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The Direct and Indirect Contribution of the International
Agricultural Research Service to World Progress
and International Good Will

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WHEAT WHEAT WHEAT TO HEALTH PROGRESS AND

INTERNATIONAL COOP WILL

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Not circumstances and emergencies very often call for the modification of the approaches to the solution of problems. The unexpected and indirect benefits resulting from measures taken in such emergencies may prove to be greater than the direct benefits resulting from the solution of the problems for which the undertaking was originally initiated. The International Spring Wheat Rust Survey Program started in 1950 is an excellent example of this. This program is coordinated by the Crops Research Division, Agricultural Research Service, United States Department of Agriculture, and is conducted with the cooperation of scientists all over the world. Its initial objectives have and are being realized. The program has resulted in the finding and proving of sources of resistance to the wheat rusts as well as proving that these resistances can be and have been transferred to commercially recommended varieties of wheat grown in the United States. Indirect values derived from this extensive international program include bringing together workers of many countries, facilitating the exchange of materials and information concerning wheat rust organisms and wheat varieties, and

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contributing to increased production of basic food supplies in many countries. These direct and indirect benefits could only have been obtained through the cooperation of hundreds of scientists in over forty countries, who plant and care for the nurseries, take data and furnish the entries for the nursery.

In 1898 Dr. Mark A. Carleton of the U. S. Department of Agriculture started collecting wheats from all over the world (4). This activity has continued without interruption. This World Collection of Wheat, now containing over 17,000 entries, is housed at Beltsville, Maryland, and is the backbone of the International Spring Wheat Rust Nursery. Almost as soon as the collecting of wheat started the materials were made available to workers everywhere on an exchange basis. Unfortunately, data on rust reaction was exchanged but rarely. However, during the 1940's Dr. B. B. Boyles initiated a testing program in Mexico in cooperation with the Mexican Department of Agriculture and the Rockefeller Foundation, and data on the reaction of wheat varieties to rust on an international basis began to accumulate.

An emergency developed in the United States in the summer of 1950 when race 15B of wheat stem rust became prevalent. This race was virulent on all commercial varieties of wheat. A catastrophe was in the making and actually occurred in 1952 and 1953 when 60 and 75 percent, respectively, of the durum wheat production in the United States was destroyed. To solve the emergency called for the immediate application of a different approach to testing for rust resistance.

It was known that a race similar to 15B occurred in the wheat regions of southern South America and that a race with a wider host range occurred in Peru. In the spring of 1950 Dr. H. A. Rodenbiser made arrangements with scientists in Mexico, Colombia, Ecuador, Peru, Chile, Argentina, and Brazil to plant in field plots about 1,000 lines of wheat selected from the World Wheat Collection, thus exposing them to the stem rust populations in those countries. The results from this first International Spring Wheat Rust Nursery were beyond expectation and much of the resistance to rusts in the commercial wheat of the United States today can be traced to the resistant breeding material selected from that nursery.

Cooperators in Latin America were very enthusiastic and asked that the program be continued. As a result, new sets of varieties were made up in succeeding years and the number of locations in Latin America at which they were planted was increased. The entire program is operated on a cooperative basis and each cooperator furnishes his time, facilities, and know how.

In 1952 Dr. B. B. Boyles, while attending the F. A. O. Regional Wheat and Barley Meeting in the Near East made arrangements for the nursery to be grown in a number of countries of Africa and Asia. In 1955 the Congress of the United States made a special appropriation for foreign testing and seed increase of cereals. These funds made it possible to organize the work more adequately, to put it on a more orderly basis, to expand the nursery locations to other parts of the world, and to start nurseries with other cereals. At the present time 64 Spring Wheat Nurseries of approximately 600 entries, 32 Winter Wheat Nurseries of 300 entries, 48 Barley Nurseries

of 150 entries, and 32 Oat Nurseries of 75 entries are being grown throughout the world (Fig. 1-4). The varieties included in these nurseries are screened from the World Collection or are contributed by cooperators from many countries. They represent a cross section of the best resistance to rust that can be found. Approximately 150 scientists are at present giving cooperation to the program at about 85 locations in 40 countries. These scientists plant one or more of the nurseries, take notes, and return data to the United States. Each year the data is compiled and distributed to all cooperators. To date 37 reports have been distributed. These reports are considered a basic need in planning breeding programs.

