AN ASSESSMENT OF THE INTERNATIONAL SPRING X WINTER WHEAT GERMPLASM ENHANCEMENT PROGRAM AT OREGON STATE UNIVERSITY

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INTRODUCTION

Nearly twenty years have elapsed since Oregon State University embarked on a research program to supply cereal plant breeders around the world with genetic material that would improve the varieties they produce. The program, initiated in 1972, now serves more than 100 cooperators in 45 countries. Cooperators have received from 150 to 200 F6 SXWXW lines yearly for inclusion in their varietal selection screenings. The selected lines at Oregon State are chosen for high yields, particularly for areas with long growing seasons, and for winter hardiness, for disease resistance, as well as for other desired traits.

Assessments of the use of these genetic materials -- how they are organized in a plant breeder's research program the impact, if any, on the varieties they develop, and the way or ways the program can be improved -- has remained informal through personal conversations between staff at Oregon State University and the recipient locations. Given nearly two decades of activity, the staff at the University commissioned the Survey Research Center at Oregon State to conduct a formal study that objectively assesses the impact of the program. A 12-page questionnaire was mailed to all cooperators in April 1988 asking them to respond to items grouped in three general areas:

1. A description of the respondent's breeding program.

2. The process of dissemination and exchange of wheat germplasm.

3. The impact of the OSU wheat enhancement program.

This report summarizes survey results. The first section describes the nature of cereal research of the cooperators. The second focuses on enhancement and dissemination of wheat germplasm in general. The third section presents an assessment of the OSU program from the perspective of survey respondents. Appendix A describes the survey design and completion rate achieved. Appendix B provides verbatim comments of respondents about the OSU wheat enhancement project.

RESULTS AND DISCUSSION

Nature of cooperators' cereal breeding research.

Most cooperators are associated with a government agency, regardless of those working in a developed or in a less developed country. For instance, fifty-five percent of the total sample report they worked for a government agency. The percent rose to eighty-five percent for plant breeders in developing countries. The remainder worked primarily for universities. Eighteen percent of those in the developed countries report they worked for private industry while thirty-four percent worked for universities,

forty-two percent worked for government, and four percent worked for an international agency. Two percent worked for "other" organizations. Nearly forty percent is regional in scope while a third is considered national. Sixteen percent is local and four percent is international.

Nearly eighty percent of the breeding effort is devoted to wheat and that percent remains fairly constant across the level of development (less developed, developing, or developed countries). Eleven percent is for barley and five percent for triticales. Another five percent is for other crops. This is consistent with the land area producing these crops: 112 million hectares are in wheat production and 27 million hectares are in barley. Not surprising, grain yields and stability of yields are the two major research objectives cited, followed closely by disease resistance. These objectives are consistent regardless of the level of development of the reporting country. Insect resistance and acid/saline conditions are supported the least as research objectives.

The supply of germplasm is not viewed as a major constraint within existing channels. Only fifteen percent of the total sample said it was a problem. Difficulties of locating and hiring trained personnel are cited most frequently as a major constraint. Forty-five percent of the total sample report that finding qualified help is a major problem, and that percentage held regardless of the development level of the reporting country.

Major differences are found, however, among the countries for percent of crosses made. Nearly all (98%) of the less developed countries report making only winter x winter crosses. The percentages are about even for winter x winter, winter x spring, and spring x spring crosses for developing countries. Seventy percent of the plant breeders in developed countries report making spring x spring crosses; only eleven percent make winter x winter crosses.

The results point to remarkable similarities in the way wheat breeding research is organized around the world. Most programs are supported by government agencies, most are devoted primarily to wheat production--with yield level and yield stability specified as goals universally, followed closely by disease resistance as another important goal. Moreover, the supply of germplasm is not viewed as a serious research constraint or limitation but finding trained help is a problem. Plant breeders in less developed countries are devoting much of their research on winter x winter crosses while those in developed countries are working primarily on spring x spring crosses. Otherwise, similar organizational patterns, common objectives, and problems were reported.

The dissemination of wheat germplasm.

Common research features are less apparent when the dissemination of wheat germplasm is studied. Research workers in less developed countries rely more on germplasm from international nurseries than do their counterparts in

developed countries. Sixty-four percent of the germplasm used in breeding research for less developed countries originates from international sources, compared to twenty-five percent for developing and twenty percent for developed countries. About half the germplasm comes from an individual's own research program in the latter two types of countries. Only twenty-two percent of the germplasm is locally produced for breeders in less developed countries.

