpoint. Are they suitable from the agronomic standpoint? Even though this is a quality study, I believe that we should have varieties that are important agronomically as well as from a quality standpoint.

SCHLEHUBER: I was under the impression that in our state and in the southern district, the only reason we keep Pawnee is to provide a continuous quality series. We are not interested in it from the agronomic standpoint. In this kind of a study, can we keep in varieties that are only of academic interest?

V. JOHNSON: Not unless they have a special usefulness for the quality lab. My procedure in the past has been to contact cooperators each year. I contact Karl Finney and go over the list with him. I contact each of the cooperators in the region to get their ideas and suggestions concerning varieties they think ought to be pulled out or added. Is this procedure satisfactory? I shall continue to do it on this basis if this is satisfactory with the group.

Now, with regard to the northern district, note that we have designated Yogo, Minter and Nebred as check varieties. Do we need these three?

FINNEY: As check varieties, we don't need three. I think it is always desirable to have at least two checks, but as far as we are concerned, three is more than necessary.

V. JOHNSON: Karl, which two do you think should be retained?

FINNEY: From the standpoint of baking characteristics, I like Yogo and Nebred of the three.

V. JOHNSON: Are there comments from people in the north? Erhardt?

HEHN: It is all right with us.

V. JOHNSON: Any other comments?

AUSEMUS: We do not grow Yogo in Minnesota, our variety is mostly Minter.

V. JOHNSON: I believe that there is a definite feeling that there should be no more than two check varieties. We will not pursue this further this morning. It is something that we can work out next summer. I think we will drop the number to two. Is there any other comment, criticism, or suggestion for this series?

FINNEY: What is the status of Warrior in this area?

V. JOHNSON: Warrior is a recommended variety in western Nebraska, Colorado, Wyoming, and in the winter wheat-producing area of South Dakota. Would you like to have Warrior possibly considered as a variety for check purposes in the northern district?

FINNEY: I would in the northern area, if it is practical. I think the characteristics of Warrior, if it is suitable for the northern area, are better than either Minter or Nebred.

V. JOHNSON: So far as our evaluation of the variety, we feel it has winter hardiness equal to that of Nebred. If this is the case, there would be no reason why we could not substitute Warrior for Nebred. It is something that can be considered.

Southern Regional Performance Nursery

Number of entries in 1962 -- 17 Maximum number -- 30

Permanent check varieties - Kharkof and Early Blackhull

Long-time entries - Comanche and Concho

States in which grown - Texas (3), New Mexico (1), Oklahoma (3), Kansas (4), Colorado (4), Nebraska (3), Iowa (1), Illinois (1) (Note: Numeral refers to the number of testing sites in a state.)

Total number of testing sites - 20

Usual length of testing period for a variety - 3 years

Question:
How might the usefulness of this nursery be improved?

V. JOHNSON: The Southern Regional Performance Nursery, for years was referred to as the Uniform Yield Nursery. The number of entries in 1962 was seventeen. We consider the maximum number for the nursery, to keep it workable, to be around thirty, so we are well below the maximum. This means that new materials are not coming into the nursery very rapidly. If there are not materials for this nursery that truly deserve to be evaluated on a regional basis, I certainly subscribe to the policy of letting the nursery become smaller. Our longtime check varieties in the nursery are Kharkof and Early Blackhull. Any comment concerning these varieties as check varieties. Remember this, Kharkof has been a standard, or check variety from the very beginning of this nursery.

HEYNE: I would like to ask a question about Kharkof. Is there any source os seed better than what I have? Mine is mixed and not a good representative of Kharkof.

V. JOHNSON: We have made no special effort in Nebraska to purify Kharkof for a particular type, or particular rust reaction. We have tried to grow it as we grow most of our materials for pure seed purposes. We have not attempted to rework it in recent years.

SCHLEHUBER: We have Kharkof in the nursery primarily for academic interests. Maybe we are no longer testing Kharkof today, in view of the problems Elmer just mentioned. We want a long time permanent check, and I don't believe we are even testing Kharkof any more, we are testing something entirely different.

V. JOHNSON: I can't account for the changes that have presumably occurred in Kharkof. Elmer, is the variation that you have noted relatively recent or has it always been in the variety?

HEYNE: I think I have seen changes.

BRIGGLE: I might say that the Ohio Experiment Station has maintained Kharkof over a period of years. This appears to be a reasonably pure supply of seed. I think that some of this would be available if it was desired. That is just a suggestion.

LOEGERING: I think the seed we use in the uniform rust nursery is considered real pure. We don't have a lot of it, but if you want to go back and increase it, you could.

V. JOHNSON: Should Kharkof be retained in the Southern Regional Nursery?

I. M. ATKINS: I would be in favor of keeping it in. We have had it in our tests from the very beginning and we like to look at it and see what progress we have made along the way and in our state it serves as a winter hardy check. We do not grow other winter hardy varieties and late varieties. I am very much in favor of keeping it in.

V. JOHNSON: If we do keep it in we should do something about its purity.

SCHLEHUBER: May I say again, in the event we retain Kharkof as a permanent check then someone should undertake the responsibility of maintaining this variety.

V. JOHNSON: We have maintained the variety in Nebraska and we think we have a good pure source of Kharkof. Who has received seed of Kharkof from Nebraska in recent years?

LIVERS: We got our start from you about ten years ago. It is, in my estimation, pretty uniform.

V. JOHNSON: John, would you care to comment on your observations of Kharkof?

SCHMIDT: We think our seed isn't too bad. We do increase it every two years.

V. JOHNSON: What is the desire of the group? We maintain Kharkof in quantity in Nebraska and we will take an especially good look at it next summer. We will have seed, I think, for anyone who wishes to obtain it from us. Is this satisfactory? Should we take action on Kharkof?

SCHLEHUBER: In order to bring this to a head, I move we drop Kharkof.

V. JOHNSON: The motion has been made by Dr. Schlehuber that Kharkof be dropped from the southern regional performance nursery. Is there a second? Do I hear a second?

(No response.)

V. JOHNSON: The motion dies for lack of a second.

REITZ: What is the testing period for a variety?

V. JOHNSON: The usual testing period for a variety in this nursery is three years. We don't adhere to this entirely, because if it becomes quite apparent that the variety does not have a place after a couple of years testing, we then consider dropping it from the nursery. What about long-time entries like Comanche and Concho? Should we continue to test these?

SCHLEHUBER: What are long-time entries?

V. JOHNSON: These are entries, Dick, that have been in the nursery well beyond the usual three or four year period.

SCHLEHUBER: And for what purpose?

V. JOHNSON: They are there for various reasons; primarily because people I have contacted in the region have indicated when I contacted them, that, for one reason or another, they would like to see them retained in the nursery.

HEHN: I question the two categories but I don't have any valid objection, because the number of entries in the nursery is low. We have the long-time or permanent checks. These are standards if one wants standards for comparison purposes. I see no reason for changing that.

V. JOHNSON: Where a nursery is grown and harvested at a location, a one pound sample of each entry in the nursery is sent to the Federal Wheat Quality Lab at Manhattan from each of the locations. Karl then composites from these locations and evaluates entries on the basis of the regional composite of each of them. Karl, of the varieties we have discussed, from the quality standpoint, what is your interest in Kharkof, Early Blackhull, Comanche and Concho?

FINNEY: I always like to see standards in a variety test. It doesn't make too much difference but we would like, if possible, to have included a strong type, as well as one that is weaker. Outside of that it doesn't make any difference.

V. JOHNSON: What about Early Blackhull, Karl?

FINNEY: Early Blackhull and Comanche would be satisfactory. If you want to retain Kharkof as a long time standard, then Kharkof and Comanche would be alright.

V. JOHNSON: Early Blackhull has certain value for agronomic comparisons, particularly maturity, as well as a few other things.

I. M. ATKINS: I see no particular reason for keeping both but I think in view of the fact that Comanche is so universally used as a quality standard by the trade, why couldn't we retain three permanent check varieties, namely: Kharkof, Comanche, and Early Blackhull for quality and maturity comparisons and just let it go at that.

I move that Kharkof, Early Blackhull and Comanche be considered as permanent check varieties for maturity and quality purposes.

SCHLEHUBER: I second the motion.

V. JOHNSON: The motion has been made and seconded that the three varieties, Kharkof, Early Blackhull and Comanche be retained as permanent check varieties in the nursery for agronomic and quality comparison purposes. Is there any discussion?

All those in favor of this motion signify by saying Aye.

(Motion carried).

V. JOHNSON: For the benefit of those who may not be fully acquainted with the southern regional performance nursery, it is grown in Texas, Oklahoma, Kansas, Colorado, Nebraska and Iowa. Is there information that we should be extracting from this nursery that we are not collecting at this time? Are you satisfied with the information that you get from this nursery? If you are not, I would like to know about it.

At the last conference there was some discussion concerning the possibility of using this nursery, since it is grown at many locations over a wide area, to obtain special information from time to time. Cooperators should keep this in mind. Are there any other comments concerning this nursery? If not, we will move on to the Northern Regional Performance Nursery.