During the first few years (1950-1953) the nurseries were planted, many wheats were found that were highly resistant to the prevalent and dangerous races of stem rust which occurred in the United States. This resistance was immediately used in breeding programs in this and other countries. By 1954 promising lines of wheat incorporating this resistance were being tested internationally and by 1956 the first commercially acceptable varieties, such as Langdon, Ramsey and Yuna, were being released to farmers.

While the initial emphasis was to obtain resistance to stem rust - specifically race 15B - it was clear from the beginning that resistance to other diseases could be found and proven in the same manner. Data were accumulated on leaf and stripe rust resistance of wheat, and nurseries were initiated to find resistance to rusts and other diseases of oats and barley. Thus, each year more and better resistance to diseases in cereal crops is becoming available. As rapidly as possible intelligent use is

is being made of this resistance by plant breeders and the resulting varieties are constantly being tested to determine if all resistance has been transferred. Commercial varieties which have passed this test are Willet, Conley, Justin, Wells, and Lakota. Thus, the initial objective of the nursery has been achieved. In addition, the program has made significant contributions to human progress and international good will.

To a large extent the nurseries and the reports are now being widely utilized in cereal improvement programs throughout the world. In literature, reports, official communications, and letters, reference is repeatedly made to the importance of the International Rust Nursery as the source of rust resistant commercial varieties and parents for breeding programs. The following selected citations are given to indicate the importance that plant pathologists and plant breeders throughout the world place on this program.

At the III Latin American Meeting of Plant Scientists sponsored by the Rockefeller Foundation and held at Bogota, Colombia, in 1955 the following resolution (translated) was adopted and printed in the proceedings (3):

- (1) Considering that in the last five years there have been international nurseries of wheat, oats, and barley in various Latin American countries, the United States of America and Canada;
- (2) That the information from these nurseries has been of enormous value in the programs of breeding in these cereals;
- (3) That the opportunity for technical specialists to observe these nurseries has permitted the exchange of information valuable to these programs;

- (4) That these nurseries have been made possible thanks to the cooperation of the United States Department of Agriculture;

It is agreed to give a vote of applause and thanks to the U. S. Department of Agriculture, and we desire to indicate the necessity of continuing this work.

In an official document transmitted by the Charge d'Affaires of the Republic of South Africa to the State Department of the United States of America on August 11, 1958, is found the following:

"Members of the conference of South African wheat breeders, plant pathologists, and agronomists wish to express appreciation to the U. S. Department of Agriculture for establishing the existing system of international cooperation whereby wheat breeding material is evaluated on the world-wide basis.

South Africa's participation in this scheme has not only rendered available valuable information as to the merits of potential breeding parents, but it has made available a range of wheat varieties which otherwise would have been difficult, if not impossible, to assemble in one single collection."

In a paper presented by G. E. Dixon of the Plant Breeding Station, Njeru, Kenya, at the Sixth F. A. O. meeting on Wheat and Barley Breeding in the Near East held at Ankara, Turkey, in June of 1959 he said:

"It was in 1953 that Kenya first took part in the International Spring Wheat Rust Nursery, and with this can be said that the modern era of breeding actually began.

The most significant point at this stage in the history of wheat breeding in Kenya is the need for the greatest possible genetic hybridity in any breeding against rust diseases. Kenya has learned this the hard way, and hence, it is the dominant theme in this paper. With this goes the recognition that the International and F. A. O. nurseries collectively provide the best possible means of achieving that aim. This development in international cooperation has already had a profound influence on wheat breeding in Kenya, and it is confidently hoped, has turned the tide again."