Moreover, nearly all the sources of disease resistance genes originate in international nurseries for plant breeders in less developed countries; sources are more scattered for developing and developed countries. A few are from land race varieties (4%) and the remaining sources are scattered about equally among germplasm bank collections, an individual's own advanced lines, and from advanced lines of other breeding programs in one's area as well as from international nurseries. A slightly different pattern is observed for the best source of germplasm for abiotic stress tolerance. Plant breeders in less developed and developing countries rely more heavily on land race varieties while those in developed countries use their own germplasm sources most frequently.

Fifty-two percent of the sample report that they maintain their own winter wheat germplasm collection, but that value varies considerably by a country's level of development. Only fourteen percent of the research workers in less developed countries say they have a winter wheat

germplasm collection, compared to sixty-one percent of the respondents from developing and seventy percent from developed countries. Of the fifty-two percent with collections, about a third of the sample from less developed and developing countries say that more than three-fourths of their collection came from international nurseries. Only three percent of the wheat breeders from developed countries say the same thing. The majority (62%) report only twenty-five percent or less of their lines contained material from international nurseries.

The analysis suggests that plant breeders in less- and in developing countries rely heavily on material from international sources to fulfill their research needs. The OSU-USAID International Winter X Spring Wheat Improvement Program is intended to serve that group and survey results therefore should show that research in the past 17 years has had an effect. We now turn to examine the data.

Impact of the OSU Winter X Spring Wheat Improvement Program.

Ninety percent of all respondents say they had used entries from OSU. Parental material is used most frequently by researchers in developing and developed countries, but material employed for tests in replicated yield trials is cited most often (29%) by scientists working in less developed countries. Other possible uses, such as special genetic and agronomic studies or increased lines and cultivar releases were hardly cited by anyone. Six percent of the plant breeders from developing countries report they

have released cultivars originating with some OSU parentage. This low figure appears disappointing, but, as one respondent pointed out, it takes ten to twelve years to develop a cultivar in a typical breeding program and many cooperators have been in the exchange network far less than that. The OSU genetic material has been used extensively as a source for improvement of a number of traits, according to the survey. For instance, fifty-nine percent of those from developing countries found OSU germplasm very useful for increasing grain yields, which is the primary objective of most breeding programs. The nursery also is considered a very useful source of resistance to mildew (40%), leaf rust (26%), stripe rust (59%), and septoria (32%) in developing countries. (Disease resistance is the second most important objective of the programs surveyed).

Plant breeders are uniformly interested in only two types of enhanced germplasm: Potential parental material with specific attributes, such as stripe rust resistance, and advanced homogeneous lines. Overall, fifty-one percent of the sample opted for potential parental material and a third for advanced lines. Very few specified bulk seed from F3 plants or F2 generations as desirable germplasm types.

Respondents also split about evenly between two alternatives for making international exchanges more useful. Fifty-one percent recommended a continuation in providing screening nurseries and block materials, as CIMMYT, ICARDA,and Oregon State do now. Forty-six percent pointed

to the establishment of regional centers, where one or two cycles of enhanced materials from CIMMYT, ICARDA, or Oregon State can be made with screening materials originating from regional centers. Only a handful of scientists recommended discontinuance of any formal method of germplasm exchange.

An overwhelming majority (85%) report that OSU result books arrive in time to be useful. (They are circulated in March of each year). Of the nine persons who recommended a different timing, five suggested September as more appropriate and the remainder proffered months scattered throughout the year. Within the tables of the results book itself, the tabulation of agronomic characteristics and the location tables were identified as most useful; however, the locations of scientists and their cooperating agencies, and the description of the entries that were selected for their relative superior agronomic performance locations in low rainfall zones apparently had little value. The location of scientists may be of interest but has little agronomic value and therefore received low marks. Only a few cooperators work under conditions of low rainfall and those tables would be of interest only to them.

When all is said and done, ninety percent of the plant breeders surveyed say the OSU program is very important or quite important to themselves and to wheat improvement throughout the world. Scientists were provided ample opportunity to recommend discontinuance or a major overhauling of the project but none is apparent in the data.

Minor revisions in the results book may be helpful, but most were satisfied with the direction, scope, and timeliness of the program.

SUMMARY AND CONCLUSIONS

This study explores the perceptions of plant breeders around the world concerning the value of Oregon State University's International Spring X Winter Wheat Germplasm Enhancement Program. Through a mail survey of 103 cooperators in 45 countries, data were sought that 1) describe a respondent's breeding program, 2) evaluate the process of dissemination and exchange of wheat germplasm, and 3) assess the impact of OSU's wheat enhancement program.

The results point to more similarities than differences in the way wheat breeding research is organized throughout the world. For instance, most programs are supported by government agencies, most are devoted primarily to wheat production and disease resistance as major goals. The supply of germplasm is not viewed as a major constraint but the supply of trained help is a more serious problem. Plant breeders in less developed countries are devoting much of their resources on winter x winter crosses while those in developed countries are working primarily on spring x spring crosses. Otherwise, similar organizational patterns and common objectives and problems prevail throughout the population.