Northern Regional Performance Nursery

Number of entries in 1962 -- 16 Maximum number -- 30

Permanent check varieties - Kharkof, Minter, Yogo, and Nebred

Long-time entry - Cheyenne

States in which grown - Montana (1), North Dakota (1), South Dakota (1), Minnesota (2), Wyoming (2), Nebraska (3*), Kansas (1), New Mexico (1), Lethbridge, Alta. (1)
* Nursery grown for observation only at Lincoln, Nebraska

Total number of testing sites - 13

Usual length of testing period for a variety - 3 years

Questions:
Do we need four check varieties in this nursery?
Should the nursery be grown at additional locations in the north?
What changes in the nursery would you recommend?

V. JOHNSON: This is a nursery similar to the Southern Regional Performance Nursery but it is grown in the northern part of the region at locations in Nebraska, Wyoming, Montana, South Dakota, North Dakota, Minnesota, and Lethbridge, Alberta. You will note the number of locations in each of those states. At the present time the permanent check varieties are Kharkof, Minter, Yogo, and Nebred, and Cheyenne is a long time entry. In addition to normal yield and agronomic information this nursery also provides, frequently, useable information on winterhardiness. What are your wishes for this nursery with regard to varieties we use as standards in the nursery?

HEHN: I would be agreeable to retaining Kharkof and dropping either Minter or Yogo. I would go along with dropping Yogo. I think the two are about the same in the terms of winter survival. I think we can get along with one of these and I don't care which one it is.

AUSEMUS: Virgil, there is increased interest in winter wheat in the northern region as most of you know. South Dakota has almost doubled its acreage of winter wheat. Montana likewise has a high acreage of winter wheat. We are thinking seriously of putting winter wheat in parts of northern Minnesota. North Dakota also has increased acreage of winter wheat. We in the northern states are very much interested in some of the things that you folks send to us and we are glad to have them.

As far as checks are concerned in our spring wheat nursery, we have carried Marquis on a permanent basis, primarily because it is used as a quality check. It has been a good check for our new varieties from the pathological standpoint.

V. JOHNSON: Dr. Hehn has indicated he feels either Yogo or Minter ought to go. What about Nebred? Karl Finney earlier raised a question concerning the use of Warrior. What is your feeling about this?

AUSEMUS: Isn't the reason for a larger number of checks in the northern nursery that you are sampling a very large area?

V. JOHNSON: Yes, we are.

AUSEMUS: In other words, in South Dakota, Nebred is the best variety. I understand Yogo is the best winter hardy variety in Montana. Minter is better in our area. As long as the number of entries in the nursery is no larger than it is, I can't see why we shouldn't go ahead and carry all of them.

V. JOHNSON: If this is your wish, we certainly can. The decision rests primarily with those people who have to grow the nursery and do the work.

KOLP: I would just as soon hold up on Warrior to find out how widely adapted it is. I really think it is going to go over in our state. I would also be in favor of dropping Cheyenne. I think Minter, Yogo and the other varieties would give us more information.

HEHN: Why do we have Nebred? Is it for quality?

V. JOHNSON: Yes, and it also is one of the most winterhardy varieties among those that are grown on large acreages. What about Cheyenne?

HEHN: I would like to see it continued.

V. JOHNSON: If these nurseries become larger, I will be the first person to start pressing you people about what you really want in them. With the size of the nurseries as it is and if you do not object to growing the check varieties now included and feel that some benefit is derived from them, then perhaps they should be retained.

Now, I raise the question concerning additional locations for this nursery in the north. Conditions are hazardous and difficulties in stand establishment are encountered. Sometimes the entire nursery is lost so it yields no information. Is there any interest in cooperating states to grow the nursery at additional locations?

BUCKENAU: Perhaps I am speaking out of turn, but I think we should have an additional location in South Dakota. At the present time, the nursery is grown only at Brookings.

V. JOHNSON: It is also grown at Lethbridge, Alberta. Dr. Grant, do you continue to have interest in the nursery?

GRANT: Yes, we would like to continue to grow this nursery. It is the only yield test of winter wheat from the United States that we do grow in

Canada. It keeps us abreast what is going on in your program. Actually, it is very doubtful that we will find varieties in the nursery adequate for our area because their winter hardiness is not high enough. We are very happy to continue to grow it and I think you people may gain some useful information from the data we send back. There are times when, perhaps, our conditions there are a little more adverse than you would get in the more southern locations. You may pick up information on winter hardiness that you would not get otherwise. We would not want to grow the nursery at more than one location.

V. JOHNSON: Thank you Mark. We do feel we get valuable information from your locations, and if in growing the nursery, you obtain information that might be useful, I think it should be continued. Is there anything further concerning this nursery?

HEHN: Are you still following the policy of entering new varieties in the nursery, no matter where they originate from, for a period of time?

GRANT: What are you referring to?

HEHN: Well, all of these new varieties with names like Shoshoni, Atzec, Tascosa are might interesting. Growers hear of them and ask questions. Entering them in the nursery provides information that we need to answer these questions. I like that, I am willing to grow these, even though we may know from previous experience that they will not fit in our area for lack of winter hardiness, etc. I like to see these new varieties, no matter where they come from. I think it is a real service to have a year or two of information of these before we get hit with questions.

V. JOHNSON: If you recall, the action of this group at the last conference was to place in the northern nursery, materials out of the southern nursery that were being increased and looked like good bets for commercial production. Likewise, materials out of the northern nursery go into the southern nursery for at least one year prior to release. Is one year enough?

HEHN: No, it isn't.

V. JOHNSON: I would go along with moving these varieties into a nursery and holding them in for longer than one year. However, the last conference indicated the desire for one year of information.

This brings up the question of what to do with recently released hard red winter varieties out of the Pacific Northwest.

HEHN: Let's put it this way, Virgil. Instead of making an absolute directive, if a variety in one year of testing demonstrates complete lack of adaptability then it can be dropped. We may get years in which all entries come through everywhere. In this case varieties in question could stay in two years and we would have some positive information. I don't think we should absolutely say one year or two years.

SCHLEHUBER: Erhardt, I am wondering if this should be placed on a regional basis? If varieties are grown in the regional nursery at a particular location for one year, certainly it ought to be up to the cooperator after that to continue it at that location if he is interested in it. He would still get the information but it would not be on a regional basis.

V. JOHNSON: Is my past procedure of annually checking with each of you people who grow these nurseries, to get your ideas concerning materials of this category satisfactory? It is on this basis that new entries to a nursery are made each year. This procedure is satisfactory with me if it is with you.

SUNDERMAN: I was going to make the same comment as Erhardt. We don't have this nursery anywhere in Idaho. Many farmers, in Idaho, are interested in winter wheat. New varieties are not out more than about six months before the farmers begin to ask questions and we don't have the necessary information. For that reason, I would like to grow your nursery in Idaho.

V. JOHNSON: Would you want the nursery next year?

SUNDERMAN: I certainly would.

V. JOHNSON: What is the feeling of the group? Keep in mind that a little more seed of new entries would be required. I will contact you next summer concerning this, Don. We have the situation of new hard winter wheat varieties out of the Pacific northwest. We have had many questions in Nebraska concerning recently released varieties that came up through the western nursery series. Should such materials be picked up before release and entered in the Northern Nursery?

LIVERS: I personally feel each individual state should face up to its responsibility to evaluate all varieties in which there may be interest. I think individual states are in the best possible position to select the materials which are most likely to move into their area. I would be reluctant to see some of the things one individual state is interested in grown over the whole area in a regional nursery. I think it would be quite a waste.

V. JOHNSON: Yes, I would accept this in principle, Ron. However, in such a situation I would point out to the state suggesting a variety that there was no interest elsewhere in the variety and I probably would suggest that it be grown in their state nurseries instead of the regional nursery. Material of this kind probably would not go into the regional nursery unless there was interest on the part of more than one cooperator.

REITZ: I would like to recall to your minds the manner in which the eastern nursery is grown at a number of stations. At many locations it is grown for observation only, not for yields. You get a look at the material, you get disease readings on it, you get a time of heading, etc. If a cooperator is sufficiently interested in a strain he can put it in one of his state nurseries or perhaps the observation nursery has provided him with sufficient information. I think this manner of handling many of the eastern nurseries is serving the purpose.

HEHN: It isn't a matter of our looking at a strain and saying, "Yes, we might be interested in this." We want more than that. If I look at a variety and say it is good, the grower may take my word for it and he may not. Chances are he won't. There is a possibility you may need information in your own area on any variety released anywhere. I like the idea of placing varieties that you people are contemplating releasing in the northern nursery.

AUSEMUS: I would like to say "Amen" to what Erhardt has said. I think we should have varieties of this category in at least one year, and then if we want to continue, all right. You, Virgil, are in the best position to let us know what varieties are coming up because we have never heard of some of them. We have been asked a number of questions on a whole bunch of your new varieties. The only information we have is what we get from the northern nursery.

KOLP: I would like to see better communications between the breeders. When a variety is released, that is when we start getting questions. It is quite embarrassing to have someone ask a question about a variety and not be able to answer it. It has been suggested that varieties from southern nursery be entered in the northern nursery for two years. I don't think that is necessary. I think one year is enough. If we want to see a variety an additional year, then we can put it in a state nursery and not burden everyone else. I think one year is enough.