Dr. A. Campos of the Graduate School, National College of Agriculture at Chapingo, Mexico, in a general bulletin (2) on cereal rusts in Mexico says (translation):

"The International Rust Nursery offers an excellent opportunity for the selection of parental material with good resistance to stem rust of wheat."

In the President's Review of the 1960 Rockefeller Foundation Annual Report is found the following:

"The Inter-American Wheat Improvement Project grew out of several previous activities, one of which was the (International) spring wheat rust nursery established in 1950 under the leadership of the United States Department of Agriculture which has proved extremely helpful in throwing light on rust races and resistance to them in a number of different countries."

Certainly these citations indicate the good will which has been engendered by the International Rust Nursery program and indicate that values of the program touch every cooperating country to a greater or lesser extent. These values are of both a technical and scientific nature and have been large and varied.

Prior to the establishment of the nursery there had been a reluctance on the part of most wheat breeders throughout the world to release lines from their breeding programs to fellow scientists for fear of unethical competition. Thus, release of materials from a given program to other scientists was nearly always delayed until the variety was named. In only a few cases were early generation materials distributed to other scientists. Today it is an accepted procedure of most wheat breeders to have early generation materials tested in the nursery and an accepted policy that any wheats tested in the nursery can be used by any collaborating scientists for breeding purposes or direct commercial increase

anywhere in the world, provided acknowledgment is given as to the source of the material. This represents the penetration of a psychological barrier and has greatly accelerated the advancement in wheat breeding progress around the world.

The inclusion in the nursery of varieties and cereals from around the world has afforded each cooperator the opportunity to observe adaptation to local conditions. As a result, collaborators have initiated direct communication with scientists in other areas from which the adapted varieties came, in order to obtain additional lines of outstanding promise. In addition, agencies which operate internationally, such as F. A. O., the Rockefeller Foundation, and the Agency for International Development have been able to more quickly determine the best source from which to obtain adapted material useful in a given area. The nursery has also served as a model for similar types of progress such as the European Rust Nursery, the F. A. O. Near East Disease Nurseries, and the Inter-American and F. A. O. Spring Wheat Yield Nurseries.

The International Rust Nursery has served the practical needs of wheat breeding in several ways: as a direct source of commercial varieties, a source of rust resistant parents in breeding programs, a vehicle to assist in selecting the most resistant lines for commercial release, and as a means of decreasing the time needed for testing for resistance in local areas.

In various countries of the world varieties have been selected directly from the nursery and distributed for commercial production. The two principal varieties now being grown in Guatemala, Luna Rojo (Mexico) and Marino 59 (Colombia) were first identified as potentially valuable on the basis of performance in the nursery. In Peru the varieties Sierra I and

Sierra II, two wheats that were developed cooperatively by the Rockefeller Foundation Agricultural Programs in Colombia and Mexico were selected from the nursery and have been grown on a commercial basis in the high valleys. In Kenya a number of varieties originating in the United States, Mexico, Brazil, South Africa, and Colombia have been selected and are now being recommended for commercial production. Israel has selected a sub. of the Colombian variety Andes for commercial release, based on its performance in the nursery. In southern Pakistan several Mexican wheat varieties that were included for testing in the nursery were found to be promising and are being considered for release.

Nearly all rust resistant parental materials used in the more advanced breeding programs around the world have been identified and proved in the International Rust Nursery. These materials originated from collections made by plant explorers as well as from complex breeding programs and laboratory research. In general they possess agronomic defects and thus are not used commercially; nevertheless, their importance as parents in current breeding programs has been fundamental to development of successful and valuable commercial varieties.

Many commercial wheat varieties have been released in various countries of the world which in part owe their final selection to their performance in the International Spring Wheat Rust Nursery. Frequently, two different sister lines may look identical under conditions of a local breeding program but in one or more locations in other parts of the world may perform very differently, indicating that one of them must have at least one additional gene for resistance to rust. Upon evidence of this kind, many of the final choices have been made of new lines for increase

as commercial varieties. Examples are to be found in many different countries. In Mexico the Nursery in one way or another has assisted in developing the varieties Kentans 43, Lerma 50, Chapingo 52, Chapingo 53, Yaqui 53, Yaqui 54, Lerma Rojo, and Kainuri. In Colombia it has assisted in developing Bonza, Anies, and Marino. In Chile the variety Quofen, a sister of Peru's Sierra I and Sierra II and the Mexican variety Yaktana, in part owe its selection to its performance in the Nursery. Nearly all rust resistant spring and durum wheats released in the United States and Canada since 1936 had previously been proven in the nursery.