Moreover, plant breeders in less- and in developing countries rely heavily on material from international sources to fulfill their research needs. Scientist in developed countries rely primarily on their own material. Nearly all the genetic material related to disease resistance that is used by plant breeders in less developed countries comes from international sources.

The OSU/AID wheat nursery is intended to serve scientists who are developing improved cultivars in less developed and in developing countries. The results show that ninety percent of all respondents say they use OSU entries. However, only six percent say new cultivars carry material that originated in OSU nurseries. Most respondents have been in the genetic exchange network only a few years -- not enough to develop new varieties from OSU sources. Another survey conducted in ten years will allow one to check on the carry-through of genetic material more fully. In the meantime, respondents say that OSU nursery stock is used heavily for improving yields and disease resistance, their two main program goals.

There is danger in assuming that genetic material from OSU has only a direct link to wheat improvement in foreign countries. The material also is used in other developed countries for their own foreign genetic exchanges. Secondary benefits should be considered in any follow-up survey to assess the full impact of the University's foreign wheat improvement research.

APPENDIX A: Sampling Plan, Data Collection, and Completion Rates

The universe sampled is all (113) cooperators in 45 countries who currently receive genetic material from the International Spring X Winter Wheat program at Oregon State University.

A 12-page questionnaire was written, based on questions and information scientists associated with the program provided the Survey Research Center. The questionnaire was pre-tested with a mailing to 10 scientests selected at random from the population. The results were studied and a revised questionnaire was developed for mailing to the remainder of the population.

Respondents were mailed the revised questionnaire in April 1988. A $5 check, payable to the respondent, was included as an incentive to respond. A telex message was sent to nonrespondents in May 1988. That was followed by a second mailing of the questionnaire in July 1988. A second telex was sent to nonrespondents in September 1988.

A total of 83 plant breeders returned usable questionnaires, providing an adjusted completion rate of 80%. Results, stratified by the level of development of a respondent's country, are:

Country	No. Returned	No. Not Returned	Total
Less Developed.....	7	5	12
Developing.....	26	5	31
Developed.....	50	10	60
Total	83	20	103

The response rate for a mail questionnaire of this special population (81%) is considered good, but comparison information is lacking. It is slightly lower (58%) for respondents working in less developed countries than the 80%+ rates observed for scientists in developing and developed countries. Moreover, a few respondents did not answer some of the questions and therefore required reduced sample sizes for some comaparisons. For instance, the number of cases for plant breeders in less developed countries frequently was too small for comparison purposes and were merged with those from developing countries for analysis.

APPENDIX B: Verbatim comments about the impact of the OSU wheat germplasm program on respondent's research

Less Developed Countries

053 It takes time to evolve new lines. We have only been getting IWSWSN material for 3-6 years. Good material has been selected but it is too early to release a variety.

063 The UNIVERSIDAD NACIONAL AGRARIA has been evaluating diverse winter wheat germplasm for use in the highlands areas at an elevation of 4,000 meters (m). Although this region is known for its unexpected frosts and hail storms, the research points to the possibility of dramatically increasing the wheat production by increasing the area under production without displacing other crops and expanding the agricultural frontier.

At this time, the research has shown promising approaches to pursue toward self-sufficiency in wheat production. it is very important to give very special recognition to the wheat germplasm sent by OREGON STATE UNIVERSITY. Probably one of the best lines to become new varieties come from IWSWSN.

097 From the 14th IWSWSN, it was possible to select lines that mature regularly under the condition of VHR. These selections will be entered in different national trials and nurseries for further study in order to impose a selection for materials possessing disparate characteristics and may satisfy the objectivity of national program as well as to enrich the existing germplasm.

Developing Countries

04 We have to accept that many agro-ecological zones there are in the countries and regions so international programs such as CIMMYT, have to change their standpoint on working method.

014 Although the NATIONAL WHEAT RESEARCH CENTER (CENTRO NACIONAL DE PESQUISA DE TRIGO/EMBRAPA), the institution where I am working is national in scope, the answers to the questions were put in relation to the wheat situation in the state where I am located. Our institute is also working with barley and triticale.

Winter or facultative wheats have been used in our breeding program and also in other programs and some cultivars descendant of these crosses were released for cultivation in Brazil, such as RS2, RS3, CEP14, CEP17, CEP19, descendant of Kavkas or Arthur 71. The line Tifton 72-5Y received

from the United States was in recommendation in RS for some years.