V. JOHNSON: I recognize the need for good communication in a cooperative effort such as regional evaluation. I need to receive seed at an early date and get it to you so you can make your plantings in a timely manner. There isn't much time for this so I too would like to see better communications. I try to keep people in the region informed of progress and up to date on what is going on.

SCHLEHUBER: Workers not knowing about the release of a variety has been a problem in the past. I personally feel that we are doing about all we can today to get information out through collaborative test series and other means. This discussion is a pretty good indication that many of you are thinking seriously about this problem. By entering promising strains from the southern nursery in the northern nursery and vice-versa for at least one year, cooperators have some indication of likely commercial varieties.

V. JOHNSON: Are there further comments? Ideas expressed this morning are a matter of record and I certainly will keep them in mind when planning regional nurseries for next year.

Uniform Winterhardiness Nursery

Type of nursery - duplicated single rows for observation and winter-killing notes

Number of entries in 1962 - 225 Maximum number - 200?

Check varieties - Minter, Nebred, and Pawnee (one check variety every 25 rows)

Where grown - Alliance, Nebr.; Laramie, Wyo.; Brookings and Watertown, S. Dak.; St. Paul, Minn.; Fargo, N. Dak.; and Moccasin, Mont. Total number of testing sites = 7

Materials eligible for nursery - new entries in southern and northern regional performance nurseries, breeding materials and advanced experimental strains from breeding programs of cooperating states

Questions for consideration;

This perhaps is one of the most important regional nurseries. How can we improve the nursery so as to get better and more consistent information on winterhardiness of entries?

Are the present nursery locations satisfactory?

Do we need more information on fall emergence and stand establishment, winter temperatures, snow cover, etc.?

Note; I am particularly interested in having the thinking and suggestions of those cooperators who grow the nursery.

V. JOHNSON: As is indicated, I believe that this is one of the more important of the nurseries that we grow. I say this, because we may not be holding the line on winterhardiness in the new materials we are releasing. I recognize also the inadequacies of our system of evaluating winterhardiness. We do not have, at this time, a good system of testing materials under controlled artificial conditions. Therefore we rely upon this observation nursery grown in areas where winter killing is likely to occur. I know some of you have ideas about this. I have asked Erhardt Hehn, one of the people who has the job of growing this nursery and taking notes on it, to make some comments.

HEHN: We in the north are becoming increasingly interested in this nursery, but I think we are trying to place in the nursery materials that are not completely compatible. On the one hand, we are trying to give you folks in the southern region some idea as to the winterhardiness of your entries with a simple yes or no sort of answer. If as you say, Virgil, we are slipping on winterhardiness, then, I must again make the statement I made three years ago, and I think I nearly got hung for it. I may be wrong, but I don't feel you southern cooperators pay too much attention to winterhardiness when you come right down to the stretch and decide whether to go with selection A or B. Is it really very important to you whether these things survive in St. Paul or Brookings? At any rate, we are willing to go along and we will continue to give you this information if you want it in the kind of crude way we are doing it now. On the other hand, I think all of us in the north, now have good enough winter wheat programs that increasing the level of winterhardiness above and beyond what we have today is a real possibility. We are really serious about this. We are serious about getting above Yogo and above Minter, and therefore, we need a little more meaningful information than we now get. Some of us have talked this over since we have been here and we might suggest several things. One that we could probably consider is separate nurseries; one for the southern material (by southern I mean south of South Dakota) where we continue about as we are doing today with a minimum amount of effort. As you know, planting today is not much af a problem. In an hour or two hours we can plant hundreds of rows. It is not much of a problem if we don't harvest and only make observations. But for the northern material I think we must be more critical. I think you all know techniques by which we might possibly accomplish this. We might increase replications or we might maintain the same number of replications and increase the frequency of the checks. That is the approach we use in our own material. We plant the winter hardy checks at 10-row intervals and adjust our survival observations to the nearest check. This would be much better than having the winter hardy check occurring every 75 rows as it is now. These are possibilities as I see them. The materials make a difference in the intensity of our observations. I think this is justifiable since the possibility of our picking up anything of superior winterhardiness from you folks in the south is just about nil. I can illustrate this for you. If we take the uniform winterhardiness nursery in the year 1959 at St. Paul, Minnesota, there were 18 entries from the southern regional performance nursery. The survival of those 18 entries was zero. There were 9 from Wyoming; the average survival averaged 15 percent. There were 18 from Montana with an average survival of 47 percent. There were 24 from South Dakota that survived an average 46 percent. The average survival of 45 entries from Nebraska was 2 percent and the average of 72 from Kansas was zero. The odds don't look too favorable for us to pick up something with winterhardiness from southern states. So I would say on this kind of material, let's proceed as we have been doing and give you information of how your materials stack up against Nebred or Pawnee for winterhardiness. However, we need to concentrate and do a better job on the entries from the northern states.

V. JOHNSON: You have heard someone who is facing up to this problem of winterhardiness.

HEHN: I would like to say one more thing. We are always crying that we don't have laboratory techniques for measuring winterhardiness. Consider all the facets of winter survival. If we had laboratory techniques for measuring each of these facets, I am afraid I wouldn't get around to running them. Because of the complexity of winterhardiness, the observation of natural survival is probably the best we are going to do for a long time, so we better do a pretty good job of it.

V. JOHNSON: Are there other comments?

AUSEMUS: This is one of the penalties of being an old man. We started one of these nurseries in the northern region several years ago and it fell through, I guess, because the material I sent to Bamberg, didn't live, and the material he sent me from Montana didn't have very good survival in Minnesota. I certainly agree with Erhardt. I wish we had a northern nursery made up of materials from Wyoming, Montana, Minnesota and South Dakota, and perhaps Alberta.

V. JOHNSON: Will you let us sneak one or two of our Nebraska winter hardy materials into the nursery?

HEHN: Your Nebraska material hasn't looked very good.

V. JOHNSON: Another problem is the tremenduous variation in environment that we encounter from year to year and from location to location. The thing that concerns me here, Erhardt, is that the northern location of Moccasin, Montana, for example, doesn't necessarily mean that southern materials that you grow there will all winter kill. We have several instances where this has happened.

KOLP: I want to say this to Erhardt. My feeling is that these two nurseries could be grown at the same location. You would have the southern materials in one unit and the northern materials in another. By putting these in separate units the area for each would be smaller and variation less. We would have a more efficient test. In other words, we can compare the southern entries with Pawnee, and the northern ones with Minter. I would like to see our testing unit made smaller. I think we should increase the number of sites for northern varieties, but I doubt if we should do it for the southern varieties. The Nebraska wheats, by the way, look pretty good to me in Wyoming.

HEHN: We surely are not going to decide these things today.

V. JOHNSON: No.

HEHN: Even with duplicate plantings or two replications, I think it could be suggested that cooperators introduce some type of variation into these two replications. If they don't want to pull the drill out twice and seed on two dates, they could sock the drill down on one replication. If they are willing to plant one at the normal time and plant the second replication three or four weeks later, it might be just enough to give a good test on at least one replication.

SCHLEHUBER: I think very definitely, Erhardt, that we need to continue the testing of southern material. I would like to contest the statement you made (I don't think you were too serious) that southern breeders don't utilize winterhardiness data. I think you know the problem as well as anyone, that for many many reasons, the strains that have the best winterhardiness, the best survival, many times fall down in other respects. We have to balance these things off. I think we do make as much use as possible of the winterhardiness information that you provide. I would hope that you people could continue to give us this kind of information.

V. JOHNSON: Permit me to summarize the ideas that have been projected here by Erhardt and others. First of all, we should recognize that the usefulness and purpose of this nursery at this point really should be considered two-fold, in the sense that the southern breeders need this information on their varieties, the kind of information they seldom get in their own states. In addition, there are expanded winter wheat breeding programs in northern states in which there is a real effort being made to increase the level of winterhardiness over that of Yogo and Minter. These represent two different groups of materials. It has been suggested that we consider the possibility of separating the two groups to keep the size of each group smaller; that we retain the locations that we now grow the materials; but that we set up a winterhardiness group composed of northern materials. Also, the suggestion was made that we could increase the number of replications or perhaps maintain the present number of replications but increase the frequency of checks; perhaps every ten rows or some such matter in order to have a basis for survival adjustment based upon a nearby check row. We can't decide these things this morning, but you have given me a lot of ideas, and you can be sure I will pursue these ideas in the year ahead. Each of you will be hearing from me about this. I take it that the idea of having two sections of the nursery meets with your general approval and that for the proposed northern section there may be locations in addition to those we now have. Have I stated the situation adequately? All right, I will pursue this with you individually and collectively this next summer. Is there anything more that needs to be said about this nursery? If not, we will move on.

Uniform Bunt Nursery

Number of entries in 1962 -- 30   Maximum number -- 50

Check varieties - Cheyenne, Kharkof, and RedChief (susceptible checks)
Oro, Ridit, Relief, Wasatch, Hussar (resistant checks)

Type of nursery - duplicated single rows

Where grown - Bushland, Texas; Stillwater, Okla.; Manhattan, Kans.; Lincoln and North Platte, Nebr.; Ft. Collins, Colo.; and Bozeman, Mont.