In the past tests for rust resistance have been made under field conditions in local areas for a considerable number of years before a sound decision could be reached as to which lines under test had the best resistance. At the present time the same kind of materials are tested in the International Rust Nursery and more meaningful information obtained in one or two years than could have been obtained in many years under the old system.

A by-product of the Nursery has been the information obtained on the reaction of cereals to diseases other than rusts. This information has been varied. The information on powdery mildew has been very helpful from the practical standpoint. The information regarding Steropsis infection on wheat has indicated that no high resistance to this organism of a usable nature is available in any part of the world. This has focused attention on the need for basic studies to determine the best method to control this disease. Evaluation of the sensitivity of varieties to brown necrosis, a genetic weakness in wheat, has been possible in certain locations every year. This problem in wheat usually is not evident in the dry and hot wheat

growing areas, but yet in such areas in wet and cool years the wheats become blackened and considerable loss in yield results. Thus the nursery makes it possible to immediately screen out lines with this weakness. Data on other agronomic characters such as earliness, lodging, shattering, adaptation and height, have also been accumulated. These types of information have practical and basic values.

The scientific values of the program are diverse. As a result of information on the reaction of varieties in the field, it has been possible to characterize the rust populations of different regions. These regions are North America, the Andean Region of northern South America, southeast South America, Kenya and East Africa, the Mediterranean region and Europe, southeast Asia, and Australia. Such information helps in determining areas in which tests are most important. It also emphasizes the fact that varieties should not be moved from one region to another without first being tested.

Accumulation of data on adaptation of wheats in another basic value. These data are not summarized in the reports but the observations that have been made led to the development by the Rockefeller Foundation of the Inter-American and F. A. O. Wheat Yield Nurseries, which primarily measure the adaptability of the commercially grown spring wheats of the Americas, Australia, and the Near East.

A happy result of the nursery has been the strengthening of cooperative work on basic problems between the scientists in different countries. This cooperation has made possible studies on the genetics of resistance to disease using different cultures of the pathogen without actually moving the cultures outside the area where they occur. In this way the nursery has increased greatly the personal communication between scientists of different countries and led to the exchange of ideas.

SUMMARY

The establishment of the International Rust Nursery in 1950 enabled the wheat breeders of the United States to solve the threat to its wheat crop posed by race 15B of wheat stem rust and thus the initial objective of the nursery was achieved. Today it continues to serve in the continuing battle against cereal pathogens which each year reduce the potential production. In addition, there is no doubt that the establishment and continued operation of the International Spring Wheat Rust Nursery has been one of the major contributions toward wheat improvement throughout the world. A very large amount of basic information has been accumulated on the performance of wheats when subjected to attack by the races that make up the population of this organism in different geographic areas of the world. It has provided an extraordinary vehicle for testing advanced breeding materials from the breeding programs of collaborators interested in such tests and in quickly making available better rust resistant and agronomic types to breeders of all countries.

Perhaps the profoundest and most significant contribution of all is the intangible one which has led to the development of sound cooperation between the wheat scientists of the world. This is a change in philosophy that could hardly have been predicted ten years ago. There is no way of placing a value upon this indirect benefit.

It should not be concluded that all progress that has been made traces directly to the International Rust Nurseries. Many national and international organizations have had a part in this leap forward; however, the nurseries have been a thread which has served to bring together the fine

efforts and accomplishments of these organizations. But over and beyond is the fact that very little could have been accomplished without the wonderful cooperation which individual scientists around the world have given to the International Rust Nursery.

Citations

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