The segregating plants and lines from crosses using oasis, Arthur 71, ABE, Sullivan, FL 301, and lines from Coker with local cultivars seem very promising in our program. Due to this fact, and also to a new program trying to get lines with longer cycle, we are interested in the winter or facultative wheats. However, we did not use lines from the IWSWSN due to the poor adaptation in our condition.

022 The wheat germplasm program has been quite useful support for keeping a good level of genetic variability in our W&S program and for keeping us up to date in genetic resources for plant type, disease resistance, maturity date, and yield.

032 We don't want Lodging of Wheat.

055 I hope you can provide some sources which are early maturity; semi-dwarf height and winter hardness. Some sources has disease resistance.

057 Yes, I think this program helps us in enhancing disease resistance, especially rust resistance, and improving grain quality and plant type.

066 The wheat germplasm program is a good opportunity to enlarge the genetic variation and consequently to increase the chance to reach some important targets. At the moment, we are most interested to breed wheat varieties showing relatively long vegetative period and short generative period, simultaneously. So it would be possible to anticipate the sowing time what it means to can use the drill-machines with the soil in good conditions. At the same time is quite important to isolate early maturity types to scape (?) to early and hot summers. Another physiological and agronomic traits like drought tolerance, disease resistance, stiff straw, high yielding capacity, stability, capacity of adaptation, quality are also very critical ones.

Developed Countries

010 Has opened up an avenue of communication and provided an extremely useful conversation piece when meeting or being visited by foreign scientists. Has caused us a complete rethink about the desirable plant type and phenological responses for our region. Winter and intermediate types will become common in our cultivar spectrum. Could extend wheat growing into high rainfall areas.

017 A brief characteristics for the stable lines is useful. All of the participants to send you every year 10 lines

for including in the program. To be use lines or cultivars from different origin, including from East Europe.

019 It was a useful way for a very small program to contribute to an international goal. It was worth the effort. Hope it comes back.

030 A progression in the yielding potential in our conditions of the Corvallis material has been observed. But most of the lines, even the semi-dwarf, are too tall and susceptible to lodging. On the whole, most lines with white kernels are also susceptible to sprouting. It could also be of interest to improve Cereosporella resistance by using French derivatives of the line VPM.

035 The former IWSWSN are very interesting for us, but, there were maybe too many sister lines decreasing the level of lines, which I selected. Personally, I would prefer to observe and select a better fixed material (i.e., F7-F8 generations).

037 I have used material from Oregon State USAID wheat program since 1980, and I am quite sure that parents used ??? crosses, which were generally well adapted to our conditions and broad base, have contributed to the improvement of our wheat breeding program.

065 The usage of germplasm from the IWSWSN is limited because of its poor winterhardiness and tillering obiclictics. The majority of entries are of southern type, not too useful in our conditions.

067 Through cooperation of this program, four wheat scientists from our program have visited OSU. The total influence and positive effect on our breeding effort of thus gained expertise has been tremendous, over especially the past 5 years.

068 Such wheat germplasm programs are very important for dissemination of new germplasm. Unfortunately, the material from Oregon was not adapted to our environment (generally too late, not heat tolerant, soft), which made its use more difficult.

080 The reports are really after the fact. A breeder needs a generalized statement about why the cross was made so he will not spend his energy growing junk. In my opinion, the concept of providing heterozygous lines to wheat breeding programs is excellent if the breeder wants them. Probably the most positive and strongest feature of the program is the person-to-person contact available between visiting breeders and those associated with the program as it inspires and encourages and teaches.

085 The OSU/USAID wheat germplasm enhanced program has provided materials with good straw, disease resistance, and good plant type. Need better grain quality info and winterhardiness.

090 Some very high yielding advanced lines are emerging from populations in which at least one parent is from the S&W crosses selected from the IWSWSN. The Spring and Winter lines have been effectively isolated from one another for 5000+ years (possibly as long as 9000 years). Although nature usually has indulged in biological parsimony in not evolving a great variety of biological systems, certainly rare recombinations, mutations, etc., followed by isolation, have produced different gene systems in winter and spring types that must be recombined and examined.

091 Separation of lines by market class or market class combinations might have made the nursery more usable as a source of parental lines.

096 Your program is very interesting and useful from our point of view and therefore I'm interested to share this in the future. Besides your program, you are developing a regional center in Turkey, according to your information. Tell how I tried to jet in contact in vain. I would be glad and thankful if you could intervene or recommend me. Thank you, I'm looking forward to an interesting and useful cooperation in the future.

P.S. Could you inform me about your biotechnological program? I'm cooperating with the university and I'm interested in it.

099 It is not as high as it could be, if I would have more time, personnel, and funds for to use it properly.