Inoculation - locally collected inoculum used at each location

Eligible materials - strains from breeding programs in the region that have exhibited resistance in state tests or that have potential bunt resistance based on pedigree

Questions: Do we have too many check varieties in this nursery? Is interest in breeding for bunt resistance lagging in the region? If so, what should we do to improve the situation?

V. JOHNSON: I am concerned, as I know some of you people are, about what is happening to bunt resistance in new materials in the hard red winter wheat region. I am sure it is becoming apparent to many of you. I don't know whether we are holding the line and maintaining the bunt resistance which we should have in our wheat varieties. For some reason we are losing it in our new materials. Earl, would you comment on the check varieties in the bunt nursery?

HANSING: Cheyenne, Kharkof and RedChief are susceptible to all of the physiological races and I see no reason why we couldn't cut down to one or two of these susceptible checks. I would say RedChief is the most susceptible. It would not make any difference to me whether we keep Cheyenne or Kharkof. There would be some value in having a second one in case RedChief failed at a location. The resistant checks are Oro, Relief, Ridit, Hussar, and Wasatch. We ought to keep Oro, Ridit, and Hussar at least.

YOUNG: I think we should leave the resistant checks in. This is one way we have of learning something about the bunt organism. I understand this is one purpose for the nursery. I go along with Earl on dropping one check in the susceptible category. I think we ought to use this nursery more, I don't think enough people are testing early generations for bunt reaction. That is the reason we are losing ground.

V. JOHNSON: Are there other comments?

POPE: Whatever you do with this nursery, you ought to send one set of it to Ed Kendrick in Washington and ask him to test it with individual races. He doesn't mind because he is set up to test large numbers each year.

V. JOHNSON: Our group urged that this be done at the last conference.

POPE: I would like to make one additional suggestion. Dr. Kendrick also would like to have new collections of bunt from this area especially when they are collected on farms. If any of you are traveling and find bunt on a farm, collect it and send some to Dr. Kendrick.

SCHLEHUBER: I suppose one reason this has not been done, Warren, is that bunt is difficult to find. I have to go to the uniform bunt nursery to find any bunt in Oklahoma. That has been true for a number of years. Perhaps it can be found if one searched hard enough. The situation may be entirely different in other states but we haven't found any bunt in Oklahoma for a number of years, other than traces.

C. O. JOHNSTON: I think you ought to keep all five resistant checks because they represent different sources of resistance. Dwarf bunt is in Western Colorado. There is no telling when this thing is going to move east, so let's not take any of the resistance checks out.

V. JOHNSON: What about the susceptibles?

C. O. JOHNSTON: RedChief is satisfactory.

HANSING: I move that we keep RedChief and drop Cheyenne and Kharkof.

YOUNG: I second the motion.

POLP: If you want genes for resistance, you haven't got them all with your current resistant check varieties. You don't have Hohenheimer in the nursery.

V. JOHNSON: How does the group feel about this additional source of resistance?

C. O. JOHNSTON: Isn't the reason that we don't have all of the genes, the fact that some source varieties won't survive in this area?

BUCKENAU: Regarding these susceptible checks, I don't know RedChief very well. I am wondering if it is sufficiently winter hardy for the northern states to use.

V. JOHNSON: The nursery isn't grown in South Dakota.

BUCKENAU: I know, but I would like to grow it.

V. JOHNSON: I recall that you wrote to me about this. I will contact you about the nursery for 1963. RedChief would be precarious up there. Is there any further discussion? We have a motion before us. Are you ready for the question?

All those in favor of the motion signify by saying Aye.
(Motion carried)

I would make a plea to the group here. Even though bunt is not currently a problem in this region, let's not lose the resistance we have.

Soil-borne Mosaic Nursery

Number of entries in 1962 -- 108   Maximum number -- 100?

Check varieties - Pawnee (susceptible check)

Type of nursery - single observation rows

Where grown - Urbana, Ill., and Manhattan, Kansas

Eligible materials - experimental strains from breeding programs in co-operating states with potential resistance to soil-borne mosaic

Question: Should an effort be made to provide for the testing of a larger number of strains each year than the number now being tested?

V. JOHNSON: This is a relatively recent nursery. We are using Pawnee as a susceptible check variety. In the past, we have considered 100 rows to be the maximum number. Note that this year, we have 108. I don't know whether these 8 additional rows were planted or not. There is considerable interest in this nursery. We have areas in the region where soil-borne mosaic is a continuing and recurring problem. I will ask Roland Weibel whether it would be possible to grow more than 100 rows at Urbana each year.

WEIBEL: We usually grow duplicate rows. This past year, we cut down the length of our rows and feel they are as good as the longer rows. I think we can handle a little more material, pprhaps as many as 120 rows, if they are short. We have a limited area for the soil-borne mosaic nurseries.

V. JOHNSON: Your area would permit you to go up to 120 rows?

WEIBEL: I think I could, yes. We have about that number from the soft wheat region also.

V. JOHNSON: I discussed the soil-borne mosaic nursery with Webster Sill, before he left yesterday. As far as he is concerned, he would grow as many entries as we are interested in testing.

WEIBEL: The actual number I can grow varied from year to year depending on how much other material I have.

HEYNE: Pawnee in Kansas sometimes is not a true susceptible check. Occasionally it is a little better than we expect it to be. We don't have a check variety in the nursery that rosettes. I was thinking of Bison as a second check variety which would rosette.

V. JOHNSON: Are there any other suggestions? I think that the inclusion of Bison would be good. We will keep this in mind next year.

Streak Mosaic Nursery

Number of entries in 1962 -- 30   Maximum number -- 30

Check varieties - Pawnee and Mql-Oro x Pn (C.I. 12851) (susceptible checks), Blue Jacket (tolerant check)

Type of nursery - duplicated single 5-ft. rows

Where grown - Stillwater, Okla.; Manhattan, Hays, Garden City, and Colby, Kansas; Lincoln and Alliance, Nebr.; and Ft. Collins, Colo.

Inoculation - local inoculum used in each state

Eligible materials - experimental strains from breeding programs in cooperating states that have exhibited tolerance to streak mosaic in local tests

Questions:

Should this nursery be continued as a part of the regional evaluation program?

If so, what changes in the nursery should be made to improve the information collected?

Should a yield nursery be considered?

V. JOHNSON: At the present time, we restrict this nursery to thirty entries primarily because of the work involved in inoculating the nursery. The nursery is grown in short rows, four to five feet long. One-half of each row is inoculated. Should the nursery be continued as a part of the regional evaluation program? Let me say that one of the Nebraska experimental strains looks as though it has tolerance to streak mosaic equal to the better than the most tolerant varieties in the region. I doubt that we would have known this had the nursery not been in existence during the last several years. So far as Nebraska is concerned, we feel the nursery has given us valuable information.

YOUNG: It has been observed by several people I think, that tolerance to yellow streak is not uniform throughout the region. One variety will perform better in one area than in another. For this reason, I think, this nursery serves a valuable purpose and it should be continued.

V. JOHNSON: It seems to me that one of the factors involved here is differences in adaptation among varieties that influences the expression or symptoms of the disease. We should recognize also that different cultures are used in different states to which varieties may react differently. What are your wishes concerning this nursery?

HEYNE: Continue it.

V. JOHNSON: Dr. Sill indicated yesterday that he would question an increase in the number of entries. This means we ought to scrutinize what we now have in the nursery very carefully and move those strains out for which we have ample information. This will make room for new material without increasing the size of the nursery.

YOUNG: I move we continue the nursery as it is.

HEHN: I second it.

V. JOHNSON: It has been moved and seconded that we continue the nursery as is. Is there any discussion?

All those in favor signify by saying Aye.

(Motion carried)

V. JOHNSON: At this time, I will call upon John Johnson to make a brief statement concerning collaborative tests.

J. JOHNSON: The collaborative program, in which we take varieties, two or three years before they are ready for release, and submit them to the trade for evaluation, has been going on for about 12 years now. The program introduces these new varieties to the trade. It gives the trade an opportunity to share in the responsibility of evaluation prior to release. Even though many varieties that are tested are not released for commercial production, the program provides a lot of useful information. Much information already is available from the regional and state quality laboratories at the time new strains enter the program, but nonetheless, we feel that the program is valuable.

Thus far, varieties for collaborative tests have been grown on a state basis. This creates some problems. Very frequently we do not have as uniform samples as we desire. Frequently they are grown in only one, or two, or three locations in the state, and if one or two of those locations fail, there goes our testing program. Two years ago, the Hard Winter Wheat Quality Advisory Council made a recommendation that to get around some of these problems, varieties should be grown on a district basis. This would mean we would grow them, say in the southern, central, and northern districts and at probably anywhere from six to eight locations within each of those districts.

This would mean that Kansas would grow some Nebraska and Colorado varieties as well as its own and Nebraska and Colorado would grow the same group. Oklahoma would grow some of those that would be of interest primarily in Texas and vice-versa. There may be logic in this appraoch since varieties do not recognize state boundaries.

I think there is real reason to consider the merits of growing varieties for collaborative testing on a district basis. It would create some problems. For instance, if Kansas had three varieties to be tested, under the proposed system, Nebraska would have to grow these varieties as well as its own. There would be an increase in cost perhaps, unless a state could reduce the number of locations to compensate the increase in number of varieties. But, on the other hand, Kansas would reciprocate on the Nebraska samples. I think the proposal is as broad as it is long. There is a problem of uniformity of samples that would be lessened by this proposal. We need to provide the best possible samples to the people who participate in this program. The Quality Council believes this could be done better on a district basis than on a state basis.

V. JOHNSON: If we are going to participate in this program, then by all means, let us do whatever we can to give to industry for evaluation purposes, materials with which they can work and make a reasonable evaluation. This is very important. Also, I think the idea of growing materials in a number of locations and working with composites has real merit.

Dr. Schlehuber, last year, came up with a scheme for partially overcoming this problem. In 1961 he grew collaborative varieties on a replicated basis and applied nitrogen fertilizer judiciously. The samples from Oklahoma were pretty close to ideal for evaluation purposes this year.

We discussed this in our hard red winter wheat committee meeting, and it seemed to me most of the committee leaned toward this procedure rather than the district approach at this time.

I. M. ATKINS: I am not opposed to the idea of producing these varieties on a district basis but we would have problems because of our circumstances at the present time. We have de-emphasized wheat at both Denton and Chillicothe. I don't see how we could grow additional varieties at the present time.

V. JOHNSON: I don't believe that we are ready to take action on this in view of the discussion we have had. I think we should consider following the procedure that Dr. Schlehuber used this year.

SCHLEHUBER: There is nothing that speaks for success like success itself. This was highly successful. We had a prodigious problem with respect to uniform protein content. This has been a problem during all the years I have been associated with this program. Our samples have been criticized by the collaborators for good reason. I can see no better way than to utilize all the information from soils people. There is so much moisture in the soil; you know from experience that you need to apply so much fertilizer in order to produce grain with the desired protein content at a given yield level. You know also that you have variation over the area. For example, at Woodward station, where we grew the varieties for collaborative tests, in one small area, we had a variation of 2½ percent protein content within one replication out of three grown. Having three replications gave us the opportunity to balance out protein so we came within one-half of one percent of equalizing the protein content of the varieties. I say, let's put a little bit more effort in our tests in individual states. I think we will create more problems by growing varieties on a district basis than we will correct.

J. JOHNSON: I would like to comment on what Dick has said. If this matter of uniformity of protein can be corrected through replications and fertilizer, I think that is a very good appraoch. This still remains an in-state problem. States must recognize the need for replications at several locations and not try to do it all at one location. They are going to have failures at a given location.

If we continue to grow varieties by individual states I think that the states should be aware of their responsibility to produce varieties with a satisfactory level of protein by whatever means as is necessary if the collaborative program is to continue smoothly and without difficult delays.

V. JOHNSON: I think the way the collaborative program is set up in this region is sound. All phases of the collaborative effort are coordinated very closely with state experiment stations and through my office. I think this is important.

SCHLEHUBER: I wish to make one comment. When a state has samples from only one location for collaborative testing, the best place to test them is in its own laboratory. In my opinion, Nebraska should not have submitted samples this year because they were from one location only and varied widely in protein. It would have been better to postpone evaluation for a year.

V. JOHNSON: I thought that the collaborators treated us pretty well this year. At this time I will call on Bill Loegering for some comments on the uniform and international rust nurseries.

LOEGERING: After listening to the discussion here, my first comment is that we shouldn't ever forget the importance of checks, in a given year and the same check over many years. There are many good reasons but I am not going into them. I would like also to mention the rust trapping nursery. This is an attempt to know what is going to happen before it happens. These nurseries have been somewhat disorganized the past few years. But I want to thank those of you who have helped with the nurseries and assure you that this year, there will be a report coming back to you of what has been done, what observations were made, and the fact that in one case we did pick up something of some importance.

Some of the things we have obtained from the trapping nurseries indicate they are very important. We may be asking, in the future, a little more extensive distribution of these nurseries.

I'll mention just briefly the uniform rust nursery and the international nursery. The uniform nursery appears in the international nursery. The uniform nursery is primarily devised for two purposes. It is of use to the plant pathologists in keeping track of what is going on in the field in the area where rust spreads. Most of the entries in there are for this purpose.

In addition to this, I think it is extremely important that the commercial varieties that are new and on which tests have been limited, should definitely be in the uniform nursery because of its general distribution throughout the country, and the fact that data are taken strictly from the point of view of pathology without concern over whether the variety is good or not.

The international rust nursery is the one, I think, that the hard red winter wheat people should be extremely interested in. This is not a large nursery; but we don't want it to get too large. At present, we have no limitations on the number of entries you put in. The data that you get back from this is a good estimate of what you might expect in the future, on any variety, on any line, or on any parent that you may wish to test. The line may be completely resistant in the United States, but it may be susceptible elsewhere in the world. This should be warning of what could happen here. And also, we will give you in one year, from one year's test, the equivalent of ten years uniform rust nursery tests.

The hard red winter wheat people are fortunate that we can get the data back to you in one year after the nursery has been seeded. The spring wheat people have to go two years before they get the data. We do not get as good data on winter wheat as we do on spring wheat simply because winter wheats can't be planted in the tropics, and as a result, the international winter wheat nurseries are planted only south and north of the tropics. This limits distribution to a certain extent.

Also, in this nursery you get other data, things that you are not primarily interested in, on such things as septoria, stripe rust and other diseases.

This nursery is maintained and operated entirely as a service to plant breeders and pathologists. If you don't want to use it, you don't have to. If you want to use it, it is there to be used. I send a letter to Virgil, every year and indicate that it is time to ask for entries. If you don't send them in, they won't be put in. All I put in is what you send in. I am going to ask one thing. Please be careful of the seed you send me, I have had to throw some seed out. This seed goes all over the world and we have quarantine problems, and if anything makes me mad, it is to inspect a nursery and find a row of wheat with fifty percent bunt. Let's be careful about this. Remember where the seed is going.

Now, I would like to ask a question about the international winter wheat nursery. We have a great deal of difficulty in getting this nursery out, much more so than with the spring wheat nursery because of the short time between your harvest and seeding time. I have established a rule that if you don't get that seed in by the designated time it is not going to be included in the nursery, because we can't wait for it. We can't wait even for seed to come by air mail. So when the date is set, this is exactly the date I mean. After that date you will not get your entries in.

V. JOHNSON: Now, I will call on Elmer Jones to discuss the uniform hessian fly nursery.

Report on the Hessian Fly Situation and the Uniform Hessian Fly Nursery

E. T. Jones

There is a rising trend in infestation by hessian fly over Kansas, Nebraska and Missouri. In most districts populations have doubled since 1960. In 5 central Kansas counties where Pawnee has been largely replaced by susceptible varieties infestations are about five times as great as they were last year. Weather conditions have been favorable for fly development and the insect probably will cause trouble in 1962. The last fly outbreak in 1943 caused an estimated loss of 25 million bushels principally in central Kansas. Pawnee and later Ponca almost eliminated the insect in this area and held it in check through 1957. When susceptible Triumph, Concho, Wichita, Kiowa, Bison, etc. began to displace, resistant varieties causing an increase in the fly population. Susceptible varieties build new generations of flies for following years. The general buildup is in volunteer. Even a light patchwork of resistant fields will greatly reduce the population in an area by isolating sources of infestation as well as by actually destroying the larvae.

Five fly resistant varieties are now available in the hard wheat area. Pawnee and Ponca are recommended in seven states each, Pawnee is grown in seventeen others. Ottawa is recommended in Kansas and Nebraska; Warrior in Nebraska, Colorado, Wyoming and South Dakota. Omaha is recommended for eastern Nebraska. These varieties should do much to reduce the hessian fly hazard, but are of only limited adaptations. New varieties for west central, western Kansas and central Nebraska are needed. The most outstanding new prospects are CI 13548 Cmn x (Mi-Hope-Pn x Oro-Il 1-Cmn) being developed by Kansas and CI 13532, Ponca x Mi-Hope-Pn in the Nebraska program.

For more than 25 years the Uniform Fly Nursery has been tested in about a score of different locations. The main purpose being evaluation of varietal stability to biological strains of flies. Only new resistant varieties, advanced material and high grade germ plasm are included in the UFN.

At present fifteen resistant varieties are grown in 32 states. Perhaps 10-20% of the total U.S. wheat acreage. The breeding for fly resistance has until now been specialized. But with many fly resistant varieties becoming available more plant breeders will have resistant material for testing. A minimum of twenty seeds is needed. If material originates west of the Mississippi River seed should be sent to the Manhattan Kansas station. If from east of the Mississippi, seed should be sent to Dr. R. L. Gallun, Box 454, West Lafayette, Indiana. Dr. Gallun also assembles and distributes the UFN.

V. JOHNSON: George Schiller has asked to make a short statement. I'll call on him at this time.

SCHILLER: Thank you, Virgil. I promise not to take much of your time. I would like to make a very brief comment to you as a cereal chemist primarily and secondarily as representative of industry. You will eventually see the result of things you have been talking about here, things you are doing and the results therefrom.

I have listened with particular interest to all the things you are doing; that you are breeding plants with stiffer and shorter straw, for higher test weight, for better seed emergence, for weedicide tolerance, for fertilizer response, for moisture tolerance, for utilization of hybrid vigor, for resistance to diseases, insects, etc. It is of interest to me that in nearly every case, the evaluation has been in terms of stability of production, or increased production. This is my evaluation of the work you are doing.

My comments to you this morning would be as follows: I am in hearty agreement with all that you are doing, but I am a little concerned because I recall the charts Dr. Reitz showed last night showing the hard red winter wheat increase and carry-over that is plaguing the United States. In connection with this, I would ask that when you do these things, increase or stabilize the yield, consider as well what are you doing to quality.

I think in most instances you do have quality evaluations. I am urging you to make more quality evaluations in everything you do. If you do anything in the hard red winter wheat area that will increase or stabilize the production, and at the same time lower the quality of the wheat produced, you have taken a step backward, you have not progressed. I urge you to keep this in mind.

We have millions and millions of bushels of hard red winter wheat we don't know what to do with, and if anything is going to be done to produce more of that kind of wheat, then I don't think you have achieved your goals and obligations.

I hope that if I have been critical I have also been constructive.

SCHLEHUBER: If the comments made by George Schiller regarding research work on wheat quality is representative of the view of the wheat processing industry present at the conference, it is my feeling that we failed in getting across a good story. It was our hope that industry would be informed concerning the wheat quality work being done by State and Federal laboratories and that State and Federal workers would be informed concerning the research in industrial laboratories. We are hopeful that this can be a partnership activity.

The high priority given wheat quality research (first item on the program following the keynote talks), the frequent reference to quality in the sessions dealing with marketing, production, breeding and genetics, along with the fact that the major states in hard red winter wheat production spend more time and money on quality research than on any other single aspect of wheat research should be ample evidence that quality research is not neglected but rather is sitting in the front seat. It is hoped industry including our wheat exporters are fully aware of this fact.

V. JOHNSON: At this time I will call on Dr. Schlehuber, to make a report for the Hard Red Winter Wheat Improvement Committee.

HARD RED WINTER WHEAT IMPROVEMENT COMMITTEE REPORT

A. M. Schlehuber

This committee is composed of 28 people from the hard red winter wheat states appointed by the directors of the various agriculture experiment stations. Seventeen of the twenty-eight were present, including two visitors, Dr. L. Hawkins from Oklahoma and Dr. H. H. Kramer from the Nebraska Agriculture Experiment Station.

First, there was a report of the status of the wheat literature service. I will not make a detailed report on that, inasmuch as it has been the project of the National Wheat Improvement Committee and it has now been consumated successfully. I believe Dr. Louis Reitz will have something to say about this in connection with his report of the National Wheat Improvement Committee. If any of you have any questions, I would refer you to Virgil Johnson, and people from Nebraska, who have successfully carried out this project.

We discussed financial support of the Wheat Newsletter. The Chairman pointed out that the newsletter has been financed by the Agronomy Department of Kansas State University, under the very fine editorship of Elmer Heyne. It has been financed also by the Nebraska Wheat Commission and Oklahoma Wheat Foundation. We are seeking more financial support for the newsletter which we feel is a very worthwhile effort. Dr. Heyne reported that Kansas would finance the 1961 wheat letter. However, in a letter from Dr. Rollo Woodward, from Utah, we learned the Ogden Grain Exchange would contribute $100 to finance the newsletter this year. Dr. Wilson Foote, from Oregon State College indicated the reaction of the Oregon Wheat Commission in a letter. These are his words, "favorably inclined, however for this year they felt they could not give us direct support," Dr. Foote feels they would be willing to support a future issue. Incidentally, the annual cost of the newsletter remains approximately $300 per year. Virgil Johnson reported that the Nebraska Wheat Commission has encouraged the group to come to them for support in the future years. I am sure this will be done.

Dr. Harry Young, from Oklahoma State University commented about the problem of maintaining adequate amounts of high purity seed of special rust differential lines of wheat. There was considerable discussion on seed increase, maintenance of purity, outcrossing and isolation, etc. While no definite proposal was made, the general conscensus was that if the need of seed of this kind was made known to the right people, and in this connection some names that were mentioned were Loegering, Reitz, and Tatum, a way could be found to increase and maintain seed of these special varieties. One suggestion was made that some of these differentials could be farmed out to the individual states for increase. There was further suggestion that the help of the ARS should be enlisted to perform this service.

Growing of varieties for collaborative quality tests was discussed. Since one of the chief problems in this quality evaluation involves lack of uniformity of protein content of test samples, the growing of the samples by the district rather than on a state basis was recommended by the Hard Red Winter Wheat Quality Advisory Council. Pros and cons were discussed and since this involves a decision by all those concerned with wheat variety development, no action was taken.

The question of whether or not the committee should undertake new activities and whether we are serving a useful purpose was aired.

The conscensus of the members was that they were satisfied with the activities of the committee as they are carried on at the present time.

The chairman raised the question of revision of the Hard Red Winter Wheat Improvement Bulletin of which there have been two. The last one was published in 1954. After some discussion it was decided no useful purpose would be served by a revision at this time. Also, it was stated that this publication was now obsolete and should not be distributed to anyone except those who are working with wheat.

Frequency of committee meetings was next discussed. It was recommended that we play it by ear and that it be left up to the decision of the Executive Committee. In the past the entire committee has met at the time of the worker's conference, with the exception of the time when we were preparing publications when we met more frequently.

It was reported by Dr. Heyne that Dr. Quisenberry has accepted appointment to be editor of the Wheat Monograph in the American Society of Agronomy Monograph Series. I think you are all interested to learn this.

Your present chairman was re-elected. Meeting adjourned at 10:00 p.m.

V. JOHNSON: Dr. L. P. Reitz will report on the meeting of the National Wheat Improvement Committee.

NATIONAL WHEAT IMPROVEMENT COMMITTEE REPORT

L. P. Reitz

This Committee was formed January 22, 1959, as a direct result of a resolution made at the January 1958 Hard Red Winter Wheat Workers Conference to help knit the four wheat regions into one body. Personnel include A. M. Schlehuber and V. A. Johnson representing your region; C. W. Schaller and F. H. McNeal for the West; L. W. Briggle and N. F. Jensen for the East; E. R. Ausemus and V. A. Dirks for the spring wheat region; and I am permanent secretary. Dr. Schlehuber is chairman.

Projects to report today include the Wheat Literature Service. There was a news release on this in the morning paper here in Lincoln. Essentially, this is a University of Nebraska project supported by state wheat commissions and the Nebraska Department of Agriculture and will over a five year period involve a budget estimated at something like $120,000. This is indeed a tremenduous undertaking and the University here, wheat commissions, and wheat industry groups are commended for their active support of this project to bring to us the wheat literature abstracting service.

The National Wheat Improvement Committee has had several projects under consideration. One of those concerns establishment of a policy for the use of the C. I. collection. You men submit your new entries for trials, they go into a uniform performance tests and get a C. I. number. Then they go in our collection. Do you or do you not lose control of those items. This has been a matter of great concern to a large number of people. We are endeavoring through all of the Wheat Conferences, the Barley Improvement Conference, and the Oat Improvement Conference to develop a statement to cover policy with respect to the handling of the C. I. items.

We have had many useful suggestions. A tentative draft based on these suggestions is in your hands. I would like to have from this conference the reactions of individual members to the statements and, if the conference cares to do so, a word of encouragement in the form of a statement adopted by the conference.

A second item is a tentative draft suggesting a system of uniform note-taking. This has been handled by one of the sub-committees of the National Wheat Committee. It involves a standard procedure for note taking and a suggested coding system in case IBM, or some other form of punch card was used. I am sure there is not time here to discuss the details of this but again, I would like to know from you individually and from this conference as a whole, whether you encourage the committee to pursue this further, and whether you concur in the general objectives stated.

There are a number of other things we have done in the committee. I am very gratified for the participation of those on the committee. It is quite a little chore, but we are not making work for ourselves. We are trying to accomplish a purpose of bringing together the four regional conferences on wheat.

POLICY CONCERNING THE AVAILABILITY OF THE WORLD COLLECTION OF SMALL GRAINS MAINTAINED BY U.S.D.A.

All items in the official list of varieties and accessions are "open stock," i.e., small seed samples for breeding and research purposes are available to any bonafide breeder or investigator on request insofar as seed stocks permit. Generally not more than 5 grams will be supplied.

All Plant Introduction accessions (P.I.'s) are open stock as soon as quarantine restrictions are met and seed supplies can be processed from the detention sowings. It is specifically understood that seed made available from P.I. and C.I. series will not be multiplied for commercial growing, or sale, or for any other type of release without the knowledge of the originating agency or agencies. Seed of some foreign stocks may be limited by patents held by the breeder.

Accessions in the C.I. series become open stock 5 years after date of assigning the C.I. number and become a part of the official list of World Collections at that time. However, since certain of these lines are breeders' selections in the course of development, the originating agency or breeder may redesignate as limited stock, any of its own lines for one additional period of 3 years. Requests for seed of limited stock should be directed to the originator. The 5-year waiting period may be waived by the originator. Varieties that have been named officially become open stock when they become available commercially. Only open stock will be stored at the National Seed Storage Laboratory at Fort Collins, Colorado as a part of the P.I. and C.I. series.

Nothing in this statement of policy shall alter the practice of free exchange among breeders engaged in cooperative investigations conducted under memorandum of understanding or comparable agreements or under A Statement of Responsibilities and Policies Relating to Seeds established by the Experiment Station Directors and ARS in 1954.

SUGGESTED ORDER AND CODING SYSTEM FOR REPORTING WHEAT DATA ON PUNCH CARDS

Card 1 Agronomic data

Column	Type of data	Code
1-2	Year	61 (last 2 digits of year)
3-4	State	Assign code numberto each state
5-6	Location w/in state	" " " " " location
7	Irrigation	Number of applications
8-9	"	Total inches of water applied
10-12	Fertilizer	N-P-K one column each; coded from 0-9 in 20 lb. increments
13-15	Planting date	Days from January 1
16-18	Emergence date	" " " "
19-20	Seeding rate	Pounds per acre
21-22	Plot size	Number of sq. ft. harvested

Card 1 Agfonomic data (Cont.)

Column	Type of data	Code
23	Replication	Actual replication number 1---9, for mean of all reps use zero (0) in this column
24	Class of wheat	(1) HRW (2) HRS (3) SRW (4) WW (5) WS (6) Durum (7) Club
25-29	Variety	C.I. number or state assigned Code No.
30	Fall stand	Coded 0-9
31	Spring stand	Coded 0-9
32-34	Date of heading	Days from January 1 (date based on 50% heads shedding pollen or 50% heads exserted from boot)
35-36	Plant height	Nearest inch from soil surface to tip of spike, awns excluded
37-39	Date mature	Days from January 1 (combine ripe)
40	Lodging	type of lodging - root lodging; stem lodging; stem breakage; breakage due to hail, etc; Code 0-9
41	"	Severity - degrees of lodging 0° = no lodging; 90° = flat. Coded 0-9
42	"	Prevalence - coded 0-9 (portion of plot lodged)
43	Shattering	Type of shattering such as exposed grain in the head; grain on ground at harvest; grain on ground from borders left standing; loss due to hail; loss due to birds. Coded 0-9
44	"	Severity coded 0-9
45-48	Straw weight	Grams per plot, tons per acre, or lbs. per acre
49-51	Bushel weight	Pounds per bushel to nearest 1/10th
52-55	Grain weight	Grams per plot, lbs. per acre, or bushels per acre

Other possible agronomic items:
Sprouting, number of tiller, percent protein, pest resistance, drouth resistance, application of minor elements, 1000 kernel weight.

Card 2 Disease and insect reaction

Column	Type of data	Code			
1	Leaf rust	Severity	0=none visible	4=15%	7=40%
			1=trace	5=20%	8=50-60%
			2=5%	6=30%	9=70-100%
			3=10%		
2	"	Response	0=none visible		
			1=VR	4=X	7=VS
			2=R	5=MS	8=blank
			3=MR	6=S	9=blank
3	Stem rust	Severity same as for leaf rust			
4	"	Response same as for leaf rust			
5-6	Stripe rust	(no satisfactory system available at present)			
7-9	Loose smut	Number of heads per 10 (or 100) ft. of row			
10	Covered smut	% of heads Coded 0-9			
11	Dwarf smut	% of heads Coded 0-9			

Card 2 Disease and insect reaction (Cont.)

Column	Type of data	Code
12	Powdery mildew	Severity same as for leaf rust
13	"	Response same as for leaf rust
14	Streak mosaic	Mottling Coded 0-5
15	"	Stunting % of tillers Coded 0-9
16	Soil borne mosaic	Mottling % Coded 0-9
17	"	Rosette % Coded 0-9
18	Scab	% of heads partially or entirely infected Coded 0-9
19-20	Hessian fly	Time of note taking - fall or spring Coded 1-2
	"	Severity - % plants infected in fall Coded 0-9
		" - broken straw in spring Coded 0-9
21-22	Sawfly	% of stems cut
23-24	Wheat stem maggot	Number of heads per 10 (or 100 ft. of row)

Other possible disease and insect items:

Grasshoppers - fall feeding, foliage feeding during growing season, head clipping

Green bugs, Yellow dwarf, *Septoria tritici*, *Septoria nodorum*, Bacterial black chaff, Brown necrosis or black chaff, Black point, Ergot, Cephalosporium stripe, Ophiobolus (take-all), Cercosphorella, Snow mold - Typhula, black sclerotia; Fusarium, pinkish cast to leaves. Could be recorded as % stand at early date and again after regrowth starts.

V. JOHNSON: The chair would entertain a motion to the effect that we approve in principle this policy statement concerning the World Collection of Small Grains.

HEYNE: I so move.

SCHLEHUBER: I second the motion.

V. JOHNSON: The motion has been made and seconded that we approve in principle the objectives as set forth in this tentative draft. All those in favor of the motion signify by saying Aye.

(Motion carried)

Note: After some discussion no action was taken on a suggested coding system for reporting wheat data on punch cards.

V. JOHNSON: I now will call on Dr. B. C. Jenkins to report on plans for the Second International Wheat Symposium.

JENKINS: I appreciate this opportunity to tell you what little I know about the Second Wheat Symposium. Many of you were present at the First International Wheat Symposium and will be interested in knowing what has taken place since that meeting. It was recommended at Winnipeg, that the Second Symposium be held in either England or Sweden. This was based on the fact the 11th International Congress on Genetics would be held in Germany. We asked Dr. James MacKey of Sweden, and Dr. Ralph Riley of England to make inquiries about the possibility of obtaining support from these respective places.

These men found that they could not obtain the necessary support. Dr. Bell thought this was not a very good way to proceed. He wasn't at the meeting in Winnipeg, and didn't realize this was an unprecedented occasion and we were feeling our way along and had no other course to follow. I think, in any event, we will come to the next meeting with an invitation for the next symposium and we will not have this embarassment take place. At any rate, the invitation to hold the meeting in England was withdrawn and the meeting is to be held in Sweden in 1963. Dr. MacKey is the Secretary organizer of the Second International Wheat Symposium and he will be assisted by a committee made up of Dr. Sears, from the United States, Dr. Yamashita from Japan, myself from Canada, and Dr. Pugsley from Australia. These people will have the responsibility of acting as an organizing committee.

At the present time, I can only tell you that arrangements have been going forward to hold this meeting in Sweden. I expect that a preliminary program will be announced, it may even be in the mail now, but I don't know what it is. The plan is to have the main meetings at the University of Lund. The accomodations will be taken care of there in the dormitory at the university. A meeting place is available, and from my observations, when I was there in September, it will be somewhat similar to this auditorium. This facility was being built and it was in the completion stages when I saw it last September.

There will be trips to Svalaf and Landskrona. These places are not too far distant from Lund, but they are too small for the meeting to be held there. The facilities at Lund are much better for the meeting.

I think you can look forward to an interesting symposium. As for dates, this has been a great problem. You may know that the Congress on Genetics is not going to be held in Germany, but rather at the Hague, in Holland. The starting date, I believe, for the Genetics Congress is September 5th. By this time, all the interesting material that could be seen in field experiments in Sweden will have been harvested. There was some consideration of a compromise, hoping that people from outside Europe would come and take the opportunity of visiting, say in between the Wheat Genetics Symposium and Genetics Congress. I am not sure that we want to follow exactly the procedure that was followed in Winnipeg. I am only one member of the committee and it is my suggestion that we perhaps dispense with the idea of a living herbarium but rather concentrate on things that we can see there and perhaps displays that can be put up in which time wouldn't be an important factor.

The date of the Wheat Symposium has been set for August 19-24, 1963, prior to the Genetics Congress.

I know there is going to be a very interesting program. People will be be contacted. There will be main speakers and an opportunity for presentation of short papers. In this way there can be a wide range of material presented.

I was interested in this conference to learn of the great emphasis on quality. This is one thing that is being considered very strongly for the Second Wheat Symposium, especially information on the genetics of quality.

I thank you for the opportunity of letting me tell you about this. I would invite you all to consider attending the Second International Wheat Symposium, to be held in Sweden in August, 1963.

V. JOHNSON: I thank you for your cooperation in the discussion this morning. I will turn the meeting back to this morning's chairman, Dr. John Schmidt.

SCHMIDT: I will call upon Dr. L. P. Reitz for a wrap-up of the conference.

CONFERENCE WRAP-UP

L. P. Reitz

The scope and inclusiveness proposed for this conference caused some preconference head wagging by skeptics. Some said "It can't be done." But it was done, and very successfully, too! Improved production and marketing efficiency in hard red winter wheat was attacked on economic, technologic, genetic and quality fronts. New information, new ideas, mental stimulation, and personal committment to higher levels of achievement were evident. And finally, but not least, was the enrichment of cooperation that makes research in a free society so effective and so rewarding to its participants.

SCHMIDT: At this time, I will turn the program over to the permanent chairman, Dick Schlehuber.

SCHLEHUBER: Lee Briggle has a service to perform.

BRIGGLE: Ted Haus, Milburn Atkins and myself wish to present the following resolution, for your consideration.

"The members of the conference express their appreciation to the local arrangements committee, to Mr. John Cronland of the Nebraska Center, to members of the Agronomy Department, and to the Administration of the University of Nebraska for providing the excellent facilities and making arrangements for a very successful conference.

Further, the Secretary is instructed to write a letter of appreciation to the Nebraska Wheat Commission for sponsoring the dinner for the Hard Red Winter Wheat Improvement Committee, the National Wheat Committee, and the North American Leaf Rust Committee, and to the following organizations for providing refreshments at coffee breaks:

NC Hybrids
Nebraska Crop Improvement Association
Nebraska Grain Improvement Association
Nebraska Grain and Feed Dealers Association
Equity Union Grain Company
Nebraska Wheat Growers Association

Further, the members of the conference express their appreciation to Chairman A. M. Schlehuber and Secretary V. A. Johnson for coordination of efforts and planning for Hard Red Winter Wheat Research."

Mr. Chairman, I move that the resolution be adopted as read.

SCHLEHUBER: You have heard the motion, is there a second?

HEYNE: I second the motion.

SCHLEHUBER: All those in favor, signify by saying Aye.

(Motion carried)

SCHLEHUBER: I want to thank you all for your cooperation. I want to say also that I have enjoyed working with each and everyone of you.

We are adjourned.

REGISTRATION

Name	Organization	Address
Abbott, D. C.	Oklahoma State University	Stillwater, Oklahoma
Allam, Carl		Hutchinson, Kansas
Allan, Robert E.	A.R.S., U.S.D.A. and W.S.U.	Pullman, Washington
Atkins, I. M.	Texas A & M and A.R.S., U.S.D.A.	College Station, Texas
Atkins, Richard E.	Iowa State University	Ames, Iowa
Atkinson, T. G.	Agriculture Research Station	Lethbridge, Alberta, Canad
Ausemus, E. R.	A.R.S., U.S.D.A., and U. of Minn.	St. Paul, Minnesota
Baldridge, D. E.	Agr. Experiment Station	Huntley, Montana
Barmore, Mark A.	A.R.S., U.S.D.A., and W.S.U.	Pullman, Washington
Becker, Howard C.	Nebraska Consolidated Mills	Omaha, Nebraska
Bellingham, R. C.	A.R.S., U.S.D.A. and O.S.U.	Stillwater, Oklahoma
Bolte, Lerance	A.R.S., U.S.D.A. and K.S.U.	Manhattan, Kansas
Bolton, Floyd E.	Oklahoma State University	Stillwater, Oklahoma
Bonnemann, Joseph J.	South Dakota State College	Brookings, South Dakota
Borlaug, Norman	The Rockefeller Foundation	Mexico City, Mexico
Brakke, Myron K.	A.R.S., U.S.D.A. and U. of Nebr.	Lincoln, Nebraska
Briggle, L. W.	Agr. Res. Service, U.S.D.A.	Beltsville, Maryland
Browder, L. E.	A.R.S., U.S.D.A. and K.S.U.	Manhattan, Kansas
Brownlee, LaMoine	University of Nebraska	Lincoln, Nebraska
Buchenau, George W.	South Dakota State College	Brookings, South Dakota
Campos, Alfredo	Lab de Biologia	Chapingo, Mexico
Chada, H. L.	A.R.S., U.S.D.A. and O.S.U.	Stillwater, Oklahoma
Colville, William L.	University of Nebraska	Lincoln, Nebraska
Covey, Ernest		Hamill, South Dakota
Curtis, Byrd C.	Oklahoma State University	Stillwater, Oklahoma

Eastin, Jerry D.	University of Nebraska	Lincoln, Nebraska
Ellsworth, Robert L.		Scott City, Kansas
Finney, Karl F.	A.R.S., U.S.D.A. and K.S.U.	Manhattan, Kansas
Fitchett, D. J.	A.R.S., U.S.D.A. and U. of Nebr.	Lincoln, Nebraska
Fleming, James R.	Kansas State University	Manhattan, Kansas
Foote, Duane	University of Nebraska	Lincoln, Nebraska
Futrell, M. C.	A.R.S., U.S.D.A. and Texas A & M	College Station, Texas
Gehrig, E. J.		Chicago, Illinois
Giertz, John W.		Wichita, Kansas
Goodfellow, Vance	Crop Quality Council	Minneapolis, Minnesota
Grant, M. N.	Agr. Research Station	Lethbridge, Alberta, Canada
Greenbaum, Harry	South Dakota State College	Brookings, South Dakota
Guenzi, Wayne	University of Nebraska	Lincoln, Nebraska
Hansing, Earl D.	Kansas State University	Manhattan, Kansas
Hanway, D. G.	University of Nebraska	Lincoln, Nebraska
Haus, T. E.	Colorado State University	Fort Collins, Colorado
Hawkins, L. E.	Oklahoma State University	Stillwater, Oklahoma
Hayden, Eugene	Crop Quality Council	Minneapolis, Minnesota
Heermann, Ruben M.	Cooperative State Exp. Sta. Service, U.S.D.A.	Washington, D. C.
Hehn, E. R.	Montana State College	Bozeman, Montana
Henderson, C. F.	A.R.S., U.S.D.A. and O.S.U.	Stillwater, Oklahoma
Heyne, E. G.	Kansas State University	Manhattan, Kansas
Hoseney, R. Carl	A.R.S., U.S.D.A. and K.S.U.	Manhattan, Kansas
Isikan, Mustafa	University of Nebraska	Lincoln, Nebraska
Jenkins, B. Charles	University of Manitoba	Manitoba, Canada
Jensen, Neal F.	Cornell University	Ithaca, New York
Johnson, John A.	Kansas State University	Manhattan, Kansas

Johnson, Virgil A.	A.R.S., U.S.D.A. and U. of Nebr.	Lincoln, Nebraska
Johnston, C. O.	A.R.S., U.S.D.A. and K.S.U.	Manhattan, Kansas
Jones, Elmer T.	A.R.S., U.S.D.A. and K.S.U.	Manhattan, Kansas
Joppa, Leonard	Agr. Experiment Station	Sidney, Montana
Keeling, Bob	Oklahoma State University	Stillwater, Oklahoma
Kline, Gerald	Kansas State University	Manhattan, Kansas
Kolp, Bernard J.	University of Wyoming	Laramie, Wyoming
Kramer, H. H.	University of Nebraska	Lincoln, Nebraska
Lancaster, Dean	University of Nebraska	Lincoln, Nebraska
Linko, Pekka	Kansas State University	Manhattan, Kansas
Livers, Ronald W.	Agr. Experiment Station	Hays, Kansas
Loegering, William Q.	Agr. Res. Serv., U.S.D.A.	Beltsville, Maryland
Malm, Norman R.	Agr. Experiment Station	Clovis, New Mexico
Mattern, Paul J.	University of Nebraska	Lincoln, Nebraska
McGregor, Harrison E.		Manhattan, Kansas
Merkle, Owen G.	A.R.S., U.S.D.A. and Texas A & M	College Station, Texas
Miller, Byron S.	General Mills, Inc.	Minneapolis, Minnesota
Miller, C. J.	University of Nebraska	Lincoln, Nebraska
Mills, Richard	University of Nebraska	Lincoln, Nebraska
Moon, S. S.	University of Nebraska	Lincoln, Nebraska
Morris, Rosalind	University of Nebraska	Lincoln, Nebraska
Muehlbeier, John	University of Nebraska	Lincoln, Nebraska
Nordquist, Paul	Agr. Experiment Station	North Platte, Nebraska
Olson, R. V.	Kansas State University	Manhattan, Kansas
Ottoson, Howard	University of Nebraska	Lincoln, Nebraska
Peant, W. J.	University of Nebraska	Lincoln, Nebraska
Pence, C. W.	Sec., Kansas Wheat Imp. Assoc.	Manhattan, Kansas

Pomeranz, Y.	Kansas State University	Manhattan, Kansas
Pope, Warren K.	University of Idaho	Moscow, Idaho
Porter, Kenneth B.	Southwestern Great Plains Field Sta.	Bushland, Texas
Potucek, Charles Jr.		Garden City, Kansas
Reitz, L. P.	Agr. Res. Service, U.S.D.A.	Beltsville, Maryland
Richardson, L. R.	University Station	Laramie, Wyoming
Rozsa, Tibor A.	The Pillsbury Company	Minneapolis, Minnesota
Rubenthaler, Gordon L.	A.R.S., U.S.D.A. and K.S.U.	Manhattan, Kansas
Samborski, D. J.		Winnipeg,Manitoba, Canada
Sandstedt, R. M.	University of Nebraska	Lincoln, Nebraska
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